

# PIP-II Cryogenic Plant Building Technical Requirements Specification

---

Document number: ED0006719, Rev. B

## Document Approval

Signatures Required	Date Approved
Originator: S. Dixon, L2 Manager, Conventional Facilities	
Approver: G. Wu, L2 Manager, SRF & Cryo Systems	
Approver: B. Hansen, L3 Manager, Cryogenic Plant	
Approver: A. Martinez, Integration Coordinator	
Approver: A. Rowe, Project Engineer	
Approver: P. Derwent, Project Scientist	
Approver: A. Klebaner, Technical Director	

## Revision History

Revision	Date of Release	Description of Change
---	25 October 2017	Initial Release
A	12 October 2018	Updated to Revised Format, Latest Information
B	07 December 2018	Updated based on Requirements and Specification Review

## Table of Contents

1. Purpose .....	4
2. Scope .....	4
3. Acronyms .....	4
4. Reference .....	5
5. Key Assumptions .....	6
6. Technical Requirements .....	6
7. Design Requirements .....	15

## 1. Purpose

A Technical Requirements Specification (TRS) is a means to communicate what type of system is being designed and implemented, lists the attributes of that system as it conforms to a specific metric and establishes consensus amount stakeholders on what the system is expected to provide.

A TRS describes the technical aspects that a system or component must fulfill, such as the technical characteristics, the performance requirements and/or the reliability requirements. TRS requirements may be derived from higher-level requirements such as Functional Requirements Specifications (FRS), Interface Control Documents (ICD), or derived from the design process. TRS requirements may or may not be specific to a particular design concept.

## 2. Scope

This TRS addresses the technical requirements of the Cryogenic Plant Building which 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.

## 3. Acronyms

ANSI	American National Standards Institute
APS-TD	Applied Physics and Superconducting Technology Division
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
CBS	Cold Box Station
CDS	Cryogenics Distribution System
CFM	Cubic Feet per Minute
CHW	Chilled Water
CPB	Cryogenic Plant Building
DOE	Department of Energy
EPDM	Engineering Process Document Management
ES	Exterior Space
FESHM	Fermilab ES&H Manual
FRCM	Fermilab Radiological Control Manual
FRS	Functional Requirements Specification
GPM	Gallons Per Minute
HVAC	Heating, Ventilation and Air Conditioning
HP	Horse Power

HWR	Half Wave Resonator
IBC	International Building Code
ICW	Industrial Cooling Water
IMC	International Mechanical Code
kg	Kilograms
kVA	Kilo Volt Amps
L2	WBS Level 2
L3	WBS Level 3
NFPA	National Fire Protection Association
ODH	Oxygen Deficiency Hazard
PIP-II	Proton Improvement Plan II Project
RH	Relative Humidity
SCD	System Configuration Document
SS	Support Space
TC	Teamcenter
TRS	Technical Requirements Specification
UPS	Uninterruptible Power Supply
WBS	Work Breakdown Structure
WCS	Warm Compressor Station

#### 4. Reference

#	Reference	Document #
1	Conventional Facilities Engineering Process Document Management (EPDM)	ED0002857
2	Conventional Facilities System Configuration Document (SCD)	ED0008133
3	Associated Functional Requirement Specification	ED0006718
3	<a href="#">Fermilab Engineering Manual</a>	NA
4	<a href="#">Fermilab Environmental Safety and Health Manual</a>	NA
5	Fermilab Radiological Control Manual	NA

## 5. Key Assumptions

The assumptions for the Cryogenic Plant Building include:

1. The cryogenics equipment shall be provided, delivered, installed and commissioned by the Cryogenic Plant subproject (121.06.02.05);
2. The Oxygen Deficiency Hazard (ODH) system shall be designed in accordance with Fermilab policies and guidelines. The mechanical equipment (louvers, fans, ductwork) that interface with building systems shall be installed as part of the CPB 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 Cryogenic Plant subproject.
3. The maximum flow available from the existing sitewide Industrial Cooling Water (ICW) is 1,400 gallons per minute (gpm) for process water uses.
4. The technical equipment will be installed utilizing conventional rigging methods with the assistance of the overhead bridge cranes. The crane capacity is sized for normal maintenance activities rather than for the full capacity of the technical equipment.

## 6. Technical Requirements

Requirement ID	FRS Reference	Requirement Statement
<b>General</b>		
<b>T-121.06.03-A001</b>	<i>F-121.06.03-A009</i>	The location of the CDS header shall be upstream of the HWR
<b>T-121.06.03-A002</b>	<i>F-121.06.03-A001</i>	The location of the CPB shall provide for an unlimited occupancy for radiation shielding purposes.
<b>Architectural</b>		
<b>T-121.06.03-B001</b>	<i>F-121.06.03-A007</i>	<p>The CPB shall be developed based on the 2018 Fermilab Campus Master Plan including the desire that the "design of buildings and open spaces should encourage interaction, creating the settings to bring staff, users and visitors together, becoming vibrant centers of laboratory life."</p> <p>To this end, the CPB will incorporate the appropriate portions of the design guidelines including:</p> <ul style="list-style-type: none"> <li>• Entrances and ground floors that are welcoming and provide an opportunity for interactions;</li> <li>• Entrances that are evident in the daytime and at night;</li> <li>• The ground floor will emphasize transparency;</li> <li>• Service and utilities areas will be located so as to not negatively affect pedestrian paths or building entrances;</li> <li>• Provide long term flexibility and life cycle value; and</li> <li>• Uphold the unique character of Fermilab.</li> </ul>
<b>T-121.06.03-B002</b>	<i>F-121.06.03-A001</i>	The CPB shall be designed to accommodate safe access for maintenance and operation including roof access with minimal personal protective equipment.

Cold Box Station		
<b>T-121.06.03-C001</b>	<i>F-121.06.03-A004</i>	The Cold Box Station (CBS) shall include an overhead bridge crane with the following criteria: <ul style="list-style-type: none"> <li>• Capacity of 25 tons (50,000 pounds);</li> <li>• Hook limits to provide coverage for the major equipment and loading dock;</li> <li>• Hook height of 26 feet above finished floor;</li> </ul>
<b>T-121.06.03-C002</b>	<i>F-121.06.03-A004</i>	The CBS shall include at grade loading dock space to accommodate a standard 55-foot-long semi-trailer.
<b>T-121.06.03-C003</b>	<i>F-121.06.03-A004</i>	The CBS shall include, as a minimum, a 16-foot-wide by 16-foot-tall overhead door;
<b>T-121.06.03-C004</b>	<i>F-121.06.03-A003</i>	The flatness and levelness of the new floor slabs built as part of the conventional facilities shall be designed for normal construction tolerances and a ASTM E1155 floor flatness value of F(F) 25 and a floor levelness F(L) of 20.
<b>T-121.06.03-C005</b>	<i>F-121.06.03-A003</i>	The CBS shall provide space/infrastructure for one (1) <b>Cold Box</b> equipment with the following characteristics: <ul style="list-style-type: none"> <li>• 52 feet (15.8 m) long by 26.25 (8 m) wide by 23 feet (7.1 m) tall, which includes the cold box, control equipment and associated steel access platform and stairs;</li> <li>• Weight: 165,347 pounds distributed on four (4) base plates (1.5 feet wide x 1.5 feet long)</li> <li>• Electrical: <ul style="list-style-type: none"> <li>○ 70 amps @ 480 volts</li> <li>○ 10 amps @ 240 volts</li> <li>○ 110 amps @ 120 volts</li> </ul> </li> <li>• CHW: Maximum of 150 gpm</li> <li>• ICW: none</li> </ul>
<b>T-121.06.03-C006</b>	<i>F-121.06.03-A003</i>	The CBS shall provide space/infrastructure for one (1) <b>4.5 Cold Box</b> equipment with the following characteristics: <ul style="list-style-type: none"> <li>• 6.2 feet (1.9 m) long by 5.3 feet (1.6 m) wide by 15.7 feet (4.8 m) tall, which includes the cold box and associated equipment;</li> <li>• Minimum envelope required with control cabinet is 430 square feet (40 m<sup>2</sup>)</li> <li>• Weight: 6,266 pounds distributed equally over the footprint listed above</li> <li>• Single largest piece for installation shall be 6,266 pounds</li> <li>• Electrical: <ul style="list-style-type: none"> <li>○ 3 kW @ 480 volts</li> <li>○ 30 amps @ 120 volts</li> <li>○ 5 HP @ 208 volts</li> </ul> </li> <li>• CHW: 5.3 gpm</li> <li>• ICW: none</li> </ul>
<b>T-121.06.03-C007</b>	<i>F-121.06.03-A003</i>	The CBS shall provide space/infrastructure for one (1) <b>Liquid Helium Storage Tank</b> with the following characteristics:

		<ul style="list-style-type: none"> <li>• 12.1 feet (3.7m) diameter 16.4 feet (5m) tall, which includes storage tank and associated steel access platform and stairs;</li> <li>• Weight: 8,000 pounds distributed on 1 continuous circular base plate with 11.15 feet (3.4 m) outside diameter and 10.15 feet (3.1 m) inside diameter.</li> <li>• Electrical: <b>5 kW at 480V</b></li> <li>• CHW: none</li> <li>• ICW: none</li> </ul>
<b>T-121.06.03-C008</b>	<i>F-121.06.03-A003</i>	<p>The CBS shall provide space for four (4) <b>Cryogenics Control Cabinets</b> each with the following characteristics:</p> <ul style="list-style-type: none"> <li>• 2.7 feet (0.8 m) long by 1.75 feet (0.5 m) deep by 7.4 feet (2.3 m) tall;</li> <li>• Weight: 500 pounds distributed equally over the footprint listed above</li> <li>• Electrical: <b>120-volt, 30-amp</b> circuit for each cabinet fed from UPS backed generator circuit</li> </ul>
<b>T-121.06.03-C009</b>	<i>F-121.06.03-A003</i>	<p>The CBS shall have a HVAC system capable of achieving the following space parameters:</p> <ul style="list-style-type: none"> <li>• Temperature in Cooling Mode: 78 degrees Fahrenheit (+/- 5F)</li> <li>• Temperature in Heating Mode: 68 degrees Fahrenheit (+/- 5F)</li> <li>• Humidity: 55% RH Max, No Minimum</li> </ul>
<b>T-121.06.03-C010</b>	<i>F-121.06.03-A003</i> <i>F-121.06.03-A001</i>	<p>The CBS shall have a louvers, dampers and fans to accommodate ODH mitigation with the following capabilities:</p> <ul style="list-style-type: none"> <li>• Upper portion: 45,000 cfm</li> <li>• Lower portion: 10,000 cfm</li> </ul>
<b>T-121.06.03-C011</b>	<i>F-121.06.03-A003</i>	<p>The CBS shall include a generator backed UPS for cryogenics controls systems and oxygen deficiency hazard (ODH) control equipment sized for 8 minutes of full load run time.</p>
<b>T-121.06.03-C012</b>	<i>F-121.06.03-A003</i>	<p>The CBS shall include 480V, 60-amp welding receptacles sized and located to accommodate standard Fermilab welding machines and cord lengths.</p>
<b>T-121.06.03-C013</b>	<i>F-121.06.03-A003</i>	<p>The CBS shall include one (1) 208V, 20-amp receptacle at each column line.</p>
<b>T-121.06.03-C014</b>	<i>F-121.06.03-A003</i>	<p>The CBS shall include one (1) 120V, 20-amp receptacle at each column line.</p>
<b>T-121.06.03-C015</b>	<i>F-121.06.03-A003</i>	<p>The CBS shall be provided with general lighting to achieve an average of 20 foot-candles.</p>
<b>T-121.06.03-C016</b>	<i>F-121.06.03-A003</i>	<p>The HVAC system in the CBS shall be designed to accommodate a combined 15 kW of heat load rejected to air.</p>
<b>T-121.06.03-C017</b>	<i>F-121.06.03-A003</i>	<p>The CBS shall provide space/infrastructure for one (1) <b>CDS Distribution Box</b> and related equipment with the following characteristics:</p> <ul style="list-style-type: none"> <li>• 6.2 feet (1.9 m) long by 5.3 feet (1.6 m) wide</li> <li>• Weight: 6,266 pounds distributed equally over the footprint listed above</li> <li>• Single largest piece for installation shall be 6,266 pounds.</li> </ul>



		<ul style="list-style-type: none"> <li>This equipment shall be supported by the platform/stairs installed as part of the Cold Box.</li> </ul>
<b>Warm Compressor Station</b>		
<b>T-121.06.03-D001</b>	<i>F-121.06.03-A004</i>	<p>The Warm Compressor Station (WCS) shall include an overhead bridge crane with the following criteria:</p> <ul style="list-style-type: none"> <li>Capacity of 25 tons (50,000 pounds);</li> <li>Hook limits to provide coverage for the major equipment and loading dock;</li> <li>Hook height of 26 feet above finished floor;</li> </ul>
<b>T-121.06.03-D002</b>	<i>F-121.06.03-A004</i>	The WCS shall include at grade loading dock space to accommodate a standard 55-foot-long semi-trailer.
<b>T-121.06.03-D003</b>	<i>F-121.06.03-A004</i>	The WCS shall include, as a minimum, a 16-foot-wide by 16-foot-tall overhead door;
<b>T-121.06.03-D004</b>	<i>F-121.06.03-A002</i>	The flatness and levelness of the new floor slabs built as part of the conventional facilities shall be designed for normal construction tolerances and a ASTM E1155 floor flatness value of F(F) 25 and a floor levelness F(L) of 20.
<b>T-121.06.03-D005</b>	<i>F-121.06.03-A002</i>	The structural systems for the WCS shall include vibration isolation in order to avoid impacting the operation of the linac. Machine and compressor foundations will be isolated from the adjacent construction to minimize vibration transmission. The design of the structural systems shall accommodate the installation of vibration isolation pads.
<b>T-121.06.03-D006</b>	<i>F-121.06.03-A002</i>	<p>The WCS shall provide space/infrastructure for two (2) <b>MyCom Compressors and associated oil removal skids</b> each with the following characteristics:</p> <ul style="list-style-type: none"> <li>Equipment footprint of 17 feet (m) long by 10 feet (m) wide by 10 feet (m) tall</li> <li>Weight: 7,000 pounds (3,175 kg) distributed equally over the footprint listed above</li> <li>Weight of single largest piece for installation shall be 7,000 pounds (3,175 kg)</li> <li>Electrical: 400 HP requiring 600 amps at 480 volts</li> <li>CHW: none</li> <li>ICW: Maximum of 200 gpm per operating compressor.</li> </ul>
<b>T-121.06.03-D007</b>	<i>F-121.06.03-A002</i>	<p>The WCS shall provide space/infrastructure for one (1) <b>SP Skid</b> with the following characteristics:</p> <ul style="list-style-type: none"> <li>18.4 feet (5.6 m) long by 10.2 feet (3.1 m) wide by 14.5 feet (4.4 m) tall</li> <li>Weight: 26,455 pounds (12,000 kg) distributed equally over the footprint listed above</li> <li>Weight of single largest piece for installation shall be 26,455 pounds (12,000 kg)</li> <li>Electrical: 400 kW at 4160 volts</li> <li>CHW: none</li> <li>ICW: Maximum of 240 gpm</li> </ul>

<b>T-121.06.03-D008</b>	<i>F-121.06.03-A002</i>	<p>The WCS shall provide space/infrastructure for one (1) <b>Low Pressure Skid</b> with the following characteristics:</p> <ul style="list-style-type: none"> <li>• 18.4 feet (5.6 m) long by 10.2 feet (3.1 m) wide by 14.5 feet (4.4 m) tall</li> <li>• Weight: 26,455 pounds (12,000 kg) distributed equally over the footprint listed above Weight of single largest piece for installation shall be 26,455 pounds (12,000 kg)</li> <li>• Electrical: 400 kW at 4160 volts</li> <li>• CHW: none</li> <li>• ICW: Maximum of 240 gpm</li> </ul>
<b>T-121.06.03-D009</b>	<i>F-121.06.03-A002</i>	<p>The WCS shall provide space/infrastructure for two (2) <b>High Pressure Skid each</b> with the following characteristics:</p> <ul style="list-style-type: none"> <li>• 18.4 feet (5.6 m) long by 10.2 feet (3.1 m) wide by 14.5 feet (4.4 m) tall</li> <li>• Weight: 26,455 pounds (12,000 kg) distributed equally over the footprint listed above Weight of single largest piece for installation shall be 26,455 pounds (12,000 kg)</li> <li>• Electrical: 1450 kW at 4160 volts</li> <li>• CHW: none</li> <li>• ICW: Maximum of 240 gpm</li> </ul>
<b>T-121.06.03-D010</b>	<i>F-121.06.03-A002</i>	<p>The WCS shall provide space for two (2) <b>Gas Management Panels each</b> with the following characteristics:</p> <ul style="list-style-type: none"> <li>• 16.4 feet (5.0 m) long by 3.3 feet (1.0 m) wide by 7.2 feet (2.2 m) tall</li> <li>• Weight: 3,750 pounds (1,700 kg) distributed equally over the footprint listed above Weight of single largest piece for installation shall be 3,750 pounds (1,700 kg).</li> <li>• Electrical: <b>none</b></li> <li>• CHW: none</li> <li>• ICW: none</li> </ul>
<b>T-121.06.03-D011</b>	<i>F-121.06.03-A002</i>	<p>The WCS shall provide space for one (1) <b>Oil Absorber Skid</b> with the following characteristics:</p> <ul style="list-style-type: none"> <li>• 7.6 feet (2.3 m) long by 6.4 feet (2.0 m) wide by 12.2 feet (3.7 m) tall</li> <li>• Weight: 8,160 pounds (3,700 kg) distributed equally over the footprint listed above Weight of single largest piece for installation shall be 8,160 pounds (3,700 kg)</li> <li>• Electrical: <b>30 kW at 480 volts</b></li> <li>• CHW: none</li> <li>• ICW: none</li> </ul>
<b>T-121.06.03-D012</b>	<i>F-121.06.03-A002</i>	<p>The WCS shall provide space for one (1) <b>Oil Coalescer Skid</b> with the following characteristics:</p> <ul style="list-style-type: none"> <li>• 11.6 (3.5 m) long by 3.4 feet (1.0 m) wide by 9.2 feet (2.8 m) tall</li> </ul>

		<ul style="list-style-type: none"> <li>• Weight: 5,511 pounds (2,500 kg) distributed equally over the footprint listed above</li> <li>• Weight of single largest piece for installation shall be 5,511 pounds (2,500 kg)</li> <li>• Electrical: <b>none</b></li> <li>• CHW: none</li> <li>• ICW: none</li> </ul>
<b>T-121.06.03-D013</b>	<i>F-121.06.03-A002</i>	<p>The WCS shall provide space for one (1) <b>Oil Dryer Skid</b> with the following characteristics:</p> <ul style="list-style-type: none"> <li>• 6.2 feet (1.9 m) long by 6.5 feet (2.0 m) wide by 8.4 feet (2.6 m) tall</li> <li>• Weight: 1,984 pounds (900 kg) distributed equally over the footprint listed above</li> <li>• Weight of single largest piece for installation shall be 1,984 pounds (900 kg)</li> <li>• Electrical: <b>XX</b></li> <li>• CHW: none</li> <li>• ICW: none</li> </ul>
<b>T-121.06.03-D014</b>	<i>F-121.06.03-A002</i>	<p>The WCS shall provide space for three (3) <b>Oil Absorber Skids</b> each with the following characteristics:</p> <ul style="list-style-type: none"> <li>• 32.8 feet (10 m) long by 11.8 feet (3.6 m) wide by 14.9 feet (4.5 m) tall</li> <li>• Weight: 39,685 pounds (18,000 kg) distributed equally over the footprint listed above</li> <li>• Weight of single largest piece for installation shall be 39,685 pounds (18,000 kg)</li> <li>• Electrical: <b>30 kW at 480 volts</b></li> <li>• CHW: none</li> <li>• ICW: none</li> </ul>
<b>T-121.06.03-D015</b>	<i>F-121.06.03-A002</i>	<p>The WCS shall provide space for one (1) <b>SP/LP Control Cabinet</b> with the following characteristics:</p> <ul style="list-style-type: none"> <li>• 15.8 feet (4.8 m) long by 2.0 feet (0.6 m) wide by 7.2 feet (2.2 m) tall</li> <li>• Weight: <b>2,200 pounds (1,000 kg)</b> distributed equally over the footprint listed above</li> <li>• Weight of single largest piece for installation shall be <b>2,200 pounds (1,000 kg)</b></li> <li>• Electrical: 16 kw at 480 volts</li> <li>• CHW: none</li> <li>• ICW: none</li> </ul>
<b>T-121.06.03-D016</b>	<i>F-121.06.03-A002</i>	<p>The WCS shall provide space for one (1) <b>High Pressure Control Cabinet</b> with the following characteristics:</p> <ul style="list-style-type: none"> <li>• 13.1 feet (4.0 m) long by 2.0 feet (0.6 m) wide by 7.2 feet (2.2 m) tall</li> <li>• Weight: <b>2,200 pounds (1,000 kg)</b> distributed equally over the footprint listed above</li> </ul>

		<ul style="list-style-type: none"> <li>Weight of single largest piece for installation shall be <b>2,200 pounds (1,000 kg)</b></li> <li>CHW: none</li> <li>ICW: none</li> </ul>
<b>T-121.06.03-D017</b>	<i>F-121.06.03-A002</i>	<p>The WCS shall provide space for one (1) <b>Inventory Control Manifold</b> with the following characteristics:</p> <ul style="list-style-type: none"> <li>11.6 feet (3.5 m) long by 3.4 feet (1.0 m) wide by 9.2 feet (2.8 m) tall</li> <li>Weight: <b>1,000 pounds (455 kg)</b> distributed equally over the footprint listed above</li> <li>Weight of single largest piece for installation shall be <b>1,000 pounds (455 kg)</b></li> <li>CHW: none</li> <li>ICW: none</li> </ul>
<b>T-121.06.03-D018</b>	<i>F-121.06.03-A002</i>	<p>The WCS shall provide space for one (1) <b>Purifier Skid</b> with the following characteristics:</p> <ul style="list-style-type: none"> <li>3.0 feet (0.9 m) long by 3.0 feet (0.9 m) wide by 9.8 feet (3.0 m) tall</li> <li><b>2,200 pound (1,000 kg)</b> distributed equally over the footprint listed above</li> <li>Weight of single largest piece for installation shall be <b>2,200 pounds (1,000 kg)</b></li> <li>Electrical: none</li> <li>CHW: none</li> <li>ICW: none</li> </ul>
<b>T-121.06.03-D019</b>	<i>F-121.06.03-A002</i>	<p>The WCS shall provide space for two (2) <b>Air Compressors</b> each with the following characteristics:</p> <ul style="list-style-type: none"> <li>6.8 feet (2.1 m) long by 3.4 feet (1.0 m) wide by 5.6 feet (1.7 m) tall</li> <li>Weight: <b>500 pounds (227 kg)</b> distributed equally over the footprint listed above</li> <li>Weight of single largest piece for installation shall be <b>500 pounds (227 kg)</b></li> <li>Electrical: <b>110 amps @ 480 volts, 60 amps at 120V, 10-amps at 120V</b></li> <li>CHW: none</li> <li>ICW: none</li> </ul> <p>Note: This equipment can be located in a building mechanical space.</p>
<b>T-121.06.03-D020</b>	<i>F-121.06.03-A002</i>	<p>The WCS shall have a heating and ventilation system capable of achieving the following parameters:</p> <ul style="list-style-type: none"> <li>Temperature in Ventilation Mode: Ambient + 10 degrees Fahrenheit</li> <li>Temperature in Heating Mode: 68 degrees Fahrenheit (+/- 5F)</li> </ul> <p>Humidity: No requirement</p>
<b>T-121.06.03-D021</b>	<i>F-121.06.03-A002</i> <i>F-121.06.03-A001</i>	<p>The WCS shall have a louvers, dampers and fans to accommodate ODH mitigation with the following capabilities:</p> <ul style="list-style-type: none"> <li>Upper portion: 45,000 cfm</li> </ul>

		<ul style="list-style-type: none"> <li>Lower portion: 10,000 cfm</li> </ul>																																																																																																				
<b>T-121.06.03-D022</b>	<i>F-121.06.03-A002</i>	The WCS shall include a generator backed UPS for cryogenics controls systems and oxygen deficiency hazard (ODH) control equipment sized for 8 minutes of full load run time.																																																																																																				
<b>T-121.06.03-D023</b>	<i>F-121.06.03-A002</i>	The WCS shall include 480V, 60-amp welding receptacles sized and located to accommodate standard Fermilab welding machines and cord lengths.																																																																																																				
<b>T-121.06.03-D024</b>	<i>F-121.06.03-A002</i>	The WCS shall include one (1) 120V, 20-amp receptacle at each column line.																																																																																																				
<b>T-121.06.03-D025</b>	<i>F-121.06.03-A002</i>	The CBS shall include one (1) 120V, 20-amp receptacle at each column line.																																																																																																				
<b>T-121.06.03-D026</b>	<i>F-121.06.03-A002</i>	The WCS shall be provided with general lighting to achieve an average of 20 foot-candles.																																																																																																				
<b>T-121.06.03-D027</b>	<i>F-121.06.03-A002</i> <i>F-121.06.03-A003</i>	The WCS shall be acoustically isolated from the Cold Box Station.																																																																																																				
<b>T-121.06.03-D028</b>	<i>F-121.06.03-A002</i>	<p>The ICW for the WCS shall meet the following characteristics:</p> <table border="1"> <thead> <tr> <th></th> <th></th> <th>Vendor 1</th> <th>Vendor 2</th> </tr> <tr> <th>Desription</th> <th>Unit</th> <th>Open loop</th> <th></th> </tr> </thead> <tbody> <tr> <td>Electrical conductivity</td> <td>[μS/cm]</td> <td>400-800</td> <td>10 - 500</td> </tr> <tr> <td>pH value</td> <td></td> <td>8.3 - 9.0</td> <td>7.5 - 9.0</td> </tr> <tr> <td>m-alkalinity</td> <td>meg/l</td> <td>2.0 - 4.0</td> <td></td> </tr> <tr> <td>Calcium</td> <td>mg/l</td> <td>30 - 60</td> <td></td> </tr> <tr> <td>Chloride (Cl)</td> <td>[mg/l]</td> <td>&lt; 50</td> <td>&lt; 150</td> </tr> <tr> <td>Sulphate (SO<sub>4</sub>)</td> <td>[mg/l]</td> <td>&lt; 100</td> <td></td> </tr> <tr> <td>Ammonium (NH<sub>4</sub>)</td> <td>[mg/l]</td> <td>&lt; 5</td> <td>&lt; 2.0</td> </tr> <tr> <td>Micobacterial count</td> <td>[CFU/ml]</td> <td>&lt; 10<sup>4</sup></td> <td></td> </tr> <tr> <td>Suspended Soilds</td> <td>mg/l</td> <td>&lt; 5</td> <td></td> </tr> <tr> <td>COD (chemical oxygen demand)</td> <td>mg/l</td> <td>&lt;20</td> <td></td> </tr> <tr> <td>Soilds (particle size)</td> <td>mm</td> <td>&lt; 0.1</td> <td>&lt; 0.1</td> </tr> <tr> <td>Antifreeze/Glycol</td> <td>%</td> <td>---</td> <td>&lt; 50</td> </tr> <tr> <td>Free Chlorine Gas (CL<sub>2</sub>)</td> <td>mg/l</td> <td></td> <td>&lt; 1.0</td> </tr> <tr> <td>Sulphate (SO<sub>3</sub>)</td> <td>mg/l</td> <td></td> <td>&lt; 1.0</td> </tr> <tr> <td>Dissolved iron (Fe)</td> <td>[mg/l]</td> <td></td> <td>&lt; 0.2</td> </tr> <tr> <td>Hydrogen Carbonate (HC0<sub>3</sub>)</td> <td>mg/l</td> <td></td> <td>70 - 300</td> </tr> <tr> <td>HC0<sub>3</sub> / SO<sub>4</sub></td> <td></td> <td></td> <td>&gt; 1.0</td> </tr> <tr> <td>Dissolved manganese (Mn)</td> <td>[mg/l]</td> <td></td> <td>&lt; 0.1</td> </tr> <tr> <td>Dissolved aluminum (AL)</td> <td>mg/l</td> <td></td> <td>&lt; 0.2</td> </tr> <tr> <td>Dissolved Nitrate (NO<sub>3</sub>)</td> <td>mg/l</td> <td></td> <td>&lt; 100</td> </tr> <tr> <td>Hydrogen Sulfate (H<sub>2</sub>S)</td> <td>mg/l</td> <td></td> <td>&lt; 0.05</td> </tr> <tr> <td>Free Carbon Dioxide (CO<sub>2</sub>)</td> <td>mg/l</td> <td></td> <td>&lt; 5.0</td> </tr> <tr> <td>Algae</td> <td></td> <td></td> <td>0</td> </tr> </tbody> </table> <p>It is recognized that the cryogenics equipment vendor may be able to design the compressor heat exchangers based on the water quality testing available from the Fermilab ICW system.</p>			Vendor 1	Vendor 2	Desription	Unit	Open loop		Electrical conductivity	[μS/cm]	400-800	10 - 500	pH value		8.3 - 9.0	7.5 - 9.0	m-alkalinity	meg/l	2.0 - 4.0		Calcium	mg/l	30 - 60		Chloride (Cl)	[mg/l]	< 50	< 150	Sulphate (SO <sub>4</sub> )	[mg/l]	< 100		Ammonium (NH <sub>4</sub> )	[mg/l]	< 5	< 2.0	Micobacterial count	[CFU/ml]	< 10 <sup>4</sup>		Suspended Soilds	mg/l	< 5		COD (chemical oxygen demand)	mg/l	<20		Soilds (particle size)	mm	< 0.1	< 0.1	Antifreeze/Glycol	%	---	< 50	Free Chlorine Gas (CL <sub>2</sub> )	mg/l		< 1.0	Sulphate (SO <sub>3</sub> )	mg/l		< 1.0	Dissolved iron (Fe)	[mg/l]		< 0.2	Hydrogen Carbonate (HC0 <sub>3</sub> )	mg/l		70 - 300	HC0 <sub>3</sub> / SO <sub>4</sub>			> 1.0	Dissolved manganese (Mn)	[mg/l]		< 0.1	Dissolved aluminum (AL)	mg/l		< 0.2	Dissolved Nitrate (NO <sub>3</sub> )	mg/l		< 100	Hydrogen Sulfate (H <sub>2</sub> S)	mg/l		< 0.05	Free Carbon Dioxide (CO <sub>2</sub> )	mg/l		< 5.0	Algae			0
		Vendor 1	Vendor 2																																																																																																			
Desription	Unit	Open loop																																																																																																				
Electrical conductivity	[μS/cm]	400-800	10 - 500																																																																																																			
pH value		8.3 - 9.0	7.5 - 9.0																																																																																																			
m-alkalinity	meg/l	2.0 - 4.0																																																																																																				
Calcium	mg/l	30 - 60																																																																																																				
Chloride (Cl)	[mg/l]	< 50	< 150																																																																																																			
Sulphate (SO <sub>4</sub> )	[mg/l]	< 100																																																																																																				
Ammonium (NH <sub>4</sub> )	[mg/l]	< 5	< 2.0																																																																																																			
Micobacterial count	[CFU/ml]	< 10 <sup>4</sup>																																																																																																				
Suspended Soilds	mg/l	< 5																																																																																																				
COD (chemical oxygen demand)	mg/l	<20																																																																																																				
Soilds (particle size)	mm	< 0.1	< 0.1																																																																																																			
Antifreeze/Glycol	%	---	< 50																																																																																																			
Free Chlorine Gas (CL <sub>2</sub> )	mg/l		< 1.0																																																																																																			
Sulphate (SO <sub>3</sub> )	mg/l		< 1.0																																																																																																			
Dissolved iron (Fe)	[mg/l]		< 0.2																																																																																																			
Hydrogen Carbonate (HC0 <sub>3</sub> )	mg/l		70 - 300																																																																																																			
HC0 <sub>3</sub> / SO <sub>4</sub>			> 1.0																																																																																																			
Dissolved manganese (Mn)	[mg/l]		< 0.1																																																																																																			
Dissolved aluminum (AL)	mg/l		< 0.2																																																																																																			
Dissolved Nitrate (NO <sub>3</sub> )	mg/l		< 100																																																																																																			
Hydrogen Sulfate (H <sub>2</sub> S)	mg/l		< 0.05																																																																																																			
Free Carbon Dioxide (CO <sub>2</sub> )	mg/l		< 5.0																																																																																																			
Algae			0																																																																																																			
<b>T-121.06.03-D029</b>	<i>F-121.06.03-A002</i>	The ventilation system in the WCS shall be designed to accommodate a combined 200 kW of heat load rejected to air.																																																																																																				

Support Space		
<b>T-121.06.03-E001</b>	<i>F-121.06.03-A006</i>	The Support Space (SS) shall provide space/infrastructure for a <b>Control Room</b> that will accommodate four (4) work stations, monitors and related equipment.
<b>T-121.06.03-E002</b>	<i>F-121.06.03-A006</i>	The SS shall provide space/infrastructure for a <b>Team Room</b> that will accommodate an eight (8) person conference table, video display and related equipment.
<b>T-121.06.03-E003</b>	<i>F-121.06.03-A006</i>	The SS shall provide space/infrastructure for <b>Open Office Space</b> with cubicles to house four (4) people and associated spaces.
<b>T-121.06.03-E004</b>	<i>F-121.06.03-A006</i>	The SS shall provide space/infrastructure for a <b>Main Networking Room</b> to house the following: <ul style="list-style-type: none"> <li>• Two (2) 42 “U” networking racks (~2’ wide x 4’ long x 6.1’ high)</li> <li>• Two (2) 42 “U” Cryogenics Plant Building specific racks</li> <li>• Each rack shall have the following power requirements: <ul style="list-style-type: none"> <li>○ One (1) 30-amp 208 V circuit fed from generator backed UPS power for each rack.</li> <li>○ One (1) 30-amp 208 V circuit fed from building power for each rack</li> <li>○ One (1) 20-amp 120 V circuit fed from building power for each rack</li> </ul> </li> <li>• The networking equipment shall have access to a grounding bar connected to the overall building ground.</li> </ul>
<b>T-121.06.03-E005</b>	<i>F-121.06.03-A006</i>	The SS shall be provided with general lighting to achieve an average of 30 foot-candles in the Control Room, Open Office and Team Room. Other areas shall be provided with lighting to achieve 10 foot-candles
<b>T-121.06.03-E006</b>	<i>F-121.06.03-A006</i>	The SS shall have a HVAC system capable of achieving the following parameters: <ul style="list-style-type: none"> <li>• Temperature in Cooling Mode: 78 degrees Fahrenheit (+/- 5F)</li> <li>• Temperature in Heating Mode: 68 degrees Fahrenheit (+/- 5F)</li> <li>• Humidity: 55% RH Max, No Minimum</li> </ul>
<b>T-121.06.03-E007</b>	<i>F-121.06.03-A003 F-121.06.03-A006 F-121.06.03-A001</i>	The CBS shall have an isolated HVAC system that can pressurize the space to reduce the oxygen deficiency hazard of the space relative to other portions of the CPB.
Exterior Space		
<b>T-121.06.03-F001</b>	<i>F-121.06.03-A003</i>	The Exterior Space (ES) of the CPB shall provide space and foundations for the seven (7) 113,000-liter (30,000 gallon) gaseous helium storage tanks, fill station and related piping. These tanks will be relocated from the existing location at the Main Ring A Sector.
<b>T-121.06.03-F002</b>	<i>F-121.06.03-A003</i>	The Exterior Space (ES) of the CPB shall provide space and foundations for the three (3) 113,000-liter (30,000 gallon) gaseous helium storage tanks, fill station and related piping. These tanks will be new.
<b>T-121.06.03-F003</b>	<i>F-121.06.03-A003</i>	The ES shall provide space and foundation for one (1) 34,000-liter (9,000 gallon) liquid nitrogen Dewar, fill station and related piping.

<b>T-121.06.03-F004</b>	<i>F-121.06.03-A003</i>	The ES shall provide space for one (1) trailer mounted mobile purifier.
<b>T-121.06.03-F005</b>	<i>F-121.06.03-A003</i>	The ES shall provide parking for one (1) tube trailer.
<b>T-121.06.03-F006</b>	<i>F-121.06.03-A003</i>	The ES shall provide space for maneuvering of standard 55 foot long semi-trailers and nitrogen deliveries.
<b>T-121.06.03-F007</b>	<i>F-121.06.03-A001</i>	The ES shall provide parking spaces for eight (8) vehicles.
<b>T-121.06.03-F008</b>	<i>F-121.06.03-A001</i>	The ES shall be provided with general lighting to achieve an average of 2 foot-candles.

## 7. Design Requirements

The design of the work will be done in accordance with recognized engineering practices and design standards and will comply with the applicable portions of the U.S. Department of Energy and the State of Illinois codes, orders and regulations as incorporated into contract No. DE-AC02-07CH11359 between the U.S. Department of Energy and Fermi Research Alliance, LLC.

Fermilab has adopted the Necessary and Sufficient Process (NSP) for determining the Work Smart Set (WSS) of Standards which are used to determine the appropriate environment, safety and health standards used to ensure the safe and environmentally responsible operations of the Laboratory. Where no edition or "latest edition" is noted on the Work Smart Set, it is assumed that the edition in effect at the time of the acceptance of this Project Plan will be used.

As a minimum, the system shall abide by the following:

<b>Fermilab ES&amp;H Manual (FESHM)</b>
<ul style="list-style-type: none"> <li>• FESHM Chapter 2000 – Planning for Safe Operations</li> </ul>
<ul style="list-style-type: none"> <li>• FESHM Chapter 7000 – Occupational &amp; Subcontractor Safety</li> </ul>
<ul style="list-style-type: none"> <li>• FESHM Chapter 8000 – Environmental Protection</li> </ul>
<ul style="list-style-type: none"> <li>• FESHM Chapter 9000 – Electrical Safety</li> </ul>
<ul style="list-style-type: none"> <li>• FESHM Chapter 10000 – Material Handling and Transportation</li> </ul>
<ul style="list-style-type: none"> <li>• FESHM Chapter 11000 – Radiation Safety</li> </ul>
<ul style="list-style-type: none"> <li>• FESHM Chapter 12000 – Quality Assurance</li> </ul>
<b>Fermilab Radiological Control Manual (FRCM)</b>
<b>DOE Orders and Standards</b>
<ul style="list-style-type: none"> <li>• DOE Order 430.2B – Departmental Energy, Renewable Energy and Transportation Management</li> </ul>
<ul style="list-style-type: none"> <li>• DOE STD-1066-99 – Fire Protection Design Criteria</li> </ul>

<ul style="list-style-type: none"> <li>• DOE Guide 420.1-2 – Guide for the Mitigation of Natural Phenomena Hazards for DOE Nuclear Facilities and Non-Nuclear Facilities</li> </ul>
<ul style="list-style-type: none"> <li>• DOE Order 430.1B – Real Property Asset Management</li> </ul>
<ul style="list-style-type: none"> <li>• DOE Order 436.1 – Departmental Sustainability</li> </ul>
<ul style="list-style-type: none"> <li>• DOE Order 413.3 - Program and Project Management for the Acquisition of Capital Assets</li> </ul>
<b>Building Codes and Design Standards</b>
<ul style="list-style-type: none"> <li>• International Building Code (IBC)</li> </ul>
<ul style="list-style-type: none"> <li>• International Fire Code</li> </ul>
<ul style="list-style-type: none"> <li>• NFPA 101</li> </ul>
<ul style="list-style-type: none"> <li>• International Mechanical Code (IMC)</li> </ul>
<ul style="list-style-type: none"> <li>• NFPA 55 – Compressed Gases and Cryogenic Fluids Code</li> </ul>
<ul style="list-style-type: none"> <li>• NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating</li> </ul>
<ul style="list-style-type: none"> <li>• NFPA 90B – Standard for the Installation of Warm Air Heating and Air Conditioning Systems</li> </ul>
<ul style="list-style-type: none"> <li>• ASHRAE 90.1 – Energy Standards for Buildings</li> </ul>
<ul style="list-style-type: none"> <li>• ANSI/ASHRAE Standard 62.1-2004 Ventilation for Acceptable Indoor Air Quality</li> </ul>
<ul style="list-style-type: none"> <li>• ANSI/ASME B31.3 – Process Piping</li> </ul>
<ul style="list-style-type: none"> <li>• ANSI 31.9 – Building Services Piping</li> </ul>
<ul style="list-style-type: none"> <li>• NFPA 13 – Standard for the Installation of Sprinkler Systems</li> </ul>
<ul style="list-style-type: none"> <li>• NFPA 24 – Standard for the Installation of Private Fire Service Mains and Their Appurtenances</li> </ul>
<ul style="list-style-type: none"> <li>• NFPA 70 – National Electrical Code</li> </ul>
<ul style="list-style-type: none"> <li>• NFPA 70E – Standard for Electrical Safety in the Workplace</li> </ul>
<ul style="list-style-type: none"> <li>• NFPA 72 – National Fire Alarm Code</li> </ul>
<ul style="list-style-type: none"> <li>• NFPA 110 – Emergency and Standby Power Systems</li> </ul>
<ul style="list-style-type: none"> <li>• NFPA 80 – Fire Doors and Fire Windows</li> </ul>
<ul style="list-style-type: none"> <li>• ANSI 17.1 Safety Code for Elevators and Escalators</li> </ul>
<ul style="list-style-type: none"> <li>• ICC/ANSI A117.1 – Standard for Accessible and Usable Buildings and Facilities Illinois Accessibility Code</li> </ul>
<ul style="list-style-type: none"> <li>• ADA Accessibility Guidelines for Buildings and Facilities (ADAAG) – 2004 will be used for those areas of facility not exempted by Fermilab policy</li> </ul>



- |  |
|--|
| <ul style="list-style-type: none"><li>• Illinois Accessibility Code</li></ul>  |
| <ul style="list-style-type: none"><li>• Illinois Plumbing Code and Standard Specifications for Water &amp; Sewer Main Construction in Illinois</li></ul> |

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.