Fermi National Accelerator Laboratory

Fermilab

PIP-II Booster Connection
Functional Requirements Specification

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Document Approval

Signatures Required	Date Approved
Originator: S. Dixon, L2 Manager, Conventional Facilities	See TeamCenter Workflow for approvals
Approver: Alex Martinez, Integration Coordinator	See TeamCenter Workflow for approvals
Approver: S. Dixon, L2 Manager, Conventional Facilities	See TeamCenter Workflow for approvals

Revision History

Revision	Date of Release	Description of Change
	25 October 2017	Initial Release
Rev A	27 June 2019	Updated to Revised Format

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1. Purpose

An FRS describes the project needs and/or requested behavior of a system or component. The document typically outlines what is needed by the end user as well as the requirements and requested properties of inputs and outputs. The FRS specifies the functions that a system or component must perform and establishes consensus among stakeholders on what the system is expected to provide.

2. Scope

This FRS addresses the functional requirements of the Booster Connection conventional construction to provide below grade shielded enclosures required to support assembly, installation and operation of the PIP-II accelerator components from the Beam Transfer Line portion of the Linac Complex to the existing Booster beamline enclosure.

3. Acronyms

ALARA	As Low as Reasonably Achievable
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
BC	Booster Connection
FESHM	Fermilab ES&H Manual
FRCM	Fermilab Radiological Control Manual
FRS	Functional Requirements Specification
HVAC	Heating, Ventilation and Air Conditioning
ICW	Industrial Cooling Water
L2	WBS Level 2
L3	WBS Level 3
ODH	Oxygen Deficiency Hazard
PIP-II	Proton Improvement Plan II Project
TC	Teamcenter
WBS	Work Breakdown Structure

4. Reference

#	**Reference**	**Document #**
1	Conventional Facilities Engineering Process Document Management (EPDM)	ED0002857
2	Fermilab Engineering Manual (FEM)	-

3	Fermilab Environmental Safety and Health Manual (FESHM)	-
4	Fermilab Radiological Control Manual (FRCM)	-
5	PIP-II Project Assumptions	PIP-II-doc-144
6	PIP-II – Fermilab Interface Document	PIP-II-doc-528

5. Key Assumptions

The assumptions for the Booster Connection include:

1. The area does not contain cryogenics equipment and will not require Oxygen Deficiency Hazard (ODH) systems.
2. The existing Booster Tower Southeast will be demolished as part of the Booster Connection work. The following assumptions concerning the building are taken from the PIP-II- Fermilab Interface Document:
    a. Fermilab will relocate the existing occupants and functions currently housed in the building;
    b. Fermilab will mitigate lead, asbestos and activated components within the building;
    c. Fermilab will terminate existing utilities (electrical, industrial cooling water, domestic water, sanitary sewer, natural gas, data/communication) to a point outside the building demolition limits;
    d. Fermilab will prepare and submit paperwork and notification of demolition in accordance with current procedures;
    e. Fermilab demolition preparation will be completed by October 2023;
    f. PIP-II will demolish the Booster Tower Southeast building;
    g. At the conclusion of the PIP-II work an earthen shielding berm will be installed above the existing Booster enclosure and new PIP-II enclosures;

6. Functional Requirements

Requirement #	Requirement Statement
F-121.06.06-A001	The BC shall provide a safe environment for employees.
F-121.06.06-A002	The BC shall provide space and infrastructure for the conventional beamline components.
F-121.06.06-A004	The BC shall be located adjacent to the Beam Transfer Line portion of the Linac Complex
F-121.06.06-A005	The BC shall provide penetrations for power and instrumentation.
F-121.06.08-A007	All penetrations between the BC and Linac Gallery (cables, conduits, piping) shall be sealed to reduce to the extent possible air movement between the spaces.
F-121.06.06-A008	The BC shall provide space and infrastructure for the installation and operation of the new booster injector process equipment.
F-121.06.06-A009	The BC shall connect to the existing Booster enclosure.

F-121.06.06-A010	The BC shall provide a tunnel extension for a future beamline to serve the Muon Campus.
F-121.06.08-A011	The flatness and levelness of the new floor slabs shall be designed for normal construction tolerances.
F-121.06.08-A012	The Beam Transfer Line shall be designed to accommodate earth shielding.
F-121.06.08-A013	The below grade portion of the BC shall include embedded Unistrut anchors along the walls at regular intervals.
F-121.06.08-A014	The HVAC systems shall conform to ASHRAE 90.1 and ASHRAE 62.
F-121.06.08-A015	Ventilation outside air shall be supplied to the spaces in accordance with the requirements of ASHRAE 62.1.
F-121.06.08-A016	All plumbing work shall be designed in accordance with Illinois Plumbing Code and Standard Specifications for Water & Sewer Main Construction in Illinois.
F-121.06.08-A017	All sump discharges from the BC shall be directed to cooling ponds or ICW return ditches.
F-121.06.08-A018	Exit passages and corridors shall incorporate shielding labyrinths to reduce radiation exposure to as low as reasonably achievable (ALARA) levels per FESHM Section 1100.

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
• FRCM Chapter 10 Radiation Safety Interlock Systems
• FRCM Chapter 11 Environmental Radiation Monitoring and Control
General Safety
• FESHM Chapter 2000 Planning for Safe Operations
Construction Safety
• FESHM Chapter 7010 ES&H Program for Construction
• FESHM Chapter 7030 Excavation
• FESHM Chapter 7060 Fall Protection
• FESHM Chapter 7070 Ladder & Scaffold Safety
Environmental Protection
• FESHM Chapter 8011 Groundwater Protection – Excavations and Wells
• FESHM Chapter 8012 Sedimentation and Erosion Control Planning
• FESHM Chapter 8026 Surface Water Protection

Any changes in the applicability or adherence to these standards and requirements require the approval and authorization of the PIP-II Technical Director or designee.

In addition, the following codes and standards in their latest edition shall be applied to the engineering, design, fabrication, assembly and tests of the given system:

ASME B31.3 Process Piping
ASME Boiler and Pressure Vessel Code (BPVC)
CGA S-1.3 Pressure Relief Standards
NFPA 70 – National Electrical Code
IEC Standards for Electrical Components

In cases where International Codes and Standards are used the system shall follow FESHM Chapter 2110 Ensuring Equivalent Safety Performance when Using International Codes and Standards and requires the approval and authorization of the PIP-II Technical Director or designee.

Additional Safety Requirements that are not listed in the general list above shall be included in the Requirements table in the Functional Requirements section.