Closeout Report

on the

Department of Energy
Review Committee

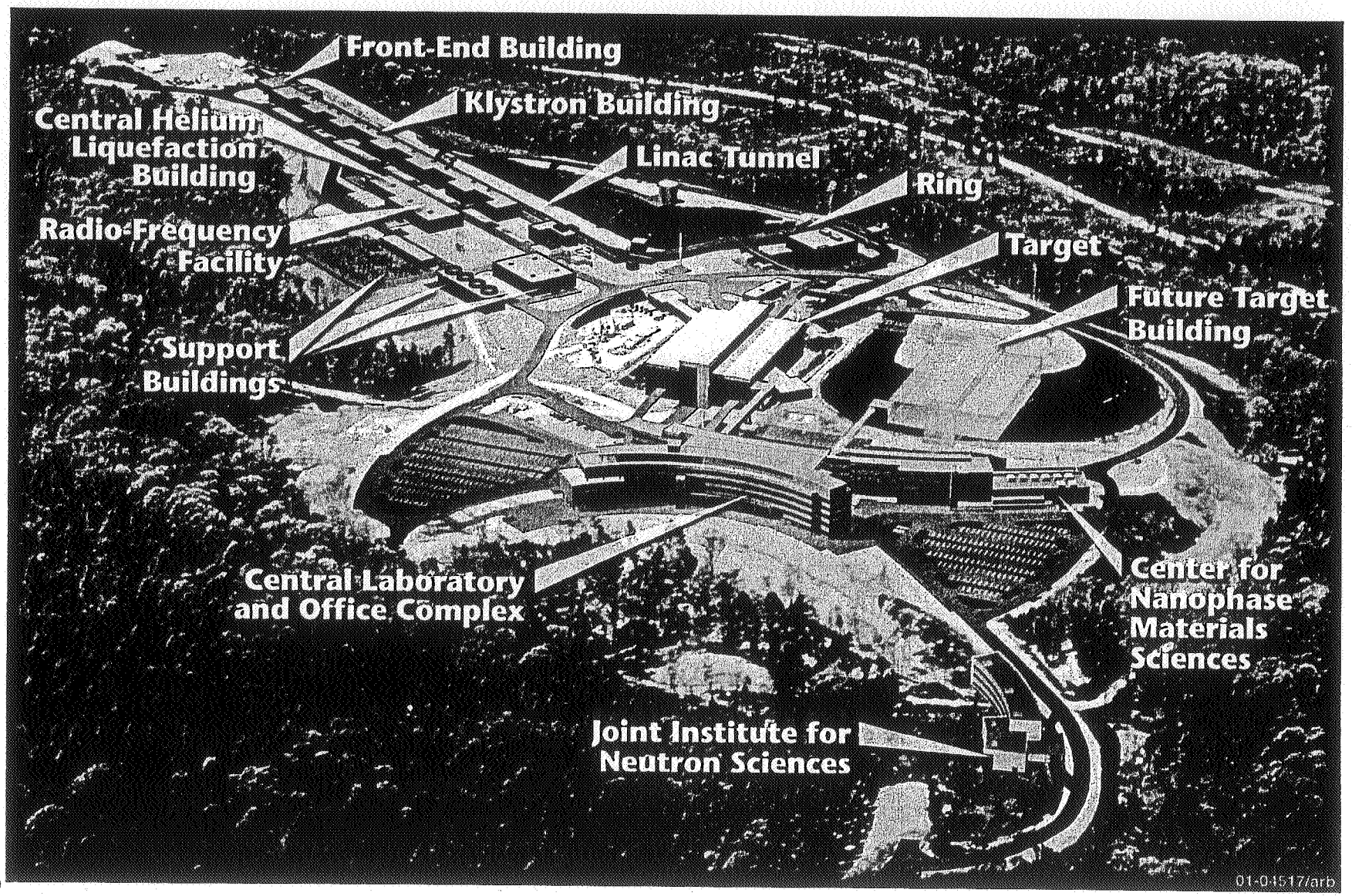
for the

Technical, Cost, Schedule, and
Management Review

of the

SPALLATION NEUTRON SOURCE (SNS) PROJECT

May 9, 2002


Front-End Building
Klystron Building
Central Helium Liquefaction Building
Linac Tunnel
Ring
Radio-Frequency Facility
Target
Future Target Building
Support Buildings
Central Laboratory and Office Complex
Center for Nanophase Materials Sciences
Joint Institute for Neutron Sciences
01-01517/arb

DOE F 1325.8
(08-93)

United States Government **Department of Energy**

memorandum

DATE: March 15, 2002

REPLY TO
ATTN OF: SC-13

SUBJECT: SEMI-ANNUAL STATUS REVIEW OF THE SPALLATION NEUTRON SOURCE

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

I would like to request that you organize and lead an Office of Science (SC) semi-annual status review of the Spallation Neutron Source (SNS) project in Oak Ridge, Tennessee during May 7 - 9, 2002. The purpose of this review is to evaluate progress in all aspects of the project: technical, cost, schedule, management, and ES&H.

Large-scale conventional construction activities at the site are approaching their peak level, technical hardware is being procured and integrated by the partner laboratories, and subsystems are beginning to arrive at SNS. In light of this progress, the committee should focus whether the project's status is consistent with overall cost, schedule, and technical baselines.

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

1. Are the project's cost, schedule, and technical baselines consistent with those in FY 2003 Project Data Sheet and the current DOE-approved SNS Project Execution Plan (e.g., Total Project Cost of $1,411.7 million, and CD-4 in June 2006), and is there adequate progress to meet the baseline objectives? Is the information in the DOE Project Assessment Reporting System consistent with physical progress?

2. Is the project being managed as needed for its proper execution?

3. Is the schedule of remaining project work credible and reasonable? Is there adequate contingency to address the risks inherent in the remaining work and is it being properly managed? What is the appropriate timing for the next bottoms-up estimate to complete?

4. Are the installation and commissioning plans reasonable from the standpoint of technical logic, costs, project-wide staffing plans, and transfer of responsibilities from the partner labs? Has there been adequate progress on instrument installation planning?

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

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

Jeff Hoy, the SNS Program Manager, will work closely with you as necessary to plan and carry out this review. I would appreciate receiving your committee's report within 60 days of the review's conclusion.

[SIGNED]

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

cc:
R. Orbach, SC-1
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Department of Energy Review
of the
Spallation Neutron Source (SNS) Project

REPORT OUTLINE/WRITING ASSIGNMENTS

Executive Summary ..... Hoy

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2. Technical Systems Evaluations [Charge Questions (CQ) 1, 3, 4, 6]
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     - 2.1.1 Findings
     - 2.1.2 Comments
     - 2.1.3 Recommendations
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   - 2.3 Linac System (WBS 1.4) ..... Bogert, Subcommittee 3
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6. Cost Estimate [CQ 1, 4, 6] ..... Krupnick, Subcommittee 7
7. Schedule and Funding [CQ 1, 6] ..... Krupnick, Subcommittee 7
8. Management (WBS 1.2) [CQ 2, 6] ..... Berkner, Subcommittee 8

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E. Schedule Charts
F. Funding Tables
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Department of Energy Review
of the
Spallation Neutron Source (SNS) Project
May 7 - 9, 2002

Daniel R. Lehman, DOE, Chairperson
James R. Carney, DOE, Co-Chairperson

SC1

Accelerator Physics

* Steve Peggs, BNL

SC2

Front End, WBS 1.3

Control Systems, WBS 1.9

* Ben Prichard, Jr., LANL
Rusty Humphrey, SLAC

SC3

Linac System, WBS 1.4

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

SC4

Ring System, WBS 1.5

* Rod Gerig, ANL
Dick Cassel, SLAC
Jack Jagger, ANL

SC5

Installation

Pre-Operations

* Tom Roser, BNL
Lowell Klaisner, SLAC

SC6

Conventional

Facilities, WBS 1.8

* Dale Knutson, PNNL
Dale Flowers, PNNL
Greg Pitonak, DOE/PAO

SC7

Cost and Schedule

* Jim Krupnick, LBNL
Joe Harkins, LBNL

SC8

Project

Management, WBS 1.2

* Klaus Berkner, Consultant
Ron Lutha, DOE/FAO
Bruce Warner, LLNL/NIF
Tom Elioff, SLAC

SC9

ES&H

* George Stalnaker, LLNL/NIF

SC10

Target

Systems, WBS 1.6

* Gunter Bauer, PSI
James Jones, INEEL

SC11

Instrument

Systems, WBS 1.7

* John Tranquada, BNL
Kristen Bennett, LANL
David Mildner, NIST
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Katherine Johnescu, DOE/LBNL
Rick Korynta, DOE/TJNAF
Lance Haworth, NSF
Jeff Bostock, NRC

LEGEND

SC Subcommittee
* Chairperson

Count: 32 (excluding observers)

5/8/2002:q:sc-81:sns:0003rev:revcmsns.xls

2.1 ACCELERATOR PHYSICS

5/9/02 1100

Steve Peggs, BNL

Findings

Much excellent Accelerator Physics work is being performed, both on the SNS site and at the partner laboratories. The Accelerator Physics group at ORNL continues to enhance its lead role.

At the last review it was recommended to:

> **"Resolve how to control the halo of the beam distribution, as it emerges from RFQ, for example by putting collimators in DTL tank 1."**

Accelerator Physicists at ORNL, LBNL, and LANL have made a careful simulation study of this issue, summarized in the extensive report *"Linac Halo*

Mitigation". One scenario considers inserting scrapers in the first 10 empty drift tubes in DTL tank 1. A second scenario places a collimator next to the chopper target in the middle of the MEBT section. A last scenario considers optics changes in the MEBT, designed to make the beam rounder, and therefore less susceptible to the generation of halo tails.

The report concludes that a hybrid solution is optimal, with a collimator in the MEBT chopper target box and modified MEBT optics. Simulations suggest that this results in a 97% reduction in the halo, when nominal beam parameters are used. **This proposal has been accepted, and will be implemented** when the Front End is re-commissioned at SNS in fall 2002.

Real beam distribution measurements are becoming available, now that the commissioning of the Front End at LBL is entering its final stages. For example, the beam emittances at moderate beam currents appear to be consistent with nominal specifications.

The other recommendation at the last review was to:

> "Prepare, for Front End recommissioning at ORNL in fall 2002, a diagnostic system in the Medium Energy Beam Transport to demonstrate beam gap cleanliness, as well as to measure transverse halo."

There is a plan to put instrumented isolated scrapers in the chopper target box that. It is hoped that this diagnostic will be able to measure the beam distribution, including halo, over 4 orders of magnitude. Also present in this plan is an in-line emittance measurement device.

The interfaces between Accelerator Physics, Controls, and Diagnostics groups are strong, and are developing in a healthy fashion. This is necessary for efficient and rapid beam commissioning. The "global database" is a central repository for the well regulated maintenance of public data owned by these three groups and others, including the survey, magnet measurement, power supply, and RF groups. There are two version of this database -- "development" and "production". The first "production" release is about to take place. While it

is clear that this database will expand greatly over the next few years, the present effort is going very well.

A list of approximately 200 application codes has been generated, in the process of writing the *"SNS Commissioning Program Plan"*. The majority of these codes will be written by individuals within the ORNL Accelerator Physics group. Some scope has been transferred from Controls to Diagnostics, with the shift to "Network Attached Devices". The ORNL Diagnostic group has significant operational and physics experience. Currently there are 5.8 FTEs in the ORNL diagnostics group, 7.0 at BNL, 7.5 at LANL, and 1 at LBNL. There are 2 open requisitions at ORNL with more to come.

The Accelerator Physics, Controls, and Diagnostics groups will also be centrally involved in the full "system integration" tests that the 4 Area Managers from the Accelerator Physics group will lead. These Area Managers represent accelerator sections: the Front End, Warm Linac, Cold Linac, and Transport lines and Ring. The goal of these "dry runs" is to save precious beam-time. The philosophy is to set readiness deadlines some weeks ahead of beam, to enable the broad exercise of the next accelerator section as if it were fully operational, with enough time to fix problems before actual beam commissioning.

Remote operations proved very useful during initial MEBT commissioning, for example in debugging Network Devices, and in testing applications. Long run benefits of remote operations include the enhancement of continued long term involvement of specialists at the partner labs. For example, when the Front End is re-commissioned at ORNL the remote operations connection will work the other way around, enabling specialists from LBNL to remain closely connected. An anomalously large spread in Transfer Functions is observed in Ring dipoles, as delivered. About 70% of this effect comes from variations in the iron, and 30% from dimensional errors. It is easily possible to correct these errors for operation at 1.0 GeV by shimming the magnets.

The neutron back scattering and RTBT aperture problems that arose since the last review have been resolved. There is now a close collaboration between ASD and XFD, enhanced by the assignation of a liaison between the two divisions. For example, XFD perform shielding calculations for ASD.

The "*Critical Decision 4 Criteria*" document includes the statement that "the SNS must have in place all capital facilities to achieve a proton power on target of $\geq$ 1 MW" but goes on to state that "these tests will consist of demonstrating

that particles can be stored in the accumulator ring to a level of 1×10^{13} protons in a pulse (and) can be extracted .. and transported to the target" (et cetera). This is consistent with the."*Operational Aspects and Reliability*" white paper that describes the evolution from CD-4 to full operation over a two year period. In particular, operation at average power beyond 10 kW is only possible after the Accelerator Readiness Review, scheduled for 6 months after CD-4.

Many other important Accelerator Physics studies are also making good progress at ORNL, in collaboration with the partner labs. These include:

- the fate of partially chopped beams
- sources of beam loss in the linac
- linac mismatch
- missing superconducting cavity
- drift tube linac tuning results
- Ring/Target integration, aperture, fault studies, and target parameters
- collective effects and impedance budgeting
- H^- laser stripping
- electron cloud code development and data analysis

Comments

Great advances have been made in Front End commissioning at LBNL since the last review. More realistic data are becoming available for input into halo evolution simulations, now that MEBT commissioning is in its final stages. Enhanced understanding can be gained from continued, more realistic, beam halo studies.

It is vital that the accelerator system groups "buy-in" to contributing and maintaining public data that they own, in the global database. This necessitates the full support of management, including the provision of appropriate database administration support.

The 4 Area Managers need adequate management support in planning and implementing broad system integration tests without beam, before beam commissioning each of the accelerator sections.

Other partners labs such as LANL can expect significant benefits from remote operations, and should carefully observe its ongoing use in the Front End activities.

Recommendations

1. Prepare, for Front End recommissioning at ORNL in fall 2002, a diagnostic system in the Medium Energy Beam Transport to demonstrate beam gap cleanliness, as well as to measure transverse halo.

2. Present, at the next review, refined beam dynamics simulations down the accelerator chain, using the latest beam distribution input information from the commissioning and re-commissioning of the Front End.

3 Keep up the good work.

Ben Prichard, Jr.

5-9-02 Draft

2.2 Front End Systems (WBS 1.3)

2.2.1 Findings

Virtual completion of the Front End scope at Berkeley has been achieved by LBNL/ORNL since the previous review

LBNL/ORNL has made significant progress since the previous review in the following areas:

1. Improved RF antenna coatings developed.
2. "24x7" performance test performed.
3. Beam through all four modules of the RFQ (32 mA – 93% transmission).
4. MEBT fully installed and commissioned one day ahead of schedule.
5. Output current of 36 mA achieved with the Ion Source Extractor configured for lower currents.

LANL and BNL contributed substantially to the success at LBNL.

The recommendation from the Previous review has been implemented

LBNL/ORNL has addressed the recommendation from the last review. That recommendation stated, "Clarify to all participants the availability of and budgeting for partner lab performance in FES installation/commissioning." Engineering oversight by LBNL staff at ORNL during the FE shipment will be provided. Significant SNS-ORNL participation has occurred and will continue until shipment of the FES takes place. 12 FTE-weeks of LBNL staff at ORNL for participation is commissioning is budgeted for. Additional LBNL effort is not budgeted for but could be arranged within the existing post-handoff MOA.

Some of the recommendations from the ASAC review have been implemented and the remainder will be addressed at ORNL.

The ASAC committee made six recommendations in February of 2002. The one that could be implemented at LBNL given the constraints of the project schedule has been implemented. The other five will be considered for implementation at ORNL.

Schedule and Cost

The shipment of the FES is expected to occur as scheduled. The testing at LBNL will conclude on May 31, 2002. Shipping is scheduled to be complete on July 15, 2002. The FES budgets remain unchanged from December 2001. The Cost and Schedule performance shows less that 1% variance through March 02.

Progress on Source reliability

The source antenna reliability has made substantial progress. One antenna, with a 0.3-mm coating was tested to 107 hours uninterrupted operation. New coatings, 0.75-mm thick have been developed which are expected to provide substantially longer life. A second extended lifetime test of the FES will begin this coming Monday. Backup efforts that include an external RF antenna or a microwave drive are being examined.

MEBT and RFQ Components

Since the last review, all MEBT and RFQ components have been completed, installed, and commissioned. Only three major tasks remain. They are: 1) operation at full 6% duty factor, 2) a 24x5 performance test of the full FES with beam, and 3) the final acceptance test.

2.2.2 Comments

LBNL/ORNL/LANL/BNL interaction continues to be very positive

The relationship between LBNL and ORNL FES personnel continues to be a very positive benefit to the project. Both sides have contributed to the effort both at LBNL and at ORNL. The atmosphere of cooperation has amplified the effort in a way that has more than paid for itself. The contributions to the MEBT hardware and diagnostics by LANL and BNL have also been a very positive contribution to the recently achieved success at LBNL.

Schedule on target, but some details may be left to be resolved at ORNL

While there is full confidence that the FES will be shipped as scheduled, several items of lesser importance will remain to be exhaustively demonstrated at LBNL. Therefore several items such as operational reliability will need continued attention after the FES is recommissioned at ORNL. The integration of the final RF system will be a major change in hardware from that used at LBNL. Several minor systems such as the Personnel Safety System, the timing system, Machine Protection System, and closed loop control of various FES systems will not occur until commissioning at ORNL. No measurements of FES longitudinal properties have been included in the scope of testing at Berkeley. Similarly full MEBT chopping performance will not be tested at LBNL. The items to be resolved at ORNL are not considered to be major risks.

MEBT modification will be completed at ORNL

Halo reduction, previously discussed in terms of scrapers in the DTL, is currently envisioned to be accomplished in the MEBT. This effort will be carried out by the SNS-ASD at ORNL.

Current Budget appears adequate

The current budget is adequate to complete the FES effort at Berkeley.

2.2.3 Recommendations

No new recommendations are made as a result of this review.

SNS Project – DOE SC Review, May 9, 2002

2.3 Linac Systems (WBS 1.4)

2.3.1 Linac Overview

The Linac structure is unchanged since the November 2001 DOE review. As shown in Figure 2.1, the Linac structure is a conventional Drift Tube Linac (DTL) to 87 million electron volts (MeV), a cavity coupled linac (CCL) from 87 to 186 MeV, a "medium-Beta" (Beta=0.61) superconducting linac (SCL) from 186 MeV to 379 MeV, and a "high Beta" (Beta=0.81) SCL from 379 MeV to approximately 1 GeV. The medium Beta SCL has 33 cavities in 11 modules and the high Beta SCL has 48 cavities in 12 modules.

2.3.1.1 Findings:

Good progress has been made in most areas since the November 2001 DOE review. The first DTL section (actually unit #3) has been assembled at LANL and will be ready for shipment of SNS-ORNL soon. The first rf systems (needed for the front end) were delivered to LBL for power tests of the front end RFQ through MEBT systems. First item klystrons for the 402 MHz DTL were delivered and are being used in a test configuration for the high voltage converter modulator (HVCM) prototype system at LANL. **With the placement of a second source order (by SNS-ORNL) for the 402 MHz klystrons (as recommended at the last review) and the initial delivery**

of units from the first vendor, much of the uncertainty surrounding this klystron procurement has been removed.

Parts for the rest of the DTL are being received. The vendor building the CCL has made many pieces, and is reported on schedule for fabrication and later assembly of CCL modules. SNS-ORNL staff have concluded that collimation in the MEBT is much more effective than in the DTL for the removal of beam halo, which satisfies an issue from the November 2001 DOE review.

The low level rf system (Field Resonance Control Module) is designed to be able to be used for control of all the linac rf systems (warm and cold). The present status appears to be about 2 months behind plan. About 1/4 of the $14 M of this element is costed or committed. Prototype systems are scheduled to be delivered to ORNL for the RFQ and DTL-3 in June and a limited production run of 4 systems is planned for June/July. One of these systems should be available for the superconducting cavity test stand at JLab in September.

A prototype Converter Modulator built by LANL has been undergoing tests and has been used to test rf components and superconducting cavity couplers. Full peak power capability of the modulator has been demonstrated at low duty factor. An average power of 400kW (out of 1 MW required) has been reached. But failures of the IGBT switches have occurred at high average power. Testing continues with different switches and possibly increased switch gate drive may cure the problem. Recent tests have been favorable. Also, an alternate design using double IGBTs is being developed. HVCM production units have been ordered as several "build to design" orders of sub-

components, at a significant savings versus the first request for complete "build to specification" units.

Installation of a 1 MW RF source for prototype cryomodule tests at JLAB, an action item from the May 2001 DOE Review, was completed and installed on schedule.

Assembly of the prototype cryomodule with three beta 0.61 cavities has been completed and testing can now begin.

Tests of the prototype medium-beta cryomodule have been delayed nearly three months from the date scheduled at the November 2001 DOE review.

Problems with vacuum seals and various mechanical assembly problems with the prototype cryomodule have been solved, and design changes incorporated in a timely fashion for the production cryomodules.

Procurement of cavities and cryomodule elements, and preparation for production assembly of cavities and cryomodules is proceeding well.

The 1st production module is scheduled for assembly completed in 11/02 and installation at the end of this year.

The cryosystems are mostly committed. There is a large quantity of equipment awaiting installation. Major component deliveries are on schedule. Installation of 80 ft sections of transfer lines has already started. Cold box installation should start this summer. Commissioning of the plant is planned for a start of 3/03 and finish of 10/03. By this time 11 medium beta cryomodules should have been installed as well.

A significant transfer of responsibility for installation of the majority of the DTL, CCL, and rf systems from LANL to SNS-ORNL has been mutually accepted. The value of the transferred effort is approximately $10M. LANL retains responsibility for several "initial" installation tasks as well as for "mentoring" of the SNS-ORNL staff during the installation of some other items.

2.3.1.2 Comments:

Overall, the progress on the Linac continues to be encouraging. The expected delivery of the first DTL structure to Oak Ridge, as well as progress with prototyping of major systems such as the HVCM is commendable. This is especially important, as the prototype HVCM operation has revealed a few problems that are being addressed in an appropriately responsible fashion. These problems are not believed by engineering staff or managers to represent a serious threat to technical performance or schedule, and when discovered at a appropriately early date can be rectified, as is happening. This history indicates the importance of lifetime testing of such new designs, in addition to the identification of start-up failures. This review committee therefore notes an urgency to pursue remaining development of items such as the LLRF system, and the necessity to test concepts as well as final engineering in test beds whenever possible.

The review committee notes, as responsive to a concern in the November DOE report, the development of a good working relationship with vendors of components for the HVCM and the CCL modules. These and similar close working relationships with other vendors should continue to be carefully developed. The review committee also again notes with approval the continued growth of the working relationships between the partner laboratories.

As was noted in the report of the November 2001 DOE review, "The timely completion of tests of the prototype cryomodule is needed to establish the adequacy of the system designs to cope with the electromagnetically-induced mechanical vibrations resulting

from pulsed operation of the superconducting cavities." **A substantial risk of design changes** needing to be retrofitted to the cavity and cryomodule configuration **will exist** until rf phase and amplitude control is demonstrated in pulsed operation at the design gradient in the prototype cryomodule.

It is critically important that the prototype production llrf system be installed and operated with a cryomodule as soon as possible, so that cavity amplitude and phase can be controlled and the issue of Lorentz and microphonic detuning can be laid to rest. As studies of the prototype low beta module are about to begin now, **the planned delivery of the llrf in September is already later than desirable.**

The modulator developed at LANL and planned for the linac klystron systems has many unusual or unique features. Though the IGBTs are giving difficulty at this time, there are other untried components such as the transformer rectifier units. **It is critical that the modulators be life tested. Long term testing should be carried out not only on the prototype but more importantly on production units.**

It appears that the procurements and installation of the cryosystems are off to a very good start. **We note however that cryoplant commissioning is scheduled for completion by 10/03,** when a considerable number of cryo modules will have been installed. **Some temporary cryo capability (dewars?) should be considered for an earlier time, so that integrated systems tests can be performed on rf systems and modules.**

We believe that **testing the first production cryomodules is very important** in order to be assured that all aspects of the cavity preparation and assembly are under control, and that the module system can be operated as expected with rf. Measurements of cryo load, Lorentz and microphonic detuning will be important here as well as with the prototype module. The first production module should be tested with the planned llrf with phase and amplitude control.

Cost and schedule issues do not represent a major concern generally except in the few particular areas noted.

2.3.1.3 Recommendations:

1. Expedite the prototype cryomodule testing at JLab. In particular, demonstrate full control of rf phase and amplitude in pulsed operation at design gradient for one or more cavities before concluding the prototype tests.
2. Life-test a production modulator unit at the earliest possible time.
3. Ensure that the delivery of the low level rf system is on schedule, and if possible advance it in order to integrate with cryomodule tests as soon as possible. Additional resources, including experts from across the collaboration, should be considered as a means of speeding up the development.
4. Incorporate internal milestones for cryomodule production and testing into the schedule and report on progress against these at the next DOE Review .
5. Develop a plan by the next DOE Review for the integrated testing of a cold module with the rf system at SNS. This will require a temporary cooling system.
6. Continue to closely monitor klystron production at the various vendors.

2.4 Ring Systems (WBS 1.5)

2.4.1 Findings

Considerable progress has been made in all areas in the ring. The progress that we observe is consistent with what we expect at this point in the project. Technical challenges, which are few, are being addressed; and cost and schedule goals are being met.

2.4.2 Comments

An early operations plan, outlining reliability and beam power expectations for the first two years after CD4 was presented. The committee encourages further development and distribution of this plan.

The committee was shown responses to the ring recommendations from the last review. One of the recommendations was not fully addressed:

> Present a plan, at the next DOE review, for spares of all devices that will be in high radiation areas. The project is encouraged to obtain spares for these devices before beam is introduced in order that these devices can be replaced in-situ, in a "dry run" scenario. This would provide the one chance to work out unforeseen problems before these devices become activated, and should be made part of the installation schedule.
>
> **The spares for these regions have been identified and a number of them are in the baseline. Others are proposed. However, he committee feels that it was not presented with a plan to develop in-situ dry run replacements in the high radiation areas. We continue to encourage SNS to incorporate this into their installation plans utilizing any special handling equipment necessitated by the high radiation environment.**

The committee had asked for a report on diagnostics at this review. The report that was presented focused on project wide diagnostics progress and not on ring specific problems. We would like to see a ring specific diagnostics talk at the next review. Although the diagnostic group to controls group interface is functioning well we know there are some unique problems in the ring such as turn-by-turn BPM data collection and circulating beam profile monitors that are challenging.

2.4.3 Recommendations

1. Address recommendation 2 from the November 2001 review, concentrating on the development of procedures and tooling for rapid, low exposure replacements in high radiation areas.
2. Present, at the next review, a specific report on all ring diagnostics.
3. Collect, at ORNL, all component and subsystem drawings from the partner labs and include them in the Document Control Center in preparation for installation.
4. Plan to create a complete set of installation drawings in support of installation.

May 9 2002

Target Systems

G. Bauer, FZJ

J.Jones, INEEL

2.5.1 Findings

- Recommendations were adequately addressed
- The Committee concurs with the Project's decisions.
- The Committee welcomes Ian Anderson and commends him for the leadership shown so far
- The Committee wishes to thank Tony Gabriel for his outstanding work as Acting Division Director
- In general, TS progressed very well on all fronts
- Cost and schedule variances, to date, are minimal.

Findings (contd.)

- Hiring an Installation Engineer was good move.
- Installation planning of TS is adequately detailed for the present status of the project.
- Installation schedules proposed are tight throughout but not unrealistic.
- Cost impact of a decision for a solid commissioning target is estimated at 6M$ minimum
- The need to negotiate a significant part of the installation activity with contractor already on board may weaken position.

Findings (contd.)

- Pitting phenomenon not yet understood well enough to explain all experimental findings, let alone develop predictive capabilities based on computational modelling
- Obtaining a high number of impacts of a proton beam is difficult due to activation issues
- Relevance of surrogate experiments not fully established

2.5.2 Comments

- The position of the newly hired installation engineer is very important and needs to be a strong one.
- The Committee concurs with October 02 date for the decision on the commissioning target.
- This decision may still be a question of risk management

Comments (contd.)

Solid target

- A clad tungsten target presently considered a smaller technical risk than a liquid mercury target
- Not a fully proven concept at SNS load levels though
- Operating costs including waste handling and disposal likely be markedly higher.
- May limit the upgrade options of SNS unless suitable provisions for transition to mercury are made up front.

Comments (contd.)

Mercury target

- Time available to find a dependable solution is of the order of five years.
- Concepts developed on theoretical grounds for mitigation of the pressure pulse effect in liquid metals, by injection of non-condensable gas bubbles of suitable size, has not been tested at all so far.

2.5.3 Recommendations

Provide DOE with a status report on target development by July 31, which reviews the current situation and proposed actions.

Identify opportunities world wide to carry out meaningful pitting tests in the multi-million pulse regime and on a prototypical target configuration during the next three years.

Recommendations (cntd.)

For the mercury target option, evaluate in detail, the procedures, time and cost required for changing to a solid one soon after CD4, (i.e. before any significant activation has occurred that would make extensive remote handling necessary) in case the pitting problem is not resolved by then.

For the solid target option, identify the provisions and associated costs necessary up front to facilitate a later transition to a liquid metal target, once its feasibility for high power operation has been established.

2.6 Instrument Systems (WBS 1.7)

Tranquada (BNL), Bennett (LANL), Mildner (NIST), Pierce (NIST), Smith (LANL)

Findings

• As requested, a draft plan for integrated instrument installation has been prepared. The initial plan is good, but optimization is necessary and planned.

• 7 instruments (5 SNS and 2 IDT) can be installed before CD-4. (Installation of 2 of the SNS instruments is not yet funded.)

• Instrument design is on schedule. Costs of initial procurements are, on average, consistent with expectations.

- Planning for the transition from construction to commissioning (and eventual user support) has begun and is to be encouraged.

- There is a recognized need for an enhanced effort on detector development, including collaboration among existing groups at national labs.

Recommendations

- Evaluate, by the next review, the incremental costs of designing and procuring optimized target-vessel inserts for proposed, but not yet funded, instruments in time for initial installation *versus* the costs of replacing activated blank inserts with optimized ones after commissioning has begun.

- Prepare a draft plan by the next review covering staffing changes required for an efficacious transition from construction to commissioning, and looking towards eventual user support.

CONTROL SYSTEMS
(WBS 1.9)

Rusty Humphrey (SLAC)

Findings:

Status is Excellent.

Teamwork between Controls, Beam Diagnostics, and AP Applications Programming is excellent. All three teams have been delivering great product. Functions provided by those products to the FE commissioning gave excellent results. Tools put in place and proven there will work for the rest of the accelerator. Remote Operations went well.

Control Global Systems – Timing, Machine Protection System (MPS), Network, EPICS, Database, Personnel Protection System (PPS) – are all

well along. MPS and Timing are being deployed at the partner labs. The database design and schema is in place. Coordination and planning between the PPS team and the project in this important area is going well.

Comments:

The Beam Diagnostics System Architecture of NADs (Network Attached Devices) works and was very effective in the FE commissioning process.

There is a lot of device database entry that has to be done. The project should find some way to support this need during the next few years; it is a temporary staffing issue.

There are many functions and tools available for users of the device database; e.g., cable plant wiring diagrams, rack profiles, etc. Some

groups are using the device database and its associated tools more than other groups. See recommendation below.

Recommendation:

1. Support the use of the device database as a project wide tool.

3. CONVENTIONAL FACILITIES (WBS 1.8)

Subcommittee Members: Knutson, Flowers, Pitonak

Observers: Elioff, Bostoc, et.al.

3.1 Findings

- **Cost and Schedule is in good shape**

The project remains on track to deliver against the cost and schedule baseline approved in November. The Conventional Facilities (CF) cumulative cost performance index (0.98) and schedule performance index (0.96) are based on reasonable earned value to date. Additionally, the current month SPI of 0.70 was adequately explained as weather related and does not reflect the overall project schedule performance.

- **Manpower Issue Resolved**

The committee finds that there are sufficient manpower resources to support the current planned work, and the current construction sequence identifies peak manpower requirements in the remainder of FY'02 and FY'03.

- **Integration approach is not strong enough**

The SNS project is using an Integrated Systems approach in a distributed team relationship and as a result, accountability and ownership are difficult to conceptualize. The committee finds that the level of integration between CF and Accelerator Systems Division (ASD) is adequate for an initial turnover project stage. However, the level of management discipline needs to increase to deal with the anticipated increase in project turnover complexity between CF and ASD / XFD as the project continues.

3.2 Comments

- **DOE Issue**

The committee notes that the CF team has completed a seismic design standard review that compares existing SNS civil structural design requirements to emerging requirements sponsored by the Department of Energy at other ORNL locations. Based on review, there are no apparent benefits or significant impacts to current design caused by the emerging standards, however the process of certifying a completed design to a new or otherwise imposed standard is expensive and time consuming.

- **Installation Cost Issue**

As noted in previous reviews, and reinforced here, equipment installation poses a near term issue as beneficial occupancy and equipment installation occur in parallel with continuing construction. The project must ensure adequate field engineering and installation coordination between CF forces and technical installation staff.

3.3 Recommendations

1. The SNS project has completed a seismic design margin analysis of emerging USGS standards that concludes the current design, based on DOE standards in effect at the initiation of design, is adequate. The DOE Federal Project Manager should verify that the standards are therefore appropriate for current design and construction prior to the target building general construction contract award in July 2002.

2. Clarify and implement the project wide integrated systems management team approach to equipment integration tasks, and verify equipment component installation designs are being integrated with the CF design media and project earned value system by the next review.

4. Installation/Pre-Operations Planning

Thomas Roser [BNL], Lowell Klaisner [SLAC]

4.1. Findings

All recommendations of the November 2001 review have been implemented.

ASD produced subproject schedule, component delivery schedule, RATS assembly schedule, installation schedule, commissioning schedule and field coordination schedule.
ASD schedule integrated in ISP.

The installation schedule very tight;
Relies on "Ready for Equipment" (RFE) before BOD
Conditions for RFE defined and signed onto by ASD and CF.
Actual situation is then negotiated at the Division level.

Hand-off agreements are in place for all partner labs.
Post-hand-off MOAs with LBNL, BNL for commissioning support by the partner labs.
Draft MOA exists with LANL.

Intermediate storage space addressed with ORNL building 7039 and new RATS II.

Commissioning by four area managers for FES, DTL/CCL, SRFL, ring.
Responsible for commissioning and system integration tests ("dry runs").

Installation schedules for target and instruments well developed for present stage of project.

4.2. Comments

Possibility of off site (partner lab) commissioning and/or troubleshooting help.
Ensure that this capability is available in case special expertise is needed.
ORNL controls group already demonstrated remote diagnostic of FE at LBNL.

FE system well documented and installation at ORNL well prepared and supported.
For Linac and ring documentation and expertise should follow equipment from the partner labs to ORNL.
Transfer (translate) CAD files from partner labs into ORNL document system.

Commissioning plan very comprehensive and allocated time for commissioning tasks adequate.
Plan for phased Accelerator Readiness Reviews generated and presently under review.
ARR for FE scheduled to be completed within only 25 days.
Since this is the first ARR more time should be allocated to ensure timely completion.

4.3. Recommendations

Collect all component and subsystem documentations and drawings from the partner labs at ORNL and include them in the Document Control Center in preparation of installation.

Create a complete set of installation documents (e.g. drawings) in support of installation.

Present updated installation plan including all necessary documentation and lessons-learned from Front End installation at the next review.

Environment, Safety and Health

George Stalnaker – LLNL

5.1 Construction Safety

November 2001 recommendations:

- All recommendations from the November 2001 DOE review have been satisfactorily addressed

Comments:

- Management Support/ Commitment
  - Involvement in safety audits and incidents
  - Reviewed the "Headache Ball" incident
    - Reflects management's involvement with safety
  - Contractor "Expectation Letter" an excellent example of management commitment to safety.

- Safety Team
  - Very professional
  - Properly involved
    - Guide/consult
    - Not responsible
- Documentation Complete
  - Integrated safety management included in safety process
- Great safety morale in the field
  - A reflection of site leadership
- 600,000 safe hours
- Total Recordable Incident Rate (TRIR): 1.3 / 7.8 Average nationally

Recommendations:

- Review the safety and health aspects of the Commissioning Program Plan in the next project review.
- Review in the next project review "lessons learned" from construction incidents as they pertain to like work/equipment at ORNL.

Cost/Schedule Sub-Committee: Jim Krupnick (LBNL), Joe Harkins (LBNL)

Cost Estimate

Committee satisfied with current cost estimate – no changes are suggested.

We also concur with the strategy of phased preparation of new ETCs.

Commend the project for adding the 5% contingency allowance on outstanding commitments. We think it leads to a more credible result.

But, the committee was unconvinced by the data presented in support of the contingency analysis on the work remaining. The 'new' approach does not appear to be appropriately rigorous.

Given the areas of significant risk that still remain: (target, cryo-modules, installation, CLO, etc.), we repeat the advice of many previous committees: SNS management should continue to pay careful attention to the application of remaining contingency funds.

Recommendation:

Prepare a quantitative, risk-based analysis of contingency needs for the next review.

DOE Assessment Chart

(All values shown in $K)

SNS											DOE Assessment								
				Burdened, escalated $		Contingency on Awards		Contingency on Remaining			Burdened, escalated $			Contingency on Awards		Contingency on ETC			
WBS	WBS Title	Estimated Costs thru April 2002	Estimated Awards thru April 2002	Remaining at Risk	BAC	%	$	% *	$	TEC	Remaining at Risk (calc)	EAC	EAC Variance (calc)	%	$ (calc)	%	$ (calc)	TEC (calc)	Comments
1.2	Project Support	45,447	2,755	27,491	75,693	5%	138	12%	3,198	79,030	-		-		-		-	-	
1.3	Front End Systems (LBNL)	18,749	38	1,268	20,055	5%	2	15%	189	20,245	-		-		-		-	-	
1.4	Linac Systems	119,637	61,718	59,422	240,777	5%	3,086	15%	9,183	253,046	-	-	-	0%	-	0%	-	-	
LANL		89,629	47,079	45,978	182,686	5%	2,354	16%	7,162	192,202	-		-		-		-	-	
JLAB		30,008	14,639	13,445	58,092	5%	732	15%	2,021	60,845	-		-		-		-	-	
1.5	Ring and Transfer System (BNL)	47,898	12,072	53,397	113,367	5%	604	14%	7,513	121,483	-		-		-		-	-	
1.6	Target Systems	29,041	19,939	52,899	101,880	5%	997	16%	8,464	111,340	-		-		-		-	-	
1.7	Instrument Systems	19,232	3,197	41,003	63,431	5%	160	15%	5,953	69,544	-		-		-		-	-	
1.8	Conventional Facilities	133,485	93,967	96,108	323,560	5%	4,698	15%	14,402	342,660	-		-		-		-	-	
1.9	Integrated Control Systems	17,291	1,428	40,807	59,527	5%	71	16%	6,475	66,073	-		-		-		-	-	
ASD	Accelerator Systems Division	20,161	3,904	65,767	89,832	5%	195	18%	11,740	101,767	-		-		-		-	-	
Subtotals:		450,941	199,018	438,162	1,088,121		9,951		67,116	1,165,188	-	-	-		-		-	-	
Additional Management Contingency:										27,512									
Total Estimated Cost (TEC):										1,192,700								-	

Notes: ** Composite % derived from allocations by Phase.*

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Schedule and Funding

While several specific concerns have been raised by the technical sub-committees, overall we are generally satisfied with schedule progress over the last six months.

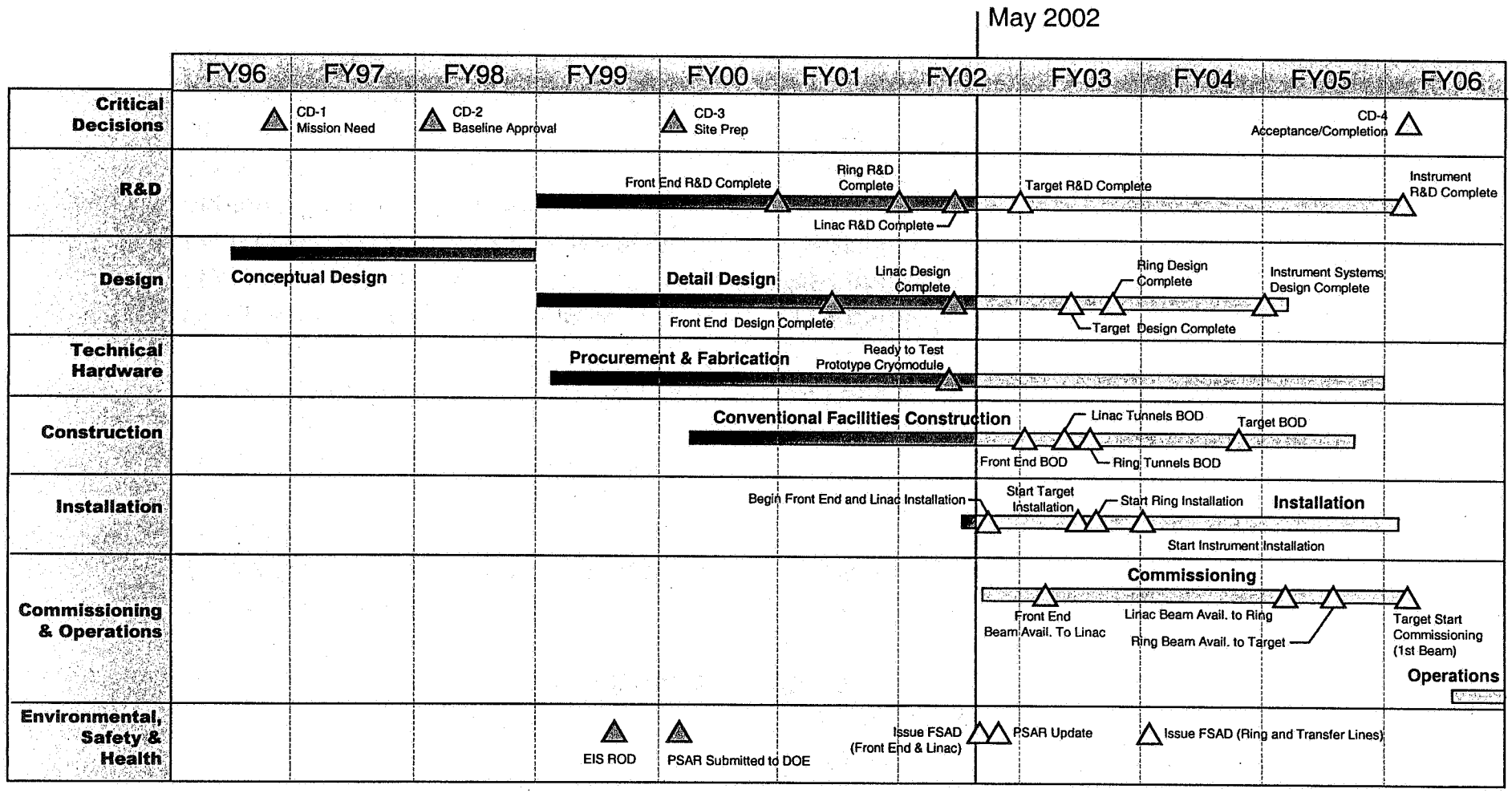
However, the committee believes that the project's early finish goal of December 2005 will likely be difficult to achieve. Considering that the planned outlay over the next 30 months is approximately $500M, with only $27M in funding available for contingency between now and the end of FY04, it is quite likely that some project activities will slip into FY05 and beyond. This will put significant pressure on the project's ability to meet the December 2005 early finish date. This in itself is not a cause for concern, given the official DOE completion milestone of June 2006. But the project needs to ensure that adequate funds are available to fully fund all activities through CD-4.

Recommendations:

None

SNS Project Schedule

May is Month 44 of 87 Month (Early-Finish) Schedule



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8. Management

Klaus Berkner, consultant; Ron Lutha, DOE/FAO; Bruce Warner, LLNL; Tom Elioff, SLAC

8.1 Findings

- **Management team is fully in place and appears to be cohesive and effective – good internal communication**
- **Good working relations with partner labs. Deliverables and staff phase-down defined**
- **Draft commissioning plan has been developed – phased operation**
- **Drafted a White Paper on performance expectations after CD-4**
- **ESH performance has been excellent**
- **Integration activities handled as part of work scope of the three divisions, appropriate for current level of project activity**

8.2 COMMENT

Active project management support (clearly defined responsibility and resources) for timely resolution of integration issues is required as project activities ramp up; responsibility for civil/technical and technical/technical interfaces should be assigned to specific individuals.

8.3 RECOMMENDATION

Assess whether the current methodology for addressing integration issues is adequate to handle the increased level of activity the project will experience between now and CD-4. If it is not, strengthen processes that address these needs and report at the next review.

Action Items

Resulting from the May 2002
Department of Energy Review of the

Spallation Neutron Source

Action	Responsibility	Due Date
1. Conduct a Semi-Annual Project Status Review	DOE/SNS	November 12-14, 2002
2. Provide to DOE a Status Report on the Target	SNS	July 31, 2002

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