Fermi National Accelerator Laboratory

A Department of Energy National Laboratory Managed by Fermi Research Alliance, LLC

Project Plan

Cryo AIP

May 2013

The Project Plan describes the management, control systems, and procedures used by Fermi National Accelerator Laboratory (Fermilab) to meet the technical, cost, and schedule objectives of this project. This controlling document establishes the basis against which progress will be measured.

The Project Plan is to be viewed as a "living document," and as such, will be revised when necessary. The Project Manager is authorized to approve non-substantive changes to the Project Plan (e.g., name changes to the positions cited in the Project Plan), but will inform the DOE Project Director via e-mail of such changes. Baseline changes will require approval by the Department of Energy's (DOE) Fermi Site Office.

Table of Contents

A. Submittal Page

Submitted, Accepted, and Approved by:

5/23/13
Stuart Henderson — Date
Associate Director
Fermilab Directorate

5-21-13
Roger Dixon — Date
Accelerator Division Head

5/21/13
Mary Convery — Date
Muon Campus Program Coordinator

5/21/13
Gerald Annala — Date
Project Director

5/21/13
Arkadiy Klebaner — Date
Project Manager

B. Project Objectives

Fermilab is upgrading the accelerator complex to facilitate the creation of more intense particle beams for experiments that explore particle interactions. The upgraded complex will enable the laboratory to proceed with planned muon experiments, Muon g-2 and Mu2e, that will explore rare sub-atomic processes and make precision measurements.

These experiments utilize superconducting magnets that require cryogenic services. A cryogenic system to provide these services consists of four Tevatron Satellite refrigerators, a compressor system, a cryogenic distribution system, and an auxiliary system necessary for the cryogenic system operation. The scope of the Cryo AIP project includes materials, services and effort associated with the design, construction, testing, installation and commissioning of the cryogenic system described in Section C. The estimated Total Project Cost (TPC) is $9.74M.

C. Project Scope

The project scope includes design, fabrication, installation, testing, and commissioning of the Muon Campus cryogenic system (the Cryogenic System) in support of experiments in the following configurations:

1. Muon g-2 experiment (Superconducting muon storage ring)
2. Mu2e experiment (Three superconducting solenoid magnets)
3. Mu2e and Muon g-2 combined

The Cryogenic System includes the following key components and sub systems:

1. Four Tevatron model 2016C Mycom oil-flooded screw compressors located at the A0 compressor building;
2. Four Tevatron Satellite refrigerator cold boxes;
3. Four modified Tevatron reciprocating dry expanders;
4. Four modified Tevatron reciprocating wet expanders;
5. Four modified Tevatron valve boxes;
6. Refrigerator building interconnect cryogenic transferlines;
7. Single modified AP10 bayonet can;
8. Hard piped connection to interface Muon g-2;
9. Mu2e to the refrigerator building transfer line with a bayonet can at the refrigerator end and a distribution box at the Mu2e end;
10. A0 compressor building to the Muon Campus helium piping system (suction and discharge headers);
11. Refrigerator building interconnect piping system;
12. Modified CHL's vertical liquid nitrogen dewar;
13. Two 30,000 gal Tevatron helium gas storage tanks;
14. Gas management system;
15. Instrument air system;
16. ODH systems;

17. Local refrigerator and compressor controls.

D. Project Organization Structure

Funds will be made available to the U.S. Department of Energy (DOE) for the project on an annual basis following passage of legislation by the U. S. Congress..

The FSO administers the Management and Operations (M&O) contract with Fermi Research Alliance (FRA) for the operations of Fermilab and exercises oversight of Fermilab. The FSO Manager, Michael J. Weis, has been delegated responsibility and authority for execution of the project. This includes line management authority, responsibility and accountability for overall project implementation and contract administration. The specific responsibilities of the FSO Manager are:

- Supervision of DOE Project Director and FSO staff;
- Review of and concurrence with this Project Plan;
- Review and approval of documents as required by federal regulations or departmental orders or notices;
- Approval of Fermilab subcontract actions, within the authority delegated to FSO.

The Chicago Office (CO) of DOE may provide support to the FSO in the following areas as requested:

- Quality Assurance;
- Implementation of ES&H;
- Project Management Systems;
- Design Review;
- Legal.

The FSO Manager has delegated authority and responsibility for management and direction of the project to the DOE Project Director, Paul Philp. The specific responsibilities of the DOE Project Director include:

- Review and approval of this Project Plan and changes thereto;
- Measurement of performance against established goals including technical performance, cost levels, and schedule milestones;
- Making any necessary changes or corrective actions within the appropriate thresholds established in this Project Plan;
- Overseeing Fermilab's management of construction activities;
- Monitoring project progress via reports prepared by the Fermilab Project Manager.

The DOE has delegated the responsibility for this project to Fermilab.

Fermilab Management

This project will be managed based on the guidance provided in DOE Manual 413.3-1. Other DOE Order and Manuals, especially regarding design, engineering, contingency and indirect costs have been used to determine the basis for estimating costs and establishing baselines. This identification, implementation and compliance with other relevant Orders, Manuals and requirements are the responsibility of the Integrated Project Team (IPT).

The IPT structure shown in Figure 1 identifies the organizational structure that will be responsible for procurement and installation of this Project.

As with all activities at Fermilab, the Directorate is at the highest level of responsibility. Fermilab's Associate Director, Stuart Henderson, and Accelerator Division Head, Roger Dixon, are the Project Sponsors championing the project. The Project Sponsors establish and approve the mission need and allocate the funds from the Fermilab budget.

Procurement, installation, cost and schedule for this project are the responsibility of the Accelerator Division (AD). The AD will manage the work associated with this project, as well as accept line management responsibility for safety.

The Project Sponsors have designated Mary Convery of the AD as the Muon Campus Program Coordinator (Program Coordinator) and Gerald Annala of the AD as the Fermilab AIP Director (Project Director). The Program Coordinator and the Project Director are key stakeholders that have accepted the scope of work as described within this Project Plan. The Program Coordinator will initiate all scope changes and shall secure any additional funding authority as defined by the Fermilab Project Manager and coordinate interaction with other Muon Campus projects.

Fermilab has designated Arkadiy Klebaner (AD Cryogenics Department) as Project Manager. The Fermilab Project Manager will utilize the resources of the AD Cryogenics Department as appropriate for design, construction, installation, and testing coordination.

All project stakeholders are considered to be organizational project assets and are considered invaluable during the planning and execution of the project. The Program Coordinator and Project Manager will identify those key stakeholders and obtain the relative inputs critical to the project's success.

Prospective users, landlord ES&H personnel and building managers are always key stakeholders that are included in the process.

The AD ES&H Department, headed by John Anderson, has the responsibility for providing Environmental, Safety, and Health coordination and oversight of ES&H throughout the project. As with all Fermilab projects, attention to ES&H concerns will be part of the project management and Integrated Safety Management (ISM) will be incorporated into all processes. Line management responsibility for ES&H will be maintained on this project. Safe coordination of installation activities will be accomplished through the Project Manager, Project ES&H Coordinator, Project Engineer, and Task Manager. During installation the Subcontractors, T&M Crafts, and all Fermilab personnel will utilize Project Hazard Analyzes (PHA) to plan all work

and mitigate hazards. The Project Manager and Project ES&H Coordinator will audit compliance with all applicable ES&H requirements.

Accelerator Division will be responsible for reviewing the project for NEPA compliance. We expect that the project will comply within the Fermilab Muon Campus Categorical Exclusion (CX) approved by DOE on June 8, 2012.

Organizational Chart

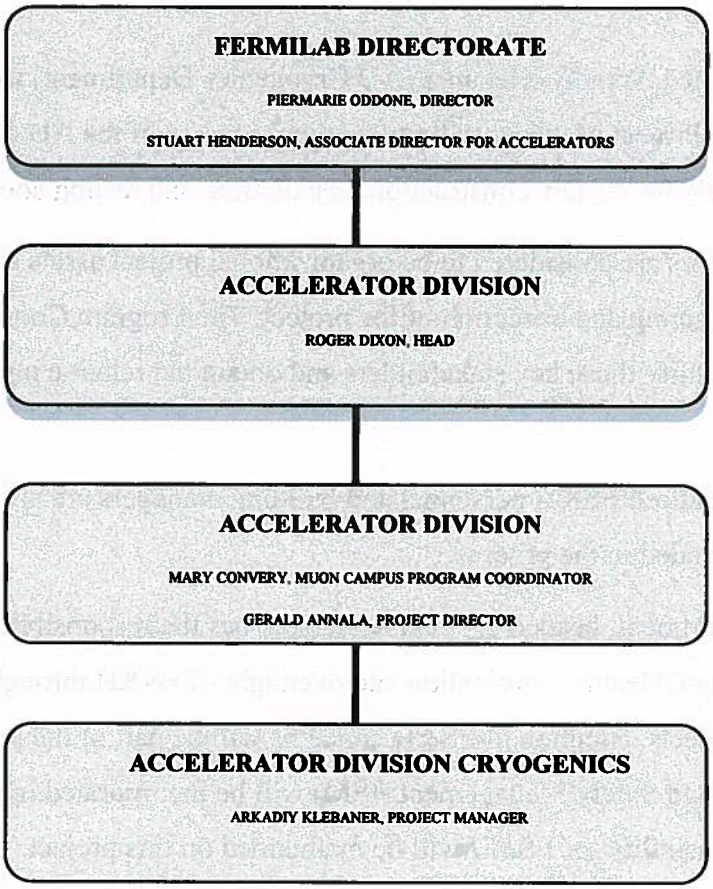

Figure 1 Project Organizational Chart

E. Resource Requirements

Funding

This project is an Accelerator Improvement Project (AIP) with a Total Project Cost (TPC) of $ 9,737,269.

Personnel

Fermilab Divisions and Sections will be responsible for assigning the responsibilities of individuals within the project organization. The Project Manager will be responsible for coordinating within the Accelerator Division and other divisions to obtain the appropriate technicians and project support personnel. The Task Coordinator/ Manager will coordinate with the Fermilab Time and Materials office to arrange all necessary craft support.

F. Project Baseline

The Project Baseline identifies the basis for evaluating project performance. The components are the Work Breakdown Structure (WBS), which identifies each component of the project, the Baseline Cost Estimate, and the Baseline Schedule and Milestones.

Work Breakdown Structure (WBS) Dictionary

Listed below in Table 1 is the breakdown of the WBS for this project. Further breakdown of the WBS may be applied as required for accounting purposes.

Table 1 WBS Dictionary

WBS	Item Description
Cryo1	**Muon Campus Cryogenics - AIP**
Cryo1.02	Project management
Cryo1.03	Cryo Basic engineering
Cryo1.04	Cryogenic plant sub systems
Cryo1.05	Experiment interfaces
Cryo1.06	Safety documents
Cryo1.07	Testing/Checkout
Cryo1.08	g-2 Acceptance tests
Cryo1.09	Mu2e Acceptance tests
Cryo1.10	Safety documents are completed
Cryo1.11	Testing/Checkout complete

For accounting purposes, the contingency of the above listed WBS items will be included in the WBS items. DOE Guide G430.1-1, Chapter 11 was used as guidance in estimating the appropriate contingency for this project.

For accounting purposes, the indirect costs of the above listed WBS items will be included in the WBS items. For reference purposes, Indirect Costs rates are defined by DOE Order 4700.1 that states indirect costs are "...costs incurred by an organization for common or joint objectives and which cannot be identified specifically with a particular activity or project." The multipliers used in this document are based on Fermilab rates in effect as of April 2013.

Baseline Project Costs

Listed below in Table 2 are the baseline project costs for this project.

Table 2 Baseline Project Cost

WBS	Item Description	Base Cost*	Contingency	Indirect Costs	TPC
Cryo1	Muon Campus Cryogenics - AIP	$ 4,872,874	$ 2,416,014	$ 2,448,381	$ 9,737,269
Cryo1.02	Project management	$ 211,488	$ 135,429	$ 198,904	$ 545,821
Cryo1.03	Cryo Basic engineering	$ 83,085	$ 53,205	$ 78,141	$ 214,431
Cryo1.04	Cryogenic plant sub systems	$ 2,982,067	$ 1,394,517	$ 1,243,740	$ 5,620,324
Cryo1.05	Experiment interfaces	$ 1,385,038	$ 697,621	$ 728,965	$ 2,811,624
Cryo1.06	Safety documents	$ 97,126	$ 62,196	$ 91,347	$ 250,669
Cryo1.07	Testing/Checkout	$ 79,113	$ 50,661	$ 74,406	$ 204,180
Cryo1.08	g-2 Acceptance tests	$ 17,047	$ 10,916	$ 16,033	$ 43,996
Cryo1.09	Mu2e Acceptance tests	$ 17,910	$ 11,469	$ 16,844	$ 46,223

* - Base cost includes escalation

Escalation

The baseline estimates have been escalated by task within Microsoft Project using the following escalation rates:

M&S= 2.7% /year

SWF= 2.7 % /year

The rates utilized for Materials and Service (M&S) are as suggested by the most recent OECM published escalation rates. The escalation rates for Salary with Fringe (SWF, Labor) costs are based on input from the Fermilab Directorate based on our latest understanding of our annual labor costs.

Baseline Project Milestones

The baseline milestones listed below in Table 3 set forth the major activities essential for the completion of the project. Note that all milestones are tied to funds availability within thirty days of the beginning of each fiscal year.

Table 3 Project Milestones

MILESTONE	DEFINITION	BASELINE
Start Project	Project Plan signed, funding available	Month 0
Begin refrigerator building installation	Refrigerator building and A0 to MC1 piping support beneficial occupancy	Month 6
Compressor system is ready	All compressors are refurbished	Month 16
Refrigeration system commissioned	Heat exchangers, expanders, gas management system, storage are installed	Month 21
Muon g-2 acceptance tests	The Muon g-2 distribution system is cold	Month 22
System engineering	System detailed engineering is complete, majority of installation drawings and specifications are finished	Month 45
Mu2e acceptance tests	The Mu2e distribution system is cold	Month 52
Project Complete	Project Closed	Month 52

Funding Profile

Listed below in Table 4 is the anticipated total Obligation Profile for this project as presented in the Fermilab Project Request Form.

Table 4 Obligation Profile

	FY13	FY14	FY15	FY16	FY17	Total
Labor						
SWF Base Escalated	$ 193,422	$ 883,469	$ 472,560	$ 106,854	$ 346,769	$ 2,003,074
SWF Indirect Costs	$ 181,913	$ 830,902	$ 444,442	$ 100,496	$ 326,137	$ 1,883,891
Subtotal	$ 375,335	$ 1,714,371	$ 917,002	$ 207,350	$ 672,906	$ 3,886,965
SWF Contingency	$ -	$ 689,603	$ 302,611	$ 68,426	$ 222,059	$ 1,282,698
Total	$ 375,335	$ 2,403,974	$ 1,219,613	$ 275,776	$ 894,965	$ 5,169,663
M&S						
M&S Base Escalated	$ 687,954	$ 1,473,912	$ 39,374	$ 329,834	$ 338,726	$ 2,869,801
M&S Indirect Costs	$ 59,532	$ 335,116	$ 38,336	$ 64,878	$ 66,627	$ 564,490
Subtotal	$ 747,486	$ 1,809,028	$ 77,711	$ 394,713	$ 405,353	$ 3,434,291
M&S Contingency	$ -	$ 843,650	$ 25,644	$ 130,255	$ 133,767	$ 1,133,316
Total	$ 747,486	$ 2,652,678	$ 103,355	$ 524,968	$ 539,120	$ 4,567,607
Labor and M&S						
Base Escalated	$ 881,376	$ 2,357,381	$ 511,934	$ 436,688	$ 685,495	$ 4,872,875
Indirect Costs	$ 241,445	$ 1,166,018	$ 482,779	$ 165,375	$ 392,764	$ 2,448,381
Subtotal	$ 1,122,821	$ 3,523,399	$ 994,712	$ 602,063	$ 1,078,259	$ 7,321,255
Contingency	$ -	$ 1,533,253	$ 328,255	$ 198,681	$ 355,826	$ 2,416,014
Total	$ 1,122,821	$ 5,056,652	$ 1,322,968	$ 800,744	$ 1,434,085	$ 9,737,269

G. Acquisition Execution Plan

Most of the project activities are associated with refurbishment and re-engineering of existing Tevatron cryogenic equipment. For major items of procurement that include cryogenic distribution system components to interface the experiments, we will publish the Request for proposal (RFP) on the Federal Business Opportunity Website. To ensure the competence of vendors participating in a bid process, we'll develop a Technical Questionnaire. Vendors participating in the bid process will be required to submit answers to the Technical Questionnaire with their proposal.

The contract award will be based on a combination of technical merit and total cost. Each proposal will undergo a first round evaluation where only the technical merit is considered. Proposals that score "Very Good" or better in the technical evaluation will undergo a second round of evaluation that considers both technical merit and total cost.

The intent of the two step evaluation process is to ensure the technical competence and preparedness of the vendor and to avoid an initial bias towards the lowest priced offering. Since price is only one component of the evaluation process the award may conceivably go to a higher priced offering. Each of these elements is to be judged individually against a predetermined weighted formula.

Engineering, Design, Inspection and Administration

Conceptual Engineering designs were performed and are not included herein. Engineering Design, Inspection and Administration efforts for the fabrication and installation will be carried out by Fermilab AD personnel.

H. Project Controls

Cost Control

The baseline budget for eachWBS element will be shown on all reports and associated costs and obligations will be reported monthly in a report issued by the Finance Section. The Project Manager or designee will review the report and verify the validity of all costs accrued during the reporting period, that commitments are correct, and that projections of future costs can be covered by the baseline budget for each work element.

The Project Manager has the responsibility for the use and commitment of project funds. Any costs or commitments that are made without his signed approval or that of higher Laboratory management may be rejected.

The Project Manager, within authorized limits (see thresholds), will be responsible for the administration of the project's contingency funds.

The Funding Profile, depicted in Section F, is based on the current DOE funding profile. This plan reflects the best estimate of funding levels and the baseline schedule. The Funding Profile establishes the planned rate of obligations for the life of the project. The Project Manager is responsible for updating, as needed, the project Estimate at Completion (EAC) for each WBS element to reflect changes in design and construction, and for overall project fiscal management.

Schedule Control

The Baseline Milestones, shown in Section F of this report depict the project milestones and their expected achievement dates. The Project Manager shall have the responsibility for monitoring and controlling these tasks within the baseline. The baseline may be revised with DOE FSO concurrence through the change control process

Change Control Procedures and Authorities

Changes to the project baseline can occur to the scope, cost, or schedule aspects of the project. Changes at WBS Level 1 and below will be made with the approval of the Project Manager for cost changes up to $100,000 and schedule changes up to 3 months. Cost and schedule changes above these amounts and changes to the scope of the project will require the approvals of the Change Control Board. Any change to the Total Project Cost will require the approval of the Change Control Board and DOE Fermi Site Office. Project change control will be accomplished in accordance with practices listed in Table 5 below.

Table 5 Project Change Control

Change	Approval Required	Change Request Form
Change ≤$100k or ≤3 months schedule change	Project Manager	Required
Change >$100k or >3 months schedule change	Control Board	Required
Total Project Cost	Control Board DOE Fermilab Directorate	Required
Non-Emergency required for ES&H regulations	Control Board	Required
Change to Project Scope	Control Board DOE Fermilab Directorate	Required

The Change Control Board (Control Board) will be comprised of the following named individuals or the designees:

DOE FSO	P. Philp (non-voting)
Fermilab Directorate	S. Henderson
Fermilab AD	R. Dixon
Program Coordinator	M. Convery
Project Director	G. Annala
Project Manager, Chair	A. Klebaner

The Project Manager will act as Chair to the Control Board. The Control Board will consider change requests promptly and, in cases not requiring additional information or discussion, will respond within two weeks.

I. Design and Construction Principles

Integrated Safety Management (ISM)

Fermilab subscribes to the philosophy of Integrated Safety Management (ISM), in accordance with Department of Energy Order 413.3 "Program and Project Management for the Acquisition of Capital Assets." Fermilab requires its subcontractors and sub-tier subcontractors to do the same. ISM is a system for performing work safely and in an environmentally responsible manner. The term "integrated" is used to indicate that the Environment, Safety & Health (ES&H) management systems are normal and natural elements of doing work. The intent is to integrate the management of ES&H with the management of the other primary elements of construction: quality, cost, and schedule.

Quality Assurance

All aspects of this project will be periodically reviewed with regard to Quality Assurance issues from Conceptual Design through Title III completion. This review process will be completed in accordance with the applicable portions of the Director's Policy Manual, Section 10. The following elements will be included in the design and construction effort:

- An identification of staff assigned to this project with clear definition of responsibility levels and limit of authority as well as delineated lines of communication for exchange of information;
- Requirements for control of design criteria and criteria changes and recording of standards and codes used in the development of the criteria;
- Periodic review of design process, drawings and specification to insure compliance with accepted design criteria.

Reliability and Maintainability

Both reliability and future maintenance are considered in the design of all components of Fermilab site. Materials and construction techniques are selected during the design process to provide adequate design life, accessibility, and minimal maintenance.

Risk Management

All potential risks will be identified and tracked to insure that sufficient budget and schedule contingency are incorporated into the baseline plan. These risks will be monitored and reported, at a minimum at the monthly PMG, and retired as appropriate.

J. Reporting and Reviews

The objective of the reporting and review activity is to provide the assemblage and integration of project related cost data, schedule status and performance progress into reports for the monitoring and management of the project.

Reporting

Daily – The Project Manager will hold meetings as necessary to discuss progress and issues.

Quarterly - The Project Manager will review progress, changes, in order to prepare a Quarterly AIP report.

Reviews

Directorate Level Review – If appropriate and requested, the project team will meet with the Directorate to review the project related cost data, schedule status and performance progress.

DOE Review – Occasional Site visits will be arranged between the Project Manager and DOE Project Director

PMG – Status will be reported monthly to Fermilab Division Heads and the DOE at Project Management Group (PMG) meetings.

POG – Status will be reported monthly to the Fermilab Directorate at Project Oversight Group (POG) meetings.