Department of Energy
Review Committee Report

on the

Technical, Cost, Schedule, and
Management Review

of the

SPALLATION NEUTRON SOURCE (SNS) PROJECT

May 2004

EXECUTIVE SUMMARY

A Department of Energy (DOE) Office of Science review of the Spallation Neutron Source (SNS) project was conducted at Oak Ridge, Tennessee during May 11-13, 2004, at the request of Dr. Patricia M. Dehmer, Associate Director for Basic Energy Sciences, Office of Science. The purpose of the review was to evaluate progress in all aspects of the project: technical, cost, schedule, management, and environment, safety and health. Special emphasis was given to evaluating how well the project is managing contingency and its adequacy for completing the remaining project work, and identifying areas where improvements could be made to ensure that the project is completed within the $ 1,411.7 million Total Project Cost (TPC) baseline.

Overall, the Committee found that the SNS project is appropriately managing the issues and can meet its Level 0 Baseline objectives: a TPC of $1,411.7 million; project completion by June 2006; and facilities capable of delivering at least 1 megawatt proton beam power on target. Cost control and contingency management are still the project's biggest challenges. The contingency based on the Estimate-at-Completion (EAC) dropped from $31.3 million to $25.3 million with about $121.0 million worth of line item work in the baseline left to be committed. The Committee again challenged the project to identify additional cost savings and recommended an EAC-based contingency goal of at least $20.0 million by the next DOE review. In response to a previous recommendation, the project has developed a plan for transferring staff to the SNS operating budget in FY 2006 as major subsystems are successfully commissioned.

Although not presently impacting the project's critical path, production problems with Linac components seem to be under control. Problems with fabrication and assembly of the Drift Tube Linac (DTL) caused some commissioning schedule replanning, but this is acceptable. More recently, superconducting cryomodule production had fallen behind schedule, and the project has developed and begun implementation of a recovery plan, which the Committee endorsed. Appropriate management attention at all levels has been dedicated to resolving both the DTL and cryomodule production issues.

The overall project schedule contains three to four months of contingency relative to the June 2006 completion milestone. Against that schedule, the current rate of progress is limited by the available Budget Authority (BA), and FY 2004 and 2005 BA constraints will continue to represent a significant cost and schedule risk for at least the next 16 months. Accordingly, human resources are also tight, especially in installation and commissioning of the technical systems. Schedule issues will require constant management attention for the duration of the project. It is important that the Target Building completion date (February 2005) be

maintained—it is a crucial milestone. Given that Target Systems installation is on the critical path, it is imperative that a comprehensive integrated installation schedule be developed and implemented for the Target Building and all Target installation activities as soon as practical—the Committee recommended that it be ready for review by July 1, 2004.

Technical and construction progress have been impressive, and as of March 31, 2004, the project is 79.5 percent complete versus 80 percent planned. The information in DOE's Project Assessment and Reporting System (PARS) accurately reflects this status. Activities since the November 2003 DOE review included: commissioning DTL Tanks #1-3; commencing cryoplant commissioning; receiving all four Coupled Cavity Linac modules; receiving 9 of 23 Superconducting Linac (SCL) cryomodules; continuing Linac, Target, and Ring Systems installation; and starting Instrument Systems installation. About 97 percent of SNS procurements have been awarded; most of those remaining are in Instrument Systems. The project's safety record has remained outstanding with about 5 million work hours without a lost workday away injury. There has been appropriately detailed planning for transitioning the SNS facility into operations following project completion.

The SNS project is a multi-laboratory partnership led by the SNS Project Office in Oak Ridge, Tennessee. The partners are Argonne National Laboratory (ANL), Brookhaven National Laboratory (BNL), Lawrence Berkeley National Laboratory (LBNL), Los Alamos National Laboratory (LANL), Oak Ridge National Laboratory (ORNL), and Thomas Jefferson National Accelerator Facility (TJNAF). Relations among the SNS partner laboratories continue to be generally good. Three of the laboratories (ANL, LANL, and LBNL) have essentially completed their scopes of work and transitioned off of the project. BNL and TJNAF are scheduled to complete their work and transition off of the project in 2005.

The SNS project was responsive to the recommendations from the November 2003 DOE review. At this review, the Committee made 23 recommendations and assigned one Action Item (to conduct the next DOE review during November 16-18, 2004).

In summary, the Committee found that the SNS project is still on track to meet its Level 0 Baseline objectives, and SNS management is on top of the issues including those associated with managing the BA limitations on schedule and production of the SCL components. The biggest challenges remain to be cost control and contingency management.

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1. INTRODUCTION

1.1 Background

When completed in 2006, the Spallation Neutron Source (SNS) will be the world's foremost neutron scattering facility. It will be an important scientific tool for basic research in materials science, life sciences, chemistry, solid state and nuclear physics, earth and environmental sciences, and engineering sciences. The design calls for a beam of negatively-charged hydrogen ions (H^-) to be generated in a Front End and accelerated to an energy of one billion electron volts (1 GeV) using a linear accelerator (Linac). The H^- beam will then be transported to an accumulator Ring, where it will be injected by stripping away the electrons to leave the desired protons to be collected in the Ring. Finally, the protons stored in the Ring are directed in a short (under one microsecond) pulse onto a liquid mercury target at a rate of 60 pulses per second, where pulses of neutrons will be created through spallation reactions of the protons with the mercury nuclei. Inside the Target Building, the emerging neutrons will be slowed, or moderated, and channeled through beamlines to instrumented experimental areas where users will carry out their research. Figure 1-1 shows a pictorial view of the facility.

The SNS project is being carried out as a multi-laboratory partnership, led by the SNS Project Office at Oak Ridge, Tennessee. Besides Oak Ridge National Laboratory (ORNL), the other laboratory partners include: Argonne National Laboratory (ANL), Brookhaven National Laboratory (BNL), Los Alamos National Laboratory (LANL), Lawrence Berkeley National Laboratory (LBNL), and the Thomas Jefferson National Accelerator Facility (TJNAF). This collaborative approach is being used to take advantage of the best expertise available in different technical areas and to make the most efficient use of Department of Energy (DOE) laboratory resources. As defined in the SNS Project Execution Plan (PEP), each laboratory is responsible for a specific scope of work. Design and construction management of the Conventional Facilities (CF) is being handled by a commercial architect engineer/construction management (AE/CM) team (Knight-Jacobs) under a task order contract to ORNL.

In February 1995, the Administration's FY 1996 Budget Proposal to Congress included funds to begin design of an accelerator-based neutron source that will provide the nation with a new, world-class facility for basic research and technology development. Congress provided

Figure 1-1. Spallation Neutron Source Facility

$7.6 million to begin that effort in FY 1996, and the Secretary of Energy approved Critical Decision (CD) 1, Approve Mission Need, in August 1996. The following year, Congress continued supporting the design effort with an appropriation of $7.9 million.

In June 1997, the first Office of Science review of the SNS project was conducted to assess the conceptual design report (CDR) that was developed during FY 1996-1997, at a cost of about $16 million (report DOE/ER-0705). The committee validated the technical scope of the CDR and determined the cost estimate of $1.233 billion to be credible, subject to a few adjustments; however, they also found the proposed six-year schedule to be overly aggressive. In response to recommendations from these reviews, the project schedule was extended from six to seven years, and other adjustments were made that increased the Total Project Cost (TPC) from $1,266 million to $1,333 million (as spent[1]). These adjusted cost and schedule values, along with the CDR defined scope formed the basis for the proposed Level 0 project baseline. Later that same year, a DOE Independent Cost Estimate was performed, that closely agreed with the CDR estimate.

The CD-2, Approve Performance Baseline, and the PEP, for the SNS were approved by the Secretary of Energy in December 1997. The SNS PEP governs how the project is managed, and it is maintained with the most recent updates of the Level 0, 1, and 2 sections being made in August 2002, April 2002, and October 2003, respectively. The Level 0 Cost and Schedule Baselines set at CD-2 comprised a TPC of $1,333 million and a seven-year design/construction schedule, with facility commissioning to occur at the end of FY 2005. The approved Level 0 Technical Baseline stipulated that the accelerator complex would be capable of producing a proton beam on target of $\geq$ 1 megawatt (MW). Receiving $23 million in FY 1998, the project carried out advanced conceptual design and further R&D activities in anticipation of starting Title I design in FY 1999.

In June 1998, a DOE technical, cost, schedule, and management review was conducted. Its principal finding was that the project's management organization and systems were sufficiently mature to initiate the construction project beginning in FY 1999. Further work was deemed necessary, however, to complete a detailed cost and schedule baseline, and to restore project contingency to at least 20 percent. A strong recommendation was made to hire a permanent Project Director as soon as possible and to continue building up the Accelerator Systems Division (ASD) at ORNL.

[1] All cost figures throughout this report are in "as-spent" (i.e., escalated) dollars.

At the start of FY 1999, the SNS project construction line item was approved and funded by Congress to start Title I design and initiate long-lead procurements, but only at a level of $130 million, as compared to $157 million requested in the President's FY 1999 Budget Request. As a result of the $27 million funding shortfall in FY 1999, the project schedule was extended by three months (completion due in December 2005), and the TPC was increased to $1,360 million. The President's FY 2000 Budget Request for the SNS project was $214 million ($196.1 million of line item construction funds and $17.9 million of operating expense funds).

In October 1998, ORNL competitively awarded an AE/CM contract to a joint venture led by Lester B. Knight and Sverdrup Facilities, Inc. (Sverdrup has since been acquired by Jacobs Engineering Group, Inc. and Knight has since been acquired by M+W Zander, but the joint venture retains the name Knight-Jacobs). The AE/CM team is responsible for design and construction of all CF.

At a January 1999 DOE review, the committee determined that the SNS collaboration was continuing to work well together, and technical progress was generally good, however the lower tier baselines were still not judged to be ready for DOE approval. The main reasons were weak technical integration of the partner laboratories and the lack of project-wide ownership by the relatively inexperienced SNS Project Office management team then at ORNL. The committee strongly recommended that a new Project Director be recruited with extensive experience in construction of large technical/scientific facilities and with the technical background, including accelerators, needed to make major design decisions. Overall, the $1,360 million TPC was deemed to be adequate to complete the facility as designed. The Committee, however, urged a further increase in contingency.

As an immediate result of the January 1999 DOE review, a new Project Director was brought on board from ANL in early March to lead the project for a two-year term. He brought with him a strong track record in managing large scientific construction projects and a user perspective as a neutron scientist. Between April and June 1999, the SNS Project Office at ORNL was reorganized and additional technical and management staff members were recruited to fill key positions. The partner laboratories were directed to optimize and fully integrate the technical design, and to strengthen the business and project management systems to support construction activities. The SNS technical goals were revised to include an average proton beam power on target of up to 2 MW, enhanced ("best-in-class") instruments, and expanded laboratory and office space for users and staff.

A Final Environmental Impact Statement for the SNS was issued in April 1999. On

June 18, 1999, the Secretary of Energy signed the Record of Decision to proceed with construction of the SNS at ORNL on Chestnut Ridge (the preferred site). A Mitigation Action Plan (MAP) was prepared, identifying actions taken by DOE and the project to avoid or minimize environmental harm in building and operating the facility. All actions identified in the MAP have been properly implemented.

In July 1999, another DOE review was conducted for the purpose of evaluating the project's proposed technical, cost, and schedule baselines. The review committee judged the baselines to be credible and consistent with the FY 2000 Budget Request funding profile, and recommended their approval by DOE. Confidence was expressed that the new SNS project team could lead the project to success; however, the committee emphasized the need to improve LANL's management approach for the Linac and for the project team to permanently fill the lead CF position. The committee felt that the management team had moved aggressively to take full ownership of all technical, cost, and schedule aspects of the project, and defined a clear vision and a disciplined management approach. In order to strengthen the commitment among the partner laboratories, the 1998 inter-laboratory Memorandum of Agreement (MOA) was revised, and signed by the laboratory directors in October 1999. It replaced the original MOA in the SNS PEP, and is also included by reference in the laboratories' management and operations (M&O) contracts. The latter step had the effect of making the MOA a legally binding agreement as required by Congress (see below).

At $117.9 million, the FY 2000 appropriation for SNS was $96.1 million less than the $214 million request. This, coupled with the project's restructuring under new management, led to an estimated delay in project completion of six months (to June 2006), and a corresponding increase in the TPC of $80 million (to $1,440 million including Tennessee taxes, see below). In addition, the House report (Report 106-253, pages 113-114) accompanying the FY 2000 Energy and Water Development Appropriations Act prohibited DOE from obligating FY 2000 funds to SNS until seven conditions had been satisfied. As FY 2000 began, the project used FY 1999 uncosted obligations to continue making progress until satisfying the stated congressional conditions. In particular, CD-3, Approve Start of Construction, was obtained on November 19, 1999, and site preparation work on Chestnut Ridge began soon thereafter. A formal groundbreaking ceremony for SNS was held on December 15, 1999. By February 2000, DOE and the project had satisfied the seven congressional conditions and all FY 2000 construction funds were released to the project. Later in FY 2000, the project managed to complete most Title I design activities, as well as nearly all site clearing, excavation, and road work.

One of the conditions in the FY 2000 House report was for the cost baseline and project milestones for each major SNS construction and technical system activity to be reviewed and certified by an independent entity as the most cost effective way to complete the project. In order to satisfy this condition, DOE tasked an External Independent Review contractor (Burns & Roe) who then conducted such a review during September through November 1999. The final Burns & Roe EIR report (December 1999) stated: "Burns and Roe's view is that the planned approach to executing the SNS project, as reflected by the baseline documents that support the FY 2000 Budget Request, is the most cost effective approach to project completion."

Another condition imposed by Congress was that the General Accounting Office (GAO) had to certify that the total taxes and fees on SNS paid to the State of Tennessee or its counties/municipalities would be no greater than if SNS were located in any other state that contains a DOE laboratory. In response, the Tennessee Legislature enacted a law in January 2000 to completely exempt SNS from state and local sales and use taxes (estimated at $28.3 million). This tax exemption addressed the last remaining condition in the House report, and GAO provided the necessary certification. The TPC was then reduced from $1,440 million to $1,411.7 million.

In March 2000, another DOE review was conducted for the purpose of evaluating progress in all aspects of the project: technical, cost, schedule, management, and environment, safety and health. The committee judged that the new management team was making good progress due to their demonstrated ownership of all technical, cost, and schedule aspects of the project. Cost and schedule information supported the President's FY 2001 Budget Request, and the committee expressed confidence that the project could be successfully completed as planned by June 2006 and within the $1,411.7 million TPC. The project's proposal to change the high-energy end of the Linac to a superconducting design was supported, subject to completion of necessary R&D as soon as possible, and TJNAF was added as a partner laboratory on the project. The SNS Integrated Project Schedule (IPS) was found to be resource-loaded, self-consistent, and supported by detailed schedules, and the management control systems (configuration control and earned value reporting) were found to be working adequately. Previously identified issues with LANL's management approach had been resolved with their establishment of a dedicated SNS Linac Division.

In April 2000, the M&O contract for ORNL was turned over from Lockheed Martin Energy Research Corporation to a team led by the University of Tennessee and Battelle Memorial Institute (UT-Battelle). From the SNS project perspective, the transition went smoothly—there were no adverse impacts.

Congress appropriated the entire requested amount for FY 2001 (minus a $512,000 rescission) and DOE provided the project with $258.9 million in construction funds and $19.1 million in operating expense funds.

In October and December 2000, a two-phase DOE review was conducted that included an initial evaluation of the SNS pre-operations plan and cost estimate. Three major issues were identified in the first review phase, two of which had to do with the potential for significant cost growth in different areas, one in CF and the other in pre-operations. It was also noted that the project was using contingency at an alarming rate. The cost growth concerns stemmed from the AE/CM's preliminary Title I design estimate for CF, which was about $80 million over the cost baseline, and an overly aggressive pre-operations staffing plan. The third issue was that the IPS was more aggressive (i.e., provided 14 months of contingency) than could be supported by the FY 2001 Project Data Sheet's annual Budget Authority (BA) profile.

SNS management took immediate steps to resolve these issues, and by December, the committee found that the project had developed workable plans to address them. The overall approach to dealing with the cost concerns involved value engineering and selective scope reductions that still allowed the project to meet its Level 0 Baseline objectives while providing a facility that meets or exceeds the capabilities defined in the CDR. There were significant scope reductions or deferrals in CF that included deferring a commitment to construct the Central Laboratory and Office (CLO) Building, reducing the size of the Target Building, and reducing the Instrument Systems budget from $93 million to $53 million (still more than the conceptual design level of $45 million). In addition, the last three cryomodules of the Superconducting Linac (SCL) were deleted to save money, resulting in an estimated lower Linac output energy of 840 million electron volts (MeV), while still providing a proton beam power on target capability of over 1 MW (the Level 0 Baseline parameter). The pre-operations staffing level was returned to the initial level, i.e., the minimum level necessary to commission the machine. Lastly, the IPS was re-planned to be more consistent with the BA in DOE's annual funding profile and still provide six months of schedule contingency.

SNS management met with DOE in February 2001 to finalize actions needed to resolve the cost and schedule issues described above. As a result, authorization to proceed with a reduced-scope CLO was given; the Instrument Systems budget was adjusted to $60 million to provide for five best-in-class instruments plus design of common components for future instruments; certain intermediate DOE schedule milestones were relaxed to conform with the revised IPS; and the specification for Linac output energy was restored to 1 GeV (while retaining the proton beam power on target requirement of $\geq$ 1 MW). Although there was a net shift in baseline installation scope from the partner laboratories to SNS to allow the necessary buildup of ASD staff, there was no change in the Total Estimated Cost (TEC), TPC, or project completion date.

In February 2001, the Project Director had reached the end of his two-year term as leader of the SNS project, and he elected to return to ANL. After an extensive search by the Director of ORNL, the incumbent SNS Experimental Facilities Division (XFD) Director, Dr. Thomas Mason, was selected to take charge as SNS Project Director and Associate Laboratory Director for SNS. Having been with the project since its conceptual design, he was thoroughly familiar with SNS and was also well known in the neutron scattering research community. Other changes in the senior management team were completed over the following months with the permanent appointment of new personnel to the three SNS Division Director positions (ASD, XFD, and Conventional Facilities Division or CFD).

In May 2001, another DOE review was conducted. Special emphasis was given to the SNS installation and commissioning plans, and there was a confirmation that project cost and schedule baselines were consistent with the President's FY 2002 Budget Request. The committee judged that the project was making satisfactory progress; that the three issues noted in the October 2000 review had been resolved; Linac energy output had been restored to 1 GeV; the number of state-of-the-art instruments stood at five with a total instrument budget of $60 million; and a reduced-cost CLO Building was included. There had been a smooth transition to a new Project Director and Deputy Director since the previous review, and a search was under way to permanently fill Division Director positions for XFD and CFD. An outstanding technical concern regarding the performance of the new cryomodules led to a recommendation to establish a radio frequency (RF) test stand at TJNAF.

In the November 2001 DOE progress review, special emphasis was given to evaluating the SNS updated Estimate-to-Complete (ETC), as well as installation and commissioning plans. The committee judged that the project was continuing to make satisfactory progress and remained on track to meet its Level 0 Baseline objectives. Technical progress had been excellent since the May 2001 review, with the design baseline exceeding requirements, five best-in-class instruments had been baselined, RF testing capability was being established at TJNAF, and there was significant progress on component fabrication and site construction. The committee endorsed the project's proposed ETC, and a Baseline Change Proposal was processed in December 2001 to incorporate it into the project baseline.

The May 2002 DOE progress review found that over 60 percent of all project procurements had been placed, the Front End was scheduled for shipment to ORNL in June 2002, conventional construction was progressing with some facilities nearing completion, and over 600,000 construction work-hours had been accumulated without a lost workday injury. Two areas of concern were raised by the committee that resulted in recommendations. First, there was a need for a quantitative, risk-based contingency analysis to be prepared, and second, until a definitive solution could be found for the recently identified target window pitting issue, the project should retain a solid target back-up design.

In the November 2002 DOE review, special emphasis was given to evaluating the project's decision to retain the liquid mercury target concept in the baseline, and to whether project contingency was adequate to address the risks associated with completing the SNS on schedule. The committee found that the project remained on track to meet its Level 0 Baseline objectives, and that the baseline was consistent with the FY 2003 Project Data Sheet and the PEP. The project reported that SNS was over 51 percent complete with more than 90 percent of all procurements placed. The Front End Systems had arrived in ORNL, and were being commissioned. Two problem areas had recently surfaced with the Linac, including: 1) vacuum leaks in a large fraction of the Drift Tubes supplied to LANL by a vendor required rework or rebuilding; and 2) the Low Level Radio Frequency (LLRF) Control System being developed by LANL fell seriously behind schedule and could not meet functional requirements. The committee recommended that the SNS Project Director and both Directors of ORNL and LANL become involved in a Drift Tube recovery plan, and that ORNL/SNS assume the lead role in a joint ORNL/LBNL/LANL team to resolve the LLRF problem. After a review of test results to understand the target pitting issue, the committee concurred with the project's decision to retain the liquid mercury target as the baseline design.

In the May 2003 DOE review, special emphasis was given to accelerator system component manufacturing problems that were threatening or delaying deliveries, and to whether project contingency was adequate to address the risks associated with completing the SNS on schedule. The committee found that the project remained on track to meet its Level 0 Baseline objectives, and that the baseline was consistent with the FY 2004 Project Data Sheet and the PEP. The project reported that SNS was over 61 percent complete, with design at 88 percent, construction at 60 percent, and installation at 26 percent complete. Recommendations focused on the need for increased vendor oversight for accelerator and radiofrequency component manufacture, and on the need for improving project completion planning and budgeting. This latter topic led to a follow-on DOE mini-review of the "End Game Plan" in July 2003, which recommended incorporation of the revised plan into the project baseline and the initiation of regular reporting of contingency status to DOE.

The FY 2001 through 2004 congressional appropriations for SNS ($278.0 million, $291.4 million, $225.0 million, and $142.3 million, respectively) have nearly met the levels contained in the President's Budget Requests, but Congress enacted minor reductions in FY 2001 and FY 2004 of $512,000 and $738,000, respectively, as part of general reductions/ rescissions. The project's TEC and TPC have remained constant at $1,192.7 million and

$1,411.7 million, respectively. The FY 2002 appropriation was the peak of the project's annual funding profile. The President's FY 2005 Budget Request for SNS is $113.6 million.

In the November 2003 DOE review, special emphasis was given to evaluation of the End Game Plan, the project cost and schedule contingency, and to the progress of installation and commissioning. As of September 30, 2003, the overall project was 72 percent complete, had awarded 95 percent of procurements, and completed 92 percent of all design work, 97 percent of R&D, 70 percent of conventional construction, 66 percent of technical hardware, and 39 percent of installation. Beneficial occupancy of the Ring and Ring Target to Beam Transport (RTBT) Service Buildings, Ring and RTBT Tunnels, Cooling Tower, Central Utility Building, and Linac and Ring Extraction Dumps had been accomplished. The site was transitioned from temporary to permanent electrical power. The last two remaining major civil construction activities at that point were the Target Building (62 percent complete) and the CLO Building (45 percent complete). The project had logged a safety record of over 2.5 million work hours without a lost work day away case. Completed technical milestones included: commissioned Drift Tube Linac (DTL) Tank #1, continued Linac and Target installation, completed Ring design and started Ring installation, installed the Target Core Vessel, and completed Target Systems design and R&D. The overall size of the project work force, including construction workers, was about 1,100 full-time equivalents (FTEs), and had started to decline as civil construction approaches completion in March 2005 and the partner laboratories transitioned off of the project (as have ANL and LBNL). Major recommendations from the review focused on understanding the causes for large quality variations being encountered in the production of SCL cryomodules at TJNAF and on reducing the rate of contingency consumption by the project.

As of March 31, 2004, the overall project was 79 percent complete, had awarded 97 percent of procurements, and completed 94 percent of all design work, 99 percent of R&D, 86 percent of conventional construction, 75 percent of technical hardware, and 50 percent of installation. The last two remaining major civil construction activities are still the Target Building (81 percent complete) and the CLO Building (76 percent complete). The Target Building and Target Systems installation remain on the project's critical path. The project has logged a safety record of over 5 million work hours without a lost work day away case. Recent technical milestones include: commissioned DTL Tanks #1-3; commenced cryoplant commissioning; received all four Coupled Cavity Linac (CCL) modules; received 9 of 23 SCL cryomodules; continued Linac, Target, and Ring Systems installation; and began Instrument Systems installation. The overall size of the project work force, including construction workers, is about 1,020 FTEs, which will continue to decline as civil construction approaches completion in March 2005 and the partner laboratories transition off of the project (as have ANL, LANL, and LBNL).

1.2 Charge to the DOE Review Committee

In an February 13, 2004 memorandum (see Appendix A), Dr. Patricia M. Dehmer, Director for Basic Energy Sciences, Office of Science, requested that Daniel R. Lehman, Director, Construction Management Support Division lead a review to evaluate all aspects of the project, including technical, cost, schedule, management, and ES&H. In addition, the Review Committee was asked to verify that the project's technical, cost, and schedule baselines are consistent with the current DOE-approved SNS PEP and FY 2005 Project Data Sheet. The Front End Systems (WBS 1.3) was not explicitly covered in this review because it has now been completed, installed, and commissioned at SNS.

1.3 Membership of the Committee

The Review Committee (see Appendix B) was chaired by Daniel R. Lehman. Members were chosen on the basis of their independence from the project, as well as for their technical and/or project management expertise, and experience with building large scientific research facilities. Continuity and perspective were provided by the fact that many of the members have served on one or more of the previous twelve DOE review Committees. The Committee was organized into ten subcommittees, each assigned to evaluate a particular aspect of the project corresponding to members' areas of expertise.

1.4 The Review Process

The review was conducted on May 11-13, 2004, at Oak Ridge, Tennessee. The agenda (Appendix C) was developed with the cooperation of the SNS Project Office, DOE/Office of Science Headquarters, and DOE Oak Ridge Operations Office (ORO) staff. Comparison with past experience on similar projects was the primary method for assessing technical requirements, cost estimates, schedules, and adequacy of the management structure. Although the project requires some technical extrapolations, similar accelerator projects in the United States and abroad provide a relevant basis for comparison.

The first day was devoted to project overview plenary sessions with presentations given by members of the SNS Project Office staff and a tour of the construction site. In the afternoon and on the second day, there were presentations by the two remaining partner laboratories with subcommittee breakout sessions to discuss detailed questions from the Committee. The third day was spent on committee deliberations, report writing, and drafting a closeout report. The preliminary results were discussed with SNS management at a closeout session on the last day.

2. TECHNICAL SYSTEMS EVALUATIONS

2.1 Linac Systems (WBS 1.4)

The Linac structure is unchanged since the November 2003 DOE review. As shown in Figures 2-1 and 2-2, the Linac structure is a conventional DTL to 87 MeV, a CCL from 87 to 186 MeV, a “medium-β” (β =0.61) SCL from 186 MeV to 379 MeV, and a “high- β” (β =0.81) SCL from 379 MeV to approximately 1 GeV. The medium- β SCL has 33 cavities in 11 modules and the high- β SCL has 48 cavities in 12 modules.

2.1.1 Findings

An enormous amount of progress has been made in the past six months on the DTL and CCL systems. DTL Tanks #1-3 have been successfully commissioned with 100 percent transmission of beam (to within the three or four percent measurement uncertainty) after only two days of running. The emittances were found to be as expected, although with some dependence with current (planned to be reduced by chopping the beam). The commissioning of DTL Tanks #1-3 went so well that the tests were completed in two weeks, finishing well ahead of schedule and thus allowing for an early start on the next phase of Linac installation. DTL Tanks #4-6 have been aligned and tuned and are ready for installation. RF conditioning of these tanks is planned for early July 2004.

All four CCL modules have been assembled, aligned, tuned, and leak tested at the vendor (ACCEL) in Germany. They were then disassembled and shipped to ORNL, and the first three have been reassembled on the SNS beam line. The fourth module has arrived in the SNS tunnel and is ready for reassembly. CCL Module #1 has been RF conditioned to about 120 percent of nominal power after only five 12-hour shifts. It is planned to start commissioning the entire warm Linac (except for RF and cooling in CCL Module #4) in early September 2004.

With the successful delivery of the DTL and CCL components, LANL has completed all its major deliveries, and the LANL hand-off to ORNL was made on April 2, 2004, as planned. LANL is continuing to provide valuable expertise.

LANL has completed their efforts on the RF systems and has handed off responsibility to ORNL. LANL has done an excellent job managing the large klystron and associated equipment procurements. Klystron procurements are close to the end. Out of a total of 116 ordered, 85 have passed factory acceptance.

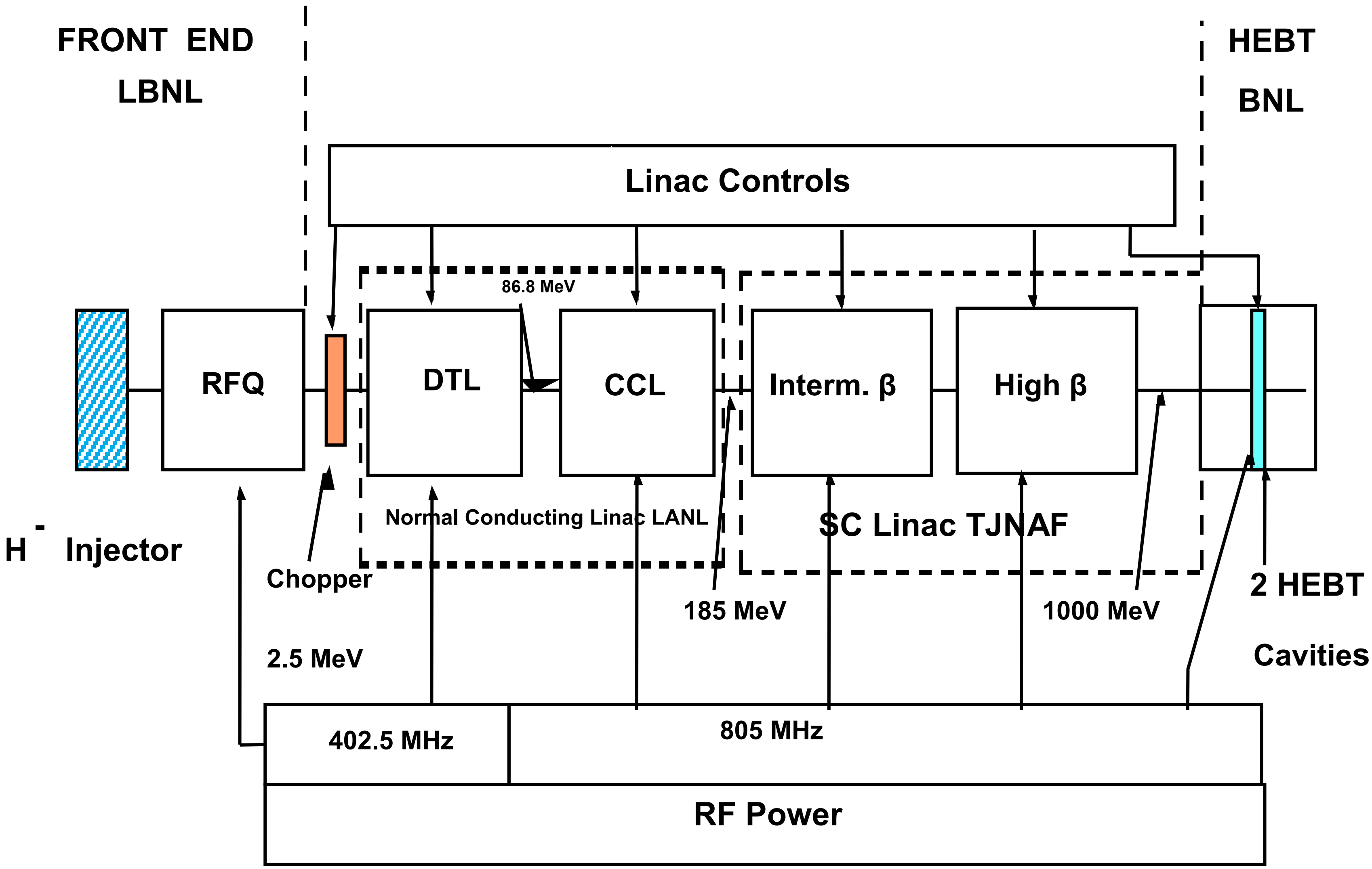

Figure 2-1. SNS Linac Configuration

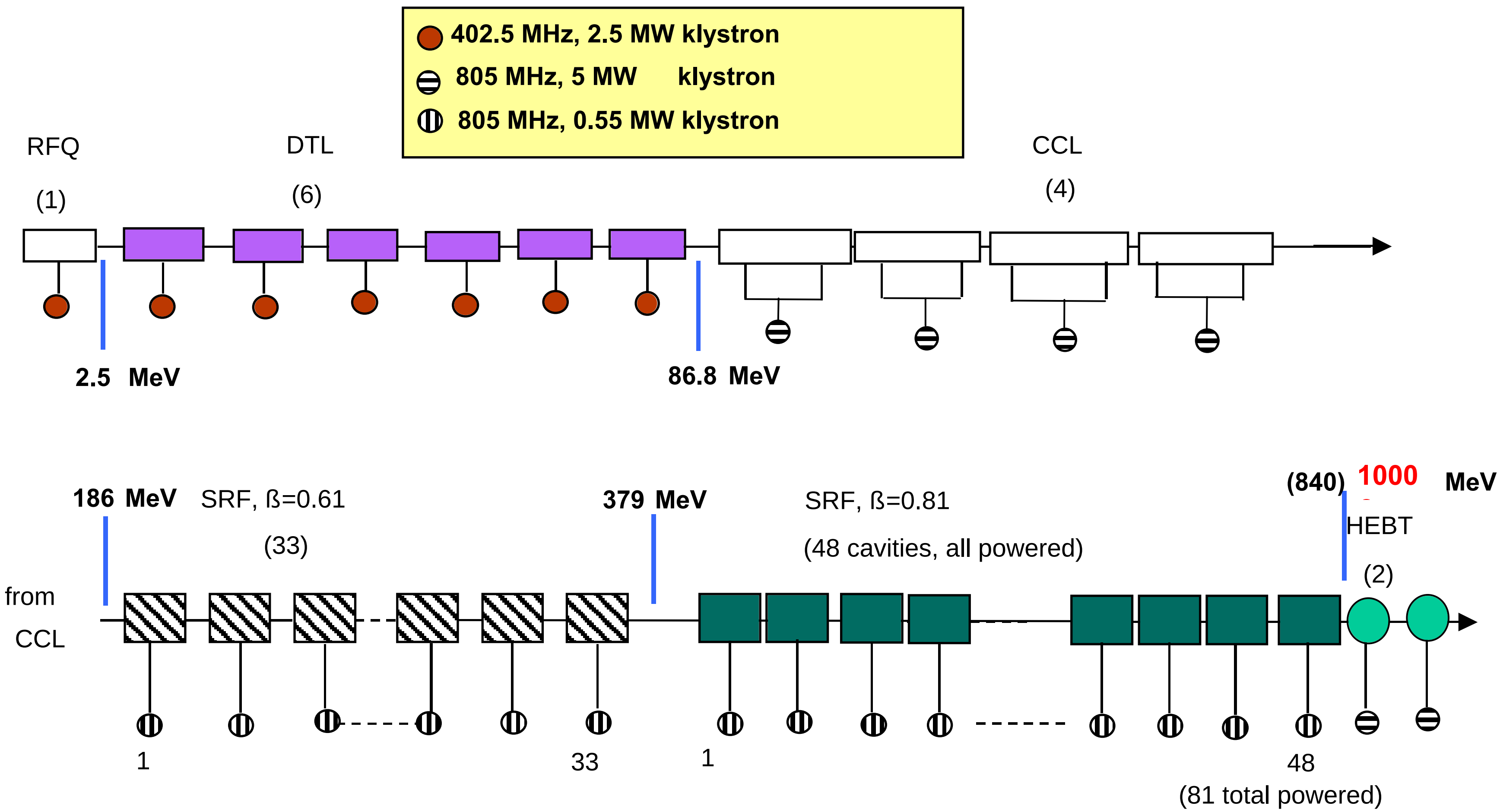

Figure 2-2. Layout of Linac RF with NC and SRF Modules

The Thales 5 MW klystrons have had the greatest problems. Of the nine Thales 5 MW tubes, three are installed. Three more are awaiting test or under test. The klystron efficiency specification for acceptance has been reduced to 62 percent. High power loads and circulators have had low acceptance rates. Load problems have been fixed. Circulators must be carefully checked during acceptance.

LANL is supplying three person installation teams working at SNS. This has been a great help in the installation and checkout of the RF systems.

The modulator systems (High Voltage Converter Modulators or HVCM) are essentially all delivered (14 units). Eight units have been installed and checked. Over 7,000 hours of total operation have been logged, summed over about five units that were operated at different power and repetition rates.

On the tour, the Committee saw the RF Gallery and all the equipment that has been installed. Seven DTL 402 MHz klystron systems are installed. All CCL klystrons will be operational in the latter part of July. Forty-eight SCL klystrons are in position and piping is complete.

The LLRF status looks very good. There will be 98 plus systems and production is under way. LLRF systems have been used in beam commissioning of the DTL and they worked well.

Tests on a medium-β cryomodule cavity at TJNAF achieved ± 0.1 percent, ± 0.2 degree, well below the one percent, 1 degree specification. During this test, SC cavity operation up to 17 mega Volts per meter (MV/m) was achieved without using the Piezo tuner. A 4.5° Kelvin (K) test was performed in order to see if this mode would be feasible for preliminary module tests at SNS in the event the cryoplant is deferred further. A series of internal and external reviews of cavity preparation and cryomodule assembly techniques have been conducted and have led to a number of procedural modifications which have increased the cavity yield and production rate. The full complement of 33 medium-β cavities has been qualified in single-cavity tests. All eleven medium-β cryomodules have been assembled and nine are already in the Linac tunnel.

Of the required 48 high-β cavities, 18 production cavities have been tested and all but one met minimum specifications (E_a>12.3 MV/m at $Q_0=5x10^9$). Eleven of the tested cavities exceed the enhanced specification of E_a>15.6 MV/m at $Q_0=5x10^9$. At the present time, high-β cavities are being qualified at a rate exceeding four cavities per month, a rate that, if sustained, will enable delivery of all cryomodules by mid-March 2005. The first high-β cryomodule has been completed.

High-level multipacting at gradients of 12-15 MV/m has been observed in the high-β cavities. Although such multipacting could potentially limit accelerating gradients, RF conditioning for brief periods of time effectively eliminated the multipacting in single cavity tests.

Repeated failure and low availability of the 1-MW 805-MHz klystron at TJNAF has delayed cryomodule testing and component qualification there. Several medium-β cryomodules have been shipped to SNS without testing at TJNAF, a choice based on the uniformly excellent performance obtained in the cryomodules so far tested. There is a reasonable module and integration testing plan. This plan calls for locating modules according to their gradient performance. The delay in commissioning of the cryoplant is delaying tests of cryomodules and ancillary systems at SNS. Integrated module testing is now scheduled to begin in July (medium-β) and September (high-β) 2004. Many initial tests will be warm, but the testing is contingent on cryoplant operation.

Cryomodule production is being supported at SNS by testing and conditioning of power couplers, by preparation and installation of the warm sections interconnecting cryomodules, and by a number of other activities preparatory to cryomodule installation.

Site preparation delays resulted in the expiration of the 4.5° K refrigerator warranty prior to commissioning. As a result, any required repairs experienced will place an additional resource burden on the SNS project. The 4.5° K refrigeration system has only been operated for 48 hours. Commissioning was cut short to avoid a higher electric power demand charge for May. Considerable flow meter and thermometry issues were discovered during commissioning and this was a source of confusion. Preliminary results suggest that full design capacity in liquefaction mode and 90 percent of design capacity in refrigeration mode were achieved. Liquid Nitrogen (LN_2) consumption during commissioning was considerably higher than expected. Preliminary data suggests that this may be due to an undersized 300° K to 80° K heat exchanger.

The 2° K cold box has been delivered and installed. During shipping, two cold compressor housings were damaged. The damage was investigated by the vendor and found to not affect operation. Many of the cold electrical connectors associated with the cold compressors were found to leak. Several attempted fixes have not been successful. It was discovered that the connector manufacturer changed the design since the TJNAF cold compressors were made. Old style connectors are being made to replace all required connectors (24 including those for the spare motors). Connectors are expected the end of May and will require one month for installation.

A contingency plan has been developed to allow for individual cryomodule testing in the tunnel should the 2° K cold box and/or 4.5° K refrigerator unavailable. A cryomodule could be cooled down to 4.5° K using a liquid helium (LHe) dewar in the tunnel. Tests at TJNAF have shown that meaningful data can be obtained at this temperature. With the addition of a vacuum pump, 2.1° K could be achieved with higher helium consumption.

U-tubes connecting individual components within the refrigerator building need to be completed. The U-tubes are welded in place to ensure proper sizing. The current estimate for completion is mid-July 2004.

Plans are being made to install a shield wall at an intermediate point along the Linac Tunnel for DTL and CCL commissioning and this may generate a tunnel oxygen deficiency hazard (ODH).

2.1.2 Comments

Progress on the DTL and CCL has been truly impressive. Don Rej and his colleagues at LANL are to be congratulated on this success and for overcoming numerous problems, especially with the DTL Tanks. The fast, successful commissioning of DTL Tanks #1-3 is inspiring and reflects the hard work and competence of both the LANL and SNS/ASD teams. There are still many steps remaining to make the entire DTL/CCL system work, however, and this will require close attention and a large effort over the next few months— installation, alignment, tuning, conditioning, etc. This effort deserves high priority, but is in jeopardy of being slowed down somewhat by tight funding in FY 2004. If possible, it would be good to fully commission CCL Module #4 along with its mates in September 2004.

Modulator reliability and required retrofit seem to be a potential problem. The general approach to the HVCM problems seems to be adequate to complete CD-4, Approve Start of Operations, but may provide problems with the eventual experimental program. The modulators run more reliably when not at maximum output power. As this power level is not needed for some time, it is probably better to run and test the units at lower power until known retrofits can be implemented.

Thought now needs to be given to LLRF issues associated with beam operation such as beam loading compensation and to fully understand just how (approximately) 100 systems will be operated in a coordinated fashion for beam acceleration.

The actions taken at TJNAF to improve cavity production rates are most commendable and appear to have been successful. The Committee noted that delivery of the cryomodules continues to be a near-critical path for project completion, and also that there is appreciable potential for further problems with cavity production. Continued close attention to these tasks is still warranted.

A contingency plan for testing modules without the cryoplant has been developed. Local cooling with dewars is possible. Operation of individual modules at 4.5° K would be easiest. This testing could start as soon as the end of June 2004. It would allow for development and experience with module test procedures. The 4.5° K operation has been successfully checked at TJNAF.

The Committee noted that the maintenance of low-particulate, high-performance cavities will depend critically upon the cleanliness of preparation and installation of the warm interconnect pipes and components joining the cryomodules. The Committee heard for the first time about SNS/ORNL plans for superconducting module installation and test, and other related activities. Warm intra-module beam line assembly is about to start. This assembly must follow clean procedures and gives SNS first experience with these necessary procedures for the superconducting cavities. A review of their planned assembly procedures and implementation should be completed.

Cryogenic personnel resources are very tight to complete the required tasks to cool down the refrigeration system and transfer line. Additional problems or added scope, such as cooling down a cryomodule from dewars, would likely result in a schedule delay (i.e., no contingency).

The solution to the cold compressor electrical connector leaks is credible. Alternatives are available, but would require considerably more time to implement.

Improvement of the 4.5° K refrigerator instrumentation prior to long-term operation is necessary to ensure reliable operation. Once the system is operating, it will not be possible to address many of the thermometry issues. Long-term system reliability will benefit from starting a running period with properly operating instrumentation. There will be considerable pressure to start the refrigeration system as early as possible. Prioritizing the instrumentation list will ensure that essential instruments are repaired prior to start-up. If the time is available, all instruments should be repaired.

Commissioning data has been sent to the refrigeration system designer for analysis to determine the proper path to take to correct the 300° K to 80° K heat exchanger deficiency. Operation of the system as-is appears to be possible, but with a higher operating cost due to higher LN_2 consumption. If it is determined that the repair is relatively straightforward, project management can weigh the cost/benefit of the schedule slip to long-term operating cost. More difficult repairs will require an engineered solution and a future plant shutdown.

The intermediate shield wall to be installed for DTL and CCL commissioning has the potential to isolate the tunnel ventilation system used to prevent an ODH. The addition of this barrier may defeat the intent of the control measures of the tunnel ODH system. Intermediate vertical shafts and fans may be required to ensure air flow throughout the test area. Life safety should be reviewed related to exit locations available during the test period.

2.1.3 Recommendations

1. Monitor closely the rate of superconducting RF cavity qualification and module assembly, and ensure that appropriate experts give close attention to hands-on quality procedures.

2. Seek out and take advantage of opportunities to advance the production schedule for the superconducting cavities and modules.

3. Give high priority to comprehensive cold testing of cryomodules at SNS. If appreciable further slippage in schedule for the cryoplant occurs, employ workaround options to expedite the cryomodule tests, such as testing at 4° K.

4. Develop detailed plans and procedures for installation of the warm beam line interconnects between cryostats and have these plans reviewed before assembly starts.

5. Supply the necessary resources and effort to hardening and upgrading the High Voltage Converter Modulators. This should be an ongoing activity.

6. Prioritize the repair of the 4.5° K refrigerator instrumentation by June 1, 2004, to ensure that necessary instrumentation is available prior to long-term system operation.

7. Understand the apparent deficiency in the 300° K to 80° K heat exchanger and develop a long-term correction plan prior to cryoplant startup.

8. Consider, prior to cool down, the tunnel oxygen deficiency hazard implication of adding the intermediate shielding wall planned during Linac commissioning.

2.2 Ring Systems (WBS 1.5)

2.2.1 Findings

There has been considerable progress in the development of the Ring Systems as evidenced by the installation of components in the High Energy Beam Transport (HEBT), and much of the Ring tunnel. There has also been considerable installation activity in the Ring Service Building. BNL and ORNL are commended for excellent work in a number of different areas as noted in overviews on each subsystem below. Overall the Ring Systems are doing very well with respect to the technical quality of components, cost, and schedule. The Committee saw no obstacles and was encouraged to see work on the remote handling of components in high radiation areas.

The Committee was shown an approved BNL roll-off plan, an issue that received attention during the November 2003 DOE review. The plan includes a specific FTE count, and it appeared to the Committee that the plan is being followed. The plan also includes an additional $500,000 of itemized scope. There is an increase of $275,000 in the Ring Systems EAC for installation labor.

Comments from the November 2003 DOE review have been addressed.

There has been good progress in magnet fabrication. Dipole field variations and shimming/sorting requirements, and quad field variations and shimming/sorting requirements have been resolved. The 30 cm quad edge trimming/orientation flip/re-measurement activity is on-going. Of the 312 required magnets, 242 have been delivered to SNS. This is approximately twice the number of magnets that were available in November 2003. The injection septum has been measured and accepted. The dump septum has been received. Injection chicane magnets #2 and #3 have been measured and accepted. Measurements on #1 and #4 are underway. The injection pulsed dipole magnets (8) are being tested and shipped to SNS. The extraction kicker magnets (14) are assembled and ready for titanium nitride (TiN) coating. The Lambertson septum magnet order is placed. Magnet system deliverables are expected to support schedule milestones.

Approximately 80 percent of the fabricated and purchased vacuum components have been delivered to SNS. TiN coating on all Ring arc chambers and the injection kicker chamber is complete. Coating for straight sections is 40 percent complete. A third coating station has been brought on-line at BNL. Vacuum system deliverables are expected to continue to support schedule milestones.

HEBT collimators #1 and #2 have been installed with shielding. RTBT collimators #1 and #2 have been delivered to SNS. The beam scraper and thick foil strippers are in process at BNL. The remaining collimators and shielding assemblies are in process.

There has been very good progress on Ring installation during the last six months. The early installation schedule for delivery of Ring components has been met. Installation of the HEBT accelerator components is 90 percent complete, and the HEBT is partially under vacuum. The HEBT betatron collimators (2) with shielding, and momentum dump, have been installed. Installation of Ring accelerator lattice components is 40 percent complete, primarily composed of 27 (total 32) Ring arc half cells. Four Ring arc quarter cells are staged for installation. It is expected that all Ring arc sections will be installed and under vacuum by the end of July 2004. The start of Ring straight section installation is being accelerated by about three months. Installation of HEBT and Ring magnet cabling is 90 percent complete. There are contingency plans for accommodating the RTBT tunnel settlement. The tunnel flooding problem experienced in May 2003 appears to have been corrected. The BNL scheduled activities for remaining deliverables support project milestones.

Work has continued on design and development of the remote handling devices. The quick release remote water couplings for collimator cooling have been built, tested, and installed for one collimator. A bellows compression mechanism and remote vacuum clamps are being designed and prototyped. Initial test results are good. Work began on a Linac dump window co-axial bellows assembly, including a remote handling mechanism. Considerable effort is ongoing related to the RTBT/target interface. Written procedures for removal and replacement of remote devices are being prepared.

The transfer of drawing documentation from BNL to SNS has continued. Approximately 5,800 documents have been transferred.

All of the magnet cables in the Ring Service Building have been installed including AC power cables. The power supplies are in good condition; there are no outstanding problems. The 367 low field corrector power supplies are at SNS with 51 commissioned. Of the 69 medium supplies plus eight spares, 36 have been delivered with the remaining to be shipped to SNS by February 2005, delayed primarily by the End Game Plan. The first of the extraction kicker supplies has been tested at BNL, with testing at the factory and delivery to SNS for the remainder of the units (scheduled by the end of FY 2004). The main dipole supply transformers have been installed with the rectifier system. The supplies will be installed at SNS in September 2004 with testing to follow in January 2005. Two production injection supplies are at SNS with the remaining supplies to be delivered by July 2004.

The first RF cavity power system has been delivered to SNS. Two additional systems will be delivered in May 2004. BNL continues to develop the LLRF controls and control interface using one of the RF systems until September 2004, when these systems will be shipped to SNS.

The excellent performance of the Linac beam diagnostic systems during the recently completed DTL commissioning run is recognized and applauded. This bodes well for the capability of the SNS/ORNL diagnostics' staff to integrate partner laboratory systems into the operational SNS complex.

The 400 MHz Ring Beam Position Monitor (BPM) electronics designed by BNL was successfully tested with DTL beam signals. The electronics clearly observed real beam motion correlated with Linac BPM results and traced to DTL #3 cavity tuning system problems. This is a very positive sign.

The recently prepared "SNS Ring Diagnostics Production Plan" indicates that communication and project management concerns of the SNS Accelerator Systems Advisory Committee (ASAC) and the Diagnostics Advisory Committee are being addressed. The plan contains definitions of deliverables, current status, production and delivery schedules, and draft acceptance criteria. It is significant that technical personnel from both BNL and ORNL referenced their plans and status relative to this document. Additionally, BNL management has positively re-affirmed its commitment to assure adequate manpower is available to meet the diagnostic systems schedule and performance requirements.

The Ring diagnostics equipment delivery schedules have been fully integrated into the Ring installation plan. The resulting schedules for deliverables from BNL are aggressive but realizable; BNL has bought into these schedules. The Committee was told that the definition of "delivery" has been clarified and is being consistently applied across the Ring Systems WBS element.

Diagnostics systems have been prioritized and current activities are being focused, consistent with those priorities. The SNS IT group has been fully incorporated into instrumentation front end PC systems integration and configuration control. Recent negotiations between BNL and ORNL produced an updated EAC and seem to have established bounds on diagnostics systems costs.

The plan to pre-assemble the injection straight section at BNL to identify potential mechanical interferences or interface problems is a very good, pro-active step.

The increase to the EAC for the Ring diagnostics due to the re-evaluation of the system is approximately $600,000. However, this has been offset by postponing the Ionization Profile

Monitor electronics, resulting in no net increase to the diagnostics EAC.

2.2.2 Comments

Work remains to be done to complete designs for remote handling in high radiation areas, including further analysis of dose rate calculations, HARP (beam diagnostics) assembly removal, integration of the Q27-Q30 quadrupole magnets with the removable overhead shielding, and selection of materials for the high radiation environment.

The deliveries of the kicker supplies, and most of the medium supplies, have been delayed. Further delays of these supplies could jeopardize installation, commissioning, and operation. SNS should take steps to insure that future deliveries schedules are fulfilled.

Turn-over of the RF Systems to SNS will be in December 2004. SNS should take steps to ensure the appropriate manpower is available for turn over and operation of Ring RF Systems including low-level controls, particularly when beam is introduced.

Maintain a working copy of the “SNS Ring Diagnostics Production Plan” as a living document to maintain focus on the agreed upon objective. Diagnostics systems acceptance criteria and performance verification tests have yet to be defined.

During normal operation, the BPMs will present 400 Mhz and baseband signals simultaneously to the electronics. The 400 MHz components will be very large relative to the baseband signals during much of the injection process (many, many turns). Rigorous testing of the Ring BPM electronics is important to determine that 400 MHz signals are sufficiently rejected so as to not affect the accuracy of the baseband measurements.

2.2.3 Recommendation

1. Identify design criteria and prepare a cost estimate for all Ring and Ring-Target interface remote handling devices. Present the results at next DOE review.

2.3 Target Systems (WBS 1.6)

2.3.1 Findings

The project responded to the recommendations of the November 2003 DOE review by refining the planning for target change and proton beam window replacement and by defining a detailed quality assurance plan for the inner reflector plug in close collaboration with the selected manufacturers. The target change plan currently shows approximately 12 (eight-hour) shifts as minimum duration required to perform the operation. The Committee determined that these issues can be considered as closed for the time being.

Procurement and installation work on the target monolith is progressing well and is essentially on schedule. Out of the 67 major procurements defined for Target Systems, 63 have been committed or costed, with an 11 percent variance over the baseline cost estimate. Eleven procurements were awarded since the November 2003 DOE review amounting to a total of $6.7 million. A significant deviation between the estimated cost and the contracted price occurred for the inner reflector plug, where the project decided to go forward with a highly integrated design in view of a calculated 15 percent gain in neutron beam intensity relative to the original concept (25 percent over a "simplified" version that was considered, but rejected as a backup solution).

The cost estimate for the remaining four procurements is less than $1 million. This leaves Target Systems with $11 million of uncommitted funds, much of which is required to cover the staff salaries for the remaining duration of the project. The contract for target manufacturing was awarded in March 2004 with three (minor) modifications relative to the earlier design:

- A stiffening baffle plate has been added along the symmetry plane of the target vessel to shift the natural frequency of dilational oscillations from 70 Hz to 280 Hz to reduce the risk of resonant excitations by the 60 Hz pulse rate;
- In the interest of easier manufacturing and improved stiffness, the transition piece between the target vessel and the mercury pipes has been modified and is now one single piece providing the transition for all mercury feed and return lines;
- Contrary to the original plan, the target cannot presently be Kolsterized as a whole after welding because of constraints in the process equipment. (Kolsterizing is presently the method of choice to enhance the target's resistance to cavitation erosion).

The milestone for starting maintenance cell installation (April 12, 2004) was met, but the plan forward foresees many activities of equipment installation in the maintenance cell going on in parallel with civil construction work around it. This will cause coordination and cleanliness problems and also has brought the maintenance cell installation onto the critical path of the project. So far, however, the project has managed to retain the six-month testing period for Target Systems that is deemed necessary to carry out comprehensive testing of all systems. It will not, or only with great difficulties, be accessible for repair once operation of SNS has started.

A comprehensive high-level (draft) list of tasks has been prepared for the subsystem and integrated test plan. Although time estimates for individual tasks are not yet complete, a six-month schedule beginning in June 2005, and approximately 16 people have been allocated for the integrated system testing. This draft plan is currently being refined with assistance from target operations.

Several crucial decisions and plan adjustments have become necessary in the past due to BA constraints, but SNS management has been very efficient in setting priorities and rearranging work to save cost without jeopardizing the project's scientific and technical goals and taking into account the short- and long-term importance of the equipment. While some equipment that will only be needed at a later stage (such as the shielded handling flask for the proton beam window) has been postponed, others, like a pedestal manipulator and a portable manipulator, which are also not required for the early phases of commissioning, have been retained to allow for use in certain tests and handling exercises. One used-target container for in-maintenance-cell storage has been procured that constitutes the minimum requirement for practicing. In the long run, several of them will be needed to allow sufficient flexibility for target cool-down and transport planning.

Finally, XFD has developed a convincing and timely plan for transition to operations that implies a change in organizational structure, as well as in staffing. Besides facility operation, the new structure will explicitly reflect the orientation of the Division towards science and technology development. Recruitment of new personnel seems to be timed well to foreseeable needs and a facility specific training program has been initiated with a clear schedule for the preparation of the required documents.

2.3.2 Comments

The new design of the target transition piece is clearly an improvement, making assembly easier and reducing the risk of a mercury leak to the target vault. The Committee raised concerns, however, with respect to the baffle plate down the center of the target—right where the beam intensity is at its maximum—although the designers claim that it has minimal effect on the flow and that stresses and temperatures from direct heat deposition are acceptable. In full power operation, this plate will be subject not only to the intended mechanical stress, but also to high radiation damage, cavitation erosion and rapid thermal cycling, with the attendant potential for metal fatigue. Detailed studies of these combined loads have yet to be performed. These concerns are clearly not an issue for the first target, which will not see full beam intensity for any extended period of time, but confidence needs to be built for long-term operational safety. A piece of metal breaking away from the baffle plate might cause severe damage downstream in the loop.

The International Collaboration on High Power Target Development, in which ORNL participates with a view toward future improvements and upgrades of their target system, continues to produce valuable information on the issue of cavitation erosion and has recently developed a method with high-time resolution for the observation of the surface acceleration of the liquid metal container after an imposed pressure pulse. This seems to give important clues on the phenomena going on inside the container. The Committee strongly supported the use of this technique also in the next experiments at Weapons Neutron Research (WNR) Facility at LANL to examine how the results depend on the pressure generated in the volume versus at the surface of the liquid metal and on the pulse repetition rate. Progress is also being made on the bubble injection technique with a suitable system presently being installed at the SNS Target Test Facility loop in preparation for the experiment at WNR.

The Committee agreed that the initial coolant for the moderator/reflector assembly should be light water (H_2O). Installation of (potentially tritium contaminated) heavy water (D_2O) should be delayed until good confidence in the integrity and functionality of the cooling system has been achieved. Because the potential degradation of the neutronic performance of the system from contamination of the ultimate D_2O coolant by minor residual amounts of the initial H_2O is not significant, the Committee agreed that the confirmation of the computed performance difference between D_2O and H_2O would be an added benefit of this strategy in any case.

The thermocouples used for providing safety-class interlocking require annual recalibration. The current plan is to replace them annually with newly calibrated thermocouples. The Committee was concerned about the effort and risk associated with replacing these thermocouples remotely and suggested that the project re-examine the possibility of using an in situ calibration approach.

The personnel budget for Integrated System Testing appears to be adequate given the time (six-month) and space constraints. However, the list of tasks has been neither prioritized nor scheduled. The total time and personnel to complete all finally approved tasks has not yet been determined. The schedule should also include contingency to account for correcting deficiencies.

The Committee noted that, in their test plan, the project only foresees commissioning of the remote handling procedures and tools to a limited extent. While a complete or even multiple remote replacement of the target is foreseen, in many other instances the project plans to limit themselves to demonstrating that all screws or connectors are accessible, while refraining from actually detaching the component in question and demonstrating that it can be removed, replaced, and tested without human access. The Committee felt that, given the perceived inaccessibility of the maintenance cell after a certain period of operation and the importance of the Target Systems remote handling procedures, together with the difficulty of actually performing them, there may be a risk involved in this reduced plan that has not yet been properly assessed.

The Committee was concerned that there will be a large amount of installation work remaining in Target Systems after the AE/CM contract ends in February 2005. This will require a shift of responsibilities and leadership to SNS personnel with significant implications in numerous respects.

2.3.3 Recommendations

1. Carefully assess, by the next DOE review, the risk involved in the reduced remote handling practicing plan and make sure that every procedure required to re-establish the functionality of a failed or worn out component is fully understood.

2. Re-examine, by the next DOE review, options to use a less risky approach for the annual calibration of the safety class thermocouples than remotely replacing them each year.

3. Establish, and prepare to implement, a plan that ensures smooth transition to an efficient installation management organization after the AE/CM contract has ended. The plan should be ready for review by July 1, 2004.

2.4 Instrument Systems (WBS 1.7)

2.4.1 Findings

The Committee was pleased with the considerable progress reported by the Instrument Systems team. With the delivery of the vacuum tank for the Backscattering Spectrometer, the milestone for starting construction of the first instrument has been met. The installation of core-vessel and shutter inserts will begin this summer. Installation work on other instruments cannot begin until beneficial occupancy of the Target Building is achieved (presently scheduled for February 2005). Table 2-1 identifies the instruments currently under design and construction for SNS along with their funding sources.

Table 2-1. SNS Instrument Status

Five Instruments in SNS Baseline (Funded within the Project TPC)

Three to be installed by CD-4

- High Resolution Backscattering Spectrometer
- Vertical Surface (Magnetism) Reflectometer
- Horizontal Surface (Liquids) Reflectometer

Two to be installed after CD-4 during low-power operations

- Extended Q-Range Small Angle Diffractometer
- Third Generation Powder Diffractometer

Three EFAC-Approved Instruments to be Designed and Built by IDTs

- Wide Angle Thermal Chopper Spectrometer (funded by BES grant to Cal Tech)
- Cold Neutron Chopper Spectrometer (funded by BES grant to Penn State)
- Vulcan Engineering Diffractometer (funded by Canada)

Five EFAC-Approved Instruments Comprising the SING Project (funded by BES)

- Ultra High Pressure Diffractometer
- High Resolution Thermal Chopper Spectrometer
- Single Crystal Diffractometer
- Disordered Materials Diffractometer
- Hybrid Spectrometer

One EFAC-Approved Instrument to be Designed/Built by IDT (funded by DOE/SC Nuclear Physics)

- Fundamental Physics Beamline (actually 2 instruments on a single beam line)

Two EFAC-Approved Instrument Proposals Awaiting Funding

- Spin Echo Spectrometer (to be funded by Germany)
- Chemical Spectrometer (proposal to NSF for conceptual design)

In response to the Committee's previous recommendation, the current status of the integrated instrument installation plan was reviewed. The plan calls for installation work to begin on eight instruments (five of which have external funding) in FY 2005. The plan must remain flexible to accommodate constraints posed by Target construction. Detailed plans for neutron guide and shielding installation will be developed in the near future. The Committee was satisfied with the progress in planning.

Instrument Systems is now approximately halfway through their total major procurements of $16.5 million, with $2.7 million in major procurements scheduled during the next six months. The major milestones for the five project instruments are on track, with their design scheduled for completion by October 2004. The procurements for the first three instruments should be completed by June 2005, with in-house components assembly completed by August 2005. Some procurements for the other two baseline instruments have had to be delayed until the next fiscal year, but all procurements should be completed and the in-house components assembled and ready for installation by March 2006. There is little contingency left in the procurement schedule, but it appears to be achievable.

Neutron beam guides for the Backscattering Spectrometer have been delivered. Guides for the two reflectometers are currently being fabricated, and the procurement of the guides for the Powder Diffractometer and Small-Angle Neutron Scattering (SANS) instruments have been awarded. The Backscattering Spectrometer and Powder Diffractometer instruments had their 70-percent design reviews in April 2004.

The major risk appears to be the recent big increase in the procurement cost of steel needed for instrument shielding. The engineers are closely evaluating alternative shielding where they might have been overly conservative, in order to mitigate this unexpected increased cost (estimated to be about $1.3 million) by using high-density concrete.

Delivery of the 13 core vessel inserts began in March 2004, and should be completed by May 2004. Instrument Systems must prepare them (with alignment mirrors installed and leak tests performed) for installation by the general contractor. In the case of four inserts, this requires that guides be positioned in the inserts before installation in the core vessel. The installation of the final inserts for the non-project instruments before the Target Building beneficial occupancy date (BOD) is most welcome because it saves considerable money and time in the long run. The other beam lines will initially have a blank plug insert in the core vessel.

The shutter inserts for the five project instruments, four Instrument Development Team (IDT) instruments, and two of the SING project instruments will be delivered in June 2004. The installation of shutter inserts by the Target Building general contractor is scheduled to begin in August 2004. All of the other beam lines will initially have concrete inserts in the shutter position.

The basic hardware and software components for the data acquisition system all exist in prototype form. The fabrication and assembly of the T_0 chopper for the Powder Diffractometer instrument is underway. The testing of five bandwidth choppers has been completed at ANL. A second procurement has been awarded for bandwidth choppers with magnetic bearings.

Many of the instruments (including the Backscattering Spectrometer and a number of the IDT instruments) will have helium-3 linear position-sensitive detectors. The two reflectometers will have area detectors obtained from BNL. The count rate problems associated with the SANS instrument area detector suggest that a better solution may be the use of multiple linear position-sensitive detectors. The lithium fluoride/zinc sulfide scintillator-based detectors, coupled with wavelength shifting fibers and phototubes for the Powder Diffractometer (and for the Engineering instrument) have been developed in-house, with the expectation that these will be produced outside. Other future instruments will have segmented anode photomultiplier tubes with a scintillator screen as an Anger camera.

The extended Q-range, high-intensity, high-precision SANS instrument does not have its high-scattering angle detector bank included in the baseline project budget. Also, procurements for this instrument (except for the bender/guides and the core vessel and shutter inserts) have been delayed until FY 2005.

The Instrument Systems team has developed a staffing plan to address the installation of the baseline instruments integrated with installation of the next set of IDT instruments. They have also carried this plan forward to address post-project operations through FY 2007. They have considered a wide range of jobs, some of which exist in the present project and others of which will be needed once installation begins. These staff positions include instrument scientists, engineers, technicians, software and data acquisition support, neutron optics, administrative support, choppers, and sample-environment support. The Committee found that the level of effort detailed in the staffing plan to install the three baseline instruments concurrently with five IDT instruments is sufficient based on the installation schedules for the individual instruments. This will evolve as the integrated instrument installation plan is finalized.

Data analysis and visualization software is recognized as a key factor in making early scientific impact, and for the user community. However, it is also recognized that it is important to avoid an ad-hoc short-term solution optimized only for the baseline instruments (due to lack of resources or appropriate management). A modern grid-enabled data/software architecture must be developed that can take full advantage of the possibilities for really exploiting the power of SNS. A draft requirements document has been produced. There is close collaboration with ORNL Computational Sciences. Regular discussions are taking place with spallation sources in Europe and Japan to explore the possibilities for coordination and collaboration in software development. Discussions are ongoing with the California Institute of Technology concerning the synergy between the Distributed Data Analysis for Neutron Scattering Experiments (DANSE) software design proposal to the National Science Foundation and SNS requirements. A Task Leader has recently been appointed. As soon as the requirements have been finalized, then specific projects will be defined, additional appropriate staff will be hired, and development will start.

2.4.2 Comments

The bulk of the instrument installation tasks (such as installing neutron guides) require a climate-controlled environment in order to ensure reliable and precise alignment. It follows that these tasks cannot begin before the BOD (February 2005) of the Target Building. The installation schedule will be quite tight, so it is *critical* that the BOD not be allowed to slide.

Before the BOD, it is necessary to install poured-in-place concrete shielding adjacent to the Target. For practical reasons, and also for the sake of efficiency, this shielding should be installed for a number of instruments at the same time. Shielding for two baseline instruments has already included in the general construction contract, but shielding for the two reflectometers has yet to be negotiated. The Committee urged that this be done, the only caveat being that there should be no impact on BOD. Concrete settling will require a minimum of three months before the guides can be installed, so this concrete pouring must be complete by November 2004 in order to allow prompt initiation of installation after BOD.

In the past year, the project has hired seven employees including one instrument scientist, a data analysis team leader, four scientific associates and one person for detector support. This rate of hiring needs to be sustained for the next two years (a total of approximately 15 hires in FY 2004 and approximately 12 hires in FY 2005) in order to accomplish the integrated installation of the instruments and to be prepared for the transition to operations. The identification of top-rate candidates will be the biggest challenge in this hiring scheme.

The Committee was pleased with the plans for software development; however, there was some concern about the level of involvement of neutron scientists, which is essential for achieving useful software tools. Because of the demands of the installation schedule, it is unlikely that the instrument scientists for the first three instruments will have any significant time to devote to instrument specific software, even if the task is only to modify existing software from other sources. The Committee suggested that at least two person-years of effort at the post-doctoral level be assigned (one for backscattering and one for reflectometry), over and above the existing planned effort, to work with instrument scientists in integrating instrument-specific software within the data/software architecture that will be developed and implemented.

SNS need not be responsible for all aspects of software development, as some areas will be covered by the user community; however, SNS must clearly define those areas where it will take primary responsibility, those areas of necessary collaboration, and those where the user community takes primary responsibility. The development of a policy on data, and intellectual property arising from data, is recommended. One specific area of software development, the interface with instrument control and integration with data acquisition, needs further attention. For example, while the drivers for motion control will be supplied by the vendors, the integration of these controls with the data acquisition and provision for an adequate graphical user interface will require attention in the near future.

The equipment needs for sample environment have resulted in an inventory list totaling $7.1 million, most of which will be acquired after CD-4. The aggressive pursuit of collaborations for developing special sample environments and the effort to establish a world-class user support system are commended.

The schedule for completing the baseline instruments (three installed, and two ready to install) is not yet on the project's critical path, but it could easily be pushed there, especially if the Target Building BOD were delayed. Delays in procurement or installation schedules must be avoided.

2.4.3 Recommendation

1. Prepare a plan for the Experimental Facilities Division transition to ownership of and responsibility for the Target Building at the beneficial occupancy date, and present it at the November 2004 DOE review.

2.5 Control Systems (WBS 1.9)

2.5.1 Findings

The major finding in regard to the Control Systems is the impact of the slippage of the installation schedule on the Integrated Control System schedule and manpower plan. To be ready for the final Accelerator Readiness Review (ARR), the control system must have the formal system testing procedures complete and approved. The lengthened installation schedule for racks and power means that the Input/Output Computer (IOC) and Programmable Logic Controller hardware systems cannot be put in place so that the testing can proceed. The ARR is fixed in time, which means that the time for testing is compressed—increasing the load on the Control Systems team. This is happening when the manpower plan shows a 30 percent decrease in staff (56 FTEs in FY 2004 to 38 FTEs in FY 2005).

The recommendation made at the November 2003 DOE review calling for the hiring of a Database Management Specialist is still open, and the project is working to find the resources to do this. The Committee still felt that this is a real need of the project, based on information presented at this review.

The Control Systems team has done an excellent job responding to three problems identified at the November 2003 DOE review. In each case, the team and the project has put in place solutions that will be very useful later in the project.

- IOC Disease: The team developed Network Management and Monitoring Tools which will help in the management of the full operational network of approximately 200 IOCs and 400 Network Attached Devices (BPMs, etc.).
- Machine Protection System (MPS) Trips: MPS Post-Mortem Analysis tools are and will continue to be useful in diagnosing and re-setting from MPS events.
- Electromagnetic Interference: (EMI) is always with us at accelerators, and the project understands that they need to stay on top of this problem in order to keep it under control.

The Personnel Protection System (PPS) installation schedule looks well planned and achievable. But the schedule requires that the planned control room move be done on schedule so that the necessary infrastructure to support the PPS is available. If that move does not happen, the PPS equipment would be installed, but it would have to be re-installed and re-certified when the Control Room move does occur.

The Control Systems team has made its contributions to the SNS Linac cryogenics effort. In this case, the scope of the controls effort includes input/output wiring, sensor calibration, and a few other items. As a result, the Control Systems cryogenic effort is doubly impacted by the installation slowdown—IOC and process input/output wiring.

The project is very aware of cyber-security issues. The controls networking team is working closely with the SNS IT group and with the ORNL Network group to implement the necessary monitoring, countermeasures, security upgrades, etc.

2.5.2 Comments

Based on the schedule findings above, the Committee was concerned about the amount of schedule contingency. The schedule is set by the ARR and pinched by the rack installation. If the rack installation is so late that the Control Systems team cannot finish their testing, the date of the ARR milestone will not be met.

The Committee continued to be impressed at the level of communication and coordination between the Controls Group and the Accelerator Physics Application Programming Group. The Committee commended the Control Systems team on the development of test plans for newly installed systems. This is a good practice.

The use of a database to track the installation of equipment grows in importance as the amount of installed equipment grows. This is a specific example of where the Database Management Specialist would be helpful.

The Committee suggested that a program be developed to train installers to avoid improper grounding techniques found in the recent noise investigations.

The Committee suggested that the Control Systems team develop a comprehensive timeline of controls equipment installation with start dates and milestones. The goal here is to see the impact of schedule coordination issues, not to be drowned in details.

Prior to the scheduled commissioning periods, the project should consider procedures to verify the readiness of previously commissioned systems (e.g., all instruments communicating, no abnormal readings, archivers running, etc).

2.5.3 Recommendations

None.

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3. CONVENTIONAL FACILITIES (WBS 1.8)

3.1 Findings

Since the November 2003 DOE review, impressive progress at the construction site has been achieved and all critical path milestones have been met.

The organizational transition from the CFD to the new Project and Site Support Office (PSSO) management team has been seamless and effective. The new management approach is appropriate for this stage of the project and the organization needed to support an operational user facility is beginning to emerge.

The project cost and schedule remain defensible and are based on sound information. Progress to date is in accordance with the project baseline. The project ETC is supported through actual contract pricing and a risk assessment methodology that accounts for potential changes.

The Committee found that the FY 2004 project BA profile cannot support the current plan of CF activities. The estimated $6.5 million BA shortfall in FY 2004 is driven in large measure by a $5.0 million CF funding retention issue. This issue was compounded by authorizing approximately $2.4 million of work identified for deferral to FY 2005 and FY 2006 (from the End Game Plan). The project recognizes this shortfall and has identified potential actions to adjust funding needs and address the shortfall.

CF's EAC of $378.9 million has increased by $2 million since the November DOE 2003 review and reflects probable impacts related to deferred work and resolved claims, as well as activities driven by project transition issues. The Committee noted that this does not include the approximately $8.2 million in unresolved claims by subcontractors.

The Committee noted that the current AE/CM contract expires on February 24, 2005. This expiration date affects several ongoing and planned target installation activities. At this time the project has not finalized the planning necessary to implement the affected installation issues.

The overall CF progress is approximately 86 percent complete through April 2004, and Cost Performance Index and Schedule Performance Index values are 1.02 and 1.0, respectively, through March 2004.

The RTBT Tunnel has continued to settle following partial backfill and loading of the berm.

The project's as-built drawing system is being maintained in three divisions with varying degrees of priority and intention for completeness. For commissioning and operations, a single compiled as-built record of the machine and facility is required that contains all necessary information, CF or otherwise. The as-builts need to be completed in a timely manner to support commissioning and operations. Current plans for as-built record delivery may require better integration and important elements are not planned for completion as part of the project.

The construction site continues to be well maintained and site management continues to improve a commendable safety record of greater than three million work hours with no lost workday away cases. Work in place remains high quality in all respects.

3.2 Comments

The project implementation of transition plans for CF activities hinges on the ability of the overall project to capture and re-sequence the work through the end of the project. The first step in achieving this objective has been taken by reorganizing the CFD into the PSSO Division. Significant leadership will be required from the XFD and ASD staffs in concert with the new PSSO Division to ensure that appropriate field presence is maintained to support Target Systems installation and accelerator commissioning. As noted in previous DOE reviews, and reinforced here, equipment installation remains a continuing issue as beneficial occupancy and equipment installation occur in parallel with construction. The project must continue to focus on ensuring adequate field engineering and installation coordination between CF forces and technical installation staff. The need to support ASD and XFD installation activities will continue for some time beyond CF project transition. These resource needs must be addressed in project planning.

The RTBT tunnel has continued to settle as identified in prior DOE reviews. The maximum prediction of settlement from the November 2003 DOE review was seven inches. Current settlement has achieved 5.9 inches with a revised maximum of 9.5 inches. Review of operational needs identifies that a maximum settlement of up to 15 inches can be accommodated. Completion of backfill activities will occur in the next month and models indicate that maximum settling will occur in the 60-90 day period following completion of backfill. Two core drill samples were performed to verify that the geotechnical conditions specified (95 percent of maximum compaction) expected in the design were achieved in construction.

The Target Building continues to experience water in the basement areas caused by suspected water accumulation in the surrounding foundation backfill materials prior to final grade conditions being established. The project should assess this issue to determine if this will remain a chronic situation and identify technical solutions as required. This condition has the potential to affect the overall project cost and schedule if left unaddressed.

The project has satisfactorily addressed the recommendation from the November 2003 DOE review.

3.3 Recommendations

1. Finalize plans for completing Target Systems installation work, taking into account the needs of additional field supervision and contracting, prior to the next DOE review.

2. Provide a more comprehensive assessment of RTBT Tunnel settlement including structural evaluation of crane supports and tunnel structure repair, as well as Target Building water infiltration issues by the next DOE review. Include the necessary cost and schedule impacts of repairs as required.

3. Complete the necessary integration activities between CF, XFD, and ASD and demonstrate the readiness of the as-built system to support commissioning and operations by the next DOE review.

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4. ACCELERATOR PHYSICS/PRE-OPERATIONS (WBS 1.10)

4.1 Accelerator Physics

4.1.1 Findings

The hot spare Front End has proven useful in training, development, documentation, and reliability tests. Ion source reliability is much improved, but still needs much more improvement.

Long reliability runs of the Front End turned up unexpected issues such as deteriorating cooling water resistivity.

The Front End beam pulse is not sufficiently flat, but there are improvements planned.

Commissioning of DTL Tanks #1-3 was very productive. Energy and phase jitter appear to be within specifications, but the horizontal emittance is slightly out of specification. There are features of the beam halo and of the beam characteristics as a function of time along a single pulse that are not understood.

The Low Energy Beam Transport (LEBT) chopper still is not functional. One design has failed in operation a number of times. A new design is being worked on and developed on the hot spare Front End.

The electromagnetic noise reduction effort has paid off in improved understanding of results and better reliability.

Application software has progressed well and a system is in place that allows scripts to be quickly written which efficiently assists the commissioning efforts.

The ORBIT code has now been extended to include electron-cloud effects. In addition, it has been benchmarked more thoroughly against LANL Proton Storage Ring data. In particular, it can reproduce even fine, unforeseen details of the longitudinal motion. The project is to be congratulated for the excellent work.

4.1.2 Comments

The Committee encouraged work on improving the uniformity of beam pulse intensity and pulse-to-pulse variations.

The excellent performance of the Linac beam diagnostics systems and applications interfaces resulted in very productive DTL commissioning runs.

The beam centroid appears to wander around, especially during the first 50 microseconds of the pulse. The cause is not known, but is being pursued. It may be possible to eliminate this with the chopper system. It may also be possible to trim the horizontal emittance with the planned beam scraper system. Work should also continue on understanding the causes of the horizontal beam halo and centroid wander.

The LEBT chopper development has been disappointingly slow. The Committee applauded the decision to install it on the hot spare Front End, so that it can be developed independent of commissioning runs. There appears to be little progress on the Medium Energy Beam Transport chopper. A schedule and plan should be developed for this component.

4.1.3 Recommendation

1. Develop and publish schedules for delayed items such as choppers and scrapers.

4.2 Pre-Operations, Installation, and Commissioning

4.2.1 Findings

Tremendous progress has been made in installation since the November 2003 DOE review, but much remains to be done.

There is a detailed commissioning schedule. ARRs that follow accepted guidelines are being conducted before each new commissioning run. The lead people of the various commissioning teams have been named. Commissioning of DTL Tanks #1-3 went well and was very productive.

The cooling water system was responsible for most (75 percent) of the downtime during the commissioning of DTL Tanks #1-3. The problems were a combination of hardware and controls. There were also separate water conductivity problems affecting the ion source.

The SNS project is only planning to procure spare Lambertson magnet coils, as opposed to buying full magnets.

4.2.2 Comments

Commissioning is a major Pre-Operations activity. There will be other systems that will require "tender loving care" before and after commissioning. The Committee was gratified to see that continued attention is being given to the ion source, and advised SNS management to remember when scheduling and distributing manpower that there will be other systems that will require continued attention even after commissioning.

The Committee suspected that considerably more than half of ASD commissioning remains. In fact, the commissioning work has just begun. Hence, even though the budget is adequate to cover the salaries of the commissioning teams, the Pre-Operations budget could be very tight.

Personnel for commissioning are identified and budgeted, but delays in deliveries of components or difficulties in commissioning of systems could squeeze the commissioning, thereby stressing the available manpower. The partner laboratories might be useful as a source of expert manpower if problems arise.

SNS management recognizes the water systems problems, and remediation is underway.

Lambertson magnets have complicated vacuum chambers, which are susceptible to developing leaks. The magnets also become highly activated, complicating repairs. The magnets are also very expensive, which drives the decision to procure only spare coils. A magnet failure during commissioning could delay further commissioning by as much as two months, and of course would have similar ramifications after CD-4. The Committee viewed the decision not to have spare magnets with some concern.

4.2.3 Recommendations

1. Develop a report on the status of all water systems by August 15, 2004.
2. Consider building complete spares of the Lambertson magnets and other complicated

devices soon after CD-4.

3. Keep lines of communication and involvement open between SNS and the partner laboratories, even when their project work is complete.

4.3 Pre-Operations—Transition to Operations

4.3.1 Findings and Comments

There is a plan for making a transition from construction to operations that has considerable detail in management structure and manpower. This plan seems to make sense, but it is difficult to say whether it is the best plan. In any case, it is a dynamic document that can be changed. It is important to note that such a plan exists and SNS management should be commended for forward thinking.

It should also be noted that the manpower, particularly the technician manpower is lean. SNS is assuming exceptional quality in this group to compensate for the small numbers. The ASD’s intention is to bring in help from their laboratory partners when necessary.

4.3.2 Recommendations

None.

5. ENVIRONMENT, SAFETY and HEALTH

5.1 Findings and Comments

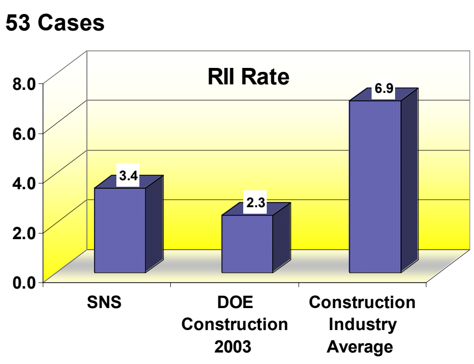
No recommendations were made during the November 2003 DOE review.

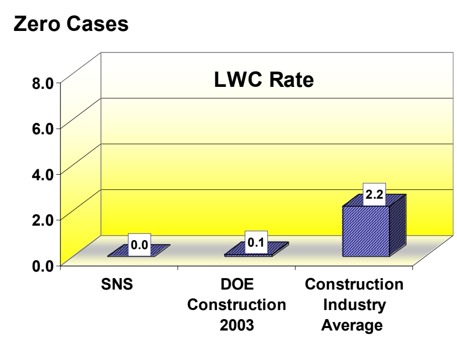
Safety performance in both construction and ORNL activities continues to be outstanding with 3 million construction and 2 million project and installation work hours accumulated to date without a Lost Workday Case (LWC).

The Construction Recordable Injury Incident (RII) rate has improved since the November 2003 DOE review (year-to-date 2.8 vs. project-to-date 3.4).

The higher than average project RII rate, given their Zero Lost Time Rate, is due to a conscious management decision; aggressive treatment of some first aid injuries to assure the health of workers is not compromised. This approach has resulted in the first aid cases being classified as recordable cases.

A low RII rate is clearly a desired objective. However, this approach has resulted in at least a $3.7 million TPC reduction in the form of lower project worker compensation costs than would have been experienced by a conventional approach to construction safety based on regional construction experience rates.





5.2 Recommendations

None.

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6. COST ESTIMATE

6.1 Findings

The SNS TPC has remained unchanged at $1,411.7 million. A summary of the cost estimate can be found in Appendix D. The TPC consists of a TEC of $1,192.7 million (construction line item) and $219.0 million of operating-expense funded activities (including R&D and Pre-Operations).

The actual FY 2004 costs-to-date (October 2003 through March 2004) were $119.8 million ($111.1 million for construction line item activities and $8.7 million for R&D and Pre-Operations). Cumulative costs and commitments through March 2004 were $1,158.7 million ($1,017.4 million for line item activities and $141.3 million for operating-expense funded activities).

The line item Budget-at-Completion presented was $1,165.5 million. This represents an increase of $17.6 million (use of contingency) over that presented in November 2003. The total contingency remaining in the baseline TEC is $27.2 million. Also presented was an EAC of $1,167.4 million with $25.3 million remaining in contingency. Using the EAC, actual costs, and awards through March 2004, the project calculated a contingency of 20.8 percent.

Each technical subcommittee reviewed cost and schedule information for the major WBS elements relevant to their subcommittee. Any findings related to the subcommittee assessments were covered in the individual technical sections where appropriate.

SNS management continues to use phase-funded procurements in the technical and CF portions of the project. Approximately 101 contracts with a total value of $293 million have been phase-funded. Sixty-seven of these with a total value of $144 million have been completed.

The value of the performance metric is limited by revisions of the baseline. However, as is appropriate for a project approaching completion, focus is shifting towards the EAC and very careful contingency management. Based on the performance reporting system, the SNS project is 79 percent complete as of the end of March 2004, as compared with 80 percent planned.

Changes in the project's risk assessment process were made since the November review. These include: revisions to risk evaluation criteria; clear delineation between EAC and risk;

changes to monthly reports to DOE Headquarters; and revisions to the Project Controls Manual.

SNS provided a project risk summary reflecting analyses performed in April 2004. The risk summary identified a cost impact of $17.7 million if all approximately 60 analyzed risks were to materialize. Previously (November 2003), the "maximum cost impact" associated with identified risks totaled $22.3 million. Risks associated with the DTL and CCL, and potential variances on awarded contracts are receding. Risks associated with SCL delivery, Target Systems installation schedule, effects of BA constraints on schedule, and requests for equitable adjustments have increased.

The Cost and Schedule recommendations from the November 2003 DOE review that established a contingency target of $25 million and requested completion of a more comprehensive risk analysis by January 1, 2004, have been adequately addressed.

Management actions are being taken by the project to meet the tight FY 2004 BA constraints and implement the project's End Game Plan. These actions include careful distribution of funds to partner laboratories, delaying hiring where feasible, and reducing overtime and travel.

6.2 Comments

The present contingency level (using the management-derived EAC) is $25.3 million. Of the $6.0 million used since November 2003, the majority was used for CF and integrated controls. This represents a slower rate of contingency use than reported at previous DOE reviews. However, current available contingency levels remain tight, and are a major concern for SNS management.

It was recommended at the November 2003 DOE review that the SNS project, "perform a more comprehensive risk analysis by January 1, 2004 and continue to update monthly." The project responded by making important improvements to both the risk assessment process and the way the data generated are used by management. Examples of these improvements include the decision to include in the EAC, all cost impacts for risks identified as "very likely", and the inclusion, in monthly management reports, of the cost impacts for risks identified as "likely."

In addition to improvements in process, the risk assessment was made more comprehensive, covering risks previously left un-analyzed. Two examples that were cited at the November 2003 DOE review (i.e., "standing army" costs if the early finish date is missed, and residual risk associated with materials that have been delivered, but where failures are still a possibility) were both analyzed in the current risk assessment.

The Committee encouraged the project to both assemble a plan for transitioning staff from commissioning to operations activities during FY 2006, and to formally document their transition to support from non-TPC operating funds.

The information being entered into the DOE Project Assessment Reporting System (PARS) is entirely consistent with the data being reported in the project's monthly status reports. This data is collected using the project's Microframe Project Manager system and appears to be fully consistent with actual physical progress.

6.3 Recommendation

1. Present a current EAC and identify additional cost savings to meet a contingency target of $20 million (as a minimum) at the next DOE review.

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7. SCHEDULE and FUNDING

7.1 Findings

The project's current cost baseline remains at a TEC of $1,192.7 million and a TPC of $1,411.7 million, which are both specified in the Construction Project Data Sheet in the FY 2005 President's Budget Request and in the SNS PEP. The FY 2005 Data Sheet contains a BA profile (see Appendix E) of $143.0 million in FY 2004; $112.9 million in FY 2005; and $74.9 million in FY 2006. The project's planned profile for budget outlay is: $228.3 million in FY 2004; $108.0 million in FY 2005; and $54.2 million in FY 2006. At the time of the November 2003 DOE review, the difference between the available cumulative funding (BA) and the planned cumulative obligations through the end of FY 2004 was $1.6 million. This remaining FY 2004 BA has since been fully allocated to the project, but the project is also considering options for executing an additional (approximate) $6 million of work in FY 2004 beyond this BA.

The IPS (see Appendix F for summary version) is consistent with the BA funding profile cited above. This IPS includes an internal goal for an early project completion in March 2006, providing three months of project schedule contingency relative to the CD-4 commitment date of June 2006. There is an additional one-month contingency within the IPS before the early finish date. Project performance continues to track well against existing DOE milestones. Major project milestones have been achieved since the November 2003 DOE review, including readying the Target Building for maintenance cell installation and starting maintenance cell installation, commissioning DTL Tanks #1-3, and starting the first instrument installation. Important milestones over the next six months include: cooldown of SCL cryoplant, completing installation and commissioning of the DTL and CCL, delivering components for the SCL RF system, and starting the target moderator refrigerator installation.

The IPS is derived from the detailed schedules provided by each WBS manager. The integrated detailed schedules are comprised of 15,637 activities, 18,448 relationships, and 620 inter-project links, approximately the same as at the November 2003 DOE review. Project elements on the critical path are completion of the Target Building and Target Systems installation. The Target Systems installation work has been broken down into a series of several phased installation packages to be awarded as contracts. The largest of those remaining, packages 3 and 4 for maintenance cell installation, have just been awarded. The contract for maintenance cell installation includes, as a deliverable, an integrated installation schedule that has not yet been provided. Integrated schedules for the other packages are also yet to be developed.

In response to previous DOE review recommendations, the project risk assessment more explicitly identifies potential schedule risks and mitigation, including risk from delays in Linac, Ring, and Target installation and commissioning, all of which are critical activities. Commissioning has been successfully initiated with the commissioning DTL Tanks #1-3, and 259 commissioning days are left in the schedule. An abbreviated IPS for the Accelerator Systems currently shows approximately 143 days of schedule contingency related to commissioning activities for the remainder of the Linac, HEBT/Ring/RTBT, and Target commissioning.

The TJNAF cryomodule production schedule has been extended two months due to BA constraints, and is now scheduled for completion in March 2005. A backup plan has been developed for the cryomodule testing and Linac commissioning to address potential risk to completing Linac commissioning.

7.2 Comments

The SNS End Game Plan moved some work to FY 2005 and changed the early finish date from December 2005 to March 2006. This plan is holding, with minor variations, as it is being implemented. The revised early finish schedule still leaves a full three months of schedule contingency before the baseline CD-4 milestone of June 2006.

SNS management has followed the plan reported at the November 2003 DOE review to hold back 15 percent of FY 2004 funding until much later in the year in order to maintain flexibility and ensure that the available BA is used most effectively. However, the relatively small buffer below the BA does not appear to have been sufficient to ensure that all adjustments that may be needed in the FY 2004 work plan can be accommodated. For example, included in the (approximate) $6 million potential FY 2004 CF work beyond the BA, are items that could help alleviate risk in the target maintenance cell installation work. To accommodate this work, the project has identified other work for possible deferral, with no or minimal schedule risk. Exercising real-time BA management will remain important, and care should be taken to ensure that potential schedule risks of BA-driven decisions are well understood, and that the early finish date of March 2006 is not compromised.

The Committee was pleased that potential schedule impacts from risks were more explicitly identified in the risk assessment. The IPS identifies the Target Building completion and the Target Systems installation as comprising the project's critical path. The risk assessment mitigation requires that CF, Target, and Instrument personnel work closely together to ensure that requirements are known and met, and that their respective schedules are well integrated. Therefore, it is imperative that a comprehensive integrated schedule for Target Building completion and Target Systems installation be developed and implemented as soon as practical. CF, Target, and Instrument management should work closely together on this schedule to ensure that the needs of each are met. This schedule is likely to provide the most efficient overall path for the earliest completion of Target Systems installation.

The IPS details remaining component and system installation, testing, and critical component production activities (e.g., SCL cryomodules and Ring diagnostics), in preparation for the important Linac, Ring, and Target commissioning periods. There is overall contingency (three months from early finish to CD-4), as well as internal contingency with respect to the early finish date for the major activities, including one to two-and-one-half months on commissioning periods (summing to 143 days of commissioning contingency). The risk assessment also identifies potential schedule risks and mitigations for these items. Given the complexity, inter-dependencies and challenges inherent in these activities, achieving project milestones on schedule will require the constant attention of the management team throughout the remainder of the project.

7.3 Recommendation

1. Develop a comprehensive, integrated schedule for completing the Target Building and all Target Systems installation activities and have it ready for review by July 1, 2004.

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8. MANAGEMENT (WBS 1.2)

8.1 Findings

Impressive progress continues to be made on the construction, technical components, and installation of the SNS project. At the end of March 2004, the SNS project was about 79 percent complete. The R&D is 99 percent complete, while the design work is 94 percent complete (the remaining work relates to the Instrument Systems). CF construction is 86 percent complete and installation of the technical systems is estimated to be 50 percent complete. All of these indices represent significant progress since November 2003 DOE review. Beam has been transported through DTL Tank #3, and installation of the target maintenance cell equipment has begun.

The SNS project has responded well to the recommendations from the November 2003 DOE review. Production of the superconducting cavities at TJNAF is much improved. Plans for completion of work and handoff to ORNL have been finalized with both BNL and TJNAF. There has been increased focus on schedule risks, as well as on cost risks, in the contingency assessment. And plans have been developed to allow costs for operations and associated infrastructure for the Linac, Ring, Target, and each instrument to shift to a FY 2006 SNS operations account (non-TPC funding) as acceptance testing is completed for each system.

Project cost contingency based on EAC is reported to be $25.3 million, 20.8 percent of the unobligated cost to go. This is to be compared with $31.3 million (21.8 percent) of contingency reported at the November 2003 DOE review. SNS management continues to examine possible technical adjustments and sequencing of activities to accommodate potential cost increases, with the goal of limiting the use of contingency funds. The project is continuing to transfer work and the associated risk to ORNL from the partner laboratories and examined other options to reduce contingency use and balance risk. The SNS project uses a risk analysis technique to identify and evaluate risks to the project and to determine the level of contingency that may be needed. This risk list totals to a potential need of $17.7 million (known risks), leaving $7 million of contingency funds to cover additional unknown risks.

Three of the five partner laboratories have been successfully transitioned off of the project. Most recently the LANL handoff was achieved as scheduled on April 2, 2004. Plans have been agreed upon between SNS and the remaining two partner laboratories, BNL and TJNAF, for their transition from the project by March 2005.

8.2 Comments

The Committee congratulated the management team on the excellent progress since the November 2003 DOE review. SNS management knows first hand what is going on at a detailed level, and is actively addressing the important issues. SNS is being managed effectively by a strong and competent team, consistent with completing the baseline project scope within the baseline TPC ($1,411.7 million) and schedule (CD-4 in June 2006). The EAC-based contingency has decreased $6 million since the November 2003 DOE review to $25.3 million. The net contingency usage has been minimized in part by judicious implementation of engineering options that still maintain the scope required to meet CD-4 criteria in the PEP. While the project has made concerted efforts in identifying cost savings, this remains a priority and will require continued attention.

SNS management provided evidence that issues are identified quickly and actions are taken to resolve them. The Project Office has good communications with the partner laboratories; issues raised by them are heard and dealt with effectively. Balancing cost, schedule, and technical risk remains a significant challenge. The SNS project relationship with both the DOE Office of Basic Energy Sciences and the local DOE ORO Project Office continues to be positive and cooperative.

Contingency remains tight and managing it will be a challenge. The risk analysis is continually updated to identify issues. The risk analysis identifies the likelihood of the risk associated with the issues, the potential timing of the risk event, and the severity of the issue in terms of cost and schedule impact. This is an important approach, but it must be recognized that this list addresses only the "known unknowns," and that problems not on the list may arise. It is also very important to keep this list up to date and aligned with the lists developed by the Level 2 WBS Managers and partner laboratories.

A key element to the success of SNS is to maintain the project on schedule, especially in FY 2004 and FY 2005. Progress on their schedule is limited by the BA available in both years. The Committee noted good progress being made by SNS management, working with ORNL and the ORO, on plans to make maximum use of the available BA to keep all work going forward as rapidly as possible. ORNL and ORO are urged to look for ways to ensure that the maximum amount of BA is made available to SNS consistent with Cost Accounting Standards, to ensure that the project is on schedule and to position the project for a successful completion in FY 2006.

The Committee was pleased with the progress, since the November 2003 DOE review, on the production of cryomodules for the SCL. The increased attention by TJNAF management has been instrumental in addressing quality issues. The cryomodules are a very important element in the project schedule and, because of their nature, will require continued close technical oversight.

Transition plans have been developed and are being put in place for the rampdown of effort at the two remaining partner laboratories and the transfer of technical expertise and responsibility to the SNS staff at ORNL. With these plans now agreed upon, it is important that they be fully implemented. The Committee noted that expertise at partner laboratories has proven to be valuable during this transition phase and the Committee acknowledged the cooperation that has been seen from partner laboratories even as they are phased off of the project. It is hoped and expected that this level of cooperation will continue as the remaining two partner laboratories complete their work.

The Committee was pleased to see that progress has been made on plans that would allow transferring staff to an off-project operating budget in FY 2006 when a major subsystem has been successfully commissioned and tested but prior to CD-4. In particular, SNS management is working closely with the DOE Office of Science to allow ASD staff to be moved onto SNS operations funding in FY 2006 once the accelerator complex has been commissioned. The project was encouraged to continue to develop these plans.

8.3 Recommendations

None.

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APPENDIX A

CHARGE MEMORANDUM

DOE F 1325.8
(08-93)

United States Government

TO: Daniel R. Lehman, Director, SC-81

I would like to request that you organize and lead an Office of Science (SC) semi-annual status review of the Spallation Neutron Source (SNS) project in Oak Ridge, Tennessee, during May 11-13. The purpose of this review is to evaluate progress in all aspects of the project: technical, cost, schedule, management, and Environmental Safety and Health (ES&H).

The SNS project is now over three-fourths complete. Key activities include installation and commissioning of the Linac and its cryogenic system, installation of Ring and Target Systems components, Instrument Systems component fabrication, and construction of the Target and Central Laboratory and Office Buildings. Based on concerns identified in the November 2003 evaluating contingency management and identifying areas where improvements could be made to ensure that the project is completed within the $1, 411.7 million Total Project Cost (TPC).

In carrying out its charge, the review committee should respond to the following questions:

1. Are the project's cost, schedule, and technical baselines consistent with those in the FY 2005 Project Data Sheet and the current DOE-approved SNS Project Execution Plan (e.g., TPC of $1,411.7 million, and CD-4 in June 2006), and is there adequate progress to meet the baseline objectives? Is the information in the DOE Project Assessment Reporting System consistent with physical progress?

2. Is the project being managed as needed for its proper execution? Do baseline plans provide for a smooth transition from a construction project into an operating user facility?

3. Is there adequate contingency (cost and schedule) to address the risks inherent in the remaining work and is it being properly managed? Is the contingency supported by and consistent with an appropriate project-wide risk analysis?

4. Is adequate progress being made on installation and commissioning of Linac, Ring, and Target Systems? Are the installation and commissioning plans reasonable from the standpoint of previous experience, technical logic, costs, project-wide staffing plans, and transfer of responsibilities from the partner labs?

5. Are ES&H aspects being properly addressed given the project's current stage of development? Are Integrated Safety Management Principles being followed?

6. Has the project responded appropriately to recommendations from prior DOE/SC reviews?

Jeff Hoy, the SNS Program Manager, will serve as the Basic Energy Sciences point of contact for this review. I would appreciate receiving your committee's report within 60 days of the review's conclusion.

Patricia M. Dehmer
Associate Director of Science
for the Office of Basic Energy Sciences

cc:
B. Weakley, SC-4
L. Dever, SC-80
S. Meador SC-81
J. Hoy, SC-12
G. Boyd, ORO
G. Malosh, ORO
L. Price, ORO
J. Wadsworth, ORNL
T. Mason, SNS
C. Strawbridge, SNS

APPENDIX B

REVIEW PARTICIPANTS

Department of Energy Review of the Spallatin Neutron Source (SNS) Project
May 11-13, 204
Daniel R. Lehman, DOE Chairperson

SC1

Linac System, WBS 1.4

* Dixon Bogert FNAL
Bob Diebold, consultant
Helen Edwards, FNAL
Ken Shepard, ANL
Jay Theilacker, FNAL

SC2

Ring System, WBS 1.5

* Rod Gerig, ANL
Dick Cassel, SLAC
George Goeppner, ANL
Rob Webber, FNAL

SC3
Target
Systems, WBS 1.6

* Guenter Bauer, FZJ
Paul Schmor, TRIUM
Ian Thorson, Consultat

SC4
Instrument
Systems, WBS 1.7

* John Tranquada, BNL
Robert McGreevey, ISIS
David Mildner, NIST
Greg Smith, ORNL

WBS 1.9

.AC

SC6
Conventional
Facilities, WBS 1.8

* Dale Knutson, ANL
Dale Flowers, PNNL

SC7
Accelerator Physics
Pre-Ops, WBS 1.10

* Peter Limon, FNAL
Rick Baartman, TRIUMF
Stan Ecklund, SLAC
Phil Martin, Consultant

SC8

ES&H

* Rich Hislop, ANL
Mark Grushka, U. of Aizona

SC9

Cost and Schedule

* Jim Krupnick, LBNL
Pepin Carolan, DOE/FAO
Stephen Meador, DOE/SC

BS 1.2

L
C

Observers

Pat Dehmer, DOE/SC
Jeff Hoy, DOE/SC
Pedro Montano, DOE/SC

Mike Osinski, DOE/SC
Les Price, DOE/ORO
Larry Radcliffe, DOE/ORO

David Wilfert, DOE/OO
Kelly Greene, DOE/OECM
Suneel Kapur, DOE/OECM

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APPENDIX C

REVIEW AGENDA

Tuesday, May 11, 2004—SNS Building, 701 Scarboro Rd., Conference Room 101

8:00 a.m. DOE Full Committee Executive Session .... Lehman
- BES Program Perspective—Charge .... Dehmer
- DOE Project Director Perspective .... Price
- SNS Cost Spreadsheet .... Krupnick

9:00 a.m. Opening Remarks
- UT-Battelle Welcome .... Wadsworth
- DOE Welcome .... Dehmer

9:10 a.m. SNS Overview .... Mason
- Safety
- Current Challenges

10:00 a.m. Break

10:15 a.m. Project Management and Conventional Facilities Summary ..... Strawbridge
- ES&H performance
- Project Cost/schedule performance (plus DOE PARS)
- Project Risk assessment, contingency status, estimate to complete
- Status of Construction
- Conventional Facilities Baseline status (cost/schedule/technical)
- Conventional Facilities Current issues
- Response to prior DOE Reviews

10:45 a.m. Experimental Facilities Summary .... Anderson
- Status of R&D, design, and procurements
- Baseline Status (cost/schedule/technical)
- Target/Instrument Installation Planning and Progress
- Response to prior Reviews
- Current issues

11:15 a.m. Accelerator Systems Summary .... Holtkamp
- Status of R&D, design, and procurements
- Baseline status (cost/schedule/technical)
- Accelerator Installation and Commissioning Planning and Progress
- Response to prior Reviews
- Current issues

11:45 a.m. Lunch

12:45 p.m.	Parallel Subcommittee Presentations/Discussions
	– Accelerator Systems..Holtkamp/STLs
	– Conventional Facilities .... Strawbridge/Lawson/Staff
	– Experimental Facilities .... Anderson/STLs
	(Management/Cost & Schedule/ES&H Subcommittees meet with above subcommittees)
3:30 p.m.	Site tour
5:00 p.m.	DOE Subcommittee Executive Sessions
5:15 p.m.	DOE Executive Session .... Lehman
6:30 p.m.	Adjourn

Wednesday, May 12, 2004

8:00 a.m.	Subcommittee Breakout Discussions
9:00 a.m.	Management Subcommittee...................... Wadsworth/Mason/Strawbridge/ Boudwin/SNS Division Directors
11:00 a.m.	Cost/Schedule Subcommittee .... Herron/Staff
12:00 p.m.	Lunch
1:00 p.m.	Continue Subcommittee Breakout Discussions
2:30 p.m.	DOE Subcommittee Executive Sessions
4:00 p.m.	DOE Full Committee Executive Session .... Lehman

Thursday, May 13, 2004

8:30 a.m.	Subcommittee Working Sessions
10:00 a.m.	DOE Full Committee Executive Session Closeout Dry Run........... Lehman
11:30 p.m.	Lunch
1:30 p.m.	Closeout with DOE and SNS Management .... Lehman
2:30 p.m.	Adjourn

APPENDIX D

COST TABLES

Cost Baseline

Cost Baseline						
WBS	Description	May 2004 Review Baseline (BAC) $M	May 2004 Review EAC $M		November 2003 Review EAC $M	
1.2	Project Support	75.6	75.1		75.9	
1.3	Front End Systems	20.8	20.8		20.8	
1.4	Linac Systems	316.9	316.8		314.6	
1.5	Ring and Transfer Systems	142.0	142.4		142.1	
1.6	Target Systems	108.2	109.0		108.1	
1.7	Instrument Systems	63.3	63.5		63.3	
1.8	Conventional Facilities	378.9	379.9		376.9	
1.9	Integrated Controls	59.8	59.8		59.6	
BAC		1,165.6	1,167.4		1,161.4	
Total Contingency		27.1	25.3	20.8%*	31.3	21.8%**
	TEC	1,192.7	1,192.7		1,192.7	
	R&D	101.9	100.0		101.9	
	Pre-Operations	117.1	119.0		117.1	
	TPC	1,411.7	1,411.7		1,411.7	

*Based on EAC and estimated costs and awards through 3/31/04

**Based on EAC and estimated costs and awards through 10/31/03

APPENDIX E

FUNDING
TABLE

SNS Budget Authority (BA) Profile

(Actual Year thousands of dollars)

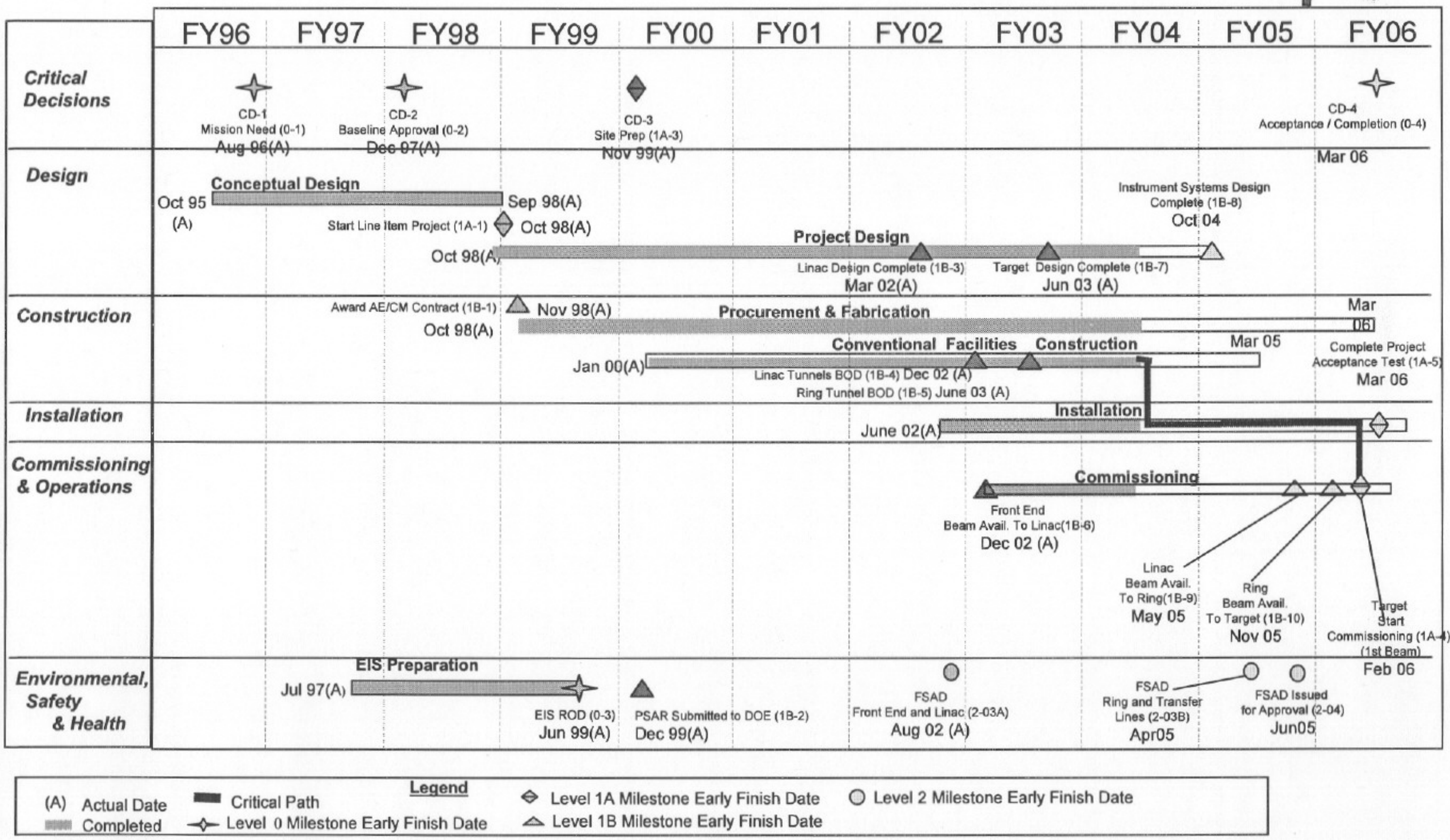
	Prior Years	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006	Total
Construction Line Item		101,400	100,000	258,929	276,300	210,571	123,865	80,535	41,100	1,192,700
Operating Expense	38,578	28,600	17,900	19,059	15,100	14,441	18,397	33,100	33,825	219,000
Total BA	38,578	130,000	117,900	277,988	291,400	225,012	142,262	113,635	74,925	1,411,700

Funding profile from President's FY 2005 Budget Request

APPENDIX F

SCHEDULE
CHART

SNS On Track for March 06 Finish



APPENDIX G

MANAGEMENT CHART

SPALLATION NEUTRON SOURCE
T. MASON
ASSOCIATE LABORATORY DIRECTOR

DEPUTY PROJECT DIRECTOR (PROJECT MANAGEMENT)	**C. STRAWBRIDGE**
ASSOCIATE PROJECT DIRECTOR	**K. BOUDWIN**
SAFETY/ENVIRONMENT MANAGER	**F. KORNEGAY**
HUMAN RESOURCES MANAGER	**J. TRIMBLE (1)**

SPALLATION NEUTRON SOURCE/HFIR USERS GROUP
J. KRUEGER, CHAIR

ACCELERATOR SYSTEMS ADVISORY COMMITTEE
R. SIEMANN, CHAIR

EXPERIMENTAL FACILITIES ADVISORY COMMITTEE
C. BROHOLM, CHAIR

EXPERIMENTAL FACILITIES
I. ANDERSON
DIVISION DIRECTOR

JINS
L. MAGID
ACTING DIRECTOR

- TARGET SYSTEMS — **T. GABRIEL** — SR. TEAM LEADER (ORNL)
- INSTRUMENT SYSTEMS — **K. CRAWFORD** — SR. TEAM LEADER (ORNL)
- EXPERIMENTAL FACILITIES OPERATIONS — **J. FORESTER** — MANAGER (ORNL)
- USER ADMINISTRATION — **A. EKKEBUS** — USER PROGRAM MANAGER (ORNL)

ACCELERATOR SYSTEMS
N. HOLTKAMP
DIVISION DIRECTOR
ASSOCIATE DIV. DIRECTOR **D. OLSEN**

- ACCELERATOR PHYSICS — **S. HENDERSON** — GROUP LEADER (ORNL)
- OPERATIONS — **G. DODSON** — MANAGER (ORNL)
- BEAM DIAGNOSTICS — **T. SHEA** — GROUP LEADER (ORNL)
- ION SOURCE — **M. STOCKLI** — GROUP LEADER (ORNL)
- SURVEY & ALIGNMENT — **J. ERROR** — GROUP LEADER (ORNL)
- INSTALLATION SERVICES — **T. MANN** — GROUP LEADER (ORNL)
- MECHANICAL SYSTEMS — **G. MURDOCH** — GROUP LEADER (ORNL)
- ELECTRICAL SYSTEMS — **R. CUTLER** — GROUP LEADER (ORNL)
- CRYO SYSTEMS — **D. RICHIED** — GROUP LEADER (ORNL)
- RF SYSTEMS — **R. FUJA** — GROUP LEADER (ORNL)
- CONTROLS — **D. GURD** — GROUP LEADER (LANL)
- CONTROL SYSTEMS — **D. GURD** — SR. TEAM LEADER (ALL LABS)
- SUPERCONDUCTING CAVITY SYSTEMS AND CRYOGENICS — **C. RODE** — SR. TEAM LEADER (JLAB)
- RING SYSTEMS — **J. WEI** — SR. TEAM LEADER (BNL)

PROJECT AND SITE SUPPORT OFFICE
C. STRAWBRIDGE

- SITE SERVICES — **J. LAWSON** — FACILITIES COMPLEX MGR (ORNL)
- CONSTRUCTION SUPPORT — **J. LAWSON** — SR. TEAM LEADER (ORNL)
- PROCUREMENT — **J. GEOUQUE (1)** — GROUP LEADER (ORNL)
- PROJ CONTROLS AND CONFIGURATION MGMT — **S. HERRON** — MANAGER (ORNL)
- QUALITY ASSURANCE — **M. SKONICKI** — GROUP LEADER (ORNL)
- BUSINESS — **J. HILL** — MANAGER (ORNL)
- TECHNICAL INFO SYSTEMS — **D. CIARLETTE** — GROUP LEADER (ORNL)

KEY
(A) ACTING
(1) MATRIX
(2) POST DOC
(3) SUBCONTRACTOR
(4) CONSULTANT

SNS
SPALLATION NEUTRON SOURCE

EFFECTIVE DATE: 05-01-04

Thomas Mason
05-01-04

APPENDIX H

ACTION
IEMS

Action Items

Resulting from the May 2004 Department of Energy Review of the

Spallation Neutron Source

Action	Responsibility	Due Date
1. Conduct a Semi-Annual Project Status Review	DOE-SC	November 2004

Carl N. Strawbridge
Deputy Project Director
Spallation Neutron Source Project
Oak Ridge National Laboratory

Lester K. Price
SNS Project Director
Oak Ridge Operations Office
U.S. Department of Energy

Jeffrey C. Hoy
SNS Program Manager
Office of Basic Energy Sciences
U.S. Department of Energy

Thomas E. Mason
Associate Laboratory Director
Spallation Neutron Source Project
Oak Ridge National Laboratory

Daniel R. Lehman
Review Chairman
Office of Science
U.S. Department of Energy

Patricia M. Dehmer
Director
Office of Basic Energy Sciences
U.S. Department of Energy

Jeffrey Wadsworth
Director
Oak Ridge National Laboratory

APPENDIX I

GLOSSARY

	Argonne National Laboratory
ARR	Accelerator Readiness Review
ASD	Accelerator Systems Division
BA	Budget Authority
BNL	Brookhaven National Laboratory
BOD	Beneficial Occupancy Dates
BPM	Beam Position Monitor
CF	Conventional Facilities
CCL	Cavity Coupled Linac
CD	Critical Decision
CDR	Conceptual Design Report
CFD	Conventional Facilities Division
CLO	Central Laboratory and Office Building
DANSE	Distributed Data Analysis for Neutron Scattering Experiments
DOE	U.S. Department of Energy
DTL	Drift Tube Linac
EAC	Estimate-at-Completion
ES&H	environment, safety, and health
ETC	Estimate-to-Complete
FTE	Full-Time Equivalents
GAO	General Accounting Office
	billion electron volts
H^-	negatively-charged hydrogen ions
HEBT	High Energy Beam Transport
IDT	Instrument Development Teams
IOC	Input/Output computers
IPS	Integrated Project Schedule
JLab	Thomas Jefferson National Accelerator Facility
LANL	Los Alamos National Laboratory
LBNL	Lawrence Berkeley National Laboratory
LEBT	Low Energy Beam Transport
Linac	linear accelerator
LLRF	Low Level Radio Frequency

M&O	Management and Operations
MAP	Mitigation Action Plan
MeV	Million Electron Volts
MHz	mega Hertz
MOA	Memorandum of Agreement
MPS	Machine Protection System
MV/m	mega Volts per meter
MW	million watts
ODH	oxygen deficiency hazard
ORNL	Oak Ridge National Laboratory
ORO	Oak Ridge Office
PARS	Project Assessment Reporting System
PEP	Project Execution Plan
PPS	Personnel Protection System
PSSO	Project and Site Support Office
RF	radio frequency
RTBT	Ring to Target Beam Transport
SANS	small-angle neutron scattering
SCL	superconducting linac
SING	SNS Instruments Next Generation
SNS	Spallation Neutron Source
TEC	Total Estimated Cost
TPC	Total Project Cost
UT-Battelle	University of Tennessee and Battelle Memorial Institute
WBS	Work Breakdown Structure
WNR	Weapons Neutron Research Facility
XFD	Experimental Facilities Division