Vacuum (VAC) – LI

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Document Approval

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Revision History

|  |  |  |
| --- | --- | --- |
| Revision | Date Released | Description |
| - | 2020-June-09 | Initial Release |
| A | TBD | Update to new IDL format  Added ACL checklist to each deliverable within section 5 |
|  |  |  |

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# Introduction

This document is a shared document between the Vacuum (VAC) L3 and the Linac Installation (LI) L3 on the agreed upon deliverables. These deliverables are to be reviewed at an Installation Readiness Review (IRR) as shown in the PIP-II LI Plan [1]. It is determined by the VAC L3 manager when and how many of their deliverables will be reviewed by the LI team at a time. Deliverables require finer definitions to LI, and the condition of those deliverables at the time of delivery. The purpose of this document is to define detailed deliverables between the VAC L3 and the LI L3.

# Acronyms

|  |  |
| --- | --- |
| Acronym | Definition |
| CAD | Computer Aided Design |
| FESHM | Fermilab Environmental Safety and Health Manual |
| ICD | Interface Control Document |
| ISD | Interface Specification Document |
| LCW | Low Conductivity Water |
| LI | Linac Installation WBS Element |
| NCR | Non-Conformance Report |
| PIP-II | Proton Improvement Plan II |
| TI | Test Infrastructure WBS Element |
| VAC | Vacuum Systems |

# References

|  |  |  |
| --- | --- | --- |
|  | Document Tile | Document Number |
|  | PIP-II Installation Plan – Accelerator Installation | ED0007915 |
|  | PIP-II MICD | ED0010443 |
|  | FERMILAB Energy Control Program (LOCKOUT/ TAGOUT) | FESHM 2100 |
|  | PIP-II WBS Dictionary | PIP-II DocDB 599 |
|  | PIP-II Vacuum Systems QC Plan | PIP-II DocDB 5709 |

# Documentation Deliverables Definitions

## **Assembly, Test & QC-QA**

These documents define acceptance criteria for hardware, firmware, and/or software deliverables, prior to the LI handoff. Related assembly procedures, bench test procedures, and acceptance travelers are listed in the PIP-II Vacuum Systems QC Plan [5].

At IRR, Discrepancy Reports (DRs) will be reviewed and discussed to understand discrepancy implications to installation, commissioning and operation.

## **Transportation & Installation**

These documents articulate the transfer of deliverables for LI, including information on the following:

* Starting and ending location of the deliverable as well as point of contact, if applicable
* The physical path of transport as well as any special handling requirements
* Method and resources required to install the hardware or equipment into their designated location.

These plans are generally prepared for the L3’s FDR and converted into handoff travelers, which are listed in the PIP-II Vacuum Systems QC Plan [5].

For Electronics Rack equipment, a Transportation and Installation Traveler is not required. However, rack locations as well as rack layouts should be documented and tracked.

## **Connections, ORC & Checkout Travelers**

These documents describe the connections across physical interfaces and data pathway to all other L3’s. These are included within the PIP2 MICD [2].

In addition, these documents include related test procedures as well as checkout travelers, which describe requirements and qualifications for a deliverable to obtain operational readiness. These are listed in the PIP-II Vacuum Systems QC Plan [5].

## **Interfaces MICD**

The Interface Control Document (ICD/MICD) [2] lists the interfaces with other L3s, along with any internal interfaces to be defined. The Interface Specification Document (ISD) describes technical details of a system’s interfaces, and should be released and verified prior to the IRR.

## **TRS/FRS/ACL Checklist**

The technical and functional requirements of deliverables are specified in L3 FRS and TRS documents, which are generated prior to the IRR. These checklists give the Linac Installation team the basis for the deliverable’s requirements, what has already been verified and what remains to be verified during subsequent installation/checkout/commissioning/operations.

## **Alignment Reference**

If the hardware interacts with the beam, as in installed in the beamline, a deliverable has been referenced with its own fiducials. This exterior fiducial map is required for final alignment within the Linac enclosure. This reference ensures the LI team that a deliverable has been reviewed by the AMG team.

## **Control System List**

This document lists the parameters that will be directly created into the controls system. It should include parameters associated with general control, readback, alarms, etc.

As a convention, the owner of the rack-mounted system reporting a parameter to the control system owns that parameter. For example, if a cryomodule tuner piezo strain is monitored by LLRF and reported to EPICS through a LLRF rack, LLRF (rather than the cryomodule) “owns” that parameter and should provide it in their control system list.

Required alarms should be identified and created prior to delivery.

## **Cable Database**

Systems owning cables shall ensure that cable database entries are made prior to delivery of associated hardware to be connected to those cables.

## **Operational Documentation**

This documentation should provide Beam Commissioning with the necessary documents to incorporate any beamline deliverable towards commissioning of the beam. This documentation will also be incorporated with a transition to operations.

## **Potential Energy Isolation**

The document identifies a deliverable’s potential energy and describes how to safely isolate that potential energy for operational maintenance or repair. E.g., if a device can be LOTO’d using General LOTO, this should be described. If a deliverable has a dedicated LOTO procedure, this should be referenced. This documentation will be included for installation through transition to operations. The document should follow the guidance of Fermilab’s FESHM Chapter 2100. [3]

## **CAD Models & Drawings**

Documentation of a technical deliverable includes CAD models and or drawings. These models and drawings should be produced for historical content and will be associated with documentation for a transition to operations where applicable.

# Deliverable and Scope Definition

## **PIP-II Tunnel and Highbay Floor Deliverables**

These deliverables are components to be integrated in the PIP-II tunnel / highbay floor.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Deliverable | Qty | Delivery/Handoff Location and Delivery trigger | Shipping/Packaging Configuration | Configuration at Handoff | Support Hardware, Labor, and Logistics | Documentation  (to be presented at IRR) | Notes and Comments | Accepted for Installation  (to be filled at IRR) |
| Vacuum kit for 325MHz warm units  (WU after HWR up to WU after SSR2 CM6) | 1Kit  9 WUs | WU integration area (tentatively A0), handoff occurs when WU integration begins | Boxes and/or bins | * Vacuum system assembled and closed with vacuum portions of instrumentation (if any) already integrated * UHV/Particle-free clean * Leak checked * Vacuum certified * Referenced for alignment (if required) * Backfilled with nitrogen * RAV tagged with vacuum state (e.g. “Backfilled”) * Double-bagged (flanged interfaces bagged separately) * Bellows restrained with tooling or packaging | This is incoming hardware for LI “Batch 1” warm unit integration activity  WUs are likely several designs | Assembly, Test & QC-QA | PIP-II Controls QC Plan DocDB 5688 [5], PIP-II Vacuum Systems QC Plan  DocDB 5709, travelers |  |
| Transportation & Installation |  |
| Connections, ORC & Checkout |  |
| Interfaces MICD |  |
| TRS/FRS/ACL Checklist |  |
| Alignment Reference |  |
| Control System List |  |
| Cable Database |  |
| Operational Documentation | manuals |
| Potential Energy Isolation |  |
| CAD Models & Drawings | N/A |
| Vacuum kit for 650MHz warm units  (WU after SSR2 CM7 up to WU after HB650 CM6) | 1Kit  16WUs | WU integration area (tentatively A0), handoff occurs when WU integration begins | Boxes and/or bins | * Vacuum system assembled and closed with vacuum portions of instrumentation (if any) already integrated * UHV/Particle-free clean * Leak checked * Vacuum certified * Referenced for alignment (if required) * Backfilled with nitrogen * RAV tagged with vacuum state (e.g. “Backfilled”) * Double-bagged (flanged interfaces bagged separately) * Bellows restrained with tooling or packaging | This is incoming hardware for LI “Batch 2” warm unit integration activity  WUs are likely several designs | Assembly, Test & QC-QA | PIP-II Controls QC Plan DocDB 5688 [5], PIP-II Vacuum Systems QC Plan  DocDB 5709, travelers |  |
| Transportation & Installation |  |
| Connections, ORC & Checkout |  |
| Interfaces MICD |  |
| TRS/FRS/ACL Checklist |  |
| Alignment Reference |  |
| Control System List |  |
| Cable Database |  |
| Operational Documentation | Manuals |
| Potential Energy Isolation |  |
| CAD Models & Drawings | N/A |

5.1 These deliverables are components to be integrated in the PIP-II tunnel / highbay floor - continued

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Deliverable | Qty | Delivery/Handoff Location and Delivery trigger | Shipping/Packaging Configuration | Configuration at Handoff | Support Hardware, Labor, and Logistics | Documentation  (to be presented at IRR) | Notes and Comments | Accepted for Installation  (to be filled at IRR) |
| Vacuum station kit for HB650CM5, HB650CM6 upgrade slots and SCL-BTL interface slot | 3 kits  (TBD) | WU integration area (tentatively A0), handoff occurs when WU integration begins | Boxes and/or bins | * Vacuum system assembled and closed with vacuum portions of instrumentation (if any) already integrated * UHV/Particle-free clean * Leak checked * Vacuum certified * Referenced for alignment (if required) * Backfilled with nitrogen * RAV tagged with vacuum state (e.g. “Backfilled”) * Double-bagged (flanged interfaces bagged separately) * Bellows restrained with tooling or packaging | Up to and including the SCL-BTL interface gate valve in slot HB-SLOT-700 (see F10138795)  This is incoming hardware for LI “Batch 2” warm unit integration activity | Assembly, Test & QC-QA | PIP-II Controls QC Plan DocDB 5688 [5], PIP-II Vacuum Systems QC Plan  DocDB 5709, travelers |  |
| Transportation & Installation |  |
| Connections, ORC & Checkout |  |
| Interfaces MICD |  |
| TRS/FRS/ACL Checklist |  |
| Alignment Reference |  |
| Control System List |  |
| Cable Database |  |
| Operational Documentation | manuals |
| Potential Energy Isolation |  |
| CAD Models & Drawings | When PIP-II vacuum schematics are available, request that this shows refurbished equipment locations |
| Beamline vacuum kit for WFE – Refurbished PIP2IT equipment | 1 kit | PIP-II highbay dock, schedule driven by LI request | Crates, boxes, bins | * Refurbished * Leak Checked * UHV cleaned (if applicable) * Tagged with S/N and service date |  | Assembly, Test & QC-QA | PIP-II Controls QC Plan DocDB 5688 [5], PIP-II Vacuum Systems QC Plan  DocDB 5709, travelers |  |
| Transportation & Installation |  |
| Connections, ORC & Checkout |  |
| Interfaces MICD |  |
| TRS/FRS/ACL Checklist |  |
| Alignment Reference |  |
| Control System List |  |
| Cable Database |  |
| Operational Documentation | manuals |
| Potential Energy Isolation |  |
| CAD Models & Drawings |  |

5.1 These deliverables are components to be integrated in the PIP-II tunnel / highbay floor - continued

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Deliverable | Qty | Delivery/Handoff Location and Delivery trigger | Shipping/Packaging Configuration | Configuration at Handoff | Support Hardware, Labor, and Logistics | Documentation  (to be presented at IRR) | Notes and Comments | Accepted for Installation  (to be filled at IRR) |
| Beamline vacuum kit for WFE – New Equipment | 1Kit | PIP-II highbay dock, schedule driven by LI request | Crates, boxes, bins | * Includes spools for new MEBT sections not present at PIP2IT, and vacuum components for 2nd Ion Source * All vacuum chambers fully welded with flanged interfaces * Leak checked * UHV cleaned * Particle-free cleaned A/R * Integrated systems (e.g. instrumentation) vacuum certified * Integrated systems referenced for alignment * Commercial hardware (valves, gauges, pumps, etc. QC’d and clean in vendor packaging) * Hardware included in kit (gaskets, O-rings, clamps, etc.) * Vacuum fasteners included in kit (in UHV clean/Particle Free state where needed) |  | Assembly, Test & QC-QA | PIP-II Controls QC Plan DocDB 5688 [5], PIP-II Vacuum Systems QC Plan  DocDB 5709, travelers |  |
| Transportation & Installation |  |
| Connections, ORC & Checkout |  |
| Interfaces MICD |  |
| TRS/FRS/ACL Checklist |  |
| Alignment Reference |  |
| Control System List |  |
| Cable Database |  |
| Operational Documentation | manuals |
| Potential Energy Isolation |  |
| CAD Models & Drawings |  |
| Beamline vacuum kit for HWR – existing equipment | 1 system | Delivery at PIP2 | Installed on HWR  Beamline Pump may be eliminated | Existing system – Installed prior to LI work |  | Assembly, Test & QC-QA | PIP-II Controls QC Plan DocDB 5688 [5], PIP-II Vacuum Systems QC Plan  DocDB 5709, travelers |  |
| Transportation & Installation |  |
| Connections, ORC & Checkout |  |
| Interfaces MICD |  |
| TRS/FRS/ACL Checklist |  |
| Alignment Reference |  |
| Control System List |  |
| Cable Database |  |
| Operational Documentation | manuals |
| Potential Energy Isolation |  |
| CAD Models & Drawings |  |

5.1 These deliverables are components to be integrated in the PIP-II tunnel / highbay floor.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Deliverable | Qty | Delivery/Handoff Location and Delivery trigger | Shipping/Packaging Configuration | Configuration at Handoff | Support Hardware, Labor, and Logistics | Documentation  (to be presented at IRR) | Notes and Comments | Accepted for Installation  (to be filled at IRR) |
| Beamline vacuum spools kit for HB650CM5 and HB650CM6 upgrade slots and SCL-BTL interface slot | TBD Kits | PIP-II highbay dock, schedule driven by LI request | Shipped via FNAL truck | * All vacuum chambers fully welded with flanged interfaces * Leak checked * UHV/Particle-free cleaned * Vacuum certified * Hardware included in kit (gaskets, O-rings, clamps, etc.) * Vacuum fasteners included in kit (in UHV clean/Particle Free state) |  | Assembly, Test & QC-QA | Assume pumping stations are pre-assembled during WU integration. All we receive at the SCL is the spools to connect-the-dots. PIP-II Vacuum Systems QC Plan  DocDB 5709, travelers |  |
| Transportation & Installation |  |
| Connections, ORC & Checkout |  |
| Interfaces MICD |  |
| TRS/FRS/ACL Checklist |  |
| Alignment Reference |  |
| Control System List |  |
| Cable Database |  |
| Operational Documentation |  |
| Potential Energy Isolation |  |
| CAD Models & Drawings | Up to the SCL-BTL interface gate valve in slot HB-SLOT-700 (see F10138795) |
| Beamline vacuum kit and window for diagnostic section | TBD Kits | PIP-II highbay dock, schedule driven by LI request | Binned | * Includes connection spools and exit window for movable diagnostic section * All vacuum chambers fully welded with flanged interfaces * Leak checked * UHV cleaned * Particle-free cleaned * Integrated systems (e.g. instrumentation) vacuum certified * Integrated systems referenced for alignment * Commercial hardware (valves, gauges, pumps, etc. QC’d and clean in vendor packaging) * Hardware included in kit (gaskets, O-rings, clamps, etc.) * Vacuum fasteners included in kit (in UHV clean/Particle Free state where needed) |  | Assembly, Test & QC-QA |  |  |
| Transportation & Installation | Needs to be clarified what delivers to COMM for diagnostic cart integration.  Assumption is that window moves downstream with the diagnostic cart, eventually landing in permanent position upstream of the straight-ahead absorber |
| Connections, ORC & Checkout |  |
| Interfaces MICD |  |
| TRS/FRS/ACL Checklist |  |
| Alignment Reference |  |
| Control System List |  |
| Cable Database |  |
| Operational Documentation |  |
| Potential Energy Isolation |  |
| CAD Models & Drawings |  |

5.1 These deliverables are components to be integrated in the PIP-II tunnel / highbay floor.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Deliverable | Qty | Delivery/Handoff Location and Delivery trigger | Shipping/Packaging Configuration | Configuration at Handoff | Support Hardware, Labor, and Logistics | Documentation  (to be presented at IRR) | Notes and Comments | Accepted for Installation  (to be filled at IRR) |
| Particle-free fastener kit for beamline connection | 1 kit | PIP-II highbay dock, schedule driven by LI request | Binned | * UHV/Particle-free cleaned and bagged * Includes CF gaskets for field connections |  | Assembly, Test & QC-QA | This is the general stock of particle-free fasteners needed to make field connections in the tunnel. PIP-II Vacuum Systems QC Plan  DocDB 5709 |  |
| Transportation & Installation |  |
| Connections, ORC & Checkout |  |
| Interfaces MICD |  |
| TRS/FRS/ACL Checklist |  |
| Alignment Reference |  |
| Control System List |  |
| Cable Database |  |
| Operational Documentation |  |
| Potential Energy Isolation |  |
| CAD Models & Drawings |  |
| Insulating vacuum kits for cryomodules – up to turbo exhaust port | 23 Kits | Assume delivers at PIP2IT, installed for test, stays installed | ~~Installed~~ Assembled | Prior to PIP2IT installation:   * All vacuum components fully welded with flanged interfaces * Leak checked * HV cleaned * Commercial hardware (valves, gauges, pumps, etc. QC’d and clean in vendor packaging) * Hardware included in kit (gaskets, O-rings, clamps, etc.) * Vacuum fasteners included in kit (in HV clean state)   At handoff to LI:   * Installed and qualified at PIP2IT |  | Assembly, Test & QC-QA | PIP-II Vacuum Systems QC Plan  DocDB 5709, travelers |  |
| Transportation & Installation |  |
| Connections, ORC & Checkout |  |
| Interfaces MICD |  |
| TRS/FRS/ACL Checklist |  |
| Alignment Reference |  |
| Control System List |  |
| Cable Database |  |
| Operational Documentation |  |
| Potential Energy Isolation |  |
| CAD Models & Drawings |  |
| Insulating vacuum kits for cryomodules – from turbo exhaust port to scroll exhaust port | 23 Kits | PIP-II highbay dock, schedule driven by LI request | Kitted in single-cryomodule kits | * All vacuum components fully welded with flanged interfaces * Leak checked * HV cleaned * Commercial hardware (valves, gauges, pumps, etc. QC’d and clean in vendor packaging) * Hardware included in kit (gaskets, O-rings, clamps, etc.) * Vacuum fasteners included in kit (in HV clean state) |  | Assembly, Test & QC-QA | PIP-II Vacuum Systems QC Plan  DocDB 5709, travelers |  |
| Transportation & Installation |  |
| Connections, ORC & Checkout |  |
| Interfaces MICD |  |
| TRS/FRS/ACL Checklist |  |
| Alignment Reference |  |
| Control System List |  |
| Cable Database |  |
| Operational Documentation |  |
| Potential Energy Isolation |  |
| CAD Models & Drawings |  |

5.1 These deliverables are components to be integrated in the PIP-II tunnel / highbay floor.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Deliverable | Qty | Delivery/Handoff Location and Delivery trigger | Shipping/Packaging Configuration | Configuration at Handoff | Support Hardware, Labor, and Logistics | Documentation  (to be presented at IRR) | Notes and Comments | Accepted for Installation  (to be filled at IRR) |
| ~~Roughing system kit for cryomodule insulating vacuum~~ |  | Not Planned |  | * Not currently planned. Will revisit need after PIP2IT |  | Assembly, Test & QC-QA | PIP-II Vacuum Systems QC Plan  DocDB 5709, travelers |  |
| Transportation & Installation |  |
| Connections, ORC & Checkout |  |
| Interfaces MICD |  |
| TRS/FRS/ACL Checklist |  |
| Alignment Reference |  |
| Control System List |  |
| Cable Database |  |
| Operational Documentation |  |
| Potential Energy Isolation |  |
| CAD Models & Drawings |  |
| Vibration isolating mounts for scroll pumps | 1 per scroll | Delivers to PIP-II highbay dock with associated scroll pumps | Boxed or binned | * Kitted with fasteners |  | Assembly, Test & QC-QA |  |  |
| Transportation & Installation |  |
| Connections, ORC & Checkout |  |
| Interfaces MICD |  |
| TRS/FRS/ACL Checklist |  |
| Alignment Reference |  |
| Control System List |  |
| Cable Database |  |
| Operational Documentation |  |
| Potential Energy Isolation |  |
| CAD Models & Drawings |  |

## **Deliverables to Gallery Installation Activities**

These deliverables are components to be integrated in the PIP-II gallery (including the highbay gallery level)

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Deliverable | Qty | Delivery/Handoff Location and Delivery trigger | Shipping/Packaging Configuration | Configuration at Handoff | Support Hardware, Labor, and Logistics | Documentation  (to be presented at IRR) | Notes and Comments | Accepted for Installation  (to be filled at IRR) |
| Vacuum controller kit for WFE | 1 Kit | PIP-II highbay dock, schedule driven by LI request | Crates, Boxes, bins | * Controllers ready to install in racks * Rack mounting hardware included in kits * Associated hardware (e.g. fuse panel?) included in kits |  | Assembly, Test & QC-QA | PIP-II Vacuum Systems QC Plan  DocDB 5709, travelers |  |
| Transportation & Installation |  |
| Connections, ORC & Checkout |  |
| Interfaces MICD |  |
| TRS/FRS/ACL Checklist |  |
| Alignment Reference |  |
| Control System List |  |
| Cable Database |  |
| Operational Documentation |  |
| Potential Energy Isolation |  |
| CAD Models & Drawings |  |
| Special vacuum cables for WFE | A/R | PIP-II highbay dock, schedule driven by LI request | Spooled | * Labeled with cable database # * Ordered to BLDGI-specified length * Connector kits to allow for in-tunnel termination |  | Assembly, Test & QC-QA |  |  |
| Transportation & Installation |  |
| Connections, ORC & Checkout |  |
| Interfaces MICD |  |
| TRS/FRS/ACL Checklist |  |
| Alignment Reference |  |
| Control System List |  |
| Cable Database | E.g. turbo cables. BldgI buys standard cables. |
| Operational Documentation |  |
| Potential Energy Isolation |  |
| CAD Models & Drawings |  |
| Vacuum controller kit for SCL from HWR thru SSR1 CM2 | 1 Kit | PIP-II highbay dock, schedule driven by LI request | Crates, boxes, bins | * Controllers ready to install in racks * Rack mounting hardware included in kits * Associated hardware (e.g. fuse panel?) included in kits |  | Assembly, Test & QC-QA | PIP-II Vacuum Systems QC Plan  DocDB 5709, travelers |  |
| Transportation & Installation | Corresponds to “phase 1” commissioning campaign |
| Connections, ORC & Checkout |  |
| Interfaces MICD |  |
| TRS/FRS/ACL Checklist |  |
| Alignment Reference |  |
| Control System List |  |
| Cable Database |  |
| Operational Documentation |  |
| Potential Energy Isolation |  |
| CAD Models & Drawings |  |

5.2 These deliverables are components to be integrated in the PIP-II gallery -continued

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Deliverable | Qty | Delivery/Handoff Location and Delivery trigger | Shipping/Packaging Configuration | Configuration at Handoff | Support Hardware, Labor, and Logistics | Documentation  (to be presented at IRR) | Notes and Comments | Accepted for Installation  (to be filled at IRR) |
| Vacuum controller kit for SCL from SSR2 CM1 thru SSR2 CM7 | 1 Kit | PIP-II highbay dock, schedule driven by LI request | Crates, boxes, bins | * Controllers ready to install in racks * Rack mounting hardware included in kits * Associated hardware (e.g. fuse panel?) included in kits |  | Assembly, Test & QC-QA | PIP-II Vacuum Systems QC Plan  DocDB 5709, travelers |  |
| Transportation & Installation | Corresponds to “phase 2” commissioning campaign |
| Connections, ORC & Checkout |  |
| Interfaces MICD |  |
| TRS/FRS/ACL Checklist |  |
| Alignment Reference |  |
| Control System List |  |
| Cable Database |  |
| Operational Documentation |  |
| Potential Energy Isolation |  |
| CAD Models & Drawings |  |
| Vacuum controller kit for SCL from LB650 CM1 thru HB650 CM6 | 1 Kit | PIP-II highbay dock, schedule driven by LI request | Crates, boxes, bins | * Controllers ready to install in racks * Rack mounting hardware included in kits * Associated hardware (e.g. fuse panel?) included in kits |  | Assembly, Test & QC-QA | PIP-II Vacuum Systems QC Plan  DocDB 5709, travelers |  |
| Transportation & Installation | Corresponds to “phase 3” commissioning campaign |
| Connections, ORC & Checkout |  |
| Interfaces MICD |  |
| TRS/FRS/ACL Checklist |  |
| Alignment Reference |  |
| Control System List |  |
| Cable Database |  |
| Operational Documentation |  |
| Potential Energy Isolation |  |
| CAD Models & Drawings |  |
| Special vacuum cables for SCL | TBD | PIP-II highbay dock, schedule driven by LI request | Spooled | * Labeled with cable database # * Ordered to BLDGI-specified length * Connector kits to allow for in-tunnel termination |  | Assembly, Test & QC-QA |  |  |
| Transportation & Installation |  |
| Connections, ORC & Checkout |  |
| Interfaces MICD |  |
| TRS/FRS/ACL Checklist |  |
| Alignment Reference |  |
| Control System List |  |
| Cable Database | E.g. turbo cables. BldgI buys standard cables. |
| Operational Documentation |  |
| Potential Energy Isolation |  |
| CAD Models & Drawings |  |

## **Support Hardware Deliverables**

“Support Hardware Deliverables” are tools and equipment that do not become part of the accelerator, but are required for installation or operation of the machine.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Deliverable | Qty | Delivery/Handoff Location and Delivery trigger | Shipping/Packaging Configuration | Configuration at Handoff | Support Hardware, Labor, and Logistics | Documentation  (to be presented at IRR) | Notes and Comments | Accepted for Installation  (to be filled at IRR) |
| Vacuum certification station | 1 | WU integration area (tentatively A0), handoff occurs after VAC is done using it for warm unit assembly | FNAL truck | * Assembled, tested, ready for use | Vacuum uses this hardware for assembly of warm units, then delivers to LI when complete. | Assembly, Test & QC-QA | PIP-II Vacuum Systems QC Plan  DocDB 5709 |  |
| Transportation & Installation |  |
| Connections, ORC & Checkout |  |
| Interfaces MICD |  |
| TRS/FRS/ACL Checklist |  |
| Alignment Reference |  |
| Control System List |  |
| Cable Database |  |
| Operational Documentation |  |
| Potential Energy Isolation |  |
| CAD Models & Drawings |  |
| Beamline-clean He leak detectors | 2 | WU integration area (tentatively A0), handoff occurs when WU integration begins | FNAL truck | * Ready to use |  | Assembly, Test & QC-QA | PIP-II Vacuum Systems QC Plan  DocDB 5709 |  |
| Transportation & Installation |  |
| Connections, ORC & Checkout |  |
| Interfaces MICD |  |
| TRS/FRS/ACL Checklist |  |
| Alignment Reference |  |
| Control System List |  |
| Cable Database |  |
| Operational Documentation |  |
| Potential Energy Isolation |  |
| CAD Models & Drawings |  |
| Standard He leak detectors for insulating vacuum | 1 | PIP-II highbay dock, schedule driven by LI request | FNAL truck | Ready to Use |  | Assembly, Test & QC-QA | VAC does not pre-assemble any insulating vacuum, so LI pays for this. Vac must spec and run procurement |  |
| Transportation & Installation |  |
| Connections, ORC & Checkout |  |
| Interfaces MICD |  |
| TRS/FRS/ACL Checklist |  |
| Alignment Reference |  |
| Control System List |  |
| Cable Database |  |
| Operational Documentation |  |
| Potential Energy Isolation |  |
| CAD Models & Drawings |  |

5.3 “Support Hardware Deliverables” are tools and equipment that do not become part of the accelerator, but are required for installation or operation of the machine -continued

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Deliverable | Qty | Delivery/Handoff Location and Delivery trigger | Shipping/Packaging Configuration | Configuration at Handoff | Support Hardware, Labor, and Logistics | Documentation  (to be presented at IRR) | Notes and Comments | Accepted for Installation  (to be filled at IRR) |
| Mass flow control cart | 3 | WU integration area (tentatively A0), handoff occurs when WU integration begins | FNAL truck | Assembled, tested, ready for use |  | Assembly, Test & QC-QA | Need to confirm phasing when carts become available |  |
| Transportation & Installation |  |
| Connections, ORC & Checkout |  |
| Interfaces MICD |  |
| TRS/FRS/ACL Checklist |  |
| Alignment Reference |  |
| Control System List |  |
| Cable Database |  |
| Operational Documentation |  |
| Potential Energy Isolation |  |
| CAD Models & Drawings |  |
| Standard vacuum cart for WFE and/or BTL | 2 | PIP-II highbay dock, schedule driven by LI request | FNAL truck | Assembled, tested, ready for use |  | Assembly, Test & QC-QA |  |  |
| Transportation & Installation |  |
| Connections, ORC & Checkout |  |
| Interfaces MICD |  |
| TRS/FRS/ACL Checklist |  |
| Alignment Reference |  |
| Control System List |  |
| Cable Database |  |
| Operational Documentation |  |
| Potential Energy Isolation |  |
| CAD Models & Drawings |  |
| Backfill fixture for WFE beamline | 2 | PIP-II highbay dock, schedule driven by LI request | Binned | * UHV clean   Relief valve integrated |  | Assembly, Test & QC-QA |  |  |
| Transportation & Installation |  |
| Connections, ORC & Checkout |  |
| Interfaces MICD |  |
| TRS/FRS/ACL Checklist |  |
| Alignment Reference |  |
| Control System List |  |
| Cable Database |  |
| Operational Documentation |  |
| Potential Energy Isolation |  |
| CAD Models & Drawings |  |

5.3 “Support Hardware Deliverables” are tools and equipment that do not become part of the accelerator, but are required for installation or operation of the machine - continued

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Deliverable | Qty | Delivery/Handoff Location and Delivery trigger | Shipping/Packaging Configuration | Configuration at Handoff | Support Hardware, Labor, and Logistics | Documentation  (to be presented at IRR) | Notes and Comments | Accepted for Installation  (to be filled at IRR) |
| Backfill fixture for SCL cryostats | 2 | PIP-II highbay dock, schedule driven by LI request | Binned | * HV clean * Relief valve integrated |  | Assembly, Test & QC-QA |  |  |
| Transportation & Installation |  |
| Connections, ORC & Checkout |  |
| Interfaces MICD |  |
| TRS/FRS/ACL Checklist |  |
| Alignment Reference |  |
| Control System List |  |
| Cable Database |  |
| Operational Documentation |  |
| Potential Energy Isolation |  |
| CAD Models & Drawings |  |
| ~~Vacuum diagnostic kit~~ isn’t this already included in pump carts/ MFC carts/backfill fixtures on other lines? | 1 Kit | WU integration area (tentatively A0), handoff occurs when WU integration begins | Binned | Vacuum diagnostic kit:   * Calibrated leaks * Utility RGAs * Filters | To be detailed from VAC’s misc. hardware list | Assembly, Test & QC-QA |  |  |
| Transportation & Installation |  |
| Connections, ORC & Checkout |  |
| Interfaces MICD |  |
| TRS/FRS/ACL Checklist |  |
| Alignment Reference |  |
| Control System List |  |
| Cable Database |  |
| Operational Documentation |  |
| Potential Energy Isolation |  |
| CAD Models & Drawings |  |
| Any other specialty tooling, fixtures or test equipment for VAC Systems |  | PIP-II Highbay, schedule driven by LI request | Kitted and Binned | * To connect mass flow carts/pump stations to vacuum systems | Placeholder for specialty equipment not captured above | Assembly, Test & QC-QA |  |  |
| Transportation & Installation |  |
| Connections, ORC & Checkout |  |
| Interfaces MICD |  |
| TRS/FRS/ACL Checklist |  |
| Alignment Reference |  |
| Control System List |  |
| Cable Database |  |
| Operational Documentation |  |
| Potential Energy Isolation |  |
| CAD Models & Drawings |  |

5.3 “Support Hardware Deliverables” are tools and equipment that do not become part of the accelerator, but are required for installation or operation of the machine – continued

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Deliverable | Qty | Delivery/Handoff Location and Delivery trigger | Shipping/Packaging Configuration | Configuration at Handoff | Support Hardware, Labor, and Logistics | Documentation  (to be presented at IRR) | Notes and Comments | Accepted for Installation  (to be filled at IRR) |
| Standard tooling, fixtures or test equipment |  | PIP-II Highbay |  | See ED0007992 for standard equipment provided by LI |  | Assembly, Test & QC-QA |  |  |
| Transportation & Installation |  |
| Connections, ORC & Checkout |  |
| Interfaces MICD |  |
| TRS/FRS/ACL Checklist |  |
| Alignment Reference |  |
| Control System List |  |
| Cable Database |  |
| Operational Documentation |  |
| Potential Energy Isolation |  |
| CAD Models & Drawings |  |