U.S. DEPARTMENT OF ENERGY

OFFICE OF SCIENCE

CD-1 Review for the

LHC ATLAS Detector Upgrade Project

Brookhaven National Laboratory

(review conducted at Fermi National Accelerator Laboratory)

August 28-29, 2013

Kurt Fisher
Review Committee Chair
Office of Science, U.S. Department of Energy
http://www.science.doe.gov/opa/

DOE/SC EXECUTIVE SESSION AGENDA

Wednesday, August 28, 2013—Wilson Hall, the Comitium

8:00 a.m.	Introduction and Overview	K. Fisher
8:15 a.m.	Program Office Perspective	M. Procario/S. Rolli
8:30 a.m.	Federal Project Director Perspective	G. Penny
8:45 a.m.	Questions	

Project and review information is available at:

http://www.fnal.gov/directorate/OPMO/Projects/USCMS/DOERev/20130826/review.html

http://www.usatlas.bnl.gov/LHC_ATLAS-U/reviews/CD1_DOE_Review_Aug_2013/

User Name: **review** Password**: 4atlasUG**

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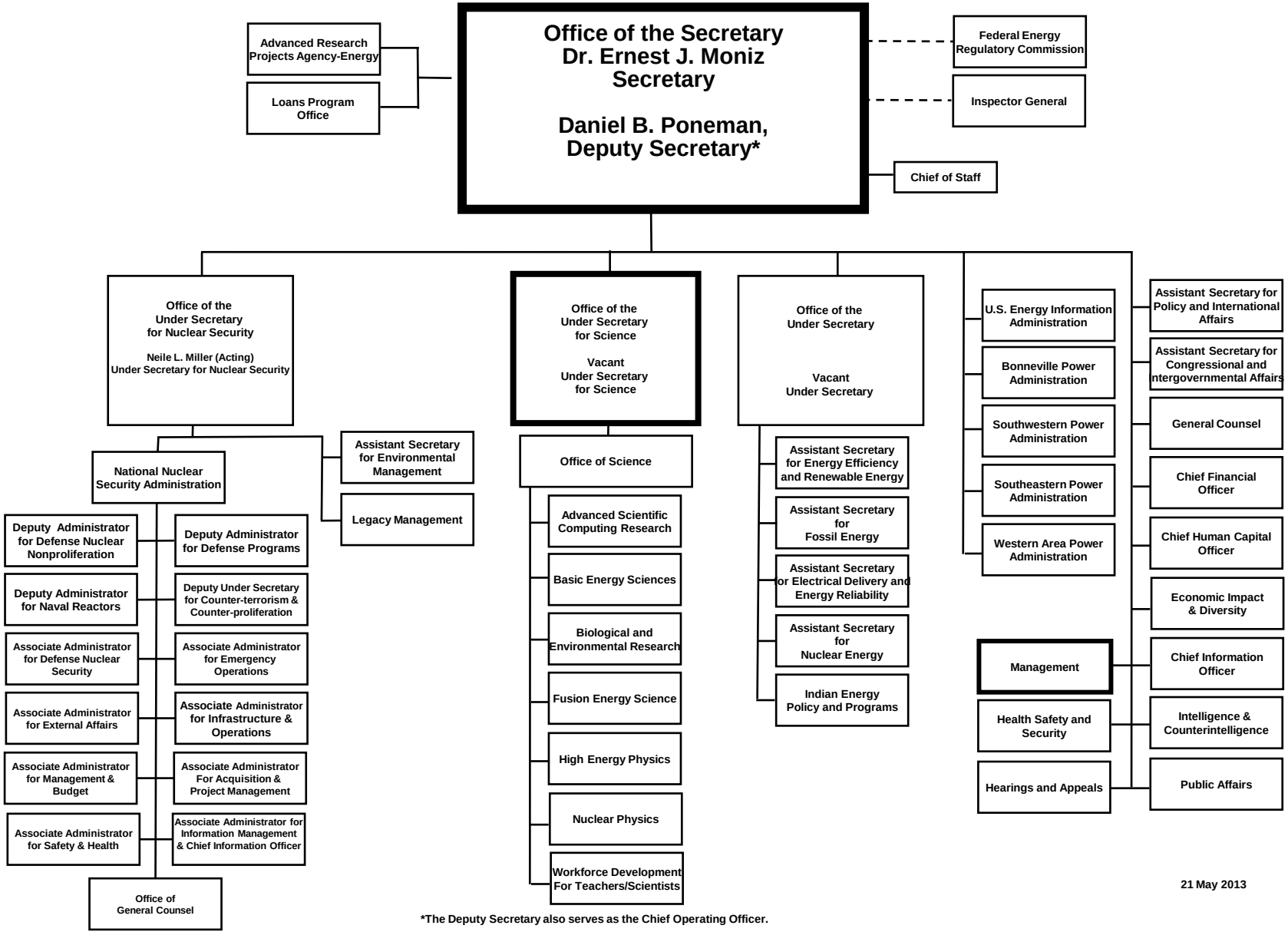

21 May 2013

*The Deputy Secretary also serves as the Chief Operating Officer.

U.S. DEPARTMENT OF ENERGY

SC Organization

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(A) Acting

4/2013

Review Committee Participants

Kurt Fisher, DOE/SC, Chairperson

SC1
LAr—Liquid Argon Calorimeter Trigger Readout (WBS 1.1)

Bill Wisniewski, SLAC
Gina Rameika, FNAL

SC2
Muon New Small Wheel (WBS 1.2)

* Phil Schlabach, FNAL
Andrey Korytov, U. of Florida

SC3
Trigger and Data Acquisition (WBS 1.3)

* Myron Campbell, U. of Michigan
Peter Wilson, FNAL
Luciano Ristori, FNAL

SC4
Cost and Schedule

Ethan Merrill, DOE/SC
Steve Webster, DOE/FSO

SC5
Project Management (WBS 1.4)

* Mark Reichanadter, SLAC
Michael Levi, LBNL
Mark Palmer, FNAL

Observers

Jim Siegrist, DOE/SC
Mike Procario, DOE/SC
Simona Rolli, DOE/SC
Gail Penny, DOE/BHSO
Lloyd Nelson, DOE/BHSO

LEGEND

SC Subcommittee
* Chairperson

Count: 13 (excluding observers)

Charge Questions

1. Conceptual Design: Is the conceptual design sound and likely to meet the MIE project's technical performance requirements most efficiently and effectively? Do the conceptual design report and supporting documentation adequately justify the stated cost range and project duration?

2. Project Scope: Are the project's scope and specifications sufficiently defined to support preliminary cost and schedule estimates?

3. Cost and Schedule: Are the cost and schedule estimates credible and realistic for this stage of the project? Do they include adequate scope, cost and schedule contingency?

4. Management & ES&H: Is the project being appropriately managed at this stage? Does the proposed project team have adequate management experience, design skills, and Laboratory support to produce a credible technical, cost and schedule baseline? Are ES&H aspects being properly addressed and are future plans sufficient given the project's current stage of development?

5. Documentation: Is the prerequisite documentation required for approval CD-1 complete?

Expectations

- **Present closeout reports in PowerPoint.**
- **Forward your sections for each review report (in MSWord format) to Casey Clark, casey.clark@science.doe.gov,**

  by September 3, 8:00 a.m. (EDT).

2.1 LAr Calorimeter Trigger Readout

G. Rameika, FNAL; B. Wisniewski, SLAC*
SC1

1. Conceptual Design: Is the conceptual design sound and likely to meet the MIE project's technical performance requirements most efficiently and effectively? Do the conceptual design report and supporting documentation adequately justify the stated cost range and project duration?

   Yes.

2. Project Scope: Are the project's scope and specifications sufficiently defined to support preliminary cost and schedule estimates?

   Yes.

5. Documentation: Is the prerequisite documentation required for approval of CD-1 complete?

   Yes.

- **Findings**

- The conceptual design of the LAr upgrade was presented. The goal of this part of the ATLAS Upgrade is introduction of greater segmentation in η in the signals sent to TDAQ, along with substantial improvement in energy resolution.
- Level 3 managers detailed their scope of work. This includes production of new Layer Sum Boards (LSBs) to be mounted on the Front End Boards; the baseplane for the FCAL readout crate; the LAr Trigger Digitzer Board (LTDB); and the Digital Processing System (DPS).
- The LSBs rely on existing designs modified to pass signals over the backplane to the LTDB where a summed signal is passed on to the Tower Builder Board of the existing readout. This allows continuation of use of the existing system in parallel while bringing the new system on line.
- The LTDB digitizes the signals from the LSBs. The digitizer design and prototyping is part of the scope of the project. Three versions are in preparation: the Nevis ADC, which meets the performance specification, requiring only rad-hardness testing which will occur this calendar year; a COTS ADC, with more limited but acceptable performance; and a Grenoble design that is further behind in prototyping. ATLAS (International) will select the device to be used by the end of January 2014.

- **Findings (cont'd)**

- The analog signal shaping on the LTDB is a U.S. design responsibility, with production at Orsay and Saclay in France. These components are needed for integration of the LTDB.
- A Demonstrator is being assembled for the test of all system components using a ¼ LTDB prototype.
- An LTDB prototype will be tested via inclusion on the detector before the next data run.
- The DPS is a shared responsibility between U.S. and Annecy, which will provide a component for the board produced to U.S. design.
- Bases of Estimate were reviewed for the LTDB integration task and for the LSBs. These are two of the 26 BoEs produced.
- A resource loaded schedule was presented. Connections between the BoEs and schedule were shown, along with details of the resource loading.
- An extensive set of milestones was presented at both L2 and L3.
- Scope contingency items (LTDB integration labor) that add up to ~$.6-.8M were identified.
- The TDR preparation will be ready for submission in two weeks for consideration for approval at the September LHCC meeting.

- **Comments**

- This portion of the project is at or above CD-1 maturity in design, prototyping, costing and scheduling.
- The management team of the LAr upgrade is fully conversant with and on top of all details of this project.
- Engineering and physicist labor has been identified and overlaps with ATLAS Ops have been considered.
- Maintaining the existing trigger path during the commissioning of the upgraded system is solid, conservative practice. This is particularly welcome considering the complexity of the LTDB.
- The U.S. project is dependent on non-U.S. contributions for its success. However, the dependencies are for products that should be well within the capabilities of the collaborators, and thus present limited risk.

- **Comments (cont'd)**

- The Committee endorses the Demonstrator scheme, and encourages the team in installing for test the most advanced version of the LTDB prototype for this next run.
- The LAr team is commended for designing the LTDBs to be used in Phase 2 of the ATLAS upgrades, with easy modifications.
- The BOEs are quite detailed and complete for those items which have entered prototype stage. Final LTDB integration is a bit sketchier, but is based on prior experience on similar boards designed, prototyped and produced by the same engineers, and is quite conservative.
- The cost estimate is reasonable. Contingency estimated is healthy for this stage of the project.
- The resource loaded schedule is at sufficient level of maturity for this stage of the project. Milestones are abundant. The Committee expects that the schedules will be fleshed out for CD-2. In particular, details through the prototyping phase should be expanded.
- TDR review and approval provides some risk of design change. However, the Committee feels that design maturity is sufficient that this risk is small for LAr upgrade.

2.2 Muon New Small Wheel

A. Korytov (UF), P. Schlabach* (FNAL) / SC2

1. Conceptual Design: Is the conceptual design sound and likely to meet the MIE project's technical performance requirements most efficiently and effectively? Do the conceptual design report and supporting documentation adequately justify the stated cost range and project duration? YES

2. Project Scope: Are the project's scope and specifications sufficiently defined to support preliminary cost and schedule estimates? YES

5. Documentation: Is the prerequisite documentation required for approval of CD-1 complete? YES

Findings: deliverables

- ATLAS has made a technology choice for the small muon wheel which has redundancy for both trigger and tracking (MM chambers for best tracking and sTGC for best trigger, but trigger and tracking capabilities for both)
  - US-ATLAS is providing front end ASICS, front end boards, trigger interface ASICS and boards, and an alignment system
  - Deliverables are well defined with a project end point well defined

Findings: performance

- With the increase in pile up with luminosity in the next run as well as other backgrounds, the upgrade is well motivated
  - We explored the background rate estimates and uncertainties and found no issue
  - Trigger rate reductions are credible
  - Consistent with our experience

Findings: FE electronics

- There are 2 ASICs produced in the US
  - The VMM chip are the most complicated and farthest along
    - 1st submission for the analog part is done and successful
    - 2nd submission adding digital functionality is due soon
    - 3rd submission is expected to be the last before production
    - There is room for one extra submission (cost and schedule contingencies are in place) – we deem this is enough
  - TGS chip (all digital)
    - FPGA-based prototyping is in progress
    - 2 submissions are planned
  - FE boards are at the conceptual design phase

Findings: alignment system

- The alignment system upgrade is required to tie the new chambers into the existing system
  - Concept is the same as the old system
    - Obsolete technology replaced (CCDs+drivers)
    - System made more rad hard
  - We see no issues

Findings: dependencies/interfaces

- Dependencies on non-US institutions
  - 2 ASICs (in design stage)
  - A CERN developed global interface chip (in production)
  - Communication protocols, etc.
- Specifications of detector/electronic electromechanical interface, interfaces to services and infrastructure
- Specification of final alignment details
  - Transfer of alignment to detector
  - # of needed alignment bars (presently covered by 100% contingency), lines of sight

Comments

- Deliverables are well matched to institutional capabilities

- We identified no technical risks beyond those presented by proponents
- We found the cost and schedule credible
- Contingency estimates are done at a high level, adequate for CD-1; need be more detailed for CD-2

- Funding for engineering in FY14 is critical to achieve construction in FY15
- Construction must begin early in FY15 to meet the delivery dates required

Recommendations

- Proceed with CD-1 approval
- Detail a test plan which includes testing of prototype electronics with prototype chambers
  - Add test milestones to the schedule including a “module 0” full scale prototype detector test before production
- Identify a person to stay abreast of the various interfaces with the detector and infrastructure as they develop. Before proceeding with production, all interface specs should be formalized.
- Check available margin in the systems with respect to trigger and DAQ specs for phase 2
  - The systems may achieve, possibly with minor modifications, the phase 2 specs

1. Conceptual Design: Is the conceptual design sound and likely to meet the MIE project's technical performance requirements most efficiently and effectively?
   YES. The conceptual design is to increase the segmentation of the calorimeter information used in the level 1 trigger and to implement new algorithms using the increased segmentation. This is needed to keep the level 1 trigger rate within the bandwidth limitations after the luminosity and energy increase. The design is based on measurements made in the current system and Monte Carlo extrapolations. Based on this, the design meets the technical performance goals.

1. Conceptual Design: Do the conceptual design report and supporting documentation adequately justify the stated cost range and project duration?
   YES, it is adequate for CD-1.
2. Project Scope: Are the project's scope and specifications sufficiently defined to support preliminary cost and schedule estimates?
   YES
5. Documentation: Is the prerequisite documentation required for approval CD-1 complete?
   YES

2.3 Trigger and Data Acquisition

Findings

- The Level 1 Trigger Upgrade is needed to respond to the increase in luminosity, the increase in energy, and the increase in number of events per crossing (Pile-up)
- There are three major components to the Level 1 Trigger Upgrade. The first is the fiber plant to map the calorimeter into the electromagnetic and jet feature extractors. The second is to develop firmware to implement new tau algorithms using the increased segmentation and to implement data readout from the FEXs. The third part is the ATCA Hub module and associated firmware.
- The project cost is dominated by engineering needed for FPGA design.
- The M&S is from NSF or non-US ATLAS funding sources.
- The performance estimates are based on a combination of measurements using current data and extrapolation using Monte Carlo.
- The system uses a modular design with well specified interfaces.

2.3 Trigger and Data Acquisition

Comments

- The electron (as well as muon) trigger rate estimates are at the limit of the level 1 bandwidth. If the estimates are low there are few options beyond what will be implemented for adjusting the trigger rates other than increasing the threshold. It was shown that increasing the threshold reduces the efficiency for key physics processes.
- The infrastructure needed to program and test the FPGA's is either already existing or will be acquired off project. The dependencies on the availability of some of the hardware for testing the FPGA firmware was not included in the schedule.
- The level of detail of the cost estimate and schedule is sufficient for CD-1, and needs to be significantly refined before CD-2.
- The need for well defined interfaces for the modular design to be successful is understood by project management. Good configuration control over the interfaces will be required.

2.3 Trigger and Data Acquisition

Recommendations

- Proceed with CD-1
- Develop a more detailed plan of the items which need to be tested together before CD-2.
- Validate the jet and electron feature extraction trigger rates as a function of energy threshold before CD-2.
- Validate the labor estimates for the firmware and fiber plant design before CD-2.

3. Cost and Schedule

E. Merrill, DOE/SC*/S. Webster, DOE/FSO / SC4

1. Conceptual Design: Is the conceptual design sound and likely to meet the MIE project's technical performance requirements most efficiently and effectively? Do the conceptual design report and supporting documentation adequately justify the stated cost range and project duration? **YES**

2. Project Scope: Are the project's scope and specifications sufficiently defined to support preliminary cost and schedule estimates? **YES**

3. Cost and Schedule: Are the cost and schedule estimates credible and realistic for this stage of the project? Do they include adequate scope, cost and schedule contingency? **YES**

5. Documentation: Is the prerequisite documentation required for approval of CD-1 complete? **YES**

3. Cost and Schedule

E. Merrill, DOE/SC*/S. Webster, DOE/FSO / SC4

Findings

- The project has prepared a preliminary resource-loaded schedule with 727 activities and includes appropriate CERN and NSF activities.
- The project schedule includes 18 months of schedule contingency to CD-4 (~25%) as well as at 6 to 9 months float to the needed by dates at CERN. Subproject schedules and critical paths are independent. The TDAQ subproject controls the overall critical path for the project.
- The proposed CD-1 cost range is $32.2M-$34.5M. The preliminary DOE total project cost is $33.25M including $8.9M estimate uncertainty contingency and $1.1M risk-based contingency. Total project contingency is approximately $9.9M (~46% of to-go costs).
- Annual project contingency levels appear adequate during peak production and assembly.
- The total base estimate is 2% travel, 29% materials and services, and 69% labor
- The project includes nominal scope contingency. Potential opportunities were discussed during the review.
- The NSF contribution is estimated at $12.8M based on the June 2013 proposal.

3. Cost and Schedule

E. Merrill, DOE/SC*/ S. Webster, DOE/FSO / SC4

Comments

- The cost contingency is time-phased in the project schedule and appears reasonable at 46% of to-go costs. The cost estimate is sufficiently detailed and mature for this stage of the project.
- Bases of Estimate are credible and detailed; contingencies for labor and M&S are sufficiently conservative and appropriately applied. Plans are in place to revise the BoEs as the project evolves.
- The schedule contingency appears reasonable for this stage of the project.
- The preliminary resource loaded schedule is well-developed and detailed. The project should continue to evaluate subproject linkages to ensure interdependencies are appropriately identified and managed.

Recommendations

- Proceed to CD-1.

PROJECT STATUS

Project Type	MIE	
CD-1	Planned: September 2013	Actual:
CD-2	Planned: 1st Q FY15	Actual:
CD-3	Planned: 1st Q FY15	Actual:
CD-4	Planned: 4th Q FY19	Actual:
TPC Percent Complete	Planned: Not applicable %	Actual: 1.3 %
TPC Cost to Date	$407K	
TPC Committed to Date	$1,227K	
TPC	$32,250K	
TEC	$24,750K	
Contingency Cost (w/Mgmt Reserve)	$9,988K	46 % to go
Contingency Schedule on CD-4	18 months	25 %
CPI Cumulative	Not applicable	
SPI Cumulative	Not applicable	

2. Project Scope: Are the project's scope and specifications sufficiently defined to support preliminary cost and schedule estimates?

   Yes, project scope and specifications are advanced to or beyond CD-1 maturity to adequately support the preliminary cost and schedule estimates.

4. Management and ES&H: Is the project being appropriately managed at this stage? Does the proposed project team have adequate management experience, design skills, and Laboratory support to produce a credible technical, cost and schedule baseline? Are ES&H aspects being properly addressed and are future plans sufficient given the projects current stage of development?

   Yes, the project is appropriately managed by an experienced team. ES&H requirements for CD-1 approval are in place. Yes, future plans are sufficient given the current stage of development.

5. Documentation: Is the prerequisite documentation required for approval of CD-1 complete?

   Yes, all required CD-1 documentation was available for review.

- **Findings**
  - The US ATLAS Upgrade Project is part of a larger multi-national upgrade of the ATLAS Detector to address increasing demands for LHC instantaneous luminosity with improved trigger capacity and capabilities.
  - The Project scope includes upgrades to three subsystems:
    - Liquid Argon Calorimeter Trigger Readout
    - New Muon Small Wheel
    - Trigger and Data Acquisition System
  - The US ATLAS Preliminary PEP has been drafted and includes a defined set of threshold KPPs (minimum) and Objective KPPs (desired).
  - An Integrated Project Team (IPT) has been organized and is functioning. The Joint Oversight Group (JOG) has been established to coordinate shared DOE and NSF responsibilities. A Joint Integration Group (JIG) has been established to coordinate between the Project and the US ATLAS Operations effort. The Project Management Integration Team (PMIT) has been established to coordinate horizontal and vertical integration within the Project.
  - Brookhaven is the lead US lab responsible for the coordination of 16 US universities and one other laboratory.

- **Findings**
  - A 5-year NSF proposal for $12.8M has been submitted by Stonybrook (NSF Lead Lab) for the NSF portion of the US ATLAS Upgrade and is under review.
  - The Project Manager will be DOE-supported while the Deputy Project Manager will be NSF-supported. The NSF PI is also a member of the PMIT.
  - All documentation necessary for CD-1 approval were available for review by the committee, including, but not limited to:
    - Risk Management Plan and Risk Registry.
    - ES&H Plan and Integrated Safety Management
    - All necessary NEPA documentation.
  - The US ATLAS Project objectives have been developed in coordination with the international ATLAS collaboration. Deliverables have been carefully scoped to limit the exposure to uncertainties in the ATLAS international collaboration, as well as the LHC schedule. DOE and NSF have non-overlapping deliverables. No substantive cost descope options were identified.
  - Critical documentation is controlled via the ATLAS document management system (docdb). US ATLAS technical specification are maintained under configuration control.

- **Comments**
  - The technical design of the US ATLAS Upgrade Project is sufficiently advanced to provide a good basis for establishing cost and schedule range, and therefore a good foundation for proceeding to CD-1 approval.
  - Early investments funded through the US ATLAS Operations Program have allowed the Upgrade design to rapidly converge on a sound technical approach. Kudos…
  - The US ATLAS team has extensive management experience and skill level and is capable of producing a technical, cost and schedule baseline.
  - It was noted in the presentations that both the Project Manager and Deputy Project Manager also serve a secondary role as an L2 Manager. This may present issues for management bandwidth.
  - The NSF funding profile is likely to be near flat, which may create cash flow issues given the current work plan. Assuming the NSF proposal is approved with a problematic budget profile, US ATLAS should work closely with its NSF institutions to determine the feasibility of forward funding to stay to schedule.

- **Comments**
  - The Project is currently planning a joint CD-2/3 decision in 1Q15. Uncertainties in the federal budget approval process may result in delays in equipment funds and the Project should evaluate the possibility to advance critical procurements (e.g., VMME3 Production chip submission) to maintain schedule.
  - The Project is urged to develop Verification and Validation strategies, as part of its QA program. This will be of particular importance in the TDAQ development. TDAQ is a highly distributed complex system, which will benefit from a more formal and unified approach in order to meet its performance goals.
  - There are some inconsistencies in the CD-1 documentation (e.g., PPEP, the OPC and TEC categories). Please review all documentation for correctness and update as needed.

- **Recommendations**
  - Prior to CD-2, refine Project's KPP's and project completion criteria to clarify the deliverables and that performance tests are conducted via emulation in the test stand.
  - Prior to CD-2, work closely with DOE, in considering a split CD-3a/b in order to advance long-lead procurements while the final design continues OR, in the case that the designs are all well in hand, a combined CD-2/3 to ensure the same.
  - Prior to CD-2 and in collaboration with the US ATLAS NSF institutions, develop forward-funding scenarios to mitigate a potential cash flow risk.
  - Prior to CD-2, consider developing Verification and Validation strategies as part of its QA program to more rigorously manage the US ATLAS distributed systems.
  - Prior to CD-2, rework milestone framework to ensure a more frequent rate of milestones (at least quarterly) for all institutions.
  - Prior to CD-2, review the staffing needs in the management team to ensure coverage of key roles and responsibilities.

  - Prior to CD-1, update CD-1 documentation to reflect recommendations of this report as well as typographical errors (e.g. Table 6 of the PPEP).
  - Proceed to CD-1 approval.