PIP-II High Beta 650MHz Cryogenic Transfer Line Quality Control Plan

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# Scope of Quality Control (QC) Plan

#### Scope

The 650MHz Cryogenic Transfer line (650 CTL) is a jumper transfer line used to align the PIPII-IT transfer line interfaces to HB650 MHz cryomodule, specifically the 5K Return, 40K supply, and 80K Return helium circuits. Additionally, the u-tube to connect the 650 CTL to the PIPII-IT transfer line and HB650MHz cryomodule. The 4K supply and 2K pumping line will be handled with separate U-tubes which is also within the scope of this document.

The 650CTL and associated u-tubes shall be built in-house by experienced Fermilab technicians and welders. This Quality Control document will outline the codes and standards to be followed in the construction of the 650 CTL which include design, procurement, final acceptance testing, transportation, and installation in the PIPII-IT cave.

#### DEFINITIONS

* + 1. The 650MHz Intermediate Cryogenic Transfer line shall be referred as the DEVICE.
		2. Standards listed below in Section 2.2 shall collectively be referred to as CODE
		3. The fabricator of the DEVICE shall be referred to as the SELLER.

# 2.0 QC Test and Measurements

#### QC Test

The DEVICE will be built with piping and components commonly used in piping systems around the lab that have been in-house for years. All piping and components come with material certification and/or certificate of compliance from the vendor to ensure quality assurance. These documents shall reside in the FESHM 5031.1 Piping Engineering note associated with the DEVICE: EN04344.

#### LIST OF STANDARDS

#### The following list of codes in their latest edition, drawings, and standards shall be applied to the engineering, design, fabrication, assembly, and tests of the DEVICE and its components:

* Fermilab Environment, Safety and Health (ES&H) Manual
* AISC Manual of Steel Construction
* ASCE 7-10-2013 Minimum Design Loads for Buildings and Other Structures
* ASME B31.3-2014 Process Piping
* ASME B31E-2008 Standard for Seismic Design
* ASME Boiler and Pressure Vessel (BPV) Code-2015
* ASME Y14.5M Dimensioning Tolerance Code
* ASTM A380 Cleaning and De-scaling Stainless Steel Parts
* ASTM E493 Testing for Leaks Using the Mass Spectrometer Leak Detector in the Inside-Out Testing Mode
* ASTM E498 Testing for Leaks Using the Mass Spectrometer Leak Detector in the Tracer Probe Mode
* EJMA standards-2011
* NIST Technical Note 1334: Thermophysical Properties of Helium-4 from 0.8 to 1500 K with Pressures to 2000 MPa

# 3.0 Requirements Traceability

Due to the simplistic nature of this design/deliverable for the PIP-II Project, no specific Functional Requirements or Technical Requirements specification have been identified.

# 4.0 Procedures and Checklists

* 1. There are several procedures and checklists listed throughout this document. Below is a list of procedures described and where to find them within this documents
		1. Acceptance criteria checklist can be found in Section 5.1
		2. Required welding documents required by CODE can be found in Section 5.3.11
		3. The Leak Test procedure is discussed in section 5.6.3
		4. Pressure Testing procedure is discussed in section 5.7

# 5.0 Acceptance Tests & Criteria

##### The tests, inspections and examinations required by design and/or construction codes that are listed below shall be performed:

##### Proper welding In-process Inspection documentation per CODE. See section 5.3, 5.4, 5.5 below for best practices on welding, bending, and cleaning.

##### Mass Spectrometry Leak testing. See Section 5.6 below for requirements.

##### Pressure Testing at 110% MAWP per CODE. Pressure Testing Procedure will be written and accompany the FESHM 5031.1 Piping engineering note. See Section 5.7 for details.

* + 1. Results for these tests will be stored in Teamcenter with the Piping Engineering note.

##### All examinations required by the ASME/ANSI B31.3 Process Piping Code, including materials tests and non-destructive examinations shall be performed.

* 1. WELDING
		1. Vacuum vessel welding shall be done in a manner equivalent to a standard welding procedure specified and qualified under the rules of the CODE Section IX.
		2. All weld joint preparation and welding techniques shall be done in accordance with Section VIII and IX of the *CODE* and/or Chapter V of the ASME/ANSI B31.3 code.
		3. The tests required to qualify the Welding Procedure Specification (WPS) as required by Section VIII and IX of the *CODE*, and/or Chapter V of the ASME/ANSI B31.3 shall be performed
		4. The tests required to qualify Welders as required by Section VIII and IX of the *CODE* and/or Chapter V ASME/ANSI B31.3 code shall be performed

##### Records shall be maintained in accordance with paragraph UW-48 Section VIII Division I of the *CODE* for all welders and welding operators working on the *DEVICE* and the welds made by each so that all the data will be documented

* + 1. All welding shall be done by the Gas Tungsten Arc Weld (GTAW) process, using welding quality argon gas for the inert shield.
		2. All welds shall be internally purged with welding quality argon gas during the time of welding and post welding treatment.
		3. Welds that show evidence of a lack of purge will be deemed unacceptable.
		4. All welding shall be done in such a manner that the weld surface is smooth and free of irregularities. No visible metal chips or foreign material may be detectable inside any component of the *DEVICE*. All external surfaces in the weld area shall be cleaned of heat tint, slag, and other deposits. No mechanical process shall be used to achieve the smooth appearance.

##### No production work shall be done until both the WPS and welders or welding operators have been qualified in accordance with the Section VIII paragraphs UW-28 and UW-29 and Section IX of the *CODE* and/or Chapter V ANSI ASME B31.3.

##### Copies of the WPQ, WPS, and PQR for each welder and welding procedure utilized in welding operations on the DEVICE shall be documented and submitted.

#### TUBE AND PIPE BENDING

* + 1. Bending shall be done in accordance with good machine shop practices.
		2. All bends shall be free of kinks, cuts, and abrasions.
		3. Conduits shall remain circular after bending to within 90% of original minimal diameter.
		4. *SELLER* may substitute tube bends for fittings where desirable.

#### CLEANING

##### Each component and subassembly shall be thoroughly cleaned at every stage of all scale, spatter, flux, foreign materials, etc.

##### Cleaning agents shall be suitable for the materials of construction, and shall be neutralized if necessary.

##### Weld spatter shall be removed by wire brushing using stainless steel brushes.

##### Each assembly shall be cleaned to provide an inner surface of all pipes and tubes free of grease, flux, moisture, dirt, and other foreign materials by vapor degreasing or suitable wash. Surfaces shall be visibly inspected and wiped down with a white cloth. In order to be considered free of contamination, no discoloration shall appear on the white cloth.

##### After cleaning, each section shall be blown dry with clean dry air until no moisture remains.

##### LEAK TESTING

##### Leak tests of the *DEVICE* or its subassemblies to assure leak tightness shall be performed. No leaks should be detected on the most sensitive scale of the leak detector (minimum sensitivity 1 x 10-9 torr\*l\*s-1) during the leak testing.

##### A final integrated *DEVICE* leak test shall be performed. No leaks should be detected on the most sensitive scale of the leak detector (minimum sensitivity 1 x 10-9 torr\*l\*s-1) during the leak testing.

##### All leak tests should be made in accordance with written procedure of the APS-TD Cryogenic Sector Department which can be found in the Cryogenics Sharepoint website The procedure includes the following:

##### Description of the sub-assembly or component;

##### Test equipment specification;

##### Name and qualification of the person(s) performing the test.)

##### Any test failure which is correctable by simple rewelding or rebrazing may be undertaken. Any unacceptable leaks which are repaired shall be fully documented and described in writing

##### PRESSURE TESTING

* + 1. All piping circuits shall be pneumatically pressure tested with dry inert gas in accordance with paragraph 345.5 of the ASME/ANSI B31.3 Process Piping Code

#####  All inspections, examinations, and tests as required by the Code shall be completed.

#####  All inspection, examination, and test reports shall be fully documented.

* 1. Dimensional inspections on the DEVICE and interfaces are within required dimensional tolerances shall be verified.

# 6.0 In-process monitoring and measurement activities

* 1. All in-process monitoring activities will take place at the fabrication site, Meson West-9 (MW-9). All material certification and quality certification documents will be verified and collected by the Project Engineer: Joseph Hurd.
	2. All components and piping are inspected and quality certification is verified upon delivery to Meson West -9, where the fabrication will take place.
	3. The Chief Weld Inspector (CWI), Greg Johnson in APS-TD Cryogenics Sector, will perform In-process Welding inspections of welding procedures in accordance with ASME B31.3.

# 7.0 Verification Plans: Methods & Activities

The QC data collected will be reviewed by an independent and qualified engineer at Fermilab to assure the DEVICE conforms to CODE as well as FESHM 5031.1 along with the Piping engineering note. Should the DEVICE not conform, cooldown authorization cannot be given therefore rendering the DEVICE unusable until approved through Teamcenter by the reviewer and Cryogenic Department Head. It is the responsibility of the Design engineer, Joe Hurd (31324), to ensure all documents and data are collected and stored onto Teamcenter.

# 8.0 Deliverable Documentation and Records

Material certifications and completed final acceptance test forms shall reside with the FESHM 5031.1 Piping engineering note in Team Center along with any nonconformance documentation that may arise.

# 9.0 Associated Equipment

Associated equipment for the final acceptance testing shall include a calibrated helium leak detector, a calibrated pressure gauge, and associated pressure test equipment to include a pressure relief valve, two ¼”manual valves (one to act as an isolation from the pressure source and the other as a system bleed valve), pressure regulator and a compressed Nitrogen gas cylinder. Sizes of the calibrated pressure gauge, pressure regulator, and pressure relief as set by FESHM 5034 based on the needs of the test.

# 10.0 Calibrations Plans

* 1. No equipment exists on the DEVICE requiring calibrations.
	2. A calibrated leak cylinder exists withing the helium leak detector. The machine automatically calibrates itself upon start up.
	3. A manual pressure gauge which is calibrated annually is used to verify the pressure inside the DEVICE is accurate for pressure testing required by B31.3.

# 11.0 Traceability Requirements

* 1. The DEVICE shall have a Piping engineering note associated with it which must be approved in Team Center prior to use per FESHM 5031.1; which will include an engineering analysis to ensure CODE compliance.
	2. Each of the three circuits on the DEVICE has two pressure relief devices. These pressure relief devices will have their model, set point, location, and serial number listed in a master pressure relief database per DOE.

# 12.0 Training and Qualification

* 1. All Fermilab personnel will have any necessary training as required by their ITNA.
	2. Welders must be certified using approved welding procedure as specified by CODE and section 5.3.4 above.

# 13.0 Planned Partner and Vendor Communication & Visits

The DEVICE is to be built in-house using commonly used parts and components. No Vendor visits required.

# 14.0 Control of Nonconformances

Any non-conformances in the integrated DEVICE, parts and tests shall be recorded and reported per the PIP-II Project Nonconformance Handling Procedure ([PIP-II-doc-3100](https://pip2-docdb.fnal.gov/cgi-bin/sso/ShowDocument?docid=3100)) within one week of discovering the non-conformance.

#  15.0 Transportation/Shipping

The DEVICE shall be transported from MW-9 to Cryomodule Test Facility to be installed in the PIPII-IT cave via FERMILAB trucks. No special precautions are considered from transport.

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