July | 2009

Statement of Mission Need

SMN

Fermi National Accelerator Laboratory
SLI Modernization Project FNAL-11-002
Utilities Upgrade

Non-Major System Acquisition Project

Submitted by:

______________________________ 8/17/09
Stephen L. Webster
Federal Project Director
DOE Fermi Site Office

Date

______________________________ 8/17/09
Joanna M. Livengood
Site Manager
DOE Fermi Site Office

Date

Recommended for Approval:

______________________________ 8/21/09
Gary Brown, SLI Program Manager
Laboratory Infrastructure Division
Office of Science (SC-31)

Date

______________________________ for 8/21/09
Daniel R. Lehman, SC-1.3
Director
Office of Project Assessment

Date

______________________________ 9/8/09
Marcus Jones, SC-31
Director
Office of Security, Safety and Infrastructure

Date

Approval

After reviewing the project justification material, including the positive recommendation from the Office of Project Assessment (SC-1.3), I find the Statement of Mission Need for the Utilities Upgrade project, satisfactory and authorize FSO to proceed to CD-0.

______________________________ SEP 18 2009
W.F. Brinkman, SC-1
Director, Office of Science

Date

MISSION NEED STATEMENT

A. STATEMENT OF MISSION NEED

Maintaining a dependable base from which science programs can be accomplished is dependent upon robust, redundant, maintainable, and flexible utility systems. The backbone of Fermilab's utility systems is its Industrial Cooling Water (ICW) and High Voltage Electrical (HV) systems. Without these systems, science at Fermilab cannot exist.

The ICW system consists of ponds, pumping stations and approximately 72,000 feet of underground network piping, supplying process cooling and fire protection water throughout the lab's 6,800 acre site. As most of the system was installed during the construction of the lab almost 40 years ago, most components of the system have reached the end of their useful life. The fragile state of the piping and valves currently in service, reduction in flows by biofouling as well as frequent pipe failures jeopardize the reliability and maintainability of the ICW system. The current state of the system requires frequent and unscheduled repairs which are complicated by insufficient and often malfunctioning isolation valves, enlarging the disabled area being repaired. Reliable process cooling and fire protection water service cannot be provided to current accelerator and experimental facilities areas as well as those areas slated for development of future facilities unless substantial re-investment in the lab's ICW system is provided.

The HV electrical system consists of substations, switches and transformers. There are various elements of the high voltage distribution system that are rated as poor based on their current condition, are unreliable and will continue to deteriorate with age. Future science at Fermilab is dependent upon a robust, redundant, maintainable, and flexible High Voltage (HV) electrical distribution system for both programmatic and conventional power needs. The Master Substation (MSS) and numerous oil switches and transformers across the site were installed during the original construction of the lab in the early 70's. Much of this equipment is now beyond its useful life, and substantial reinvestment in this system is required for continued science in support of the Fermilab mission.

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B. ALIGNMENT OF MISSION NEED

B.1 OFFICE OF SCIENCE STRATEGIC PLAN

The American Competitiveness Initiative encourages “Federal investment in the tools of science - the facilities and instruments that enable discovery and development.” The DOE Office of Science (SC) strategic plan lays out four broad goals: solving the Nation's energy challenges, supporting the physical sciences, building major research facilities, and keeping the Nation at the forefront of intellectual leadership in science.

The mission of the Department of Energy's Office of Science is to deliver the remarkable discoveries and scientific tools that transform our understanding of energy and matter and advance the national, economic, and energy security of the United States. The Office of Science executes this mission by managing fundamental research programs in basic energy sciences, biological and environmental sciences, high energy and nuclear physics, fusion and computational science. In addition, the Office of Science is the Federal Government’s largest single funder of materials and chemical sciences, and it supports unique and vital parts of U.S. research in climate change, geophysics, genomics, life sciences, and science education.

Another critical element in the execution of this mission is the management of 10 world-class laboratories, which often are called the “crown jewels” of our national research infrastructure. The national laboratory system, created over a half-century ago, is the most comprehensive research system of its kind in the world. The mission of the Science Laboratories Infrastructure (SLI) program within the Office of Science (SC) is to support the conduct of Departmental research missions at SC laboratories by funding line item construction for revitalization and repair of the general-purpose infrastructure, and by cleaning up and removing excess facilities that are not transferable to the Office of Environmental Management.

B.2 STRATEGIC FIT OF MISSION NEED

Fermilab provides a singular focus on the grand challenges of particle physics; understanding the fundamental nature of matter and energy, and of space and time. It is the only laboratory that is entirely devoted to this field.

Fermilab strives to understand the universe at a more basic level by investigating the elementary particles that are the fundamental constituents of matter and the forces between them, thereby underpinning and advancing DOE missions and objectives through the development of key cutting-edge technologies and trained manpower that provide unique support to these missions. This program will provide world-class, peer-reviewed research results in high energy physics and related fields, including particle astrophysics and cosmology, executing a long-range strategy for high energy physics research and technology.

Fermilab will remain entirely focused on particle physics. For the U.S. to remain among the leaders in this field, a central laboratory that builds and exploits new facilities in partnership with universities and other national and international laboratories is essential. Facilities for particle physics are global and ever more challenging. A laboratory with a singular focus where such facilities can be consolidated will be a competitive advantage for the U.S. in the future.

Particle physics is a central component of the physical sciences, focused on the fundamental nature of matter and energy, and of space and time. Discoveries in this field, often called high-energy physics, will change our basic understanding of nature. The Standard Model of particle physics provides a remarkably accurate description of elementary particles and their interactions. However, experiment and observation strongly point to a deeper and more fundamental theory that breakthroughs in the coming decade will begin to reveal.

To address the central questions in particle physics and thus to deliver on the Department of Energy's missions, we use a range of tools and techniques at three interrelated frontiers:

- The Energy Frontier, using high-energy colliders to discover new particles and directly probe the architecture of the fundamental forces.

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- The Intensity Frontier, using intense particle beams and/or high precision, ultra-sensitive detectors to study rare or very subtle processes and to discover the fundamental symmetries that govern the interactions of elementary particles.
- The Cosmic Frontier, using naturally occurring processes (which do not require particle accelerators) to obtain new insight and new information about elementary particles and fundamental forces and to reveal the natures of dark matter and dark energy.

These three frontiers form an interlocking framework that addresses fundamental questions about the laws of nature and the cosmos. These three approaches ask different questions and use different techniques, but they ultimately aim at the same transformational science.

Fermilab has, for several decades, conceived, planned, designed, constructed, managed, and operated large-scale user facilities and hosted international scientific collaborations for particle physics and particle astrophysics, which led to many discoveries including the top quark, the bottom quark, the tau neutrino, and the matter-antimatter transition in the *Bs* system. Examples of current large scale user facilities are the Tevatron (the highest-energy and highest-luminosity proton-antiproton accelerator in the world), the proton accelerator complex and NuMI (providing the highest-power neutrino beams in the world), the CDF and DZero Tevatron collider experiments, and the MINOS neutrino experiment. A second generation long-baseline neutrino experiment (NOvA) is currently under construction. Design concepts have been established and technology development has been initiated for the next generation of world-leading facilities including the International Linear Collider, longer baseline (>1000 km) neutrino beams, facilities for the study of rare processes, and a multi-MW proton facility. Design concepts for a multi-TeV muon collider are being established as well.

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B.3 INTERNAL/EXTERNAL FACTORS

The Mission Readiness Assessment Process was initiated at Fermilab during FY08. An initial overview assessment was conducted with the Directorate to evaluate Technical facilities and Infrastructure capabilities relative to the planned mission. This effort will be expanded in cooperation with the various stakeholders to assess and document current and anticipated utility requirements throughout the existing complex.

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C. CAPABILITY GAP

C.1 CAPABILITY GAP

Fermilab is entirely focused on particle physics. While CERN will continue research at the energy frontier, design concepts have been established and technology development has been initiated to refocus the lab's research efforts to neutrino physics at the intensity frontier. Future accelerators and experimental facilities will exhaust the capabilities of the existing utility systems, in required capacity, reliability and redundancy. Existing facilities are subjected to decreased reliability as pipe breaks and electrical equipment failures become ever more frequent.

The Industrial Cooling Water System - **ICW**

The ICW system provides surface water to process cooling and fire protection systems throughout the laboratory. Large portions of the current ICW system, including the major pumping and distribution backbone, were designed and installed around fixed target experiments as part of the initial laboratory construction. The program focus has since shifted to colliding physics, expanding the areas of ICW service to new areas of the site and changing capacity needs throughout the system. Large projects have modified and extended the ICW system to provide service to the new facilities, but are still reliant upon the original system for their water supply. The reliability of this system is being reduced by the age and condition of the piping, biofouling as a result of zebra mussel accumulation as well as a lack of segmentation and control valves. Isolated pipe repairs to the system are required at an accelerating rate due to the age and corrosion of the piping. Each repair impacts larger areas of the site, and therefore programs. The repairs themselves are made more difficult because of the failure of segmentation control valves.

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Figure 1 – Typical ICW Break

Figure 2 – Typical ICW Repair

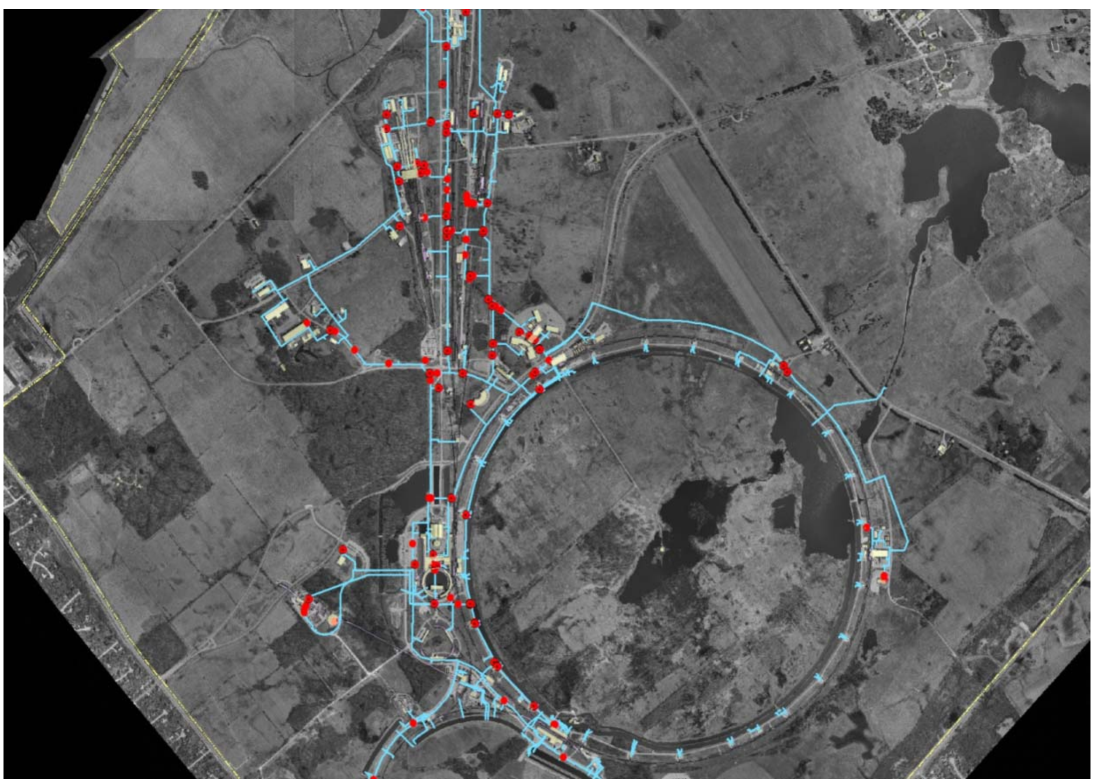

Figure 3 – History of ICW System Breaks (18 years)

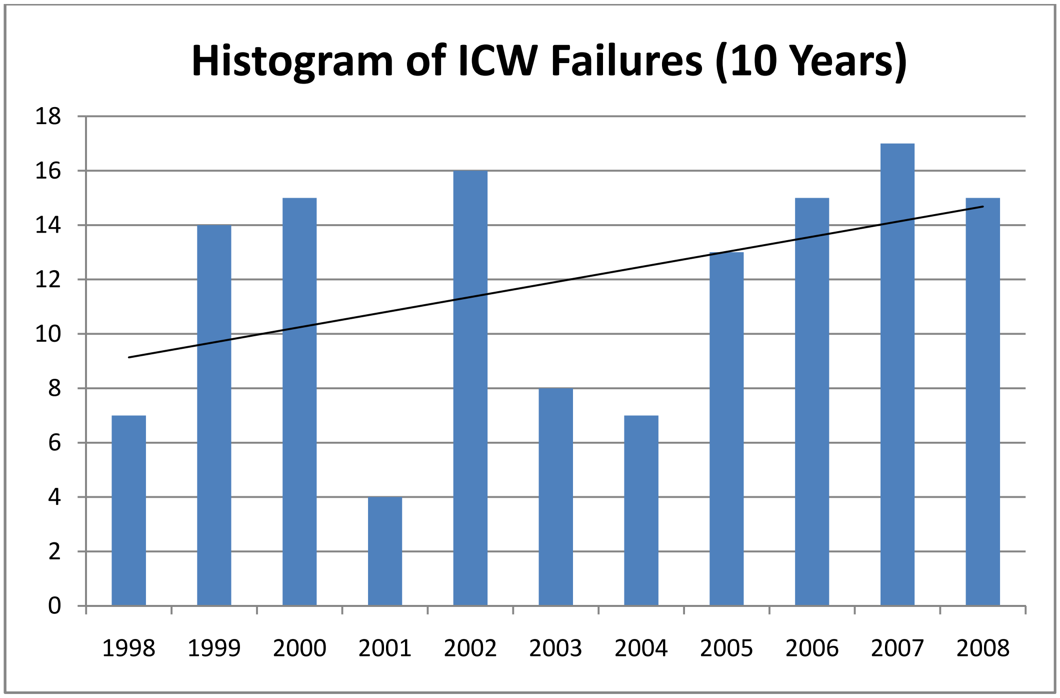

Figure 4 – Histogram of ICW System Breaks (10 years)

TABLE 1 - APPROXIMATE YEARLY COSTS ($K)										
1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
$300	$700	$800	$200	$800	$400	$300	$700	$800	$900	$800

The yearly cost of maintenance and repair costs directly related to ICW failures averages $600,000 per year. With the rate of failures increasing over time, it is expected that maintenance and repair costs related to ICW failures will increase 4-6% per year.

<u>The High Voltage Electrical System – **HV Electrical**</u>

The Master Substation, part of the original construction of the laboratory, receives power from the local utility company at 345kVa and transforms it to 13.8kVa for distribution throughout the Fermilab site.

Figure 5 – Master Substation Cable Vault

Figure 6 – Proposed Cable Vault

Aging switchgear, disconnect switches, internal distribution equipment, and monitoring and control systems have become obsolete or unsuitable for safe, efficient, and reliable operation. 100% of the Master Substation equipment is original equipment from the original construction of the laboratory.

Figure 7 - Typical Oil Switch Termination

Figure 8 - Typical Air Switch Terminations

Unit substation equipment throughout large portions of the site consists of oil-filled switches and transformers that are at end-of-life. This equipment presents both reliability and environmental vulnerabilities.

C.2 OTHER POTENTIAL CAPABILITIES

Because Fermilab is the only DOE laboratory focused on high-energy physics, the future of high-energy physics in the United States relies on building new accelerators and experimental facilities at Fermilab. DOE has no other means to address the capability gap other than to mitigate the lab's failing ICW and HV electrical systems.

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C.3 BENEFITS FROM CLOSING THE GAP

Refurbishment of the utilities will provide a reliable and flexible base to serve existing facilities and provide the backbone from which future projects will build to serve new facilities. This will establish a stable base from which to serve both programmatic and conventional power requirements across the site.

The Industrial Cooling Water System - **ICW**

A refurbished Industrial Cooling Water system will provide a reliable and flexible utility to serve existing facilities and provide the backbone from which future projects can be supported. Revitalization of the ICW system will establish a stable base for both process cooling and fire protection requirements across the site. The existing ICW system is increasingly expensive to operate and maintain and represents an ever-present vulnerability to the laboratory's ongoing programs.

- Without a revitalized ICW system, current experimental facilities will continue to be jeopardized by the lack of dependable cooling water.
- A failure of the ICW system impacts the fire protection of buildings and enclosures whenever the ICW systems are shutdown while repairs are made.

The High Voltage Electrical System – **HV Electrical**

A dependable Master Substation facility is essential to the support of mission critical programs. Under normal operating conditions, it works in tandem with the Kautz Road Substation to provide power throughout the site. Neither substation can support the entire program alone. If one substation goes down, science programs at the laboratory will be shutdown. During periods of reduced power usage, each substation, in turn, is de-energized for maintenance activities. The redundancy of these facilities is critical to proper maintenance of the power distribution system as a whole and to the laboratory's ability to support the scientific programs without interruption.

The unit substations spread throughout the site are critical to the operation of individual accelerator, experiment, and computing operations. Without replacement of aging equipment, maintenance costs and service interruptions will continue and likely grow in both frequency and severity (increasing exponentially), putting our scientific programs at risk.

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C.4 IMPACT IF GAP IS NOT RESOLVED

The costs of operating and maintaining the existing Industrial Cooling Water system continues to increase. Many components of this system are at or beyond end of life. The costs of repairing leaks and replacing pipe sections redirect our maintenance resources from other areas important to laboratory operation. Both day-to-day and R&D activities are being impacted by the system shutdowns required to conduct these repairs. On average, a typical ICW repair requires 100 man-hours of effort to repair and results in a one to two week delay to programming. In many cases, the areas impacted are enlarged due to non-functioning segmentation valves, critical in allowing redirection of flow. Without a major refurbishment (or redesign and reconstruction) of this system, these costs and interruptions will continue and increase in both frequency and severity, putting our scientific programs and fire protection safety at risk.

Refurbishment of the Master Substation will provide a reliable and flexible utility to serve existing facilities and provide the backbone from which future projects will build to serve new facilities. This will establish a stable base from which to serve both programmatic and conventional power requirements across the site. The existing equipment within this facility is difficult to maintain as replacement parts become less available. Diminishing supplies of spare 13.8kV transformers or main breakers are available to supply critical spare parts unavailable in today's marketplace. Frequent disrepair and changing out of dated components put the laboratory's personnel's safety at risk. This facility represents an ever-present vulnerability to the laboratory's ongoing programs.

Deferred maintenance requirements of the lab's utility infrastructure currently comprises 82% of the lab's total FY08 Deferred Maintenance backlog, or $26M of the $32M. Most significantly, the increasing repair costs have a secondary, negative effect on maintenance and repair funding by diverting funds to the utility systems, putting other infrastructure at additional risk.

D. APPROACH

D.1 PLANNED APPROACH

The Industrial Cooling Water System - **ICW**

Computer models will be used to study alternative distribution layouts and size pumps and piping to meet flow and pressure requirements. Anticipated ICW requirements for future facilities will be entered into the system model. This will help ensure that the refurbished system will have the flexibility to accommodate future needs without major re-construction. Segmentation valves will be designed into the system to improve leak monitoring and locating activities and minimize impacts from shutdowns for repairs. A segmented system will be designed to overlap with multiple sources, decreasing the likelihood of total failure at any single point in the system. Final routing of distribution mains will be designed to minimize environmental disturbances and accommodate ongoing physics programs with minimum interruption.

The High Voltage Electrical System – **HV Electrical**

The technical requirements for the Master Substation are well established. Overall capacity is adequate for portions of existing loads assigned to this facility. An assessment of future loading will be conducted using the Laboratory Plan as a basis to establish future modes of operation. While there is no increased capacity anticipated, this effort will help ensure that adequate distribution flexibility is designed into the upgrades.

The laboratory has recently conducted an assessment of existing unit substations in the Fixed Target Area. From this assessment, underutilized transformers and switchgear have been identified and, where feasible, are being taken out of service. An inventory of existing oil-filled switchgear and transformers across the site has also been completed. Using the Laboratory Plan as a foundation, the various stakeholders will assess and document current and anticipated high voltage power requirements throughout the existing complex. Working with information gathered from these efforts, candidates for replacement will be selected and prioritized.

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D.2 PROPOSED ALTERNATIVES

The following project alternatives will be analyzed in the conceptual design phase to ensure the proposed strategy is the most cost-effective method of meeting the identified mission need.

The Industrial Cooling Water System - **ICW**

- Alternative 1 (Proposed): Successfully complete the scope of the Industrial Cooling Water upgrades as part of the Utilities Upgrade Project within the cost and schedule to achieve the replacement of the vulnerable ICW components.
- Alternative 2: Utilize domestic water from adjacent community to provide fire protection service and mechanical cooling for process heat rejection through all or portions of the site.
- Alternative 3: Do nothing. (i.e., continue to operate the current HV system with isolated repair or replacement of switchgear, transformers, and distribution equipment as needed)

The High Voltage Electrical System – **HV Electrical**

- Alternative 1 (Proposed): Successfully complete the scope of the High Voltage Electrical upgrades as part of the Utilities Upgrade Project within the cost and schedule to achieve the replacement of the vulnerable Master Substation and substation components.
- Alternative 2: Do nothing. (i.e., continue to operate the current HV system with isolated repair or replacement of switchgear, transformers, and distribution equipment as needed)

D.3 CONSTRAINTS AND ASSUMPTIONS

D.3.1 Operational Limitations

All equipment and work on the project involves technology based on industry standards and conventional construction practices. There are no unusual operational limitations or other special considerations associated with this project. This project is not expected to involve highly complex or unique technologies or methods. No unusual technical requirements or constraints are known to exist that would hinder fulfillment of the capability gap.

D.3.2 Geographic, Organizational and Environmental Limitations

This work will be accomplished at the FNAL site to fulfill its strategy and mission need. While the physical work will likely cross organizational landlord boundaries and areas of radiological and environmental concern, the laboratory has well established and institutionalized controls to deal with these issues. FNAL will coordinate and integrate the design and construction activities with scientific research stakeholders to ensure the mission need is met without interruption of ongoing programs.

D.3.3 Standardization and Standards Requirements

All project work will be executed in accordance with applicable Public Laws, Executive Orders, OMB Circulars, Federal Property Management Regulations, and DOE Orders. All systems will be designed to applicable ASHRAE standards, and the planning, acquisition, siting, designing, construction, operating and maintenance decisions for this project will be based on considerations of LEED sustainable development principles as appropriate.

D.3.4 Environmental, Safety and Health

No environmental issues have been identified to date that would significantly impact this acquisition. All requirements of the National Environmental Policy Act (NEPA) and its implementing regulations will be addressed during this acquisition. A NEPA determination will be made early in the conceptual design phase, well before CD-1 approval. No action will be taken that could have adverse environmental effects or that would limit the choice of reasonable alternatives prior to NEPA determination. DOE ES&H requirements will be fully integrated into the life cycle of the project. An assessment of the hazards associated with the operations of this system will be undertaken during the design phase, to ensure that adequate hazard controls are incorporated.

D.3.5 Safeguards and Security

The alternatives under consideration would not result in any special safeguard and security issues, nor would they require any changes to the safeguards and security requirements at FNAL. The site is categorized as a low hazard non-nuclear facility. Currently access to the site is controlled primarily to ensure worker and public safety and for property protection. Normal safeguards and security requirements will be continued.

D.3.6 Interface with Existing and Planned Acquisitions

There are no known interfaces that must be identified and planned for with existing or planned acquisitions beyond this project.

D.3.7 Affordability Limits on Investments

This acquisition will be accommodated within the planned out year budgets of the SLI Program, subject to annual congressional appropriations. Standard cost control measures will be implemented during all phases of the acquisition, including but not limited to obtaining cost estimates at various phases; the development of cost, schedule and scope contingency based upon SC and Fermilab experience, and value engineering and design reviews conducted in accordance with established procedures.

The preliminary Total Estimated Cost (TEC) range for this project is $31.3M to $34.9M. The Total Project Cost (TPC) range is $32.4M to $36.0M. Design activities for this project will be constrained using a ‘design to cost’ approach. Acquisition for design activities will incorporate requirements to ensure construction cost estimates reflect the latest market conditions.

D.3.8 Goals for Limitations on Recurring or Operating Costs

No new operating costs are anticipated. The overall energy usage may be somewhat lower because of the opportunity to reduce the inventory of under-utilized, energized equipment, and install energy efficient systems. Operational savings will be

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realized due to improved performance, increased reliability, and elimination of secondary containment structures.

D.3.9 Legal and Regulatory Constraints or Requirements

The acquisition will be in full compliance with all applicable Federal, state and local requirements. No negative environmental impacts have been identified or are anticipated. Similarly, there are no known legal or regulatory issues that require special considerations as part of the detailed alternative analysis to support a CD-1 decision.

D.3.10 Stakeholder Consideration

Considerable stakeholder issues are anticipated in the areas of needs assessment and operation disruptions. Internal and external stakeholders will be extensively involved in the analysis of project alternatives, planning, design and implementation phases of the project to minimize the disruption to scientific programs and assure responsiveness to stakeholder needs and requirements.

D.3.11 Limitations Associated with the Program Structure, Competition and Contracting, Streamlining, and Use of Development Prototypes or Demonstrations

This project is expected to be completed utilizing conventional construction. All proposed work can be accomplished with current technology and methods. No research or development is required.

D.3.12 Space Management

Congress established the requirement that all new space be offset by eliminating an equivalent square footage of excess buildings and facilities. The potential increase in square footage from this project would be offset via the subsequent demolition of existing facilities as outlined in the Statement of Mission Need for the Disposition of Excess Facilities at SC Laboratories or via allocation of space already banked by Fermilab and/or from another SC site.

D.3.13 Sustainable Design

Fermilab will incorporate sustainable design principals into the planning, design and construction of these upgrades. The project processes and each project element will be evaluated to reduce their impact of natural resources without sacrificing program objectives. Fermilab designs will incorporate maintainability, aesthetics, environmental justice and program requirements to deliver a well-balanced project. If appropriate, internal and external reviews of design and construction provide a check and balance system for environmental, aesthetic and maintenance issues.

E. RESOURCE AND SCHEDULE FORECAST

E.1 RESOURCE FORECAST

For the purpose of the mission need analysis, the following preliminary costs and schedule are based upon a refurbished Industrial Cooling Water and High Voltage Electrical system that meets the capabilities required to close the performance gap.

Total Estimate Cost: $34.9M
Total Project Cost: $32.4M to $36.0M

Funding Profile					
Fiscal Year	**10**	**11**	**12**	**13**	**14**
Other Project Costs	$1.1M				
PED Funding Profile		$1.3M			
Construction Funding Profile			$16.8M	$16.8M	

E.2 SCHEDULE FORECAST

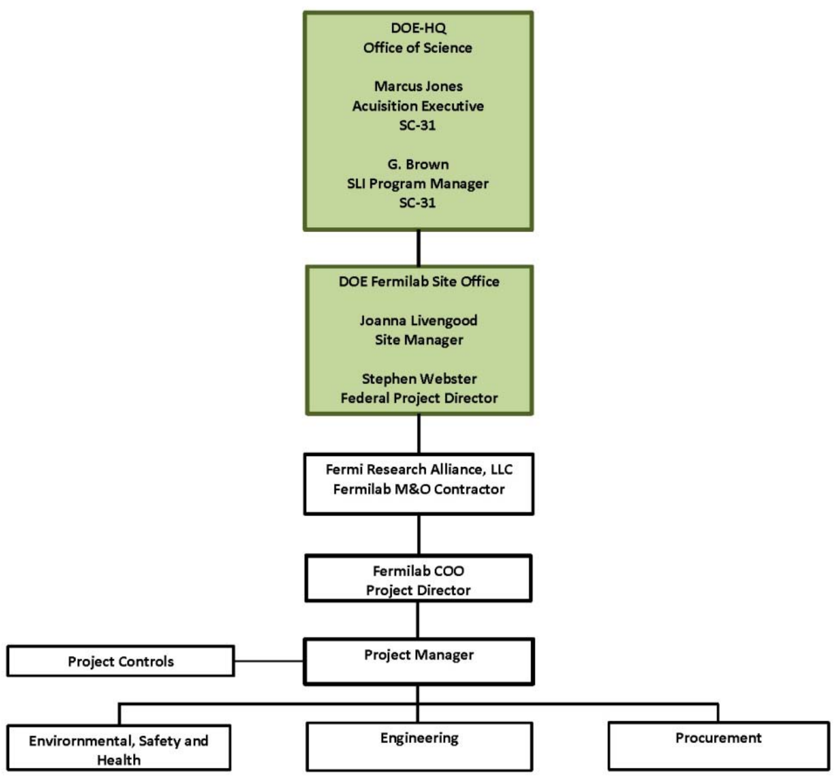
CD-0 Approve Mission Need	FY10
CD-1 Approve Alternate Selection and Cost Range	FY10
CD-2 Approve Performance Baseline	FY11
CD-3 Approve Start of Construction	FY12
Construction Complete	FY14
CD-4 Approve Start of Operations	FY14

Section F

F. Development Plan

DOE SC-31 will serve as the Acquisition Executive after the Acquisition Strategy is signed by SC-1 and will approve the remaining critical decisions and level 1 baseline changes. The Federal Project Director, with the support of the Fermi Site Office, will provide overall project management oversight, approve key project documents, and provide necessary funds via approved financial plans. Fermilab will provide engineering support and management support services, and administer all design and construction subcontracts. Preliminary work will be managed by the Facilities Engineering Services Section until an integrated project team is designated prior to CD-1.

Planning meetings will begin once CD-1 is approved. If and when this occurs, these meetings will include project stakeholders, the project team, and an Architect/Engineering Firm (A/E), who will develop the design documents for this project.



Organizational Chart