Closeout Report on the DOE/SC CD-1 Review of the

Core Facility Renovation (CFR) Project

Brookhaven National Laboratory

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Committee Chair

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http://www.science.doe.gov/opa/

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1. Have performance requirements been appropriately and sufficiently defined for this stage of the project? **YES**

2. Has a credible and sufficient alternatives analysis been performed? **YES** Are project risks identified and has a credible Risk Management Plan been developed? **YES**

5. Are environment, safety, and health aspects being properly addressed given the project's current stage of development? **YES** Are Integrated Safety Management principles being followed? **YES**

6. Are project documents (e.g., Acquisition Strategy, Preliminary Project Execution Plan, and Preliminary Hazard Analysis Report) complete and ready for approval? **YES** Is the project ready for CD-1? **YES**

7. Is the abatement of residual hazardous materials within B725 technically feasible, and if so, is abatement scope appropriately bounded in the alternatives analysis and cost and schedule ranges? **YES**

Findings

- The scope is to provide critical computational facilities and associated power and cooling infrastructure to replace the RHIC/ATLAS computing facility to fill the projected capability gaps in computing infrastructure of mid-scale computing.
- Core Facility Revitalization (CFR) will be constructed within the existing core and shell of the decommissioned NSLS-I facility (Building B725).
- The project preliminary Key Performance Parameter Threshold scope is to provide 2.4 MW IT Power and 1.2 MW emergency back-up capabilities, and an objective scope of 2.4 MW IT power and 2.4 MW emergency back-up capabilities.
- Refurbishment of approximately 20,000gsf of building B725 second floor space and move-in activities are off project scope.

Findings

- The CFR will meet or exceed High Performance and Sustainable Buildings (HPSB) Guiding Principles and comply with Data Center optimization Initiative metering and power usage guidelines.
- An independent Analysis of Alternatives (AoA) and Life Cycle Cost Analysis was performed by HDR, Inc. an independent sub-contractor of the M&O site contractor. The AoA reviewed 5 alternatives, and performed life cycle cost analysis on the 3 primary viable options. Building 725 has the lowest life cycle cost of the alternatives that meet the mission need.
- The acquisition approach is best value selection for design, and best value selection for CM/GC for construction with project definition and management by the Site M&O Contractor.
- Project objective and mission need are understood by ES&H staff and they are very knowledgeable of the potential hazards and are integrated into the project team and involved in all levels of planning and field work.

Findings

- Integrated Safety Management system are mature and well integrated into the project through BNL's subject areas within the Standards-Based Management System.
- Project is within the scope of the BNL Facilities' NEPA categorical exclusion.
- Off project hazardous material remediation efforts previously performed provide confidence that remaining hazards are fully characterized.
- The Preliminary Hazard Analysis Report (PHAR) adequately addresses the identified chemical, biological and radiological hazards.
- CFR has a service level agreement to deliver 99% reliable power and cooling, with allowable downtime of 3.5 days per year. Design will accommodate concurrent maintenance.
- CFR has an efficiency requirement of < or = 1.4 with a target of 1.2 PUE, which is driven by EO 13963.
- Cooling of data center loads is planned through a combination of DAE for air cooled loads and direct water cooling for high density HPC loads.

Findings

- BNL Site has dedicated fuel delivery trucks and storage tanks to support fueling of date center generators during extended power outages.
- BNL has reliable on site power infrastructure with underground distribution and few reported outages and power quality events.
- Building 725 has greater than 50K SF available for the initial CFR project scope, with additional space available for future expansion.

Comments

- The Analysis of Alternatives is credible and comprehensive. The "do nothing" analysis includes repair, maintenance, and building infrastructure for power and cooling within the existing computing facility located in B515 in the "do nothing" alternative. Additionally, due to the lack of swing space with infrastructure capable of supporting computing while renovation of existing B515 is on-going this alternative does not satisfy the capability gap.
- The estimated value (~$3M) for abatement of residual hazardous material in building 725 and the short schedule duration of the activities provides an opportunity to complete these activities and reduce the project risk prior to establishing the performance baseline.
- Identification of multiple trade space scope alternatives that can be added or removed from the project and still meet the preliminary Threshold scope is a commendable practice at this stage of project development.

Comments

- The use of a CM/GC acquisition strategy has been successfully utilized by other Science laboratories. It is critical to ensure a preliminary procurement plan is thoroughly developed and approved at all levels of the procurement process. Successful use of a CM/GC acquisition is dependent on a thorough and clear Statement of Work.
- The Risk Management Plan concludes, at this stage of the project, that the available cost and schedule contingency exceeds the 80% probability of success.
- Residual metals on surfaces have been adequately evaluated to develop an approach to remediate the dispersible metal hazards. A validated statistical approach should be considered, in lieu of professional judgement, to confirm the 40 ug/ft2 housekeeping criteria has been achieved.

Comments

- Lead shielding remains in the X-17 hutch and the X-Ray tunnel mezzanine HVAC penetrations. Removal of this material is in the project scope. Consider removing all lead shielding materials prior to initiating final cleaning of the facility to minimize the potential spread of lead contamination.
- Previously performed remediation within facility B725 have provided a sound basis for the preliminary cost estimate.
- Consider performing a validation of the existing asbestos survey prior to abatement and demolition.
- Consider incorporation of a fall protection system to protect staff accessing and/or working on AHUs, chillers, cameras, lighting, etc. on the roof as part of the design.

Comments

- The plan for a staging and uncrating area is a best practice and should improve the utilization of data center space.
- The plan to cool large portions of the load with DAE is an innovative approach that should allow for achievement of PUE goals.
- The plan for use of hot aisle containment is best practice for air cooled loads.
- Consider further review of the following design parameters during the detailed design phase of the project (Prior to CD-2):
  - Review the backup generator requirement to confirm that full generator backup is needed to deliver the 99% reliability goal. It may be possible to obtain 99% reliability through use of UPS only without full generator backup on portions of the load.
  - Review the plan to put fans and pumps on UPS power. It may be possible to put these loads on generator backed power only and allow brief interruptions of air/water flow during generator startup.

Comments

- Consider delaying final design for the direct cooling water loop until more information is available on the specific system requirements. Supply water temperature, water quality, and materials of construction could vary depending on the actual HPC equipment to be supported.
- Review plans to use bus for 480v distribution. It may be possible to use cable tray and conductor cables for less cost and increased flexibility.
- Consider use of open source DCMI solution vs commercial product.
- Review decision to not install smoke detectors and sprinklers under raised floor in data center. Confirm there are no code issues with this decision.
- Review decision to use DAE in the network and tape storage spaces. Light loads may be better suited to more traditional cooling approaches.
- Availability of large capacity chilled water storage tank on site (1MG) is a valuable asset for increasing reliability of the cooling infrastructure. It may be possible to achieve reliability goals with less generator backup as a result.

Recommendation

- Approve CD-1

2. Has a credible and sufficient alternatives analysis been performed? Yes Are project risks identified and has a credible Risk Management Plan been developed? Yes

3. Are the estimated cost and schedule ranges supporting the alternatives credible and realistic for this stage of the project? Yes Are scope, cost, and schedule contingency adequate? Yes

7. Is the abatement of residual hazardous materials within B725 technically feasible, and if so, is abatement scope appropriately bounded in the alternatives analysis and cost and schedule ranges? Yes

Findings

- The Total Project Cost (TPC) range is $64.5M - $77.5M and is based solely on the proposed alternative of renovating Bldg. 725. The low end represents completing the threshold KPP (2.4 MW IT Power with 1.2MW Emergency Pack-up), 10% of scope contingency, 2% escalation, and A/E fees of 10% of construction contract. The high end represents completing the objective scope (2.4 MW Emergency back-up), 25% contingency, 3% escalation, and A/E fees of 11.5% of construction.
- The proposed $67.9M optimal point estimate includes 3% escalation, 11% of scope contingency, 20% cost contingency, and partial design contingency built into the estimate. The conceptual design cost estimate has gone through a 30%, 60%, and 90% review. Vendor quotes are being used for much of the equipment being specified, and do not have design contingency. 10% to 15% design contingency was added to areas with more uncertainty such as demo, HVAC, and raised flooring.
- The $67.9M includes components of the objective scope that have been identified as scope contingency to meet the preliminary threshold KPPs. 100% (2.4MW) backup generation is in the point estimate and 50% (1.2MW) backup is scope contingency.
- HVAC and electrical make up two thirds of the construction cost.

Findings

- A bottoms up cost estimate was prepared by a consulting firm using unit/qty pricing from current market and regional pricing data for data centers being built in the DC/NY/Boston area.
- CD-4 is currently planned for 4Q FY21 with 12 months of schedule contingency. Early finish is scheduled for 4Q FY20.
- There is a need by RHIC/ATLAS to have the new computational facility online by April 2021.
- This schedule currently includes long lead procurement (CD-3a) approval for site preparation and procurement of generators/air handlers. The generators and air handlers can take up to 8 months to procure after award.
- The project has developed a preliminary resource loaded schedule with 143 activities and 35 milestones.
- The project has developed a plan based on the assumption of a 1 year CR in FY17 and a 3 month CR in FY18.

Findings

- The critical path runs through a projected 15 month (FY17/18) continuing resolution, design/site preparation, then construction.
- The project is currently funding and CR constrained. The project is scheduled to receive $1.8M in PED funds in FY17, but due to a potential year long FY17 CR, preliminary design and the use of PED funds is scheduled to start 2Q FY18 after the projected 15 month CR is completed. Site Prep activities are scheduled to start 3Q FY18.
- The risk registry identified 31 risks. A preliminary cost and schedule Monte Carlo analysis was performed showing 80% confidence of completing by November 2020 with a cost of $64M.
- A Risk Management Plan was developed and the project is currently holding quarterly meetings to review and update risks. Monthly meetings will occur after CD-1 approval.
- The $67.9 TPC includes an EDIA percentage of approximately 21%.
- The anticipated time window for migration to the new computational facility is in early FY21, inline with the LHC shutdown and RHIC schedule.

Findings

- No external dependencies are specifically identified in the cost estimate or schedule.
- The project analyzed 5 different alternative strategies. It was determined that alternatives 2 (B725) and 3 were viable and further analyzed. The total life cycle cost for alt. 2 ($125M) was the lowest when compared to alt. 3 ($148M).
  1.) Do Nothing
  2.) Utilize Existing BNL Facilities (B515, B725, Other)
  3.) Construct New Facility (Line Item)
  4.) Construct New Facility (Alternative Financing)
  5.) Establish Capacity at Another Location (ie. Cloud)
- For the preferred Alternative 2 (B725), the renovated building is anticipated to last at least 25 years, which is the life of the HVAC/electrical equipment.
- The PPEP states that no project permits will be needed.

Findings

- B725 hazardous removal site preparation scope was estimated using internal in-house estimators ($2.0M w/o contingency) and then verified by a consultant cost estimate. Full characterization of the remaining lead was done using a metals wipe survey.
- A local environmental consulting firm who has preformed work at BNL in the past completed the cost estimate and lead dust removal plan for the project.

Comments

- The project has completed a thorough analysis of several alternatives and the proposed renovation of B725 appears to be the best and lowest cost alternative to fulfill the mission gap.
- The potential future growth from additional user programs at the lab further validates the selection B725.
- The cost range based on Alternative 2 (Renovate B725) appears realistic at this stage of the project.
- The proposed optimal cost estimate of $67.9M appears adequate to meet the threshold KPPs. Traditionally, projects at this stage contain more design contingency. However the project's cost estimate, which was independently estimated from bottom's up, is further along than the typical conceptual design cost estimate.
- Consider including into the point estimate additional design contingency to account for unknown design issues/comments that occur during design development. The 11% scope contingency currently on the point estimate can be considered design contingency and partially offset this need.

Comments

- The CD-4 date of September 2021 with 12 months of schedule contingency appears realistic and achievable. The early finish date is based on obtaining CD-2/3a (site preparation and long lead procurement approval) and adequate construction funding in FY18. Without early authorization of site prep, schedule contingency may be inadequate.
- Also without performing site preparation activities in FY18 (residual B725 residual hazardous materials abatement), the project will likely not be able to meet the required computing needs in a timely matter by 2020.
- The proposed funding profile calls for $10M in construction funding during FY18. If the full $10M isn't available, the project may be able to optimize and prioritize the long lead activities in order to meet the early completion schedule.
- Consider breaking out the site preparation construction scope from CD-3a and performing this scope on a PME letter approval basis. This provides better flexibility to meet the early completion schedule.

Comments

- With current estimates, it appears the letter approval would be in the range of $3M (includes contingency and project management/ES&H support).
- Performing site prep early would retire one of the major cost risks and allow for project costs to be better bound at CD-2.
- The risks in the register appear thorough and complete.
- The higher risk items include scope creep, failure to capture user requirements, unknown contaminated materials, limited competition for construction, escalation in construction costs, and continuing resolution/funding availability.
- The cost ($11.2M) and schedule contingencies (12 months) presented appear adequate and were validated qualitative analysis and Monte Carlo analysis.
- EDIA of 21% is in the range of similar conventional construction projects completed within the Office of Science.

Comments

- There will likely be RHIC/ATLAS computing and storage needs beyond current BNL capability before the CD-4 date. If the project does not complete by the early completion timeframe, the project can prioritize and have partial BOD in those areas that are needed. Ensure the RFP and construction schedule are optimized to accommodate the computing needs of the users given the late finish scenario.
- Confirm and validate the need for project permits. The project includes environmental components, such as diesel generation, water and sanitary sewer construction, that may require specific permits. If permits are needed, ensure permit information is included in the PEP and schedule by CD-2.
- The scope and cost related to B725 residual hazardous materials abatement appears properly included in the alternatives analysis and cost/schedule ranges.

Recommendations

- Proceed to CD-1

PROJECT STATUS – Pre CD-1 as of July 2016		
Project Type	Line Item	
CD-1	Planned: 4Q FY16	Actual:
CD-2/3A	Planned: 3Q FY18	Actual:
CD-3B	Planned: 1Q FY19	Actual:
CD-4	Planned: 4Q FY21	Actual:
TPC Percent Complete	Planned: __NA___%	Actual: _____%
TPC Cost to Date	$400.3K in OPC	
TPC Committed to Date	$734.9K in OPC	
TPC - Preliminary Range	$64.5M - $77.5M	
TEC – Preliminary Range	$63.6M - $76.6M	
Contingency Cost – Preliminary	$11.2M	__
Contingency Schedule on CD-4b – Preliminary	_12 months	__
CPI Cumulative	NA	
SPI Cumulative	NA	

2. Has a credible and sufficient alternatives analysis been performed? *Yes* Are project risks identified and has a credible Risk Management Plan been developed? *Yes*

4. Is the project being appropriately managed? *Yes* Is the Integrated Project Team established and functioning? *Yes*

6. Are project documents (e.g., Acquisition Strategy, Preliminary Project Execution Plan, and Preliminary Hazard Analysis Report) complete and ready for approval? *Yes* Is the project ready for CD-1? *Yes*

Findings

- An Analysis of Alternatives (AoA) document has been developed in accordance with DOE 413.3B along with a Life Cycle Cost Analysis (LCCA) report subject to OMB A-94 was prepared by HDR.
- The Analysis of Alternatives (AoA) considered five alternatives:
  - Maintain Status Quo (do nothing)
  - Renovate Existing Facilities at BNL
  - Construct New Building at BNL (Line Item Funding)
  - Construct New Building at BNL (Alternative Financing)
  - Establish Capability at Another Location (capability at another national laboratory or cloud computing)
- The preferred alternative was to renovate B725.

Findings

- The 70K cores of computing capacity is being expanded to 100K cores in FY17.
- The Alternative Analysis estimated the following In-House savings over the Cloud in 3 years (for only 10% for computing/data storage):
  - $3.3 million for 7 PB since the Cloud is 3.6 more expensive than In-House for data storage.
  - $0.6 million for 5K cores since the Cloud is twice as expensive as In-House for computing.
- The project will reduce Power Usage Effectiveness (PUE) from the present 2 to meet the 1.4 requirement.
- The low reliability of the existing power and cooling may result in the existing system failing to function before the CD4 for this project.

Findings

- The FPD will be formally appointed at CD-1, but the FPD has been following very closely the development of the project since its inception.
- The CFR Laboratory project team is supported by:
  - BNL Modernization Project Office
  - BNL CFR Advisory Group
  - BNL CFR User Representatives
  - BNL Procurement & Property Management
  - BNL Support Organization (Env. Services, Fire Protection, QA, ES&H Oversight, and Env. Compliance)
- In the future the team will be supported by an A/E, CM/GC and a Commissioning Agent.
- When fully staffed the project management will be 5.8 FTEs (2 FTEs full time)

Findings

- The Preliminary Project Execution Plan (PPEP) has been drafted outlining the roles and responsibilities of the project team.
  - A/E Services will be fixed price contract, best value section
  - CM/GC will be a fixed price contract, best value selection with two phases:
    - Phase I – pre-construction services
    - Phase II (option) – construction
- As part of a tailoring strategy the CFR project will propose a CD-2/3A for the start of early site preparation activities (hazardous material remediation, procurement of LLP HVAC and electrical equipment).

Findings

- A Preliminary Risk Management Plan has been developed with the very high impact risk being stated as:
  - Significant increase in project scope (Creep)/Design contingency/estimate uncertainty.
  - Limited competition results in higher that expected cost
  - User generated scope changes during construction
  - Increasing construction cost escalation rates (cost)
  - Continuing resolution and delays in FY17/18 funding
- Risk associated to the design and execution of the project seems to be sufficiently captured in the risk registry.
- The risk registry is reviewed monthly during the status meetings and quarterly by the risk management team.

Comments

- Good management team has been formed and the project seems to be managed very well, with experienced project director, project manager, and project control personnel.
- Documentation required for CD-1 has been adequately developed and is ready for CD-1
- Early Procurements of Long Lead Equipment for Generators and Air Handlers is planned for FY18 is approximately $7M
- $3M will be required in FY18 for lead removal that will take approximately 6 months.
- Early removal of Lead from the space would help reduce scope and schedule risk.

Comments

- The concept of using a CM/GC is a good concept, but has to be a good contractor that you can work with (it's the relationship)
- The impacts of BES computational/data needs have not been quantified in the scope of the project. If BES is included into the project scope, there will be impacts on the cost and schedule.
- At this stage, the project has an appropriate risk registry and risk management plan
- Documentation should clarify that the steep ramp up to the 6MW would be need in 2025 or later. Close monitoring over the next couple years to make sure that the modularity of the solution provided by CFR are still relevant to the needs of ATLAS by the time the facility will be operational in late 2021.
- Data Center Optimization Initiative (DCOI) memo requirements are still being discussed. The memo does not go into effect until January 2017. Should not have impact on the CD-1.

Recommendations

- Request approval for CD-1