PIP-II Linac Complex

Functional Requirements Specification

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**Document Approval**

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Revision History

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| Revision | Date of Release | Description of Change |
|  | 20 June 2018 | Initial Release (\*) |
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(\*) This FRS is a combination of the following previous FRS documents:

* ED0006756 - High Bay Building
* ED0006790 - Linac Tunnel
* ED0007079 - Linac Gallery
* ED0006785 - Beam Transfer Line

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# Purpose

An FRS describes the programmatic or 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.

# Scope

This FRS addresses the functional requirements of the Linac Complex (LC) which includes the conventional construction required to support assembly, installation and operation of the PIP-II accelerator components. The Linac Complex is divided into the following components:

## High Bay Building

The High Bay Building (HBB) includes the construction package includes the below grade and above grade structures, mechanical, electrical, conveying systems and related support systems to house the PIP2IT components and related infrastructure;

## Linac Tunnel

The Linac Tunnel (LT) that includes the work required to install the below grade beamline enclosure to accommodate the beamline components and related support infrastructure;

## Linac Gallery

The Linac Gallery includes the above grade service building and associated infrastructure to support the technical equipment for the beamline components;

## Beam Transfer Line

The Beam Transfer Line (BTL) that includes the work required to install the below grade beamline enclosure to accommodate the beamline components, beam dump and related support infrastructure.

# Acronyms

|  |  |
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| BTL | Beam Transfer Line |
| FESHM | Fermilab ES&H Manual |
| FRCM | Fermilab Radiological Control Manual |
| FRS | Functional Requirements Specification |
| HBB | High Bay Building |
| ICW | Industrial Cooling Water |
| L2 | WBS Level 2 |
| L3 | WBS Level 3 |
| LC | Linac Complex |
| LG | Linac Gallery |
| LT | Linac Tunnel |
| ODH | Oxygen Deficiency Hazard |
| PIP-II | Proton Improvement Plan II Project |
| PIP2IT | PIP-II Injector Test |
| SCD | System Configuration Document |
| TC | Teamcenter |
| WBS | Work Breakdown Structure |

# Reference

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| **#** | **Reference** | **Document #** |
| 1 | Conventional Facilities Engineering Process Document Management | ED0002857 |
| 2 | Conventional Facilities System Configuration Document (SCD) | ED000xxxx |
| 3 | [Fermilab Engineering Manual](http://directorate-docdb.fnal.gov/cgi-bin/RetrieveFile?docid=34) | NA |
| 4 | [Fermilab Environmental Safety and Health Manual](http://eshq.fnal.gov/manuals/feshm/) | NA |
| 5 | Fermilab Radiological Control Manual | NA |
| 6 | PIP-II Project Assumptions | PIP-II-doc-144 |
| 7 | PIP-II – Fermilab Interface Document | PIP-II-doc-528 |

# Key Assumptions

The assumptions for the Linac Complex include:

1. The Linac Tunnel portion is the only section of the Linac Complex that will be designated as an Oxygen Deficiency Hazard (ODH) system. The ODH system shall be designed in accordance with Fermilab policies and guideline. The mechanical equipment (louvers, fans, ductwork) that interface with building systems shall be installed as part of the LC work scope. The ODH analysis, design and installation of the control components, wiring, sensors and related work as well as commissioning is the responsibility of the others (list subproject).

# Functional Requirements

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| **Requirement #** | **Requirement Statement** |
| F-121.06.05-001 | The LC shall provide a safe environment for employees and the public. |
| F-121.06.05-002 | The LC-HBB shall provide space and infrastructure for the PIP2IT components. |
| F-121.06.05-003 | The LC-HBB shall provide space and infrastructure for unloading/loading activities. |
| F-121.06.05-004 | The LC-HBB shall provide control room space. |
| F-121.06.05-005 | The LC-LT shall provide space for the installation, operation and maintenance of cryogenic beamline components. |
| F-121.06.05-006 | The LC-LT shall provide passive radiation shielding. |
| F-121.06.05-007 | The LC-LG shall house beamline support equipment. |
| F-121.06.05-008 | The LC-LG shall be located adjacent to the LC-LT. |
| F-121.06.05-009 | The LC-LT shall be located adjacent to the LC-HBB |
| F-121.06.05-010 | The LC-LG shall house the beamline power supplies for the LC-BTL. |
| F-121.06.05-011 | The LC-BTL shall house conventional beamline components. |
| F-121.06.05-012 | The LC-BTL shall provide passive radiation shielding. |
| F-121.06.05-013 | The LC shall connect to existing Fermilab infrastructure |
| F-121.06.05-014 | The LC shall comply with the overall character of the PIP-II campus |

# 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:

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| 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 ANSI ASC A14.3  -2000  Safety Requirements for Fixed Ladders |
| * 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 8025 Wastewater Discharge to Sanitary Sewers |
| * FESHM Chapter 8026 Surface Water Protection |
| * FESHM Chapter 8050 Domestic Water Protection |
| * FESHM Chapter 8080 Air Emissions Control Program |
| * FESHM Chapter 8081 Refrigeration Management |
| Material Handling and Transportation |
| * FESHM Chapter 10100 Overhead Cranes and Hoists |
| * FESHM Chapter 10110 Below-the-hook Lifting Devices |

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:

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| ASME B31.3 Process Piping ANSI ASC A14.3  -2000  Safety Requirements for Fixed Ladders |
| 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.