Department of Energy
Review Committee Report

on the

Technical, Cost, Schedule, and
Management Review

of the

SPALLATION NEUTRON SOURCE (SNS) PROJECT

May 2003

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 6-8, 2003, 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 whether project contingency is adequate to address the risks associated with completing the SNS on schedule.

Overall, the Committee found that the SNS project is appropriately managing the issues and can meet its Level 0 Baseline objectives: a Total Project Cost of $1,411.7 million; project completion by June 2006; and greater than or equal to 1 megawatt proton beam power on target. With one exception, the project's cost, schedule, and technical baselines are consistent with the FY 2004 Project Data Sheet and the Project Execution Plan. The issue is that the Integrated Project Schedule (IPS), which provides about six months of schedule contingency with an early finish of December 2005, requires roughly $25 million more funding in FY 2004 than contained in the approved project Budget Authority (BA) profile. This can be rectified by re-sequencing work in the IPS to remain within the BA limits, and will probably result in sacrificing some amount of schedule contingency. Another issue is that contingency funds have been reduced during the last six months from $67.3 million to $44.6 million (accounting for in process changes).

Technical and construction progress have continued to be excellent, and as of March 31, 2003, the project is 61 percent complete versus 62 percent planned. The information in DOE's Project Assessment and Reporting System accurately reflects this status. Technical milestones completed since the November 2002 DOE review included: recommissioning the Front End at Oak Ridge, starting Linac and Target installation, and successfully testing the Low Level RF control system with a production cryomodule. The Drift Tube Linac (DTL) progress is slightly behind the DTL Recovery Plan, but acceptable. Key technical risk items include delivery/performance of the Linac components (especially the DTL and High Voltage Converter Modulators) and installing components in the Linac and Target Systems.

In the area of Conventional Facilities, the Committee found the cost and schedule defensible; however, the Estimate-at-Completion (EAC) needs to be evaluated to include probable impacts of weather, pending claims, and BA optimization. The Conventional Facilities

EAC of $366.1 million represents a cumulative cost growth of 19.2 percent since the May 2001 DOE review and it is the chief contributor to the IPS-BA profile mismatch. Over three million work-hours (construction and non-construction) to date have been accomplished without a lost workday injury. Integrated Safety Management principles are being followed.

The SNS project is a multi-laboratory partnership led by the SNS Project Office in Oak Ridge, Tennessee. The partners are Argonne National Laboratory, Brookhaven National Laboratory, Lawrence Berkeley National Laboratory, Los Alamos National Laboratory, Oak Ridge National Laboratory (ORNL), and Thomas Jefferson National Accelerator Facility. Relations among the SNS partner laboratories continue to be excellent and internal communications are generally good. There have been no changes in key project management positions; however, the ORNL Director has announced that he will be leaving for a higher position in the corporate office but would remain supportive of the project. The relationship between the SNS project and the State of Tennessee remains positive.

The SNS project has been responsive to the recommendations from the November 2002 DOE review. In response to the November management recommendations, BNL has developed an acceptable plan for transitioning staff off of the SNS project as work is completed.

The Committee assigned three Action Items:

1. By July 3, 2003, the SNS project is to prepare a comprehensive End Game Plan that re-sequences project activities to better match the approved funding plan.

2. On July 9-11, 2003, the DOE SNS Project Office is to conduct a review of the End Game Plan.

3. On November 4-6, 2003, the DOE Office of Science is to conduct another Semi-Annual Project Status Review.

In summary, the Committee found that the SNS project is still on track to meet its Level 0 Baseline objectives, and management is cognizant of the issues. The biggest challenge is cost. Contingency management is a major concern and the IPS-BA profile mismatch needs to be resolved as soon as possible.

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<u>Appendices</u>

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 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 and bunching them into a short (under one microsecond) pulse 60 times per second. Finally, the proton beam will be directed onto a liquid mercury target, 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: ANL—Instrument Systems (WBS 1.7); BNL—Ring Systems; LANL—Normal Conducting Linac; LBNL—Front End Systems; ORNL—Target Systems; and TJNAF—Superconducting Linac. Design and construction management of the Conventional Facilities is being handled by a commercial architect engineer/construction management (AE/CM) team (Zander-Jacobs) under a task order contract to ORNL.

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 are being properly implemented.

Figure 1-1. The Spallation Neutron Source

The SNS conceptual design was carried out during FY 1996 and FY 1997, at a cost of about $16 million, and evaluated by a DOE review committee in June 1997 (report DOE/ER-0705). At the same time, a DOE Independent Cost Estimate was performed. 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 $1,226 million to $1,333 million (as spent[1]).

Critical Decision (CD) 1, Approval of Mission Need, and CD-2, Approval of Preliminary Baseline Range, for the SNS were approved by the Secretary of Energy in August 1996 and December 1997, respectively. The SNS PEP, which governs how the project is managed, was initially approved by the Secretary at the time of CD-2, and was most recently updated in April 2002. 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 produce a proton beam on target of ≥ 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.

A DOE Technical, Cost, Schedule, and Management Review was conducted in June 1998. Its principal finding was that the project's management organization and systems were sufficiently mature to initiate the construction project at the beginning of 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 the Accelerator Systems Division (ASD) at ORNL.

The FY 1999 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).

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

In November 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). The AE/CM team is responsible for design and construction of all Conventional Facilities.

At the January 1999 DOE review of the SNS project, the committee determined that the SNS collaboration was continuing to work well together, and technical progress was generally good, however the baselines were still not judged to be ready for DOE approval. The main reason was lack of technical leadership and 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.

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 Office team could lead the project to success. 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. The project was able to make continued progress, however, by using uncosted obligations remaining from FY 1999 while efforts were made to satisfy these conditions. In particular, DOE approved CD-3, Start Construction, on November 5, 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 (EIR) 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 state government enacted a law 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.

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.

The President's FY 2001 Budget Request for SNS was amended to reduce the TPC from $1,440 to $1,411.7 million to account for the Tennessee tax exemption. 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 Conventional Facilities 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 Conventional Facilities (CF), which was about $80 million over the cost baseline, and an overly aggressive pre-operations staffing plan. The third issue was that the Integrated Project Schedule (IPS) required more Budget Authority (BA) than that contained in the FY 2001 Project Data Sheet's annual funding 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. There were significant scope reductions in CF that included deleting the Central Laboratory and Office (CLO) Building (while retaining a minimum level of functionality) and reducing the size of the Target Building, and the instrument budget was reduced 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 were deleted to save money, resulting in a lower Linac output energy of 840 MeV, while still providing a proton beam power on target of over 1 MW (the Level 0

Baseline parameter). The pre-operations staffing level was reduced to the minimum level necessary to commission the machine. Lastly, the IPS was re-planned to be 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, a reduced-scope CLO was retained in the baseline; the instrument budget was adjusted to $60 million to provide for five Best-in-Class instruments plus design of common components for future instruments; certain DOE milestones were relaxed to conform with the revised IPS; and the energy specification for Linac output energy was restored to 1 GeV (while retaining the proton beam power on target requirement of ≥ 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 rather than extend, he elected to return to ANL. After an extensive search by the Director of ORNL, the SNS Experimental Facilities Division (XFD) Director, Dr. Thomas Mason, was selected to take charge as SNS Project Director (now the Associate Laboratory Director for SNS). Having been with the project since its inception, 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 the Conventional Facilities Division or CDF).

The FY 2001, 2002, and 2003 congressional appropriations for SNS have met the levels contained in the President's Budget Requests ($278.0 million, $291.4 million, and $225.0 million, respectively). Accordingly, 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 2004 Budget Request for SNS is $143.0 million.

Thus far in FY 2003, construction activities at the Chestnut Ridge site have included completion of the Front End Building, Linac and High Energy Beam Transport Tunnels, Klystron Gallery, and Target Building foundation. The Central Utilities Building is nearly finished. Steel erection is underway on the CLO and Target Buildings. The Front End has been re-commissioned, and Linac and Target Systems installation have just begun. As of March 31, 2003, the overall project was 61 percent complete, had awarded nearly $480 million in procurements, and completed 88 percent of all design work, 95 percent of all R&D, 60 percent of conventional construction, 49 percent of technical hardware, and 26 percent of installation. The first Drift Tube Linac Tank has been installed in the Linac Tunnel and radiofrequency (RF) conditioning has begun. Other technical components are continuing to arrive at ORNL at the Receiving, Assembly, Test and Storage (RATS) Building I on Union Valley Road and at RATS II on the SNS construction site. The overall size of the project work force, including construction workers, is about 1,200 full-time equivalents, which is its peak level.

1.2 Charge to the DOE Review Committee

In a March 3, 2003 memorandum (see Appendix A), Dr. Patricia M. Dehmer, Director for Basic Energy Sciences, Office of Science (SC), 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 2004 Project Data Sheet. The second question in the charge memorandum concerning the impact of a FY 2003 funding reduction was dropped because Congress restored the reduction just prior to the review. The Front End Systems (WBS 1.3) was not explicitly covered in this review because it has now been completed and installed at SNS.

1.3 Membership of the Committee

The Review Committee (see Appendix B) was chaired by Daniel R. Lehman and James R. Carney. 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 ten DOE review Committees. The Committee was organized into eleven 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 accomplished during May 6-8, 2003, at Oak Ridge, Tennessee. The agenda (Appendix C) was developed with the cooperation of the SNS Project Office, DOE/SC Headquarters, and DOE Oak Ridge Operations Office 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 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.

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2. TECHNICAL SYSTEMS EVALUATIONS

2.1 Accelerator Physics

2.1.1 Findings

The Front End System has been re-commissioned. The beam intensity and root mean square (rms) emittance goals have been achieved, but reliability over long time periods has not yet been demonstrated.

Not all of the intended commissioning tasks were completed. This was due to hardware failures, and not due to lack of time. During the re-commissioning, roughly one-third of the downtime was related to the ion source, and one-third was related to RF. The ion source downtime was almost all related to the Low Energy Beam Transport (LEBT).

The pulse flatness question raised at the November 2002 DOE review has been answered. Pulse flatness of five percent can be achieved by tuning the ion source. Emittance has been measured along the beam pulse, and these measurements indicate that it takes a variation of 20 percent to cause an emittance growth of five percent.

Tuning of the Medium Energy Beam Transport (MEBT) was successful in the sense that after steering and focusing correction, the emittance figures look quite clean. However, they appear to be easily damaged by small misalignments through the re-bunchers. One of the lessons learned was the importance of having an on-line emittance scanner. It will remain permanently in what was the anti-chopper box.

On the other hand, the phase pickups did not function, and there were no bunch length measurements. Obtaining the design bunch length (rms and full) from the MEBT is important for commissioning the Linac. This is on the task list for the next commissioning run. The MEBT halo scrapers have been downgraded in priority. They will only be installed when tests show that they are needed. Space has been left available.

There has been impressive progress in developing the “laser wire” beam position monitor. Good resolution has been achieved as a profile monitor. First attempts of measuring the “beam in gap” look very promising.

A strategic sorting scheme has been developed for the magnets in the Ring. Using the characteristics of the magnets at the field setting required for the upgrade energy of 1.3 GeV, will reduce closed orbit distortion to a tolerable level, without compromising performance at 1.0 GeV.

Solenoids and clearing electrodes for controlling the electron cloud effect are now in the baseline. Good progress is still being made in closing the gap between theory and experiment on the Proton Storage Ring (PSR)/e-cloud instability. The most recent analytic calculations and simulations predict that the SNS Ring would support stable operations up to 2 MW. The beneficial effects of “beam scrubbing” on secondary electron yield (SEY) have been observed at other labs (LANL PSR, CERN SPS). Beam scrubbing of the vacuum chamber walls to reduce SEY may require extra pumping. Ports have been made available for this.

2.1.2 Comments

The “hot spare” ion source has been moved on site from the RATS building, and is being restarted. It consists only of an ion source and extraction system. As most of the problems arose from the LEBT system, it would be wise to augment the hot spare with its own LEBT. This would allow study of the alignment issues, and would also allow tests to determine whether long term running would require cooling of the LEBT electrodes.

The laser wire development work should be continued, especially as applied to the “beam in gap” measurement. Also, with the addition of a picosecond pulsed laser (approximately $50,000), it can be used to measure the bunch shapes in the Linac. This could prove to be the most cost-effective way of making this measurement.

Absolute, as opposed to relative, energy measurements should be planned—they are necessary in the transitions to each of the three different linacs: Drift Tube Linac (DTL), cavity coupled linac (CCL), and superconducting linac (SCL). These measurements will help to eliminate any accumulated systematic error during the amplitude and phase setting in the Linac resonators. Measurements of the bunch length and longitudinal emittance are helpful in the transition between the DTL and CCL, because of the reduction of longitudinal phase acceptance by a factor of two. Development and installation of bunch shape monitors in this transition region are encouraged.

2.1.3 Recommendation

1. Augment the “hot spare” ion source with a LEBT by the time of the next DOE review.

2.2 Linac Systems (WBS 1.4)

The Linac structure is unchanged since the November 2002 DOE review. As shown in Figures 2-1 and 2-2, the Linac structure is a conventional DTL to 87 million electron volts (MeV), a CCL from 87 to 186 MeV, a "medium-ß" (ß=0.61) SCL from 186 MeV to 379 MeV, and a "high-ß" (ß=0.81) SCL from 379 MeV to approximately 1 GeV. The medium-ß SCL has 33 cavities in 11 modules and the high-ß SCL has 48 cavities in 12 modules.

2.2.1 Findings

Good progress has been made since the November 2002 DOE review. Significant progress has been made in two areas that were identified as requiring particular attention in the November 2002 DOE Review Report. No new issues of comparable impact have become apparent in the last six months. The two problem areas identified at the November DOE review as requiring urgent attention were hardware problems with the DTL and the Low Level RF (LLRF) control system. A brief report of findings on these two subjects, both topics of recommendations from the November DOE review, follows:

1. A recovery plan to fix the manufacturing flaws in the DTL was urgently developed in consultation with outside experts. The plan was adopted and has been followed. Among other changes, a substantial increase in engineering and technical oversight was made with additional experienced LANL staff responsible for the remediation and ongoing production of the DTL. The first rebuilt item, DTL Tank #3, has recently been put under power for conditioning and functioned at full voltage and 44 percent of full power for a short period of time. This is very encouraging, and an excellent measure of the success of the remediation plan. An adequate and appropriate recovery plan, supporting the commissioning schedule, is clearly in place. Given the potential severity of this problem when discovered last year, and its potential impact on the timely completion of the project, the project wide cooperation and response has been exemplary.

2. A recovery plan for the LLRF control system, developed just prior to the November DOE review, has also been implemented with very good results. Operation of LLRF control systems at both the MEBT and at the TJNAF cryomodule test facility has been successful. This includes an impressive demonstration of "closed-loop" operation of the superconducting cavity modules using the 1 MW klystron provided for these tests. The entire Integrated Cryomodule Test program begun at TJNAF in September 2002

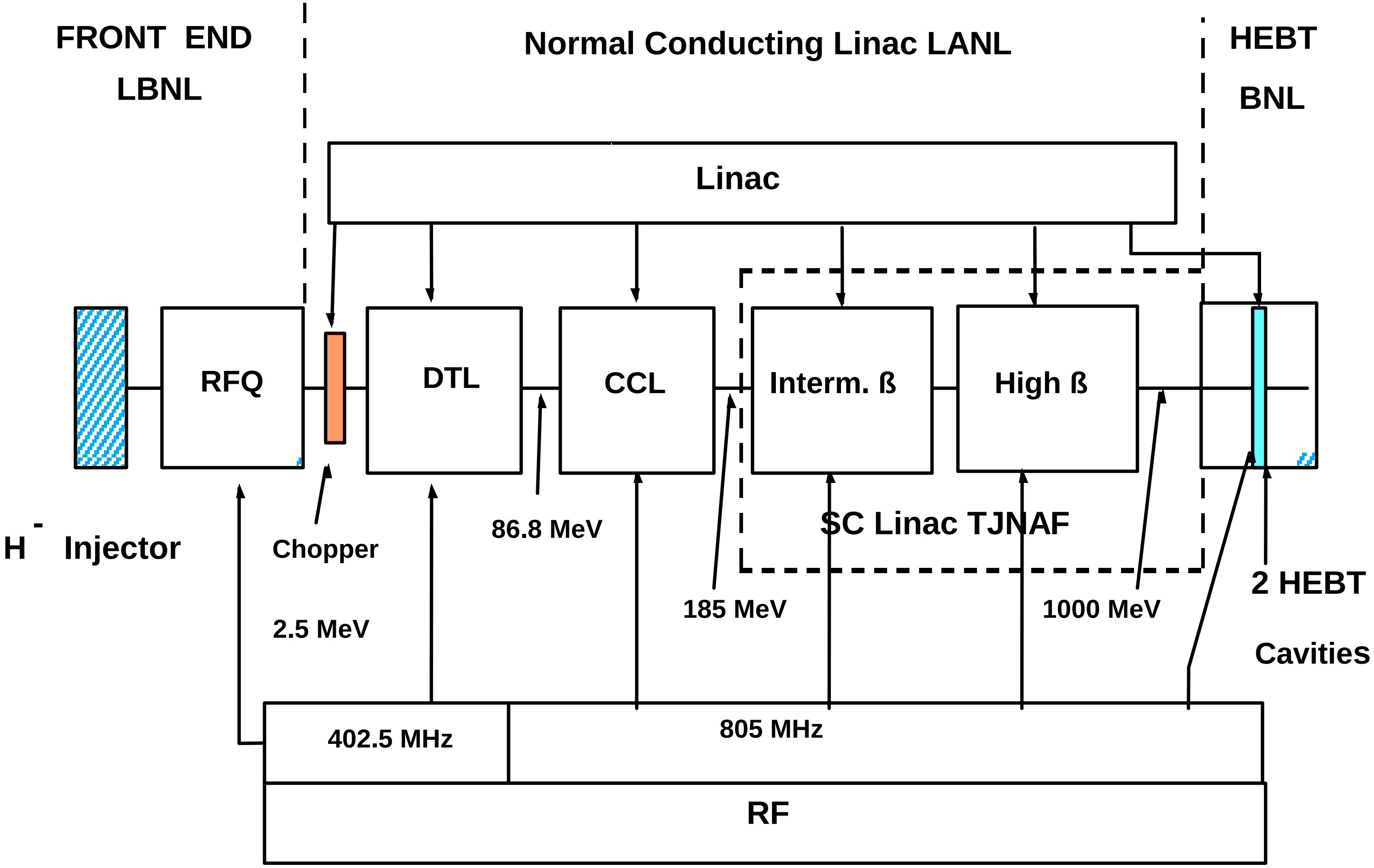

Figure 2-1. SNS Linac Configuration

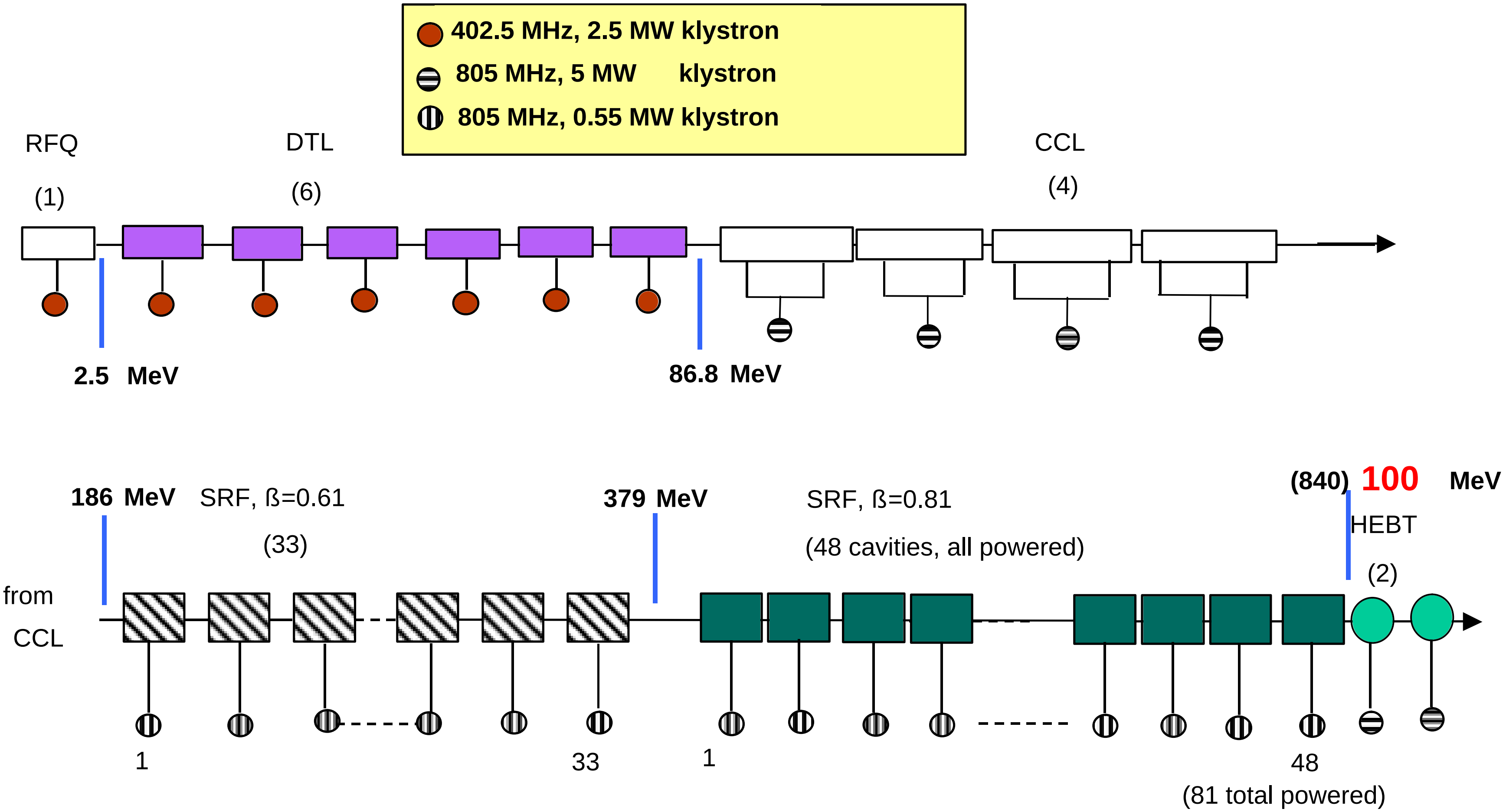

Figure 2-2. Layout of Linac RF with NC and SRF Modules

> was successfully completed, including a demonstration of phase and amplitude feedback control. The final hardware development is nearing completion, and should be available for use as other systems become ready for commissioning.

Additional Linac progress was reported by the project and is listed here in summary fashion. The production of the DTL components using the methods and additional quality assurance/quality control (QA/QC) approaches included in the recovery plan mentioned above is making good progress. The (new) components for DTL Tank #1 are delivered and being assembled. The other four tanks are again in production. The CCL structures continue to be produced and assembled at the subcontractor in Germany. Processes for QA/QC are in place and the first production module is far along, as are many bridge couplers. Machining for several more modules is at an advanced stage. The first of the CCL modules will be shipped in late July 2003 directly from the vendor in Germany to SNS/ORNL.

Some of the high voltage converter modulators (HVCM) designed at LANL and being built under contract by Dynapower have been delivered. Staff has been assigned from LANL to carry out daily supervision at the vendor. Testing of the HVCM prototype has also continued. An extensive testing program, designed to accumulate 8,000 hours of running time on a production modulator, was recommended at the November 2002 DOE review. Some testing has been accomplished, and some of the modulators have operated for (relatively short) periods of time at close to full power. The operation of the HVCM has been accompanied by a variety of failures, however, and the previously recommended test program has not yet been implemented. The failures have been traced to both manufacturing flaws and QC problems. Some parts are now being manufactured using alternate techniques (wound coils in oil baths rather than cast in epoxy) and changes in the staffing and QC methods at the vendor have been implemented. The technical staff has proposed a full power testing program of the HVCM in the spirit of the recommendation from the November 2002 DOE review.

klystrons to power the various RF structures of the Linac continued in production at several vendors, and more deliveries have been made. Perhaps most important was the delivery from the vendor Thales of a first item 5 MW klystron noteworthy for its demanding combination of a long pulse and high peak power (for use in the CCL portion of the Linac.) This tube achieved 5 MW at 60 Hz with a 1.3 millisecond pulse at LANL, although some arcing problems were noted in early running. A vacuum failure, under investigation, cut the testing program short, but the early results were typical for a new klystron design. A modification of the output transition section has been specified for later production of this 5 MW klystron. Tests of multiple items of both the 402 mega

Hertz (MHz) klystron for the DTL (built by E2V) and the 550 kilowatt (KW) klystron for the SCL have been satisfactory. Two vendors are under contract for the 550 KW klystron production; most deliveries to date have been from one vendor (CPI), but the second (Thales) is expected to ship soon.

Excellent progress is being made on the superconducting cavities and modules. Two medium-ß modules are complete and one will be shipped to ORNL in May 2003. All 34 medium-ß cavities have been received at TJNAF. The first high-ß cavity has been received and TJNAF expects delivery of six per month starting in May 2003. Fourteen medium-ß cavities have been tested in the vertical dewar and have met or exceeded acceptance specifications (10 Mega Volts per meter or MV/m at $Q=5x10^9$). High-ß cavity 1B treated with buffered chemical polishing (BCP) has been tested and reached 20.5 MV/m at $Q=7x10^9$ (the specification is 15 MV/m at $Q=5x10^9$). The electropolish facility has been brought into operation and first results on high-ß cavity HB06 gave 22 MV/m at $Q >10^{10}$, a very encouraging result.

Some lack of reproducibility of the medium-ß cavity performance in the vertical dewar after BCP and high-pressure rinsing (HPR) has existed for some time and has led to the necessity for repeated etch preparation on a number of cavities. The cause of this difficulty is not completely understood, but is thought to be associated with incomplete HPR, water contamination, or drying effects. Other types of cavities (high-ß or free electron laser) prepared during this same time interval have not had the same problems.

A number of reliability issues have occurred during module assembly and test. These include freezing of the cavity tuner motor, vacuum leaks of the flange seals, and high order mode (HOM) coupler tuning. These problems are being investigated (the HOM Q specifications have been reevaluated and lowered to $3x10^{10}$) to reduce the timing requirement.

One recommendation from the November 2002 DOE review was that SNS personnel be fully involved in cryomodule assembly and testing at TJNAF. This has been followed, with five people from SNS training and working at TJNAF through the cryomodule production and assembly process.

Cryoplant and transfer line fabrication and installation are progressing very well. All refrigerator components except the 2° Kelvin coldbox have been delivered to ORNL and installation is nearing completion. The 2° Kelvin cold box should be shipped in June 2003. The helium refrigeration and distribution systems are on a schedule which will support operation of cryomodules within the Linac tunnel by March 1, 2004.

The Linac work to be performed at LANL is now 88 percent complete (costed and committed). At TJNAF, the work is 92 percent obligated and 82 percent costed.

2.2.2 Comments

Overall, the progress on the Linac is encouraging. There has been close coordination and working relations at all levels between ORNL, LANL, and TJNAF. This will continue to be needed as the Linac moves forward.

The LLRF appears to be progressing very well and initial tests are very encouraging. It may be time to start to consider implementation of initial operational and commissioning features. For example, how to deal with beam loading fluctuations like beam or no beam pulse to pulse, unexpected short pulses, etc., and how to implement feed forward and feedback to deal with the changes in beam intensity that can be erratic during startup. The DTL recovery also appears to be proceeding effectively.

The increased attention being applied to the various problems identified during the production and testing of the HVCM is appropriate. It is extremely important that modulator quality be dramatically improved. There has been difficulty with two designs of the transformer. The present design returns to an unpotted type, as was the initial design. Particular attention needs to be given here. There needs to be assurance that the mechanical design is adequate for long-term operation (especially the boost transformer operating at 20 kHz). If it has not already been done, calculations of the mechanical stresses and fatigue of the transformer should be done.

The “2000 hour” testing program using the DTL klystron (or alternatively, a beam stick) at close to 75 percent full average power presented to the Committee would be a first step toward the testing program recommended at the November 2002 DOE review, and an example of the minimum next step for lifetime testing the HVCM components. The Committee therefore repeated its observation that the HVCM developed at LANL and planned for the Linac klystron systems has many unusual or unique features. It is encouraging that significant time has been accumulated on the prototype and some time now accumulated on early production systems. It continues to be critical that these modulators be life-tested. Long-term testing should be completed, not only on the prototype, but more importantly on production units under the various operating conditions required. Based on experience to date with the modulators, it seems prudent to develop and implement an inspection program, as suggested by LANL engineers.

One production HVCM is at LANL. This unit will be used by the lead engineer to further investigate the operational characteristics and address features not yet implemented. It seems highly desirable to carry out these studies before the engineer moves on to other commitments and before the end of the year. The list of activities needs to be reviewed. Long-term testing may also be possible and beneficial with this unit.

Completion of the closed-loop testing of the prototype cryomodule with LLRF was noted in previous DOE Review Reports to be critically important. The successful demonstration of closed-loop control reported to the Committee is therefore noteworthy.

Cost and schedule issues do not generally represent a major concern, and the management decision to offset a reduction of the spares testing program against some of the increased costs for the DTL remediation is appropriate.

While the difficulties with medium-ß cavity surface processing are likely to be overcome soon, they are a reminder that the technology is sufficiently new and that the aggressive schedule is not at this point entirely without risk. This also indicates the longer term need for a superconducting cavity facility at ORNL for processing and testing the unique cavities used by SNS. Such a facility would directly support Linac maintenance as well as enabling Linac performance upgrades and long-term R&D. The Committee noted that the SC cavity production run for SNS represents a unique opportunity for statistically meaningful comparisons of SC cavity preparation and handling techniques. The project should be encouraged to support such development efforts provided that they have no negative effect on technical risk, schedule, or costs.

2.2.3 Recommendations

1. Continue to implement the plan for the remediation of the DTL manufacturing problems. Apply the lessons learned as appropriate to other manufacturing. Continue to minimize cost and schedule impacts of the remediation.

2. Complete the execution of the LLRF Development and Production Plan.

3. Continue to monitor the manufacturing of the CCL, and prepare for full power tests at the earliest opportunity after first item delivery.

4. Continue to closely monitor production of klystrons and other high-power RF components.

5. Continue to monitor the production and testing of the superconducting cavities.

6. Give high priority to cold tests/operation of one or more cryomodules in the Linac tunnel. Currently this is nominally scheduled to start March 1, 2004, with the first availability of liquid helium in the tunnel. All necessary efforts should be made to meet or advance the date of such tests and operation.

7. Continue to improve the HVCM design and work closely with the vendor to ensure the quality and reliability of production units.

8. Implement a plan, such as the “2000 hour” plan, to support life-tests of a production HVCM modulator unit. Ultimately a plan with a goal of at least 8,000 operating hours remains justified.

2.3 Ring Systems (WBS 1.5)

2.3.1 Findings

There continues to be good progress on Ring Systems. The Committee commended BNL and ORNL for excellent work in a number of different areas as noted in overviews on each subsystem below.

The SNS project is planning on beginning installation in the High Energy Beam Transport (HEBT) and Ring earlier than what the Committee had been told in previous reviews, primarily because of delays in installation of the DTL. This accelerated schedule can be met if there are no problems encountered in the delivery of components. The budgeted cost goals in the Ring Systems are being met. Spares continue to be a primary driver for cost increases, but savings have been realized in other areas. The components that have been received are meeting the requirements for the project technical baseline.

Recommendations from the November 2002 DOE review have been addressed. Among the significant findings, Beneficial Occupancy of the HEBT and Ring Tunnels has been received, and eight assembled half-cells have been delivered from BNL to ORNL.

Since the November 2002 DOE review the ring dipoles have been measured and shimmed to meet specifications. An open issue was if the ring quadrupoles would need to be measured and shimmed. The Committee was pleased to see that this has taken place; all ring and transfer line quadrupoles have, or will be measured, and where needed, shimming and sorting are being done to meet specifications. However, magnet delivery for the 21Q40, 26Q40, and 30Q40 quadrupoles is behind the original schedule by six to eight months. This is slowing work on quadrupole sorting and shimming, but does not yet threaten the accelerated installation schedule. In addition to the half-cells delivered, eight additional half-cells are being assembled for delivery. However, delivery of half-cells to ORNL is dependent on the timely arrival of the remaining quadrupoles, sextupoles, and octupoles.

The special injection/extraction magnets are on order or in magnet measurement, except for the extraction kicker and extraction Lambertson septum magnets, which are in design and fabrication.

Closed-loop de-ionized water tests on the revised water fitting have confirmed the suitability of the new design.

All of the standard vacuum hardware components are on order and items are being received at BNL and SNS. There has been a scope transfer of the residual gas analyzers from BNL to SNS, and procurement of these is in process. HEBT vacuum chambers will be completed by the end of June, and will meet the HEBT accelerated installation schedule. The ring arc chambers are in fabrication and are to be completed in July. Straight section chambers are being fabricated, with the final variants being detail designed. Design of the Ring to Target Beam Transport (RTBT) chambers is complete. The titanium nitride (TiN) coating of ring vacuum chambers is going well and will not pace the delivery of chambers.

It was suggested at the November 2002 DOE review that high throughput pumps can be added to the ring vacuum system to mitigate the vacuum pressure increases associated with surface outgassing and beam scrubbing for the electron cloud (PSR) instability, and that a cost estimate for this should be done. The Committee was shown an estimate of $1.081 million in FY 1999 dollars.

Collimator fabrication is in process. Delivery dates support the installation schedule. One design change has been made since the November 2002 DOE review: the primary collimator now has a uniform collimating dimension (as opposed to the previous design that contained a narrowing of the collimator chamber). This will lead to greater reliability and cost reduction, at the expense of somewhat higher activation of the downstream corrector.

All of the 283 power supplies for the Ring Systems are under contract and scheduled for delivery in accordance with the baseline. The 184 low-field corrector power supplies have been received and are under test. The first article of the medium-range power supplies has been delivered to SNS and has been successfully low-power tested. The remaining 77 medium-range power supplies and injection kicker supplies are expected to be delivered by January 2004. The extraction kicker contract is placed with a local company and the majority of parts have been procured. Delivery is expected by February 2004.

The contract for the main dipole power supply has been placed and delivery is due by December 2003. All of the supplies will be tested and controlled by the Power Supply Interface through the machine control system. BNL has ordered sufficient redundancy in power supplies to ensure reliable operation of the Ring Systems.

The first RF cavity power supplies have been received and testing is underway for delivery to SNS in May 2003, with all systems delivered by February 2004. There are no major technical, schedule, or cost issues.

The responsibility for Ring RF systems at ORNL has been transferred from the power supply group to the RF group. With this reorganization, clear lines of responsibility for the Ring RF power supplies have been established.

Specifications and design work for Ring diagnostics are progressing well. The project has utilized a diagnostics advisory group which has provided considerable input and whose recommendations have been seriously considered. The Committee recently met with the BNL diagnostics staff, and made a number of recommendations and prioritizations. The Committee judged the complement of diagnostics to be sufficient and necessary to meet the project technical baseline. The concern is the staffing level of the ORNL SNS Diagnostics Group. This is discussed later in the comments section.

Significant progress has been made in the injection area. Clearing electrodes have been added to collect reflected or regenerated electrons. The diamond stripping foil has been tested at the BNL Alternating Gradient Synchrotron. Design specifications are being met with no observable damage during five-day testing periods. Commissioning and installation activities are further addressed in Section 4.

2.3.2 Comments

The Committee was shown responses to the Ring recommendations from the November 2002 DOE review. The recommendations and discussion follow:

1. *Present, at the next review, a plan for timely acceptance testing, installation, and commissioning of Ring diagnostics.* Considerable work has been done in addressing this recommendation, in spite of the fact that the SNS Diagnostics Group has been involved in the Linac LLRF issue. A draft plan is in place including the identification of responsible individuals at each laboratory for each diagnostic subsystem. However, the shortage of staff at ORNL will necessitate a reduced but adequate set of diagnostics for initial commissioning.

2. *Present, at the next review, a solution for implementing the full magnet measurement plan.* The Committee is satisfied that this recommendation has been resolved. All magnets are being measured.

Timely magnet delivery from vendors is critical to the installation schedule.

The Committee continued to encourage the SNS project to explore all issues related to spares, and replacement strategies in high radiation areas. Much work has been done, but there are still some areas where the project is exposed to single failures without a plan for recovery. Specific examples are the quadrupole doublets just upstream of the Target. Should these fail, repair will not be possible due to activation, and no spares have been budgeted.

Considerable progress has been made in creating and delivering component, subsystem, and installation drawings to ORNL. These drawings are 75 percent complete.

As opposed to the November 2002 DOE review, the vacuum interface to the Target is defined. However, the Committee expressed concern about this area in that it will become activated and it is not clear that sufficient planning is in place. As noted above, complete spares for the quadrupole doublets should be considered, as well as replacement procedures.

All 77 of the medium power supplies are placed with a single vender with delivery by the last quarter of 2003. The Ring Systems are dependent on the delivery by this single vendor. Tracking these procurements will be essential to insure timely deliveries of power supplies.

2.3.3 Recommendations

1. Consider ways to supplement the staffing of the SNS Diagnostics Group to better support installation and commissioning.

2. Continue to examine maintenance procedures, and spares issues for devices in activated areas, and identify resources for remediation.

2.4 Target Systems (WBS 1.6)

2.4.1 Findings

The project responded positively to previous review recommendations. Excellent progress was again observed, with Target Systems on schedule to complete Title II design by June 2003. Procurements are generally well on track; and 34 of 58 major procurements have been awarded. Of the remaining 24, 11 were issued for procurement and 13 are in preparation. The seven percent difference between baseline and contract values is acceptable. The beginning of installation, planned for June 2003, was actually accomplished early in April! The schedule was adjusted to recover from a 14 percent variance due to delayed deliveries without affecting the IPS.

The new Estimate-to-Complete (ETC), March 2003, as well as other Project Change Requests since the November 2002 DOE review resulted in a cost increase for Target Systems ($103.2 to 106.4 million), mainly due to redesigns of the target assembly and target utility systems and transfer of scope from CF. More progress was reported on the proton beam window pitting issue. The Japanese partners in the international R&D collaboration reported results showing that high rate pulsing (60 Hz) gives less damage than low rate (20 Hz) pulsing. Together with Kolsterizing, this may result in substantially longer Target service life than cold-worked 316 stainless steel (CW 316 SS). It is estimated that two weeks at 1 MW are deemed possible with CW 316 SS and low repetition rate damage.

2.4.2 Comments

Reconfiguration of WBS 1.6.7 (Remote Handling) has allowed including certain high priority items by eliminating other less urgent items from the project budget (mainly tooling for handling of radioactive parts). Since all of the deleted items will be needed at some point after operation has started, this results in some increase in risk. In a similar way, elimination of certain pre-operational tests also contributes to increased risk.

Not having a spare inner reflector and moderator vessels constitutes a high risk. The assembly is extremely complex and difficult to manufacture, and bears the risk of cold leaks that cannot be detected at ambient or liquid nitrogen temperature. An option for a spare unit is retained in the procurements. The Committee would like to see a high priority given to the execution of this option.

The Committee supported efforts to develop a method to Kolsterize a full-size front portion of the Target with the goal of achieving a longer service life.

The Committee judged that a leak in the inner mercury container could be an acceptable failure mode. This requires a reliable and redundant detection system, and a clear concept and suitable provisions to handle a Target with mercury in the interstitial space between the mercury container and the water cooled shroud. With this provision running a target to failure would be an effective and low-risk way to determine its long-term service life.

The current planning for Target exchange procedures was briefly reviewed. It became obvious that more work needs to be done on this issue to produce a detailed work procedure and time estimate.

There is a need also for regular exchange of the proton beam window that cannot be allowed to fail. The project should make sure that the proton beam window can be exchanged independently of the Target, since the service lives of the two units may be quite different. Also, changing both units during the same shutdown period would most likely put too much stress on the service team. In order to allow this, it must be possible to establish a directed air flow into the proton beam pit without air flowing through the hot cell as presently planned.

As part of their recent cost cutting exercise, the project developed the idea of supplying eight dummy concrete shutters for initially unused beam lines. These shutters would be replaced by the final shutters when the beam lines would be put in use. The Committee questioned the wisdom of this move for several reasons:

- There is additional design effort involved;
- It is difficult to fabricate and handle large units of heavy concrete to the required precision;
- Testing and prototyping may be required;

- There is an increased risk of damaging the shutters during handling and of contamination in the shutter vaults;
- The behavior of concrete under irradiation is uncertain, it may release water or start to crumble; and
- The concrete shutters will be a waste burden when taken out.

2.4.3 Recommendations

1. Design and cost a simplified (backup) inner reflector and moderator system for potential use in the commissioning phase in case a problem arises with the currently planned system by the next DOE review.

2. Aim for no more than two Target changes per year at 1 MW by developing the scenario for operation of the Target Systems to the point where mercury enters the interstitial space. This requires a provision for leak detection and safe Target removal to be defined before issuing the relevant procurement.

3. Complete the detailed planning, with time estimates, for the Target changeout by the spring 2004 Experimental Facilities Advisory Committee (EFAC) meeting.

4. Work with ASD to establish a plan for controlled air flow during changeout of the proton beam window, independent of the position of the Target by the next DOE review.

5. Precisely evaluate near-term savings and long-term cost and risk of using dummy concrete shutters and report on the final decision at the next DOE review.

2.5 Instrument Systems (WBS 1.7)

2.5.1 Findings

The Instrument Systems team continues to make good progress on all tasks. In particular, the efforts towards the baseline goals of designing, building, and installing three instruments, and having two more ready for installation, remain within budget and on schedule. The project's responses to the previous recommendations are quite satisfactory as discussed below:

1. Contact has been made with funding agents, and it appears that outside funding has been identified for a reasonable number of core vessel and shutter inserts. This will

allow efficient and cost-effective procurement and installation of these components. Unnecessary future costs will be avoided at no net cost to the SNS project.

2. Good progress has been made toward preparing an integrated installation plan for the core vessel and shutter inserts. (The recommendation requested that the plan be completed by November 2003.) Meetings with Target Systems personnel have begun, as close coordination will be required for this effort. The procurements for the inserts are under way, and installation is scheduled to begin one year from now.

3. Work is underway on revising the integrated installation plan for instruments. (The recommended completion date is November 2003.) Progress in the development and funding of Instrument Development Team (IDT) instruments is very positive, and this is a necessary ingredient for a vibrant user facility. Timely installation of these instruments, following the installation of those in the baseline, will require careful scheduling and appropriate staffing. The planning process will help to define the future staffing needs, as the emphasis in Instruments Systems shifts from design to installation and commissioning. The first instrument installation tasks are schedule to begin in September 2003, so detailed planning must be completed very soon.

The baseline calls for the completion and installation of three instruments (on two beam lines), plus another two instruments funded within the project. Instrument Systems has been progressing steadily, and is approximately at the half-way stage in terms of expenditures. The cost baseline for these five instruments has remained constant. Approximately one-third of the procurement amounts have been costed, and they are in line with estimates. The largest procurements are for the guide systems. The contracts for the guide systems for the first three instruments have been awarded, with delivery expected in the summer of 2005 (early 2005 for the backscattering instrument). The request for proposal (RFP) for the guide system for the Small Angle Neutron Scattering Diffractometer instrument will go out shortly.

Contracts have been awarded for the core vessel inserts for the above five instruments. Awards have also been made for core vessel inserts for IDT instruments, with options for other possible IDT instruments. Core vessel insert procurements have therefore been awarded for 17 of the 18 beam lines, with the RFP for the dual-beam core vessel (and shutter) insert for the reflectometers to go out this summer. It is currently expected that ten of the beam lines will have engineered shutters, for those instruments with expected completion dates within a couple of years of CD-4, Approve Start of Operations (with the other eight having temporary shutters).

These shutters will house optics or beam defining apertures. The 90-percent design review has been completed, and the RFPs will go out this summer. The bulk of the remaining procurements consists of the necessary shielding for the first three instruments. The Committee was informed about the possible delay of procurements for the last two planned instruments, with procurements being postponed from FY 2004 to FY 2005 to accommodate BA limits.

Excellent progress has been made on the data acquisition hardware. Software development is benefiting from contributions by the Angular-Range Chopper Spectrometer IDT and from collaboration with the National Institute of Standards and Technology (NIST).

The XFD staffing profile for the start of operations was presented. The plan contained a functional outline for the desired permanent SNS staff at the end of construction and heading into operations. The structure and organization displayed in the plan is a good goal for the end of the construction project. The challenge associated with this goal is ramping up from the present, permanent SNS staff. The shift of remaining instrument scientists and support activities from ANL to ORNL will be completed by the end of 2003. Contractor and ANL employees presently comprise a large fraction of the SNS XFD workforce. It is planned that these employees will be replaced with permanent SNS staff. In some cases, desired employees may not want to join the SNS staff permanently, and in other cases the mix of skills will be changing. The XFD will need to roughly double their permanent staff between today and 2006 to achieve their installation goals and to be ready for the transition to operations. While this can be achieved, XFD management must pursue an aggressive hiring plan in order to find highly skilled employees, hire them, and train them as needed for operations to accomplish the stated goals in a timely fashion.

2.5.2 Comments

Progress on Instrument Systems seems very good. For the more mature instruments, the installation phase is fast approaching, starting with the core vessel and shutter elements. A vague description was given for the installation of these along with the alignment of the optical elements contained within them. While the ability to make the necessary adjustments to the optics was shown, no details were given regarding how the beam axes will be defined or demarcated. Alignment of these core optics is very important because slight errors can result in large displacements of the instrument or in intensity losses when the guide train deviates from a straight line. Another important aspect of the optics alignment is the placement of fiduciary marks/devices that clearly define the beam axes to the specified accuracy and are accessible (visible) at later stages in the life of the facility. These marks must be built and placed in such a way that normal activities do not pose a threat to their validity. A detailed plan for the alignment of the neutron optics and the placement of beam axis fiduciaries should be considered, possibly with input from the guide suppliers.

Many of the instrument subassemblies have been or are being purchased through the use of design/build contracts. This is an efficient way of procuring instrument components when the operational interfaces and performance specifications are well defined. It makes available a wide range of expertise in particular fields advantageous to the success of the instrument. Consideration should be given to requiring that the vendor supply the solid models of the final detailed design as an early deliverable. Most, if not all, engineering design firms make use of a solid modeler for their design work. While there are many different solid-modeling application programs, most can store the models in a standard format (i.e., Initial Graphic Exchange Specification) that is recognized by the others.

There are a few reasons that it is advantageous to have a detailed solid model of all instrument subassemblies. First, it allows the SNS instrument engineers to perform a design review and to verify that there are no compatibility/interference issues between instrument subassemblies. Secondly, it is important to have an inclusive top-level assembly of the entire instrument facility and these contracted subassemblies must be included. This can provide improved efficiency in making detailed plans for installation of components, new instrumentation or instrument upgrades. This top-level model should be placed in a database that is accessible to all engineering staff and that is easily navigated.

The instrument engineering team has a great opportunity to refine this model as installations are being performed. Invariably, there are field changes made as instruments are being installed and these changes should be reflected in the top-level model to conform to proper configuration management. The best time to document these changes is as they occur, not after the components become irradiated or are covered by shielding.

Concerns remain about the lack of neutron-guide spares. When this issue was raised, it was stated that each guide was unique and that having full spare coverage would require ordering entire duplicate guides, which is impractical. In a convergent guide, this would certainly be the case. The risk of guide breakage still exists, however, and it would have a large impact on installation timing. It would be prudent to develop a plan for mitigating this risk. One possibility would be to seek arrangements with the guide suppliers that would allow fast-track construction and procurement of replacements in the event that they are needed.

The future is bright for the ultimate scientific success of the SNS. A total of 16 instruments have received formal approval by EFAC. Their status is summarized in Table 2-1. This success also brings along another challenge—congestion in the Target Building, which may bring difficulties with future instruments. With most of the beam lines conceptually accounted for, space is at a premium. This means that few beam lines may be available for future new concepts, let alone a beam for development purposes. It is possible that background levels within the Target Building caused by the installed instruments might affect future instruments. The Committee was not shown detailed numerical calculations that would show whether this might become a problem.

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)

Four EFAC-approved instruments to be designed and built by IDTs (funded by BES)

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

Two EFAC-approved instruments to be designed and built by IDTs (funding TBD)

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

Two instrument proposals being developed for EFAC approval

- Spin Echo Spectrometer (to be funded by Germany)
- Chemical Spectrometer (funding TBD)

The XFD should be commended for their efforts to grow and unify the neutron scattering community. Together with the Joint Institute for Neutron Scattering, they have fostered or co-sponsored several neutron scattering workshops including the "Neutrons in Solid State Chemistry and Earth Sciences, Today and Tomorrow (NICEST)" workshop held in March 2003 and a "Pulsed Polarized Neutrons" workshop held at NIST in February. They co-organized the Neutron Facilities Roundtable to bring together the directors from the North American neutron scattering facilities (SNS, Los Alamos Neutron Science Center, Chalk River, High Flux Isotope Reactor, Intense Pulsed Neutron Source, and NIST) to discuss common issues and goals. They continue to coordinate their efforts in detector development with European and Japanese programs. Within ORNL, they have been working with HFIR staff and other laboratory user facilities to tackle problems in user access, user policies, and critical staff hires. The XFD management team has embraced the idea of a new software architecture, Distributed Data Analysis Architecture for Neutron Scattering Experiments, developed by the ARCS IDT as a cost effective way to develop and distribute data analysis software. All of these efforts point to a continued, correct focus on serving the neutron scattering community through continuing education of future users, especially including "non-experts," and the development of new technologies essential for keeping neutron scattering a viable tool for studies of matter.

2.5.3 Recommendations

1. Complete the resource-loaded integrated installation plan for core vessel and shutter inserts by November 2003.

2. Complete the integrated installation plan for instruments by November 2003.

2.6 Control Systems (WBS 1.9)

2.6.1 Findings

The ETC for Control Systems is in excellent shape. Areas were found in the LANL and BNL estimates that were too conservative, freeing up dollars that could be reallocated to other controls support functions. Some tasks previously allocated to Pre-operations were returned to WBS 1.9. This resolved the recommendation from the November 2002 DOE review about the adequacy of resources to meet the goals for Pre-operations. The Control System worked well for Front End Systems recommissioning. This involved the successful integration of the Machine Protection System (MPS) and Timing System.

The MPS and Timing System work well. Use of the project Oracle Database to generate the MPS configuration data is commendable, but displays need work. The Control Systems team noted that operators find it hard to understand the source of MPS trips. Better displays are also needed to convey the timing and logical relations of timing system events. Such displays have been developed at other laboratories by the operations team itself, as the operators become more familiar with these complicated systems.

The Personnel Protection System (PPS) team has successfully completed two certifications for the Front End PPS. The next phase will include the DTL Tank #1 and DTL Tank #3, which will be the first PPS phase that includes a real sweep and area lockdown.

Problems with electromagnetic interference (EMI) in control system communications were discovered when modulators were started. The project quickly responded to the problem, developing in a short time, a technical approach that decreased these interference levels by a factor of ten. The Control Systems team at SNS has good working relations with their counterparts at the partner laboratories, the Accelerator Physics Applications Programming team, and the Beam Diagnostics team.

This is not a Control Systems issue, but the Committee noted that empty electronic racks are being installed in the Klystron Gallery. This means that the contents of these racks must be installed by the Davis-Bacon workforce. When queried, the project responded that this is happening for a combination of reasons, including late delivery of equipment and lack of space in the gallery to install the completed racks at a later date. Even at this late stage, it may still make sense to deliver the electronics to the SNS rack factory, assemble the racks, test the rack contents, and return to the original goal of installing completed racks (see recommendation below).

2.6.2 Comments

When the Front End Systems arrived for installation and re-commissioning, the Control Systems team assumed responsibility for a small Programmable Logic Controller system that monitored events and took action to turn off power to affected equipment. This system points out the possible need for a system that provides inter-system equipment protection—the Equipment Protection System (EPS). This is not the Machine Protection System, which turns off the beam to protect equipment. The EPS is a system that turns off equipment to protect equipment. The Control Systems team is assessing the need and scope for the EPS. An EPS is not currently within the project scope, and it is expected that such functions will be supplied as part of the equipment itself.

2.6.3 Recommendation

1. Evaluate the delivery of electronics to the SNS rack factory for assembly and testing of Linac electronic racks. Develop a cost and schedule analysis of this option by July 1, 2003.

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3. CONVENTIONAL FACILITIES (WBS 1.8)

3.1 Findings

Since the November 2002 DOE review, progress at the construction site has been slowed by weather related impacts. Of the 136 available work days, 92 have had negative schedule impacts ranging from 30 to 90 days. It is commendable that the project continues to demonstrate significant progress in completing Beneficial Occupancy Date (BOD) turnover milestones on schedule.

The Committee judged that the project cost and schedule are defensible and based on sound information. Progress to date is in accordance with the project baseline. The CF ETC is based on defensible technical information supported through actual contract pricing and risk assessment methodology that accounts for potential changes. However, the Committee found that the approved FY 2004 project BA profile cannot support the current plan of CF activities. The Committee also determined that the CF Estimate-at-Completion (EAC) of $366.1 million should be reevaluated to include probable impacts related to deferred work and pending claims, as well as activities driven by project transition issues, which include overall sequencing of work through commissioning.

Overall, CF work is approximately 65 percent complete through April 2003, and Cost Performance Index (CPI) and Schedule Performance Index (SPI) values are both 0.99. However, these values should change as weather related delays are negotiated.

The CF EAC has increased from a $345.1 million baseline value at the November 2002 DOE review to $366.1 million. Of this $21 million increase, $9 million is associated with the incorporation of the AE/CM incentive fee in the project baseline, $9 million is associated with increased building costs, and $3 million in technical support service increases. The current EAC represents a cumulative cost growth of 19.2 percent since the May 2001 DOE review. Given the complexity of integrating 54 contracts and the issues of parallel design and construction, this represents excellent performance to date.

The CFD has begun preparing detailed staffing transition plans which support current schedules. Detailed plans from AE/CM contractors are due by May 23, 2003. However, the transition plan does not address the necessary optimization and re-sequencing of work needed to complete the project within the approved BA profile.

The construction site continues to be well maintained and site management continues to improve on a commendable safety record of greater than 1.8 million workhours with no lost workday cases. The work to date appears to be of high quality in all respects indicating that the CM is maintaining a high site-wide standard.

The level of integration during BOD acceptance and turn over, as well as incorporation of the lessons learned from November 2002 DOE review comment, has improved. Site photographs indicate very clean conditions at turnover.

3.2 Comments

The project transition planning for CF activities hinges on the ability of the overall project to capture and re-sequence the work through the end of the project. A significant business decision needs to be made in determining the appropriate balance between maintaining progress and site conditions in the current scheduled plan and deferring work into FY 2005. The cost profile improvements associated with deferred work will be offset by increases in project labor costs and overheads from leased services.

As noted in previous DOE reviews, and reinforced here, equipment installation poses a continuing issue as BOD and equipment installation occur in parallel with construction. The project must continue to focus on ensuring adequate field engineering and installation coordination between CF workforces and technical installation staff. Even as CF workforces transition off the project, the need to support ASD and XFD installation activities will continue for some time. These resource needs must be addressed in the project transition plan.

The CF team should be congratulated for the aggressive approach to schedule recovery associated with Target Building construction. Previous contractor performance was not achieving project objectives, and through reassignment of scope and innovative work planning to support parallel overhead work, the impact to Target Building construction performance was minimized.

CFD must continue to assess earned value performance figures quoted from field reports as the project transition issues begin to emerge. The CPI and SPI of 0.99 were excellent (yet surprising given the construction delay issues). These indices will change as weather impacts and contract close out costs are incorporated.

The SNS user and operational model has been worked as an issue since the November 2002 DOE review. However, it remains an issue and has not been adequately refined to understand the impact on current CF activities, especially operational turn over. Examples of areas where impact could occur are associated with security and access expectations such as prox cards or keys, badging and training infrastructure requirements, and the fundamental expectations of integration with the ORNL site infrastructure requiring additional labor and material commitments. The SNS project should continue to refine the operational model of the SNS to more clearly understand the site infrastructure/integration requirements and the potential impact on current CF planning.

The project has addressed the recommendations from the November 2002 DOE review and those elements that need further attention are listed stated below.

3.3 Recommendations

1. Complete the CFD staff and AE/CM transition plan by July 2003. This should be done as part of an overall project evaluation that addresses sequencing of work to match the project BA profile and the impacts inherent in delaying construction activities on a project of this size.

2. Update the CF EAC to reflect the areas of risk that the project assesses to have a high probability of occurrence by July 2003.

3. Refine the SNS user and operational model to more clearly understand the site infrastructure/integration requirements and the potential impact on current CF planning by the next DOE review.

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4. PRE-OPERATIONS/OPERATIONS PLANNING (WBS 1.10)

4.1 Findings

The installation effort has made very good progress over the last six months. The Target installation is progressing on schedule and the accelerator systems installation is 21 percent complete with a goal to reach 50 percent by the end of FY 2003. There is about an eight percent schedule variance relative to the installation plan that was rebaselined taking the DTL delivery delay into account.

The recommendations from the November 2002 DOE review were well addressed. A new resource-loaded installation and commissioning plan was presented. About 715 out of an estimated 1,200 installation drawings exist in the Document Control Center. Complete installation drawings are preceding the actual installation by two to six months. A data logger capability has always been part of the Experimental Physics and Industrial Control System (EPICS), but is now made available to the commissioning effort. The Front End Systems area, the Linac Tunnel, and Klystron Gallery are now being kept adequately clean. By the time of this review, BOD had been given to all Accelerator Systems buildings with the exception of the RTBT Tunnel.

The recommissioning of the Front End Systems was successfully completed and the IPS milestone to provide beam for DTL commissioning was met. The commissioning of DTL Tank #1, however, is significantly delayed to start in July 2003 due to the DTL fabrication problems. SNS management believes that it may still be possible to meet the project’s early finish date (December 2005) even with this delay.

The installation of the HEBT and Ring components is being advanced to make optimal use of the installation workforce. BNL deliveries and production schedules support the accelerated installation schedule. Eight half-cells have been delivered, and three of these have been staged in the HEBT tunnel. The remaining half-cells will arrive at a rate of three per month. Approximately 75 percent of the BNL drawings needed to support installation activities have been delivered to SNS. All technical support necessary for Ring Systems installation report to a single individual who coordinates tasks among the groups via weekly meetings.

Ramp-up of the operations staffing was advanced to better support the commissioning effort.

The installation and commissioning of the Central Helium Liquefier is proceeding well and is on schedule to be completed well before the target date of March 2004.

4.2 Comments

The achievement of BOD for the Ring Tunnel seemed to be premature. Control of environmental conditions should be in place before equipment is being installed.

The significant delay in the DTL installation makes reaching the project's early finish date very ambitious. Accelerator components, after the necessary testing, should be installed as soon as they become available.

The early installation of the HEBT and Ring components will require that resources are made available to properly receive and acceptance test the equipment. Close coordination with variances in BNL deliveries will be necessary if the Ring installation is to succeed.

Flexibility in labor, funding, schedule, and testing of equipment will be needed at all levels to respond effectively to future changes in component deliveries. Participation of the partner laboratories in commissioning should be supported. The use of an electronic log book by the partner laboratories will be very helpful.

5. ENVIRONMENT, SAFETY AND HEALTH

5.1 Findings and Comments

No safety recommendations were made during the November 2002 DOE review.

Integrated Safety Management principles are being applied on the SNS project. The level of safety expected and being practiced at the SNS is appropriate given the project's current stage of development and is being done so effectively. Safety is receiving due consideration in the coordination, installation and commissioning of technical systems.

SNS management is clearly committed to the precepts of safety and they have demonstrated their support by participating in field safety walks and prompt implementation of disciplinary action where needed. As the number of project personnel involved in installation activities at the field site grows, adding to the Advanced Integrated Management Services Incorporated (AIMSI) contract on personnel already on site, the need for good communication will become even more important. This would be a good time to implement a work and safety observation process. This observation process, which has yielded effective results on other projects, is an excellent means of reinforcing good work practices, improving productivity and of reinforcing management support of safety.

It is apparent that considerable thought has been given to the coordination and planning of both installation and commissioning activities. The identification of hazards associated with installation and commissioning activities, and their respective controls, is being effectively accomplished through the application of Job Hazards Analysis (JHA). These are developed for all work activities performed by both contracted and direct hire personnel involved in installation and commissioning activities. The JHA process will become an increasingly important safety tool as the pace of installation and commissioning activities accelerate and personnel are switched between tasks with changing priorities. The JHAs are well written and are being regularly reviewed and edited to assure that they reflect changes in work location and field conditions.

The project has recognized the challenge of coordinating complex lockout situations, particularly in light of the diverse disciplines of individuals from different corporate cultures involved in the project. SNS management has been addressing this situation on a variety of fronts. Their JHAs currently address the lockout of individual systems, but lockouts of multiple systems that are in the proximity of more than one group have yet to be addressed on a project-wide basis. Given the seriousness of this hazard and the challenge of handling complex lockout situations, the project must establish clearly defined coordination procedures that cross group boundaries. Additionally, given the lockout challenges during facility operational maintenance, thought should be given to developing a global lockout design for general access to complex systems, as well as the option of being able to lockout large sections of the accelerator.

Management of a heavy construction project given the site constraints present at SNS with a safety record of 1.9 million workhours without a lost workday injury is an impressive accomplishment.

SNS management’s high safety expectations and Jacob Engineering’s detailed attention to these expectations through their work execution approach has deservedly resulted in the outcome they have achieved.

5.2 Recommendation

1. Complete the development and implementation of procedures for the lockout of each complex system prior commissioning any of its subsystems.

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 2003 costs-to-date (October 2002 through March 2003) were $145.8 million ($139.0 million for construction line item activities, and $6.8 million for R&D and Pre-operations activities). Cumulative costs and commitments through March 2003 were $939.9 million ($815.3 million for line item activities and $124.6 million for operating expense funded activities).

Following recommendations from the November 2001 DOE review, SNS has instituted a process for maintaining "bottoms-up" ETCs in a phased approach over a cycle of 12 to 15 months. The ETCs for the Ring Systems, Target Systems, ASD (installation and commissioning), LLRF, Control Systems, and Project Support were updated in detail for this review. The next phase of updates for Pre-operations and Instruments Systems is scheduled to be performed during the last quarter of FY 2003. SNS management also maintains an EAC that provides a top-level view, accounts for in-process and expected (known) change requests, and is reported each month.

The Budget-at-Completion (BAC) presented was $1,133.4 million. This represents an increase of $16.2 million (use of contingency) over that presented in November 2002. The total contingency remaining in the TEC is $59.3 million. Also presented was an EAC of $1,148 million with $44.6 million in contingency. Using the EAC, costs and commitment actuals through March, and estimated costs and commitments for April, the project calculated a contingency fraction of 20.2 percent. This estimate is based on the following assumptions:

- Projected costs through April 2003 are $730.5 million;
- Open commitments and awards at the end of April 2003 are $101.6 million;
- Credit for contracts awarded but not funded is $94.7 million; and
- Allowance of 1.8 percent contingency on funded technical equipment contracts.

Each of the technical subcommittees reviewed the SNS ETC and provided an independent assessment of the adequacy of that estimate for the subsystems reviewed. While there were some differences between the Committee EAC and the SNS EAC at the subsystem level, there was no significant aggregate impact. Details of these analyses are covered in the individual technical sections.

SNS management continues to use phase-funded procurements in the technical and CF portions of the project. Approximately 98 contracts with a total value of $263 million have been phase-funded. Fifty-seven of those with a total value of $108.4 million have been completed.

The integrated cost performance module Microframe Project Manager (MPM) appears to be fully functional including cost estimates and detailed schedule baselines. Based on this performance reporting system, the SNS project is 61 percent complete as of the end of March 2003.

A summary of the project risk analysis, completed in March 2003 was presented. The analysis identified a "maximum cost impact" of $41.1 million if all 55 identified risks were to occur.

As noted in the May 2003 draft "SNS Project Management Transition Plan (between ORNL and LANL), LANL project controls staff will be phased out at the end of December 2003. The following activities will then transfer to the ASD with assistance of the SNS Project Office:

- Cost and schedule baseline maintenance
- Monthly schedule status
- Processing Project Change Requests
- Cost and schedule monthly performance measurement reporting
- Monthly risk assessments

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

6.2 Comments

In order to reduce costs at LANL, SNS management decided to phase out LANL project controls staff at the end of December 2003, at a time when roughly 20 percent of LANL work will be left to complete. The project has proposed that ASD staff take over LANL's project controls responsibilities. These procedures have yet to be worked out in detail, so they could not be evaluated by the Committee.

The project adequately addressed the recommendation on preparing "rolling ETCs." This method appears to be a sensible approach for regular assessment of the project baseline.

The present contingency level (using the management-derived EAC) is $44.6 million. This represents a significant reduction ($30.9 million or 41 percent) in six months from the $75.5 million contingency (using the BAC) presented during the November 2002 review. Of the $30.9 million in expected contingency usage, $21 million was in CF. The fact that there are very few additional significant construction packages planned mitigates somewhat the concern regarding the rate of contingency usage since the November 2002 DOE review.

Project staff updated the risk-based contingency analysis that was first prepared for the November 2002 DOE review. The approach used to prepare this risk assessment was as follows:

- The Senior Team Leaders (STL) were requested to identify potential risk items for their areas of responsibility;
- The STLs identified factors for probability of occurrence, technical consequence, and schedule consequence, as well as the cost or schedule impact;
- This information was forwarded to SNS project management;
- SNS project management filtered the data based on their management perspective; and
- Potential needs were summarized for each major subsystem grouped in the categories of high, moderate, or low risk.

Given appropriate management attention and the contingency remaining at this stage in the project, the Committee judged that the current TPC is adequate to complete the project. With regard to the presented contingency percentage—the percentage has increased as compared with that presented at the November 2002 DOE review, in part, because the method used in its calculation was changed. The Committee understood the argument for using a different formula, but this data point is primarily useful as a relative measure against previous data taken using the same calculation.

6.3 Recommendations

1. Develop new "bottoms-up" ETCs for Pre-operations and Instrument Systems by the next DOE review.

2. Present a plan for how ASD will assume LANL's project control functions 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 2004 President's Budget Request and in the SNS Project Execution Plan. The FY 2004 Data Sheet contains a BA profile (see Appendix E) of: $225.0 million in FY 2003, $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: $318.6 million in FY 2003; $210.0 million in FY 2004; $88.1 million in FY 2005; and $41.0 million in FY 2006. The difference between the available cumulative funding (BA) and the planned cumulative obligations (Budget Obligations or BO) through the end of FY 2004 is only $0.5 million. (See Section 6, Cost Estimate, for a discussion of the contingency analysis.)

The IPS is consistent with the BA funding profile cited above. This IPS calls for an internal goal for an early project completion in December 2005, providing six months of project schedule contingency relative to the CD-4, Approve Start of Operations, commitment date of June 2006. Project performance continues to track well against existing DOE milestones.

The IPS (see Appendix F for summary version) is derived from the detailed schedules provided by each WBS manager. The integrated detailed schedules are comprised of 15,154 activities and 19,115 relationships, approximately the same as at the November 2002 DOE review. Project elements that are on or near the critical path include the Target installation, the portion of the Target Building that supports commissioning, and commissioning. An abbreviated IPS for the Accelerator Systems currently shows approximately 250 days of schedule float, but this schedule has yet to be updated to reflect the working level schedules.

7.2 Comments

The existing "early-finish" schedule is inconsistent with the approved BA funding profile. While the project's financial obligations are being effectively tracked and managed against available BA, the practice of utilizing phased-funding of contracts as a tool for maximizing flexibility is less effective as the majority of contracts have now been placed. The concern is that the BA and BO profiles are essentially identical in FY 2004, leaving no buffer for unplanned, but necessary work. Although the project has historically planned more work than the available BA would support, SNS management acknowledged the BA/BO challenge and will begin the necessary re-planning to prepare a proper “End Game Plan” for the project. This issue will be revisited during future DOE reviews.

The project’s early finish goal of December 2005 will likely be extremely difficult to achieve, especially in light of the BA/BO challenge and risk-related items that might challenge the schedule and require additional calls on contingency. The project concurred in this assessment and has started a process of identifying and prioritizing potential areas of scope contingency in case they are needed. Based on discussions with project personnel, it is likely that a delay in the early finish date of one to three months is probable.

7.3 Recommendation

1. Prepare new working schedule, assuming a reasonable application of the contingency remaining, which is consistent with the approved BA funding profile by July 3, 2003.

8. MANAGEMENT (WBS 1.2)

8.1 Findings

Impressive progress continues to be made on the construction, technical components, and installation on the SNS project. At the end of end of March 2003, the SNS project is about 61 percent complete. Through March 2003, the R&D is over 95 percent complete, while the design work is 88 percent complete (the remaining work relates to the instrumentation). Project construction is 60 percent complete and over 90 percent of the major procurements have been awarded. Facility construction has included over 3.0 million safe workhours. Installation of the technical systems is estimated to be 26 percent complete. Significant project progress was confirmed, during the review, by the large number of important milestones that have been completed and facility tours.

The SNS project has been very responsive to the recommendations from the November 2002 DOE review. A DOE Review Recommendation/Response document was provided by the project that addresses each of the recommendations from that review. For the management activities, BNL has developed and submitted an acceptable plan for BNL staff to transition from the SNS project. About 90 percent of major procurement actions have been awarded and the remaining procurements have been planned. The procurement actions are consistent with the SNS project schedule and requirements for test plans, including first articles. Senior ORNL and LANL management have been involved in the DTL recovery plan. LANL has aggressively assigned staff to track subcontractor performance and the plan is being executed satisfactorily. While LANL has dedicated management attention and personnel to the recovery plan, continued attention on the Linac must continue through completion.

While FY 2002 was the peak year for Congressional funding of the SNS project at $291.4 million, FY 2003 is the peak year for expenditures. The FY 2003 Congressional funding was $225 million, which is what was requested. The project is holding to the internally driven schedule completion date (resulting in six months of schedule contingency in the baseline schedule). The SNS project reported that an IPS-BA profile mismatch is expected to occur in FY 2004 because the project has been managing to the early completion date, which is more aggressive than Congressional appropriations.

Project contingency (based on EAC) is reported at 20 percent ($44.6 million) and was 20.4 percent (about $67.3 million) at the November 2002 DOE review. SNS management continues to examine possible scope changes, sequencing of activities, and the level of component testing to accommodate potential cost increases. This approach focuses on limiting the use of contingency funds. The project has transferred 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. The SNS project has included likely/expected contingency usage as part of the determination of remaining contingency. About $30 million in contingency has been allocated to CF over the past year, with $10 million of that allocated to the AE/CM incentive fee and about $15 million for two major contract awards.

There have been no changes in the senior management structure of the SNS project and all key management positions are filled (see Appendix G). ORNL management, through the ORNL Director, continues to demonstrate significant support for the SNS project. Dr. William Madia, the Director of ORNL has announced that he will be returning to the Battelle Memorial Institute Corporate Office to head up their government services group. Dr. Madia will continue to serve on the UT-Battelle Board. It is planned that he will remain at ORNL until a successor is selected. It is anticipated that sufficient groundwork has been performed by Dr. Madia that the positive relationship of UT-Battelle with the other involved organizations will be maintained.

SNS and ORNL management continue to work closely to ensure that the SNS project will be integrated into ORNL when completed. The integration of the conventional facilities operation is particularly important for efficient operation of the completed SNS project. ORNL has a Standards Based Management System that is used for all of the Laboratory organization. Memoranda of Understanding are being written between the SNS project and ORNL Facilities and Operations Division (three of nine are completed).

The MOA between the SNS project and the partner laboratories remains in place. This document reflects the business relationships between the SNS project and the individual partner laboratories that are required to manage the SNS project. Installation and commissioning plans use a “rolling wave approach”. These plans will be used to ensure that the work can be completed and the necessary roll-off of partner laboratory staff occurs in a timely manner. Roll-off of partner laboratory staff is underway. While some risk remains as the technical components are transferred to the SNS project, experience with the quality of received technical components has generally been satisfactory.

Installation of the accelerator technical systems is underway with a planned installation target of 50 percent complete established for the end of FY 2003. Since the November 2002 DOE review, the installation needs have been re-estimated and additional funding was added to the cost baseline from contingency. This re-estimate takes advantage of work performed to date, but also assumes that future installation tasks will be more efficient based on lessons learned. If additional installation needs occur, it is planned that these will come from contingency or additional cost offsets.

The SNS project has conducted a variety of management reviews to ensure that the project plans are adequately implemented. In March 2003, the Accelerator Systems Advisory Committee met and discussed accelerator status and issues. Specific recommendations were made to ensure that this system would meet scope and schedule requirements. The EFAC also met during the second quarter of FY 2003 to review progress.

The SNS Quality Assurance Program is well conceived and provides for the appropriate level of controls. The value of quality assurance appears to be well established and well understood within SNS management. Many noteworthy practices were observed. Each of the partner laboratories has developed detailed design drawings for technical components and provided these drawings to ORNL.

8.2 Comments

Overall, excellent progress has been made on the SNS project. It is being managed effectively, consistent with completing the baseline project scope within the baseline TPC ($1,411.7 million) and schedule (operation in June 2006). While contingency levels are reported as $44.6 million and 20 percent, SNS management needs to remain diligent to ensure that the cost baseline is met.

Based on decisions and actions taken by the SNS project team, the Committee reaffirmed its confidence in the SNS management team. SNS management provided evidence that issues are identified quickly and actions are taken to resolve them. A 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.

The SNS project has identified much of the remaining risk to be in the areas of installation and commissioning. In particular, as the partner laboratories roll-off the project, any remaining issues are assigned to ORNL. Some additional planning and identification of options should be considered to ensure that the cost baseline for installation and commissioning will be met. This could include some non-critical scope contingency.

The SNS management team continues to have an excellent working relationship with DOE and is effectively integrating the multi-laboratory partners. The SNS project relationship with both the DOE Office of Basic Energy Sciences and the local DOE Project Office has been positive and cooperative. The SNS Project Director mentioned the positive support provided by the Director of LANL on addressing Linac Systems issues.

The SNS project is maintaining a very constructive relationship with key external stakeholders. The SNS project is viewed positively in Congress as demonstrated by the FY 2003 appropriation. The SNS project is working well with the neutron user community to plan and prioritize instrument availability and experimental operations, and maintaining good relations with existing neutron research facilities. Communication is positive with labor unions and no significant problems are expected in the required workforce to complete installation and for operations. Positive relationships with the State of Tennessee are recognized.

The SNS project has been monitoring the installation and commissioning plans with special attention to actual delivery schedules. Roll-off plans for partner laboratory staff are also tracked as part of cost control. ORNL has assumed some additional risk as expeditious roll-off occurs for cost control purposes and some issues remain in the commissioning of components and systems.

While LANL has been very responsive to SNS requests since the November 2002 DOE review, LANL management needs to stay engaged until the Linac components are transferred to ORNL. Completion of the post hand-off MOA between the SNS project and LANL needs to be a high priority.

The project has an internal goal for an early finish date of December 2005, to ensure the DOE baseline completion date (June 2006) can be met. However, the project’s schedule and budget requirements are not consistent with the approved BA funding profile. The project plan requires additional BA in FY 2004 to meet the early finish date. This problem will be exacerbated by any significant contingency usage in FY 2003 or FY 2004. This inconsistency needs to be resolved as soon as possible to optimize the efficient use of resources. Some additional end game planning is needed to ensure the most efficient use of FY 2004 through FY 2006 BA, and to minimize cost and schedule impacts.

At the last two DOE reviews, the SNS project has shown increases in the CF cost estimate on the order of $30 million. With the construction at 60 percent complete, the SNS project needs to ensure that CF does not continue to require contingency usage presented at the rates experienced over the last year. Control of the roll-off of ORNL CFD staff and AE/CM staff needs to occur to ensure that this does not become an issue.

While many elements of the QA program have been satisfactorily applied, there have been some issues with the inconsistent application of the QA program among the partner laboratories. These inconsistencies include the application of QA controls, quality of turn-over records, and follow-up on QA findings. Continued diligence in this area is warranted. The QA program is particularly important in the hand-off of deliverable components and systems from the partner laboratories to ORNL to ensure that expectations are achieved (through appropriate acceptance tests) and the necessary documentation is available. The calibration program should be implemented as soon as possible. QA considerations should be part of the End Game Plan.

8.3 Recommendations

1. Prepare a comprehensive End Game Plan (FY 2004 through FY 2006) that addresses the approved BA funding profile for the SNS project by July 3, 2003.

2. DOE SNS Project Office will conduct a review of this completed End Game Plan during July 9-11, 2003.

3. Finalize the post-hand-off MOA between the SNS project and LANL by June 2003.

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