Department of Energy
Office of Science
Washington, DC 20585

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Dr. R. A. Crone
Acting Director
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Dear Dr. Crone:

Many thanks to you and your team for organizing and hosting the November 19-20, 2013, Office of Basic Energy Sciences (BES) Scientific User Facilities Division (SUFD) budget and operational review of the Spallation Neutron Source (SNS) and the High Flux Isotope Reactor (HFIR) at Oak Ridge National Laboratory (ORNL). A summary of the reviewers' remarks, as well as the complete verbatim reports from the reviewers, are enclosed.

The format of the review with oral presentations by the Neutron Sciences Directorate (NscD) and ORNL management combined with parallel breakout sessions with HFIR and SNS staff on specific topics provided an excellent opportunity for the reviewers to learn and assess the overall budget process at SNS and HFIR.

BES congratulates the ORNL NScD staff and management for their progress and notable successes in a number of areas. The committee members were uniformly impressed by the amount and level of detail of the information assembled for the review, the transparency of the presentations and information supplied and/or requested, and the organization of the review presentations and breakout sessions. It reflected a lot of effort on the part of your staff and hopefully the assembly of this cost information was also valuable to your organization as well as to the committee.

The committee focused primarily on an evaluation of the staffing levels and costs in four distinct categories: (a) source (accelerator or reactor) operations; (b) instrument operations; (3) management and business operations; and (d) Environment, Safety & Health and Quality Assurance. Although the review was organized as separate reviews for HFIR and SNS, it was recognized that significant cost and personnel savings had been achieved by sharing resources between the two facilities as noted below.

The committee quickly recognized the dramatic and positive changes that had occurred at all levels for both facilities as a result of the management changes that occurred in October 2011. The new organization seems to be more responsive to the needs of both the in-house staff as well as the users.

The reviewers noted the benefits and efficiencies of the new organization:

- The integration of the facility operations groups and crafts into the accelerator operations division.
- The joint synergy between SNS and HFIR particularly in sample environments, the user office, and shared technical support.

- The staff-driven development of a comprehensive strategic plan that is based on projected future directions in science areas for which neutron scattering can have a major impact.

Other items of special mention from the reviewers:

- The high reliability of the accelerator and the continuing efforts to push toward the 1.4MW design power level.
- The major achievement of 100% reliability for HFIR during FY2013.
- The effort to improve quality control and lifetime predictability of the SNS Hg target following the disastrous sequential failure of two targets in October 2012.
- The vastly improved facilities for users including new user labs, greatly expanded sample environment equipment, and the significant strides in developing and improving the data acquisition and analysis software.
- The added attention paid to refurbishing aging instruments at HFIR and to improve low temperature and magnetic field sample environments.
- The strong involvement of advisory groups and topical workshops in defining the future direction of neutron scattering at ORNL.

Based on the reviewer responses and additional information provided, BES has developed the following recommendations that need to be addressed by the facility and ORNL management.

Please consider and respond to the recommendations listed below within 60 days of this letter.

HFIR Specific Recommendations:

- HFIR fuel inventory is at its lowest level in the past 40 years with only two years of supply (12 cores) on hand. The facility should evaluate if this fuel inventory is sufficient to protect against any fuel supply disruptions.

- HFIR should evaluate the potential for running a 7^{th} cycle within the existing budget.

- A significant difference exists between the cost of operating an instrument at HFIR vs SNS. The facility needs to analyze the relative instrument operating and upgrade investments at HFIR to ensure that HFIR instruments are performing optimally.

SNS Specific Recommendations:

- SNS must continue to make improvements that will facilitate sustained operation at the 1.4MW power level while maintaining better than 90% reliability. A timeline for 1.4MW operation should be provided to BES.

- Target reliability and lifetime issues must be quantified so that a predictable run schedule can be maintained without major concern over unexpected target failures.

- The total of $23,271K in materials and supplies (M&S) capital-type costs identified to bring "previously completed" SNS instruments up to full capabilities are exceedingly large and requires an appropriate prioritization based on cost vs. scientific benefit. A time-line (suggested 3-4 years) and milestones for completion should then be developed. The facility should establish an upgrade account carved out of operating funds at an appropriate level (e.g., a few per cent of the total ops budget) from which to derive upgrade funds for prioritized accelerator and instrumentation upgrades.

- The nearly $4M average annual operating cost (staff, M&S, and equipment) for SNS instruments is excessive compared to other neutron centers worldwide. The facility should develop plans for bringing these costs in line with international norms.

- The total of 13 full-time employees (FTEs) [scientists, scientific associates, pooled technical support, engineers, etc.] ascribed to an average instrument at SNS is excessive and outside comparable numbers from other facilities. The facility must produce a plan to establish the number of FTEs per instrument to be on a par with international levels (6-8 FTEs/instrument). In particular a strong justification is needed for the large number of staff from Neutron Data Analysis and Visualization, Instrument and Source Division, and Research Accelerator Division supporting instrument operations

General Recommendations:

- Publication output, while in a strong overall uptrend, is not uniform across the instrument suite. This needs to be evaluated on an instrument by instrument basis to assess the instrument capabilities, staff skills, and ancillary equipment and take appropriate steps to rectify these issues.

- The decline in number of unique users (not in number of proposals submitted) at both facilities since 2011 may have a rational explanation; however, these trends are a concern and should be closely evaluated for every instrument as guidance for future instruments development or enhancement.

The SNS and HFIR have demonstrated great progress over the past two plus years in reaching the goal of providing world leading scientific facilities for neutron scattering. BES has made an enormous investment in these facilities, and a significant number of world-class instruments have been placed in operation with others to follow as SING-II is completed. Optimization of staff skills, instruments, ancillary equipment, and software must be the overarching priority for the facilities to meet or exceed their potential in producing high impact science. The management and staff are to be congratulated for embracing this goal and refocusing their efforts to achieve maximum scientific productivity.

Sincerely,

James B. Murphy
Director
Scientific User Facilities Division
Basic Energy Sciences

Enclosures: As noted

cc: T. Mason , ORNL
H. Kung, DOE/BES
J. Rhyne, DOE/BES
L. Cerrone, DOE/BES

Summary of Reviewer Comments on the SNS

Accelerator

Staffing and Budget:

Overall the reviewers concluded "…that the SNS accelerator operations are adequately funded. The fiscal year operations cost for accelerator operations including allocation of personnel, materials and supplies (M&S), capital expenditures, and other budget items seems adequate and appropriately managed. In particular, the cost to BES for general administrative support and for ESH&Q support is low."

"The administrative and support staff in the Research Accelerator Directorate that is directly supported by BES is noticeably lean at 2.9 FTEs. Likewise, the employees who are identified as management are only 7.9 FTEs. This provides for an employee span of control ratio of 32 (253.9/7.9). This span of control is sufficiently high to question the proper (safe & effective) level of supervision provided to the workers. Therefore, it's clear that first line management of workers must be additionally provided by "non-management" staff, who are also directly supported by BES funding. "

Concern was expressed over the level of R&D support for the accelerator physicists. One reviewer commented "The level of support efforts related to accelerator improvements, both operational and longer-term [upgrade oriented] has been in continuous decline. It was mentioned several times by medium level managers that R&D was systematically "first to cut" when it came to budget reductions over the past years. For example, the accelerator physics group shrunk in half over 3 years. It seems that maintaining core expertise in beam physics is not Priority 1 and they can dearly pay for that as scientific/technical issues are often the hardest and longest to address, they cannot be solved by increased personnel or bigger funding and usually require intellectual power and time." Also mentioned was the desirability of seeking R&D funding outside the SNS Accelerator Operations budget, e.g. "There are essentially no LDRD funds for the RAD/SNS works." "So far the SNS team has not shown up enough initiative to explore additional sources of funding. There are other sources to support the R&D [OHEP, BES funds, etc] which will need to be more actively explored."

The shift of personnel in 2012 from neutron source operations to the science divisions was applauded by the committee, "These changes in staff make up are an inevitable and in many ways desirable consequence of the facility maturing and transitioning to steady-state operations with the primary goal of delivering science. **The leaner staff operations for the accelerator source is however not without risk to facility operations when critical expertise is held by progressively fewer staff members.** In this case providing internal cover for these highly skilled individuals becomes increasingly problematic and, in case of staff turnover, recruiting a one-to-one replacement then becomes a major challenge."

Efficiencies:

"The use of an in-house Facility Operations group provides substantial operational efficiencies by ensuring that the customer and the management are all part of the same organization. In addition this arrangement allows for effective sharing of craft personnel for work on the accelerator or the conventional facilities, as needed. The staff and costs are appropriately sized, but these efficiencies have left the site services one-deep in a number of areas."

"What can be commended is growing appreciation by the SNS management that in the reduced budgets climate, additional efficiencies will likely be best realized by managing the workforce more carefully to hire highly competent individuals with diverse skill sets. That objective cannot be achieved in few years and will require sustained multi-year attention." "The Research Accelerator Department [RAD] seems to be quite lean on management [29 supervisors total for organization of 242], finance [only 1 person], and HR [1]. SNS overall has one of the lowest "S&T charge out rate" in ORNL , of about 2.4 [243k$ per 100k$ salary]. "

Another reviewer expressed concern about the return of the ORNL LDRD tax to NScD as follows: "The Directorate contributes $36M of the BES funding to ORNL LDRD, but receives only about a tenth of that in return. Returning a larger share to the facility would support development of new technologies that would certainly benefit BES and SNS."

"The reduction of 40 FTEs over the past three years may still represent some of the transition from a construction project to an operating facility. That transition is probably complete at this point. Implementation of additional efficiencies will be important, but difficult."

Strategic Plan:

"The Strategic plan document covers 2014-2018 and assumes quite aggressive funding of the accelerator improvements, of the order of ~5% annual *increase*. This assumption seems to be already obsolete – therefore making the Plan to look more of a kind of a "wish list" – as the accelerator operation budget in FY14 is expected to face 5-10% *reduction*. There are no indications for that trend to change in the out years .... One can recommend that SNS upper management and BES jointly develop a more diverse "budget-deliverable" matrix : a plan for three budget scenarios [e.g., good, bad and realistic] augmented with detail risk analysis – what they will and will not be able to deliver in terms of hours, reliability, # of instruments, # of users and publications under each scenario. Without such analysis, there might appear a misleading feeling that SNS can continue to deliver excellent/acceptable performance with flat or even reduced budget year after year, in a long run."

"The planned FY 2014 budget supports approximately 250 full-time employees (FTEs), delivery of about 4250 hours of neutron production (at 90% availability), and limits procurement of spares and consumables to approximately half of the desired level for sustainable operation. Out year planning assumes that this shortfall will not continue. Should it do so, then SNS will begin to accumulate deferred maintenance and there could be associated reductions in availability of beam for users. It should also be noted that the staffing level for support of the RAD scope of work has been reduced by ~40 FTEs over the past three fiscal years." "However, it is in BES' best interest to watch carefully how this situation progresses, as significant accumulation of deferred maintenance is not acceptable." "The most important consideration for BES going forward as stewards of this signature facility is to maintain this balance between adequate base maintenance funding and modest investment in modernization and upgrades as the available technologies advance."

Facility Management:

"SNS is operated efficiently and effectively, and at an appropriate financial level." "The use of an in-house Facility Operations group for the Chestnut Ridge site allows for effective sharing of craft personnel for work on the accelerator or the conventional facilities, as needed. The staff and costs are appropriately sized, but these efficiencies have left the site services one-deep in a Number of areas."

"The overall budget levels are appropriate, with the possible exception of the high FTE-level for instrument operations." "SNS provides a very high level of service to users as part of the "cost of doing business." In response to a question as to what, if anything, non-proprietary users pay for, reviewers were told that users are charged only if they have special requests that go considerably beyond what the facility normally provides, and that this rarely happens. It would be desirable for SNS to have a written policy specifying the types of services to users that would incur charges." "The level of external funds for non-BES instruments appears appropriate compared to the BES instruments, however the pro-rated pooled user support is not charged to these instruments."

Regarding the overall management structure that was put in place during the 2012 re-organization, one reviewer commented "The neutron sciences directorate is a large, fairly complex organization encompassing both SNS and HFIR. Because of the large scope of effort many different skill sets are required. Skilled personnel are homed in organizations that support their skills and objectives and are either assigned as needed as part of the pooled resources, matrixed into a client organization for long-term programmatic efforts, such as, data analysis and visualization, or using a client-provider model for shorter term efforts, such as instrument and sample environment engineering and realization." "On perusing the organizational charts I am struck by the seemingly artificial division of the directorate into science divisions with different objectives and responsibilities. The organizational charts show that staff members have their effort is split among one or more directorates and groups and the instrument teams are spit among different organizations. How does management work in agreeing to employee goals and performance criteria with more than one line of authority, particularly in serving the needs of the user program? "

Efficiencies:

"Commendable organizational efficiencies implemented at SNS have included the recent reduction in the number of accelerator groups from 12 to 6; the integration of accelerator controls with instrument data acquisition and controls; and the transfer of craft employees from the central ORNL organization to RAD. Efficiencies have also been gained by matrixing of business management and IT staff from the central campus; and, although not captured in the numbers for SNS, the sharing of resources and expertise where appropriate between SNS and HIFR."

Instrument Operations:

Staffing and Budget

Much of the discussion of the SNS instrumentation revolved around the number of FTEs associated with the instruments and the M&S budget for the instruments. The initial data supplied on these two topics were supplemented with a more complete breakdown of staff and costs at the request of the committee. After analyzing these supplementary data, the committee concluded that the staffing levels for day to day operation of the instruments was appropriate and that the M&S budgets were acceptable. As stated by several reviewers, "For each instrument there is an average of 3 designated FTE's who are responsible for day-to-day operations. This staffing level is consistent with staffing at other US neutron facilities but lower than the level (5-6 FTE's) at ILL and ISIS." The inclusion of the 4.0 pooled support FTEs (hall coordinators, sample environments, engineering and technical support, etc.) brings the number of FTEs associated with the instruments to 7.0. One reviewer commented "I have to question three to four personnel in the pooled staff for each instrument, particularly given current and future budget constraints." The instrument FTE level was further augmented by the inclusion of 6.1 FTEs from the accelerator and instrumentation division, whose work is very much behind the scenes and as commented "… a factor that is typically not taken into account in this same manner at other facilities." "This is the origin of the somewhat misleading statistic that the instruments at SNS operate at a steady-state of 13 FTEs per instrument. In the opinion of this reviewer the substantial effort on the part of the committee to decipher this aspect of the budget points to something of a failing of the facility management in its preparation for the review ... ." "The current and apparent high level of technical support staff may well reflect the on-going transition from a phase of facility building and commissioning of multiple instruments in parallel to one of more steady-state operations and step-wise instrument deployment and the need to continue to redeploy staff to operational roles apposite to the increased maturity of the facility."

"A similar apparent irregularity occurs in considering the statistic that almost $400k of the $2.2M per year per instrument costs are accounted for by M&S. Closer analysis reveals that the majority of these costs are what might typically be considered capital expenditures. … these costs go to hardware items such as detector bank expansions, guide positioners, additional shielding, monochromators … etc. The actual expenditure on what might typically be characterized as "consumables" is actually only around $50 k per instrument, slightly higher in the area of Biology and Soft matter." "This raises the obvious question of whether these (capital) costs represent spending to achieve true completion of the instruments, over and above SINGII. Overall this reviewer is reasonably convinced that this is not the case and that this spending is justified in the considerable majority of cases, in terms of adding additional functionality and capability, over and above that which was achieved when the instruments became fully operational." "… the application of personnel and fiscal resources toward strategic upgrades and expansions of the SNS instrumentation is essential at this stage of the facility's development in order to address legacy issues in the initial instrument construction, to expand capabilities of the current instruments beyond the scope of their original design, and to innovate new instrumentation geometries that can address the future needs of cutting-edge research."

The committee noted that relatively large number of FTEs assigned to data acquisition (RAD – 16.7 FTEs) and data analysis (NDAV – 15.6 FTEs). This large, composite, and in part matrix-managed team has been asked to address both legacy issues from the initial instrument construction and commissioning phase along with expanding capabilities that in all likelihood are beyond the scope originally envisaged. Whilst this is a critical area for the sustained success of the facility and requires an appropriate level of staffing, clear short- and long-term goals should be specified to justify the current and increasing level of staff effort assigned."

Efficiencies:

The SNS has established as its primary goal the "production of high-impact science." "The distribution of the $157M BES cost for SNS in FY2013 (Table II.E.1) among the categories defined for this budget review (Accelerator Operations, Reactor Operations, Beamline Instrument Operations, Facility Management and Business Operations, and ESH&Q) clearly reflects this priority while providing sufficient resources to ensure reliable, consistent operation of the neutron source. **To that end, the reorganization in 2011 was designed to eliminate some of the unnecessary redundancy in facilities management and operation at SNS and HFIR and to integrate their scientific efforts in key areas such as quantum condensed matter, chemical and engineering materials, and biology and soft matter. Judging by both the budget data provided to the review panel and by the feedback from the facility managers present at the review, significant progress has been made toward achieving these goals."**

It was noted that "The model where "instrument controllers" are present in the guide hall 24/7 during operation is a fairly innovative one and it seems that this provides a number of improvements in user experience and efficiency."

User Program and Science Productivity:

"One issue worthy of specific discussion is the potentially misleading statistic that, since 2011 both the total number of users, and the number of unique users, has dropped substantially at SNS (and HFIR for that matter). Closer inspection of the relevant data reveals that this is almost entirely ascribable to a decrease in the number of users per experiment, perhaps slinked to tightening travel budgets at universities and other laboratories. This reviewer feels that it would be very advisable for the facility to adopt a more useful metric, perhaps based on the number of experiments run per year, a figure that can also be normalized to the hours of beamtime awarded."

"Overall, the impressive number of SNS publications (> 160 in 2013) indicates that the scientific productivity of the facility was high despite the reduction in available beamtime due to target failure issues."

ESH&Q

"ESH&Q at SNS appears effective and efficient. There have been no recent events resulting in down time. The staff supports safe accelerator and target operations and a productive user program."
"Considering the work that was performed the ESH&Q resources were appropriate and efficiently used."

"ESH&Q has implemented operational efficiency measures. One was to minimize footprint of radiologically controlled areas."

REVIEWER #1

Evaluation of SNS operations budget, November 2013

1. *Assess the fiscal year (FY)2013 operations cost including allocation of personnel (full time equivalents [FTEs]), materials and supplies (M&S), capital expenditures, and other budget items. This includes costs for:*

   a) *Facility management and support staff*
   b) *Accelerator or reactor operations*
   c) *Scattering instrument staffing and M&S allocations*
   d) *Pooled support staff (e.g., sample environments, user office)*
   e) *ESH&Q support levels*

This reviewer's focus was on facility operations and business management. In FY13, considering only funds from BES-SUF, the burdened costs to SNS for these functions were as follows: $10,371,000 for personnel (44.1 FTEs); $3,247,000 for M&S; and $11,453,000 for all other expenses. The scope of activities included the following:

- Business management of $178,448,000 of BES-SUF new budget authority (per Table II.D)
- Personnel management of 457.8 FTEs
- Management of 344,699 ft^2 of conventional and programmatic buildings, along with the associated roads, grounds, and utilities (including site management; maintenance management and information systems; engineering and business systems; facility integration; and craft supervision)
- Site services for the above facilities (including project management; engineering and design; facility/maintenance engineering; and materials management)

Within each activity, the staffing and other costs are reasonable relative to the scope and complexity of the tasks.

2. *Comment on the overall budget levels and sources of funds (e.g., BES operations, LDRD and other internal funds, external funds received from other government agencies, industry, and fee for service work (e.g., isotope production and materials irradiation at HFIR). Is the yearly carryover amount appropriate? Are there additional sources of funds that should be explored?*

In FY13, in addition to the $178.4M mentioned above from BES-SUF, SNS received ~$2.6M from other DOE sources; ~$1.4M from Work for Others; ~$3.2M from LDRD; and small amounts from other laboratory-overhead-funded sources ($900K from Program Development and $220K from the User Management System). These figures are reasonable relative to what was accomplished, and the yearly carryover amount is appropriate considering the funding delays that have historically occurred.

SNS provides a very high level of service to users as part of the "cost of doing business." In response to a question as to what, if anything, non-proprietary users pay for, reviewers were told that users are charged only if they have special requests that go considerably beyond what the facility normally provides, and that this rarely happens. It would be desirable for SNS to have a written policy specifying the types of services to users that would incur charges.

Given the reduction in the number of annual users over the last two fiscal years, there might be enough excess capacity to justify some marketing directed at prospective proprietary users, who would pay full cost recovery for their use of SNS.

3. *Evaluate the operational efficiencies the facility has implemented, plans to implement in future, or could implement.*

Commendable organizational efficiencies implemented at SNS have included the recent reduction in the number of accelerator groups from 12 to 6; the integration of accelerator controls with instrument data acquisition and controls; and the transfer of craft employees from the central ORNL organization to RAD. Efficiencies have also been gained by matrixing of business management and IT staff from the central campus; and, although not captured in the numbers for SNS, the sharing of resources and expertise where appropriate between SNS and HIFR. Examples of operational efficiency measures are the use of occupancy sensors, energy-efficient lighting, and nighttime thermostat setbacks and the scheduling of the longest maintenance shutdowns in the summer, when energy demand is highest, to save on utility costs.

4. *Assess the appropriateness of the Facility Strategic Plan: scientific goals, upgrade plans, Research and Development (R&D) program, etc.*

The "Strategic Plan 2014" addresses four major scientific goals: The enhanced understanding and development of quantum materials; advanced synthesis capabilities for high-performance materials; synthesis and understanding of soft molecular matter; and synthesis and understanding of bio-inspired materials. The Plan provides ample justification for these choices.

Upgrade plans include the development of new detectors and enhanced detector capabilities, improved neutron beam optical devices, advanced sample environments, and expanded laboratory facilities; improved data analysis and visualization, including integration of high-performance computational simulation and modeling with the analysis of neutron scattering data; operation at 1.4 MW of beam power; and implementation of a Second Target Station. These complementary approaches constitute a robust plan for readying the SNS to accommodate the above-mentioned scientific goals.

Specific examples of planned R&D (from the "Five-Year Plan 2014–2018") include the development of local expertise in pulsed high-field capabilities; investigation of the use of high-power lasers for beam stripping; and the study of "high-albedo" mesoscale materials that may act as improved reflector materials. All of these have demonstrable value for the upgrade programs.

5. *Evaluate the appropriateness of the projected FY2014-2018 operations budget profile. Is the budget profile appropriately documented, justified, consistent with the Strategic Plan, and reflects funding needs for the overall strategic goal(s) of the facility?*

The "Five-Year Plan 2014–2018" shows the following annual increases in new budget authority levels relative to the previous FY: FY14, +9%; FY15, +20%; FY16, +8%; FY17, +0%; and FY18, +1%. (The average of these five percentages is +7.6%.) By way of documentation, the Five-Year Plan shows timelines for various upgrades, with estimated costs per year for some but not all of the efforts. Overall, the need for the specified budget increases seems well supported, but this reviewer would have liked to see some prioritization that takes into account the possibility that SNS will not get annual budget increases at the levels projected for FY14–16. The only statement on this topic is that the Plan has been developed "at a level of detail that enables prioritization going forward."

6. *Evaluate if there is an appropriate level of R&D funding for efforts related to improving operations, instrumentation, sample preparation, etc.*

As noted above, the Five-Year Plan shows timelines for various upgrades, with estimated costs per year (for some but not all of the efforts) that seem appropriate.

7. *Evaluate the Environment, Safety and Health (ES&H) and Quality Assurance (QA) at the facility.*

The ES&H record of SNS for FY11–13 is commendable, with no DART incidents and with TRC rates well below both Office of Science and ORNL goals. Moreover, there have been no user injuries. This level of safety performance is accomplished with a very modest number of FTEs. This reviewer would like to see SNS share "best practices" information with any fellow BES user facilities that have less impressive safety records.

The quality management program described in the SNS ESH&Q presentation is comprehensive and, again, makes efficient use of a very small staff.

REVIEWER #2

1. Assess the fiscal year (FY)2013 operations cost including allocation of personnel (full time equivalents [FTEs]), materials and supplies (M&S), capital expenditures, and other budget items. This includes costs for:

a. *Facility management and support staff*
b. *Accelerator or reactor operations*
c. *Scattering instrument staffing and M&S allocations*
d. *Pooled support staff (e.g., sample environments, user office)*
e. *ESH&Q support levels*

The presentations were well organized and provided a good overview of the costs. ORNL does not account for costs in the method required for the presentation. This presented a challenge for the presentation of the material. During the presentations and ESH&Q break-out sessions reasonable explanations were given for the supporting documentation.

The SNS is projecting an upward trend in FTEs, Direct and Burdened (Indirect) costs for FYs 2014 and 2015 (FY 2013 considered as the base line). FYs 2016 - 2018 is FTEs and the Burdened are projected to be about the same. However, the Direct costs FY 2016 and FY 2017 while FY 2018 decreased. The increase is to accommodate increased experiments. This is dependent on funding and the ability to expand and improve the equipment.

SNS

Category/FY	2013	2014	2015	2016	2017	2018
FTEs	534.2	572.8	607.4	612.7	611.4	611.3
Direct in 000s	$ 143,358	$ 155,858	$ 164,937	$ 179,965	$ 193,444	$ 180,649
Burdened in 000s	$ 175,910	$ 196,945	$ 227,391	$ 246,233	$ 245,638	$ 247,804
Total Dollars	$ 319,268	$ 352,803	$ 392,328	$ 426,198	$ 439,082	$ 428,453

The SNS should continue to monitor and adjust the FTE and indirect rates to achieve an adequate staffing level and proper costing of projects. The current FTE and out years are below.

SNS ESH&Q FTEs

	2013	2014	2015	2016	2017	2018
BES-Funding	11.1	14.7	14.7	14.7	14.7	14.7
Other Funding	8	6.6	7.6	7.6	7.6	7.6
Total	19.1	21.3	22.3	22.3	22.3	22.3
Difference		2.20	1.00	0.00	0.00	0.00
Change Rate		19.82%	6.80%	0.00%	0.00%	0.00%

The increase in staffing from FY 2013 to FY 2014 was hiring of additional staff and partially filling a position of a person on long term disability.

The other funding source is mostly from overhead funded FTEs. The use of shared FTEs provides cost savings because employees are shifted based on the demand of work.

2. *Comment on the overall budget levels and sources of funds (e.g., BES operations, LDRD and other internal funds, external funds received from other government agencies, industry, and fee for service work (e.g., isotope production and materials irradiation at HFIR). Is the yearly carryover amount appropriate? Are there additional sources of funds that should be explored?*

The budget for out years FY 2014-2018 is looking to add a second target. They provided a presentation that should the productivity verse funding on the second day of the review. SNS has been able to do more with less. The lab stressed that if future budgets are not provided, experiments per year, scheduled maintenance & repair will be deferred. Deferring scheduled maintenance & repair is a short term fix and can impact the safety and efficiency in later years. The lab has a plan to reduce its scope (experience, maintenance, etc) to meet the budget given by the government. In the past, they have used these methods and reduction in force to balance the funding and workload.

There was some conversation about the carryover. It was stressed and I agree there should be some clearly defined plan for the carryover. My suggestion is for the lab, the DOE ORNL Site Office and DOE HQ to come to some agreement. In this congressional environment, I think no more than 1/12 of the operating budget would be reasonable. My basis for the 1/12 is that government shutdowns have not exceeded 30 days. This should help hedge against going into shutdown mode and incurring additional costs.

There was some conversation about LDRD. During the presentation I did not take issue to what was said about LDRD. LDRD is capped at 8% and the areas of R&D are assessed at DOE HQ and/or the DOE ORNL Site Office per DOE O 413.2B.

3. *Evaluate the operational efficiencies the facility has implemented, plans to implement in the future, or could implement.*

The ESH&Q has improved the operational efficiencies by

- Minimizing waste cost by storing and combining partial containers of waste into larger containers.
- Developing procedures and processes for routine work by defining scope, conditions, and planning considerations. This risk based method provides for costs savings both in FTE and dollars.

- Internally developed web-based application increase efficiency from the proposal of work through the completion of work.
- Training for users is given online and in person. Redundant training was eliminated.
- Users take the samples they bring. The lab does not store samples and all legacy samples are gone.

During the review I asked the DOE ORNL Site Office if they felt the staffing was adequate. They gave no indication the staffing was not reasonable based on the presentations. During discussions with my co-reviewer for ESH&Q, Mr. Charles Kelsey, he felt the FTE to the work described was generally reasonable. He has much more experience than I in the specific EHS&Q related work, so I considered his comments.

4. *Evaluate the appropriateness of the projected FY2014-2018 operations budget profile. Is the budget profile appropriately documented, justified, consistent with the Strategic Plan, and reflects funding needs for the overall strategic goal(s) of the facility?*

The lab provided the indirect rates and wage rate data. The indirect rates were flat for out years. The lab stated escalation would be 2% per year for salary and material. I applied the 2% escalation to the FY 2014 Organization Burden Rates (Hourly), Space/Utilities (Yearly), and Wage Pool Rates (Hourly). All of the per dollar rates showed escalation above 2%. There is a disconnect with the 2% escalation rate and the actual escalation rate used. Based on my analysis, the actual escalation rates used are below.

Category/FY	2015	2016	2017	2018
Organization Burden Rates (Hourly)	2.60%	2.66%	2.59%	2.67%
Space/Utilities (Yearly)	3.30%	3.00%	3.00%	3.00%
Wage Pool Rates (Hourly)	3.70%	3.93%	3.94%	3.94%

I used the FY 2014 as the base year. I also totaled each category and did not look at each subcategory rate. I would not expect these labor and space rates to change because the indirect rates and escalation rates were straight lined. The variance range is 0.59% (2.59%-2.00%) to 1.94% (3.94%-2.00%) overstated. I applied the rate variance to the SNS direct costs only. I did not consider the Burdened or Indirect costs because the rates were straight lined for out years. The overall impact would range from $973,128 to $3,504,591 per year. I did not consider the compounding. The chart below shows the estimated impact.

SNS In Thousands

Category/FY	2015	2016	2017	2018
Direct	$ 164,937	$ 179,965	$ 193,444	$ 180,649
Applied to Direct 0.59%	$ 973.128	$ 1,061.794	$ 1,141.320	$ 1,065.829
Applied to Direct 1.94%	$ 3,199.778	$ 3,491.321	$ 3,752.814	$ 3,504.591

Please note, I did not realize the variance in the escalation until after returning back to the office. The lab has not had a chance to explain.

7. Evaluate the Environment, Safety and Health (ES&H) and Quality Assurance (QA) at the facility.

The overall comments are above.

REVIEWER #3

Operations Budget Review, Spallation Neutron Source (SNS)

November 19/20, 2013

1. **Assess the fiscal year (FY)2013 operations cost including allocation of personnel (full time equivalents [FTEs]), materials and supplies (M&S), capital expenditures, and other budget items. This includes costs for:**

    a) **Facility management and support staff**
    b) **Accelerator or reactor operations**
    c) **Scattering instrument staffing and M&S allocations**
    d) **Pooled support staff (e.g., sample environments, user office)**
    e) **ESH&Q support levels**

The SNS completed its commissioning stage around six years ago, in 2007, and received in FY2013 a $157M operational budget from the DOE SUFD. This compares to approximately $73M of SUFD support at ORNL's HFIR facility and approximately $10M at LANL's LANSCE facility, meaning that the SNS accounts for the majority of the DOE SUFD expenditure on neutron facilities. The approximately $250M per year total costs to DOE for operation of neutron facilities corresponds to around 1/3 of the total DOE facilities expenditure. Neutron facilities thus consume a considerable fraction of the DOE SUFD budget, and the SNS accounts for the majority of this support.

In FY2013 the SNS expended 16 % of its total DOE budget on facility management, 44 % on neutron source operations, 37 % on operational costs for instruments, and 3 % on ESH&Q. Of these funds, 67 % went to personnel, 25 % to M&S, 7 % to utilities, and less than 1 % to travel. In terms of the 458 FTEs at the facility, 45 % are assigned to source operations, 43% to instrument operations, 10 % to facility management and business operations, and the remaining 2 % to ESH&Q.

Comments on these costs and FTE allocations are provided below, organized by the five categories listed above:

(a) Facility management and support staff: This reviewer's overall opinion is that the 16 % expenditure on management, corresponding to 10 % of the FTEs at the facility, is relatively reasonable, and on a par with other large scale scientific user facilities of this type. Importantly, these figures include business operations also, and the overall impression acquired from the review was that these business operations are lean and efficient. It should be noted in particular that the two review panel members specifically charged with examining this aspect of the facility relayed to the committee their findings that this aspect of the SNS budget was largely appropriate, given the scope and output.

(b) Accelerator operations: The 44 % expenditure on source operations, amounting to 45 % of the FTEs at the facility, was assessed as reasonable on the whole by the two members of the panel charged with assessing this particular aspect. It seems quite clear that these figures must be considered in light of the considerable trials and tribulations that have occurred with the SNS targets. The source was originally designed for 1.4 MW operation, but has run mostly at 800 kW for extended periods, with solid tests at 1.2 MW operation, and operation at 1.4 MW demonstrated, albeit with (unacceptably) poor reliability. The 1.2 MW operation period delivered good reliability on the other hand, which is obviously encouraging. Although 90 % of the planned beamtime was delivered in FY2013, this comes on the back of considerable issues with early target failure, which have clearly placed substantial burden on source operation budgets. In this context, this reviewer finds both the expenditure and FTE allocations reasonable for accelerator operations.

(c) Scattering instrument staffing and M&S allocations
(d) Pooled support staff
Given the manner in which the facts and figures in these two areas were accounted, and presented to the committee, it seems most appropriate to consider them together. The first item to note is that the allocation of FTEs across the 15 instruments currently in operation at SNS is remarkably uniform, fluctuating only over a range from 6.4 to 7.9 per instrument. This average of about 7 FTEs per instrument should be compared to an approximate internationally-averaged value of 5-6 FTEs per instrument, leading to the conclusion that while the SNS is positioned at the high end of the spectrum, these values are not so large as to cause significant concern. The average costs per instrument run at $2.2M per year, exceeding HFIR for instance by $800k per year per instrument. An important finding from the review however was that 60 % of these costs at SNS include pooled support for the instruments, a factor that is typically not taken into account in this same manner at other facilities. As an illustration of the magnitude of this cost, it can be noted that that this pooled support amounts to a total of about 6 FTEs per instrument. This is the origin of the somewhat misleading statistic that the instruments at SNS operate at a steady-state of 13 FTEs per instrument. In the opinion of this reviewer the substantial effort on the part of the committee to decipher this aspect of the budget points to something of a failing of the facility management in its preparation for the review and the management's overall familiarity with the SNS cost model.

A similar apparent irregularity occurs in considering the statistic that almost $400k of the $2.2M per year per instrument costs are accounted for by M&S. Closer analysis reveals that the majority of these costs are what might typically be considered capital expenditures. While it is understood that the DOE-mandated definitions are being employed, it seems that there are simple ways to make clearer distinctions in this regard. Going in to some detail, these costs go to hardware items such as detector bank expansions, guide positioners, additional shielding, monochromators, sample environment equipment (in the Chemical and Engineering Materials Division), choppers, collimators, components for He3 polarization analysis, shielding and sample environment equipment (Condensed Matter Sciences), and ovens, environmental cells, and computational facilities (Biology and Soft Matter). The actual expenditure on what might typically be characterized as "consumables" is actually only around $50 k per instrument, slightly higher in the area of Biology and Soft matter. This raises the obvious question of whether these costs represent spending to achieve true completion of the instruments, over and above SINGII. Overall this reviewer is reasonably convinced that this is not the case and that this spending is justified, in the considerable majority of cases, in terms of adding additional functionality and capability, over and above that which was achieved when the instruments became fully operational. Comments on how this is reflected in productivity statistics can be found elsewhere in this review.

(e) ESH&Q support levels: This area is largely beyond the expertise and familiarity of this reviewer. It should be noted however that the two members of the committee responsible for reviewing this area reported to the committee as a whole that they found the staffing levels and expenditures in FY13 to be reasonable.

2. **Comment on the overall budget levels and sources of funds (e.g., BES operations, LDRD and other internal funds, external funds received from other government agencies, industry, and fee for service work (e.g., isotope production and materials irradiation at HFIR). Is the yearly carryover amount appropriate? Are there additional sources of funds that should be explored?**

The SNS budget from DOE SUFD ($157M) is supplemented with $19M of additional support from non-DOE sources. A considerable fraction of this comes from cost recovery from ORNL overhead. As a simple statement of the overall magnitude of these overhead costs (which are significant due to factors such as scale, nuclear footprint, and legacy management issues), the total multiplier on a $100k example salary is 2.43x at SNS. This does compare favorably however with the overall lab average of 2.91x, and the benefits of this were repeatedly emphasized by the facility management. In terms of LDRD funding, which to a large extent is enabled by ORNL overhead, the neutron science directorate currently has 13 such active projects. $9.7M was additionally injected into facilities improvements by ORNL. These LDRD projects typically cost $300-$500k per year, fund mostly post-docs, and are clearly an area in which the SNS (and HFIR) must compete as aggressively as possible for the maximum possible leveraging of DOE investment. Unlike HFIR it seems that fee for service work is not a significant part of the SNS portfolio, which may be a hard limitation given the nature of the source and the mode of operation. On a different note, this reviewer found it particularly noteworthy that UT/Batelle management amounted to less than 1% of the total ORNL budget, a figure that seems to compare very reasonably with that seen at other facilities with similar management models.

The issue of carryover amounts in yearly budgets is one which deserves special mention. It became clear over the course of the review that, at several levels, the facility management did not seem to have a complete familiarity with the standard approaches that seem to be in place for modeling and setting these carryovers. The finance personnel did provide a coherent picture of this process though, and confirmed the current approach of budgeting the carryover to enable 21 day operation with no funding stream. This would appear to amount to over 10 % of the budget for the facility and it is not clear to this reviewer whether this is in-line with DOE SUFD expectations based on the operational processes at other facilities.

In terms of identifying additional funding sources, it appears that the facility is currently doing a good job of maximizing ORNL support, both in terms of direct project funding, LDRD funds, and other forms of indirect cost recovery. It is not clear to this reviewer that other obvious sources exist.

3. **Evaluate the operational efficiencies the facility has implemented, plans to implement in the future, or could implement.**

Given this reviewers area of expertise, most comments in this area will be restricted to the issue of instrument operation. As mentioned elsewhere, sample handling, user support, and ESH&Q appear to run very efficiently, as do business operations. The statistic regarding the approximately 7 FTEs per instrument suggests a reasonable degree of overall efficiency, and this is supported by the trends discussed below with regard to costs per experiment, and other output metrics. In terms of scientific associates and beamline scientists the allocations per instrument appear reasonable. The model where "instrument controllers" are present in the guide hall 24/7 during operation is a fairly innovative one and it seems that this provides a number of improvements in user experience and efficiency. A variety of other comments regarding efficiency are provided in other sections of this review.

4. **Assess the appropriateness of the Facility Strategic Plan: scientific goals, upgrade plans, Research and Development (R&D) program, etc.**

The SNS facility director provided a clear picture of the history of the development of the current SNS strategic plan, and the manner in which it is evolving. This was put in context from remarks during the review from ORNL Deputy Director R. Ramesh, who emphasized the overall commitment to SNS at ORNL, and the ongoing process of organizing workshops in order to understand community needs in key areas (specifically Condensed Matter, Bio/Soft Materials, and Energy). Beierschmitt reviewed in some detail the increase in instrument operations budgets relative to facility management, and the restructuring of the science effort into four divisions (Condensed Matter Sciences, Chemical and Engineering Materials, Biology and Soft Matter, and Data Analysis and Visualization). Good evidence of commensurate improvements in productivity in the period through to 2011 were provided, including the rise to 163 publications in 2013, and 1655 total users (890 unique users) in 2011. Importantly, since 2008 the cost per experiment has decreased from $800k to $279k. The number of experiments per hour of delivered beamtime also continues to rise, commensurate with this. The ORNL neutron sciences directorate publications currently arise 1/3 from SNS, 1/3 from HFIR, and 1/3 from joint efforts between the two, and it is the management's expectation that the total output should become the biggest from any single facility, worldwide, by 2015. As a side note it should be commented that, in the opinion of this reviewer, the appointments of the division leaders in the four areas mentioned above seems to have had a positive effect.

This reviewer is particularly impressed with the vision of these four individuals and plans they are putting into place in their respective areas.

One issue worthy of specific discussion is the potentially misleading statistic that, since 2011 both the total number of users, and the number of unique users, has dropped substantially at SNS (and HFIR for that matter). Closer inspection of the relevant data reveals that this is almost entirely ascribable to a decrease in the number of users per experiment, perhaps slinked to tightening travel budgets at universities and other laboratories. This reviewer feels that it would be very advisable for the facility to adopt a more useful metric, perhaps based on the number of experiments run per year, a figure that can also be normalized to the hours of beamtime awarded.

5. Evaluate the appropriateness of the projected FY2014-2018 operations budget profile. Is the budget profile appropriately documented, justified, consistent with the Strategic Plan, and reflects funding needs for the overall strategic goal(s) of the facility?

The FY2014-18 budget profile (which calls for a 4 % increase in FY2014) is designed to enable increase in neutron capacity, build-out of existing instruments, and so on. The priority at SNS is an expanded user base. While the neutron science directorate seems to be active in engaging the community in order to define user goals over the medium term, the complex question of how well the specific upgrades planned map to the five year plan, total strategic plan, and entire community needs and goals, is certainly important. It does however seem that individual items for improvement are created with the strategic plan in mind, in addition to the recommendations from the most recent triennial review. One specific and concrete example of the input from this review being used to define development priorities occurs in the area of sample environment, where significant investments and improvements have been made recently at the SNS. A further complex issue here is the balance between striving for improved capability and improved capacity. While the former is clearly the overall driver, the importance of the latter is underscored by the order of magnitude difference between the numbers of DOE SUFD x-ray and neutron users. This reviewer commends the SNS staff, overall, for the balance between these two issues that they are seeking to strike with planned instrument improvements.

6. Evaluate if there is an appropriate level of R&D funding for efforts related to improving operations, instrumentation, sample preparation, etc.

This item is closely related to (4) and (5) above, and also has overlap with statements made in (1c and d). It seems quite clear that the SNS staff are very forward thinking in terms of improving operations, instrumentation, and laboratories. This is illustrated very well by the commitment to instrumentation and sample environment improvements discussed in 1(c,d). Instrument scientists are clearly working very hard to expand the capabilities and capacities of their instruments and it seems the only questions that could be asked is whether this process is even too aggressive, or is being appropriately managed. It is the opinion of this reviewer that it probably is indeed appropriate, as investments in improved functionality and sample environment can only drive the facility in the direction of higher, and more visible, scientific output. Similar statements can be made regarding sample preparation labs, particularly relevant to the biology and soft matter effort. Expenditure and planning seem reasonable there, and well justified by the number of users.

7. Evaluate the Environment, Safety and Health (ES&H) and Quality Assurance (QA) at the facility.

As mentioned above this is an aspect of the operations of the facility that is largely beyond the expertise and familiarity of this reviewer. On the whole however the reviewer notes that the safety record at the SNS appears to be exemplary and that all indications point to efficiently operating systems with appropriate costs and effectiveness. The consideration of safety aspects of the beamtime proposals, and the whole process of sample handling, seem particularly well organized.

REVIEWER # 4

2013 SNS Operational Budget Review

Introductory remarks

The Spallation Neutron Source (SNS) at Oak Ridge National Laboratory (ORNL) is a world-class user facility that provides the U.S. research community with unique neutron measurement capabilities and, perhaps of equal importance, much needed measurement capacity. SNS is the world's highest-power spallation neutron source. Power levels of between 800 kW and 1 MW have been delivered routinely since 2009—an impressive achievement following the start of operations in April 2006. And very recently the design power of 1.4 MW has been achieved and delivered to target marking another major record and milestone. In recent years the facility has recognized the importance and need to focus on reliability-centered operations and the (on-going) commitment to BES of operational reliability in excess of 90% has been realized.

More recently the facility has received a strong mandate from BES to "produce science" and following a review by senior management at the SNS the current organizational structure including four science-based divisions was set up at the beginning of FY2012. In many ways this could be considered as marking the end of the initial construction and commissioning phase of the facility. The management assessment at that time identified staffing and equipment limitations affecting scientific output across both the SNS and HIFR facilities and resource allocation was adjusted significantly to increase funding of the science program. The distribution of the $157M BES cost for SNS in FY2013, among the categories defined for this budget review (Accelerator Operations, Reactor Operations, Beamline Instrument Operations, Facility Management and Business Operations, and Environmental Safety Health and Quality (ESH&Q)), clearly reflects this re-prioritization while providing sufficient resources to ensure reliable, consistent operation of the spallation source.

At the time of this review the SNS has currently 15 BES-funded instruments in the user program (as stated in ORNL staff presentations for the review) and some seven years after the initial commissioning period is now approaching steady state operations. However, it will likely take a few more years before SNS reaches a true steady state in terms of the number of instrument days delivered per year which is a commonly cited facility performance metric.

FY2013 Operations Costs

The $157 M BES budget supports 458 full-time employees (FTEs) divided between the functions of Facility Management and Business Operations (44), ESH&Q (11), Neutron Source Operations (205), and Instrumentation Operations (197). It was noted that these numbers reflect comparatively recent changes in the composition of staff following three rounds of reductions in force (both voluntary and involuntary) that saw the release primarily of engineering and business operations personnel.

The proportion of BES-funded staff (10 %) allocated to Facility Management and Business Operations and ESH&Q (2 %) was clearly adequate for the support function roles assessed during the review. (In particular it was noted that both SNS and HIFR had good safety records.) Indeed, additional non-funded BES staff in these areas, 56 and 8 respectively, appears to support the received wisdom that the intrinsic operational overheads of U.S. Department of Energy sponsored laboratories are higher and more demanding than perhaps other comparable non-DOE sponsored laboratories in the USA and also comparable labs in Europe.

In recent years personnel assigned to science (instrumentation) operations have been on a growth curve whilst staff assigned to neutron source and business operations have been reduced; this trend looks set to continue. These changes in staff make up are an inevitable and in many ways desirable consequence of the facility maturing and transitioning to steady-state operations with the primary goal of delivering science. **The leaner staff operations for the accelerator source is however not without risk to facility operations when critical expertise is held by progressively fewer staff members.** In this case providing internal cover for these highly skilled individuals becomes increasingly problematic and, in case of staff turnover, recruiting a one-to-one replacement then becomes a major challenge. SNS Management seem well aware of this trade off which will likely become a more difficult equation to balance with planned development activities for a second target station should projected funding levels not be realized or indeed current funding be reduced.

During the review, resource levels for instrument operations were a particular focus of this sub-committee. For FY2013 instrument operations received funding of $58.7M, of which 78 % was allocated for staff salaries and associated overhead costs. Salaries and overhead costs were deemed in line with similar US institutions.

A calculation of personnel directly involved in operating neutron scattering instruments—essentially staff members who a visiting user could reasonably expect to interact with—yields 7.0 FTEs per instrument and represents an average annual operating cost of some $2.2M per instrument. When additional staff categorized as supporting instrument operations are included in the calculation— principally in instrument engineering, data acquisition and controls, and data analysis and visualization—the number rises to 13.0 FTEs per instrument. **These staffing levels are on the higher side of international standards and it is not apparent that facility output currently reflects these numbers although scientific output from the facility has improved markedly in recent years.**

Comparisons of staffing levels at the various neutron scattering centers should take into account the relative size of operations as indicated, for example, by the number of instrument days. Data for 2012 show the Institut Laue-Langevin[1] (ILL), the NIST Center for Neutron Research[2] (NCNR), and the ISIS Spallation Neutron Source[3] with operations of 8000, 6141, and 3360 instrument days respectively and staffing levels per instrument of 7.0 and 4.5 FTEs for ILL and NCNR respectively with ISIS essentially midway between these two figures. SNS operations supported some 3000 instrument days in the same period; although, as stated above, SNS requires more time to reach a steady state appropriate for this metric and is a relative newcomer as compared with the long-established programs at ILL, NCNR, and ISIS.

[1] http://www.ill.eu/fileadmin/users_files/Annual_Report/AR-12/page/publications.htm.
[2] http://www.ncnr.nist.gov/AnnualReport/FY2012/AR_2012_large.pdf. Data reported here are for mid-2011 to mid-2012
[3] http://www.isis.stfc.ac.uk/aboutisis/annual-review/2012/isis-annual-review-2012-pdf13438.pdf.

In comparing the SNS staff levels with other neutron facilities it is also important to be mindful of the unique and specific challenges that the facility is facing. SNS is the world's most powerful spallation neutron source by a factor five and in this respect there is no directly comparable neutron scattering center. The source characteristics imply that the underlying rate of turnover of experiments across the instrument suite should, in general, be higher and will demand an appropriate level of scientific and technical support to be maximally productive. Similarly, the unique source characteristics will also enable previously flux-limited experiments, often requiring challenging and complex sample environments, to be undertaken on a more routine basis—given adequate staff support. The facility must also cater to the particular technical demands of developing and supporting large-area detectors on multiple instruments and then managing subsequently the large volume data sets they produce that require archive, reduction, analysis, and visualization tools and processes. Nevertheless, there are two specific areas of staff levels for instrument operations that management may wish to review.

Firstly, re-evaluate the proportion of instrument scientists in the numerator of the FTEs/instrument metric. It might seem an obvious truism that scientists do science; however, when seeking to increase the scientific output of the facility their numbers are key—in particular as they tend to be to sole point of contact once users leave the facility. (This is acknowledged in the facility 5-year plan.) The current and apparent high level of technical support staff may well reflect the on-going transition from a phase of facility building and commissioning of multiple instruments in parallel to one of more steady-state operations and step-wise instrument deployment and the need to continue to redeploy staff to operational roles apposite to the increased maturity of the facility. This is not to diminish the vital role played by technical staff, as demonstrated by the greatly improved instrument and sample environment equipment reliability figures at the SNS; however, their interaction typically ends once the users leave the facility.

Second, management must ensure the scope and what constitutes "success" of the data acquisition software and controls and data handling projects is clearly defined. A large proportion of the additional staff categorized as instrument operations (in the 13 FTEs/instrument calculation) are from the NDAV and RAD Divisions and assigned to these projects. This large, composite, and in part matrix-managed team has been asked to address both legacy issues from the initial instrument construction and commissioning phase along with expanding capabilities that in all likelihood are beyond the scope originally envisaged. Whilst this is a critical area for the sustained success of the facility and requires an appropriate level of staffing, clear short- and long-term goals should be specified to justify the current and increasing level of staff effort assigned. It is well known (and has been demonstrated at other similar facilities!) that if a project is behind schedule simply upping staff numbers assigned to the project doesn't deliver a concomitant shortening of the time to delivery.

This sub-committee also spent considerable time focusing on resources allocated to materials and supplies (M&S) for beam line instrument operations. In FY2013, M&S costs account for $12.6 M a significant proportion of the total budget of $58.8 M. Supplementary information supplied at the time of the review from ISD personnel established that beam line consumables account for some $50K per year per beam line. These are very reasonable figures to support a burgeoning user program across the facility. BES funding for each of the user support laboratories constitutes a further $100K annually and represents a good return for essential sample preparation, sample handling, and expanding sample characterization capabilities. The bulk of M&S costs however were assigned to what constitute major enhancements of existing neutron scattering instruments to improve and/or expand capabilities in addition to funding new sample environment equipment, and improvements to the support laboratories. The prioritization and justification for this spend was clearly driven by the likely returns for increased scientific productivity. Projects funded include: new optics, shielding, and a goniometer for TOPAZ; a Fermi chopper and shields for HYSPEC; (seven) new detectors for POWGEN. It could be argued that many of the enhancements undertaken simply constitute (overdue) completion of baseline instrument configurations; however, this capability is critical to the realizing the full potential of the SNS source. The sub-committee was able to verify that a clear delineation had been made by the facility between these line items and funding for new instruments (specifically uSANS, CORELLI and MANDI) under SING II.

Budget carryover

Details provided for carryover funds for FY2009-FY2013 show typical figures of around 10 % of the total operations budget. This represents a major dollar amount. Although there was no formally presented policy or strategy for carryover funds it was clear that a significant proportion is committed carryover on long lead-time items. The review panel also recognized that the unpredictable government funding modes of late (for example continuing resolutions and the recent lapse in appropriations) represent a major challenge for sustained operations and in such an environment carryover funds provide a vital contingency. Management expressed the intention to reduce the carryover figure for operations to some $5M per FY which is a more appropriate figure. **The accommodation reached between SNS Management and BES to facilitate funding for critical replacement targets following recent failures should help allay concerns of facility management in moving towards operations with a lower carryover figure.**

Facility Strategic Plan & projected FY2014-2018 operations budget

As stated previously, SNS is a maturing facility and now moving toward a phase of steady-state operations. Current funding levels are clearly sufficient to maintain the present upward trend in scientific productivity from the current instrument suite (based on current source levels) and continue with the on-going program of strategically targeted instrument upgrades and enhancements. Bringing the three additional instruments funded currently through SING-II into the user program will require a modest increase in running costs as reflected in the proposed FY2014 budget. The need to secure critical source spares (e.g. targets) and complete essential maintenance activities to ensure reliable source operations in the future is also reflected in the FY2014 budget. **This short-term plan, which includes a projected $3.5M carryover for FY2014, should be considered essential in order to reap optimum returns on the investment in SNS to date.**

The budgets proposed for 2015 through 2018 reflect the more extensive funding increases required in order to execute fully the 5-year plan and prepare for longer-term facility developments as laid out in the strategic plan. The facility goals are—quite rightly—ambitious. Key elements include the transition to routine SNS source operations at design power of 1.4 MW and preparations to implement heavy water moderators in 2016. The plan and accompanying budget proposal also envisage a SING III project which seeks major upgrades to existing instrument at SNS (in many cases to realize the original design specification and performance of the instruments) and design of the second target station. **These elements are appropriately prioritized and justified in the documentation provided, and set out a compelling vision of the long-term provision of world-class neutron measurement capability and capacity at SNS.** The instrument operations sub-committee expressed some concerns that the proposed power upgrade could lead to unforeseen issues on instruments such as increased backgrounds and count-rate saturation along data acquisition chains. These problems have been experienced in the past and have the potential to negate some of the gains promised due to the increase in raw flux. It is important therefore that these issues are very thoroughly investigated in advance and, ideally, sufficient budget contingency is built up to address any unpredicted events.

SNS Management has been successful in the past leveraging BES funding against income from other sources and the facility is strongly encouraged to continue to promote existing links and foster new ones. Notable examples to date include BER contributory funding of the Biology and Soft Matter Division and the specific collaboration with KFA Jülich on the neutron spin echo instrument. The facility should continue to strive for increased funds through the internal LDRD funding route and the project covering design and development of the second target station would seem an excellent fit to this funding source.

The facility should also continue to maximize the potential of "in kind" contributions through collaborative projects with sister neutron scattering facilities. ORNL is currently a partner in the International Collaboration on Neutron Detector Development and whilst contributing expertise to the development of wave-length shifting fiber detectors it should also seek to leverage complementary expertise from the collaboration for efficiencies and cost savings for other detector technologies that may be of utility at SNS. Similarly, the collaboration with ISIS, to adopt their model and contribute to the development of data analysis software and algorithms (the MANTID framework), is a highly commendable and extremely cost-effective approach to take.

Concluding remarks

The SNS current budget levels and future budget projections set out an ambitious plan to establish steady-state operations in FY2016 as defined by reliable operations at 1.4 MW with a built out instrument suite on the First Target Station servicing essentially its maximum user capacity. The plan is appropriately justified and its promised return is backed up by the increasing scientific productivity of the facility of late. The plan also recognizes the reality of budget constraints and can be appropriately prioritized should it prove necessary to delay some projects.

SNS provides the U.S. research community with unique neutron measurement capabilities and much needed measurement capacity. It is imperative the facility continues to be supported appropriately such that it fully meets the needs of the wider U.S. research community and remains competitive with planned developments at ISIS, ILL, and the European Spallation Source (ESS) in the future.

REVIEWER #5

Spallation Neutron Source Operations Budget Review
Individual Reviewer's Report

Summary

SNS is operated efficiently and effectively, and at an appropriate financial level.

The use of an in-house Facility Operations group provides substantial operational efficiencies by ensuring that the customer and the management are all part of the same organization. In addition this arrangement allows for effective sharing of craft personnel for work on the accelerator or the conventional facilities, as needed.

The reorganization and shifting of resources from Source Operations to Instrument Operations is appropriate and puts more emphasis and resources on the scientific program.

However, the instrument support level appears to be high compared to international neutron source and national synchrotron facility standards, even when making adjustments for upgrades such as SING-II.

1. *Assess the FY2013 operations cost including allocation of personnel (full time equivalents [FTEs]), materials and supplies (M&S), capital expenditures, and other budget items. This includes costs for:*

   a) Facility management and support staff

   Overall FY13 costs for Facility Operations and Business Management include $10,371k of personnel costs, $3,247k for M&S, and other costs (almost entirely utilities) of $11,459k. Of this total, $10,627k is used for Site Services, Facility Maintenance, IT, and Maintenance Management systems. These costs do not include an additional total of $14,375k provided from non-BES-SUF funding, primarily from ORNL space charges. (A significant portion of the space charges paid by SNS and other programs at the Chestnut Ridge site return to this group.)

   The use of an in-house Facility Operations group for the Chestnut Ridge site allows for effective sharing of craft personnel for work on the accelerator or the conventional facilities, as needed. The staff and costs are appropriately sized, but these efficiencies have left the site services one-deep in a number of areas.

   The SNS total overhead multiplier of 2.43 for a $100k salary is reasonable and in line with other DOE laboratories.

   b) Accelerator operations

   The current funding level from BES-SUF of $69,203k allows them to operate at the 1 MW level for the out-years. Efficiencies have been made to provide more resources for the science program. Running at 1.4 MW reliably, without providing the additional funding as specified in their 5-year plan, is not possible. It is not clear what happens if the funding level is in between these two options. The Research Accelerator Division is looking to have more generalists to further increase their efficiency in the future.

c) Scattering instrument staffing and M&S allocations

d) Pooled support staff (e.g., sample environments, user office)

The number of FTE per instrument, even after excluding the SING-II project, is significantly higher than other neutron sources. The direct, pooled, and lab support staff match other facilities at about 7.0 FTE per instrument. However, when the infrastructure and software and development FTE are included the number goes up to 13.1 FTE per instrument, which is higher than comparable facilities, even if the SING expenditures are included.

The M&S costs include equipment purchases for improvements and upgrades, and are appropriate.

e) ESH&Q support levels

The ESH&Q support level appears to be appropriate, with plans in place for improving efficiency and replacing vacant positions. The level should also be sufficient for their immediate future plans.

User experiments and samples are reviewed for safety. Communications with the users and instrument staff are primarily done by floor coordinators (24/7 staffing).

2. *Comment on the overall budget levels and sources of funds (e.g., BES operations, LDRD and other internal funds, external funds received from other government agencies, industry, and fee for service work (e.g., isotope production and materials irradiation at HFIR). Is the yearly carryover amount appropriate? Are there additional sources of funds that should be explored?*

The overall budget levels are appropriate, with the possible exception of the high FTE-level for instrument operations. The SNS provides significant support for users, and could benefit from a clear policy to determine what constitutes extraordinary user support that should be charged to the user experimental group.

The yearly uncommitted carryover ($18M in FY13) is appropriate for the scale of the SNS operations. Carryover also ensures cryogenics can be maintained if the facility is temporarily shut down.

The level of external funds for non-BES instruments appears appropriate compared to the BES instruments, however the pro-rated pooled user support is not charged to these instruments.

3. *Evaluate the operational efficiencies the facility has implemented, plans to implement in the future, or could implement.*

The reductions in RAD, due to operational efficiencies, are appropriate to support the scientific program.

The movement of Facilities to in-house management at Chestnut Ridge and Milton Valley has resulted in significant efficiencies.

4. *Assess the appropriateness of the Facility Strategic Plan: scientific goals, upgrade plans, Research and Development (R&D) program, etc.*

The Facility Strategic Plan provides a good basis for optimal use of the facility assuming the objective is to maximize the total scientific output. Even under these assumptions it will need modifications to deal with budget realities.

The SNS had 726 unique users in FY13, and approximately 170 instrument publications. The SNS budget from DOE-SUF is $157M. To compare with synchrotrons, the total of SNS and HFIR had approximately 487 publications in FY13. The SNS and HFIR budget from DOE-SUF is $230M. The average of the four DOE synchrotrons for FY12 has approximately 2600 unique users and 760 refereed publications, and a budget of approximately $63.5M. Given the high cost per user (SNS) and per publication (SNS+HFIR), greater than 8 times and 5 times, respectively, compared with synchrotron facilities, the scientific justification for the planned upgrades needs to be extremely high.

5. *Evaluate the appropriateness of the projected FY2014-2018 operations budget profile. Is the budget profile appropriately documented, justified, consistent with the Strategic Plan, and reflects funding needs for the overall strategic goal(s) of the facility?*

The budget profile is appropriately documented, justified, and consistent with the Strategic Plan. The profile is optimistic with more realism in the earlier years. As SNS management is aware, it will need modifications each year to deal with budget realities.

6. *Evaluate if there is an appropriate level of R&D funding for efforts related to improving operations, instrumentation, sample preparation, etc.*

Although complete numbers for R&D funding were not provided, the upgrade plans presented appear to be well considered, which implies a healthy R&D effort for improvements.

7. *Evaluate the Environment, Safety and Health (ES&H) and Quality Assurance (QA) at the facility.*

The ES&H and QA program at the SNS appears to be effective and efficient, given the scale of the hazards at the facility. The user safety program appears to be efficient and effective, requesting more detailed information on the experiments and samples at appropriate times.

REVIEWER #6

Operational Budget Review of the Spallation Neutron Source

Neutron scattering has long been established as a powerful, essential tool for determining the properties of a wide-range of complex materials. Among the limited neutron user facilities in the U.S. and in the world, the combined capabilities at SNS and HFIR provide a unique, comprehensive suite of neutron instruments that span an extensive range of energy-momentum space. **The ever-changing focus of the growing scientific community requires that both facilities continue to pioneer new neutron capabilities and to upgrade existing instrumentation and ancillary equipment in order to advance measurement sensitivity, efficiency, and flexibility.**

Currently, 17 neutron instruments at the SNS are operating as part of the user program, and the primary focus of the facility (as stated by Dr. Kelly Beierschmitt) is the production of high-impact science. The distribution of the $157M BES cost for SNS in FY2013 (Table II.E.1) among the categories defined for this budget review (Accelerator Operations, Reactor Operations, Beamline Instrument Operations, Facility Management and Business Operations, and ESH&Q) clearly reflects this priority while providing sufficient resources to ensure reliable, consistent operation of the neutron source. **To that end, the reorganization in 2011 was designed to eliminate some of the unnecessary redundancy in facilities management and operation at SNS and HFIR and to integrate their scientific efforts in key areas such as quantum condensed matter, chemical and engineering materials, and biology and soft matter. Judging by both the budget data provided to the review panel and by the feedback from the facility managers present at the review, significant progress has been made toward achieving these goals.** As examples, a cross section of users now perform complementary experiments on their materials at both facilities, and instrument development priorities(such as ^{3}He spin polarizers) are established with the benefit of both facilities in mind. **Overall, the impressive number of SNS publications (> 160 in 2013) indicates that the scientific productivity of the facility was high despite the reduction in available beamtime due to target failure issues.**

While the levels of support for Reactor Operations, Accelerator Operations, Facility Management and ESH&Q are reasonable (as assessed by other members of the review panel), the resources available to the Beamline Instruments has increased in recent years (cost of $58.7M in FY2013 from Table II.E.1) in order to serve the experimental needs of the growing pool of users, to expand the number of instrument-related personnel, and to support the continued development and construction of cutting-edge neutron instrumentation. Of the portion of the BES budget apportioned to Beamline Instrument Operations, the large fraction (77.7%) allocated for salaries and associated overhead costs is justified considering the staff coverage required for the increasing number of high throughput experiments. **For each instrument there is an average of 3 designated FTE's who are responsible for day-to-day operations. This staffing level is consistent with staffing at other US neutron facilities but lower than the level (5-6 FTE's) at ILL and ISIS** (Source: *Office of Science and Technology Policy Interagency Working Group on Neutron Science: Report on the Status and Needs of Major Neutron Scattering Facilities and Instruments in the United States*, 2002). This average jumps to approximately 7 FTE's per instrument when pooled staff members, who provide a wide-range of direct support (such as sample environment, lab management and maintenance, chopper maintenance, instrument hall coordination, and technical support), are included. **Again, this staffing number seems reasonable considering the unique experimental requirements of each of the 1267 research visitors (84.5 per instrument) associated with approximately 500 unique experiments performed at the SNS in FY2013.** Of greater possible concern is the *effective* number of staff per instrument (13) obtained by dividing the total FTE's in the Beamline Instruments category (197) by the number of BES-supported, operating instruments (15). A large number of these additional FTE's (approximately 40) are associated with the Neutron Data Analysis and Visualization Division. This large, matrixed team (headed by Thomas Proffen) is dedicated to addressing the software needs associated with the collection, reduction, and analysis of data obtained using the complex, multi-detector SNS instrumentation. **It is essential that SNS provide a high level of staffing and resources to address these software needs in order to fully support their user base.** This priority is best described by the 2009 APS report, entitled *Access to Major International X-ray and Neutron Scattering Facilities,* which states that, "The growing user community has also fueled a need for modern menu-driven interactive data acquisition and reduction software interfaces to instruments... Users will want to arrive at the facility with their sample and leave with the fully-analyzed data set ..." In addition to software-development staff, the inflated average of BES-funded FTE's include 26 Instrument Engineer staff, 7 Instrument Projects staff, and 9 Compliance and Quality Assurance staff, many of whom are focused on the design and development of next-generation detectors, optics, sample environment and scattering instrumentation. As detailed below, **the application of personnel and fiscal resources toward strategic upgrades and expansions of the SNS instrumentation is essential at this stage of the facility's development in order to address legacy issues in the initial instrument construction, to expand capabilities of the current instruments beyond the scope of their original design, and to innovate new instrumentation geometries that can address the future needs of cutting-edge research.**

During the review, one of the primary focus areas of the Instrument Beamline sub-committee was the origin of the expenses in the SNS budget designated as Materials and Supplies (M&S). **The M&S cost of $12,620K in 2013 is a significant fraction of the total BES cost of the Beamline Instrument Operations.** The portion of that expenditure directly associated with SNS instrument operations is $5.7M (from the adjusted instrument table provided by Ron Crone), which is significantly higher than that same expenditure at HFIR, and **the yearly cost per BES-funded beamline exceeds $2M when all pooled SNS instrument expenses (including personnel) are included**. Supplementary information provided by Ron Crone and his management team members revealed that instrument-specific costs for daily supplies and consumables (such as nuts and bolts, chemicals, chem wipes, gloves, etc), which are typically assumed to be the primary component of M&S expenses, are quite reasonable, but only account for approximately $50K per beamline. The user support laboratories, which are essential for sample preparation and complementary characterization, each cost approximately $100K per year. **The remainder of the M&S costs in 2013 is primarily attributed to the purchase of large-ticket items that substantially improved and expanded existing neutron instrumentation and sample preparation/characterization laboratory capabilities.** As examples, these lifecycle upgrades include guide positioners, shielding and goniometer for TOPAZ (total cost of $119K), high resolution Fermi chopper and shielding for HYSPEC (total cost of $108.3K), pure water systems for JINS and SNS labs (total cost of $100K), dilution refrigerators and orange cryostats (total cost of $438K), and seven new detectors for POWGEN (cost of $300K). Verbal justification was provided for many of these strategic purchases by the Division leaders, and it is clear that the process for prioritizing costly instrument-related purchases takes the potential impact on scientific productivity into full consideration (though many important upgrades had to be deferred due to limitations in available funding). It is also noted that the M&S purchases fall outside the scope of the SING II project which primarily provided resources to construct new instruments (USANS, CORELLI, and MANDI) in FY2013. **Overall, the justification for the M&S expenses is straightforward considering the current development stage and recent arrival of the SNS as a premier, world-class neutron facility.**

The future plans for the SNS are described in full in the 2014 Strategic Plan, the Neutron Sciences Directorate Five-Year Plan, and in the budget worksheets. **While the current funding level is sufficient to sustain operation of existing instruments, to implement limited instrumental improvements, and to run at current source power levels, the budget request for FY2014 includes a modest increase for critical items such as hiring of new instrument personnel for the 3 instruments being commissioned (USANS, CORELLI and MANDI), purchasing of spare targets (half as many as actually needed), and performing deferred source maintenance (that was postponed due to recent budget crises). These tasks are essential in the short term to ensure reliable operation of all the instruments currently available at the facility.** The more aggressive increases in the budget proposed for 2015 – 2018 reflect anticipated costs associated with the power increase to 1.4 MW, the replacement of the inner reflector plug in 2016, the higher user throughput (approximately 800 experiments per year anticipated by 2018), the advancement of detectors and optics for existing and future instruments, the acquisition of sophisticated sample environment equipment (such as a container-less levitator), the design of the Second Target Station, and other priorities justified in both the Strategic Plan and the Five-year Plan. **These major upgrades are essential in the long term in order for SNS to fully embrace and routinely provide new neutron measurement opportunities at the cutting edge.** The proposed budgets leverage the BES funding against income from other sources for specific projects (such as Jülich sponsorship of NSE instrument, BER funding of the Biology and Soft Matter Division, etc.) and the anticipated SING III funding for large-scale instrumentation projects. The facility is strongly encouraged to pursue other funding sources and to obtain a greater share of internal LDRD funding for well-defined, forward-thinking projects that further expand the broad user base.

While the proposed budgets for FY2014-2018 accurately reflect the short-term needs and long-term priorities of the facility, the Instrument Beamline sub-committee concurred that there was insufficient contingency built in for unanticipated source problems (as occurred in FY2013) or for unanticipated neutron instrumentation issues associated with the power upgrade. Other concerns involved the recent growth of personnel in the Neutron Data Analysis and Visualization Division and the projected future needs in this area. **Targeted software development in many areas (i.e., data collection, analysis and modeling) is critical to producing high-impact science. However, the appropriate usage of resources requires**

careful planning and sustained collaboration with other neutron facilities (like ISIS) with comparable software needs. In addition, the budget carryover, which is mostly committed to future procurements, should be sustained at its current level to allow for approximately 21 – 30 days of operation in the event of an interruption of cash flow, as occurred at the beginning of FY14. The current constraints on domestic spending may limit the growth rate of the budge, and the SNS may be required to postpone projects of lower priority to future years. The management team appears to be prepared for this possibility.

In conclusion the SNS current budget levels and future budget projections are justified in light of the instrument oversubscription rate and the impressive scientific productivity that is increasing at an aggressive rate. **Any reductions in funding from the requested levels will have a significant impact on the ability of the facility to reach its maximum user capacity for the First Target Station and to run reliably at 1.4 MW by 2016, as projected**. The ongoing development and improvement of the complementary measurement capabilities at SNS and HFIR should be fully supported in order to address the needs of the U.S. scientific community and to remain competitive with other facilities (such as ESS, ISIS and ILL) around the world.

REVIEWER #7

BES Operational Budget Review – 19/20 November 2013
Individual reviewer evaluation report on SNS Accelerator Source operations

Introduction

The review was held on 19/20 November 2013. It was clear from the data provided ahead of the meeting and from the quality of the presentations that a great deal of preparation went into making the review a success. SNS had to re-bin their budgets and cost data into the four requested categories for this review, which may have led to some confusion and misunderstanding. I very much appreciated the level of openness and cooperation from everyone on the SNS staff as we worked through the data.

This report will focus almost exclusively on review of the SNS accelerator source operations. Many detailed discussions are difficult to boil down to an overall assessment. In general, the discussions concentrated on justifying what is an apparently ample funding level. In some cases, we focused on identifying areas that might be underfunded or that are accumulating deferred maintenance. My summary finding is that the SNS accelerator operations are adequately funded. Additional caveats may be found below.

Discussion

The accelerator and target operations are embedded in a larger Research Accelerator Division (RAD) that includes Facility Operations, Data Operations and ESH&Q/Deployed Services. This is an effective combination of pertinent responsibilities and seems to work well.

The Research Accelerator Division is then part of the larger Nuclear Science Directorate. One unfortunate situation with respect to NScD's relationship with the larger ORNL is that the Directorate contributes $36M of the BES funding to ORNL LDRD, but receives only about a tenth of that in return. Returning a larger share to the facility would support development of new technologies that would certainly benefit BES and SNS. This is not an unusual situation at accelerator laboratories, but continues to be an inequity relative to the overhead paid by the customer. NScD did receive nearly $10M in ORNL investment in SNS conventional facilities.

Labor relations at the institution are another area where inefficiencies are built in to the system. The strong union system that prevents employees from working across boundaries is inherently inefficient. The fact that SNS (alone) has "Research Mechanics" is a considerable help. These are a blended Craft who can work on things attached to the Control System of the Accelerator. SNS must be constantly vigilant of trying to work within these limitations yet still being reasonably effective.

Three major documents have been developed to characterize the planning and execution of SNS Ops & Maintenance and upgrades for the future. These are the NScD Strategic Plan, which begets the Five-Year Plan, from which the Integrated Work Plan is derived. These are aggressive plans, almost unrealistic in some of their hopes for the future, but that is their purpose and they do well to set the framework for stewardship of the facility. The Five-Year Plan is based on an assumption of 5% increase in the FY14 budget followed by larger increases in

FY15. It is these larger subsequent increases that may overly hopeful in today's funding environment.

It is possible to make some comparisons between the operations & maintenance costs for the SNS accelerator and the LANSCE accelerator at Los Alamos. While the facilities are roughly the same scale, the power level at SNS is nearly an order of magnitude greater, the superconducting linac adds another level of complexity and the targets are replaced on a much different time line. So, real apples to apples comparisons are difficult. It is interesting to compare how the customers influence the distribution of funding.

At LANSCE, the Weapons Program (RTBF) funds the accelerator operations and, separately, some of the user programs. Office of Science funding supports most of the Lujan Center program and, separately, Isotope Production. At SNS, where BES funds nearly everything, more flexibility exists to shift available funding between the different field work proposals as necessary. As the imperative to improve the science at SNS grew over the last several years, it makes sense that funding priorities have shifted away from accelerator operations.

The SNS Research Accelerator is primarily funded by BES through Field Work Proposal ERKCSNR at about $89 M plus $3M for Accelerator Improvement Projects. The total RAD staff supported by the FY13 budget of $95.0 M burdened is 254 FTEs. For the scope of work related specifically to accelerator and target operations, FY13 funding of $80.6M supported about 205 FTEs. To first order, these levels compare to about $56 M plus $1M for projects at LANSCE where the accelerator and target operations are funded by the Weapons Program under the program formerly known as RTBF. This supports 153 FTEs of LANL labor and a smaller fraction of materials & services. Considering the higher power level and the overhead of running a superconducting accelerator, these levels seem ample but not excessive.

Another comparison of the cost of doing business or the bang for BES' buck at SNS would be the cost to the sponsor of the proverbial $100 K employee. At a charge-out rate of $243.25 K, the Laboratory/SNS burdens do not seem at all excessive. These overhead rates are said to be lower than most BES-funded peer laboratories.

A key statement in the Description of the projected operational budget and planning assumptions for the next five years is "The planned FY 2014 budget supports approximately 250 full-time employees (FTEs), delivery of about 4250 hours of neutron production (at 90% availability), and limits procurement of spares and consumables to approximately half of the desired level for sustainable operation. Out year planning assumes that this shortfall will not continue. Should it do so, then SNS will begin to accumulate deferred maintenance and there could be associated reductions in availability of beam for users. It should also be noted that the staffing level for support of the RAD scope of work has been reduced by ~40 FTEs over the past three fiscal years."

The reduction of 40 FTEs over the past three years may still represent some of the transition from a construction project to an operating facility. That transition is probably complete at this point. Implementation of additional efficiencies will be important, but difficult. The similar reduction in spares may be manageable as a steady state is reached beyond infant mortalities.

We are aware that the team has been quite successful in modifying several important subsystems that were exhibiting poor reliability or end-of-life symptoms, including the high voltage convertor modulators, the extraction kicker power supplies and the LEBT chopper HV switches.

However, it is in BES' best interest to watch carefully how this situation progresses, as significant accumulation of deferred maintenance is not acceptable. My belief is that the current budget is sufficient, and that used properly may support even more productivity. However, total ORNL funding has dropped over the last few years from about $1.6B to about $1.46 B. It is possible that over time the cost of doing business at the Lab will rise incrementally, at which point the currently sufficient budget will no longer be enough. Care must be given to understand the difference between funding the base/sustainable budgets and budgeting for improvements and to ensure that the base continues to increase with the cost of doing business.

The RAD's approach to mitigating obsolescence through upgrading spares should be effective and require little or no "Improvement Funding." Investing in additional Accelerator Improvement Funding at about the 5% level is appropriate.

I recommend that the RAD continue to strive to tilt the Make-Buy decision process further toward buying hardware and services commercially. I appreciate that in-house control of such work is preferable from a technical perspective, but performing this work in-house also adds to the mortgage that BES must continue to support into the future.

The creation of the Integrated Test Stand Facility by using so much existing on-hand equipment has made the development of this capability very cost-effective for BES. Integrating the additional ion source test stand into the ITSF has minimized the needed investment. The staff is to be commended for this approach.

The SNS Research Accelerator carry-over from FY13 into 14 was $6144K, which is 1/3 of the total $18M SNS carry-over. The SNS Accelerator number doesn't seem excessive to me. At 7%, it is a smaller percentage of operating budget than is carried over by either the Neutron Scattering Sciences Account or by Instrument & Source Design.

There was an energetic discussion of carry-over funding. The reality is that there is a multi-faceted need for adequate carry-over funding that the need changes over the course of the fiscal year. Early in each fiscal year, the uncommitted carry-over may be required to pay the burdens on carried-over commitments as they come in. In the present federal budget environment, the carry-over may also sustain the facility while the annual budget is negotiated and allocated, in advance of a higher anticipated budget than permitted by a CR. It might even be used to pay the costs for a funding cessation as in October 2013. At any time during the year, emergent issues may require dipping into a pool of carry-over funding to keep the facility alive. Finally, the carry-over may be spent on "one-time" projects or on longer lead items. However, the RAD must take care not to accumulate these funds over time in order to augment negotiated pools of accelerator improvement or upgrade funds.

The fraction of the operating budget that is spent on management & administration is often a concern. There are a few ways to address this issue. The administrative and support staff in the

Research Accelerator Directorate that is directly supported by BES is noticeably lean at 2.9 FTEs. Likewise, the employees who are identified as management are only 7.9 FTEs. This provides for an employee span of control ratio of 32 (253.9/7.9). This span of control is sufficiently high to question the proper (safe & effective) level of supervision provided to the workers. Therefore, it's clear that first line management of workers must be additionally provided by "non-management" staff, who are also directly supported by BES funding.

At the end of the first day of presentations, a set of 11 questions was presented to the RAD and are listed below. These were promptly and completely dispatched overnight and during the second day's sessions and are available for further review. Some of the resulting discussions are touched on above, but the set of complete answers (not included here) was much appreciated.

1. There was a lot of discussion about the philosophy of maintaining a sustainable operating budget versus discretionary work, improvement projects, etc. How do you differentiate between investment for sustainability, rather than for improvement?
2. What is the ratio of mortgaged investment (like staff) vs. discretionary investments such as new hires and one-time projects?
3. Similarly, in the current $80.1M FY14 budget, how much is simply paying for existing staff and necessary spares?
4. The RAD is requesting the return of $4M of FY13 uncommitted carry-over. When can he count on that, and what is the appropriate level of planned carry-over going forward in today's fiscal environment?
5. We talked about average call-ins to address emerging maintenance needs during production. Are there metrics that can be used to trend the accelerator reliability with respect to annual budgets?
6. There is still significant investment in equipment and facilities. What process has been used for deciding that these investments should be made rather than buying the services externally?
7. On the Integrated Test Stand Facility, what is the total of new equipment that is included?
8. What is the manager to worker ratio?
9. Why does the Kelly Bucks Pie Chart show that S&F is 40% of each dollar, but Kevin's pie chart shows that 57.7% of the cost of labor is S&F?
10. The 5-year plan shows $93.5M for FY14 already, and annually goes up 5% or so from there. How does this plan relate to the reality of today's budget environment?
11. Is the transition from a construction project to an operating facility complete? If not, what's left to do? If so, what are some additional operational efficiencies that are being discussed?

Summary

The fiscal year operations cost for accelerator operations including allocation of personnel, materials and supplies (M&S), capital expenditures, and other budget items seems adequate and appropriately managed. In particular, the cost to BES for general administrative support and for ESH&Q support is low.

BES doesn't realize a proportionate return on its LDRD investment. Additional LDRD returned to the SNS facility would help develop valuable technologies for the future.

The yearly carryover amount (about $6M) in the Research Accelerator Division is quite appropriate. Their request to have the NScD return these funds in FY14 should be granted.

The RAD has implemented operational efficiencies as the manpower level has been reduced over the past few years. Their plan for avoiding obsolescence through upgrading spares will continue to improve operational effectiveness.

The goals and plans summarized in the three major planning documents are aggressive, but do a good job of creating a framework for making investment decisions over the next 5 years. There is little need to provide detailed planning for flat budgets. Flat funding levels may continue to fund basic operations and avoid deferred maintenance, but will limit the ability to achieve the overall strategic goals for the facility.

As stated above, the current funding level is appropriately funding accelerator operations at a level that provides some flexibility and avoids accumulation of deferred maintenance. The most important consideration for BES going forward as stewards of this signature facility is to maintain this balance between adequate base maintenance funding and modest investment in modernization and upgrades as the available technologies advance. Distinct from funding for facility upgrades or even "accelerator improvement projects" which might be more discretionary, this base level of funding will likely continue with steady, regular, but modest increases.

Thanks for the opportunity to study the SNS funding and cost models during this review and thanks again for the cooperation of the staff.

REVIEWER #8

Overview:

ORNL neutron science directorate is a large, complex operation. The materials submitted for the review and the presentations gave an adequate overview of how the operating budgets were spent in FY13. Funding has been below requests and certain neutron source goals and procurements have been deferred in favor of meeting instrument performance goals. The budgeting and five-year planning methodology was also presented. However, it was difficult to assess all aspects of the instrument operations, funding and operational efficiency within one and one-half days. Directorate and division level management gave presentations for the plenary and breakout sessions. We asked for input and Q&A at lower organizational levels for the second day, but these personnel were not provided; thus, it was difficult to draw well-based conclusions on allocation methodology, effectiveness of personnel and supporting facilities and matching of funding allocation to science productivity.

Two questions were posed by OBES PM's for particular attention in the review: namely, the appropriateness of the number of staff at SNS per instrument (~13 FTE's) and the level of M&S support allocated for the facilities (~$34 M). For the later point, SNS did supply a detailed listing of acquisitions purchased from the M&S pool. For the former we were informed how the personnel binning per instrument was calculated. I concluded that whereas the M&S funding levels were appropriate, given the division funding levels, I was left to question if the allocations provided the most effective use of these funds. Staffing allocations in the pooled resources appeared large and perhaps not sustainable.

We were asked to report separately HFIR and SNS budgets and operations. The organization within the directorate, scientific and support divisions and groups are integrated across the two facilities. However, ORNL did provide a detailed breakdown of level of effort between the two facilities of scientific and technical personnel. The fraction of the divisional budget allocated to each facility appeared to be correct.

1. Assess the fiscal year (FY)2013 operations cost including allocation of personnel (full time equivalents [FTEs]), materials and supplies (M&S), capital expenditures, and other budget items. This includes costs for:

   a) Facility management and support staff (SNS & HFIR):

   Directorate level facility management and support efforts are well-staffed ad funded. Business and HR functions are matrixed from other ORNL directorates and are allocated at all levels between HFIR and SNS. Directorate-level operations and strategic planning, user office and communications, are all within the Neutron Directorate line authority. Again these efforts span HFIR and SNS. Besides the usual tasks of administrating the large user program, the user and outreach programs have additional functions to organize various workshops, schools and other activities needed to grow the user base and gather input for improvement of instrumentation, sample environments and management of the user program. Given these additional functions the level of effort appears largely justified. The level of effort in the management of breakout of the directorate into science and other technical divisions with into one full management and one-half to one administrative FTE appears reasonable, given the average sizes of these divisions of 30-50 FTE's. The exceptions are the accelerator and instrument source divisions, which have 188 and 177 FTE personnel, respectively. It is surprising that that the instrument and source division (ISD) shares its director with the reactor operations division; HFIR does have a full time plant manager, however. The divisions are further divided into groups, which are comprised of less than ten to over 50 FTE's. The scaling of 0.5 to 1.0 management FTEs with the size of the group appears to be the correct level of effort in most cases. The general administrative, management and support costs appear in line with the practices of other DOE facilities.

b) Accelerator operations:

SNS: SNS accelerator operations had difficulty due to QA of the target, leading to premature failures. Post mortem assessment was carried out and the QA of the manufactured targets has been improved. Directorate has deferred addressing other less critical operational issues. As a result certain benchmarks in accelerator operations have not been met. A lack of priority for beam physics funding may prove to be an issue down the road.

Reactor operations:

HFIR: To stay within budgetary constrains the number of annual HFIR operation cycles has been reduced from 7 to 6, reductions in operational staff were made and further reductions planed and procurement and fabrication of critical spares has been curtailed. Materials for some critical assemblies have been procured to stage fabrication and assembly at a later date. Furthermore, fuel inventory has been reduced. Thus, the operations managed to meet current fiscal constraints, but at risk of having to curtail operations further if future budget allocations are not made for critical reactor components.

c) Scattering instrument staff and M&S allocations

SNS:

SNS instruments in operation or commissioning each have two to three instrument scientists and 0.5 to 1 instrument associates. SNS wants this staffing to include at least one instrument associate for each operational instrument. I deem this level of staffing appropriate given the operational hours and number of users for each operational instrument in the user program and the magnitude of tasks required to commission an instrument. One instrument scientist is assigned to each instrument under construction. I presume that the IS leads a team of engineers, designers, programmers and support staff in realizing this instrument, which is appropriate. I gather, however that the later is funded under SING II, and is thus outside the purview of this review.

There are 105 FTEs that provide direct support for instruments including pooled staff hall coordinators that help maintain the user instruments on a 24/7 basis, and technical instrument support. This gives 7 personnel on average in direct support per SNS instrument, four of which are in the pooled resources. Whereas, 2 to 3 ISs and 1 IA appears appropriate for operations, I have to question three to four personnel in the pool staff for each instrument, particularly given current and future budget constraints.. An assessment of likely operational issues, failure and other issues that require 24/7 attention should help determine the skill sets that will most effectively keep the operations running.

M& S: On questioning, it was stated that an average of $50K was allocated for each operational instrument from the M&S pool. Assuming that this level of support is appropriately spread among the active instruments and that budget information is passed to the IS for planning and prioritization, this amount is more than adequate for instrument operations. In addition, the directorate allocated significant M&S funding based on division-level request for sample cells and supplies, sample environments, detectors and additional acquisitions needed to improve operational instrument performance, such as

shielding, guides, choppers *etc*. The M&S allocation was approximately 19% of the SNS budget, on the high side of expectations, and likely reflects a need to deal with instrument operational difficulties in the user program.
HFIR:

HFIR instruments operate on a model similar to SNS with 1 to 3 ISs and 0.25 to 1 IA FTEs each, depending on demand and through put. As with SNS this level of effort is justifiable.

M&S amounted to $1.3M for sample environments, including two orange cryostats, upgrades of DAQ computers to server quality ones, consumables, sample holders and tooling for shutter systems. These uses of the M&S pool appear justified. The percentage of HFIR M&S was approximately 3% of the total budget, significantly lower than expectations. This likely reflects the more mature state of HFIR instruments relative to SNS.

Comments: The method for prioritizing allocations from M&S funding pool using the IWP are determined at the AD level from requests rolled up through the management chain from the instrument staff and using information obtained from user community through the instrument workshops. Thus, although the procurements that were outlined appeared to be appropriate. The final top down decision process opens the question if other acquisition priorities would have better served the needs of the user community. These issues aside, the $34 M level of M&S through out the directorate is more than adequate to maintain the user program and make necessary instrument improvements and provide additional sample environment capability for the user program.

Recommendations: Management should examine methods to assure that priorities in the decision process of M&S allocation are more transparent and effectively meets the needs of the user program.

d) Pooled support staff (e.g., sample environments, user office)

SNS:

The roles of the pooled resources were summarized in the review. The pool for SNS includes hall coordinators, whose duties are outlined above. 92 additional FTEs provide indirect support, including data analysis and visualization and instrument engineering divisions, the control systems group from RAD (chopper controls) and the DAQ group from ISD. The pooled resources include mechanical and electrical technicians and engineers from the instrument support group of ISD for trouble-shooting and instrument commissioning. In all cases the costs associated with each FTE mapped onto their various functions were in line with this reviewer's knowledge of other DOE facilities..

HFIR:

Pooled resources for HFIR are like that of SNS. Currently HFIR pooled resources amount to 36.5 FTEs.

I have summarized the user office effort, which spans the two facilities, in 1a.

e) ESH&Q support levels: skipped

2. Comment on the overall budget levels and sources of funds (e.g., BES operations, LDRD and other internal funds, external funds received from other government agencies, industry, and fee for service work (e.g., isotope production and materials irradiation at HFIR). Is the yearly carryover amount appropriate? Are there additional sources of funds that should be explored?

SNS:

BES funding for SNS averages \$2.2 M operational funding per instrument. 25% of this substantial funding goes to scientists, 12% for technical support and 60% for pooled support.

SNS has attracted funding and personnel from Julich for BASIS and NSE. Additional funding for WFO, US-Japan collaboration and NIST accounts for approximately \$5 M. Clearly, other sources from other US government agencies and industry can be tapped. Proposals in these arenas must be carefully crafted to include external collaborators with an eye to growing the user bas and expanding capability to offset obligations that are incurred that can impact user programs.

ORNL LDRD are of the order of \$300-500 K largely to fund postdocs to interact with other divisions. ORNL sees this funding as investment to develop capability and to train future users. In FY13 LQD accounted for 1.3% of the directorate's operating budget, while paying out roughly 4%. Clearly, improvements are in order in this regard.

HFIR:

HFIR BES-SUD funding averages \$1.5M per instrument. No LDRD was allocated to HFIR. There is a small level of funding from WFO, presumably a portion of which is for isotope production. We did not discuss the ways in which this effort impacts the rest of HFIR operations.

Carryover (SNS & HFIR):

Business practices regarding committed funding carryover appear normal. There was an interesting discussion regarding operational carryover. ORNL policy is for 21 days of operation and to maintain critical functions, with additional carry over for committed allocations. In my opinion the amounts of carry over were reasonable and necessary

3. Evaluate the operational efficiencies the facility has implemented, plans to implement in the future, or could implement.

   SNS & HFIR:

   The neutron sciences directorate is a large, fairly complex organization encompassing both SNS and HFIR. Because of the large scope of effort many different skill sets are required. Skilled personnel are homed in organizations that support their skills and objectives and are either assigned as needed as part of the pooled resources, matrixed into a client organization for long-term programmatic efforts, such as, data analysis and visualization, or using a client-provider model for shorter term efforts, such as instrument and sample environment engineering and realization.. While these varied approaches have the strong advantage of providing flexible, efficient use of resources, we could not assess in any detail if improvements could be made. However, responses to Q&A and anecdotal information indicate that efficiencies could be improved. Concerns were in matching of objectives of the data analysis and visualization division to the individual instrument requirements and dealing with legacy issues. Other indications were inadequate support for the instrument teams by the pooled resources.

On perusing the organizational charts I am struck by the seemingly artificial division of the directorate into science divisions with different objectives and responsibilities. The organizational charts show that staff members have their effort is split among one or more directorates and groups and the instrument teams are spit among different organizations. How does management work in agreeing to employee goals and performance criteria with more than one line of authority, particularly in serving the needs of the user program?

4. Assess the appropriateness of the Facility Strategic Plan: scientific goals, upgrade plans, Research and Development (R&D) program, etc.

   SNS & HFIR:

   The strategic plan has drawn from a number of sources including BES, NAS reports and other sources including community input to identify key targets for advancing the scientific capabilities of SNS and HFIR The strategic plan correctly points out the need for both accelerator and reactor based neutron sources in the US effort, as each type of source provides optimal benefit for a given class of measurements; thus, it considers the integration of both facilities as essential. The strategy of the plan involves six components towards achieving its goal of advancing the neutrons science, improving SNS and HFIR capabilities and addressing the needs of the scientific community: community engagement to set objectives and goals, integration of scattering with synthesis and computation, improved neutron production, optimizing neutron instruments, realizing new capabilities through SING III and realizing a second target station. Of these I consider community outreach and instrument improvements (optics and data reduction and assessment) to be the most important. Improving source production through increased power into the megawatt domain, while important improvements are secondary to assuring that SNS instruments will work properly under current source power levels to understand and anticipate what additional issues will arise at higher power and formulate plans to mitigate these. Although SING III and the STS programs are important for SNS's future, assuring optimal operation of the current source and instruments is an essential of first order. The strategic plan correctly identifies procurement and fabrication of essential reactor components and fuel as having first priority over other improvements at HFIR and increasing the number of cycles to 7.

5. Evaluate the appropriateness of the projected FY2014-2018 operations budget profile. Is the budget profile appropriately documented, justified, consistent with the Strategic Plan, and reflects funding needs for the overall strategic goal(s) of the facility?

   Too all appearcances the directorate has used the IWP tool extremely effectively to upwardly load and budget the five-year plan with yearly updates. Consistent with the strategic plan, the five-year plan places emphasis on source and instrument reliability, upgrades of instrument components, DAQ etc to reach full optimization, improved sample environments and provide a quality user experience. The components of the plan to upgrade instrument capability and DAQ are all reasonable. There are excellent plans to provide new equipment for the user labs and to further the development of the deuteration facility. The accelerator improvements seek to address deferred benchmarks in the accelerator development program on the path to 1.4 MW. For the HFIR source the priory is for allocation of funds for essential reactor components, again a differed procurement, but essential for the continued operation of the facility. Of all the proposed efforts, I consider detector development program to be the most problematic. Considerable effort has and is being expended on the problem of a practical alternative to ^{3}He with improved performance needed for high power pulsed sources. I do not see from the plan how ORNL can effectively contribute.

Unfortunately, likely budget scenarios place parts of the plan at risk. Acknowledging this, the plan is designed as a living document that can be rescoped, reprioritized and rebudgeted as the situation changes.

6. Evaluate if there is an appropriate level of R&D funding for efforts related to improving operations, instrumentation, sample preparation, etc.

   I have already commented on the appropriateness of the substantial M&S allocations in improving operations. A notable practice is the conduct of workshops to assess the needs of the user program, three of which will be held this year. Also notable, and very important to the user programs, is the heavy investment in user laboratories, instrumentation, supplies and equipment for sample preparation and evaluation.

7. Evaluate the Environment, Safety and Health (ES&H) and Quality Assurance (QA) at the facility. Skipped

REVIEWER #9

SNS operations budget

The total burdened FY13 SNS operations budget includes $157M from BES-SUF and $19M identified as being from other sources. Overall this budget was split by function into about 22% for facility management and business operations, 40% for neutron source operations, 35% for instrument operations and 3% for ESH&Q. This is a reasonable distribution for an accelerator facility. By budget category the overall breakdown is 67% personnel, 24% M&S, 8% utilities and 1% travel. This also appears reasonable.

The ESH&Q group leader presented FY13 staffing level as 19.7 FTEs: 11.4 radiation protection, 3 occupational safety and health, 2.3 environmental protection and waste management, 1.9 quality, 0.9 safety basis, and 0.2 training. The 19.7 FTEs total does not match the 19.1 FTEs presented in the response to the information request. Explanation was that group was formed on October 1, 2013 and in FY13 ESH&Q functions were spread out and more difficult to account for. The radiation protection staff provided 24/7 coverage for neutron source and instrument operations. The occupational safety and health staff performed safety and health reviews for all user experiments (513 in FY13) and provided work control and permitting support for laboratory and accelerator operations and maintenance activities. The environmental protection and waste management staff managed emissions and waste generation and disposal. The quality staff supported target fabrication and procurement, calibrations, assessments, investigations, improvements, and lessons learned. The safety basis staff maintained the Safety Assessment Document and performed Unreviewed Safety Issue Determinations. Training staff was responsible for training coordination and compliance. Considering the work that was performed the ESH&Q resources were appropriate and efficiently used. The ESH&Q burdened funding was sourced $4.3M from BES-SUF and $1.6M from others. The other sources were described as mostly organization burden.

ESH&Q has implemented operational efficiency measures. One was to minimize footprint of radiologically controlled areas. This has minimized the need to issue and process dosimeters and require radiation worker training. There is a philosophy for taking unnecessary work out of the system. A two-step proposal submission process has been implemented that only requires detailed safety and health input and review after beam time is awarded. To limit re-review of the same work generalized safety and health reviews are being prepared. The addition of a confirmation step to the submission process has helped to efficiently process last minute changes including new samples. Tailoring processes to new versus routine users has also improved efficiency.

The FY14 staffing and budget for ESH&Q is an increase from FY13, 21.05 FTEs versus 19.7 FTEs from the group leader's presentation. Again some discrepancy from the information request response of 21.3 FTEs. Radiation protection, occupational safety and health, and safety basis staffing planned for FY14-FY18 is same as for FY13. With the formation of the group, 1.25 TFEs for group leader and admin support was added. Training staff responsibilities were increased and staffing for training support commensurately increased from 0.2 to 1.0 FTEs. The formation of an ESH&Q group with the additional management and admin and training coordination staffing costs is perceived as an operational efficiency improvement. Quality work for target fabrication and procurement was completed in FY13 and staffing for quality commensurately decreased from 1.9 to 1.0 FTEs. Environmental protection and waste management staff is converting a student worker to full time employee resulting in a staffing increase from 2.3 to 2.5 FTEs. FY15 staffing is same as FY14 except 1 additional occupational safety and health FTE is added. This is the expected replacement of an unfunded staff member currently on long term disability. As operating schedule is optimized and additional instruments are built as anticipated in strategic plan the planned additional staff member is justified. FY16-FY18 ESH&Q staffing is projected to be same as FY15.

ESH&Q at SNS appears effective and efficient. There have been no recent events resulting in down time. The staff supports safe accelerator and target operations and productive user program. They contributed to ORNL's lower than average FY13 TRC and DART rates of 0.82 and 0.31 respectively.

REVIEWER #10

1. **Assess the fiscal year (FY)2013 operations cost including allocation of personnel (full time equivalents [FTEs]), materials and supplies (M&S), capital expenditures, and other budget items. This includes costs for:**

    a) **Facility management and support staff**
    b) **Accelerator or reactor operations**
    c) **Scattering instrument staffing and M&S allocations**
    d) **Pooled support staff (e.g., sample environments, user office)**
    e) **ESH&Q support levels**

As with all complex facilities, the HFIR and SNS neutron sources require significant personnel resources just to operate safely and reliably. Both facilities have reduced or reallocated personnel resources to align with recent operational priority changes and this has resulted in much improved user satisfaction. The NScD primary mission is to provide the necessary resources and infrastructure to support a robust and growing user program. To that end, the external user must have the resources directed to their experiment and the beam time allocated (and available) such that the user considers the project a success. By this metric, the NScD has directed sufficient resources towards the user program (user office, instrument commissioning, sample environment).

On-going instrument design, installation, and upgrades is essential to maintain a competitive, leading-edge research program. Currently, the NScD will have only one instrument still in a commissioning phase in 2015 but a program of continuous improvement should support some level of new instrument development based on lessons learned and new research directions. The HFIR and SNS share some resources for instrument development which is cost effective but will reduce the day to day progress at one or both facilities.

Source operations and engineering personnel are linked together to provide safe source operations. Technician support for maintenance and solid engineering support to repair or replace failed equipment, design upgrades necessary upgrades to sources for age management or programmatic expansion may be too low. This could be corrected over the next few years by budget increases or as resources that had been directed towards final commissioning of new instruments are shifted to facility operations. Shared resources within the Directorate is a cost effective way to manage operations and maintenance but may not provide sufficient buffer for large, unexpected failures or new projects.

From the documentation and presentations provided for this review, the FY13 operations cost and allocation to budget items appears to be well-managed and correct for the scope of current programs.

2. **Comment on the overall budget levels and sources of funds (e.g., BES operations, LDRD and other internal funds, external funds received from other government agencies, industry, and fee for service work (e.g., isotope production and materials irradiation at HFIR). Is the yearly carryover amount appropriate? Are there additional sources of funds that should be explored?**

The SNS and HFIR are scientific and engineering research tools that require DOE funding to support and maintain the essential infrastructure of the user program. There is limited laboratory overhead support, such as LDRD and Melton Valley project, to support projects or infrastructure not allowable by contract to DOE or the current budget cycle. User fees and work for others are additional funding sources are already exploited by the HFIR but these funds may not support the core mission activities. Flat budgets with a mandated increase in operational days and metrics that require a minimum number of neutron production days or hours are difficult to sustain.

Federal budget uncertainties and delays increase the difficulty to plan and adjust budgets early in the fiscal year due to unexpected significant costs. This past fiscal year, NScD management carried over more funds then the typical 10% but this seemed a wise management decision considering the likelihood and reality of a federal government shutdown. Carryover at the HFIR facility is essential to provide early fiscal year funding to the reactor fuel manufacturer and assure continuity of operations and fuel supply. User facility availability and reliability of operations can be quickly impacted if budget shortfalls or delays in allocations result in insufficient funds in the first or second quarter of a fiscal year. It was noted that ORNL and NScD did not receive their full budget allocation until August of this year.

3. **Evaluate the operational efficiencies the facility has implemented, plans to implement in the future, or could implement.**

The two facilities have implemented operational efficiencies by focusing on critical work to maintain the base operations of the neutron sources. Flat or reduced budgets have resulted in a rise in the personnel attrition rate. At the HFIR, the staff levels are 38 FTEs lower than 2010 levels. This has resulted in a leaner organization but only to a level sufficient to maintain core capabilities. The reduction in staff levels has resulted in the delay of some important projects. One example of a delayed project has been the installation of emergency diesel generators at HFIR which has been delayed for years due to lack of engineering resources. The temporary transfer of personnel resources from one part of the NSCD to another to support critical projects is an efficient use of personnel and expertise in a lean environment. This has caused delays for projects or repairs in other areas of the Directorate. The impact of these "efficiencies" may not be seen for a few years but the HFIR and the SNS were able to achieve excellent reliability metrics in 2013 even with limited staffing.

4. **Assess the appropriateness of the Facility Strategic Plan: scientific goals, upgrade plans, Research and Development (R&D) program, etc.**

The 2014 facility strategic plan (SP) is an update to the 2011 Plan. The NScD Director notes that this plan is "ambitious" and will require a decade or more to achieve the goals in the plan. The SP identifies many of the well-known scientific opportunities in neutron sciences (Quantum Materials, Soft Matter, and Biosciences) and provides a reasonable plan to exploit these opportunities. These plans include significant scientific instrumentation and infrastructure upgrades. Upgrades to the SNS accelerator and target have near-term (2016) and long-term (2021 and 2026) schedules but requires additional R&D and funding to achieve the planned upgrades (higher beam power, new inner reflector plugs, and improved ion source). Another planned and prominent upgrade is the R&D to increase the accelerator power to 2 MW and to design, develop, and install the second target station (STS). This effort will likely occur in parallel with the existing user program support and thus requires additional resources (essentially new construction effort) to achieve the goal without impacting the on-going research from the FTS. One key and necessary activity in the SP is the planned near term increase in the number of cycles for the HFIR and the increase of neutron production hours at the SNS. A step jump in neutron capacity will occur when the STS and new beams become available in approximately 10 years but not operating the current sources at the optimal schedule is a waste of capacity now. The SP appears appropriate, even in the current budget climate, and sets realistic goals with a flexible direction that is acknowledged to be dependent on future technologies and stakeholder input.

5. **Evaluate the appropriateness of the projected FY2014-2018 operations budget profile. Is the budget profile appropriately documented, justified, consistent with the Strategic Plan, and reflects funding needs for the overall strategic goal(s) of the facility?**

Reviewers were provided with the 2014 Strategic Plan (SP) and the Five Year Plan (2014 to 2018) (FYP). The SP reflects a long view out to the next decade but the FYP is more tactical in the near term planning.

Throughout the FYP, there is a discussion of maintenance deferral and reduced spare parts caused by budget shortfalls at the two sources. The FYP assumes a 5% budget increase in 2014 and increases into the future that reflect the scope of the plan. If the budget is not available or actually decreases, the expectation from this reviewer is there will begin a steady decline in reliability of the neutron sources. One staff member interviewed commented that the HFIR budget was reduced and maintenance was deferred in the 90's because in the mid-1990s it was expected that the planned Advanced Neutron Source (ANS) would be built as a replacement for the HFIR in the next decade. The ANS project was cancelled in 1996 and the SNS project was born. HFIR budgets from the 1990s and 2000s were not available but it does not seem to be a coincidence to this reviewer that the poor record of HFIR reliability from 2001 to 2006 occurred after roughly five years of reduced HFIR operational and maintenance budgets. The point of this is simply to strongly encourage the DOE to provide the necessary operational budgets to SNS and HFIR to manage the maintenance and operations and sustain these valuable national resources.

The HFIR fuel inventory has reached the lowest level in the past 40 years. There is currently only two years of operational inventory (12 cores) available. The FYP assumes that sufficient funding will become available in 2014 and beyond to purchase at least the fuel burned annually and gradually create a 3 year fuel inventory as a buffer for fuel supply disruptions. It is absolutely essential that the DOE provide the additional funding necessary to restart and increase the HFIR fuel supply chain.

Continuing the preventive maintenance program and maintaining an inventory of critical spares for rapid corrective maintenance should allow the facility to maintain the reliability greater than 90% for the immediate future with a reasonable horizon in the range of a decade. Going forward, there is a development plan for the SNS to design and install the second target station (STS) to expand the capacity of the facility. The U.S. needs this capacity to meet the increasing demand for neutron measurement tools and the continuing growth of the neutron science community. The FYP includes CD-1 and CD-2 development of the STS in the schedule and this budget and schedule are appropriate.

6. **Evaluate if there is an appropriate level of R&D funding for efforts related to improving operations, instrumentation, sample preparation, etc.**

There are two major neutron facilities in the Directorate. The SNS is relatively young and, based on the reliability and availability statistics presented, has passed the early phase of its lifetime and the lifetime of critical subsystems for operations at 1MW. It was noted in the briefings that the current operating power of 850 kW was lower than desired and was chosen to minimize issues with the mercury target reliability. Two significant beginning of life target failures this past fiscal year may have been resolved by applying significant resources to correct the engineering design, fabrication, and quality assurance processes that had been in place prior to this year. Operating at the lower power may have contributed to the high availability of the SNS this past fiscal year by reducing the stress on the accelerator and the mercury target. From a user perspective, operating the facility with a lower but useful power with a higher reliability is preferred. Briefly operating at 1.4 MW in September was risky but revealed weaknesses in the existing systems that must be resolved before there is serious consideration to increase the SNS operating power and install the STS. The engineering and financial resources to identify and correct these operational issues would need to be allocated in parallel with the design of the STS and the instrumentation plans to utilize the STS. These resources do not appear to be currently available to a sufficient level to balance normal facility operations and maintenance with increasing the capacity of the SNS. Constant low-level progress towards that goal will continue but to reach the final design goal and capability in the next ten years will require a major funding initiative.

7. Evaluate the Environment, Safety and Health (ES&H) and Quality Assurance (QA) at the facility.

The NScD facilities appear to have a good ES&H program. This reviewer was not directly involved with this portion of the review and did not have a tour of the facilities to evaluate the program directly.

REVIEWER #11

Reviewer Evaluation Report of SNS and HFIR Operations Budget

1. *Assess the fiscal year (FY)2013 operations cost including allocation of personnel (full time equivalents [FTEs]), materials and supplies (M&S), capital expenditures, and other budget items. This includes costs for:*

    a) *Facility management and support staff*
    b) *Accelerator or reactor operations*
    c) *Scattering instrument staffing and M&S allocations*
    d) *Pooled support staff (e.g., sample environments, user office)*
    e) *ESH&Q support levels*

Overall assessment is quite positive. Despite reduced funds available in FY13 wrt FY12, the SNS was able to set record beam power on target of 1.4MW [for 30 minutes], and decent 89-90% reliability at ~1MW typical beam power operation. Part of the overall budget strategy was to count on significant - sometimes >10% - year-to-year carryover. For example, the RAD is requesting $4M of FY13 uncommitted and 15M$ of committed carryover. Significant part of the uncommitted carryover covers burdens on committed procurements. The total carryover funds at the SNS and HFIR are reviewed annually in relation to projected annual costs to ensure an optimal level is maintained. Carryover funds are utilized to cover continued operations as well as direct outstanding commitments for purchases and subcontracts, and the applicable overhead associated with those items. Systematic carryover of about ~10% of annual budget seems to be somewhat excessive, and lower value of 5-7% is more typical/acceptable for other BES facilities. The higher value of the carryover might need additional justification.

2. *Comment on the overall budget levels and sources of funds (e.g., BES operations, LDRD and other internal funds, external funds received from other government agencies, industry, and fee for service work (e.g., isotope production and materials irradiation at HFIR). Is the yearly carryover amount appropriate? Are there additional sources of funds that should be explored?*

    There is essentially no LDRD funds for the RAD/SNS works. So far the SNS team had enough funds to carry out most important R&D in support of the "continuously improving" operations of the accelerator complex. Situation had started to change few years ago when it become clear that operations budget will not be able to support many – overall, potentially, very useful – R&D initiatives. It needs to be said that despite the fact that some most burning problems, like unreliable stripping foils at high power operation, have been temporarily addressed, there are many fundamental underlying physics and technology issues which will need to be studied sooner or later [most notable are understanding of the SRF and warm linac limitations and degradation, ion source, targetry, etc]. So far the SNS team has not shown up enough initiative to explore additional sources of funding. The only example of success in that regard is ~1M$ grant from OHEP to explore laser stripping. Note, that that research is pushing state-of-the-art - and will be very helpful for the OHEP Intensity Frontier accelerators - rather than being and example of the SNS-focused R&D. There are other sources to support the R&D [BES funds, etc] which will need to be more actively explored.

3. *Evaluate the operational efficiencies the facility has implemented, plans to implement in the future, or could implement.*

No outstanding issues were identified. What can be commended is growing appreciation by the SNS management that in the reduced budgets climate, additional efficiencies will likely be best realized by managing the workforce more carefully to hire highly competent individuals with diverse skill sets. That objective can not be achieved in few years and will require sustained multi-year attention. A recent example of the hiring of an excellent electrical engineer who has made the task of maintaining and improving all the DC and pulsed power systems much more efficient and essentially replacing three FTE for the same scope of work – that's quite illustrative.

4. *Assess the appropriateness of the Facility Strategic Plan: scientific goals, upgrade plans, Research and Development (R&D) program, etc.*

The SNS facility has demonstrated quite reliable operation at the planned power level of 1MW. At the same time it was designed for 1.4MW, and BES has stated an expectation that we will operate near or at that power level in the future. Operating at 1.4MW pushes complex systems to minimal operating margin. The remaining work centers on system modification to maintain highly reliable operation with smaller operating margin, and to achieve the full design energy of 1 GeV. This scope is a key element of the accelerator portion of the 5-year plan, which includes very long list of needed improvements – technical and operational, hardware and software, systems and personnel.

5. *Evaluate the appropriateness of the projected FY2014-2018 operations budget profile. Is the budget profile appropriately documented, justified, consistent with the Strategic Plan, and reflects funding needs for the overall strategic goal(s) of the facility?*

The Strategic plan document covers 2014-2018 and assumes quite aggressive funding of the accelerator improvements, of the order of ~5% annual *increase*. This assumption seems to be already obsolete – therefore making the Plan to look more of a kind of a "wish list" – as the accelerator operation budget in FY14 is expected to face 5-10% *reduction*. There are no indications for that trend to change in the out years, although the scheduled BES "facilities budget priority meeting" in December of 2013 might come out with more positive news for the

SNS [TBD]. One can recommend NScD and SNS upper management and BES jointly develop a more diverse "budget-deliverable" matrix : a plan for, e.g., three budget scenarios [good, bad and realistic] augmented with detail risk analysis – what they will and will not be able to deliver in terms of hours, reliability, # of instruments, # of users and publications under each scenario. Without such analysis, there might appear a misleading feeling that SNS can continue to deliver excellent/acceptable performance with flat or even reduced budget year after year, in a long run. Of note: so far the only communicated indication that the performance is not granted was slight decrease of the overall machine reliability from 92-93% three years ago to ~89% in FY13.

6. *Evaluate if there is an appropriate level of R&D funding for efforts related to improving operations, instrumentation, sample preparation, etc.*

The level of support efforts related to accelerator improvements, both operational and longer-term [upgrade oriented] has been in continuous decline. It was mentioned several times by medium level managers that R&D was systematically "first to cut" when it came to budget reductions over the past years. For example, the accelerator physics group shrunk in half over 3 years. It seems that maintaining core expertise in beam physics is not Priority 1 and they can dearly pay for that as scientific/technical issues are often the hardest and longest to address, they can not be solved by increased personnel or bigger funding and usually require intellectual power and time. As said above, there are worrisome signs of incomplete understanding of targetry, ion source, SRF degradation and other issues which without doubt will demand to be properly addressed. As an example, the last year target failures required 4 long period to replace targets and they do not seem to be explicitly due to Q&A – there is some part of that happening due to basic technology and physics, understanding of which required and continues to requiring sustained intellectual efforts/analysis. One should commend SNS management for being consistent on the construction of the Integrated Test Stand Facility [ITSF] which will be invaluable resource for the front-end and RF-related R&D [in addition to be kind of a "hot spare" for the RFQ].

7. *Evaluate the Environment, Safety and Health (ES&H) and Quality Assurance (QA) at the facility.*

I see no issues with that, safety record of the SNS looks quite good and satisfactory overall.

8. ***General comments:***

The Research Accelerator Department [RAD] seems to be quite lean on management [29 supervisors total for organization of 242], finance [only 1 person], and HR [1], it SNS overall has one of the lowest “S&T charge out rate” in ORNL , of about 2.4 [243k$ per 100k$ salary].

Summary of Reviewer Comments on the HFIR Facility:

Staffing and Budget:

"…It appears that HFIR is adequately staffed at the managerial, engineering, technical, craft and administrative levels (approximately 189 FTE)." "At HFIR, the RRD has managed to reduce expenditures to stay within flat or reduced budget appropriations for six consecutive years. This has resulted in a reduction of 38 full time employees (FTE) compared to FY 2010. Additionally, 15 division FTEs are allocated to support work outside the division in FY 2014. Even though the workforce has been reduced, HFIR continues to meet its operational goals. However, the reduction in staff has resulted in the delay of some critical projects." "The five year plan discusses maintenance deferral and reduced spare parts caused by budget shortfalls at HFIR and SNS. The five year plan also assumes a 5% budget increase in 2014 and increases into the future that reflect the scope of the plan. If the budget is not available or actually decreases instead of increases, the most likely scenario will be a steady decline in the reliability of the neutron sources."

"Currently, the HFIR fuel inventory is at its lowest level in the past 40 years with only two years of supply (12 cores) on hand. The five year plan assumes sufficient funding in 2014 and beyond to purchase at least the fuel that is consumed annually with a gradual increase to create a 3 year fuel inventory to protect against any fuel supply disruptions. If there is only one takeaway from this review it's the following: it's imperative that DOE make this goal a number one priority – no fuel, no operating, no neutrons."

"… HFIR and SNS share resources for instrument maintenance and development on their beam lines. While this can definitely be cost effective and result in greater expertise and versatility among the technicians and perhaps some standardization between the two facilities, management must sensitive to ensure that shared resources do not result in an imbalance in support between the two facilities…" "… Another potential area of concern when using shared resources is the potential lack of sufficient reserves to cover any new projects or unexpected equipment failures that can result in significant loss of experiment time."

A reviewer expressed concern about staff succession planning and recommended "A very formal program, consisting of examining and documenting the material condition of every reactor system or component, must be established and maintained with all vulnerable areas identified."

Concerning the level of carryover funds, one reviewer cautioned that "Carryover is critical at HFIR since this provides early fiscal year funding to the fuel manufacturer. Reactor fuel is not an off the shelf item and typically requires two years to manufacture and procure. It is critical to the reliable operation of HFIR that funding dedicated to fuel stays dedicated to fuel and not be diverted to pay for something else."

It was remarked that future planned budget expenditures for 2014-2018 "…are being directed at appropriate areas, such as fuel production improvements, replacement/upgrades to major equipment systems, replenishment of critical spares, and operations and maintenance to support the annual operating cycles."

Instrument Operations

Staffing and Budget

"…Beam reliability at HFIR has improved dramatically in recent years and appears to have played a major role in the significant improvement in scientific output at the facility." "…the fact that beam reliability at HFIR has improved dramatically in recent years and appears to have played a major role in the significant improvement in scientific output at the facility." "...the allocation of FTEs across the 13 instruments currently in operation at HFIR is quite non-uniform, fluctuating by a factor of more than two, between 3.0 and 6.7 per instrument. This average of about 4.5 FTEs per instrument should be compared to an approximate internationally-averaged value of 5-6 FTEs per instrument, leading to the conclusion that there could be some concern over staffing levels at HFIR, particularly on certain instruments. The average costs per instrument run at $1.4M per year, a relatively modest level." "...the large apparent expenditure on M&S is found by this reviewer to be slightly misleading, actually reflecting a careful and deliberate plan to improve instrument capability. " "The need for sufficient staff coverage for day-to-day instrument operation is critical, especially on SANS and other high through-put instruments."

Some concern was expressed by reviewers about the lack of major upgrades to HFIR instruments, some of which are quite aged. "To address the future needs of cutting-edge neutron research, targeted allocation of personnel and fiscal resources toward strategic upgrades of HFIR instrumentation is essential to expand capabilities of the current instruments and to innovate new measurement geometries." "Unfortunately, there seems to be minimal effort directed toward development of next-generation data acquisition software for the planned instrumental upgrades at HFIR. Targeted software development in many areas (i.e., data collection, analysis and modeling) is critical to producing high-impact science. "

While the proposed budgets for FY2014-2018 accurately reflect the short-term operational needs and long-term scientific priorities of the facility, the Instrument Beamline sub-committee concurred that there was insufficient contingency built in for unanticipated maintenance-related problems (such as the pipe issue that occurred just prior the review).

ESH&Q

ESH&Q at HFIR appears effective. Nuclear facility operations requirements dictate the higher safety basis, quality and training staffing requirements to accelerator facilities. The staffing levels presented are reasonable but appear under budgeted in the data provided compared to the group leader's expectations.

REVIEWER #1

Operational Budget Review of the High Flux Isotope Reactor

Neutron scattering has long been established as a powerful, essential tool for determining the properties of a wide-range of complex materials. Among the limited neutron user facilities in the U.S. and in the world, the combined capabilities at SNS and HFIR provide a unique, comprehensive suite of neutron instruments that span an extensive range of energy-momentum space. For many decades, materials investigations using the neutron scattering capabilities at HFIR have consistently provided transformative insight into a broad range of novel materials from simple antiferromagnets to high temperature superconductors. In addition, HFIR's contributions in its other mission areas of isotope production, fission and fusion-related materials development, and support for non-proliferation programs continue to be significant. The reactor refurbishment and cold source installation in 2007 expanded the experimental scattering opportunities dramatically with the addition, for example, of two SANS instruments, an imagining instrument and a single-crystal diffractometer. User demand for both the existing and new HFIR instruments is strong. **The ever-changing focus of the growing scientific community requires that both HFIR and SNS continue to pioneer new neutron capabilities and to upgrade existing instrumentation and ancillary equipment in order to advance measurement sensitivity, efficiency, and flexibility.**

Currently, 12 neutron instruments at HFIR are operating as part of the user program, and the primary focus of the facility (as stated by Dr. Kelly Beierschmitt) is the production of high-impact science. The distribution of the $72.8M BES cost for HFIR in FY2013 (Table II.E.1) among the categories defined for this budget review (Accelerator Operations, Reactor Operations, Beamline Instrument Operations, Facility Management and Business Operations, and ESH&Q) clearly reflects this priority while providing sufficient resources to ensure reliable, consistent operation of the neutron source. **To that end, the reorganization in 2011 was designed to eliminate some of the unnecessary redundancy in facilities management and operation at SNS and HFIR and to integrate their scientific efforts in key areas such as quantum condensed matter, chemical and engineering materials, and biology and soft matter. Judging by both the budget data provided to the review panel and by the feedback from the facility managers present at the review, significant progress has been made toward achieving these goals.** As examples, a cross section of users now perform complementary experiments on their materials at both facilities, and instrument development priorities(such as ^{3}He spin polarizers) are established with the benefit of both facilities in mind. **Overall, the impressive number of HFIR publications (> 120 in 2013) indicates that the scientific productivity of the facility was high despite the reduced number of cycles due to budget limitations.**

While the levels of support for Reactor Operations, Accelerator Operations, Facility Management and ESH&Q are reasonable (as assessed by other members of the review panel), the resources available to the Beamline Instruments has increased in recent years (cost of $18.9M in FY2013 from Table II.E.1) in order to serve the experimental needs of the growing pool of users and to support the continued development and construction of cutting-edge neutron instrumentation. Of the portion of the BES budget apportioned to Beamline Instrument Operations, the large fraction (79.4%) allocated for salaries and associated overhead costs is justified considering the staff coverage required for the increasing number of high throughput experiments. **For each instrument there is an average of < 2 designated FTE's who are responsible for day-to-day operations, which is much smaller than the level at other US neutron facilities.** (Note that for the triple axis spectrometers, the actual number is 1.5 FTE's.) This average jumps only to approximately 4.7 FTE's per instrument when pooled staff members, who provide a wide-range of direct support (such as sample environment, lab management and maintenance, and technical support), are included. **Again, this staffing number seems very low when considering the unique experimental requirements of each of the 824 research visitors (69 per user instrument) associated with approximately 300 unique experiments performed at HFIR in FY2013.** Even the *effective* number of staff per instrument (5.1) obtained by dividing the total FTE's in the Beamline Instruments category (66.3) by the number of BES-supported instruments (total of 12 user instruments plus the optics test station) is barely consistent with the average number of staff (5-6 FTE's) responsible for day-to-day instrument operations at ILL and ISIS (Source: *Office of Science and Technology Policy Interagency Working Group on Neutron Science: Report on the Status and Needs of Major Neutron Scattering Facilities and Instruments in the United States*, 2002). **The need for sufficient staff coverage for day-to-day instrument operation is critical, especially on SANS and other high through-put instruments.** This priority is best described by the 2009 APS report, entitled *Access to Major International X-ray and Neutron Scattering Facilities,* which states that, "Scientifically productive access for most users will require increasing intervention and assistance from instrument scientists with planning experiments, with "hands-on" assistance during the experiment and with assistance in interpreting and analyzing the data. " When asked about the current staffing levels during the review, the members of the HFIR management team were resigned, and they indicated that short-term hires and/or conversions from contract positions are planned for WAND (which is grossly understaffed) and for other instruments. In addition, they stated that the current workload on the instrument scientists is currently less than anticipated in the future due to the reduced number of run cycles per year (6 in FY2012 and FY2013 instead of 7). Large apparent differences between the *effective* staffing levels at HFIR and SNS can be explained, in part, by the supplementary staff (such as instrument hall coordinators) required to address specific operational issues associated with the SNS pulsed source. In addition, a large number of the additional FTE's at SNS (approximately 40) are members the Neutron Data Analysis and Visualization Division which develops complex software for the collection, reduction, and analysis of high volume of data obtained using the multi-detector SNS instrumentation. HFIR only has 4 FTE's in the HFIR Instrument Operations Group dedicated to maintaining and improving data acquisition software, though HFIR benefits, to a limited degree, from the data analysis and reduction efforts of the SNS software team. Finally, since it is a mature facility, the instrumentation development efforts at HFIR are strong, but less aggressive than those at the SNS. Specifically, the HFIR Instrument Engineering Group has only 6 FTE's compared to 30 FTE's for SNS, and the Instrument Projects and Development Group has 4.5 HFIR FTE's compared to 16.6 SNS FTE's. **To address the future needs of cutting-edge neutron research, targeted allocation of personnel and fiscal resources toward strategic upgrades of HFIR instrumentation is essential to expand capabilities of the current instruments and to innovate new measurement geometries.**

During the review, one of the primary focus areas of the Instrument Beamline sub-committee was the origin of the expenses in the HFIR budget designated as Materials and Supplies (M&S). The M&S cost of $3,764K in 2013 is a seemingly large fraction of the total BES cost of the Beamline Instrument Operations. The portion of that expenditure directly associated with HFIR instrument operations is $2,780K (from the adjusted instrument table provided by Ron Crone), and the corresponding yearly cost per BES-funded beamline (total of 12 user instruments plus the optics test station) is only $1.4M when all pooled HFIR instrument expenses (including personnel) are included. Supplementary information provided by Ron Crone and his management team members revealed that instrument-specific costs for daily supplies and consumables (such as nuts and bolts, chemicals, chem wipes, gloves, etc), which are typically assumed to be the primary component of M&S expenses, are quite reasonable but only account for approximately $50K per beamline. The user support laboratories, which are essential for sample preparation and complementary characterization, each cost approximately $100K per year. The remainder of the M&S costs is primarily attributed to acquisitions that modestly improved existing neutron instrumentation and expanded sample preparation/characterization laboratory capabilities. As examples, these lifecycle upgrades included new collimators for the powder diffractometer HB-2A (cost of $96K), rebuild and recommissioning of the residual stress instrument HB-2B (cost of $50K), and an equipment lift in the Guide Hall (cost of $43K). Verbal justification was provided for many of these strategic purchases by the Division leaders, and it is clear that the process for prioritizing costly instrument-related purchases takes the potential impact on scientific productivity into full consideration. Unfortunately, many important purchases, such as the SANS magnet, had to be deferred due to limitations in available funding. As acknowledged in the Five-Year Plan, "the thermal beam instruments were not substantially upgraded during the period of SNS construction" and there are "many opportunities for improvement." **Overall, the M&S expenses for HFIR seem to be small on a relative scale, and the facility could benefit from additional M&S resources in the future in order to maintain HFIR's long-time status as a premier, world-class neutron facility.**

The future plans for the HFIR are described in full in the 2014 Strategic Plan, the Neutron Sciences Directorate Five-Year Plan, and in the budget worksheets. While the current funding level is sufficient to sustain operation of existing instruments for 6 cycles, **the budget request for FY2014 includes an increase directed primarily to Reactor Operations in order to replenish fuel inventory and to perform critical plant upgrades that have been deferred in recent years. These tasks are essential in the short term to ensure reliable operation of the facility beyond 2014 and to prepare for operation for 7 cycles per year by 2015.** The future budget also includes provisions for high-priority instrumentation projects such as purchase of a low-temperature sample environment for WAND and improvements in the triple axis spectrometers (including new goniometers) to accommodate high-field magnets. (Note that the 11 T magnet remains as a purchase priority.) It is notable that the 2014 budget includes only a small increase in the number of instrument personnel. The HFIR budgets proposed for 2015 – 2018 have only a modest increase relative to 2014, and they reflect anticipated Reactor Operation costs associated with restoration of the number of run cycles to 7, personnel costs associated with increasing instrumentation staff to 2.5 per instrument, instrumentation development costs associated with major upgrades to the aging triple axis spectrometers (HB-1, HB-1A, and HB-3), and additional costs associated with other priorities justified in both the Strategic Plan and in the Five-year Plan. The proposed budgets leverage the BES funding against income from other sources for specific projects (such as sponsorship of WAND by the Japan Atomic Energy Research Institute, BER funding of the Biology and Soft Matter Division, NSF support for IMAGINE, etc.). Of particular importance is the anticipated SING III funding ($23.3M for HFIR instruments) for large-scale instrumentation projects such as detector coverage expansion for the GP-SANS and Bio-SANS and installation of PSD's for many of the diffraction instruments. **These major upgrades are essential in the long term in order for HFIR to embrace new neutron measurement opportunities (such as time-resolved kinetics) and to remain at the cutting edge.** The facility is strongly encouraged to pursue other funding sources and to obtain a greater share of internal LDRD funding for well-defined, forward-thinking projects that further expand the broad user base.

While the proposed budgets for FY2014-2018 accurately reflect the short-term operational needs and long-term scientific priorities of the facility, the Instrument Beamline sub-committee concurred that **there was insufficient contingency built in for unanticipated maintenance-related problems** (such as the pipe issue that occurred just prior the review). While there was recent growth of personnel in the Neutron Data Analysis and Visualization Division, their efforts are primarily directed toward the challenges associated with SNS data collection and analysis. **Unfortunately, there seems to be minimal effort directed toward development of next-generation data acquisition software for the planned instrumental upgrades at HFIR. Targeted software development in many areas (i.e., data collection, analysis and modeling) is critical to producing high-impact science.** Finally, the budget carryover, which is mostly committed to future procurements, should be sustained at its current level to allow for approximately 21 – 30 days of operation in the event of an interruption of cash flow, as occurred at the beginning of FY14. The current constraints on domestic spending may limit the growth rate of the budget, and HFIR may be required to postpone projects of lower priority to future years. The management team appears to be prepared for this detrimental possibility.

In conclusion the current budget levels and future budget projections for HFIR are justified in light of the impressive, sustained scientific productivity as exemplified by the instrument oversubscription rate and the growth of the user base during the past five years. **Any reductions in funding from the requested levels will have a significant impact on the ability of the facility to run reliably beyond 2014 in light of fuel issues and to run for 7 cycles by 2015.** The ongoing development and improvement of the complementary measurement capabilities at SNS and HFIR should be fully supported in order to address the demands of the U.S. scientific community and to remain competitive with other facilities (such as ESS, ISIS and ILL) around the world.

REVIEWER #2

Evaluation Report of the Facility Operations Budget Review for the Office of Basic Energy Sciences

Spallation Neutron Source and High Flux Isotope Reactor Oak Ridge National Laboratory

1. Introduction

A facility operations budget review of the Spallation Neutron Source (SNS) and the High Flux Isotope Reactor (HFIR) at Oak Ridge National Laboratory (ORNL) was requested by the Office of Basic Energy Sciences (BES). I was one of twelve reviewers tasked with commenting on all of the cost/personnel items listed below for the SNS and HFIR; providing a more detailed review in my area of expertise. Additionally, Sean O'Kelly, from National Bureau of Standards Reactor (NBSR) at the National Institute of Standards and Technology (NIST), and I were specifically tasked with addressing these items for the HFIR (Reactor Source Operations).

- Assess the fiscal year (FY) 2013 operations cost including allocation of personnel (full time equivalents [FTEs]), materials and supplies (M&S), capital expenditures, and other budget items. This includes costs for the facility management and support staff, accelerator or reactor operations, scattering instrument staffing and M&S allocations, pooled support staff (e.g., sample environments, user office), and Environment, Safety and Health (ES&H) support levels.
- Evaluate the appropriateness of the projected FY 2014-2018 operations budget profile. Is the budget profile appropriately documented, justified, and reflects funding needs for the overall strategic goal(s) of the facility?
- Evaluate the operational efficiencies the facility has implemented or plan to implement in the future.
- Evaluate ES&H and Quality Assurance (QA) at the facility.
- Assess the appropriateness of the Facility Strategic Plan: scientific goals, upgrade plans, Research and Development (R&D) program, etc.
- Evaluate if there is an appropriate level of R&D funding for efforts related to improving operations, instrumentation, sample preparation, etc.

The following evaluation report is based on observations made at the two-day (November 19-20, 2013) review meeting held at ORNL, which included: an Overview of Neutron Sciences Directorate (SNS and HIFR) by Kelly Beierschmitt, Associate Laboratory Director, Neutron Sciences Directorate (NScD); ORNL Cost Model by Debbie Mann, Director, Financial Management Services; breakout sessions in our specific area of review (Reactor Source Operations) and information requested (by Dr. James Rhyne) from both the SNS and HFIR facilities that was available online and a hardcopy distributed at the meeting. This evaluation report outline follows the suggested outline as provided by Dr. Ryne. If there any questions regarding this report, please contact me at 573-882-576 or foytol@missouri.edu.

2. Evaluation Report

a. *Assess the fiscal year (FY)2013 operations cost including allocation of personnel (full time equivalents [FTEs]), materials and supplies (M&S), capital expenditures, and other budget items. This includes costs for:*

   i) *Facility management and support staff*
   ii) *Accelerator or reactor operations*
   iii) *Scattering instrument staffing and M&S allocations*
   iv) *Pooled support staff (e.g., sample environments, user office)*
   v) *ESH&Q support levels*

The Spallation Neutron Source (SNS) and the High Flux Isotope Reactor (HFIR) require significant resources, both personnel and budgetary, to operate safely, reliably and on schedule. Recently, both facilities have reduced or reallocated personnel resources to align with operational priority changes which appear to have resulted in enhanced user satisfaction. In conversations with HIFR staff and a review of the Organizational Chart (Information Request I.A and I.B) for the Research Reactors Division (RRD), it appears that HFIR is adequately staffed at the managerial, engineering, technical, craft and administrative levels (approximately 189 FTE).

The Neutron Sciences Directorate (NScD), which provides the necessary resources and infrastructure to support the user and science programs, must ensure that the current beam line experiments are maintained and eventually enhanced, while also introducing new capabilities on the experiment. Therefore, the users must have adequate resources directed to their experiment and adequate beam time allotted to them to ensure successful completion of their project. It appears, by the number of experiments and users and the successes of the experiments, that NScD has directed sufficient resources towards the user and science programs.

It appears that both HFIR and SNS share resources for instrument maintenance and development on their beam lines. While this can definitely be cost effective and result in greater expertise and versatility among the technicians and perhaps some standardization between the two facilities, management must sensitive to ensure that shared resources do not result in an imbalance in support between the two facilities, i.e., one facility having preferential treatment over the other. Additionally, another potential area of concern when using shared resources is the potential lack of sufficient reserves to cover any new projects or unexpected equipment failures that can result in significant loss of experiment time.

Aging management is a very critical component or program of any facility that operates safely and reliably. Although HFIR has had a very recent (since 2006) reliable operational schedule, resources, both personal and financial, should, nonetheless, be directed in this area. A very formal program, consisting of examining and documenting the material condition of every reactor system or component, must be established and maintained with all vulnerable areas identified.

b. *Comment on the overall budget levels and sources of funds (e.g., BES operations, LDRD and other internal funds, external funds received from other government agencies, industry, and fee for service work (e.g., isotope production and materials irradiation at HFIR). Is the yearly carryover amount appropriate? Are there additional sources of funds that should be explored?*

The U.S. Department of Energy's (DOE) Office of Basic Energy Sciences (BES) primarily funds the support, maintenance and infrastructure of the user and science programs at HFIR and SNS. There is limited laboratory overhead, such as Laboratory Directed Research and Development (LDRD), to support the infrastructure or programs not authorized by contract to DOE or the current budget cycle (Information Request II.A, II.B, II.C, II.D, and II.E).

User fees and fees for service work are additional funding sources that are already utilized by the HFIR but these funds may be limited and not support the primary mission of the facility. Exploring additional areas of service work to increase funding may be an option, but should not interfere with the core mission of providing the maximum number of neutrons to the maximum number of users. It is very difficult to meet the expectation of increasing the yearly operating schedule (more hours online) to fulfil this core mission when operational budgets remain relatively constant year after year.

When operating in an environment of uncertainties and delays in the Federal budget, it is extremely difficult to plan and adjust, as necessary, the operating budgets of HFIR and SNS. This past fiscal year, NScD management decided to carry over funding that was greater than the typical 10%. In this case, it was a prudent and sensible decision based on the looming reality of a Federal government shutdown.

Carryover is critical at HFIR since this provides early fiscal year funding to the fuel manufacturer. Reactor fuel is not an off the shelf item and typically requires two years to manufacture and procure. It is critical to the reliable operation of HFIR that funding dedicated to fuel stays dedicated to fuel and not be diverted to pay for something else. User availability and reliability of operations can be quickly impacted if shortfalls in the budget or delays in allocations result in insufficient funds in the first or second quarter of a fiscal year. It was noted that Oak Ridge National Laboratory (ORNL) and NScD did not receive their full budget allocations until August of this year.

It appears that the FY 2014-2018 budgets (Information Request III.A) for HFIR are being directed at appropriate areas, such as fuel production improvements, replacement/upgrades to major equipment systems, replenishment of critical spares, and operations and maintenance to support the annual operating cycles.

c. *Evaluate the operational efficiencies the facility has implemented, plans to implement in the future, or could implement.*

HFIR and SNS have both implemented over the past few years or plan to implement operational efficiencies (Information Request IV.C) that have focused on reducing the cost of operating the facility in areas such as resources, material and supply, user support, facility upgrades, etc.

At HFIR, the RRD has managed to reduce expenditures to stay within flat or reduced budget appropriations for six consecutive years. This has resulted in a reduction of 38 full time employees (FTE) compared to FY 2010. Additionally, 15 division FTEs are allocated to support work outside the division in FY 2014. Even though the workforce has been reduced, HFIR continues to meet its operational goals. However, the reduction in staff has resulted in the delay of some critical projects. One example has been a delay of several years in the implementation of a new emergency diesel generator due to lack of engineering resources.

The temporary transfer of personnel resources from one part of the NScD to another to support critical projects is an efficient and effective use of personnel in a lean budget environment. However, this has caused delays for projects or repairs in other areas of the Directorate.

Other operational efficiencies that have been implemented over the years at HFIR include the Reliability and Risk Management (RRM) Program, system upgrades, the Integrated Work Plan (IWP), and organizational changes related to the maintenance of facilities. All of these programs appear to be effective.

d. *Assess the appropriateness of the Facility Strategic Plan: scientific goals, upgrade plans, Research and Development (R&D) program, etc.*

The 2014 Strategic Plan (Information Request IV.A) is an update to the document "Plan for Delivering High-Impact Science Using Neutrons, 2011." In the "Director's Message" of the 2014 plan, the NScD Director recognizes that the goals and plan are ambitious and will require a decade or more of intense work.

The plan identifies the key science priorities, such as Quantum Materials, Material Synthesis and Performance, Soft Molecular Matter, and Biosciences, and provides a reasonable approach to studying these overlapping areas.

The plan also outlines new and upgraded capabilities of the scientific instrumentation on the beam lines based on detector development, neutron optics, technique development, sample environment, support laboratories, and data analysis and visualization. Upgrades and improvements to the SNS accelerator and the First Target Station (FTS) target are planned with a goal of operating at its design power level of 1.4 MW with 90% availability. But this will require additional R&D and funding to achieve (higher beam power, new inner reflector plug (IRP) assembly, and improved ion source).

Another planned upgrade is to increase SNS power to 2 MW and to design and install a Second Target Station (STS) (the facility was originally designed to accommodate a STS). This effort will likely occur in parallel while supporting the existing user and science program and thus will require additional resources without impacting the on-going research from the FTS.

In executing a major goal of the plan, which is meeting the increasing demand for neutron scattering capacity, two actions are planned to increase this capacity. First, HFIR and SNS must achieve optimal operating schedules that maximize neutron production hours. Currently, operation of HFIR and SNS has been limited because of budgetary constraints. Restoration of operating funds to the facilities would enable HFIR to restore two operating cycles and SNS to increase its neutron production scheduled hours to 5,000 annually. Second, funding will enable construction of instruments on the undeveloped beam lines at SNS (4 beam lines) and HFIR (2 beam lines).

Overall, though ambitious, the 2014 Strategic Plan appears appropriate, even in the current budget climate, and sets realistic and what appears as obtainable goals with a flexible direction that is acknowledged to be dependent on future technologies and stakeholder input.

e. *Evaluate the appropriateness of the projected FY2014-2018 operations budget profile. Is the budget profile appropriately documented, justified, consistent with the Strategic Plan, and reflects funding needs for the overall strategic goal(s) of the facility?*

Reviewers were provided both the 2014 Strategic Plan (Information Request IV.A) and the Neutron Sciences Directorate Five-Year Plan 2014 to 2018 (Information Request III.C.3). The five year plan sets forth the tactical investments required to execute the strategic plan.

The five year plan discusses maintenance deferral and reduced spare parts caused by budget shortfalls at HFIR and SNS. The five year plan also assumes a 5% budget increase in 2014 and increases into the future that reflect the scope of the plan. If the budget is not available or actually decreases instead of increases, the most likely scenario will be a steady decline in the reliability of the neutron sources.

One of the staff members interviewed commented that, in the 1990s, the HFIR budget was reduced and maintenance deferred because it was assumed that within the next 10 years the Advanced Neutron Source (ANS) would be built to replace HFIR. The ANS project was then cancelled in 1996. The poor record of HFIR reliability from 2001 to 2006 occurred roughly five years after the reduced HFIR operational and maintenance budgets and may have been a direct result of this. It is important that DOE learn from this and provide the necessary operational budgets to SNS and HFIR to ensure reliability.

Currently, the HFIR fuel inventory is at its lowest level in the past 40 years with only two years of supply (12 cores) on hand. The five year plan assumes sufficient funding in 2014 and beyond to purchase at least the fuel that is consumed annually with a gradual increase to create a 3 year fuel inventory to protect against any fuel supply disruptions. If there is only one takeaway from this review it's the following: it's imperative that DOE make this goal a number one priority – no fuel, no operating, no neutrons.

Plant lifetime extension projects to replace ageing equipment beyond the scope of normal maintenance and the replenishment of critical spares are also outlined in the five year plan and are essential that they are funded to ensure reliable operation. There is a development plan for the SNS to design and install the STS to expand the capacity of the facility. The five year plan includes Conceptual Design (CD) CD-1 and CD-2 of the STS in the schedule and budget.

f. *Evaluate if there is an appropriate level of R&D funding for efforts related to improving operations, instrumentation, sample preparation, etc.*

The SNS is relatively new facility and based upon the operational reliability and availability data presented during the review appears to be operating, for the most part, as designed at a power level of 1 MW. However, it was noted during the review that the current operating power level of 850 kW is lower than desired (this is based on the cavitation issues with the mercury target).

Two significant target failures that occurred within this past year may have been resolved, through significant resources, by correcting the design, fabrication, and quality control processes. Operating at the reduced power level, which minimizes the cavitation of the mercury target, may have contributed to the high availability of the SNS this past year. It appears, from the perspective of the user, that operating the SNS at 850 kW (reduced power level) is preferred because of the increased reliability versus operating at a power level of 1 to 1.4 MW with reduced reliability.

Operation of the SNS recently at a power level of 1.4 MW revealed areas and systems that must be improved before an increase in power level to 2 MW can be achieved. The engineering and financial resources to identify and correct these issues would need to be allocated in parallel with the design of the STS and the instrumentation plans to utilize the STS. These resources do not appear to be currently available to a sufficient level to balance normal facility operations and maintenance while increasing the capacity of the SNS. Constant low-level progress towards that goal will continue but to reach the final design goal and capability in the next ten years will require a major funding initiative.

g. *Evaluate the Environment, Safety and Health (ES&H) and Quality Assurance (QA) at the facility.*

This reviewer was not directly involved in the review of the Environment, Safety and Health (ES&H) and Quality Assurance (QA) programs.

REVIEWER #3

HFIR operations budget

The total burdened FY13 HFIR operations budget includes $72.8M from BES-SUF and $6.5M identified as being from other sources. Overall this budget was split by function into about 13% for facility management and business operations, 51% for neutron source operations, 25% for instrument operations and 11% for ESH&Q. This is a reasonable distribution for a nuclear facility. By budget category the overall breakdown is 73% personnel, 24% M&S, 3% utilities and <1% travel. This also appears reasonable.

The ESH&Q group leader presented FY13 staffing level as 32.5 FTEs: 10 radiation protection, 2 occupational safety and health, 1.3 environmental protection and waste management, 6.6 quality, 7.1 safety basis, and 5.5 training. The 32.5 FTEs total does not match the 29.7 FTEs presented in the response to the information request. The radiation protection staff provided 24/7 coverage for neutron source and instrument operations. The occupational safety and health staff performed safety and health reviews for all user experiments (333 in FY13) and provided work control and permitting support for laboratory and reactor operations and maintenance activities. The environmental protection and waste management staff managed emissions and waste generation and disposal. The quality staff supported engineering, fabrication, procurement, maintenance, operations, compliance and assessments. The safety basis staff maintained the Documented Safety Analysis and performed Unreviewed Safety Question Determinations. Training staff was responsible for training, qualification and certification for general employees, maintenance personnel, technicians, technical staff, reactor operators and shift supervisors. Considering the work that was performed the ESH&Q resources were appropriate. The ESH&Q burdened funding was sourced $7.9M from BES-SUF and $1.2M from others. The other sources were described as mostly safety analysis work for others.

ESH&Q has implemented operational efficiency measures. One was to develop a radiological work scoping process to identify scope, conditions and planning for routine work minimizing the re-review of the work. Efforts to minimize waste costs through use of larger containers and centralized packaging have been successful in minimizing costs.

The ESH&Q group leader indicated staffing at HFIR is expected to remain relatively constant through FY18. The information request response shows inconsistent budgeted variations from about 27 to 30 FTEs, all less than the staffing described as required to support the work in FY13.

ESH&Q at HFIR appears effective. Nuclear facility operations requirements dictate the higher safety basis, quality and training staffing requirements to accelerator facilities. The staffing levels presented are reasonable but appear under budgeted in the data provided compared to the group leader's expectations. The staff supports safe reactor operations and a productive user program. They contributed to ORNL's lower than average FY13 TRC and DART rates of 0.82 and 0.31 respectively.

REVIEWER #4

1. Assess the fiscal year (FY)2013 operations cost including allocation of personnel (full time equivalents [FTEs]), materials and supplies (M&S), capital expenditures, and other budget items. This includes costs for:

- *a. Facility management and support staff*
- *b. Accelerator or reactor operations*
- *c. Scattering instrument staffing and M&S allocations*
- *d. Pooled support staff (e.g., sample environments, user office)*
- *e. ESH&Q support levels*

The presentations were well organized and provided a good overview of the costs. ORNL does not account for costs in the method required for the presentation. This presented a challenge for the presentation of the material. During the presentations and ESH&Q break-out sessions reasonable explanations were given for the supporting documentation.

The HFIR is projecting an upward trend in FTEs, Direct and Burdened (Indirect) costs for FYs 2014 – 2017 (FY 2013 considered as the base line). However, FY 2018 is less than FY 2017. The increase is to accommodate increased cycles. This is dependent on funding and the ability to expand and improve the equipment.

HFIR

Category/FY	2013	2014	2015	2016	2017	2018
FTEs	261.0	272.4	290.8	292.3	303.9	292.3
Direct in 000s	$ 62,268	$ 81,613	$ 88,056	$ 91,616	$ 97,523	$ 97,074
Burdened in 000s	$ 79,291	$ 102,366	$ 110,012	$ 114,083	$ 121,522	$ 120,926
Total Dollars in 000s	$ 141,559	$ 183,979	$ 198,068	$ 205,699	$ 219,045	$ 218,000

The HFIR should continue to monitor and adjust the FTE and indirect rates to achieve an adequate staffing level and proper costing of projects. The current FTE and out years are below.

HFIR ESH&Q FTE

	2013	2014	2015	2016	2017	2018
BES-Funding	25.1	24.1	24.5	23.9	25.2	25.2
Other Funding	4.6	3.2	3.3	3.5	3.5	3.6
Total	29.7	27.3	27.8	27.4	28.7	28.8
Difference		(2.40)	0.50	(0.40)	1.30	0.10
Change Rate		-9.56%	2.07%	-1.63%	5.44%	0.40%

The other funding source is mostly from overhead funded FTEs. The use of shared FTEs provides cost savings because employees are shifted based on the demand of work.

2. *Comment on the overall budget levels and sources of funds (e.g., BES operations, LDRD and other internal funds, external funds received from other government agencies, industry, and fee for service work (e.g., isotope production and materials irradiation at HFIR). Is the yearly carryover amount appropriate? Are there additional sources of funds that should be explored?*

The budget for out years FY 2014-2018 is for 7 cycles and not 6 cycles. The lab stressed that if future budgets are not provided, cycles per year, scheduled maintenance & repair will be deferred. This is a short term fix and can impact the safety and efficiency in later years. The lab has a plan to reduce its scope (cycles, maintenance, etc) to meet the budget given by the government. In the past, they have used these methods and reduction in force to balance the funding and workload.

There was some conversation about the carryover. It was stressed and I agree there should be some clearly defined plan for the carryover. My suggestion is for the lab, the DOE ORNL Site Office and DOE HQ to come to some agreement. In this congressional environment, I think no more than 1/12 of the operating budget would be reasonable. My basis for the 1/12 is that government shutdowns have not exceeded 30 days. This should help hedge against going into shutdown mode and incurring additional costs.

There was some conversation about LDRD. During the presentation I did not take issue to what was said about LDRD. LDRD is capped at 8% and the areas of R&D are assessed at DOE HQ and/or the DOE ORNL Site Office per DOE O 413.2B.

3. *Evaluate the operational efficiencies the facility has implemented, plans to implement in the future, or could implement.*

The ESH&Q has improved the operational efficiencies by

- Minimizing waste cost by storing and combining partial containers of waste into larger containers.
- Developing procedures and processes for routine work by defining scope, conditions, and planning considerations. This risk based method provides for costs savings both in FTE and dollars.
- Internally developed web-based application increase efficiency from the proposal of work through the completion of work.
- Training for users is given online and in person. Redundant training was eliminated.

- Users take the samples they bring. The lab does not store samples and all legacy samples are gone.

During the review I asked the DOE ORNL Site Office if they felt the staffing was adequate. They gave no indication the staffing was not reasonable based on the presentations. During discussions with my co-reviewer for ESH&Q, Mr. Charles Kelsey, he felt the FTE to the work described was generally reasonable. He has much more experience than I in the specific EHS&Q related work, so I considered his comments.

2. *Evaluate the appropriateness of the projected FY2014-2018 operations budget profile. Is the budget profile appropriately documented, justified, consistent with the Strategic Plan, and reflects funding needs for the overall strategic goal(s) of the facility?*

The lab provided the indirect rates and wage rate data. The indirect rates were flat for out years. The lab stated escalation would be 2% per year for salary and material. I applied the 2% escalation to the FY 2014 Organization Burden Rates (Hourly), Space/Utilities (Yearly), and Wage Pool Rates (Hourly). All of the per dollar rates showed escalation above 2%. There is a disconnect with the 2% escalation rate and the actual escalation rate used. Based on my analysis, the actual escalation rates used are below.

Category/FY	2015	2016	2017	2018
Organization Burden Rates (Hourly)	2.60%	2.66%	2.59%	2.67%
Space/Utilities (Yearly)	3.30%	3.00%	3.00%	3.00%
Wage Pool Rates (Hourly)	3.70%	3.93%	3.94%	3.94%

I used the FY 2014 as the base year. I also totaled each category and did not look at each subcategory rate. I would not expect these labor and space rates to change because the indirect rates and escalation rates were straight lined. The variance range is 0.59% (2.59%-2.00%) to 1.94% (3.94%-2.00%) overstated. I applied the rate variance to the HFIR direct costs only. I did not consider the Burdened or Indirect costs because the rates were straight lined for out years. The overall impact would range from $519,530 to $1,883,236 per year. I did not consider the compounding.

HFIR In Thousands

Category/FY	2015	2016	2017	2018
Direct	$ 88,056	$ 91,616	$ 97,523	$ 97,074
Applied to Direct 0.59%	$ 519.530	$ 540.534	$ 575.386	$ 572.737
Applied to Direct 1.94%	$ 1,708.286	$ 1,777.350	$ 1,891.946	$ 1,883.236

Please note, I did not realize the variance in the escalation until after returning back to the office. The lab has not had a chance to explain.

7. Evaluate the Environment, Safety and Health (ES&H) and Quality Assurance (QA) at the facility.

Please see the comments above.

REVIEWER #5

Evaluation of HFIR operations budget, November 2013

1. *Assess the fiscal year (FY)2013 operations cost including allocation of personnel (full time equivalents [FTEs]), materials and supplies (M&S), capital expenditures, and other budget items. This includes costs for:*

    a) *Facility management and support staff*
    b) *Accelerator or reactor operations*
    c) *Scattering instrument staffing and M&S allocations*
    d) *Pooled support staff (e.g., sample environments, user office)*
    e) *ESH&Q support levels*

This reviewer's focus was on facility operations and business management. In FY13, considering only funds from BES-SUF, the burdened costs to HFIR for these functions were as follows: $7,331,000 for personnel (31.4 FTEs); $198,000 for M&S; and $13,000 for travel. The scope of activities included the following:

- Business management of $58,000,000 of BES-SUF new budget authority (per Table II.D)
- Personnel management of 228.2 FTEs
- Management of 182,000 ft^2 of conventional and programmatic buildings, along with the associated roads, grounds, and utilities (including janitorial, building maintenance, and site projects)
- Scheduling and project controls
- Procurement of nuclear materials
- Training/qualification/certification in accordance with DOE O 426.2
- Operations analysis and document control
- Information technology

Within each activity, the staffing and other costs are reasonable relative to the scope and complexity of the tasks.

2. *Comment on the overall budget levels and sources of funds (e.g., BES operations, LDRD and other internal funds, external funds received from other government agencies, industry, and fee for service work (e.g., isotope production and materials irradiation at HFIR). Is the yearly carryover amount appropriate? Are there additional sources of funds that should be explored?*

In FY13, in addition to the $58M mentioned above from BES-SUF, HFIR received $800K from the lab overhead-funded Melton Valley Project and $2.8M from Work for Others. These figures are reasonable relative to what was accomplished, and the yearly carryover amount is appropriate considering the funding delays that have historically occurred.

3. *Evaluate the operational efficiencies the facility has implemented, plans to implement in future, or could implement.*

Commendable organizational efficiencies implemented at HFIR have included the elimination of 38 FTEs from the staff working directly on the reactor since FY10 while sustaining 100%

predictability in operations; a strategic procurement of beryllium in FY13; measures to reduce the costs of waste disposal; efficiency gains in the fabrication of control plates; the use of Web-based applications for administrative and business processes; and the transfer of craft employees from the central ORNL organization to RRD. Efficiencies have also been gained by matrixing of business management and IT staff from the central campus; and, although not captured in the numbers for HFIR, the sharing of resources and expertise where appropriate between SNS and HIFR.

4. *Assess the appropriateness of the Facility Strategic Plan: scientific goals, upgrade plans, Research and Development (R&D) program, etc.*

The "Strategic Plan 2014" addresses four major scientific goals: The enhanced understanding and development of quantum materials; advanced synthesis capabilities for high-performance materials; synthesis and understanding of soft molecular matter; and synthesis and understanding of bio-inspired materials. The Plan provides ample justification for these choices.

Upgrade plans include improvements to existing instruments and sample environments; development of new instruments, such as a continuous cold neutron spectrometer and a neutron spin echo spectrometer; development of improved neutron optics; development of a polarized cold neutron beam line; expanded laboratory facilities; and improved data analysis and visualization, including integration of high-performance computational simulation and modeling with the analysis of neutron scattering data. These complementary approaches constitute a robust plan for readying HFIR to accommodate the above-mentioned scientific goals.

5. *Evaluate the appropriateness of the projected FY2014-2018 operations budget profile. Is the budget profile appropriately documented, justified, consistent with the Strategic Plan, and reflects funding needs for the overall strategic goal(s) of the facility?*

The "Five-Year Plan 2014–2018" shows the following annual increases in new budget authority levels relative to the previous FY: FY14, +5%; FY15, +25%; FY16, +3%; FY17, +4%; and FY18, +2%. By way of documentation, the Five-Year Plan shows timelines for various upgrades, with estimated costs per year for some but not all of the efforts. It was not clear to this reviewer, from the data provided here and elsewhere, why HFIR would need a 25% increase between FY14 and FY15.

6. *Evaluate if there is an appropriate level of R&D funding for efforts related to improving operations, instrumentation, sample preparation, etc.*

As noted above, the Five-Year Plan shows timelines for various upgrades, with estimated costs per year (for some but not all of the efforts) that seem appropriate.

7. *Evaluate the Environment, Safety and Health (ES&H) and Quality Assurance (QA) at the facility.*

The TRC rate for HFIR has decreased in the FY11–13 time frame, although it remained above the FY13 Office of Science and ORNL goals. There were no DART incidents in FY12; the DART rate in FY13 was lower than in FY11 but still above the FY13 Office of Science and

ORNL goals. For evaluation purposes, it would be helpful to know the actual numbers, and the natures, of these incidents.

The quality management program described in the HIFR ESH&Q presentation is comprehensive and appears to make efficient use of a relatively small staff.

REVIEWER #6

Operations Budget Review, High Flux Isotope Reactor (HFIR)

November 19/20, 2013

1. **Assess the fiscal year (FY)2013 operations cost including allocation of personnel (full time equivalents [FTEs]), materials and supplies (M&S), capital expenditures, and other budget items. This includes costs for:**

    a) **Facility management and support staff**
    b) **Accelerator or reactor operations**
    c) **Scattering instrument staffing and M&S allocations**
    d) **Pooled support staff (e.g., sample environments, user office)**
    e) **ESH&Q support levels**

HFIR is a mature reactor source, operated as part of the Neutron Sciences Directorate, along with SNS, by ORNL. In FY2013 HFIR received a $73M operational budget from the DOE SUFD. This compares to approximately $157M of SUFD support at ORNL's SNS facility and approximately $10M at LANL's LANSCE facility, meaning that HFIR accounts for about 30 % of the DOE SUFD expenditure on neutron facilities. The approximately $250M per year total costs to DOE for operation of neutron facilities corresponds to around 1/3 of the total DOE facilities expenditure. Neutron facilities thus consume a considerable fraction of the DOE SUFD budget, and HFIR accounts for almost 1/3 of this support.

In FY2013 HFIR expended 10 % of its total DOE budget on facility management, 53 % on neutron source operations, 26 % on operational costs for instruments, and 11 % on ESH&Q. Of these funds, 72 % went to personnel, 25 % to M&S, 3 % to utilities, and less than 1 % to travel. In terms of the 228 FTEs at the facility, 46 % are assigned to source operations, 29% to instrument operations, 14 % to facility management and business operations, and the remaining 11 % to ESH&Q.

Comments on these costs and FTE allocations are provided below, organized by the five categories listed above:

(a) Facility management and support staff: This reviewer's overall opinion is that the 10 % expenditure on management, corresponding to 14 % of the FTEs at the facility, is clearly reasonable, competitive with other large scale scientific user facilities of this type. Importantly, these figures include business operations also, and the overall impression acquired from the review was that these business operations are lean and efficient. It should be noted in particular that the two review panel members specifically charged with examining this aspect of the facility relayed to the committee their findings that this aspect of the HFIR budget was largely appropriate, given the scope and output.

(b) Reactor operations: The 53 % expenditure on source operations, amounting to 46 % of the FTEs at the facility, was assessed as reasonable on the whole by the two members of the panel charged with assessing this particular aspect. A couple of prominent factors that ought to be taken into account in considering these figures are; (a) the possibility of under-staffing of certain aspects of instrument support at HFIR (which will be discussed in detail below), and (b) the fact that beam reliability at HFIR has improved dramatically in recent years and appears to have played a major role in the significant improvement in scientific output at the facility. The latter is a topic that is also discussed at greater length below. As a final note on reactor operations it should be emphasized in examining other statistics that the facility was only able to operate for six of the eight planned cycles for 2013.

(c) Scattering instrument staffing and M&S allocations
(d) Pooled support staff
Given the manner in which the facts and figures in these two areas were accounted, and presented to the committee, it seems most appropriate to consider them together. The first item to note is that the allocation of FTEs across the 13 instruments currently in operation at HFIR is quite non-uniform, fluctuating by a factor of more than two, between 3.0 and 6.7 per instrument. This average of about 4.5 FTEs per instrument should be compared to an approximate internationally-averaged value of 5-6 FTEs per instrument, leading to the conclusion that there could be some concern over staffing levels at HFIR, particularly on certain instruments. The average costs per instrument run at $1.4M per year, a relatively modest level. An important finding from the review is that a large fraction of these costs at HFIR also include pooled support for the instruments, a factor that is typically not taken into account in this same manner at other facilities. In the opinion of this reviewer the substantial effort on the part of the committee to decipher this aspect of the budget points to something of a failing of the facility management in its preparation for the review and the management's overall familiarity with the HFIR cost model.

A similar apparent irregularity occurs in considering the statistic that a substantial fraction of the $1.4M per year per instrument costs are accounted for by M&S. Closer analysis reveals that the majority of these costs are what might typically be considered capital expenditures. While it is understood that the DOE-mandated definitions are being employed, it seems that there are simple ways to make clearer distinctions in this regard. Going in to some detail, these costs go to hardware items (specific to HFIR) such as improved sample environment equipment (particularly for typical cryogenic and very low temperature experiments), an equipment lift, a rebuild of parts of the residual stress instrument, etc. The actual expenditure on what might typically be characterized as "consumables" is actually only around $50 k per instrument, slightly higher in the area of Biology and Soft Matter. In short, the large apparent expenditure on M&S is found by the this reviewer to be slightly misleading, actually reflecting a careful and deliberate plan to improve instrument capability. As discussed in more detail below, this is clearly reflected in the performance metrics of the facility, and is one of the most obvious and noteworthy points from the HFIR review.

(e) ESH&Q support levels: This area is largely beyond the expertise and familiarity of this reviewer. It should be noted however that the two members of the committee responsible for reviewing this area reported to the committee as a whole that they found the staffing levels and expenditures in FY13 to be reasonable.

2. Comment on the overall budget levels and sources of funds (e.g., BES operations, LDRD and other internal funds, external funds received from other government agencies, industry, and fee for service work (e.g., isotope production and materials irradiation at HFIR). Is the yearly carryover amount appropriate? Are there additional sources of funds that should be explored?

The SNS budget from DOE SUFD ($73M) is supplemented with $6.5M of additional support from non-DOE sources. A considerable fraction of this comes from cost recovery from ORNL overhead. As a simple statement of the overall magnitude of these overhead costs (which are significant due to factors such as scale, nuclear footprint, and legacy management issues), the total multiplier on a $100k example salary is 2.40x at SNS. This does compare favorably however with the overall lab average of 2.91x, and the SNS value of 2.43x. The benefits of this were repeatedly emphasized by the facility management. In terms of LDRD funding, which to a large extent is enabled by ORNL overhead, the neutron science directorate currently has 13 such active projects. $9.7M was additionally injected into facilities improvements by ORNL. These LDRD projects typically cost $300-$500k per year, fund mostly post-docs, and are clearly an area in which HFIR (and the SNS) must compete as aggressively as possible for the maximum possible leveraging of DOE investment. Fee for service work, unlike at SNS, forms a part of the non-DOE revenue, mostly made up of irradiation, isotope production, and neutron activation analysis work. On a different note, this reviewer found it particularly noteworthy that UT/Batelle management amounted to less than 1% of the total ORNL budget, a figure that seems to compare very reasonably with that seen at other facilities with similar management models.

The issue of carryover amounts in yearly budgets is one which deserves special mention. It became clear over the course of the review that, at several levels, the facility management did not seem to have a complete familiarity with the standard approaches that seem to be in place for modeling and setting these carryovers. The finance personnel did provide a coherent picture of this process though, and confirmed the current approach of budgeting the carryover to enable 21 day operation with no funding stream. This would appear to amount to over 10 % of the budget for the facility and it is not clear to this reviewer whether this is in-line with DOE SUFD expectations based on the operational processes at other facilities.

In terms of identifying additional funding sources, it appears that the facility is currently doing a good job of maximizing ORNL support, both in terms of direct project funding, LDRD funds, and other forms of indirect cost recovery. It is not clear to this reviewer that other obvious sources exist.

3. Evaluate the operational efficiencies the facility has implemented, plans to implement in the future, or could implement.

Given this reviewers area of expertise, most comments in this area will be restricted to the issue of instrument operation. As mentioned elsewhere, sample handling, user support, and ESH&Q appear to run very efficiently, as do business operations. The statistic regarding the approximately 4.5 FTEs per instrument suggests a high degree of overall efficiency, and this is supported by the trends discussed below with regard to costs per experiment, and other output metrics. In terms of scientific associates and beamline scientists the allocations per instrument appear reasonable in most cases, but distinctly lean in others. Obvious examples include the residual stress and WAND instruments, although the entire facility does appear lean in terms of instrument support staffing. It was noted in particular that the triple axis systems at HFIR operate at 1.5 scientists per instrument. A variety of other comments regarding efficiency and staffing levels are provided in other sections of this review.

4. Assess the appropriateness of the Facility Strategic Plan: scientific goals, upgrade plans, Research and Development (R&D) program, etc.

The HFIR facility director provided a clear picture of the history of the development of the current directorate strategic plan, and the manner in which it is evolving. This was put in context from remarks during the review from ORNL Deputy Director R. Ramesh, who emphasized the overall commitment to neutron science at ORNL, and the ongoing process of organizing workshops in order to understand community needs in key areas (specifically Condensed Matter, Bio/Soft Materials, and Energy). Beierschmitt reviewed in some detail the increase in instrument operations budgets relative to facility management, and the restructuring of the science effort into four divisions (Condensed Matter Sciences, Chemical and Engineering Materials, Biology and Soft Matter, and Data Analysis and Visualization). Good evidence of commensurate improvements in productivity in the period through to 2011 were provided, including the rise to over 140 HFIR publications in 2012, and 1300 total users (477 unique users) in 2011. The ORNL neutron sciences directorate publications currently arise 1/3 from SNS, 1/3 from HFIR, and 1/3 from joint efforts between the two, and it is the management's expectation that the total output should become the biggest from any single facility, worldwide, by 2015. As a side note it should be commented that, in the opinion of this reviewer, the appointments of the division leaders in the four areas mentioned above seems to have had a positive effect. This reviewer is particularly impressed with the vision of these four individuals and plans they are putting into place in their respective areas.

One issue worthy of specific discussion is the potentially misleading statistic that, since 2011 both the total number of users, and the number of unique users, has dropped substantially at HFIR (and SNS for that matter). Closer inspection of the relevant data reveals that this is ascribable to both a decrease in the number of users per experiment, perhaps slinked to tightening travel budgets at universities and other laboratories, and the delivery of six *vs.* eight reactor cycles in 2013. This reviewer feels that it would be very advisable for the facility to adopt a more useful metric, perhaps based on the number of experiments run per year, a figure that can also be normalized to the hours of beamtime awarded.

5. **Evaluate the appropriateness of the projected FY2014-2018 operations budget profile. Is the budget profile appropriately documented, justified, consistent with the Strategic Plan, and reflects funding needs for the overall strategic goal(s) of the facility?**

The FY2014-18 budget profile (which calls for a 4 % increase in FY2014) is designed to enable increase in neutron capacity, build-out of existing instruments, and so on. While the neutron science directorate seems to be active in engaging the community in order to define user goals over the medium term, the complex question of how well the specific upgrades planned map to the five year plan, total strategic plan, and entire community needs and goals, is certainly important. It does however seem that individual items for improvement are created with the strategic plan in mind, in addition to the recommendations from the most recent triennial review. One specific and concrete example of the input from this review being used to define development priorities occurs in the area of sample environment, where significant investments and improvements have been made recently at HFIR, very low temperatures and high magnetic fields being a prominent example. A further complex issue here is the balance between striving for improved capability and improved capacity. While the former is clearly the overall driver, the importance of the latter is underscored by the order of magnitude difference between the numbers of DOE SUFD x-ray and neutron users. This reviewer commends the HFIR and SNS staff, overall, for the balance between these two issues that they are seeking to strike with planned instrument improvements.

6. **Evaluate if there is an appropriate level of R&D funding for efforts related to improving operations, instrumentation, sample preparation, etc.**

This item is closely related to (4) and (5) above, and also has overlap with statements made in (1c and d). It seems quite clear that the HFIR and SNS staff are very forward thinking in terms of improving operations, instrumentation, and laboratories. This is illustrated very well by the commitment to instrumentation and sample environment improvements discussed in 1(c,d). Instrument scientists are clearly working very hard to expand the capabilities and capacities of their instruments and it seems the only questions that could be asked is whether this process is even too aggressive, or is being appropriately managed. It is the opinion of this reviewer that it probably is indeed appropriate, as investments in improved functionality and sample environment can only drive the facility in the direction of higher, and more visible, scientific output. Similar statements can be made regarding sample preparation labs, particularly relevant to the biology and soft matter effort. Expenditure and planning seem reasonable there, and well justified by the number of users. Specific to HFIR only, one clear concern from some of the above statements is the apparent under-staffing of certain instruments, perhaps even the entire facility. While the facility management did comment on some positions currently open to attempt to address this, an obvious source of concern, particularly when one thinks of the 1/3 of all ORNL neutron publications that results from the use of both HFIR and SNS, is that measurements at HFIR could become a "bottleneck" in this process. On a related, and very positive note, this reviewer was pleased to hear that good, if somewhat informal, systems are in place to enable user work that makes the most of both facilities. A specific example from the hard condensed matter group involved "surveys" based on inelastic neutron scattering measurements at SNS, followed up with parametric studies of specific features at HFIR. This is an excellent example of the kind of efficiency one would ideally hope to capitalize on at a facility such as this.

7. Evaluate the Environment, Safety and Health (ES&H) and Quality Assurance (QA) at the facility.

As mentioned above this is an aspect of the operations of the facility that is largely beyond the expertise and familiarity of this reviewer. On the whole however the reviewer notes that the safety record at the SNS appears to be exemplary and that all indications point to efficiently operating systems with appropriate costs and effectiveness. The consideration of safety aspects of the beamtime proposals, and the whole process of sample handling, seem particularly well organized.

REVIEWER #7

2013 HIFR Operational Budget Review

Introductory remarks
The 85 MW High Flux Isotope Reactor (HIFR) at Oak Ridge National Laboratory (ORNL) has a storied history and continues to provides much needed neutron measurement capacity to the U.S. research community. HIFR provide s complementary facilities to the Spallation Neutron Source (SNS) and the synergy between the two sources, sited on a common campus, is now being well exploited and offers unique co-located research opportunities that can be tailored to highly specific measurement needs. Unlike SNS, HFIR also contributes significantly outside of the neutron scattering scientific field. Its other mission areas including isotope production, fission and fusion-related materials development, and support for non-proliferation programs are of significant impact although largely outside the remit of the present review.

The success in installing and commissioning the cold source in 2007, allied with a refurbishment program, expanded the capabilities of the source with most notably two SANS instruments and an imaging station entering the user program. The scientific output from neutron scattering activities at HIFR is strong and of high quality—the program on magnet crystal structures is of particular note. And user demand for these facilities remains high.

The HIFR and SNS facilities recently received a strong mandate recently from BES to "produce science" and following a review by senior facility management the current organizational structure including four science-based divisions covering both facilities was set up at the beginning of FY2012. The management assessment at that time identified staffing and equipment limitations affecting scientific output across the two facilities and resource allocation was adjusted significantly to increase funding of the science program. The distribution of the $72.8 M BES cost for HIFR in FY2013, among the categories defined for this budget review (Accelerator Operations, Reactor Operations, Beamline Instrument Operations, Facility Management and Business Operations, and Environmental Safety Health and Quality (ESH&Q)), clearly reflects this re-prioritization while providing sufficient resources to ensure reliable, consistent operation of the spallation neutron source albeit with compromise to optimum operations at HIFR.

At the time of the review HIFR has currently 12 BES-funded instruments in the user program (as stated in ORNL staff presentations for the review). Unlike SNS, HIFR is a mature facility and can be considered as well established and running under steady-state operations. The productivity of the facility is generally high and in 2013 this was maintained at a good level despite a reduction of instrument days due to budget limitations curtailing the number of operating cycles.

FY2013 Operations Costs
The $72.8 M BES budget supports 228 full-time employees (FTEs) divided between the functions of Facility Management and Business Operations (31), ESH&Q (25), Neutron Source Operations (106), and Instrumentation Operations (66). It was noted that these numbers reflect comparatively recent changes in the composition of staff following three rounds of reductions in force (both voluntary and involuntary) that saw the release primarily of engineering and business operations personnel.

The proportion of BES-funded staff (14 %) allocated to Facility Management and Business Operations and ESH&Q (11 %) was clearly adequate for the support function roles assessed during the review. (In particular it was noted that both SNS and HIFR had good safety records.)

In recent years combined staff numbers across both HIFR and SNS assigned to science (instrumentation) operations have been on a growth curve whilst staff assigned to neutron source and business operations have been reduced and during the review, resource levels for instrument operations were a particular focus of this sub-committee. For FY2013 instrument operations received funding of $18.9 M, of which 79 % was allocated for staff salaries and associated overhead costs. Salaries and overhead costs were deemed in line with similar US institutions.

A calculation of personnel directly involved in operating neutron scattering instruments—essentially staff members who a visiting user could reasonably expect to interact with—yields 4.4 FTEs per instrument and represents an average annual operating cost of some $1.3 M. This figure includes pooled staff that provide vital technical support for example with sample environment and general maintenance. Day-to-day beam line operations are supported on average by less than two dedicated FTEs per instrument. **These staffing levels are on the lower side of international standards and are unlikely to sustain the current throughput of users and unique experiments over a full (7 cycle) year of reactor operations.**

Comparisons of staffing levels at the various neutron scattering centers should take into account the relative size of operations as indicated, for example, by the number of instrument days. Data for 2012 show the Institut Laue-Langevin[1] (ILL), the NIST Center for Neutron Research[2] (NCNR), and the ISIS Spallation Neutron Source[3] with operations of 8000, 6141, and 3360 instrument days respectively and staffing levels per instrument of 7.0 and 4.5 FTEs for ILL and NCNR respectively with ISIS essentially midway between these two figures. HIFR operations supported some 1800 instrument days in the same period[4].

In comparison, staff levels at SNS are 7.0 FTEs per instrument although when additional staff categorized as supporting instrument operations are included in the calculation for SNS instruments— principally in instrument engineering, data acquisition and controls, and data analysis and visualization—the number rises to 13.0 FTEs per instrument. The differential in instrument staff levels between SNS and HIFR is expected to a large degree given the major difference in maturity of each facility and the specific challenges each currently faces. The aggressive instrument build program at SNS demands higher engineering effort and the challenges presented by data acquisition and controls, and data analysis and visualization also require a significant staff effort (in both these areas any benefits to HIFR are extremely limited) and management is correct to direct effort in this way. Nevertheless, staffing levels and policy at HIFR, for example use of short-term hires, are a cause of concern for the long-term productivity of the facility in particular on the higher throughput SANS and powder diffraction instruments.

[1] http://www.ill.eu/fileadmin/users_files/Annual_Report/AR-12/page/publications.htm.

[2] http://www.ncnr.nist.gov/AnnualReport/FY2012/AR_2012_large.pdf. Data reported here are for mid-2011 to mid-2012

[3] http://www.isis.stfc.ac.uk/aboutisis/annual-review/2012/isis-annual-review-2012-pdf13438.pdf.

[4] operating cycles were reduced from seven to six in 2012 and 2013

This sub-committee also spent considerable time focusing on resources allocated to materials and supplies (M&S) for beam line instrument operations. In FY2013, M&S costs account for $3.8 M a significant proportion of the total budget of $18.9 M. Supplementary information supplied at the time of the review from ISD personnel established that beam line consumables account for some $50K per year per beam line. These are very reasonable figures to support a mature user program at the facility. BES funding for each of the user support laboratories constitutes a further $100K annually and represents a good return for essential sample preparation, sample handling, and expanding sample characterization capabilities. The remainder of M&S costs was assigned to enhancements of existing neutron scattering instruments and improvements to the support laboratories. The prioritization and justification for this spend was clearly driven by the likely returns for increased scientific productivity. The projects funded were necessarily modest in scope and include new collimators for the HB-2A powder diffractometer and refurbishment of the HB-2B residual stress diffractometer.

It was evident in discussion with instrument personnel that there remain many opportunities for lifecycle upgrades to the instrument suite at HIFR that would reap both improved efficiency and performance of scientific operations. In turn, it is acknowledged by management that developments at HIFR have been essentially on hold throughout the construction period of SNS. **As SNS matures and moves toward steady-state operations it is imperative that management continue to review very closely the productivity gains that could accrue from quite modest increase in the M&S instrument budget for HIFR.**

Budget carryover

Details provided for carryover funds for FY2009-FY2013 show typical figures of between 7-10 % of the total operations budget. Although there was no formally presented policy or strategy for carryover funds it was clear that a significant proportion is committed carryover on long lead-time items. The review panel also recognized that the unpredictable government funding modes of late (for example continuing resolutions and the recent lapse in appropriations) represent a major challenge for sustained operations and in such an environment carryover funds provide vital contingency.

Facility Strategic Plan & projected FY2014-2018 operations budget

As stated previously, HIFR is a mature facility in steady-state operations. Current funding levels are clearly sufficient to maintain the present level of scientific operations of the current instrument suite, albeit for only six reactor cycles per year. The increase in the FY2014 budget, which includes a projected $11.8 M carryover, is primarily focused toward source operations and seeks to complete critical plant upgrades. These have been deferred for some years and constitute an ever increasing risk to reliable facility operations. In addition, the new budget seeks to restock the fuel inventory. **This short-term plan should be considered essential in order to continue reliable operations of the HIFR reactor and return to an optimum running annual program of seven cycles.**

The out years budgets proposed for 2015 through 2018 reflect only modest increases above the FY2014 value and anticipate a return to seven-cycles-per-year operations. The proposed (modest) increase in staff levels on the instruments to support the higher level of operations is welcome.

The plan and accompanying budget proposal also envisage a SING III project which seeks major ($23 M) upgrades to the HIFR instrument suite. **These elements are appropriately prioritized and justified in the documentation provided, and should be considered essential for HIFR to continue long-term provision of world-class neutron measurement capability and capacity.** The instrument operations sub-committee expressed some concerns that insufficient budget contingency is being built up to address any unpredicted events following the recent period in which maintenance and obsolescence programs have been deferred due to funding constraints.

SNS Management has been successful in the past leveraging BES funding against income from other sources and the facility is strongly encouraged to continue to promote existing links and foster new ones. Notable examples to date include BER contributory funding of the Biology and Soft Matter Division and the specific collaboration with the Japan Atomic Energy Research Institute on WAND. The facility should continue to strive for increased funds through the internal LDRD funding route.

The facility should also continue to maximize the potential of "in kind" contributions through collaborative projects with sister neutron scattering facilities. ORNL is currently a partner in the International Collaboration on Neutron Detector Development and whilst contributing expertise to the development of wave-length shifting fiber detectors it should also seek to leverage complementary expertise from the collaboration for efficiencies and cost savings for other detector technologies that may be applicable at HIFR.

Concluding remarks

The HIFR current budget levels and future budget projections set out a cost-effective plan to return the facility to an optimum operating level and sustain strong and high-quality output whilst keeping pace with developments at SNS to continue to provide truly complementary measurement capacity. The synergy between the two sources sited on a common campus is unique to the BES-funded facilities at ORNL. And it is imperative the facility continues to be supported appropriately such that it fully meets the needs of the wider U.S. research community and will be competitive with planned developments at ISIS, ILL, and the European Spallation Source (ESS) in the future.

REVIEWER #8

High Flux Isotope Reactor Operations Budget Review
Individual Reviewer's Report

Summary

HFIR is operated efficiently and effectively, and at an appropriate financial level.

The use of an in-house Facility Operations group provides substantial operational efficiencies by ensuring that the customer and the management are all part of the same organization. In addition this arrangement allows for effective sharing of craft personnel for work on the accelerator or the conventional facilities, as needed.

The reorganization and shifting of resources from Source Operations to Instrument Operations is appropriate and puts more emphasis and resources on the scientific program.

The instrument support level appears to be somewhat low compared to international neutron source and national synchrotron facility standards.

Please note that each reviewer is asked to comment on all the cost/personnel items listed below, but providing more detail in your specific area of expertise:

1. *Assess the FY2013 operations cost including allocation of personnel (full time equivalents [FTEs]), materials and supplies (M&S), capital expenditures, and other budget items. This includes costs for:*

   a) Facility management and support staff

   Overall FY13 costs for Facility Operations and Business Management include $7,331k of personnel costs, $198k for M&S, and other costs for travel of $15k. These costs do not include an additional total of $2,580k provided from non-BES-SUF funding, primarily from ORNL space charges. (A significant portion of the space charges paid by HFIR and other occupants of the Melton Valley site come back to this group.)

   The use of an in-house Facility Operations group for the Melton Valley site allows for effective sharing of craft personnel for work on the accelerator or the conventional facilities, as needed. The staff and costs are appropriately sized, but these efficiencies have left the site services one-deep in a number of areas.

   The HFIR total overhead multiplier of 2.40 for a $100k salary is reasonable and in line with other DOE laboratories.

   b) Reactor operations

   The DOE reactor rules are very different from NRC rules, and given these differences the operations costs of $38.5M are reasonable. The HFIR reliability and risk management program is likely to allow long-term reliable and efficient HFIR operation. Plans have been made for replenishing the fuel inventory, but there is little margin for replacement or repair of older equipment without increased funding. Plans have been made to replace only the most critical equipment.

c) Scattering instrument staffing and M&S allocations

d) Pooled support staff (e.g., sample environments, user office)

The number of FTE per instrument is, at about 4.4 FTE per instrument, lower than other neutron sources, and potentially somewhat understaffed. The M&S costs include equipment purchases for improvements and upgrades, and are appropriate.

The reorganizations have allowed shared resources and closer collaboration between facilities and technical staff.

e) ESH&Q support levels

HFIR ESH&Q support level is appropriate to meet their safety basis. The overall ESH&Q support level appears to be appropriate, with plans in place for improving efficiency and replacing vacant positions. The level should also be sufficient for their immediate future plans.

User experiments and samples are reviewed for safety, and communications with the users and instrument staff are primarily done by floor coordinators (24/7 staffing).

2. *Comment on the overall budget levels and sources of funds (e.g., BES operations, LDRD and other internal funds, external funds received from other government agencies, industry, and fee for service work (e.g., isotope production and materials irradiation at HFIR). Is the yearly carryover amount appropriate? Are there additional sources of funds that should be explored?*

The overall budget levels are appropriate, but tight given the age and condition of the facility.

The yearly uncommitted carryover ($6.7M in FY13) is appropriate for the scale of the HFIR operations. Carryover also ensures the reactor can be maintained in standby mode if the facility is temporarily shut down.

3. *Evaluate the operational efficiencies the facility has implemented, plans to implement in the future, or could implement.*

The reductions in RAD, due to operational efficiencies, are appropriate to support the scientific program.

The movement of Facilities to in-house management at Chestnut Ridge and Milton Valley has resulted in significant efficiencies.

4. *Assess the appropriateness of the Facility Strategic Plan: scientific goals, upgrade plans, Research and Development (R&D) program, etc.*

The Facility Strategic Plan provides a good basis for optimal use of the facility, however it will need modifications to deal with budget realities.

The HFIR has 395 unique users in FY13, and approximately 125 instrument publications. The HFIR budget from DOE-SUF is $73M. To compare with synchrotrons, the total of SNS and HFIR had approximately 487 publications in FY13. The SNS and HFIR budget from DOE-SUF is $230M. The average of the four DOE synchrotrons for FY12 is approximately 2600 unique users and 760 refereed publications, and a budget of approximately $63.5M. Given the high cost per user (HFIR) and per publication (SNS+HFIR), greater than 7 times and 5 times, respectively, compared with synchrotron facilities, the modest cost of the planned upgrades seems appropriate.

5. *Evaluate the appropriateness of the projected FY2014-2018 operations budget profile. Is the budget profile appropriately documented, justified, consistent with the Strategic Plan, and reflects funding needs for the overall strategic goal(s) of the facility?*

The budget profile is optimistic with more realism in the earlier years. As HFIR management is aware, it will need modifications each year to deal with budget realities.

6. *Evaluate if there is an appropriate level of R&D funding for efforts related to improving operations, instrumentation, sample preparation, etc.*

Although complete numbers for R&D funding were not provided, the upgrade plans presented appear to be well considered, which implies a healthy R&D effort.

7. *Evaluate the Environment, Safety and Health (ES&H) and Quality Assurance (QA) at the facility.*

The ES&H and QA program at the HFIR appears to be effective and efficient, given the scale of the hazards at the facility. The user safety program appears to be efficient and effective, requesting more detailed information on the experiments and samples at appropriate times.