Department of Energy
Review Committee Report

for the

Technical, Cost, Schedule, and
Management Review

of the

12 GeV CEBAF UPGRADE PROJECT

September 2009

EXECUTIVE SUMMARY

A Department of Energy (DOE) Office of Science (SC) status review of the Continuous Electron Beam Accelerator Facility (CEBAF) 12 GeV Upgrade project at the Thomas Jefferson National Accelerator Facility (TJNAF) in Newport News, Virginia, was conducted September 22-24, 2009, at the request of Dr. Eugene Henry, Acting Associate Director of Science for Nuclear Physics. The purpose of this review was to assess all aspects of the 12 GeV CEBAF Upgrade project—technical, cost, schedule, management, and environment, safety, and health as the project proceeds with construction under the requirements of DOE Order 413.3A. The Committee found that the project is progressing well. The project is being properly managed, but root causes of labor shortfalls experienced in FY 2009, if uncorrected, will pose a significant risk to completing the project on schedule. The Committee had a total of 15 recommendations. There were no action items.

TJNAF is currently constructing the 12 GeV Upgrade, which will upgrade the maximum electron energy of the main accelerator from 6 GeV to 12 GeV, build a new experimental area (Hall D) dedicated to the study of gluonic excitations, and upgrade capabilities in the three existing experimental halls. The 12 GeV Upgrade will allow broad advances in four key areas of nuclear physics: the understanding of quark confinement, how nuclear building blocks are made from quarks and gluons, the physics of nuclei, and tests of the Standard Model.

The 12 GeV Total Project Cost for the performance baseline is $310 million (with $70 million or 40 percent contingency on the estimate-to-complete (ETC)) and has a CD-4b date of June 2015 (with one month of schedule float on the critical path and 12 months of schedule contingency).

The overall cryomodule design is conservative, evolutionary, and based on significant experience. The new cryogenic refrigerator design is complete and based on significant experience at the Laboratory.

The early (six-month shutdown) installation of radio frequency (RF) systems and cryomodules may allow testing with beam before the full installation in the 12-month shutdown.

Several other programs, e.g., Baseline Improvement Activities, will be taking place during the shutdown competing for scarce resources and tunnel access. Installation of these projects has not been integrated into the overall installation planning.

Installation of beam transport components may require more effort than was in the baseline. The preliminary estimate provided indicated that additional temporary staffing for the new plan may result in up to a $500 K draw on contingency. Additional detailed planning may reveal further cost increases.

Excellent progress has been made on detectors. There were no major issues with Halls B and C. The Hall D project is complex, and requires a great deal of oversight and a strong management team (to assist the project manager, integrate the project, and share authority over all aspects of the Hall D project). The Committee recommended that the project identify the Hall D project management team with the highest priority.

Conventional Facilities contractor (S.B. Ballard) field staff seems well qualified and motivated to provide a quality project and to work aggressively to make up current schedule slippage. The critical path includes turnover of Hall D for equipment installation at the end of October 2010. While the S.B. Ballard approved schedule shows that Hall D will be ready for equipment on July 27, 2010, project delays moved this date to late October 2010 using nearly all the schedule contingency on this activity.

Project ESH&Q issues are being properly addressed, and ESH&Q concepts are thoroughly integrated throughout the project. Safety performance and results are above average and the project is paying attention to process details to continue to produce the performance experienced to date.

It is not yet clear whether the augmented procurement staff will be able to meet the needed rate of four procurement awards per month required to achieve the project schedule.

Major recommendations resulting from the review include:

- Conduct a bottoms-up ETC not later than the first half of FY 2010 and better refine the project skills and resources needed to avoid further risk and delays in the project baseline schedule.

- Schedule the next DOE/SC progress review of the 12 GeV project in six months.

CONTENTS

1. INTRODUCTION

The Continuous Electron Beam Accelerator Facility (CEBAF) at the Thomas Jefferson National Accelerator Facility (TJNAF) is the world-leading facility in the experimental study of hadronic matter. TJNAF is located on 162 acres in Newport News, Virginia and was constructed over the period FY 1987-1995 for a Total Project Cost (TPC) of $513 million. CEBAF began operations in FY 1995 and is currently managed by the Jefferson Science Associates (JSA). Activities are now underway to upgrade the CEBAF through the 12 GeV Upgrade project.

The scope of the project includes upgrading the electron energy capability of the main accelerator from 6 GeV to 12 GeV, constructing a new experimental area (Hall D) and associated beam-line, and expanding the capabilities of the existing halls to support the most compelling nuclear physics research. The current 6 GeV accelerator is comprised of an inter-connected pair of anti-parallel linacs, each with 20 cryomodules, with each cryomodule in turn containing eight superconducting radio frequency accelerating cavities. The 12 GeV CEBAF Upgrade project makes use of the existing CEBAF tunnel 'footprint' and infrastructure in order to optimize project costs (Figure 1-1).

The Upgrade will enable CEBAF's world-wide user community to expand its research horizons, and allows breakthrough programs to be launched in three key areas:

- The experimental verification of the existence of powerful force fields ('flux tubes') believed to be responsible for quark confinement; understanding confinement is essential for understanding the structure of nuclear matter;
- The measurement of the quark and gluon structure of the proton, the neutron, and other nuclear building blocks at the most basic quantum level; and
- New research domains in key areas already under investigation.

The project received Critical Decision (CD) 0, Approve Mission Need, in March 2004; CD-1, Approve Alternative Selection and Cost Range, in February 2006; CD-2, Approve Performance Baseline, in November 2007; and CD-3, Approve Start of Construction, in September 2008.

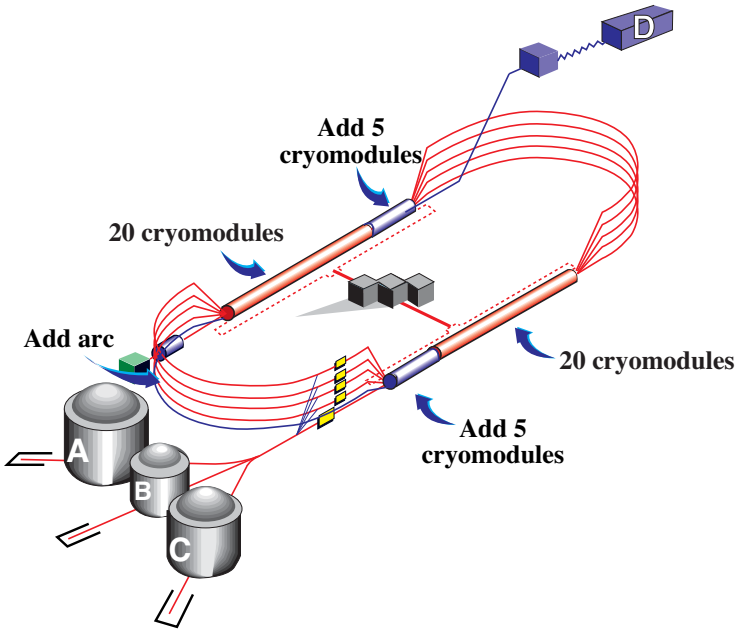

Figure 1-1. Diagram of the 12 GeV CEBAF Upgrade

In a May 14, 2009, memorandum (Appendix A), Dr. Eugene A. Henry, Acting Associate Director of the Office of Science (SC) for Nuclear Physics (NP), requested that Daniel R. Lehman, Director for the Office of Project Assessment, SC, lead an Independent Project Review to evaluate all aspects of the project, including technical, cost, schedule, management, and Environment, Safety and Health (ES&H), to assess the project as it proceeds with construction. The Review Committee (Appendix B) was chaired by Daniel R. Lehman. Members were chosen on the basis of their technical and/or project management expertise, and experience with building large scientific research facilities, as well as their independence from the project. The Committee was organized into eight subcommittees, each assigned to evaluate a particular aspect of the project corresponding to members' areas of expertise. The review was conducted on September 22-24, 2008, at TJNAF in Newport News, Virginia. The agenda (Appendix C) was developed with the cooperation of the CEBAF 12 GeV Upgrade Project Office, Department of Energy (DOE)/SC Headquarters, and DOE/Thomas Jefferson Site Office (TJSO) 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.

2. TECHNICAL SYSTEMS EVALUATION

2.1 SRF Cryomodules and Cryogenics

2.1.1 Findings

Cryomodules

There appears to be no remaining design issues or significant technical risks for the cryomodules. Based on the state of the procurements, the cryomodules should be able to be built within the given cost and schedule. The project has responded appropriately to the recommendations of all previous reviews.

The current cryomodule design, cost, and schedule is based on significant experience with the design and construction of cryomodules for the original CEBAF machine, Spallation Neutron Source (SNS), the CEBAF Free Electron Laser (FEL), the cryomodule upgrade project and the renascence cryomodule. Based on prior practice all cryomodules will be fully tested before installation in the linac.

Cavities that have had bulk chemical polishing and rough tuning are being purchased from an experienced vendor. Final cavity treatment, testing, and cryomodule construction will be carried out at TJNAF. This approach is consistent with previous TJNAF projects. The first cavities from the vendor are expected in spring 2010. If the vendor is unable to perform, TJNAF has the capacity to produce the cavities in house though this would probably impact cost and schedule.

The expected rate of cryomodule production at TJNAF is less than that of previous projects such as SNS.

The cryomodule design is more than 98 percent complete, and $11 million of $14 million of projected procurements have been or are ready to be placed.

Cryogenics

The new Central Helium Liquefier (CHL) cryogenic refrigerator design is complete and based on significant experience at TJNAF. The process design utilizes the Ganni Cycle, which promises to produce a much more efficient system.

The bids for the CHL 4.5 K coldbox have been received and the order will be placed as soon as final DOE approval is given. The cryogenic system reuses much existing equipment and is functionally identical to the existing CEBAF system. The CHL cryogenic refrigeration system is expected to be installed and commissioned by mid-2012.

The Hall D refrigeration will be provided by moving an existing refrigerator. This system is expected to be in place by early 2012.

The commissioning schedule of the CHL is independent of the cryomodule installation and is currently expected to be finished before the new cryomodules need it.

TJNAF has developed a detailed Quality Assurance (QA) plan that involves regular visits to the refrigerator vendor to monitor progress and review testing.

2.2.2 Comments

Cryomodules

The overall cryomodule design is conservative, evolutionary, and based on significant experience. There are a number of improvements in this design including the use of a space frame and the presence of fewer seals that have come from experience with the original CEBAF cryomodules.

Issues that arose during the development process including higher-order mode coupler performance, tuner reliability, and beam breakup have been adequately addressed by redesign or by returning to a previously working design. All of these changes have been tested.

While all design features have been tested and verified under various operating conditions, a full-scale prototype incorporating all the design features has yet to be tested. The project is attempting to test cryomodules using the final design individually by March 2011 and install some in the linac during the planned six-month shutdown (May–October 2011). It is critical that these be fully operated including Radio Frequency (RF) and beam before the FY 2012 12-month shutdown. This is an important final check of cryomodule performance**.**

TJNAF appears to have sufficient staffing to carry out the cryomodule assembly and testing.

Cryogenics

Construction of the new CHL building is well underway and should be complete in time to receive the new CHL components.

The use of the Ganni cycle and TJNAF's development of their own warm compressor skids incorporating previous experience should result in an overall, more efficient and reliable system.

Staffing appears to be sufficient for this effort. TJNAF should take care that other activities do not draw staff away from this project.

Placing the order for the 4.5 K cold box should be done as soon as possible. This will significantly decrease the amount of risk.

2.1.3 Recommendations

1. Operate the first cryomodules with RF in the linac during the six month down.

2. Develop a detailed plan for accelerating beam with at least one new cryomodule before the scheduled 12-month shutdown by the next review.

2.2 Accelerator and Accelerator Physics

2.2.1 Findings

This review took place 14 months after the July 2008 DOE/SC (CD-3) review. CD-3 was received in September 2008, and since that time, the project has moved into the procurement phase. Preliminary Engineering and Design (PED) work on these work breakdown structure (WBS) elements is greater than 97 percent complete, and is expected to be completed before the end of the calendar year.

Accelerator Physics

Accelerator Physics work over the last year has focused on further scrubbing of the physics design. No change in requirements or specifications for hardware has resulted from this

work. The model of the machine including the high-energy arcs and resulting synchrotron radiation is well managed.

One area of investigation that occurred in the last year was the development and refinement of Beam Break-Up SRF cavity specifications. Previously there had not been a longitudinal specification due to M_{56} being zero in the CEBAF arcs. However, this is not the case in the higher energy arcs of the upgrade. The work resulted in specifications (both longitudinal and revised transverse) that are met by the cavity design.

Accelerator Systems

This section deals with WBS elements 1.3.2 (Power Systems—including the RF and magnet power systems), 1.3.4 (Beam Transport, which is a major set of systems including the injection line, upgrading of all arcs, installation of a tenth arc, modifications to the transport lines to Halls A, B, and C, and construction of the transport line to Hall D), and 1.3.5 (Extraction systems, primarily the RF separators that allow interleaved bunches to be delivered to Halls A, B, C, and D). Note that although this section is called "Accelerator", it does not include three WBS elements that are included in the Accelerator WBS as defined by the project. These are: 1.3.1, (Cryomodules), 1.3.3 (Cryogenics), and 1.3.6 (Controls and Instrumentation), and are covered elsewhere in this report. Overall, the Committee finds that the project is making good progress after one year into construction.

Cost

Table 2-1 shows the base cost totals for CD-3. These are the same numbers shown at the July 2008 DOE/SC review, but scaled to FY 2009 dollars assuming 3.19 percent escalation.

Table 2-1. WBS for Accelerator Systems

WBS	Title	Base Cost at CD-3 in FY09 $K	Base cost now in FY09 $K	Difference $K
1.3.2	Power Systems	17,482	17,161	-321
1.3.4	Beam Transport	13,479	12,976	-503
1.3.5	Extraction	1,166	1,156	-10

These numbers reflect an overall decrease from the CD-3 numbers, including the following changes:

- In WBS 1.3.2, the reduction is due to the klystron procurement coming in lower.
- In WBS 1.3.4, the reduction is due to the 4-meter dipole procurement coming in lower. It should be noted that the numbers shown in Table 2.1 are from the June 30 report. Since that time additional procurements in 1.3.4 have also come in lower than budgeted, namely a quadrupole procurement that came in $1.1 million below budget.

Thus at the time of this review, the reduction in this budget area due to savings in procurements is about $2 million.

Schedule

Scheduling issues for these WBS elements continue to focus on two accelerator shutdowns; one is a six-month duration beginning in May 2011 and a 12-month shutdown beginning in May 2012. Between these two shutdowns, CEBAF will run the 6 GeV program. The six-month shutdown is planned to not affect subsequent 6 GeV operations. Installation of above ground systems can be done before the first shutdown and between the two shutdowns. Following the 12-month shutdown the accelerator complex will begin commissioning with beam.

Although the work in these shutdowns is very schedule constrained, this does not jeopardize the project's high-level schedule since CD-4a is in 2014.

Power Systems

This WBS includes all power supplies for magnets, and the RF power systems (including low-level RF (LLRF), RF high voltage power supplies, klystrons, etc.). The RF power systems need to provide higher power to the 12 GeV upgrade cryomodules than what is presently used at CEBAF. Magnet power supplies are similar to what is used in the present CEBAF machine; supplies and their associated control cards are being reused and refurbished where appropriate. New power supplies and their controls are based on existing designs and commercially available equipment.

Design and documentation is 97 percent complete, and the remaining work will be done by the end of 2009. There were no changes in systems requirements since the July 2008 DOE/SC review.

The klystron contract was awarded ($3.5 million; 9.1 percent under budget). The first article is expected in April 2010; production deliveries start in FY 2011. The high power RF systems consist of 80 klystrons powered by ten high voltage supplies (bid evaluations underway) and 80 associated waveguide systems. Eighty new LLRF systems use modern digital architecture designed at TJNAF and much will be build-to-print by outside vendors. Overall, $12.1 million is budgeted for RF construction.

Power Systems construction costs are budgeted at $17.2 million; $5.1 for magnet power supplies. Magnet power supplies consist of 15 large supplies consisting of eight types ranging from 35 kilowatts (kW) to 1.2 MW (procurement released for bids) and 250, 20A/75V, bipolar supplies (procurement started).

The schedule calls for magnet cabling to begin during the six-month shutdown; magnet power supply installation in new building additions will begin as delivered. RF system installations will begin in existing klystron gallery as delivered. Two-shift installation work is planned during the outages.

Beam Transport

There has been no change in requirements since CD-3. The design and documentation are 97 percent complete and PED work is on schedule.

In addition to the $503 K shown as of end of June, there is an additional savings from a quadrupole procurement.

Work done during the six-month shutdown is planned to minimize risk in turning on for the following six-month run.

Redesign of the spreader/combiner lattice required some additional PED effort.

Magnet designs are still based on the baseline proposal and existing TJNAF magnets, which are well developed and many have been tested.

Magnet procurements are on or ahead of schedule with $1,627 K in savings on both beam transport and extraction magnet contracts now totaling $3,400 K.

A detailed resource-loaded installation schedule is being developed for both the six- and twelve-month shutdowns. This work revealed a potential $500 K shortfall in resource funding that has not yet been accounted for in the baseline.

The twelve-month shutdown plan requires two shifts for many activities and has little schedule contingency. Additional unplanned work would require overtime or a third shift and hiring additional temporary workers, which could result in poor quality and additional delays.

Extraction

The extraction system provides all equipment necessary to upgrade extraction hardware for 2.2 GeV per pass. The extraction WBS consists of RF cavities, septum magnets, and dipole magnets. The project will add two new separator cavities, seven 1-meter dipole magnets, and two 1-meter septum magnets. In addition, one Lambertson magnet will be modified to meet the specifications for the 12 GeV beam delivery to Hall D. Activities in this WBS are low risk since the vast majority of the work is replication of existing designs. Extraction at higher energy is accomplished by increasing the number of devices, not by pushing their performance envelope. This is a good approach that uses successful low cost technology and minimum PED effort.

The design and documentation are complete, there have been no changes in systems requirements since the July 2008 DOE/SC review. Of the $1.2 million budgeted in this WBS, 18 percent is obligated, and 50 percent will be obligated by the end of Calendar Year 2009.

It was noted that at the completion of the project, a three-way, beam splitting system will be in place, but it will not be possible to deliver the highest energy beam to three halls simultaneously. However, there is an off-project effort, funded by the American Recovery Reinvestment Act (ARRA) to develop an 11 GeV separation scheme that would additionally allow either:

- A 12 GeV beam to Hall D and 11 GeV beam to two of the three existing halls, or
- An 11 GeV beam to Halls A, B, and C.

Accelerator Commissioning

A detailed commissioning plan was presented at the review.

2.2.2 Comments

Accelerator Physics

The Accelerator Physics work done since the July 2008 DOE/SC review reinforces the validity of the design work previously done. A better understanding of the tolerances and tuning ranges has been obtained. The project continues to keep open the recommendation from an earlier review that read, “Implement improvements to the existing 6 GeV machine which will also be helpful in the commissioning of the 12 GeV machine”. The Committee encouraged the project to continue to do so until the 6 GeV machine is turned off.

Accelerator Systems

The costs of the procurements (already awarded) have come in under budget. At the time of this review, a savings of $2 million has been realized in these WBS elements. This is an encouraging sign as some of these procurements were considered moderate cost risks at the time of the July 2008 review. The current cost concern is the effort required for the removal, modification, and reinstallation of components, as well as the installation of the new components. The preliminary estimate provided indicated that an additional temporary staffing for the new plan may result in up to a $500 K draw on contingency. If validated, the estimated increases need to be input into the Project Baseline Cost Plan.

Schedule

There is schedule contingency for these systems relative to CD-4. Sufficient time is in the schedule to achieve the CD-4 milestones after the long shutdown concludes.

The twelve-month shutdown includes a two-month Accelerator Readiness Review (ARR) period that pinches the installation to ten months. The Committee questions if the ARR work could be done in parallel with the completion of installation.

The Committee does have concerns with respect to the availability of skilled staff needed during the shutdown activities. The effort profiles have large steps leading into these shutdowns. Furthermore, several other programs (e.g., Baseline Improvement Activities) will be taking place during the shutdown competing for scarce resources and tunnel access. Installation activities of these projects have not been integrated into the overall installation planning.

The Committee realized that the twelve-month shutdown planning is in flux; however, the Committee judged that the duration of the shutdown is not adequate to deal with the work, has high-peak resource loading and makes it difficult to deal with unexpected rework. These concerns lead to the recommendation presented in Section 2.2.3.

Power Systems

Very good progress has been made toward completing designs, and moving into procurement for major systems. The klystron contract was awarded to an experienced vendor in this type of tube (vendor of the smaller, existing TJNAF tube).

Eight types of large magnet supplies may not be optimum for sparing and overall cost (e.g., considering Non-Recurring Expenses).

For LLRF system production, seek out assembly shops with electrical Nationally Recognized Testing Laboratory (e.g., Underwriters Laboratory) experience to save cost and time of certifying equipment later.

Consider the purchase of spares during procurements; prices may be lower and parts will be available during testing/commissioning.

Installation plans show a large increase in resource demand during the six- and twelve-month shutdowns. This increase is seen in all project elements and may lead to resource loading issues. Detailed planning is not yet complete.

The early (six-month shutdown) installation of RF systems and cryomodules may allow testing of the complete RF system with beam before the full installation in the subsequent shutdown.

Beam Transport

There has been excellent progress on magnet design and specification. Work was done to optimize the spreader/combiner lattice, which required redesign and relocation of some magnets. There was a review of this lattice in June with no major issues. The revisions required additional engineering effort and $386 K draw from contingency. It did not affect hardware procurement, cost, or schedule. The vacuum component and stand designs are similar to existing designs and are on schedule.

Orders have been placed for the arc quadrupoles, arc dipoles, the spreader/combiner septa magnets and dipoles and the coils for the Hall A, B, and C, three-way Lambertson magnet. The project has benefitted from the economic downturn. In additional, bid requests for transport and extraction magnets have been combined to encourage competition/lower costs. Magnet contracts have been awarded for $3.4 million so far with a savings of $1.6 million from the baseline estimate that has been returned to contingency.

Component 'installation' includes removal of a significant number of components from the tunnel that must be reworked, checked out (including magnet measurement), and then re-installed along with the installation of many new components. A detailed installation schedule with resource profile was presented for both the six-month and twelve-month shutdown periods. This new profile was prepared for an Accelerator Interim Installation Review that was held in July 2009. It takes advantage of ARRA funding to pull some of the work forward into the six-month shutdown. This could allow some testing of components in the tunnel before the final installation (twelve-month) period providing an opportunity to correct any problems that may surface. The new installation plan revealed that there was an underestimate of effort that results in increased technical personnel staffing needs and little schedule contingency in the twelve-month period. The preliminary estimate provided indicated that additional temporary staffing for the new plan may result in up to a $500 K draw on contingency. If validated, the estimated increases need to be input into the Project Baseline Cost Plan.

The new installation plan includes a second shift for some removal, rework, and installation functions staffed with the hiring of additional temporary technicians. Additional unplanned work in the present time period could result in a third shift or hiring more temporary workers increasing the likelihood of poor quality work and additional delays. The actual time for component installation in the twelve-month period appears to be pinched by a ten-week ARR period. This period should be compressed or modified to allow installation activities to continue near the end of the shutdown. Also extending the shutdown should be considered as noted above. Reducing the overall installation staffing levels to increase the number of full-time equivalent (FTE) accelerator technicians in the working groups should be a goal.

Extraction

The room temperature RF Cavities for the extraction systems are also based on existing designs that are well developed and stable. Very good progress has been made with design work done and most major procurements either awarded or underway.

Accelerator Commissioning

The commissioning activities are adequately planned for this stage of the project. The CD-4a criteria are reasonable to demonstrate the end of the project phase of these (1.3.X) WBS elements. There are additional requirements from the accelerator that will be required for CD-4b that will need to be achieved by that time (e.g., 2.2 GeV beam is required for CD-4a, 6 GeV and 10 GeV beams are needed to commission the halls at CD-4b).

Spares

The strategy for spares does not appear to be consistent across the project. Further thought should be given to acquiring all critical spares at the time of initial procurement. In particular this applies to klystrons and power supplies; the Committee judged that further spare procurements in these areas would benefit the project and subsequent operation. The strategies for obtaining these spares during the initial procurement phase should be addressed.

2.2.3 Recommendations

3. Present a plan, at the next review, for providing critical spares.

4. Develop a detailed plan for accelerating beam with the first cryomodules in the linac, in 2011; present at the next review.

5. Present a plan, at the next review, for a lengthened twelve-month shutdown. This plan should optimize the use of effort resources, tunnel access, etc.

2.3 Control Systems and Instrumentation

2.3.1 Findings

The Accelerator Instrumentation, Controls and Safety Systems (IC&S, WBS 1.3.6) includes the Personnel Safety System (PSS), Machine Protection System (MPS), Beam Envelope Limit System, electron beam diagnostic devices, and controls and monitoring of vacuum devices, beam dumps, and magnet power supplies. In general, control systems and devices are duplicates of existing, proven systems.

The remaining open-design issues have been finalized since the July 2008 DOE/SC review. As a result of finalizing the Machine Protection System (MPS) design there was a scope increase of $16 K (CR09-015) due to the decision to use photomultiplier tubes rather than ion chambers for beam loss monitoring in the Hall D extraction line. In addition, an external review of the final PSS was recently held. The PED is now 100 percent complete.

The PSS final design review resulted in a recommendation to reconsider the labor profile for PSS activities. In particular, the recommendation was to 'pull forward' work currently scheduled for FY 2012—into FY 2010, if possible. This possibility is being explored.

The 12 GeV project continues to benefit from 6 GeV operations—in areas such as mitigating parts obsolescence, modernizing high-level applications, and maintaining confidence in cost estimates.

2.3.2 Comments

The IC&S labor profile has a substantial peak in the middle of FY 2012. This is not an issue in and of itself, but as in the case of the PSS activities, it does coincide with project-wide demand for scarce resources.

2.3.3 Recommendations

None.

2.4 Detector

Detector and beam line upgrades will be constructed in the three existing experimental halls. In addition, a new photon beamline and new detector will be constructed for the new experimental hall, Hall D. New superconducting magnets will be procured for Halls B and C.

2.4.1 Findings

Detector Systems - General

PED is nearly complete (99 percent). Safety, installation, and maintenance issues are addressed by design.

FY 2009-FY 2010 procurements are proceeding well.

A new Associate Project Manager has recently joined the project, addressing the only detector recommendation of the July 2008 DOE/SC review.

Hall A (WBS 1.4.1)

Hall A will house an existing pair of High Resolution Spectrometers. Beam-line instrumentation will be upgraded to measure polarization and energy up to 11 GeV. The Hall A upgrade is relatively small and low risk. All PED is complete.

Hall B (WBS 1.4.2)

The elements of the CEBAF Large Accelerator Spectrometer (CLAS) 12 detector include the Electron Calorimeter (EC), Pre-Shower Calorimeter, Central Time-of-Flight, Forward Time-of-Flight (FTOF1a, FTOF1b, FTOF2), Forward Silicon Vertex Tracker, Barrel Silicon Vertex Tracker, Drift Chambers, Low Threshold Cherenkov Counter (LTCC), High Threshold Cherenkov Counter, Superconducting Toroid, and Superconducting Solenoid. All of these detector elements are new, except for the EC, LTCC, FTOF1a, and FTOF2, which will be reused from the CLAS detector. Each detector element is managed by one TJNAF staff member and one university collaborator.

Two moderate risk items have been identified: the Silicon Vertex Tracker (SVT) and the superconducting magnets. The SVT utilizes technology new to TJNAF. The magnets are considered moderate risk due to possible high technical and cost impact, despite low likelihood.

The diameter of the central hub was changed following a technical review and a Change Request was processed in 2009. The superconducting torus magnet contract was awarded to Wang NMR slightly above the allocated budget, but well within the contingency. TJNAF conducted a fact finding review and identified measures to strengthen quality assurance/quality control (QA/QC) and design capabilities of the successful vendor. TJNAF hired a superconducting magnet engineer to provide strong support to the Hall B superconducting magnet procurement, as recommended.

CLAS12 research and development (R&D) and PED have been completed (except for the solenoid). In addition, all detector elements have been prototyped. FY 2009 major procurements have been completed (except for the solenoid), and some FY 2010 procurements are ahead of schedule. Detailed resource-loaded schedules for CLAS removal and CLAS12 installation were

developed and reviewed. Work planning documents exist for installation and maintenance. All detector elements will be tested prior to installation.

In the last year, TJNAF developed in-house SVT expertise and infrastructure and established a collaboration with Moscow State University for SVT construction.

The Hall B cost and schedule have remained consistent over the past year. The cost has increased by approximately $700 K due to the actual cost of the torus magnet contract. The installation schedule has been advanced by approximately three months, providing an overall contingency of approximately six months in the Hall B schedule. The installation schedule assumes only one shift per day, so that multiple shifts can be employed if a detector element falls behind schedule.

The CLAS12 collaboration is large and international, and development of the Memorandum of Understanding is progressing well. Approximately 60 percent of the technical staff was involved in the original CLAS construction.

All recommendations from past DOE and TJNAF convened reviews have been closed except for one: “Determine size and location of an outside laydown area to accommodate items removed from the hall during CLAS ‘demolition’.”

Hall C (WBS 1.4.3)

The Hall C upgrade includes a new Super High Momentum Spectrometer (SHMS) requiring five superconducting magnets and a substantial support structure and shield house. The magnets are the only identified moderate risk subsystem, due to possible high technical and cost impact, despite low likelihood.

Design of the SHMS superconducting magnets is complete. The Horizontal Bend Magnet (HB) coil was demonstrated via a trial winding and testing at Michigan State University. All magnet bids have been received. All magnets were competitively bid for firm fixed price contracts except HB. The contract for the Q1 magnet has been awarded. The bids for the other magnets are under evaluation.

SHMS PED is 98 percent complete. The small amount of remaining PED, principally SHMS infrastructure, requires completion of contractor final designs of superconducting magnets in order to set certain tolerances and define interconnections. The reference design for

the support structure and shield house is complete, and the Request for Proposal for fabrications drawings and construction support are in progress.

Hall D (WBS 1.5)

The Hall D detector project has a scope that includes a tagged photon beam, solenoid magnet, detectors and associated electronics, computing, and infrastructure. Beneficial occupancy for the new hall is scheduled for first quarter FY 2011. The Hall D detector project includes the critical path for the whole 12 GeV CEBAF Upgrade.

The Hall D detector project has increased in cost by $1.68 million over the last year. The increase is due to the addition of magnet controls to the project, the hiring of a work coordinator, and additional labor for procurement oversight.

The PED is 98 percent complete. Outstanding PED issues include completion of Application Specific Integrated Circuit tests for the Central and Forward Drift Chamber, final characterization of Silicon Photomultipliers (SiPM) for the Barrel Calorimeter (BCAL), and completion of some fabrication drawings.

New problems with the existing solenoid have been identified. Coil repairs are to be completed in October 2009, with work on the braces for Coil 2 continuing into FY 2010. Testing of all coils is planned for February-August 2010.

Detector component orders have started, and contracts for detector construction are being prepared. The contract for the BCAL module construction has been awarded to the University of Regina, Canada.

BCAL fabrication is on the project's critical path. The production schedule has slipped two months in the last twelve months, and there is an indication that there will be an additional one-month slip in the near future.

The BCAL has an important design choice to make in its readout technology. The group plans to complete the technology choice by January 2010. The favored technology is a SiPM, which is a promising technology that has not been previously used in a large-scale detector. The fallback solution, a fine mesh photomultiplier (PMT) requires a more challenging mechanical solution that has been fully developed over the past twelve months. The costs of both solutions are comparable.

Hall D detector construction relies on a significant amount of contributed university labor. The need for university-contributed labor rises to approximately 30 FTEs in FY 2011- FY 2013.

2.4.2 Comments

Detector Systems - General

Excellent progress has been made on the detector projects. There have been no major changes to the cost and schedule baseline. The detector projects are positioned to be completed within the established cost and schedule.

A remaining design issue that could impact detector construction activities and planned procurements is the selection of the Hall D BCAL light sensors. In addition, the Laboratory should consider the risks associated with refurbishment of the Hall D solenoid as it is possible that an unforeseen problem will lead to a failure immediately or soon after beginning of Hall D operations.

The detector projects have responded appropriately to all recommendations from prior DOE/SC reviews.

Hall B (WBS 1.4.2)

TJNAF should continue to work closely with superconducting magnet vendors and to check QA/QC during fabrication.

TJNAF should continue to develop local expertise in SVT to complement the silicon expertise at external CLAS12 institutions.

A full chain test from prototype silicon sensors through prototype readout electronics to data acquisition should be performed prior to procurement of production sensors and electronics.

Hall C (WBS 1.4.3)

Competitive bidding of the HB magnet in industry prior to sole sourcing should be considered.

If delay of completion of SHMS infrastructure PED is an issue, then an analysis of tolerances could be performed in order to decouple the infrastructure design from uncertainties in the final magnet dimensions. However, some related connections such as cryogenics would still have to wait for final vendor designs.

Hall D (WBS 1.5)

The Hall D project is complex, and the amount of oversight needed is large. The project should be led by a coherent management team consisting of a Hall D Project Manager, Hall Leader (or Deputy Project Manager), Chief Mechanical Engineer, and Chief Electronics Engineer. The team will assist the project manager, integrate the project, and have authority over all aspects of the Hall D detector project.

A substantial risk of solenoid failure will exist even after significant refurbishment. The risk arises in part because not all defects can be repaired. For example, because of a short between the conductor and a supporting strip, a new short would create a shorted turn that could burn out and seriously damage the solenoid and nearby equipment. Risk also arises because the solenoid will be operated at higher currents and forces and in a different environment than its past applications. For instance, refurbishment work and analysis has revealed that the axial force is excessive, resulting in the need to rearrange the modules and possibly to modify the cold mass supports. The winding support for Module 2 appears to be inadequate for planned operation at 50 percent higher forces than previously, requiring further major modification. Finally, it is possible that an unforeseen problem will lead to a failure immediately or soon after beginning of Hall D operations.

Options for mitigating the risk of solenoid failure include, but are not limited to: abandon the old solenoid and build a replacement; continue refurbishment of the old solenoid and build a replacement, to reduce possible down time in case of future failure or to install at a convenient time; or keep existing refurbishment plan and accelerate testing to gain assurance in reliability.

Using the fine mesh PMT for the BCAL photo-readout instead of the SiPM would reduce the technological burden on a project that already has a challenging schedule, has experienced recent schedule slippage, and is on the critical path.

The technology choice for the BCAL photo-readout was originally scheduled to be completed by the summer of 2009, but is now scheduled for January 2010. It is important that

this technology choice be made by that date. The project should not allow this decision to be further delayed.

Timely strengthening of the GlueX collaboration is critical to the success of the Hall D project and the subsequent scientific program.

2.4.3 Recommendations

6. Revise the Hall D management organization to form a dedicated Hall D Project Management team consisting of the Hall D Project Manager, Hall Leader (or Deputy Project Manager), Chief Mechanical Engineer, and Chief Electronics Engineer. Implement with highest priority.

7. Analyze the risks associated with the existing solenoid for Hall D and with its refurbishment. Analyze the benefits, cost, and schedule impact of a new replacement solenoid. Develop a plan by end of 2009 for deciding whether to repair or replace the solenoid.

8. Consider changing the primary GlueX (Hall D) BCAL readout technology from SiPMs to fine mesh PMTs as a way to significantly reduce technical and schedule risk. Complete selection of photo-readout technology choice by January 2010.

9. Review and update the Hall D labor integral, mix, and profile, especially as it applies to the university labor. Analyze the impact on the project of a potential shortfall in university-contributed labor, and develop a contingency plan. Report at the next review.

3. CONVENTIONAL FACILITIES

Conventional Facilities (CF) construction (also called civil construction) represents only 15.5 percent (currently estimated at $28.1 million (FY 2009, direct)) of the total work of the CEBAF 12 GeV Upgrade project. This work is organized into three WBS elements; 1.6.1 Accelerator, 1.6.2 Central Helium Liquefier (CHL), and 1.6.3 Hall D.

The 1.6.1 Accelerator scope provides for modifications to existing Accelerator Service buildings and utility distribution systems to support the Accelerator operations at 12 GeV. The scope of work includes 1,800-square-foot (sf) additions to the two tunnel access buildings (north and south), upgrades to the accelerator utilities (power and low-conductivity water (LCW)), a beam switchyard services building addition, tunnel air conditioning, and revisions to the electrical distribution at the north and south linac services buildings.

The 1.6.2 CHL scope is modifications to the existing CHL facilities to provide additional space and utilities to support the CHL plant at double the capacity. The building scope includes an approximate 4,800 sf steel frame, metal clad addition to the CHL building complex fit with basic utilities. All cryogenic equipment is to be provided as part of the 1.3 Accelerator Systems portion of the project. The CHL utility upgrades include the industrial cooling water, two new five MVA substations, and new cooling towers.

The 1.6.3 Hall D scope is the construction of new facilities and distribution systems to support the operations of a new experimental hall to accomplish the GlueX experimental program. The scope includes the construction of approximately 28,000 sf of new facilities and the extension of an existing below grade tunnel stub. The facilities include an experimental hall (Hall D) with a photon beam dump, an associated counting house, a small cryo plant, a service building tagger, an electron beam dump, and necessary radiation shielding berms. Also included in the Hall D Area is a magnet area with associated site utilities and roads for a previously undeveloped section of the CEBAF site.

3.1 Findings

Approximately 60 percent of all CF construction is currently under contract, including all three phases of Hall D and the building portion of the CHL construction. ARRA funding allowed the award of Hall D Phases 2 and 3; however, the contractor, S.B. Ballard, requested that the notice to proceed (NTP) be issued upon request and not later than the planned date of

January 2010 as this could cause acceleration impacts. The project plans to provide an NTP for Phase 2 in January 2010 at the latest. ARRA funds are also available for additional out year construction awards.

Approximately $9 million of contracts have yet to be awarded including the CHL utilities and the entire Accelerator CF construction scope. The project plans to bid these contracts throughout FY 2010, 2011, and 2012.

Hall D Complex construction was awarded to S.B. Ballard for a fixed price contract of $14.6 million and a NTP for Phase 1 in February 2009. S.B. Ballard's failure to submit an acceptable safety plan, as well as disagreement on the dewatering and treatment scope of work, have led to a late start for this work. The Hall D complex construction is currently about five percent complete. Hall D construction is currently 85 calendar days behind the contract schedule primarily due to the late start. S.B. Ballard has been working some weekends to make up lost days.

S.B. Ballard submitted a Request for Equitable Adjustment (REA) for the groundwater dewatering and treatment system. The REA proposal was just received in the last few days and is currently being evaluated by project team. The project had hired a dewatering expert to help evaluate the contractor's proposed dewatering methods. S.B. Ballard has elected to proceed with the groundwater dewatering work. The treatment system for the Hall D building is now installed and functioning well.

A firm-fixed-price contract was awarded for the CHL building construction to Ritchie Curbow for a price of $1.6 million and a NTP in January 2009. The construction is currently 40 percent complete and on schedule.

The staffing for the construction management activities is provided from a combination of TJNAF staff (dedicated and matrixed 12 GeV project staff, facilities, and ESH&Q), the project architect for Hall D, the project architect for the CHL building, and from an indefinite delivery task order contract with an agent construction management company (Alpha). TJNAF staff requirements peak at five FTEs in FY 2010 and FY 2011. A full-time construction safety representative was assigned to the CF construction from TJNAF Facilities Management Group staff.

TJNAF does not have a formalized process for transfer of management authority for CF to other 12 GeV project organizations or other TJNAF organizations upon substantial completion. This has been accomplished in the past through involvement of the staff in commissioning activities, with no definitive process for turnover.

The risk analysis for CF construction follows a project-wide model for identifying the level of risk based on likelihood and severity of occurrence. The CF scope holds one moderate risk for the Hall D contractor's REA on the groundwater issue. A mitigation plan has been developed and is being implemented for this risk.

3.2 Comments

The CF team is highly motivated, interacts well with other project elements and has substantial experience in the type of design and construction required by the CF scope. The project team appears capable of meeting the baseline scope, and cost and schedule goals.

The project is competing with other civil construction work on site for technical support from the TJNAF facilities and ESH&Q organizations. This could potentially delay CF construction, especially the CHL and Accelerator subprojects, as this staff is needed for technical support, inspection, and Subcontracting Officer Technical Representative (SOTR) responsibilities. Commitment of these important resources should occur as soon as possible.

Staffing plans for the construction management efforts seems reasonable at this point. Staffing levels should be evaluated as each additional significant contract is awarded and as labor intensive issues arise.

S.B. Ballard field staff seems well qualified and motivated to provide a quality project and to work aggressively to make up for the current schedule slippage. S.B. Ballard field staff has independently extended scope of the floor finish mock up to include tunnel walls, ceiling, and waterproofing. S.B. Ballard field staff commented that the "contract drawings are awfully good".

Critical path includes turnover of Hall D for equipment installation by the end of October 2010. While S.B. Ballard's approved schedule shows Hall D ready for equipment July 27, 2010, project delays have moved this date to late October 2010 using nearly all the schedule contingency on this work. The liquidated damages are specified at $2,000/day for the Hall D Complex Phase 1 construction contract.

The project should hold an appropriate level of Management Reserve/Contingency for the REA change until resolved with S.B. Ballard.

S.B. Ballard has submitted, and the project has approved, a detailed (approximately1,200 activities) schedule for the Hall D construction. The summary Budget Cost of Work Scheduled (BCWS) has been incorporated into the 12 GeV project schedule. The CF teams should confirm that the pertinent ties to the accelerator and physics schedules (i.e., timing of accelerator and cryogenic equipment and submittals to validate anchor bolt placement, etc.) are identified and maintained as the construction proceeds.

3.3 Recommendations

10. Since 12 GeV relies heavily on facilities staff for Accelerator and CHL utilities construction work from FY 2010 through FY 2012, commitment for these resources should be secured by an agreement with senior TJNAF management no later than January 2010.

11. By January 2010, prepare a plan for transition of management authority for conventional facilities to other 12 GeV project organizations or other TJNAF organizations.

4. ENVIRONMENT, SAFETY and HEALTH

4.1 Findings

The Laboratory's Environment, Safety, Health and Quality Programs (ESH&Q) are being implemented for the construction project.

Evidence of the Laboratory's Integrated Safety Management (ISM) System core function practices are found for the construction project.

4.2 Comments

National Environmental Policy Act

Compliance with National Environmental Policy Act for the project is being met. For this status review, it has been affirmed that the scope of the project scope has not changed and that assessment is still valid. The document is DOE/EA-1534, Environmental Assessment Proposed Upgrade and Operation of the CEBAF and FEL Accelerators and Construction and Use of Buildings Associated with the 2005 Ten-Year Site Plan at the Thomas Jefferson National Accelerator Facility Newport News, Virginia dated January 2007.

Project Construction Safety and Health Plan

The project construction is performed following the 12 GeV CEBAF Upgrade Construction Safety and Health Plan (CSHP) dated June 23, 2008. The CSHP sets forth the responsibilities, guidelines, rules, policy, and regulations for all workers involved in construction, installation, and acceptance testing associated with the project. The CSHP is presented in a manner that facilitates the implementation of the Laboratory’s existing safety and health programs, and if necessary is supplemented with project specific plans that address unique issues associated with the project.

The12 GeV Upgrade Hazard Assessment (HA) and associated process has been incorporated into the CSHP. Each phase of construction consists of multiple tasks, each with its own potential for exposure based on a Hazard Profile established within the HA. In addition, a task-based exposure assessment strategy has been implemented to characterize occupational

exposures to the Laboratory's employees and subcontractors working on the project. No new hazards or exposures were identified during the incorporation of the HA into the CSHP.

Integrated Safety and Environmental Management Systems

The Laboratory's ISM Principles and Core Functions are found in the TJNAF ISM System Program Description Revision 11 (March 2008). The ISM program description states that it is the intent of the Laboratory to provide a formal, organized process to plan, perform, assess, and improve the safe conduct of work. Effective implementation of ISM will result in the complete integration of safety, health, and environmental protection elements into all management and work practices. The project states that the principles of ISM are incorporated into its planning and execution processes. A primary objective of the project is to protect the workers, public, and environment.

The following are examples of the project following ISM:

- Industrial Safety and RadCon subject matter experts reviewed and provided input to the Architect/Engineering firm at earliest design stages.
- The project safety manager was on selection board for general contractor and assured the incorporation of safety performance in selection process.
- Safety requirements were incorporated into the master specification and the general contractors safety plan was reviewed and approved by ESH&Q.

Lessons Learned

Lessons Learned from the Laboratory, as well as the project, are being applied to the project and the process is described in the Operating Experience Feedback and Lessons Learned Program (November 2008). The program provides the collection and distribution steps by which experiences of both the Laboratory, including the project, and external organizations are disseminated. The goal of the program is to share and use experienced based information to promote the recurrence of desired activities and to prevent the recurrence of undesired activities.

Quality Assurance

The Laboratory states that project management will ensure that all relevant objectives identified within the Supplemental QA Plan for the 12 GeV CEBAF Upgrade are integrated into

all construction and deployment activities where appropriate. This will be accomplished through the same management systems that support the TJNAF ISM System Program.

In addition, TJNAF has developed a Contractor Assurance System (CAS) so that the Laboratory achieves reliable, safe, and secure performance and is compliant with regulatory and contractual requirements. Work is measured against performance metrics and using self-assessments, independent assessments, internal audits/peer reviews and work observations. The CAS establishes the framework by which the project will address how incidents are reported, worker feedback is managed, tracking and closure of corrective actions, and the mechanisms for dissemination of lessons learned.

Responses to Previous Review Recommendations

The July 2008 DOE/SC review recommended filling two personnel requisitions, one for a construction safety representative and the other for a project safety manager. The project agreed with the recommendation and has filled both positions with experienced and competent professionals.

Other Observations

It is evident from conversations and walkthroughs that the project managers and in-field safety representatives are engaged in ES&H, as well as integrated safety management practices. During the closeout presentation, it was noted that the Laboratory and project's ES&H performance is exemplary. At the same time, it is important to note that the project is vigilant and is paying attention to process details to continue to produce the performance experienced to date. An example is the general contractor on the Hall D site mandates reflective vest as part of the required personal protective equipment to be donned to enter the site. The use of vests is more stringent than the Laboratory requirements and is being considered to be added to the requirements.

4.3 Recommendations

None.

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5. COST ESTIMATE

5.1 Findings

A summary of the project scope, cost estimate, and contingency profile were provided by the project team. The 12 GeV Upgrade Total Estimated Cost (TEC) is $287.5 million, Other Project Costs (OPC) are $22.5 million, for a TPC of $310 million. A breakdown of the current baseline can be found in Appendix D.

As of August 31, 2009, contingency/management reserve is $70 million or approximately 40 percent of the estimate-to-complete (ETC) work to go (taking into account obligations). The projected funding profile for the 12 GeV project is contained in Appendix F.

As of August 31, 2009, scheduled work is at 15.7 percent, performed work is at 14.9 percent and actual costs are at 15.2 percent. The Cost Performance Index (CPI) is at 0.98 and Schedule Performance Index (SPI) is at 0.95.

ARRA funds have been integrated into the project plan and ARRA milestones have been established. ARRA funds totaling $65 million are being used for work in WBS 1.3 (Accelerator) and WBS 1.6 (Civil).

There are no outstanding recommendations from July 2008 DOE/SC Review and the project has addressed prior comments, including the establishment of a closer correlation between risks and contingency.

The labor availability issue mentioned in prior reviews remains a concern.

5.2 Comments

The Committee felt that the project management systems used by the project were mature and functioning very well. The project controls staff members are knowledgeable and experienced.

An internal audit of the budget execution process was conducted and found that the JSA funds control system is adequate to address the ARRA requirements. ARRA funds are separated from other project funds and are tracked independently. ARRA milestones have been established and are being used to report progress.

The Committee was comfortable that the $70 million in contingency was sufficient to address the risks inherent in the remaining work and that there was a risk management system in place to adequately track and monitor those risks. The project is presently tracking one high risk, five moderate risks, and 47 low risks.

The high risk being monitored is related to the potential cost increase associated with the cryogenic refrigeration cost. Moderate risks include technical issues associated with magnets, silicon vertex tracker potential cost overruns, issues related to the dewatering contracts, and potential schedule delays due to labor shortages. Risks are reviewed and managed regularly and are formally reassessed at least every six months.

Labor availability was noted in prior reviews as a possible issue and it remains a concern because the project competes with other TJNAF priorities for the availability of its workforce. In FY 2009, over 200 partially dedicated staff contributed to about 50 FTEs of effort, but the labor available was about 30 percent lower than anticipated due to competing priorities. As project staffing requirements continue to ramp up to an FY 2012 peak of 130 FTEs, this issue will become more critical. In addition, 60 FTEs of university labor, which are planned for FY 2012, will add more complexity as their work will be handled through Memoranda of Understanding with other institutions.

An updated Estimate at Completion (EAC) was not presented to the Committee but should be done annually.

The opinion of the Committee is that the project can be completed within the cost and schedule performance baseline provided that the labor availability issue is addressed.

5.3 Recommendations

12. An integrated TJNAF/12 GeV staffing plan should be developed and presented at the next review. Since the project labor is directly tied to the TJNAF labor, this plan should detail how staff will be shared across the complex.

13. A comprehensive EAC should be conducted prior to the next review.

6. SCHEDULE and FUNDING

6.1 Findings

A resource-loaded schedule and list of milestones were presented by the project team. The proposed Level 1 milestones are shown in Table 6-1. A summary schedule is included in Appendix E.

Table 6-1. Level 1 Milestones

Milestone Description	Completion Date
CD-0 (Approve Mission Need)	2Q FY2004 (A)
CD-1 (Approve Preliminary Baseline Range)	2Q FY2006 (A)
CD-2 (Approve Performance Baseline)	1Q FY2008 (A)
CD-3 (Approve Start of Construction)	4Q FY2008 (A)
CD-4a (Accelerator Project Completion/Start of Operations)	1QFY2015
CD-4b (Experimental Equipment Project Completion & Start of Operations)	3Q FY2015

The 12 GeV project is using Primavera (version 6.2) as its scheduling tool with Cost Manager as the cost processor. The resource-loaded schedule contains 4,281 activities. There are 51 control accounts and 11 Cost Account Managers (CAMs).

The project team was advised that the House Mark has a $10 million 12 GeV Upgrade FY 2010 funding reduction planned. The project team presented the Committee with eight scenarios that ranged from a schedule slippage of six months to 30 months and a cost increase of $8 million to $20 million.

There are no outstanding recommendations from the July 2008 DOE/SC review and the project has addressed prior comments, including the addition to the schedule of procurement activities that take place prior to contract award.

6.2 Comments

The resource-loaded schedule was reviewed by the Committee and found to be thorough and well organized. Dependencies within and between WBS elements are identified and both labor and non-labor resources have been identified and captured at the activity level of the

schedule. The schedule is utilized to project manpower and other resource needs and shows current status of major activities. ARRA milestones are tracked in the schedule.

While the Committee understands that an internal review has determined that the ARRA costs are adequately tracked, it may be beneficial to add a code field in the schedule that identifies ARRA activities and would allow a simple and efficient method to view ARRA work within the schedule.

As part of this review, two CAMs were interviewed. The information and documentation provided during the interviews was consistent with the summary above. Specifically:

- The CAMs complete monthly reports that provide a comprehensive snapshot on the status of their piece of the project.
- Communication between the CAMS and project management is sufficient to insure that project management is kept well informed and that any issues can be raised and managed as necessary.
- The CAMS provide variance analysis consistent with project expectations, and actions to address variances are stewarded appropriately.
- The change request procedure is familiar to both CAMs and documents were reviewed that indicate it is being followed.
- The CAMS participate in risk identification and management and were well versed in the method used by the project for risk assessment.
- Both CAMS interviewed are fulfilling project obligations as well as doing ‘the rest of their job’. They face some challenges balancing project work/deadlines with the remainder of their work obligations.

Variance analyses and change requests were examined by the Committee and found to be detailed and complete. Many variance reports noted the lack of available labor as the cause for delays. Unanticipated procurement issues were also cited.

The Committee reviewed the funding scenarios associated with the possible $10 million funding reduction. The severity of the impact is dependent on when the funds would be returned and if a revised ARRA profile could be proposed. The Committee found the funding scenarios provided by the project team to be reasonable.

The Committee judged that the project can be completed within the cost and schedule performance baseline if the funding is provided as planned.

6.3 Recommendations

None.

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7. MANAGEMENT

7.1 Findings

Project and TJNAF Management

Since the July 2008 DOE/SC review, the 12 GeV Upgrade Project successfully achieved CD-3 (Approve Start of Construction) as planned in September 2008, following satisfactory completion of Earned Value Management System final certification. Construction has begun with a number of equipment and civil contracts now awarded (approximately $40 million value) and site work initiated. The TPC has remained stable over the last year at $310 million. The project reports TEC budget contingency of $65.3 million (41 percent based on ETC) and has maintained 12 months schedule contingency on the critical path. The CPI has remained constant over FY 2009 at 0.98 but the SPI has progressively declined about seven percent throughout the same period. The 12 GeV Integrated Project Team is working well together and continues to reflect the knowledge, skills, and technical/management experience appropriate to the job. A number of high-priority positions identified during the July 2008 review have been filled with well-qualified and experienced staff. TJNAF senior management receives regular progress briefings and conducts periodic internal reviews that keep project issues and needs visible to TJNAF managers and resource providers who are faced with multiple competing demands for skilled resources.

Staffing and Resource Management

The project presented a staffing plan for the duration of the project, which peaks in FY 2012 at 133 FTEs. The actual FY 2009 project staffing level of approximately 50 FTEs represents a shortfall of approximately 34 percent from the FY 2009 planned 76 FTEs. This shortfall has required deferring of 12 GeV project work and changing of priorities to suit the available skill mix. The project has developed a four-year projection for staff resources and provided the plan to the affected laboratory divisions. Nearly all (90 percent) of the project staff is matrixed from TJNAF. The project has identified shortfalls in ramping up TJNAF resources as a moderate risk to the project.

Additional contributed effort of about 120 FTE-years to support detector-related work is being arranged from approximately 30 universities through Memoranda of Understanding that define the staff contributions and scope of work for each university.

Funding

The project received $10 million in funds in October 2008 under a Continuing Resolution plus the remainder of planned FY 2009 construction funds in April 2009 and $65 million from ARRA funding. As a result, the DOE Office of Nuclear Physics funding requests for FY 2010 and FY 2011 were reduced by an equivalent amount. An unanticipated congressional mark reduced FY 2010 funding by $10 million. DOE has made an appeal to restore the additional reduction, and funding plans beyond FY 2011 remain at the baseline level. The project utilized the ARRA funds in the Accelerator ($42 million) and Conventional Facilities ($23 million) subsystems. Plans are to obligate $33 million in FY 2009 and $32 million in FY 2010. Milestones are defined in those subsystems to track ARRA expenditures.

Procurement

The project planned to award 43 major procurements (greater than $500 K) in FY 2009 and FY 2010 with a combined value of $85 million. Fifteen contracts have been awarded and 23 others are in process. With plans to award all 43 procurements by April 2010, the project will need to sustain a rate of four awards per month. There are approximately $15 million of major procurements remaining in FY 2011 and FY 2012.

The TJNAF Procurement Director has increased staff by five (above 40 percent) additional buyers/subcontract administrators since July 2008. As recommended during a previous review and subsequent to a successful DOE Procurement Evaluation Review Team review in August 2008, the TJNAF procurement authority for competitive awards was increased in August 2009. The new approved TJNAF authority is $3 million for a low bid selection and $750 K for other than low bid selections.

7.2 Comments

Staffing and Resource Management

A number of indicators point to the timely availability of labor resources as potentially the highest risk to the 12 GeV schedule. Root causes of labor shortfalls that affected the 12 GeV project in FY 2009 if uncorrected will pose a significant risk to the project baseline schedule. The project FY 2009 bi-weekly labor reports identify several periods where project planned resources have been diverted to other TJNAF work and these shortfalls directly account for the declining trend in schedule performance. Imposed hiring constraints based on annual funding uncertainties,

the growth of other work within the Laboratory, a challenging recruiting environment for external skills, and the co-dependent nature of the 12 GeV project schedule with on-going 6 GeV operations and upcoming maintenance shutdowns—all contribute increasing challenges to the effective matrix management of skills in a facility the size of TJNAF.

The 12 GeV project acted to minimize the impact of this more than 30 percent resource shortfall by delaying and leveling activities and also prepared a multi-year staffing plan with resource requests for FY 2010 that are being reviewed by TJNAF management. However, significant uncertainties could exist in this plan given that a full bottoms-up project ETC, including labor resources, has not been accomplished since April 2007 with additional, significant updates in April 2008. All recruiting tools approved by DOE for recent construction projects should be considered to promptly attract the critical skills (especially engineering) needed to achieve the project baseline. The project manpower requests for FY 2010 will need priority TJNAF management attention and action where needed to ensure the project has the skills and resources needed to meet the schedule.

The university contributed staff represent a risk to the project should the resources not become available. This risk is included in the Risk Registry and within the Contingency Risk Assessment Matrix. An estimated cost impact of $6-7 million dollars is reflected. Although there is sufficient cost contingency to cover the risk, it is not clear whether the Laboratory or outside resources would have the necessary skills mix needed to fill the gap. It would be prudent to identify where those resources may be available as a work around plan.

Funding

The ARRA funding in FY 2009 allowed the project to reduce the amount of phase-funded contracts and eliminated potential schedule risks created by constrained funding rates under Continuing Resolutions anticipated in FY 2010 and FY 2011. The FY 2010 and FY 2011 baseline funding level was proportionately reduced in the budget process; however, a House mark reduced the FY 2010 budget by $10 million. The timing of this reduction represents a measurable risk to the schedule given other project constraints, and DOE/HQ has submitted an appeal to restore it. If restored quickly, the project will be able to proceed through FY 2011 with sufficient cost contingency and with reduced risk to completing preparatory work for the planned shutdown in May 2011; otherwise, the project will have to re-plan activities and procurements to ensure sufficient budget authority through FY 2011.

An expected contribution of some Commonwealth of Virginia funds (approximately $6 million) in support of the project have been delayed by state funding constraints. Should such funds not materialize, the project has developed plans that should result in no reductions of scope.

Procurement

TJNAF has acted decisively to increase procurement staff to meet forecast demands. The procurement staff, so far, has been able to meet the schedule for placement of the major procurements. However, it is unclear whether the augmented staff will be able to meet the needed rate of four procurement awards per month required to achieve the project schedule. Close management attention is needed to ensure this target rate is met to keep the project on schedule. Ten of the remaining major procurements may require DOE approval and of those ten, one requires off-site (Oak Ridge Office (ORO)) approval. The DOE/TJSO and DOE/ORO approval process has met the project schedule to date but concern exists that bottlenecks could arise given the large amount of ARRA work in the ORO pipeline. The Cold Box (approximately $10 million) procurement currently being reviewed at ORO is critical to the project schedule and current expediting efforts should continue.

Increased coordination between TJNAF and DOE/TJSO is encouraged to ensure minimal risk to the schedule for approving future procurements. The recent increase in TJNAF procurement authority has benefitted the project and improved process times for procurements below $3 million. However, the authority specifies additional approvals for competitive awards to other than the low bidder. A possible revised implementation is under discussion between TJNAF and the DOE/TJSO to determine if added approvals are optimal in a best-value selection methodology.

7.3 Recommendations

14. Conduct a bottom-up ETC not later than the first half by FY 2010 and better refine the project skills and resources needed to avoid further risk and delays in the project baseline schedule.

15. Schedule the next DOE progress review of the 12 GeV project within six months.

APPENDIX A

CHARGE MEMORANDUM

DOE F 1325.8
(08-93)

United States Government **Department of Energy**

memorandum

DATE: May 14, 2009

REPLY TO ATTN OF: Office of Nuclear Physics, SC-26

SUBJECT: Independent Project Review of the 12 GeV CEBAF Upgrade Project

TO: Daniel R. Lehman, Director
Office of Project Assessment, SC-28

I request that your office organize and conduct an Office of Science (SC) Independent Project Review (IPR) of the 12 GeV Continuous Electron Beam Accelerator Facility (CEBAF) Upgrade project at Thomas Jefferson National Accelerator Facility (TJNAF) in Newport News, Virginia on September 22 – September 24, 2009. The 12 GeV CEBAF Upgrade project has been the recipient of funds from the American Recovery and Reinvestment Act of 2009. These funds were provided as advanced funding to reduce cost risk and schedule risk. The purpose of this review is to assess all aspects of the 12 GeV CEBAF Upgrade project – technical, cost, schedule, management, and environment, safety, & health (ES&H) as the project proceeds with construction under the requirements of DOE Order 413.3A (Program and Project Management for the Acquisition of Capital Assets).

In carrying out its charge, the review committee is requested to consider the following questions:

1. Are there any remaining design issues of the 12 GeV CEBAF Upgrade project that could impact construction activities and planned procurements?

2. Is the project positioned to be completed within the established cost and schedule Performance Baseline (e.g., adequate progress to meet baseline objectives)? Is there appropriate cost and schedule contingency to address the risks inherent in the remaining work and is it being properly managed? Have the American Recovery and Reinvestment Act funds been properly incorporated into the project plans?

3. Is the project being properly managed (e.g., properly organized, adequately staffed) as needed through the construction phase? Is there adequate support from TJNAF in all necessary areas (e.g., procurement, human resources)?

4. Are ES&H and Quality Assurance aspects being properly addressed?

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

The 12 GeV CEBAF Upgrade Program Manager, James C. Hawkins, 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.

Eugene A. Henry
Acting Associate Director of Science
for Nuclear Physics

cc:
S. Tkaczyk, SC-28
K. Chao, SC-28
J. Gillo, SC-26.2
J. Hawkins, SC-26.2
B. Tippens, SC-26.1
J. Turi, TJSO
J. May, TJSO
H. Montgomery, TJNAF
C. Rode, TJNAF
A. Lung, TJNAF

APPENDIX B

REVIEW PARTICIPANTS

Department of Energy Review of the
12 GeV CEBAF Upgrade Project
September 22-24, 2009

Daniel R. Lehman, DOE/SC, Chairperson

SC1
SRF Cryomodules and Cryogenics
(WBS 1.3.1/1.3.3)

* John Weisend, SLAC
Bruce Strauss, DOE/SC

SC2
Accelerator and Accelerator Physics
(WBS 1.3.2/1.3.4/1.3.5/1.8.1)

* Rod Gerig, ANL
Roy Cutler, ORNL
Joe Tuozzolo, BNL

SC3
Control Systems and Instrumentation
(WBS 1.3.6)

* Larry Hoff, BNL

SC4
Detector
(WBS 1.4/1.5/1.8.2)

* Andy Lankford, UCI
Bill Louis, LANL
Nicolai Martovetsky, ORNL
Ed O'Brien, BNL

SC5
Conventional Facilities
(WBS 1.6)

* Joe Harkins, LBNL
Elaine McCluskey, FNAL

SC6
Environment, Safety and Health

* Mike Scharfenstein, SLAC

SC7
Cost and Schedule

* Diane Hatton, BNL
Catherine Gee, PNNL
Scott Tingey, PNNL

SC8
Project Management
(WBS 1.7)

* Carl Strawbridge, ORNL
Hanley Lee, DOE/SSO

Observers

Jehanne Gillo, DOE/SC
Manouchehr Farkhondeh, DOE/SC
Jim Hawkins, DOE/SC
Helmut Marsiske, DOE/SC
Brad Tippens, DOE/SC
Jim Turi, DOE/TJSO
Scott Mallette, DOE/TJSO
Joe May, DOE/TJSO
Michael Epps, DOE/TJSO

LEGEND

SC Subcommittee
* Chairperson

Count: 18 (excluding observers)

APPENDIX C

REVIEW AGENDA

Department of Energy Review of the
12 GeV CEBAF Upgrade Project
September 22-24, 2009

AGENDA

Tuesday, September 22, 2009—CEBAF Center, Conference Room F113

8:00 am	DOE Executive Session ..... D. Lehman
9:00 am	Welcome ..... H. Montgomery
9:10 am	Project Overview ..... A. Lung
9:25 am	Project Status ..... C. Rode
10:00 am	ESH&Q Overview ..... M. Logue
10:15 am	Break
10:30 am	Accelerator Technical Overview (WBS 1.3) ..... L. Harwood
10:50 am	Physics (Experimental Equipment) Technical Overview (WBS 1.4, 1.5) ..... R. Ent
11:10 am	Project FY10/FY11 Installation Plans ..... D. Napier
11:25 am	Civil Construction Technical Overview (WBS 1.6) ..... R. Yasky
11:45 am	Lunch
12:45 pm	Tour (Machine, Experimental Halls, windshield tour of Hall D site)
2:15 pm	Subcommittee Breakout Sessions (see breakout agenda attached)
5:15 pm	DOE Executive Session—**Room F113** ..... D. Lehman
6:30 pm	Adjourn

Wednesday, September 23, 2009

8:00 am	Technical Breakout Sessions
12:00 pm	Lunch
1:00 pm	Subcommittee Executive Sessions (Subcommittee Meeting Rooms)
3:00 pm	DOE Executive Session—**Room F113**

Thursday, September 24, 2009

8:00 am	Subcommittee Executive Sessions (Subcommittee Meeting Rooms)
10:30 am	Closeout Dry Run—**Room F113**
12:00 pm	Lunch
1:30 pm	Closeout Presentation to 12 GeV Management—**CEBAF Center Auditorium**
2:30 pm	Adjourn

APPENDIX D

COST TABLE

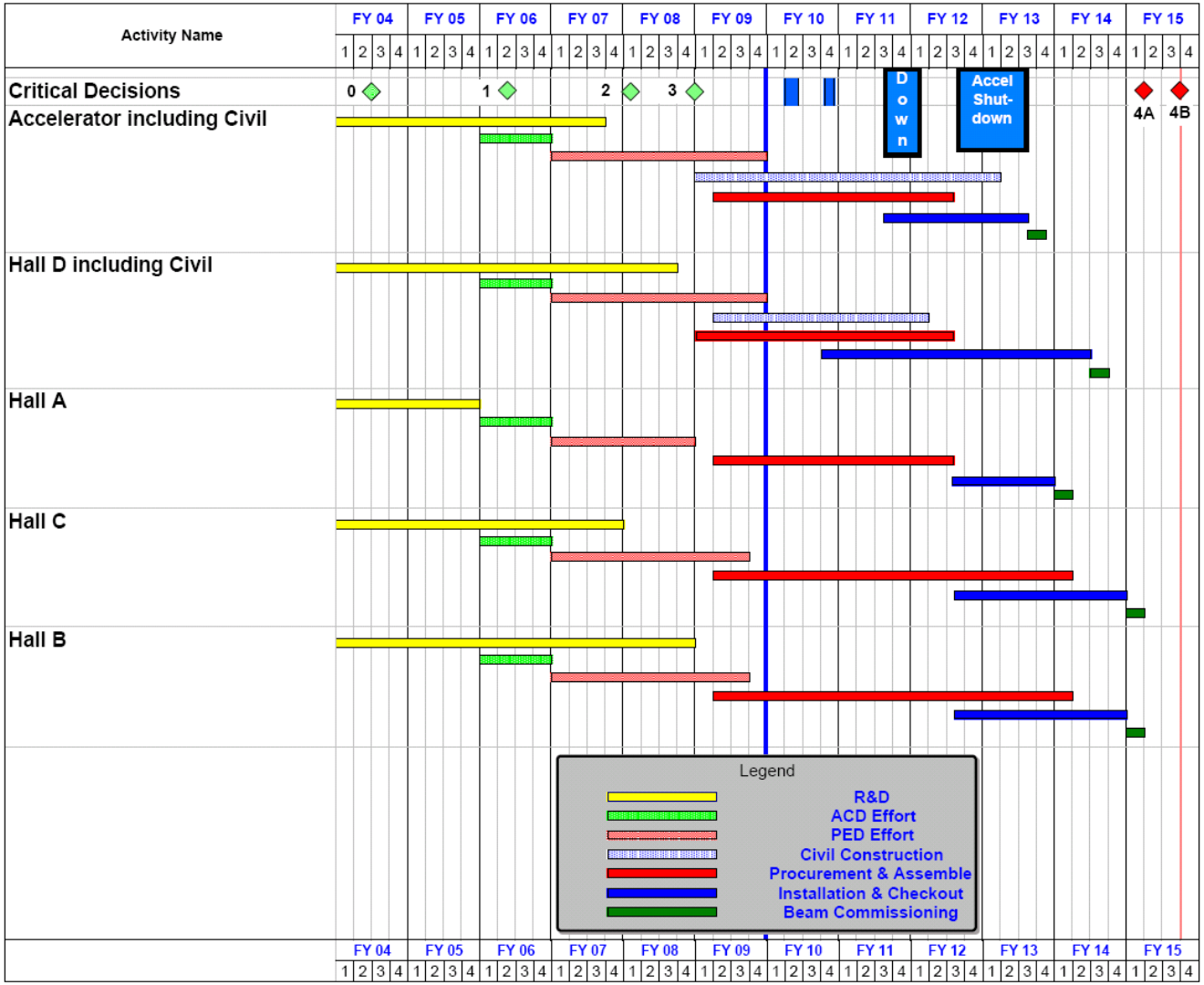
12GeV—Baseline Cost Estimate ($K)

	12 GeV Cost Summary	
		EAC FY09M$
WBS	SCOPE	COST
1.2	PED	20.1
1.3	Accelerator Systems	76.4
1.4	Upgrade Hall A,B&C	47.9
1.5	Hall D	31.1
1.6	Civil	28.4
1.7	Project Management	7.3
TEC SUBTOTAL		**211.2**
	Obligated 1-Jul-09	-36.8
	Out Year Phased Contracts	-14.1
	Escalation	11.0
TEC ETC (AY M$)		**171.3**
Contingency (AY M$)		62.9
	ETC Contingency %	37%
Management Reserve (AY M$)		2.5
	ETC Management Reserve %	1%
TEC TOTAL (AY M$)		**287.5**
1.0	CDR/ACD	3.5
1.1	R&D	7.0
1.8	Pre-Ops	6.6
OPC SUBTOTAL		**17.0**
	Obligated 1-Jul-09	-10.5
	Escalation	1.1
OPC ETC (AY M$)		**7.6**
Contingency (AY M$)		4.4
	ETC Contingency %	58%
Management Reserve (AY M$)		—
	ETC Management Reserve %	0%
OPC TOTAL (AY M$)		**22.5**
TPC TOTAL (AY M$)		**310.0**

APPENDIX E

SCHEDULE CHART

12GeV—Schedule



APPENDIX F

FUNDING TABLE

12 GeV Funding Table

12 GeV Upgrade		May-09	ONP Stimulus: +$65M in FY09					
	CDR/ACD	R&D	PED	Construction	Pre-Ops	Total	TEC	OPC
FY04	200	500				700	-	700
FY05	800	1,500				2,300	-	2,300
FY06	2,500	1,500	500			4,500	500	4,000
FY07		2,500	7,000			9,500	7,000	2,500
FY08		1,000	13,377			14,377	13,377	1,000
FY09			123	93,500		93,623	93,623	-
FY10				22,000		22,000	22,000	-
FY11				34,000		34,000	34,000	-
FY12				66,000		66,000	66,000	-
FY13				40,500	2,500	43,000	40,500	2,500
FY14				10,500	7,500	18,000	10,500	7,500
FY15					2,000	2,000	-	2,000
	3,500	7,000	21,000	266,500	12,000	310,000	287,500	22,500

APPENDIX G

MANAGEMENT TABLE

JLab 12 GeV Project Organization

Primarily matrixed staffing (~650 JLab employees)