Project Closeout Report
for the
Utilities Upgrade Project (UUP)

SLI Modernization Project # 13-SC-70

at

Fermi National Accelerator Laboratory
Batavia, IL

Office of Operations Program Management
Office of Science
U.S. Department of Energy

Project Closeout Report for the
Utilities Upgrade Project (UUP) at the
Fermi National Accelerator Laboratory

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Project Closeout Report for the
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Acronym List

A/E	Architect/Engineer
CD	Critical Decision
CM	Construction Manager
CPT	Core Project Team
DOE	Department of Energy
ES&H	Environment, Safety and Health
EVMS	Earned Value Management System
FNAL	Fermi National Accelerator Laboratory
FPD	Federal Project Director
FSO	Fermi Site Office
FY	Fiscal Year
GC	General Contractor
HV	High Voltage Electrical
HVAC	Heating, Ventilation, and Air Conditioning
ICW	Industrial Cooling Water
IPT	Integrated Project Team
LCC	Life Cycle Costs
LEED	Leadership in Energy and Environmental Design
M&O	Management and Operating
NEPA	National Environmental Policy Act
OPM	Office of Operations Program Management
OMB	Office of Management and Budget
OPC	Other Project Costs
OSHA	Occupational Safety and Health Administration
PED	Project Engineering and Design
PEP	Project Execution Plan
R&D	Research and Development
SC	Office of Science
SF	Square Feet
SMN	Statement of Mission Need
TBD	To Be Determined
TEC	Total Estimated Cost
TPC	Total Project Cost
UUP	Utilities Upgrade Project

1. EXECUTIVE SUMMARY

The Utilities Upgrade Project (UUP) provided major upgrades to Fermilab's high-voltage electrical and industrial cooling water systems. The designs considered current and future mission needs.

The project exceeded accomplishment of the Threshold Key Performance Parameters (KPP's) and executed several Objective KPP's with the project's $4.9M ($4,877,530) contingency at CD-2 baseline.

- 49% of the project's contingency was spent on objective scope and various scope enhancements. The cost of executed objective scope ($2,147,827) was 10.6% of the initial construction cost ($20,340,000).
- 51% of the project's contingency was spent on threshold scope, including cost overruns, field conditions, design errors and operational issues and constraints. The cost of additional threshold scope associated with cost overruns, field conditions, design errors and operational issues and constraints ($2,207,271) was 10.9% of the initial construction cost ($20,340,000).

The UUP was comprised of two subprojects; high-voltage electrical (HV) and Industrial Cooling Water (ICW) Upgrades. The HV subproject replaced the Master Substation Control Building in the main substation providing 345kV electrical power to the lab. In addition to replacing the control building the subproject executed the objective scope of replacing the main circuit breaker (345kV) for the substation. The ICW subproject replaced and installed over 4 miles of new ICW piping from 30" diameter to 6" diameter and installed two new pumpstations; CMTF and Swan Lake. In addition to this threshold scope the subproject executed the objective scope of add'l makeup water piping at Well No. 4 and A-1 as well as constructing an electrical room addition to the main pumpstation, Casey's Pond Pumphouse, to relocate electrical service from the basement to avoid outages during flooding.

The project obtained CD-4 September XX, 2018, 4 months ahead of schedule with a TPC at completion of $35.4M.

2. INTRODUCTION

The scope of the project included design and construction of:

1. Replacement of the Master Substation Control Building
2. Replacement of the ICW Backbone piping and the addition of 2 new pumphouses; Swan Lake and CMTF.

Per the Project Execution Plan (PEP), this project was managed in accordance with the principles in Department of Energy (DOE) Order 413.3B "Program and Project Management for the Acquisition of Capital Assets" as defined in the approved PEP and the management systems and subject areas contained in the DOE Office of Science (SC) Management System (SCMS).

3. ACQUISITION APPROACH

The Acquisition Strategy was approved by the Director of Science on August 5, 2010.

Acquisition for this project was performed by the M&O Contractor, Fermi Research Alliance, LLC

(FRA – herein referred to Fermilab) under the direction, guidance, and oversight of the DOE Fermilab Site Office (FSO). As the M&O Contractor, Fermilab is responsible for its subcontracts. Fermilab used its existing Basic Ordering Agreements (BOA's) to subcontract A/E professional services. Fermilab used firm fixed-price purchase orders and subcontracts for construction, supplies, equipment and services and made awards through competitive solicitations.

Fermilab's FESS Engineering Department held competitive solicitations in 2008, and subsequently in 2011 and 2015 for various A/E firms to provide professional engineering services for all projects managed within FESS. Firms were selected in various categories, including; general, architectural, interior design, civil, structural, mechanical, fire protection, electrical and construction/project management via an A/E source evaluation board. 33 firms were selected and retained via multiple BOA's. UUP utilized these BOA's in execution of the project and selected three firms to perform design and construction phase support:

- Laramore, Douglass and Popham (LDP) – now Gannett Fleming was selected from the existing BOA's because of their extensive experience in substation design. LDP provided design and construction support services related to the high-voltage subproject, specifically the design of the replacement of the Master Substation Control Building (Threshold Scope). LDP was also tasked to design of several objective scope items including replacement of the Fermilab's remaining oil switches as well as the replacement of the main high-voltage (345kV) breaker at the Master Substation. The installation of the main breaker was constructed under this project. The remaining 6 oil switches will be installed under lab operating funds in the future or deemed obsolete and taken out of service.
- Crawford, Murphy and Tilly (CMT) was selected from the existing BOA's because of their extensive experience in designing and modeling Fermilab's industrial cooling water system (ICW). CMT provided design and construction support services related to the industrial cooling water (ICW) subproject, specifically the design of the replacement of the ICW backbone piping as well as the design of two new pumphouses; Swan Lake and CMTF (Threshold Scope). CMT was also tasked to design several objective scope items including; ICW makeup water improvements, Casey's Pond Pumphouse electrical room addition, Kress Creek flood improvements and various pond system improvements. Both ICW makeup water improvements and the Casey's Pond Pumphouse electrical room addition were constructed under this project.
- Primera Engineers, Ltd. (Primera) was selected from the existing BOA's because of their experience in providing commissioning services for many FESS Engineering projects. Primera provided commissioning services for three major installations for this project, including; commissioning services for the Master Substation Control Building and commissioning services for the two pumphouses; Swan Lake and CMTF. The commissioning services provided documented confirmation that construction fulfilled the function and performance requirements of the project. The commissioning agent provided project specific written test procedures to test the mechanical systems in all modes of operating conditions. The test procedures, acceptance criteria, and actual findings are documented in each project's final commissioning report.

Fermilab executed 3 firm fixed-price purchase orders for construction via competitive selection:

- ABB was selected via best-value firm fixed-price solicitation to construct, in their offsite facilities, the Master Substation Control Building, ship it to site in 8 sections and install the building sections on-site. This pre-procurement was authorized at CD-2/3a – Approve Performance Baseline and Pre-procurements for the Master Substation Control Building on

February 18, 2015. All work performed under this subcontract was monitored by Fermilab personnel with support from the A/E of record, LDP. The FSO provided oversight to ensure safety and quality performance. Beneficial Occupancy of the control building was issued on December 21, 2016. Final Acceptance of all subcontract work was granted on August 3, 2017. Warranty provisions of the subcontract are initiated as of this date.

- Meade was selected via best-value firm fixed-price solicitation to final install the Master Substation Control Building including all required electrical installation, foundations, and site work required to provide a fully functional control building. This procurement was authorized at CD-3b – Approve Start of Construction on September 3, 2015. All work performed under this subcontract was monitored by Fermilab personnel with support from the A/E of record, LDP. The FSO provided oversight to ensure safety and quality performance. Meade was also selected to execute the objective scope known as the main high-voltage (345kV) breaker replacement. Beneficial Occupancy of the control building was issued on January 12, 2017 – allowing for the start of energization of the new facility. Final Acceptance of all subcontract work was granted on March 6, 2017. Warranty provisions of the subcontract are initiated as of this date.
- Whittaker Construction and Excavating, Inc. was selected via best-value firm fixed-price solicitation to final install the ICW backbone piping network including the installation of two new pumphouses; Swan Lake and CMTF. This procurement was authorized at CD-3b – Approve Start of Construction on September 3, 2015. All work performed under this subcontract was monitored by Fermilab personnel with support from the A/E of record, CMT. The FSO provided oversight to ensure safety and quality performance. Whittaker was also selected to execute the objective scope known as makeup water improvements and the Casey's Pond pumphouse electrical room addition. Beneficial Occupancy of the backbone piping network and the construction of the two new pumphouses was finalized on August 2, 2017. Final Acceptance of the construction of the two new pumphouses was granted on October 26, 2017. Warranty provisions of the subcontract are initiated as of this date. Beneficial Occupancy of the objective scope for the construction of the Casey's Pond Pumphouse electrical room addition was granted on July 18, 2018. Final Acceptance of all subcontract work was granted on July 31, 2018. Warranty provisions of the subcontract are initiated as of this date.

4. PROJECT ORGANIZATION

The Integrated Project Team (IPT) for the UUP consisted of personnel from the DOE FSO and Fermilab. The objective of the UUP IPT is to provide professional management and subject matter expertise to assure the safe, timely, and cost-effective completion of the project. The IPT supported the DOE Federal Project Director (FPD). The Project Team Charter describes the organization, and designates members, operating principles and roles and responsibilities and is included in Appendix A. The roles and responsibilities of the project participants are defined in the Project Execution Plan (PEP) and Integrated Project Team (IPT) Charter.

The DOE FPD worked closely with the Program Manager for the SC Office of Operations Program Management (OPM) to assure that the project execution is consistent with program goals and objectives and to ensure the Acquisition Executive and appropriate DOE Headquarters (DOE HQ) personnel are apprised of the project status. This was accomplished through routine conference calls, site visits, reviews, and other formal and informal forms of communication.

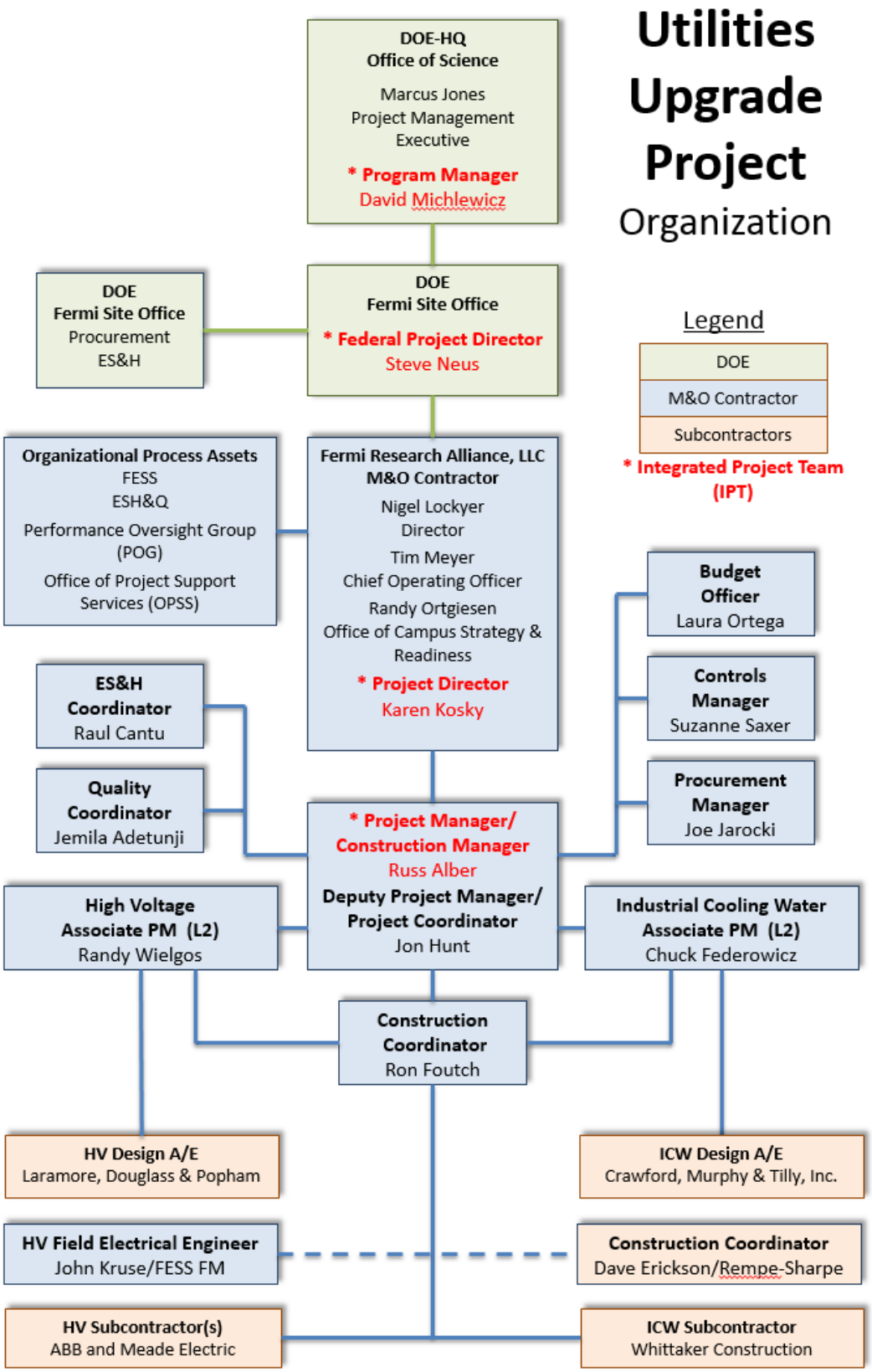


Figure 1 - UUP Project Organization Chart

Staff changes to the Integrated Project Team (since CD-2) as identified in Appendix A are:

- OPM Project Management Executive (formerly the Acquisition Executive) Stephanie Short was replaced with Marcus Jones
- Fermilab UUP Project Director, Kent Collins, was replaced with Karen Kosky
- Fermilab UUP ES&H Coordinator, Jack Cassidy, was replaced by Raul Cantu.
- Fermilab UUP Budget Officer, Jolie Macier, was replaced by Laura Ortega
- Fermilab UUP Procurement Manager, Jim Hohbein, was replaced by Joe Jarocki
- Fermilab Construction Subcontractor for High Voltage (HV) subproject, TBD, was assigned at CD-3b to ABB and Meade Electric
- Fermilab Construction Subcontractor or Industrial Cooling Water (ICW) subproject, TBD, was assigned at CD-3b to Whittaker Construction
- Additional Fermilab HV Field Electrical Engineer position was introduced at CD-3 with John Kruse/FESS FM
- Additional Fermilab ICW Construction Coordinator position was introduced at CD-3b with subcontractor Dave Erickson/Rempe-Sharpe Associates.

5. PROJECT BASELINE

The scope, cost, and schedule baselines for the UUP were established at approval of CD-2 and are detailed in the Project Execution Plan. The UUP objectives and goals are:

- Replacement of the Master Substation Control Building
- Replacement of the ICW Backbone piping and the addition of 2 new pumphouses; Swan Lake and CMTF.
- Ensure that environment, safety & health (ES&H), and security requirements are fully incorporated and properly implemented into the project's design and construction.
- Minimize any negative impact to ongoing research operations.
- Implement the Utilities Upgrade Project within the baseline cost and schedule.
- Implement Leadership in Energy and Efficiency Design (LEED) and DOE Guiding Principles into the project's design and construction where possible.

5.1. Scope Baseline and Key Performance Parameters

The scope of the project includes design and construction work to replace portions of high-voltage and industrial cooling water systems as summarized in Table 1. Table 1 shows the Threshold and Objective values for the project. The difference between the objective and threshold values are scope alternatives. Select scope alternates were designed and included in the construction bid packages as additive scope items. Some scope alternate items were added to the project baseline as budget contingency became available from retired risks. Scope alternates were added to the project baseline in accordance with the UUP Project Change Control Approval Thresholds as defined in the approved UUP Project Execution Plan.

A summary of the threshold scope that was met, as well as any objective scope that was either met or not executed, is included in Table 1 – Key Performance Parameters.

Table 1 - Key Performance Parameters

Element	Threshold KPP (Minimum)	Objective KPP (Maximum)	Met or Not Executed
High-Voltage Electrical (H/V) Upgrade	Replace Master Substation Control Building		Met
		Replace all remaining site-wide oil switches with new air switches	Not Executed
		Replace the Master Substation 345kV circuit breaker	Met
		Replace feeder cable > 25 years old	Not Executed
		Replace all end-of-life unit substations	Not Executed
Industrial Cooling Water (ICW) Upgrade	Install new ICW backbone piping network from Casey's Pond to the Main Injector		Met
		Perform Pond System Improvements to increase ICW storage capacity	Not Executed
		Perform Casey's Pond Pumphouse Improvements	
		- Pump Upgrades	Not Executed *
		- Electrical Room Addition	Met
		- Kress Creek Culvert	Not Executed
		Perform ICW Makeup Water Improvements	
		- Well 4	Met
		- A-0	Met
		- Casey's Pond Well	Not Executed
		Replace the existing Main Injector ICW piping network	Not Executed

* Not Executed under UUP - work completed under lab operating funds

5.2. Cost Baseline

The Total Project Cost at CD-2 was $36,000,000, which included Other Project Costs of $1,100,000 and $4.9M of contingency. Table 2 shows the usage of contingency as a function of time per fiscal year. Figure 2 graphically shows the contingency use over time and Figure 3 graphically shows contingency to go as a percentage of the estimate to complete (ETC) as the project progressed.

Table 3 shows where the contingency was used per usage category. The project team tracked each change order throughout the project and assigned the change into the proper usage category. 52% of the available contingency went to scope enhancements (objective scope and misc. scope additions).

Figure 4 shows the percentage of usage of contingency in each category graphically.

Table 4 shows the detailed project cost summary at WBS Level 3 for the planned baseline costs and the total project costs at completion (TPC). The costs for the construction management services were managed at Level 3 and the project management costs were managed at Level 2. The project risk registry is included as Appendix F, which shows the identified risks on the project.

Table 2 - UUP Project Contingency Usage as a Function of Time

Date of End of FY	Perccent Complete (%)	TPC ($K)	Actual Costs to Date ($K)	Contingency Remaining ($K)	Estimate to Complete ($k)
FY14	11.0%	$30,372	$3,353	$5,273	$27,020
FY15	29.3%	$32,688	$9,254	$3,337	$23,117
FY16	77.7%	$32,803	$25,131	$3,197	$7,309
FY17	94.8%	$35,291	$33,858	$354	$1,755
FY18 (July)	99.8%	$35,542	$35,484	$96	$65

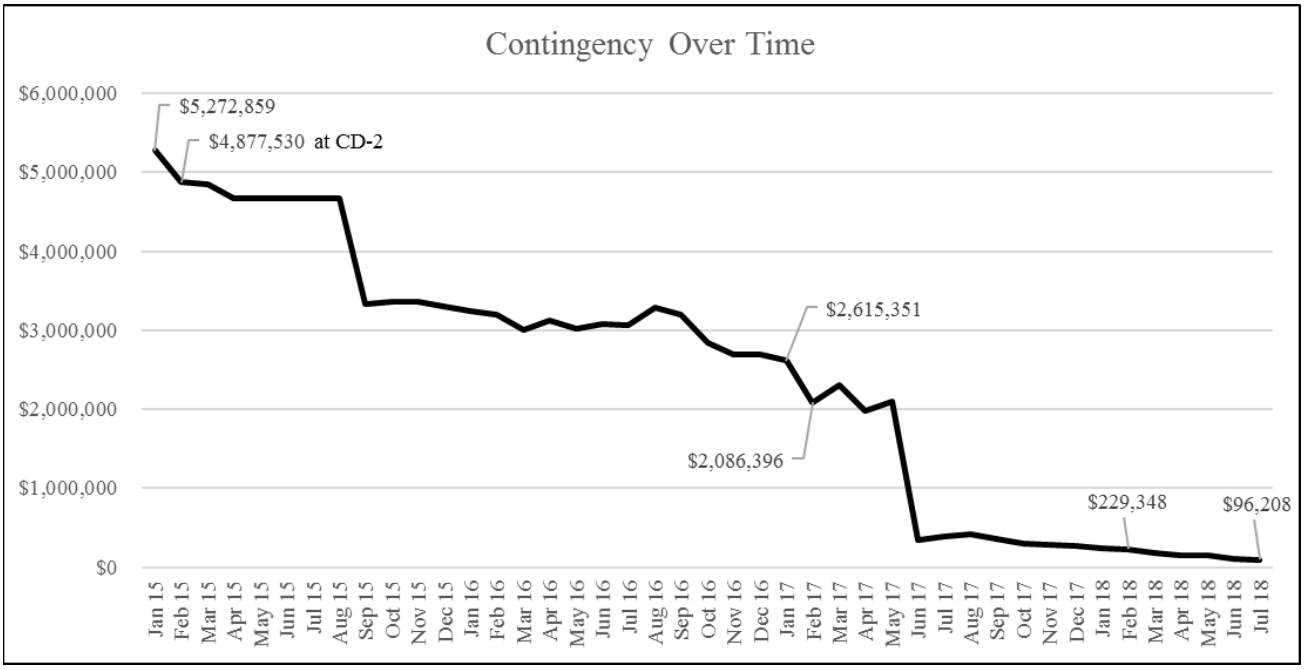


Figure 2 - Contingency Use Over Time

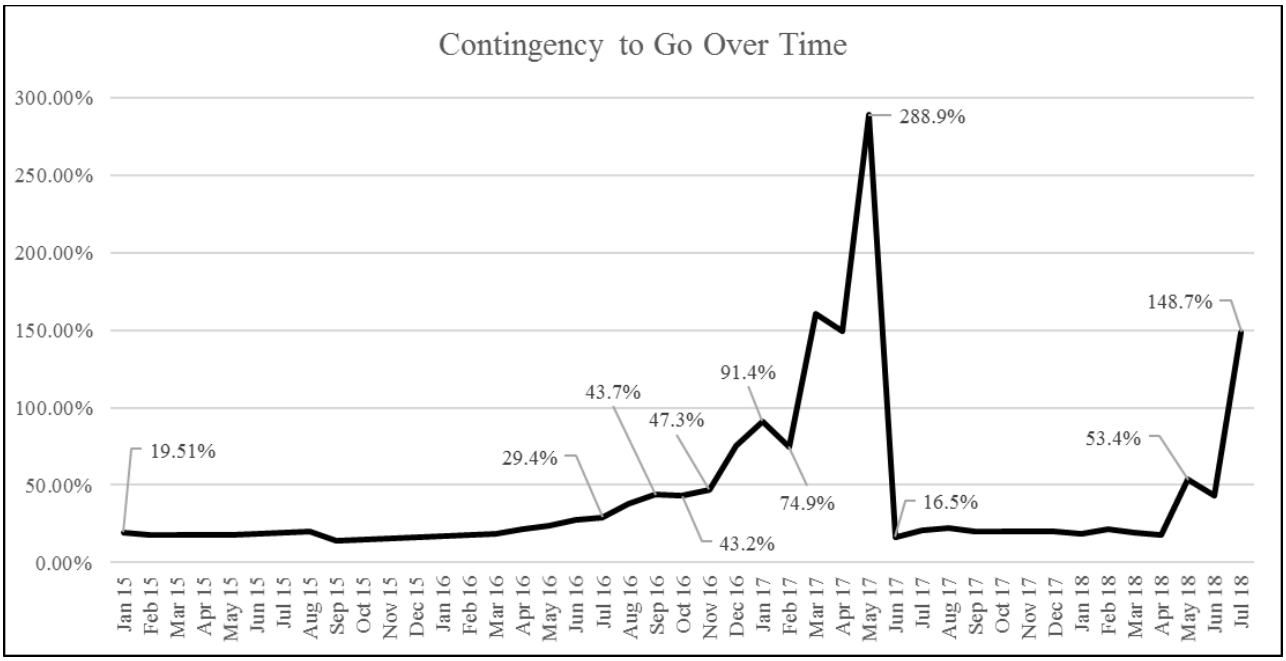


Figure 3 - Contingency To Go Over Time

Table 3- BCR History Per Category

Contingency Use	Cost
Pre-Baseline Adjustment	$ 395,329
Field Conditions	$ 564,428
Design Errors	$ 304,890
Operational Issues	$ 176,510
Misc. Scope Enhancements	$ 329,406
Objective Scope	$ 2,147,827
Misc. Adjustments (cost overruns, add'l EDIA, etc.)	$ 832,036
Total BCR Cost	$ 4,750,427

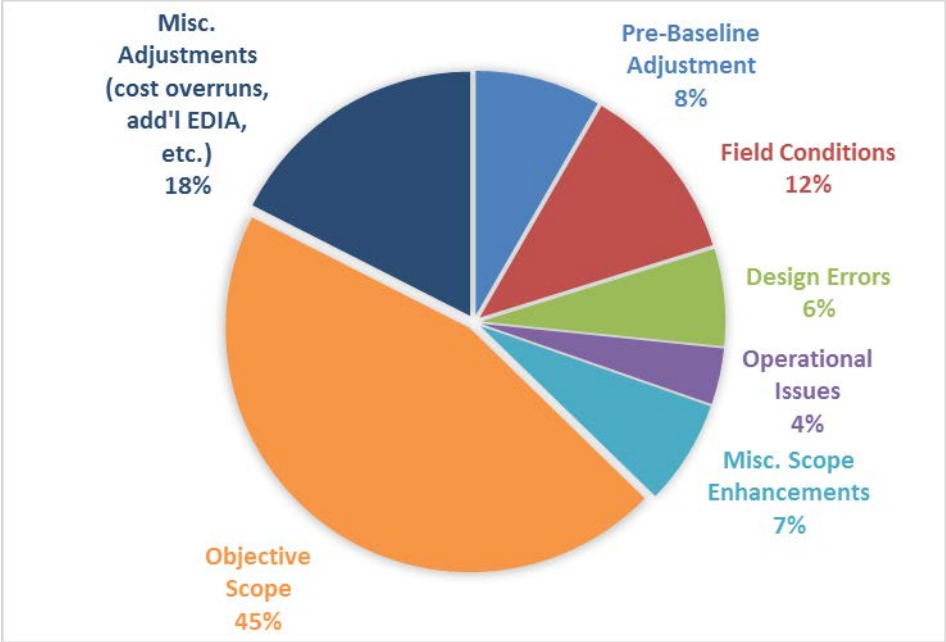


Figure 4 - Contingency Use Per Category

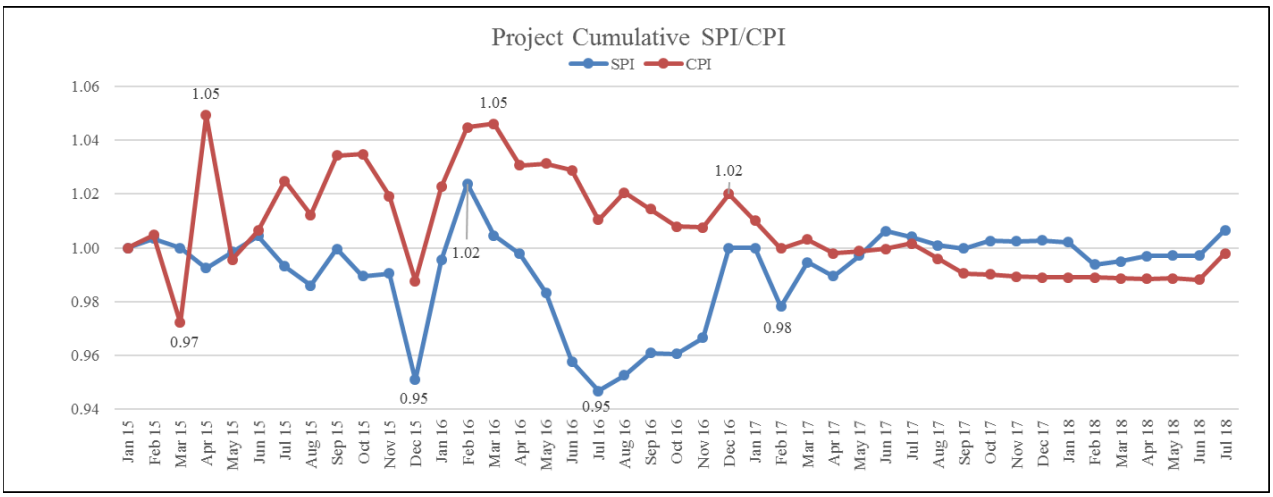


Figure 5 - Project Cumulative SPI/CPI

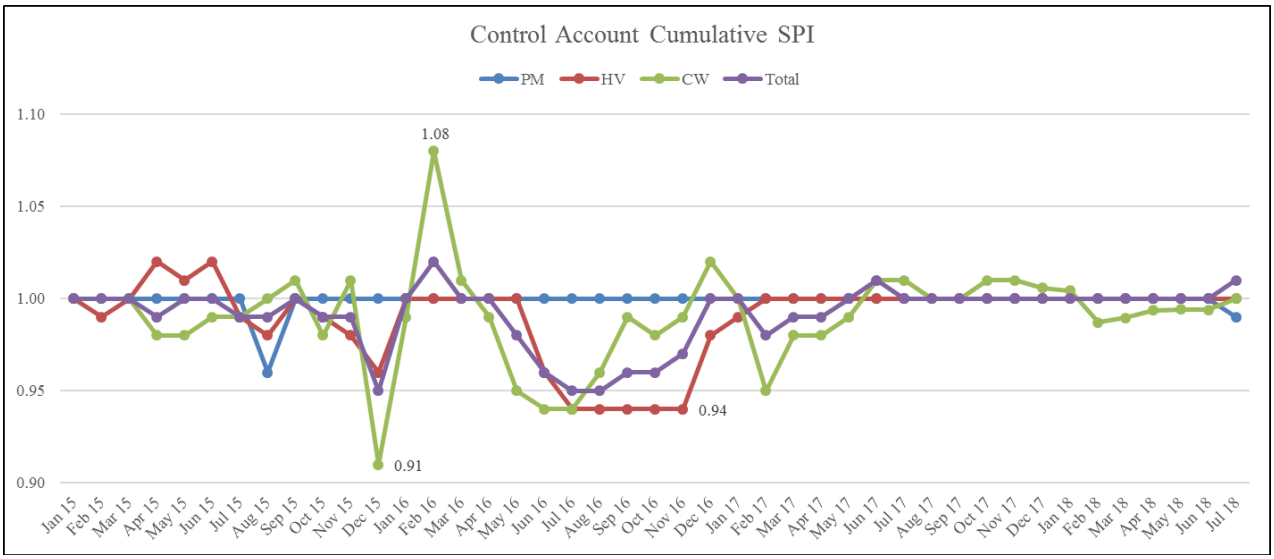


Figure 6 - Control Account Cumulative SPI

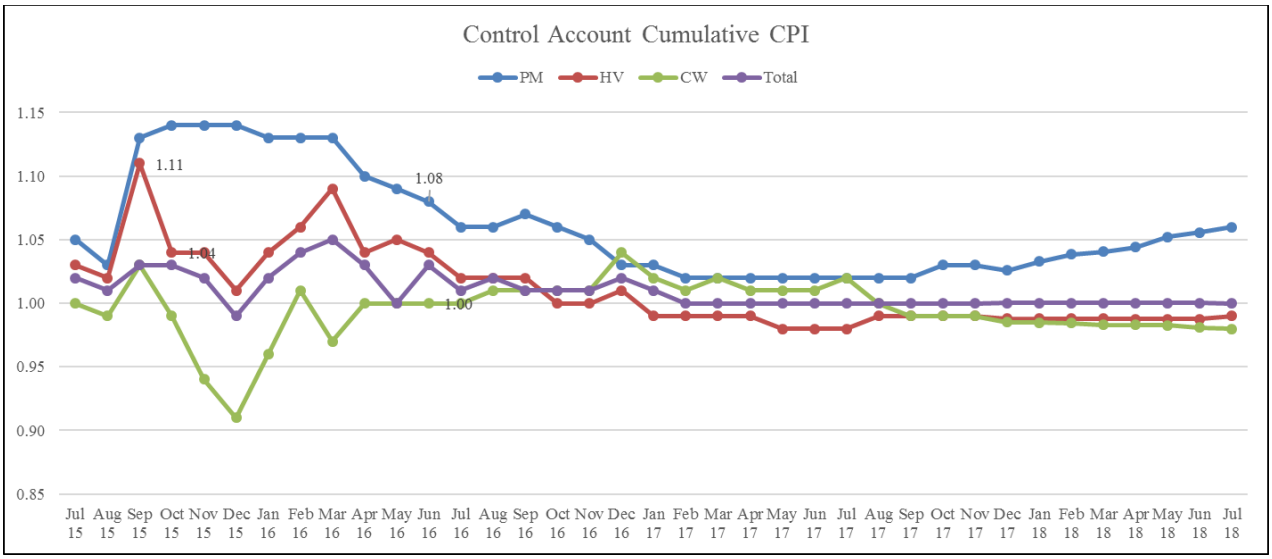


Figure 7 - Control Account Cumulative CPI

Table 4 - UUP Detailed Project Cost Summary

WBS #	WBS Title	Total at CD-2 ($K)	Current Total * ($K)
600	**Utilities Upgrade Project**		
600.01	**Project Management**	**$2,845**	**$1,838**
600.01.01	Preliminary Design Phase	$475	$595
600.01.02	Final Design Phase	$518	$290
600.01.03	Construction Phase	$1,470	$954
600.01.04	Closeout Phase	$382	$0
600.02	**High Voltage Electrical**	**$13,205**	**$15,691**
600.02.01	**HV Engineering**	**$3,485**	**$3,559**
600.02.01.01	Preliminary Design Phase	$886	$810
600.02.01.02	Final Design Phase	$632	$748
600.02.01.03	Construction Phase	$1,967	$2,001
600.02.02	**HV Construction**	**$9,720**	**$12,132**
600.02.02.01	MSS Control Building Procurement	**$5,838**	**$6,034**
600.02.02.02	Master Substation Replacement	**$3,882**	**$5,760**
600.02.02.02.01	Site Preparation	$1,865	$2,791
600.02.02.02.02	Installation	$1,664	$2,571
600.02.02.02.03	Commissioning	$353	$398
600.02.02.03	*Oil Switch Replacement*		
600.02.02.04	*Main Circuit Breaker Replacement*	$0	$338
600.02.02.05	*Feeder Replacement*		
600.02.02.06	*Unit Substation Replacement*		
600.03	**Industrial Cooling Water**	**$13,577**	**$17,211**
600.03.01	**ICW Engineering**	**$2,957**	**$3,831**
600.03.01.01	Preliminary Design Phase	$882	$990
600.03.01.02	Final Design Phase	$608	$967
600.03.01.03	Construction Phase	$1,467	$1,874
600.03.02	**ICW Construction**	**$10,620**	**$13,380**
600.03.02.01	Backbone Piping Network	**$10,620**	**$11,698**
600.03.02.01.01	Backbone Piping	$7,568	$8,477
600.03.02.01.02	CMTF Pumphouse	$1,468	$1,885
600.03.02.01.03	Swan Lake Pumphouse	$1,584	$1,336
600.03.02.02	*Casey's Pumphouse Area Improvements*	$0	
600.03.02.02.01	*Pump Upgrades*		
600.03.02.02.02	*Electrical Room Addition*	$0	$1,445
600.03.02.02.03	*Kress Creek Culvert*		
600.03.02.02.04	*Pond Improvements*		
600.03.02.03	*Makeup Water Improvements*	$0	$237
600.03.02.03.01	*Well 4*	$0	$105
600.03.02.03.02	*A-0*	$0	$132
600.03.02.03.03	*Casey's Pond Well*		
600.03.02.04	*Main Injector Piping*		
600.04	**OPC - Other Project Costs**	**$1,100**	**$745**
	Contingency	**$5,273**	
	Total Project Cost	**$36,000**	**$35,484**
	* as of July 2018		

Table 5 - UUP Baseline Change Log

CR#	Description of Change	Level	Cost	BCWS	Date
	Initial BCWS			$30,075,695	
BCR001	Initial Change to Align the Pre-DOE Review Data to the Post-DOE Review Required Changes and establish the initial baseline	3	($296,446)	$30,372,141	02/09/15
BCR002	Set Baseline and align budgets with Project cost expectations and establish initial Project Management Reserve.	3	($395,329)	$30,767,470	02/11/15
BCR003	Change due to vender acceptance and feedback of final design Purchase Order (PO) agreements. Schedules were adjusted to meet vendor delivery schedules.	3	($30,797)	$30,798,267	02/27/15
BCR004	Change due to increase costs for Master Substation and the Commissioning Agent contracts.	2	($172,573)	$30,970,840	04/08/15
BCR005	Changes due to a change order to the MSS Building in order to remove interior columns and added the balance of the OPC funds back into the project.	3	($46,133)	$31,371,972	05/27/15
BCR006	Changes due to to incorporate the MSS pre-procured control building payment schedule and change from a planning package to a work package.	3	$36,257	$31,335,715	06/09/15
BCR009	The change includes correcting the dates on activities in Cobra to match P6.	3	($93,994)	$31,429,709	09/10/15
BCR007	The change includes the actual construction prices for the Threshold KPPs for both Industrial Cooling Water (ICW) and High Voltage (HV) subprojects.	1	($1,457,244)	$32,886,953	09/15/15
BCR008	Reduction in EDIA costs & implementation of the first three options on the HV and ICW construction contracts	3	$224,176	$32,662,777	09/30/15
BCR010	$25K change to the pre-procurement contract, and a delay in the delivery of the building to the Fermilab site of 1 month.	3	($24,975)	$32,687,752	10/30/15
BCR011	Change due to a laboratory labor rate update process.	3	$42,790	$32,644,962	11/09/15
BCR012	This is a change to create two activities in P6 for ICW and HV construction for the month of December.	3	$0	$32,644,962	11/23/15
BCR013	Incorporated Subcontractors' Schedules and December Field Directed Changes:	2	($52,410)	$32,697,372	12/29/15

BCR014	January 2016 Change Orders	3	($53,569)	$32,750,941	01/22/16
BCR015	February 2016 Change Orders	3	($54,222)	$32,805,163	02/29/16
BCR016	March 2016 Change Orders	3	($183,843)	$32,989,006	03/31/16
BCR017	This change includes corrections to HV M&S resources impacting escalation and overheads as well as April 2016 Change Orders	3	$108,283	$32,880,723	04/29/16
BCR018	This change incorporates the ICW Subcontractor's latest construction schedule as well as May 2016 Change Orders	2	($93,137)	$32,973,860	06/15/16
BCR019	June 2016 Change Orders	3	($131,642)	$33,105,502	06/28/16
BCR020	This change incorporates a scope reduction to schedule ComEd construction activities as well as July 2016 Change Orders	3	($18,593)	$33,124,095	08/02/16
BCR021	August 2016 Change Orders	2	($74,822)	$33,198,916	08/31/16
BCR022	September 2016 Change Orders	3	($68,428)	$33,267,344	10/04/16
BCR025	FY17 Rate Adjustments in Cobra	3	$17,961	$33,249,383	11/03/16
BCR024	October 2016 Change Orders	3	($98,838)	$33,348,221	11/03/16
BCR023	Level 1 Performance Baseline Change Control Threshold Review - Cumulative Contingency usage of $2.7M	1	$0	$33,348,221	11/10/16
BCR026	November 2016 Change Orders	3	($165,758)	$33,513,979	12/08/16
BCR028	December 2016 Change Orders	3	($56,138)	$33,570,117	12/29/16
BCR029	January 2017 Change Orders	3	($24,912)	$33,595,029	01/31/17
BCR030	Current Period Adjustment for Schedule Change to OPC Commissioning Planning Package and ABB Scope Reduction Credit	3	$0	$33,595,029	02/09/17
BCR031	February 2017 Change Orders	3	($57,643)	$33,652,672	02/28/17
BCR032	Additional scope for the HV Engineer of Record for Controls Programming of the MSS Building as well as March 2017 Change Orders	2	($55,058)	$33,707,730	03/30/17

BCR033	April 2017 Change Orders	3	($53,669)	$33,761,399	04/28/17
BCR027	Level 1 Performance Baseline Change Control Threshold for Cost and Schedule - ICW Option 2A - Casey's Pond Electrical Room Addition	1	($1,654,303)	$35,415,702	06/23/17
BCR034	This change includes additional scope for the HV Engineer of Record as well as May 2017 Change Orders	3	$72,142	$35,343,560	05/31/17
BCR035	June 2017 Change Orders	3	($19,117)	$35,362,677	06/20/17
BCR036	Adjusted schedule activities associated with the Casey's Pond Pump Station scope addition.	3	$0	$35,362,677	07/31/17
BCR037	Update to the schedule activities for the ICW Casey's Pond Pumphouse Addition based on receipt of the subcontractor's schedule of values	2	$0	$35,362,677	08/31/17
BCR038	September 2017 Change Orders	3	($7,060)	$35,369,737	10/04/17
BCR039	FY18 Rate Adjustments in Cobra	3	$930	$35,368,807	10/30/17
BCR040	This change includes additional scope for the ICW Construction Support Services PO and October 2017 Change Orders	3	$13,759	$35,355,048	10/31/17
BCR041	November 2017 Change Orders	3	$7,060	$35,347,988	11/28/17
BCR042	January 2018 Change Orders	3	($34,011)	$35,381,999	01/31/18
BCR043	This change includes adjustments to the CD-4 IPR milestone, Director's Review activities and milestones as well as February 2018 Change Orders	3	($6,216)	$35,388,215	02/28/18
BCR044	March 2018 Change Orders	3	($26,548)	$35,414,763	03/28/18
BCR045	April 2018 Change Orders	3	($5,870)	$35,420,633	04/12/18
BCR046	May 2018 Change Orders	3	($25,618)	$35,446,251	04/30/18
BCR047	June 2018 Change Orders	3	($31,315)	$35,477,566	?
	Total:		**($4,750,427)**		

Table 6 provides a comparison of the project Engineering, Design, Inspection and Administration (EDIA) costs and construction costs. The ratio of design/project management costs to construction costs is typically called the soft cost ratio. For DOE line item projects this soft cost ratio typically varies from 20% to 35% depending on the complexity of the design and cost of construction.

At the CD-3b: Start Construction IPR, the project team presented that the soft cost ratio of 38% was high compared to most projects. The project team identified a few items that are costed in design/project management that are typically included in construction costs:

1. The electrical utility provider (ComED) provides services during construction (under contract with DOE) to provide for installation of propriety equipment in the new substation building. These costs were costed in the design of the HV subproject but have been included in construction costs for this calculation.
2. During design, the ICW design team utilized the use of potholing to identify the exact location of various utilities in advance of construction to better inform design and to avoid any struck utilities during construction. These costs were costed in the design of the ICW subproject but have been included in construction costs for this calculation.

The project team also identified a few items that were costed in design/project management that we feel can be justified to not be included in the soft ratio calculation:

1. The A/E of record provided designs for objective scope items that were bid but not executed. A large effort was expended on the design of flood improvements for Kress Creek as well as various pond storage system improvements that never materialized due to cost. These costs were costed in the design of the ICW subproject but can be justified to be excluded from design costs for this calculation.
2. At the start of this project the Finance Section determined that this project's indirect structure would be considered a "Complex Procurement" so that the project would receive a slightly decreased indirect rate on construction (M&S) only, but the procurement manager assigned to the project would be costed directly to the project (not as lab overhead) which resulted in an increased overall cost to the project. These costs were costed in the project management of the project but can be justified to be excluded from project management costs for this calculation.

Additionally, the use of fully-burdened costs skews the ratio as well. For this project, under the current Fermilab indirect structure, burdens (indirects) on design/project management averaged 35% and construction averaged 1%. This disproportionate distribution of burdens further skews the soft ratio and for a better and more comparable ratio, the project proposes to base the soft ratio on direct costs rather than indirect costs.

In summary, without the aforementioned justifications, the project ended with an unburdened soft ratio of 24%. Considering the aforementioned justifications, the project ended with an unburderned soft ratio of 21%.

Table 6 - EDIA Cost Compared to Construction

Cost Category	Project ($K) Unburdened	Project (%) Unburdened	Project ($K) Burdened	Project (%) Burdened	ON/OFF Project?	Comments
Engineering	**$2,082**	**8%**	**$2,678**	**10%**		
Design (A/E and in-house)					ON	
Value Engineering					ON	
Design Reviews					ON	
Management	**$4,087**	**16%**	**$5,714**	**22%**		
Design Management					ON	L2 design mgt. on L2 CA's
Construction Management (CM, Inspection, A/E Construction Support)					ON	L2 CM on L2 CA's
Project Management (cost estimating, scheduling, project controls, risk assessment, etc.)					ON	
Quality Control (QA staffing, testing acceptance)					OFF	ESH&Q is an overhead task
Procurement and Contracting					ON	PA was costed to project
Legal, Accounting and Real Property					OFF	All are overhead tasks
ES&H	**$0**		**$0**			
Environmental Permitting					ON	Performed by L2's
Safety Documentation					OFF	ESH&Q is an overhead task
Safety Inspections					OFF	ESH&Q is an overhead task
Security					OFF	ESH&Q is an overhead task
Construction	**$25,912**	**76%**	**$26,363**	**68%**		
Construction Subcontracts	$25,248		$25,526			
Commissioning	$218		$275			
ComEd Services	$347		$437			
Potholing/Utility Locates	$99		$125			
SUMMARY						
TEC Total:	**$32,081**		**$34,755**			
Soft Cost Ratio:		**24%**		**32%**		
Justified Soft Cost Ratio:		**21%**		**29%**		

5.3. Schedule Baseline

CD-4 was achieved four months ahead of the planned date. Table 7 and 8 provides the planned versus actual completion dates for the Level 1 and 2 Milestones.

Table 7 - Level 1 Milestones (Planned vs. Actual)

Level 1 Milestone	Baseline @ CD-2	Actual
CD-0: Approve Mission Need		September 18, 2009
CD-1: Approve Alternative Selection and Cost Range		November 15, 2010
CD-2/3a: Approve Performance Baseline and Pre-Procure Substation Control Building	May 2015	February 18, 2015
CD-3b: Approve Start of Construction	December 2015	September 3, 2015
CD-4: Approve Project Completion	January 2019	

Table 8 - Level 2 Milestones (Planned vs. Actual)

Level 2 Milestone	Baseline @ CD-2	Actual
Complete CD-1 ESAAB		November 15, 2010
Complete CD-2/3A ESAAB	February 2018	February 18, 2015
Issue Master Substation Control Building Subcontract	April 2015	April 10, 2015
Complete CD-3B IPR	July 2015	August 12, 2015
Complete CD-3B ESAAB	July 2015	September 3, 2015
Start Construction (Issue PO)	August 2015	September 21, 2015
HV MS#1 - Bldg Foundation & Site Work Ready for Control Building Delivery	August 2016	April 22, 2016
HV - MSS Building Delivered to Site	August 2016	July 11, 2016
ICW – Start CMTF Area Intake and Discharge	November 2016	September 7, 2016
HV MS#3 - Beneficial Occupancy, Construction Complete, Substation Energized	April 2017	January 12, 2017
HV MS#4 - Final Acceptance	July 2017	March 6, 2017
ICW - Swan Lake Pumphouse Complete	April 2017	August 2, 2017
ICW - Backbone Pipe from Casey's Pond to Main Injector Complete	August 2017	August 2, 2017
ICW MS#2 – Beneficial Occupancy, Substantial Completion of Backbone Piping Network	August 2017	August 2, 2017
ICW - Alternate 1 – Makeup Water Complete	August 2017	May 4, 2017
ICW MS#3 - Final Acceptance	August 2017	July 31, 2018
Complete Construction	August 2017	July 31, 2018
Complete CD-4 Readiness	July 2017	
Complete CD-4 ESAAB	November 2017	

5.4. Work Breakdown Structure

The UUP Work Breakdown Structure (WBS) to level 3 is shown in Table 9.

Table 9 - WBS Level 3

600 Utilities Upgrade Project				
	600.01	Project Management		
		600.01.01	Preliminary Design Phase	
		600.01.02	Final Design Phase	
		600.01.03	Construction Phase	
		600.01.04	Closeout Phase	
	600.02	High Voltage Electrical		
		600.02.01	HV Engineering	
		600.02.02	HV Construction	
			600.02.02.01	Master Substation Control Building Procurement
			600.02.02.02	Master Substation Replacement
			600.02.02.03	*Oil Switch Replacement*
			600.02.02.04	*Main Circuit Breaker Replacement*
			600.02.02.05	*Feeder Replacement*
			600.02.02.06	*Unit Substation Replacement*
			600.02.02.07	*Kautz Road Substation Relay Upgrades*
	600.03	Industrial Cooling Water		
		600.03.01	ICW Engineering	
		600.03.02	ICW Construction	
			600.03.02.01	Backbone Piping Network
			600.03.02.02	*Casey's Pumphouse Area Improvements*
			600.03.02.03	*Makeup Water Improvements*
			600.03.02.04	*Main Injector Piping*
	600.04	OPC - Other Project Costs		
Note: *Italicized* items are Objective Scope				

5.5. Funding Profile

Table 10 presents the funding profile approved at CD-2 as well as the final funding profile.

Table 10 - UUP Funding Profile

Fiscal Year	FY10	FY11 - FY13	FY14	FY15 - FY16	FY17	Total
Other Project Costs	$800				$300	**$1,100**
TEC PED			$4,450			**$4,450**
TEC Construction			$30,450			**$30,450**
Total Project Cost ($K)	**$800**		**$34,900**		**$300**	**$36,000**

5.6. Staffing Profile

Table 11 summarizes the direct-funded Fermilab staff manhours per organization per fiscal year. The staff associated with each organization are:

- DO-Directorate – Project controls
- FES-Administration – Project budget analysis
- FES-Engineering – Project management, subproject managers and closeout activities
- FES-Facility Management – Technical support from plant operations staff, GIS support
- FES-Site Services – Roads and grounds
- FI-Procurement – Procurement administration
- PPD-Alignment - Survey

Table 11 - Fermilab Manhours per Organization

Expenditure Org.	FY14	FY15	FY16	FY17	FY18	Total MH	Total FTE
DO-Directorate	27.3	408.5	781.8	541.3	234.5	**1,993**	**1.13**
FES-Administration	-	4.0	38.0	13.0	8.5	**64**	**0.04**
FES-Engineering	2,400.0	5,596.5	7,453.5	5,231.0	1,949.5	**22,631**	**12.80**
FES-Facility Management	23.0	261.3	2,258.0	1,708.8	33.5	**4,285**	**2.42**
FES-Site Services	16.0	22.0	12.5	54.0	-	**105**	**0.06**
FI-Procurement	-	976.0	712.8	256.8	7.0	**1,953**	**1.10**
PPD-Alignment	-	-	15.0	26.0	30.0	**71**	**0.04**
Total Manhours:	**2,466**	**7,268**	**11,272**	**7,831**	**2,263**	**31,100**	
Total FTE:	**1.4**	**4.1**	**6.4**	**4.4**	**1.3**		**17.6**

The directed-funded staffing on this project peaked at 6.4 full time equivalent (FTE) in FY16. Figure 8 illustrates the total FTE per FY by organization.

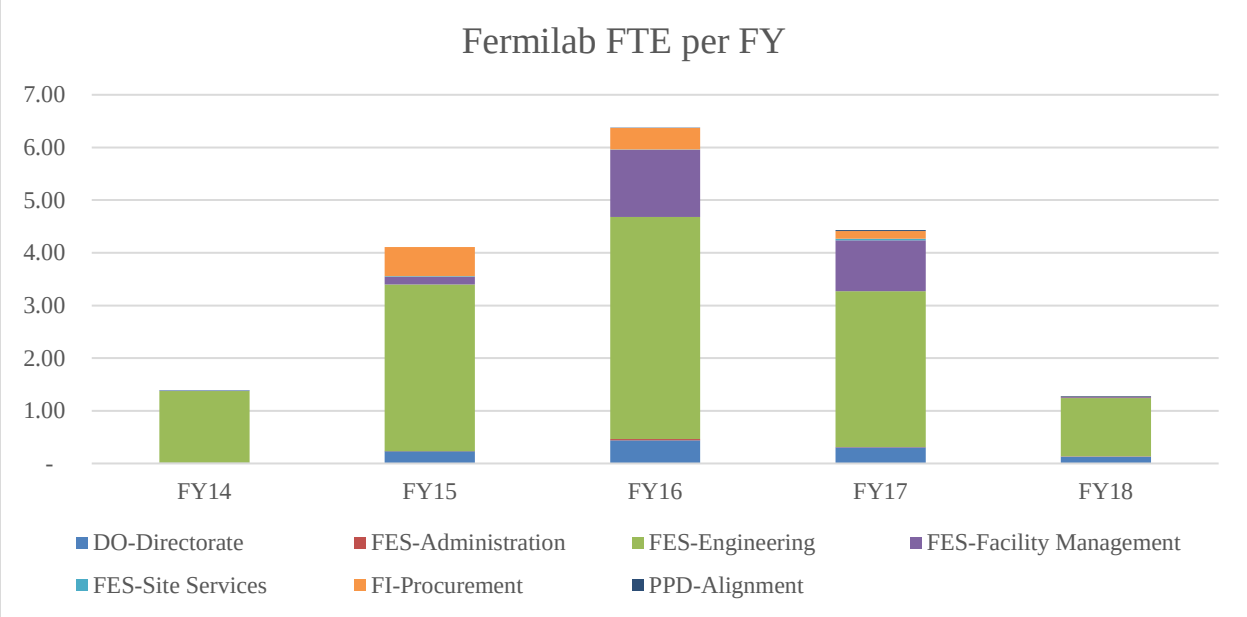


Figure 8 - Fermilab FTE per FY

5.7. Sustainable Design

The UUP project contributed to DOE's leadership in reducing greenhouse gas emissions associated with operations and general-purpose facilities by devising and implementing system elements where applicable that met the Department's sustainability goals in both best practices and consideration of available technology during design.

As many sustainable design and construction elements were incorporated as practical and cost-effective. Waste management requirements included recycling and waste minimization approaches.

5.8. Environmental Requirements and Permits

All requirements of the National Environmental Policy Act (NEPA) have been addressed. A NEPA determination was completed and a Categorical Exclusion (CX) was issued by the Fermilab site Office on November 18, 2014. Illinois Historic Preservation Agency (IHPA) review was covered as part of the NEPA process. The Stormwater Pollution Prevention Plan (SWPPP) was approved by the Illinois EPA in June 2015. The permit will be closed upon project closeout.

A Letter of No Objection was received by the Army Corps of Engineers on July 15, 2015 indicating that no wetland permit was required for any UUP activities.

5.9. Safety Record

The UUP experienced one recordable and one DART case.

Recordable - 7/11/17 at 11AM - UUP-ICW - Wrist Injury - Drilling into Concrete Wall to Install Manhole Steps

A laborer was using a Milwaukee drill with a Hilti rebar cutting bit for drilling through concrete with rebar. Drilling the last hole, the drill bit caught on the rebar which caused the drill to twist. The worker was using both hands, the left hand was on the handle and the right hand was on the attached handle. The worker was using a new bit for the last six (6) holes. The last hole was harder because it was believed that the bit was going through the center of a rebar.

DART - 11/4/16 at 2PM - UUP-ICW – Left Knee – Lifting and Loading Material into Truck
A carpenter was lifting and loading 8x2x4's into the bed of his Ford pickup truck when he twisted and felt a "pop" in his left knee. This incident occurred on the employees last day of work.

Table 12 summarizes the project safety record per fiscal year.

Table 12 - Summary of Project Safety Record

Fiscal Year	Total Hours Worked	Recordable Cases Per FY	OSHA Recordable Incident Rate	DART Cases Per FY	DART Rate
FY16	33,032	0	0.0	1	6.1
FY17	26,044	1	7.7	0	0.0
FY18	5,910	0	0.0	0	0.0
Total:	**64,986**	**1**	**3.1**	**1**	**3.1**

$$Incident\ Rate = \left(\frac{Number\ of\ OSHA\ Recordable\ Cases\ x\ 200{,}000}{Number\ of\ Employee\ Labor\ Hours\ Worked}\right)$$

$$DART\ Rate = \left(\frac{Total\ Number\ of\ DART\ incidents\ x\ 200{,}000}{Number\ of\ Employee\ Labor\ Hours\ Worked}\right)$$

The project experienced three abnormal occurrences that were reported via the Department of Energy's Occurrence Reporting System database (ORPS). All three occurrences were categorized as ORPS SC-4.

11/05/15 - UUP-ICW - Contracted employee failure to follow lockout/tagout procedure

During a construction site field visit, a subcontractor employee was observed performing an electrical Lockout (LOTO) application. The employee successfully locked out the equipment and proceeded to the verification phase, whereby observers noted that the employee was not fully following the appropriate safe work practices. Some examples included: lack of defined Arc Flash Boundary Limits, Incorrect Personal Protective Equipment (PPE) for switching the breaker, and a

lack of positive verification that the voltage meter was in proper working condition. A decision was made that this incident would be categorized as an ORPS SC-4 "…failure to follow a prescribed hazardous energy control procedure".

The questionable LOTO application and other issues that indicate we are vulnerable to an incident (verification of training, non-specific HAs, PPE use, etc.) the Chief Safety Officer issued a safety stand down on all Whittaker Construction & Excavation, Inc. including all subs until we can achieve assurances of sub-contractor qualifications, hazard analysis and work control.

07/05/16 - UUP-HV - Master Substation Excavation Incident

The Master Substation (MSS) building construction contractor (Meade) began excavating trenches for the grounding system adjacent and into the Meson beam line berm in the southeast corner of the MSS. This trenching excavation was outside the boundaries of the approved JULIE restrictions for the MSS construction. The excavation activities moved to the area in question since work had been completed in the switch yard and Meade was attempting to find areas to work since ABB was still completing work on the Substation Building. FESS engineering noticed the excavation work in the area around the berm, stopped the work and notified the Accelerator Division (AD) Radiation Safety Officer (RSO) of this occurrence that afternoon. The AD RSO investigated and determined that the shielding requirement implemented by the AD RSO for unlimited occupancy was possibly compromised and directed Operations to cease Meson beam operations.

The area in question was not posted or fenced like other areas of the berm. The Meade workers assumed that since they were outside of the fence and there were no signs that they could dig up to the large gravel north of Road A. They assumed that the excavation permit covered this area since it was similar type work done.

The Meson Beam Line was shut down and excavation activities were stopped, and Meade was directed to backfill the area in question.

07/24/17 - UUP-ICW - Contracted employee failure to follow lockout/tagout procedure

A violation of NFPA 70 E was witnessed by two (2) Fermilab Electrical Engineers and the projects Construction Coordinator. A LOTO de-energizing / verification was not correctly performed by Frank Marshall Electric. Frank Marshall Electric is a subcontractor to the Lab's subcontractor Whitaker Construction & Excavating, Inc.

The 480-distribution panel was shut off at the main transformer (rotation meter went dark) and the electrician removed the phase rotation leads. Using the rotation meter to verify that the panel was de-energized doesn't meet the NFPA 70E requirements for testing zero energy.

As result of this incident, Whittaker Construction & Excavation, Inc. terminated their relationship with Frank Marshall Electric. Whittaker Construction & Excavation, Inc. hired West Elsdon Electric Company Inc. to complete the project.

6. CLOSEOUT STATUS

Table 13 summarized the status of closeout activities. All construction is complete. With the exception of the ICW design and construction subcontracts all contracts are closed.

Table 13 - Status of Closeout Activities

Activity and Description	Complete - Yes or No?	Planned Completion Date?	Planned Remaining Costs ($K)?
Final Acceptance/Construction Complete - Completion of Remaining Work and Punchlist Items	Yes	Varied per Project	$0
Administrative Closeout - Cost associated with subcontract and financial closeout activities	No	August 2018	$15
Subcontract Closeout - overage for any potential claim by the subcontractor	Yes	Varied per Project	$0
Update the property record in the Facility Information Management System (FIMS)	No	CP Pumphouse addition remains	$1
Financial Closeout - will be closed after subcontract closeout is complete	No	September 2018	$9
		TOTAL:	**$25**

7. LESSONS LEARNED

Table 14 is a summary of the lessons learned captured on the UUP Project. For the full detail of lessons learned – see Appendix F.

Table 14 - Summary of Lessons Learned

LL #	Lessons Learned
001	OPC funds allocated at CD-0 should remain throughout the length of the project.
002	Level 2 (L2) Project Management tasks should be allocated with the L2 WBS
003	Allocate time for Fermi Site Office (FSO) to approve Request for Proposal documentation.
004	The SLI Program Office encourages project to contract preliminary and final design together to avoid unnecessary indirects/burdens on individual contracts.
005	Exempt professional services, or any exempt category >$500K per contract, is exempt from indirects.
006	Site Specific Construction Safety Plan
007	MSS Bypass Project
008	Pre-Solicitation Notifications and Pre-Bid Meetings
009	Verification of Critical Interfaces Between Subcontractors
010	Design Phase Utility Locates
011	Project Management Level of Effort Tasks
012	Contracting with ComEd
013	FMEA and Risk Register
014	Cybersecurity Vulnerability Assessment
015	LOTO Verification ORPS
016	Swan Lake LOTO ORPS
017	Master Substation Excavation Limit ORPS
018	Advanced Delivery of MSS Control Building
019	Unit Price Contracting for ICW
020	Access to Error Logs with New Equipment
021	Capturing GIS Data on Utilities During Excavation
022	Lack of Existing Information for Casey's Pond Pumphouse

8. PROJECT PHOTOGRAPHS

8.1 High-Voltage Subproject

Demolition of Existing Capacitor Tree

Demolition of Master Substation Control Building

Excavation for new control building

New control building arrives on new basement

New bus duct connects existing transformers to new control building

Completed Master Substation Control Building

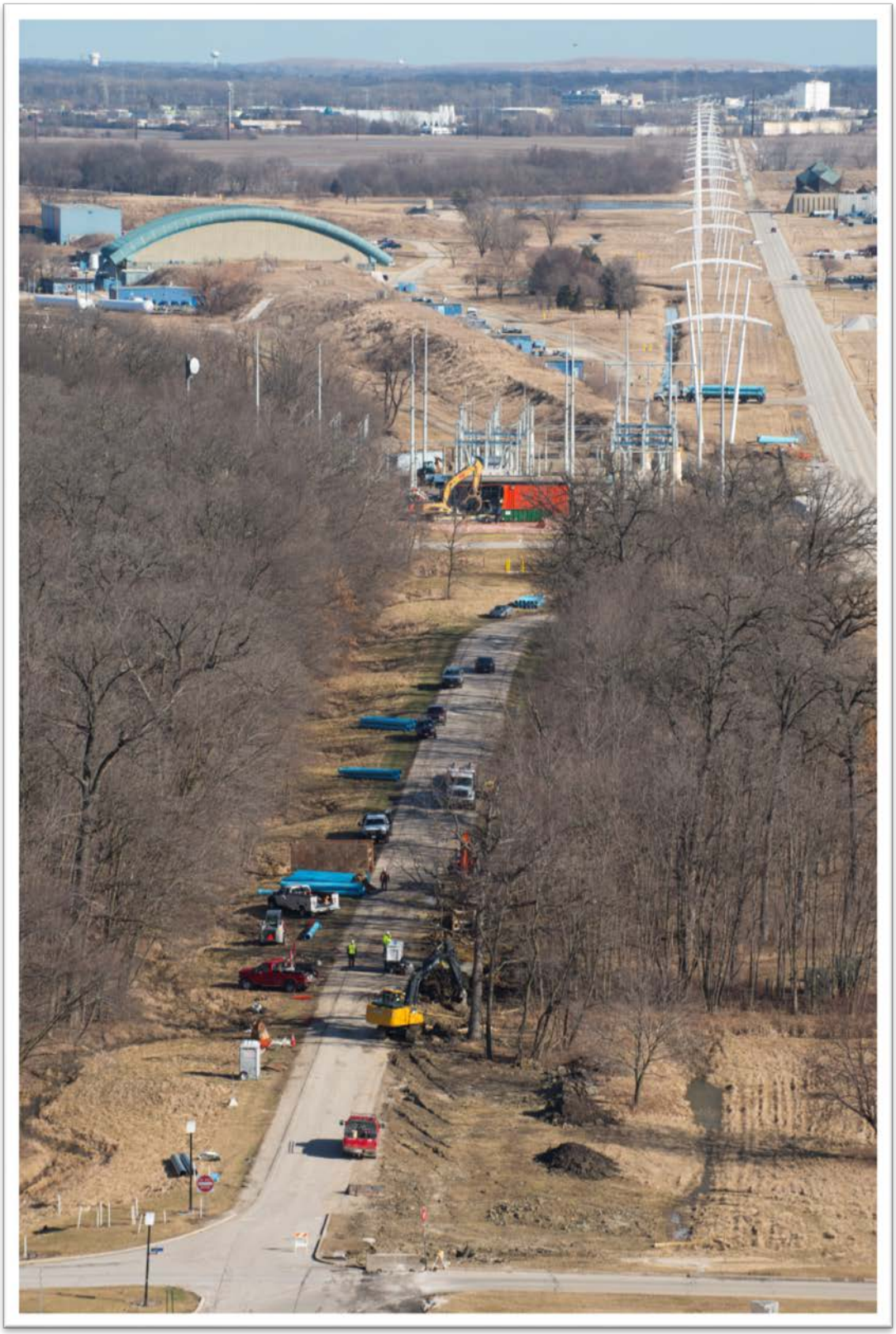
Completed Master Substation Control Building

Demolition of Main 345kV Circuit Breaker

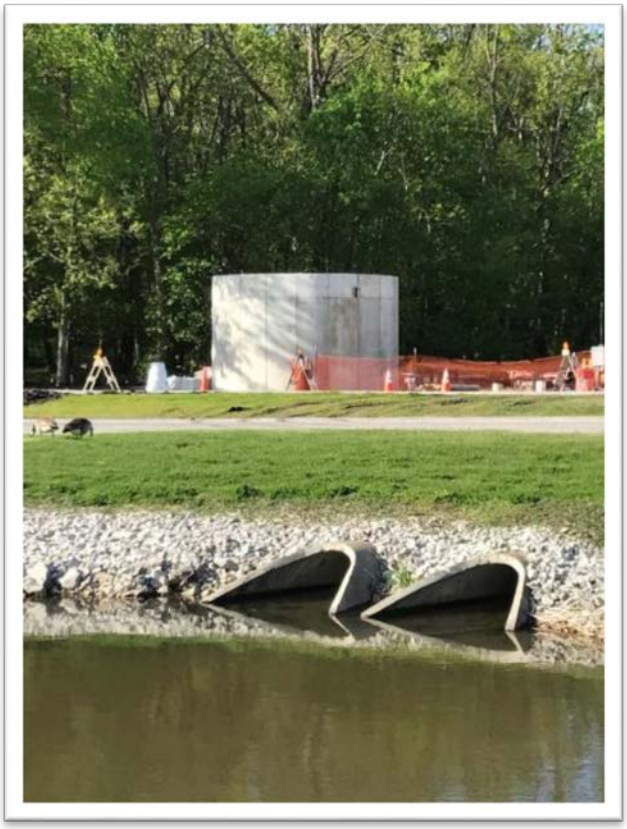
Completed Objective Scope – Main 345kV Circuit Breaker

8.2 Industrial Cooling Water Subproject

ICW Backbone Piping under construction



ICW Backbone Piping under construction
with the demolition of the old Master Substation Control Building (orange) in the background



Completed Swan Lake Pumphouse

Completed Swan Lake Pumphouse

Completed CMTF Pumphouse

Completed CMTF Pumphouse

Completed Objective Scope – Casey's Pond Pumphouse Electrical Room Addition

Completed Objective Scope – Casey's Pond Pumphouse Electrical Room Addition

Completed Objective Scope – Casey's Pond Pumphouse Electrical Room Addition

APPENDIX A – Integrated Project Team Charter

January 2015

FESS/Engineering Project No. 3-5-163

Integrated Project Team Charter

IPTC

Fermi National Accelerator Laboratory
SLI Modernization Project 11-SC-70
Utilities Upgrade Project

Non-Major System Acquisition Project

Fermi National Accelerator Laboratory | U.S. DEPARTMENT OF ENERGY | Managed by Fermi Research Alliance, LLC.

Submitted by:

7/29/10

Russell J. Alber
Project Manager
FESS/ Engineering
Fermi National Accelerator Laboratory

Date

7-29-10

Randall G. Ortgiesen
Project Director
Head FESS
Fermi National Accelerator Laboratory

Date

Approved by:

7/29/10

Stephen L. Webster
Federal Project Director
DOE Fermi Site Office

Date

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5.0 TEAM MEMBER RESPONSIBILITIES	6
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CHANGE LOG

Rev. No.	Date	Change Description	Pages Modified
Rev. 0	07/29/10	Initial Issue	Not Applicable
Rev. 1	01/16/15	Updated Organization Chart	4

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The mission of the Integrated Project Team (IPT) with the Federal Project Director (FPD) serving as the team leader is to provide strategic planning, coordination, and communication for the Utilities Upgrade Project (UUP). The Integrated Project Team is responsible for ensuring the project's objectives are achieved on schedule, within budget, and consistent with quality, environment, safety, and health standards. The Integrated Project Team is also responsible for making sure that project management is carried out with integrity and in compliance with applicable laws.

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The purpose and goals of the Integrated Project Team are as follows:

- Support the Federal Project Director and UUP Project Manager in planning, programming, budgeting, and acquisition of capital assets.
- Assist the Federal Project Director in developing and implementing the Acquisition Strategy and the Project Execution Plan.
- Assure all project interfaces are identified, completely described, defined and managed to completion.
- Identify and meet appropriate and adequate project performance parameters.
- Perform quarterly reviews and assessments of project performance and status against established performance parameters, baselines, milestones, and deliverables, taking corrective actions as appropriate.
- Plan and participate, as necessary, in project reviews, audits, and appraisals as necessary.
- Support development of all Critical Decision (CD) packages. Review all Critical Decision (CD) packages for completeness and recommend approval and disapproval.
- Review and comment on project deliverables, e.g., drawings, specifications, procurement, and construction packages.
- Review baseline change requests (as appropriate) and support change control boards as requested.
- Support the preparation, review, and approval of project completion and closeout documentation.

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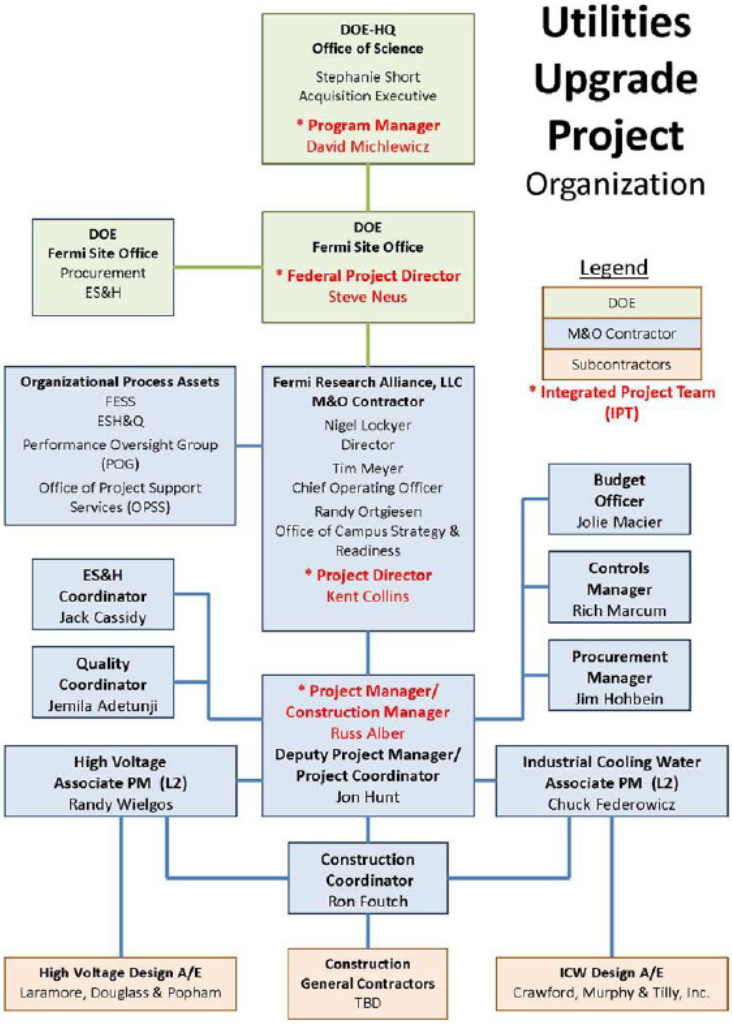
Utilities Upgrade Project Organization



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Multiple interfaces are necessary for the Utilities Upgrade Project. The integrated Project Team is responsible for ensuring well-coordinated planning and timely project performance. These include the DOE Program Manager and Federal Project Director, other DOE Headquarters stakeholders, FNAL Management, the project performance teams, and other FNAL stakeholders.

The Federal Project Director will be primary point of contact with the Program Manager for coordination, reporting to DOE HQ, and submittal of all primary documents such as CD documentation. The Federal Project Director will preside over the weekly IPT project teleconferences with the Program Office and is responsible to ensure effective coordination with other DOE and external stakeholders as appropriate. For CD approvals and project reviews it may be necessary for the Federal Project Director to interface with other DOE Headquarters organizations. However, the Program Manager will be the IPT point of contact to for day-to-day interface with these organizations.

The interface with FNAL Management and affected personnel will be necessary for coordination with site activities that may impact project performance or where the project activities may have broader site impacts. FNAL project manager will be the IPT point of contact for day-to-day interface with FNAL Management and other affected personnel to obtain input for coordination of project activities and planning.

The Project performance teams will be responsible for implementing project elements of work. The FNAL Project Manager and/or IPT team members directly associated with the elements of work being performed will be the primary points of contact with the project performance teams.

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The IPT for the Utilities Upgrade Project (UUP) consists of personnel from the DOE-Fermi Site Office (FSO) and Fermilab. The objective of the UUP IPT is to provide professional management and subject matter expertise to ensure the safe, timely, and cost-effective completion of the project. The IPT supports the DOE Federal Project Director (FPD). This section describes the responsibilities of each IPT member.

DOE Federal Project Director

The FPD is part of the DOE-FSO, which reports to SC, administers the contract with Fermilab and provides day-to-day oversight of Fermilab. The execution of the UUP Project is the responsibility of the FPD. The FPD is supported by matrix staff from within FSO and the SC Integrated Support Center in areas such as procurement, finance, safety, environmental compliance, and fire protection. The FPD's responsibilities and authorities include the following:

- Leads the IPT and development of the IPT Charter.
- Serves as the single point of contact between federal and contractor staff.
- Plans, implements, and completes the project using a systems engineering approach.
- Tailors DOE project management requirements to the project.
- Develops and implements the Acquisition Strategy and the Project Execution Plan (PEP).
- Defines project objectives and technical scope, cost, and schedule.
- Ensures timely completion and quality of required project documentation.
- Assesses contractor project performance versus contract requirements.
- Proactively identifies and resolves critical issues within federal control.
- Integrates and manages the timely delivery of government reviews, approvals, property, services and information.
- Ensures the design, construction, environmental, safety, health and quality efforts performed are in accordance with the contract, public law, regulations, and Executive Orders.
- Approves Level 2 changes in accordance with the approved change control process and recommends approval for higher level changes.
- Manages project contingency funds.
- Reports to DOE via the Project Assessment and Reporting System (PARS)
- Oversees the management and mitigation of project risks.

Fermi Research Alliance, LLC – M&O Contractor (FRA)

Fermilab's Facilities Engineering Services Section (FESS) will lead the project and provide the project management and facility expertise needed to successfully complete it. This project's leadership is composed of individuals having several years of experience managing or supporting similar projects. The FPD will be supported by a project team that includes a Project Director, Project Manager, and other Fermilab support as shown on the project organization chart and as required by the project. Senior Fermilab management support includes involvement by the Deputy Laboratory Director and the direct involvement of a Chief Operating Officer, who works directly with the project team to facilitate matters and assist the team with best practices.

Project Director

The UUP Project will be executed by a Fermilab project team that is headed by the UUP Project Director. The project director has overall responsibility for ensuring ES&H requirements are followed. The project director has established an Integrated Project Team (IPT) to accomplish the UUP Project. The project director is the main point-of-contact for the FPD. The project director provides senior management oversight and approves Level 3 or lower Baseline Change Proposals (BCPs).

Project Manager

The UUP project manager is responsible for project implementation and evaluating and mitigating project risks. Specific responsibilities of the project manager include:

- Manages day-to-day execution of the project.
- Establishes technical and administrative controls to ensure the project is executed within approved cost, schedule, and technical scope.
- Implements an Earned Value Management System (EVMS) to track performance against the approved project baseline.
- Ensures that project activities are conducted in a safe and environmentally sound manner.
- Ensures ES&H responsibilities and requirements are integrated into the project.
- Participates in management meetings and communicates the project status and issues.
- Identifies and manages project risks.
- Prepares and provides recommendations for baseline change control proposals.
- Ensure project deliverables as defined in the contract are on time and within budget.

Construction Manager

The CM will conduct constructability reviews and generate cost estimates including estimates of alternative designs or materials. The CM will also provide recommendations of actions designed to minimize adverse effects of labor or material shortages, time requirements for procurement, and installation and construction completion.

Subproject Managers (L2)

The UUP WBS Level 2 Subproject Managers (L2's) are responsible for the design, procurement and construction of their subprojects within their area of expertise. The Project Manager appoints the L2's in conjunction with the PD. The L2's manage and direct their subprojects and report to the Project Manager. They are directly responsible for generating and maintaining the cost estimate, schedule, and resource requirements for their subprojects. They are responsible for meeting the goals of their subproject within the accepted baseline cost and schedule. The L2's are in the line management for the project and are responsible for completing their subprojects safely and with respect for the environment. The L2's are designated as Control Account Managers and are responsible for Earned Value Management on their assigned control accounts.

Construction Coordinator

The UUP Construction Coordinator is responsible for providing construction oversight, construction feasibility reviews, value engineering, and cost and schedule estimating, during the design phase. During the construction phase, the construction coordinator is responsible for construction site management including construction ES&H compliance and general subcontractor management and oversight.

Project Coordinator

The UUP Project Coordinator assists in planning, researching, and developing the design, contributing in areas such as the design, design review, procurement, manufacture, installation, testing, and initial operation in compliance with all applicable local, state and federal regulations, requirements and standards and all DOE orders. The UUP Project Coordinator assists in estimating manpower, schedules work; and coordinates other engineers as assigned.

ES&H Coordinator

The UUP ES&H Coordinator develops, integrates and implements aspects of project-related Environmental, Safety, and Health (ES&H) processes, plans, procedures, systems, methods and policies critical to the success of the UUP Project. The UUP

ES&H Coordinator ensures that technical complex requirements are properly interpreted by evaluating and applying appropriate ES&H principles and formulating scopes of work, plans, and methodologies suitable for achieving and maintaining compliance with Fermilab ES&H requirements, maintains overall responsibility for project ES&H execution, ensuring project is adhering to contract requirements, standards of quality, and to Fermilab and DOE ES&H performance expectations.

Quality Coordinator

The UUP Quality Coordinator is responsible for the administration of the Quality Assurance Plan (QAP) and has the authority to manage all work affecting quality. The Quality Coordinator will provide leadership for the development, implementation, communication and maintenance of the QAP as well as Fermilab's Integrated Quality Assurance Program including quality systems policies and procedures according to the approved QAP.

Budget Officer

The UUP Project Budget Officer manages the project budget, coordinates budget reviews and reporting with the project manager, level 2 managers and all project control account managers. The budget officer consolidates data for budget presentations and also maintains and reports the financial status of the project budget submits budget reports to the project team and monitors the budget throughout the project.

Controls Manager

The UUP Project Controls Manager is responsible for the project's processes and procedures and in the implementation of the Lab's project controls systems that support the project manager in planning project cost and schedule control functions for the project. The UUP Project Controls Manager coordinates the work, resources, and costs using project controls tools, is responsible for the coordination, preparation, consistent application, and analysis of trends, Earned Value (EV) performance reports and the project risk management plan, ensuring that the results of risk analysis are incorporated into the project baseline.

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The Integrated Project Team shall meet on a weekly basis to accomplish the stated project goals and mission. Special meetings, when necessary, will be called by the FPD to address and/or resolve specific issues.

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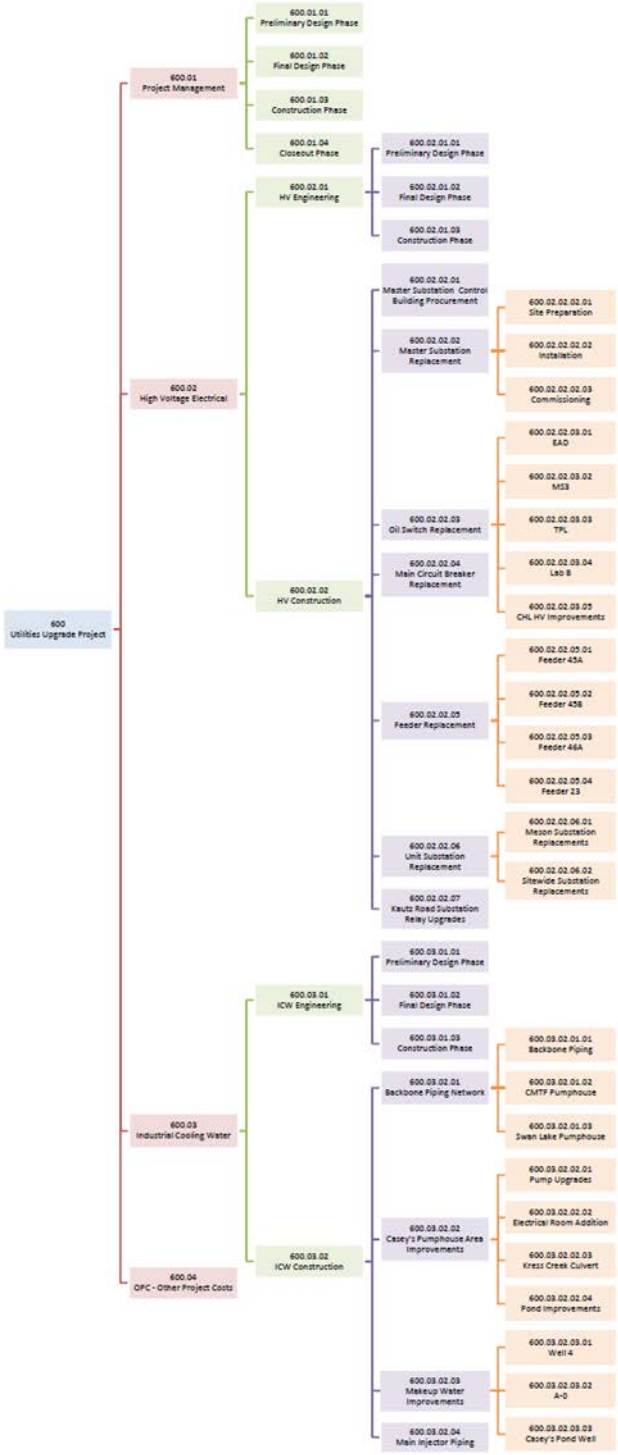
This charter will expire when CD-4, Project Closeout, is approved by the Acquisition Executive. The charter is a living document and the Integrated Project Team membership may change during the life of the project. The Federal Project Director will issue revisions to the charter as necessary.

APPENDIX B – Detailed Work Breakdown Structure

600	**Utilities Upgrade Project**				
	600.01	Project Management			
		600.01.01	Preliminary Design Phase		
		600.01.02	Final Design Phase		
		600.01.03	Construction Phase		
		600.01.04	Closeout Phase		
	600.02	High Voltage Electrical			
		600.02.01	HV Engineering		
			600.02.01.	Preliminary Design Phase	
			600.02.01.	Final Design Phase	
			600.02.01.	Construction Phase	
		600.02.02	HV Construction		
			600.02.02.	Master Substation Control Building Procurement	
			600.02.02.	Master Substation Replacement	
				600.02.02.	Site Preparation
				600.02.02.	Installation
				600.02.02.	Commissioning
			600.02.02.	Oil Switch Replacement	
				600.02.02.	EAD
				600.02.02.	MS3
				600.02.02.	TPL
				600.02.02.	Lab B
				600.02.02.	CHL HV Improvements
			600.02.02.	Main Circuit Breaker Replacement	
			600.02.02.	Feeder Replacement	
				600.02.02.	Feeder 45A
				600.02.02.	Feeder 45B
				600.02.02.	Feeder 46A
				600.02.02.	Feeder 23
			600.02.02.	Unit Substation Replacement	
				600.02.02.	Meson Substation Replacements
				600.02.02.	Sitewide Substation Replacements
			600.02.02.	Kautz Road Substation Relay Upgrades	
	600.03	Industrial Cooling Water			
		600.03.01	ICW Engineering		
			600.03.01.	Preliminary Design Phase	
			600.03.01.	Final Design Phase	
			600.03.01.	Construction Phase	
		600.03.02	ICW Construction		
			600.03.02.	Backbone Piping Network	
				600.03.02.	Backbone Piping
				600.03.02.	CMTF Pumphouse
				600.03.02.	Swan Lake Pumphouse
			600.03.02.	Casey's Pumphouse Area Improvements	
				600.03.02.	Pump Upgrades
				600.03.02.	Electrical Room Addition
				600.03.02.	Kress Creek Culvert
				600.03.02.	Pond Improvements
			600.03.02.	Makeup Water Improvements	
				600.03.02.	Well 4
				600.03.02.	A-0
				600.03.02.	Casey's Pond Well
			600.03.02.	Main Injector Piping	
	600.04	OPC - Other Project Costs			


600
Utilities Upgrade Project
600.01
Project Management
600.01.01
Preliminary Design Phase
600.01.02
Final Design Phase
600.01.03
Construction Phase
600.01.04
Closeout Phase
600.02
High Voltage Electrical
600.02.01
HV Engineering
600.02.01.01
Preliminary Design Phase
600.02.01.02
Final Design Phase
600.02.01.03
Construction Phase
600.02.02
HV Construction
600.02.02.01
Master Substation Control Building Procurement
600.02.02.02
Master Substation Replacement
600.02.02.02.01
Site Preparation
600.02.02.02.02
Installation
600.02.02.02.03
Commissioning
600.02.02.03
Oil Switch Replacement
600.02.02.03.01
EAD
600.02.02.03.02
MS3
600.02.02.03.03
TPL
600.02.02.03.04
L&D B
600.02.02.03.05
CHL HV Improvements
600.02.02.04
Main Circuit Breaker Replacement
600.02.02.05
Feeder Replacement
600.02.02.05.01
Feeder 45A
600.02.02.05.02
Feeder 45B
600.02.02.05.03
Feeder 46A
600.02.02.05.04
Feeder 23
600.02.02.06
Unit Substation Replacement
600.02.02.06.01
Mason Substation Replacements
600.02.02.06.02
Sitewide Substation Replacements
600.02.02.07
Kautz Road Substation Relay Upgrades
600.03
Industrial Cooling Water
600.03.01
ICW Engineering
600.03.01.01
Preliminary Design Phase
600.03.01.02
Final Design Phase
600.03.01.03
Construction Phase
600.03.02
ICW Construction
600.03.02.01
Backbone Piping Network
600.03.02.01.01
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600.03.02.01.02
CMTF Pumphouse
600.03.02.01.03
Swan Lake Pumphouse
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Pump Upgrades
600.03.02.02.02
Electrical Room Addition
600.03.02.02.03
Kress Creek Culvert
600.03.02.02.04
Pond Improvements
600.03.02.03
Makeup Water Improvements
600.03.02.03.01
Well 4
600.03.02.03.02
A-0
600.03.02.03.03
Casey's Pond Well
600.03.02.04
Main Injector Piping
600.04
OPC - Other Project Costs

APPENDIX C – Major External Reviews

DOE's Order 413.3B outlines a series of staged project approvals, each of which is referred to as a "Critical Decision (CD)". The system is designed to tailor to process to the varying size and complexities for any given project. The DOE conducts Independent Project Reviews (IPRs) at each of the Critical Decision points. The review committees are chaired by the SC Office of Project Assessment (OPA) and consist of individuals from the various DOE laboratories.

The following is summary of the Critical Decision IPRs that were conducted for this project.

Independent Project Review for CD-1 "Approve Alternative Selection and Cost Range"

The IPR was conducted in Germantown, Maryland on August 24, 2010 at the request of Marcus Jones, Associate Director, Office of Safety, Security and Infrastructure. The purpose of the review was to evaluate technical, cost and schedule, ES&H, and management elements and determine the readiness of the project to move forward to CD-2. CD-1 was approved on November 15, 2010. The committee had the following recommendations:

- Cost and Schedule
  - Consider using a CM to augment project personnel prior to CD-2 approval. This is based on the fact that most site utilities are usually understaffed and require 24-hour on-call maintenance. This would prevent inadequate oversight of the project. The site utilities will still be very involved in the outages and interfaces with the CM.
  - Align schedule and cost contingency with risk to support CD-2 approval.
  - Avoid partial fixes. Scope contingency, while good for meeting budgets, does not always meet utility project needs. The Project during design phase will have to provide detailed analysis for any scope addition or reduction that may only provide "partial fixes". Project will want to make wise upgrades to the systems to optimize the value of the project prior to CD-2.
  - Define additional cost and schedule details to support CD-2 approval including long lead items for H/V, method of procurement, incorporation of CM support, breakout of EDIA, escalation rate, CD approvals, etc.
  - Consider adding float and delaying CD-2 prior to CD-1 approval.

- ES&H
  - Given the hazard potential for serious accidents, provide resources for project oversight by CD-2.

- Management
  - Consider increasing project staff resources (prior to CD-1)
  - Review project schedule and determine if overall schedule contingency and plan to achieve CD-2 is adequate (prior to CD-1)
  - Consider 413.3a, tailoring strategy (e.g. combining CD-2 with CD-3A) (prior to CD-1)
  - Consider a less broad KPP range (prior to CD-2)
  - Analyze if a NEPA Cx or EA will affect the current plan (e.g. CD-2) (prior to CD-1)
  - Update and sign PPEP (prior to CD-1)

- Recommend CD-1 approval once recommendations are addressed.

Independent Project Review for CD-2 "Approve Performance Baseline" and CD-3A "Pre-Procure the Master Substation Control Building"

The IPR was conducted at Fermilab in Batavia, Illinois from December 9-10, 2014 at the request of Mrs. Stephanie Short, Associate Deputy Director for Field Operations, Office of Operations Program Management. The purpose of the review was to concurrently review aspects of the project to assess overall readiness for CD-2/3a. CD-2/3a was approved on February 18, 2015. The committee had the following recommendations:

- Technical
  - Prioritize Objective KPPs (based on risk and impact) and then finalize the design only on that scope that the project expects to have contingency to fund. Complete this prioritization by CD-2/3a.
  - Contract with an independent commissioning agent for design/constructability reviews, validation of testing of equipment, and overall systems integration within 30 days of CD-2/3a.

- ES&H
  - Revise MSS drawings and specs to include an eyewash and shower instead of just an eyewash. Required for CD-2/3a: MSS Design.
  - Include a subcontractor safety representative in the ICW and MSS projects. It would be prudent to have a subcontractor safety representative for the entire project except perhaps low risk phases, if any, of the ICW and MSS projects. Necessary qualifications should be listed in the project specifications. Required for CD-2/3a as the cost of the subcontractor safety representative would have to be added to the baseline cost estimate.
  - Revise the HAR to address the operational hazards associate with the MSS that have been incorporated in the design. Required for CD-2/3a as these are incorporated into the MSS design and specifications.

- Cost and Schedule
  - Before the CD-2/3a ESAAB, the project should update and freeze the cost performance measurement baseline allowing sufficient time to update associated project documents.
  - Before CD-2/3a ESAAB, document the commitment of Fermilab management to support the additional requirements in the event the project misses the planned August shut-down window.
  - Before CD-2/3a ESAAB, define cost and schedule reporting variance thresholds.

- Management
  - Revise the Acquisition Strategy prior to CD-2/3a to update the changes in baseline scope and milestones since its approval in July 2010.
  - Develop an Acquisition Plan by January 31, 2015 to meet the March 25, 2015 date to issue the solicitations for ICW and HV. Time frames should be established to include all phases of the procurement process and include time for finishing

specifications and drawings, submission of technical and financial documents to Procurement, development of the solicitation package, internal procurement/business review and FSO approval, receipt of offers, and evaluation/aware requirements.

Independent Project Review for CD-3B "Approve Start of Construction – Phase B"

The IPR was conducted at Fermilab in Batavia, Illinois on August 10, 2015 at the request of Mrs. Stephanie Short, Associate Deputy Director for Field Operations, Office of Operations Program Management. The purpose of the review was to assess the project's overall readiness for CD-3B. CD-3B was approved on September 3, 2015. The committee had the following recommendations:

- Cost and Schedule
  - Prior to ESAAB, recommend preparing both a cost and schedule impact of missing the Commonwealth Edison disconnect date with a path forward recommendation.
  - Recommend CD-3b approval pending completion of the above action.

- Management
  - Conduct a thorough review of the cost and schedule impacts if the ComEd disconnect cannot be completed per the current schedule prior to approval of the Baseline Change Proposal (BCP) incorporating BCR007.

Independent Project Review for Annual Project Review July 2016

The IPR was conducted at Fermilab in Batavia, Illinois from July 19-20, 2016 at the request of Mrs. Stephanie Short, Associate Deputy Director for Field Operations, Office of Operations Program Management. The purpose of the review was to assess the current status of the project and identify any concerns that could prevent the project from being successfully completed within the approved baseline. The committee had the following recommendations:

- Cost and Schedule
  - Bring baseline schedule in line with approved BCRs and PEP within 30 days or before implementation of future approved change requests.

- Management
  - Update Risk Register to ensure risk associated with remaining work is appropriately addressed and identify when risk will be retired and align this with the remaining contingency. Update the Use of Contingency and Management Reserve spreadsheet to reflect planned use and schedule for the remaining contingency. Complete prior to submission of the BCR.
  - Update the Use of Contingency and Management Reserve spreadsheet to reflect a final balance of zero or less. Add lines for expected use of contingency through the remainder of the project including field changes. Complete prior to submission of the BCR.

Independent Project Review for CD-4 "Approve Start of Operations"

An IPR will be conducted at Fermilab in Batavia, Illinois from August 22-23, 2018 at the request of Marcus Jones, Acting Director, Office of Operations Program Management. The purpose of the review was to ensure the project had met all of the requirements for CD-4.

APPENDIX D – Spend Down Plan

APPENDIX E – Risk Register

APPENDIX F – Lessons Learned

CD-4 Lessons Learned Report
Prepared in July 2018

Project Title: Utilities Upgrade Project
Project Location: Fermi National Accelerator Laboratory
Description of Project: The scope of this project includes design and construction of an upgraded Industrial Cooling Water System (ICW) and an upgraded High Voltage Electrical System (H/V). The scope includes replacing components at or near end of service life and upgrading the distribution networks with secondary distribution and additional controls.

List three most significant "success" lessons for this project.

Lessons Learned—Successes	Description, Impacts, and Solutions
Design Phase Utility Locates	• The project team elected to use design-phase funding to locate existing underground utilities via potholing and hydro excavating in order to positively obtain the location/elevation information. The engineering design firm utilized the as-built information to design the proposed ICW pipe routing. • By potholing for the existing utility elevations at locations where the new ICW piping would likely intersect, the design firm was able to identify if the proposed pipe routing required redesign. Redesigns of the proposed piping during the design phase is less costly than if redesigned during construction. • It was advantageous to gather as much information of the potential utility conflicts between existing utilities (where known) and proposed piping during the design phase versus during construction.
Unit Price Contracting for ICW	• The project team employed the use of a firm-fixed unit price contract vehicle for the ICW construction project. • Use of the firm-fixed unit price contract provided $330K in credits to the project for various scope of work items that were included in the Subcontractor's proposal, but were not installed, due to beneficial changes in the field or value engineering during construction.
Advanced Delivery of the MSS Control Building	• MSS Control Building was constructed at an offsite location by the building manufacturer. The control building was to be built, tested, disassembled, shipped to Fermilab, and installed at the project site. A separate subcontractor was responsible for preparing the project site, constructing the building foundations, and connecting the building. • Delays during fabrication of the control building threatened to delay the site subcontractor, and risked adding costs and schedule delays to the project. The project team decided to accept delivery of the fabricated building and perform testing on the Fermilab site. • Accepting delivery avoided damages by the site installation subcontractor, and the building was successfully installed, tested, and operated.

List three areas of potential improvement and how they have or might have impacted the project.

Lessons Learned—Potential Improvements	Description, Impacts, and Solutions
Contracting Professional Design Services on SLI Projects	• This project contracted preliminary and final professional design services at separate times based on funding phasing, i.e. CD-1, CD-2. • The SLI Program Office encourages the project to contract preliminary and final design together to avoid unnecessary indirects/burdens on individual contracts. • SLI Projects should contract preliminary and final design under one single Purchase Order in order to avoid unnecessary costs.
Site Specific Construction Safety Plan	• Project Management documentation was created per DOE 413.3B requirements; however, the UUP Construction Project Safety and Health Plan and the Appendix A – Site Specific Construction Safety Plan were not included as part of the subcontract documents. • Project Managers failed to include the UUP Construction Project Safety and Health Plan, including the Appendix A – Site Specific Construction Safety Plan, as part of the subcontract documents for both the ICW and HV subprojects of the UUP. • Flow down all necessary requirements of the construction project to the subcontractors during the bid phase.
LOTO Violations during ICW Construction	• Two LOTO violations occurred during the ICW construction project by a sub-tier contractor. One was a failure to properly perform LOTO of a parking lot lighting circuit and the other was a failure to perform LOTO of an electrical circuit during construction of the Swan Lake Pump Station. • Both incidents became ORPSs. The first incident resulted in a temporary stand down of the subcontractor while further investigations took place. After the second incident, by the same sub-tier subcontractor as the first, the sub-tier subcontractor was removed from the project by the project team, and is barred from working at Fermilab.

List <u>other lessons learned</u>. It is suggested that these <u>"Other"</u> lessons also be grouped as successes and potential improvements, and grouped by similar subject for easier reference.

Lessons Learned Successes	Description, Impacts, and Solutions
Capturing Existing Utility Information in GIS	• During installation of the ICW backbone piping network, while trenches were open across the site, the project team employed Fermilab's GIS resources to capture coordinates and elevations of many existing utilities that were encountered. • This data was then used to update existing data in the GIS Maps and will help to build a robust database of information that can but used by future projects.
Master Substation (MSS) Bypass Project	• General Plant Project (GPP) funds were used to make site-wide improvements to the electrical feeder system enabling isolation of Master Substation from the electrical feeder system during the control building replacement. • By making the improvements to the electrical feeder system in advance of the MSS replacement, the Laboratory was able to isolate power to critical switches and feeders, bypassing and allowing for safe shutdown of the MSS.
Lessons Learned Improvements	**Description, Impacts, and Solutions**

Lessons Learned Successes	Description, Impacts, and Solutions
Level 2 Project Management	• At the CD-2 Director's Review, UUP had Level 2 project management tasks within the Project Management WBS. • L2 project management tasks should be allocated with the L2 WBS. • All L2 PM tasks should be controlled by the L2 CAM. PM tasks are for project level effort only.
Other Project Costs Accounting	• UUP allocated $1.1M in OPC at CD-0. At CD-2, UUP costed $745K and readjusted TPC accordingly. • OPC funds allocated at CD-0 should remain throughout the length of the project. • Maintain OPC throughout the length of the project.
FSO Approval of Request for Proposals	• UUP scheduled time for approval of contract documents by the Fermi Site Office (FSO). Schedule at baseline assumed one month FSO approval of Purchase Order (PO) documents only. Approved Acquisition Plan allowed for one month of FSO approval for both Request for Proposals and PO documentation. • Allocate time for FSO to approval Request for Proposal documentation. • Ensure Acquisition Plan is consistent with new FSO requirement that contracts that can potentially be greater than $5M be sent to the FSO for approval at the Request for Proposal stage. Acquisition Plans should be completed prior to baselining.

Full List of Lessons Learned

No.	Title	Type	Description	Notes
001	OPC funds allocated at CD-0 should remain throughout the length of the project.	Opportunity for Improvement	UUP allocated $1.1M in OPC at CD-0. At CD-2, UUP costed $745K and readjusted TPC accordingly. Program Office expects laboratory to expend all allocated OPC within the project and plan to use OPC for end of project commissioning.	Maintain OPC throughout the length of the project
002	Level 2 (L2) Project Management tasks should be allocated with the L2 WBS	Opportunity for Improvement	At the CD-2 Director's Review, UUP had Level 2 project management tasks within the Project Management WBS. L2 project management tasks should be allocated with the L2 WBS	All L2 PM tasks should be controlled by the L2 CAM. PM tasks are for project level effort only.
003	Allocate time for Fermi Site Office (FSO) to approve Request for Proposal documentation.	Opportunity for Improvement	UUP scheduled time for approval of contract documents by the Fermi Site Office (FSO). Schedule at baseline assumed one month FSO approval of Purchase Order (PO) documents only. Approved Acquisition Plan allowed for one month for FSO approval for both Request for Proposals and PO documentation.	Ensure Acquisition Plan is consistent with new FSO requirement that contracts that can potentially be greater than $5M be sent to FSO for approval at the Request for Proposal stage. Acquisition Plans should be completed prior to baselining.
004	The SLI Program Office encourages project to contract preliminary and final design together to avoid unnecessary indirects/burdens on individual contracts.	Opportunity for Improvement	The project contracted preliminary and final professional design services at separate times based on funding phasing, i.e. CD-1 CD-2.	SLI Projects should contract preliminary and final design under one single Purchase Order in order to avoid unnecessary costs.
005	Exempt professional services, or any exempt category >$500K per contract, is exempt from indirects. UUP miscalculated the costing curve for exempt final design	Opportunity for Improvement	Project schedule costed design linearly. The purchase order requisition was created using the exempt professional services category. As is typical of the Fermilab accounting system, all indirects/burdens were applied upon receipt of the first invoice.	Prepare requisitions with two lines on a single Purchase Order. The first line should be $500K classified as non-exempt. The second line should be for the remainder as exempt.

	on the high voltage control account.			
006	UUP - Site Specific Construction Safety Plan	Opportunity for Improvement	Project Managers failed to include the UUP Construction Project Safety and Health Plan, including the Appendix A - Site Specific Construction Safety Plan, as part of the subcontract documents for both the ICW and HV subprojects of the UUP. Project Management documentation was created per DOE 413.3B requirements; however, the UUP Construction Project Safety and Health Plan and the Appendix A - Site Specific Construction Safety Plan were not included as part of the subcontract documents.	Flow down all necessary requirements of the construction project to the subcontractors during the bid phase.
007	UUP - MSS Bypass Project	Success	By making improvements to the electrical feeder system in advance of the MSS replacement, the Laboratory was able to isolate power to critical switches and feeders, bypassing, and allowing for safe shutdown of the MSS. General Plant Project (GPP) funds were used to make site-wide improvements to the electrical feeder system enabling isolation of Master Substation from the electrical feeder system during the control building replacement.	
008	UUP - Pre-Solicitation Notifications and Pre-Bid Meetings	Success	This process helped create interest and spurred involvement by the subcontractors early in the project. It also helped to inform the subcontractors of the Lab's expectations and processes and contributed to a successful procurement process. The project team notified potential subcontractors of the project well in advance of the proposal solicitation. Once proposal solicitations had been issued, the subcontractors were sent invitations for a Pre-Bid Meeting for the purposes of describing the project in detail, going over the procurement	

			process, safety requirements, and answering questions.	
009	UUP - Verification of Critical Interfaces Between Subcontractors	Success	The MSS replacement scope of the UUP involves two different subcontractors, one for the prefabricating offsite and installing on-site the new substation control building on the foundation, and the other for the sitework excavation, ductbank work, and tieing in the new building. The interface between placing the pre-fabricated building on the new foundation was critical.	A commissioning agent was engaged to guarantee successful interface between subcontracts.
010	UUP - Design Phase Utility Locates	Success	By potholing for the existing utility elevations at locations where the new ICW piping would likely intersect, the design firm was able to identify if the proposed pipe routing required redesign. Redesigns of the proposed piping during the design phase is less costly than if redesigned during construction. The project team elected to use design-phase funding to locate existing underground utilities via potholing and hydro excavating in order to positively obtain the location/elevation information. The engineering design firm utilized the as-built information to design the proposed ICW pipe routing.	It was advantageous to gather as much information of the potential utility conflicts between existing utilities (where known) and proposed piping during the design phase versus during construction.
011	UUP - Project Management Level of Effort Tasks	Opportunity for Improvement	Project Management Level of Effort tasks in the project schedule should be broken into smaller durations to allow for changes (e.g. split into fiscal year quarters).	The project used a single Project Management task to capture the level of effort for an entire fiscal year, preventing any changes to schedule planning until the following fiscal year.

012	UUP - Contracting with ComEd	Opportunity for Improvement	The project should have worked the FEMP and the area-wide agreement when contracting with Commonwealth Edison (ComEd) during all phases of the project (i.e. preliminary design, final design, and construction).	During the preliminary and final design phases, the project worked with ComEd through an engineering design firm who contracted directly with ComEd.
013	UUP - FMEA and Risk Register	Success	After further review of the risk register prior to start of construction, the project team realized that there were gaps in the risk register to cover the major risks during demolition and construction. A Failure Mode and Effects Analysis (FMEA) was used to quantify cost and schedule risk for the major ICW and H/V risks.	A Failure Mode and Effects Analysis (FMEA) was used to further analyze and quantify the cost and schedule risks for the demolition and de-energization for the H/V work and the excavation and utility crossings for the ICW work. Once the FMEAs were completed, the resulting cost and schedule quantities were incorporated into the Risk Register.
014	Cybersecurity Vulnerability Assessment	Opportunity for Improvement	There was no indication that there was a need for a cybersecurity vulnerability assessment for computing/software installations in the Master Substation or ICW Pumphouse operations.	The question of need was posed to the Computing Division and subsequent actions will be taken to address the risk assessment. A better method is needed to identify this need in all projects.
015	UUP - LOTO Verification ORPS	Opportunity for Improvement	A sub-tier subcontractor failed to perform proper LOTO of parking lot lighting circuit during the ICW installation work. This incident turned into an ORPS.	The project team, in conjuction with the laboratory, issued a temporary stand down to the subcontractor. After a subsequent incident later in the project by the same sub-tier subcontractor, this particular company was not allowed to work any further at the lab.

016	UUP - Swan Lake LOTO ORPS	Opportunity for Improvement	A sub-tier subcontractor failed to perform proper LOTO at the Swan Lake Pump Station during the ICW installation work. This incident resulted in an ORPS.	This was the second LOTO incident by the same sub-tier subcontractor. This particular company was not allowed to work any further at the lab.
017	UUP - Master Substation Excavation Limit ORPS	Opportunity for Improvement	The subcontractor for the MSS Control Building Site Installation work excavated outside the limits of excavation per the permit. The excavation area bordered along an active beamline berm. This incident resulted in an ORPS.	Work was halted immediately after a small area was dug, and an investigation took place on the cause for the overexcavation. The limits of the excavation permit were not clearly marked in the field. Additional effort will be made to mark critical areas near beamlines.
018	UUP - Advanced Delivery of MSS Control Building	Success	Delays during fabrication of the MSS Control Building threatened to delay the site subcontractor, and risked adding costs and schedule delays tot he project. The MSS Control Building was constructed at an offsite location by the building manufacturer. A separate subcontractor was responsible for preparing the project site, constructing the building foundations, and connecting the building.	The project team decided to advance the delivery of the MSS Control Building to maintain schedule, ahead of testing, and to avoid damages from the site installation subcontractor.
019	UUP - Unit Price Contracting for ICW	Success	The project team employed the use of a firm-fixed unit price contract vehicle for the ICW construction project.	Use of the firm-fixed unit price contract provided $330K in credits to the project for various scope of work items that were included in the Subcontractor's proposal, but were not installed, due to beneficial changes in the field or value engineering during construction.

020	UUP - Access to Error Logs with New Equipment	Success	A few days after the Master Substation Control Building was tranferred into operations, an outage was triggered and power was out to many areas of the lab for approximately 30 minutes.	Employing the use of advance technology for the substation control building equipment allowed for better diagnosis of operational issues.
021	UUP - Capturing GIS Data on Utilities During Excavation	Success	During installation of the ICW backbone piping network, while trenches were open across the site, the project team employed Fermilab's GIS resources to capture coordinates and elevations of many existing utilities that were encountered.	This data was then used to update existing data in the GIS Maps and will help build a robust database of information that can be used by future projects.
022	UUP - Lack of Existing Information for Casey's Pond Pumphouse	Success	There was minimal information on existing cables and conduits inside the Casey's Pond Pumphouse increasing the level of effort for identifying, labeling, and working around these utilities and equipment.	Additional efforts were employed to document existing conduits and cables inside the pumphouse in order to work safely in the area.