



Preliminary Design Review

WBS 121.06.02 – Site Preparation

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Conventional Facilities
29-August-2018

In partnership with:
India/DAE
Italy/INFN
UK/STFC
France/CEA/Irfu, CNRS/IN2P3

Agenda

- Charge
- Review Requirements
- Overview (by Gensler Team)
- Summary
- Next Steps



Charge

Please review the information for appropriateness of the proposed systems, impacts on existing systems and operations, specific technical requirements to be incorporated into the design and compliance with best and required practices of authority having jurisdiction.

Review Requirements

PIP-II Project Design Review Plan

- Alternatives Analysis
- Preliminary Safety by Design Assessment [4]
- Risk Assessment (RA)
- Consideration for quality control and reliability
- Lessons learned from previous projects or experience
- Preliminary budget and schedule

A successful CoDR allows the design effort to proceed to the preliminary design phase.

9.3. Preliminary Design Review [~30-50% Design Maturity]

Preliminary Design Reviews (PDRs) are technical and programmatic reviews intended to assure the design approach meets the technical requirements. Detailed designs are not expected, but preliminary design and analyses are required to demonstrate compliance with requirements. A presentation of the design and interfaces by means of block diagrams, signal flow diagrams, schematics, logic diagrams, configuration and layout sketches, analyses, modeling and any early results is required. Supporting data and analyses for mechanical, power, thermal, and reliability assessments should be shown. PDRs shall contain the following scope items and address:

- Sub-system organizational structure and team
- Sub-system scope and deliverables
- Documented functional, technical, and interface requirements
- Changes to baseline functional, technical, and interface requirements
- Safety by Design and Code Compliance
- Risk Assessment
- Engineering design and analyses
- Engineering analyses should show predicted performance and expected margin to relevant requirements.
- Assumptions and limitations of current state of the analyses.
- Draft list of critical items and single-failure point items and their analysis compared to specifications.
- Preliminary software requirements as applicable
- Preliminary reliability and maintainability requirements
- Plan for obtaining required safety approvals
- Preliminary QA/QC plan
- Lessons learned from previous projects or experience
- Closure of requests for action from previous review
- Preliminary safety hazard assessments
- Baseline cost and schedule

Typical PDR deliverables include documents (some in a preliminary stage of completion):

Requirements

- L3 Functional Requirements Specification
- L3 Technical Requirements Specification
- L4/5/6 sub-system FRS/TRS

Interfaces

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10

PIP-II Project Design Review Plan

- Interface Control Documents/Interface Specification Documents
- Interface Control Documents for Internal Sub-systems (L4 and below)

Risk & Safety

- Updated Risk Assessment Document
- Updated Safety by Design Assessment Table
- Failure Mode Effect Analysis (FMEA)
- Updated Hazard Analysis
- Up-to-date Risk Register

Project Documents

- Updated Preliminary Design Report Chapter
- Updated Basis of Estimates (BOE)
- Up-to-date Baseline Change Requests (BCR)
- Updated Resource Loaded Schedule
- Updated Alternatives Analysis

Design

- Design Review Reports of all Sub-Systems
- Resolution of all previous relevant review recommendations
- Test reports from Previous System/Sub-System Prototypes
- Preliminary 3D Models/Drawings of all Major Components; 90% complete of sub-components
- Design level schematics of major electronics systems; 90% schematics and layout of long duration items
- Software functional requirements and preliminary architecture
- Preliminary Interlock Documentation
- Preliminary System/Sub-System Engineering Calculations and Engineering Notes
- Preliminary P&ID

Procurement/Production/Installation

- Preliminary QA/QC Plan
- Preliminary Design Verification Methodology and Procedures (System/All-Subsystems)
- Preliminary System/Sub-System Procurement/Manufacturing/Oversight Plan
- Preliminary Sub-Assembly Assembly Procedures
- Preliminary Cryomodule Assembly Procedures
- Preliminary Installation Plan

The completion of the PDR and the closure of any requests for action generated by the review establish the basis for proceeding with the detailed design. The L2M may request endorsement by the design review committee for long lead items procurement or for additional advanced prototypes for final design verification prior to production start.

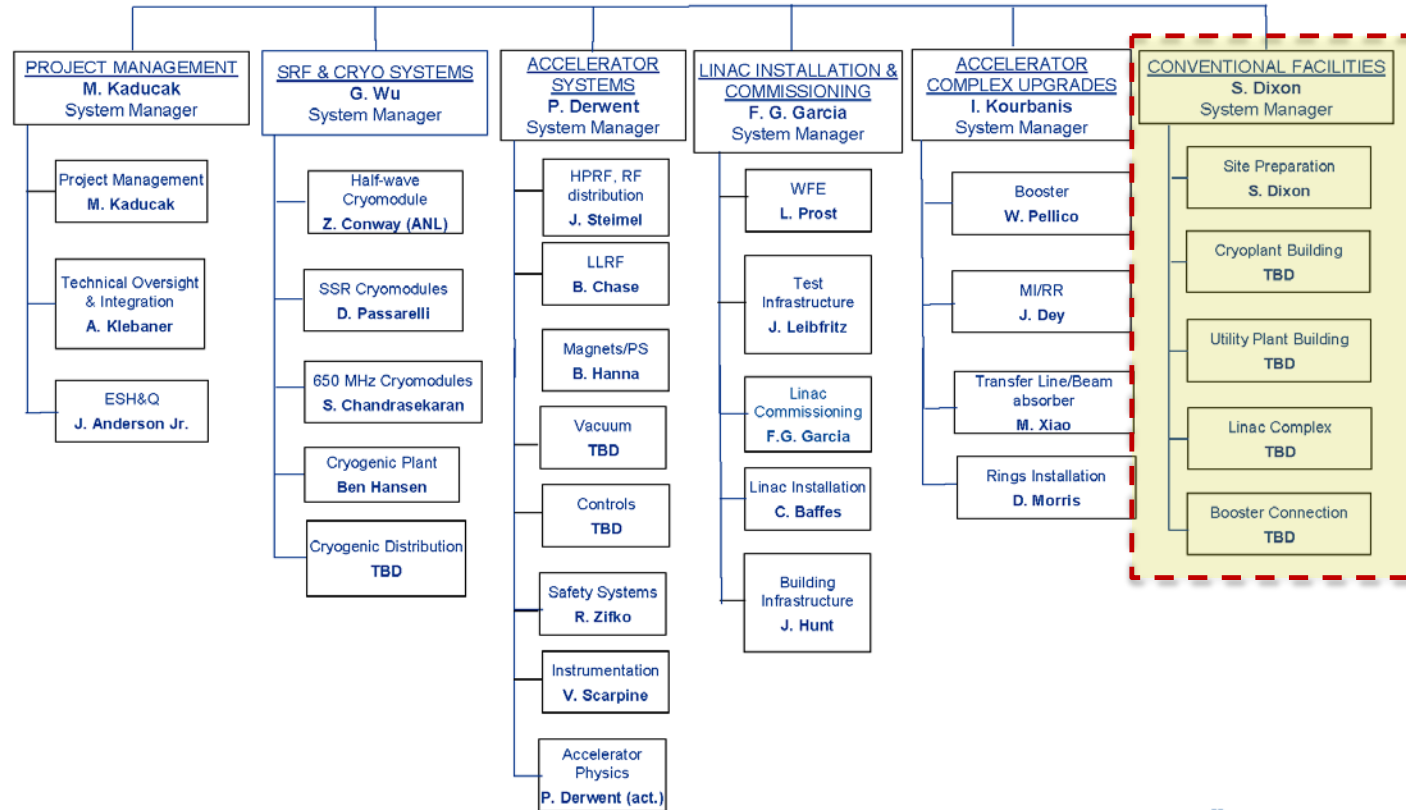
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11

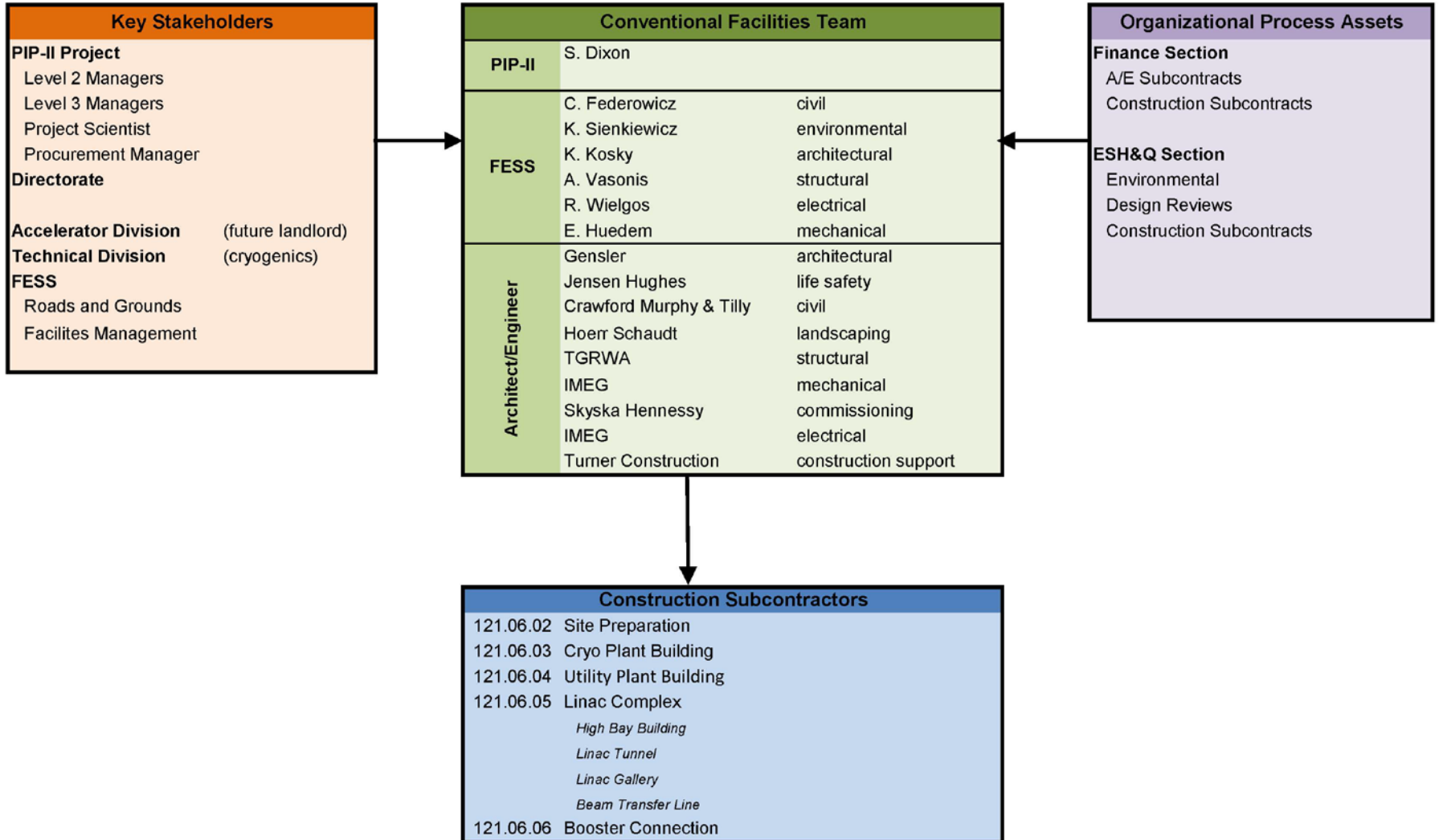
From PIP-II Project Design Review Plan

Organizational Structure

Level 3 Systems & Managers



Design Team



Scope

The Site Preparation scope includes the following phases:

Phase 1 – Site Clearing

This is the work that is required to generally prepare the site for future work packages

- Installation of erosion controls (silt fence);
- Tree removal;
- Installation of temporary road;
- Topsoil striping and stockpile;
- Sedimentation pond;
- Pond crossing;

Phase 2 – Utility Corridor (completed prior to Cryo Plant Building completion)

This extends the existing utilities to the project site including:

- Electrical ductbanks, manholes, feeders and 4-way air switches;
- Communication ductbank and manholes;
- Industrial cooling water;
- Domestic water supply
- Sanitary sewer system;
- Chilled water;
- Storm sewer;
- Make up water connection;

Scope

The Site Preparation scope includes the following phases:

Phase 3 – Site Work (Completed after Cryo Plant Building but before Linac Complex)

This work includes:

- Final grading outside of building zone;
- Roadway subgrade;
- AZero pond modifications;
- Entry roads at ponds;
- Utilities west of Linac Complex
- Modifications to Main Ring Road and South Booster Road

Phase 4 – Site Restoration

This work includes:

- Site restoration and landscaping;
- Final asphalt and grading;
- Site Lighting.

Deliverables

This submittal must convey a level of completeness that demonstrates the project is on schedule and on budget. This submittal will contain, as a minimum, the following:

- Drawings that convey the proposed design and major systems, but need not have all of the notes and details of the final product;
- Outline specification;
- The deliverables will include an estimate of construction cost and a schedule for the construction with pacing milestones and dates;
- A list of materials, if needed, that require exemption to the Buy American Act;
- Submittal shall be in PDF format plus the associated AutoCAD DWG files, REVIT models, Word and Excel files;
- The submittal will include documentation of compliance with DOE's Guiding Principles.

Technical Requirements

TRS Site Preparation, ED0006789, Rev. -

Section 1 – Conventional Facilities Purpose

The PIP-II conventional facilities will house the accelerator components and support equipment required to install and operate the PIP-II linac and transfer line. The PIP-II conventional facilities scope includes the elements of work normally included in conventional construction such as earthwork, utilities, structural concrete, structural steel, architectural cladding, finishes, roofing, plumbing, process piping, heating ventilation and air conditioning (HVAC), fire protection, fire detection, lighting and electrical. This also includes the work required to extend the utilities to the project site, excavation associated with the below grade cast-in-place concrete enclosures, creation of a shielding berm and site restoration.

Section 2 – Scope

The Site Preparation work consists of the conventional construction required to extend the existing Fermilab infrastructure to the PIP-II site and prepare the site to support PIP-II accelerator installation, assembly and operation.

Section 3 – Requirements

3.1 – Spatial Requirements

The Site Preparation work will generally be located in the infield area of the Main Ring/Tevatron portion of the Fermilab site.

3.2 – Architectural Requirements

Not applicable

3.3 – Structural Requirements

The design of structural systems will include the following requirements:

- New roads will be designed to accommodate standard truck loading (H-20);
- All buried piping will have a minimum of five (5) feet of coverage

3.4– Mechanical Requirements

The design of mechanical systems will include the following requirements:

- All plumbing work to be designed in accordance with Illinois Plumbing Code and Standard Specifications for Water & Sewer Main Construction in Illinois.
- The following site utilities will be extended to or routed to the PIP-II site:
 - Industrial Cooling Water (ICW) capable of providing a minimum of 1,400 gallons per minute (GPM) will be extended from the existing site wide network in the vicinity of AZero;
 - The PIP-II ICW return discharge will be routed to the existing AZero pond;
 - A minimum of 250 tons of chilled water will be available for PIP-II use at the Central Utility Building (CUB). The PIP-II connection point will be in the vicinity of CUB;
 - Natural gas will be extended from the existing site wide distribution network in the vicinity of CUB;
 - Sanitary sewer for PIP-II will be discharged to the existing sanitary lift station in the vicinity of CUB;
 - Domestic Water Supply (DWS) will be extended from the existing sanitary lift station in the vicinity of CUB;

Teamcenter TRS Form Revised August 3, 2015

Page 4

Technical Requirements Specifications ED0006789

TRS Site Preparation, ED0006789, Rev. -

3.5 – Electrical Requirements

The design of electrical systems will include the following requirements:

- The Master Substation (MSS) will be used to provide electrical power utilizing six (6) new feeders;
- PIP-II will install new breakers in the existing MSS panels;
- PIP-II will utilize existing ductbanks from MSS to manhole P71;
- New ductbanks will comply with Fermilab electrical isolation standards;
- Feeder 46A, fed from Kuatz Road Substation (KRS) will be used to provide backup power for critical systems;
- Communication will be extended from the existing site wide network in the vicinity of the existing Transfer Gallery;
- Lighting to be LED based where possible.
- Lighting Levels as follows:
 - Exterior Spaces: 2 to 5 foot-candles.

3.6 – Fire Protection Requirements

The design of fire protection systems will include the following requirements:

- Fire hydrants will be served from the ICW system and located within 150 feet of each building. Two (2) hydrants will be provided for each building.

3.7 – Special Requirements

The design will include:

- Provisions to accommodate the existing AZero pond;
- Incorporation of landscaping restoration will utilize both native prairie plantings and wetland specific plantings to accommodate Fermilab's long range plans for managing the available areas of the site according to principles of ecosystem management and restoration.

Section 4 – Code Requirements

4.1 – Organizational Processes

Organizational Processes provide institutional requirements for the design, construction and operations of all projects built and operated at Fermilab. For the PIP-II conventional facilities these requirements are derived from the Policies and Procedures of the Fermilab Directorate, Accelerator Division (AD), and the PIP-II project. All applicable DOE orders and standards are included in these requirements. A selection of applicable standards is listed below:

- DOE Order 151.1C – Comprehensive Emergency Management System
- DOE Order 413.3B – Program and Project Management for the Acquisition of Capital Assets, Change 1 issued 11/29/10
- DOE Order 414.1C – Quality Assurance
- DOE Order 420.1B – Facility Safety
- DOE Order 430.1B – Real Property Asset Management (2/8/08)
- DOE Order 430.2B – Departmental Energy, Renewable Energy and Transportation Management
- DOE Order 450.1A – Environmental Protection Program (6/4/08)
- DOE STD-1066-99 – Fire Protection Design Criteria
- DOE STD-1073-2003 – Configuration Management
- DOE Guide 420.1-2 – Guide for the Mitigation of Natural Phenomena Hazards for DOE Nuclear Facilities

Teamcenter TRS Form Revised August 3, 2015

Page 5

Changes to KPP

Threshold and Objective KPP – No Changes

#	Description of Scope	Threshold KPP	Objective KPP
1	SRF linac	700 MeV beam delivered to the Booster Injection Region	800 MeV beam delivered to Booster Injection Region
2	Booster/RR/MI upgrades	L11 Booster injection region, Recycler RF upgrades, and MI RF upgrades, hardware installed in respective machines. Linac beam injected and circulated in the Booster.	8 GeV beam transmitted through Recycler and Main Injector, delivered to the MI dump.
3	Cryogenic Infrastructure	Cryogenic plant and distribution lines ready to support pulsed RF operation, and operated to 2 K.	Cryogenic plant and distribution lines ready to support CW RF operation, and operated to 2 K.
4	Civil Construction	Tunnel enclosures and service buildings ready to support 700 MeV SRF linac and transfer line to the Booster	Tunnel enclosures to support 1 GeV SRF linac and transfer line to the Booster. Service buildings to support 800 MeV SRF linac and transfer line to Booster.

KPP from PIP-II Preliminary Project Execution Plan (PIP-II-doc-115)

Changes to FRS - No Changes

PIP-II Site Preparation

5. Key Assumptions

The assumptions for the Site Preparation (SP) work includes:

1. The PIP-II Project Assumption document (PIP-II-doc-144) contains the detailed list of the requirements for the SP work;

6. Functional Requirements

Requirement #	Requirement Statement
F-121.06.02-001	The SP shall provide a safe environment for employees and the public.
F-121.06.02-002	The SP shall provide and extension of the existing Fermilab utility infrastructure to the PIP-II site. This includes electrical, domestic water, industrial cooling water, sanitary sewer, chilled water and data/communication.
F-121.06.02-003	The SP shall provide an extension of the existing Fermilab road network.
F-121.06.02-004	The UPB shall comply with the overall character of the PIP-II campus.

7. Safety Requirements

The system shall abide by all Fermilab ES&H (FESHM) and all Fermilab Radiological Control Manual (FRCM) requirements including but not limited to:

Pressure and Cryogenic Safety
• FESHM Chapter 5031 Pressure Vessels
• FESHM Chapter 5031.1 Piping Systems
• FESHM Chapter 5031.5 Low Pressure Vessels and Fluid Containment
• FESHM Chapter 5031.6 Dressed Niobium SRF Cavity Pressure Safety
• FESHM Chapter 5032 Cryogenic System Review
• FESHM Chapter 5033 Vacuum Vessel Safety
Electrical Safety
• FESHM Chapter 9110 Electrical Utilization Equipment Safety
• FESHM Chapter 9160 Low Voltage, High Current Power Distribution Systems
• FESHM Chapter 9190 Grounding Requirements for Electrical Distribution and Utilization Equipment
Radiation Safety
• FRCM Chapter 8 ALARA Management of Accelerator Radiation Shielding

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5

Functional Requirements Specification can be found at TeamCenter ED0006787

Safety by Design

Identifier	Potential Hazard Description	Life Cycle Stage	Who is at risk?	What is at risk?	Pre-Mitigation Severity	Pre-Mitigation Probability	Pre-Mitigation Risk Score	Mitigations
SP-001	Electrocution while working in live manholes	Multiple	Workers	Property	High	C - Possible	2 - High	Design new ductbanks that can be accessed without live feeders
SP-002	Traffic Incident Due to Road Conditions	Operations	Workers	Property	Medium	C - Possible	3 - Moderate	Design roadways to a reasonable speed limit and post accordingly. Provide roadway lighting
SP-003	Equipment damage during transportation	Installation		Property	Medium	C - Possible	3 - Moderate	Design roadways and access drives to accommodate semi-truck truck traffic
SP-004	Personnel injury while walking to the project.	Multiple	Workers/Public		Medium	C - Possible	3 - Moderate	Design alternate path for pedestrian access separated from the roadway

Code Compliance

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- DOE Order 413.3B – Program and Project Management for the Acquisition of Capital Assets, Change 1 issued 11/29/10;
- DOE Order 414.1C – Quality Assurance;
- DOE Order 420.1B – Facility Safety;
- DOE Order 430.1B – Real Property Asset Management (2/8/08);
- DOE Order 430.2B – Departmental Energy, Renewable Energy and Transportation Management;
- DOE Order 450.1A – Environmental Protection Program (6/4/08);
- DOE STD-1066-99 – Fire Protection Design Criteria;
- DOE STD-1073-2003 – Configuration Management;
- DOE Guide 420.1-2 – Guide for the Mitigation of Natural Phenomena Hazards for DOE Nuclear Facilities and Non-Nuclear Facilities;
- 10 CFR 835 – Radiological Protection Program;
- 10 CFR 851 – Worker Safety and Health Program;
- 10 CRF 851.23 – Safety and Health Standards;
- Internal Fermilab permits and work notifications as described in the Fermilab ES&H Manual (FESHM)
- Fermilab Director’s Policy Manual (http://www.fnal.gov/directorate/Policy_Manual.html);
- Fermilab Engineering Manual (http://www.fnal.gov/directorate/documents/FNAL_Engineering_Manual.pdf)

Code Compliance

Enterprise standards from regulatory agencies, code bodies and trade organizations also provide requirements for the design and construction of the PIP-II conventional facilities.

- International Building Code (IBC) – 2015 Edition
- International Energy Conservation Code – 2009 Edition
- International Fire Code – 2009 Edition
- International Mechanical Code – 2009 Edition
- Minimum Design Loads for Buildings and Other Structures – ASCE 7-05
- Building Code Requirements for Structural Concrete – ACI 318-05
- Specification for Structural Steel Buildings – AISC 360-05
- Building Code Requirements for Structural Concrete and Commentary – ACI 318-08
- Illinois Plumbing Code – 2004
- Illinois Department of Public Health Codes
- Illinois IEPA
- NFPA 101 Life Safety Code – 2009 Edition
- NFPA 24 – Standard for the Installation of Private Fire Service Mains and Their Appurtenances – 2010 Edition
- NFPA 70 – National Electrical Code – 2008 Edition
- NFPA 70E – Standard for Electrical Safety in the Workplace – 2009 Edition
- NFPA 110 – Emergency and Standby Power Systems – 2010 Edition
- ANSI/ASME B31.3 – Process Piping (2002)
- ANSI 31.9 – Building Services Piping (1996)
- Occupational Safety and Health Administration (OSHA)
- Underwriters Laboratory
- ICC/ANSI A117.1 – 2003 Standard for Accessible and Usable Buildings and Facilities Illinois Accessibility Code
- ADA Accessibility Guidelines for Buildings and Facilities (ADAAG) – 2004 will be used for those areas of facility not exempted by Fermilab policy
- Illinois Accessibility Code

Risk Assessment

Engineering Risk Assessment

Project: PIP-II Conventional Facilities - WBS 121.06.02 Site Preparation

Lead Engineer: S. Dixon

Department: PIP-II

Date: August 23, 2018

Chapter		Engineering Risk Element						High Risk	Subtotal	Assessment	
		A	B	C	D	E	F				G
1	Requirements and Specifications	2	4				2		≥ 10	8	Standard Risk
3	Requirements and Specification Review	2	4		2	2	2		≥ 16	12	Standard Risk
4	System Design	2	4	2		2	2	1	≥ 19	13	Standard Risk
5	Engineering Design Review	2	4	2		2	2	1	≥ 19	13	Standard Risk
6	Procurement and Implementation		4		2	2	2	1	≥ 16	11	Standard Risk
7	Testing and Validation	2				2	2	1	≥ 13	7	Standard Risk
8	Release to Operations						2		≥ 4	2	Standard Risk
9	Final Documentation		4				2		≥ 7	6	Standard Risk

		Project Risk Element							High Risk	Subtotal	Assessment	
		H	I	J	K	L	M	N				O
		2	2	3	2	1	4	1	4	≥ 25	19	Standard Risk

Engineering Risk Elements	
A	Technology
B	Environmental Impact
C	Vendor Issues
D	Resource Availability
E	Safety
F	Quality Requirements
G	Manufacturing Complexity

Project Risk Elements	
H	Schedule
I	Interfaces
J	Experience / Capability
K	Regulatory Requirements
L	Project Funding
M	Project Reporting Requirements
N	Public Impact
O	Project Cost

From ED0008276

Risk Register

WBS / Ops Lab Activity	RI-ID	Title
121.05 Conventional Facility	RO-121-05-001	Value Management Opportunities
121.05 Conventional Facility	RT-121-05-01-002	Subproject Changes Impact Conventional Facilities
121.05 Conventional Facility	RT-121-05-09-005	Poor Interface Definition
121.05 Conventional Facility	RT-121-05-01-004	Unclear/Incomplete Delineation Between Construction Packages
121.05 Conventional Facility	RT-121-05-013	Construction Bids Exceed Estimates
121.05 Conventional Facility	RT-121-05-010	Poor Performance by Construction Subcontractor
121.05 Conventional Facility	RT-121-05-008	Extreme Weather Delays Construction
121.05 Conventional Facility	RT-121-05-01-001	Design Complexity
121.05 Conventional Facility	RT-121-05-08-001	Inadequate Shielding at Beam Absorber Location
121.05 Conventional Facility	RT-121-05-003	Radiation Shielding Inadequate
121.05 Conventional Facility	RT-121-05-001	Construction Escalation Greater Than Predicted
121.05 Conventional Facility	RT-121-05-02-002	Unknown Subsurface Conditions
121.05 Conventional Facility	RO-121-05-004	Construction Bids Below Estimate
121.05 Conventional Facility	RT-121-05-06-003	Equipment Induced Vibrations Impact Accelerator Operations
121.05 Conventional Facility	RT-121-05-08-003	Damage to Main Ring Beamline Equipment During Construction
121.05 Conventional Facility	RO-121-05-003	Radiation Shielding Opportunities
121.05 Conventional Facility	RT-121-05-015	Quality Deficiencies Result in Decreased Performance
121.05 Conventional Facility	RT-121-05-012	Poor Performance by A/E Team
121.05 Conventional Facility	RT-121-05-01-003	Errors/Omissions in Construction Documents
121.05 Conventional Facility	RT-121-05-006	Substantial Claim by Subcontractor
121.05 Conventional Facility	RT-121-05-007	Unavailability of Construction Workforce
121.05 Conventional Facility	RT-121-05-009	Labor Action Delays Construction
121.05 Conventional Facility	RT-121-05-02-001	Permitting Delay
121.05 Conventional Facility	RT-121-05-02-003	Unknown Soil Contaminants

Engineering Design and Analysis

Stakeholder Requirements

A/E Design Team

- Gensler - Architecture
- CMT - Site Civil
- TGRWW - Structural
- IMEG - Electrical, Mechanical
- Hoerr Schaudt - Landscape Architecture
- Turner - Constructability, Cost Estimates

Preliminary Software Requirements

- Not applicable

Reliability and Maintainability Requirements

- Included in the Engineering Design and Analysis
 - Site Layout, Landscaping, Roadways, Drainage
 - Slopes
 - Drainage
 - Traffic
 - Utility Corridor
 - ICW, LCW, Chilled Water
 - Looped Systems
 - Isolation Valves
 - Material Selection
 - Electric Power, Communications
 - Ductbank & Manhole Systems
 - Switches
 - Looped Feeds

Plan for Obtaining Safety Approvals

- Radiation Safety
 - Engage Radiation Safety with the Required Documentation Through FESS for Beamline Construction Approvals
- Review Comments
- Notice to Proceed Authorization
 - Quality Control Plan
 - Soil Erosion and Sediment Control Plan
 - Project Hazard Analysis

Preliminary QA/QC Plan

PIP-II Preliminary QA Program

(PIP-II-doc-142)

Design Phase

- Q/A requirements are included in A/E tasking;
- The Gensler team provides QA/QC following the internal corporate process;
- Design Review by Fermilab Subject Matter Experts

QUALITY ASSURANCE & QUALITY CONTROL

Why?

Goals:

Concept of QA/QC:

QA IN EVERY DOCUMENTS

DIGITAL COLLABORATION IN THE REVIEW PROCESS

SIGNING & SEALING PROCEDURES & WORKING ACROSS OFFICES

LABOR CODE TRACKING & QC

Lessons Learned – Other Projects

- UUP - Site Specific Construction Safety Plan
 - Flow down all necessary requirements of the construction project to the subcontractors during the bid phase.
- UUP - Design Phase Utility Locates
 - 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.
- UUP - Master Substation Excavation Limit 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.
- UUP - Capturing GIS Data on Utilities During Excavation
 - 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.

Previous Review Action Items

- None

Preliminary Safety Hazard Assessment

- Not applicable

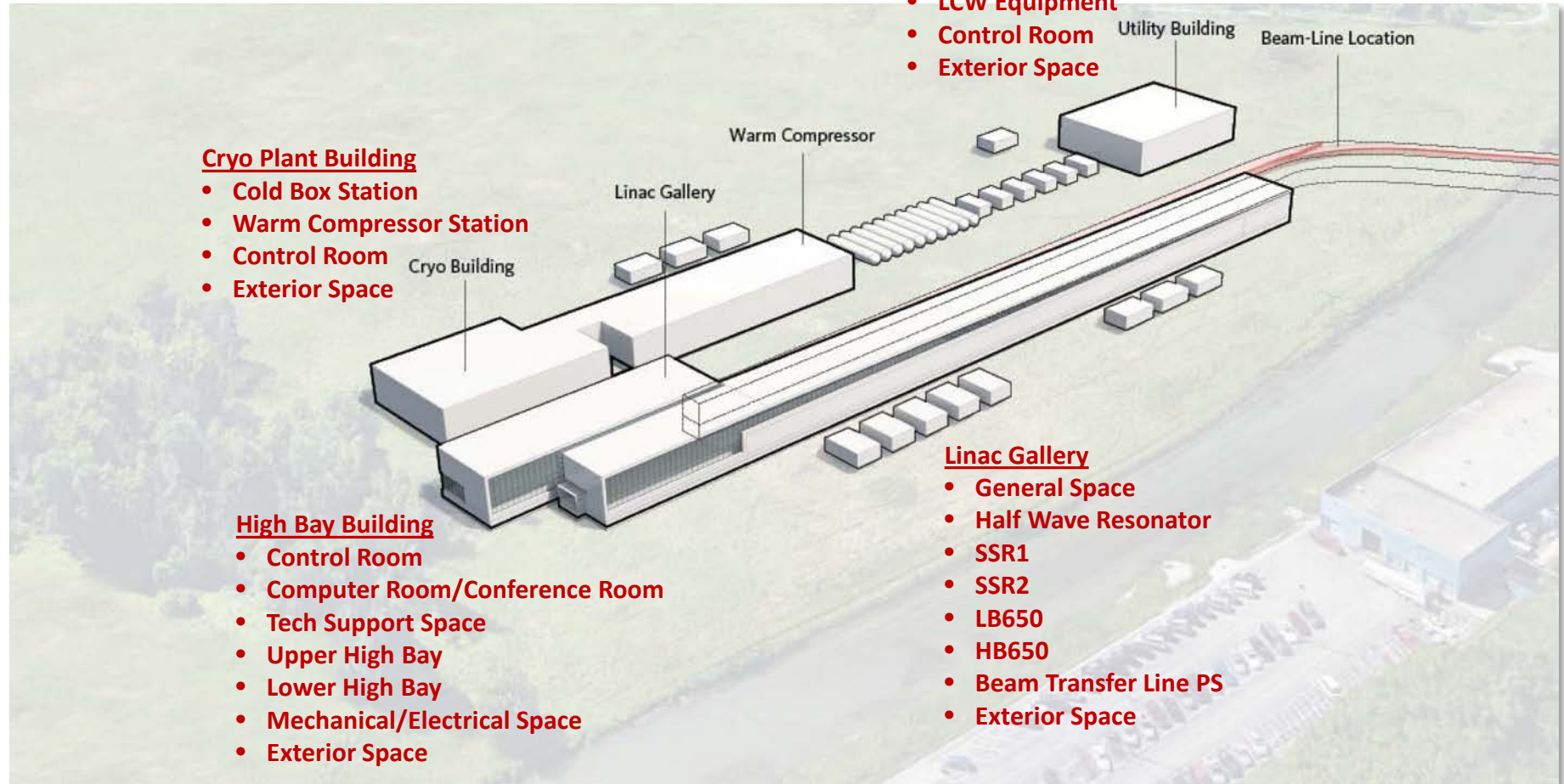
Baseline Cost and Schedule

Under development, available 04SEP18

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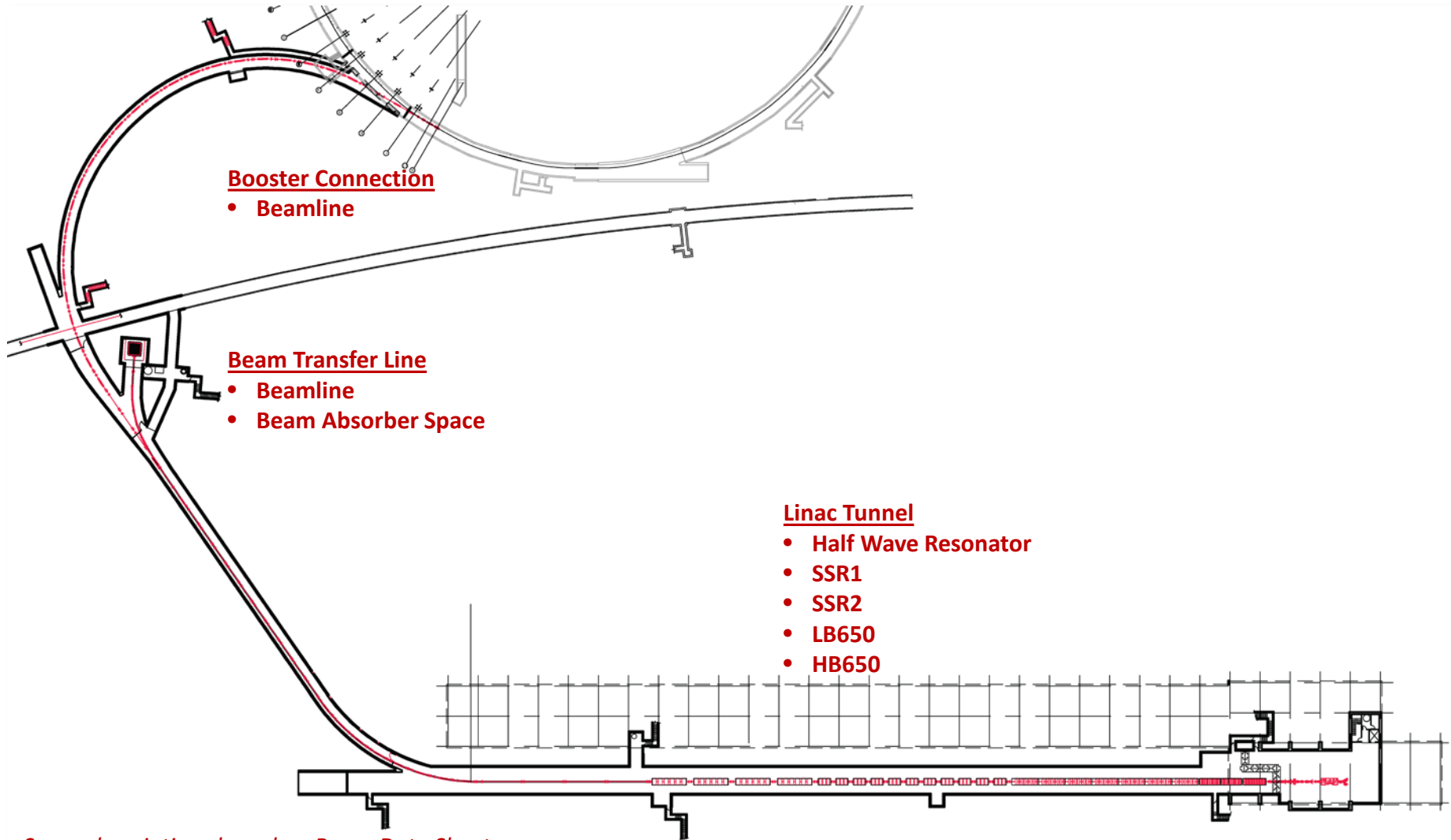
Backup

121.06 - Scope Overview – Above Grade



Space descriptions based on Room Data Sheets

121.06 - Scope Overview – Below Grade



Space descriptions based on Room Data Sheets