

**Requirements vs. Design Comparison**

WBS: **121.06.03 - Cryo Plant Building**  
Source: **Technical Requirements Specification (ED0006719), VC**

Requirement ID	FRS Reference	Requirement Statement	Response
<b>General</b>			
T-121.06.03-A001	F-121.06.03-A009	The location of the CDS header shall be upstream of the HWR	See A-1
T-121.06.03-A002	F-121.06.03-A001	The location of the CPB shall provide for an unlimited occupancy for radiation shielding purposes.	Preliminary assesement complete
<b>Architectural</b>			
T-121.06.03-B001	F-121.06.03-A007	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."  To this end, the CPB will incorporate the appropriate portions of the design guidelines including: <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>	See Architectural drawings
T-121.06.03-B002	F-121.06.03-A001	The CPB shall be designed to accommodate safe access for maintenance and operation including roof access with minimal personal protective equipment.	See A-3 for stair access to roof and 42" high parapets
<b>Cold Box Station</b>			
T-121.06.03-C001	F-121.06.03-A004	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 27 feet above finished floor;</li> </ul>	25 ton capacity crane indicated. See SS-1 and Spec 412213
T-121.06.03-C002	F-121.06.03-A004	The CBS shall include at grade loading dock space to accommodate a standard 55-foot-long semi-trailer.	See A-2
T-121.06.03-C003	F-121.06.03-A004	The CBS shall include, as a minimum, a 16-foot-wide by 16-foot-tall overhead door;	See A-12 and Door Schedule on A-47
T-121.06.03-C004	F-121.06.03-A003	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.	See Structural Concrete Note 35, sheet S-1
T-121.06.03-C005	F-121.06.03-A003	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>o 72 kW, 125A, 3PH @ 480 volts</li> <li>o 5 kW, 20A @ 208 volts</li> <li>o 10 kW, 20A, 1PH @ 120 volts with UPS back-up</li> </ul> </li> <li>• CHW: 42 gpm with a maximum 18F delta T; 43-145 psi supply pressure, 59-90 F supply temperature</li> <li>• ICW: none</li> <li>• Identifier: <b>FEQ-01A</b></li> </ul>	See drawing A-2 for location of FEQ-01A
T-121.06.03-C006	F-121.06.03-A003	The CBS shall provide space/infrastructure for one (1) <b>4.5K 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>o 72 kW at 480V, 125A, 3PH</li> <li>o 10 kW at 120V, 20A, 1PH with UPS back-up</li> <li>o 5 HP @ 208 volts</li> </ul> </li> <li>• CHW: 5.3 gpm with a maximum 18F delta T; 43-145 psi supply pressure, 59-90 F supply temperature</li> <li>• ICW: none</li> <li>• Identifier: <b>FEQ-02</b></li> </ul>	See drawing A-2 for location of FEQ-02
T-121.06.03-C007	F-121.06.03-A003	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: 5 kW at 480V</li> <li>• CHW: none</li> <li>• ICW: none</li> <li>• Identifier: <b>FEQ-01B</b></li> </ul>	See drawing A-2 for location of FEQ-01B
T-121.06.03-C008	F-121.06.03-A003	The CBS shall provide space for four (4) <b>Cryogenics Control Cabinets</b> each with the following characteristics: <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: 120-volt, 30-amp circuit for each cabinet fed from UPS backed generator circuit</li> <li>• Identifier: FEQ-03</li> </ul>	See drawing A-2 for location of FEQ-03
T-121.06.03-C009	F-121.06.03-A003	The CBS shall have a HVAC system capable of achieving the following space 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>	Basis of Design Report includes operating parameters. See Mechanical, 2.B.a
T-121.06.03-C010	F-121.06.03-A003 F-121.06.03-A001	The CBS shall have a louvers, dampers and fans to accommodate ODH mitigation with the following capabilities: <ul style="list-style-type: none"> <li>• Upper portion: 50,000 cfm</li> <li>• Lower portion: 10,000 cfm</li> <li>• Minimum 4 fans, see preliminary ODH Assessment (EN03241)</li> </ul>	Basis of Design Report includes operating parameters. See Mechanical, 4.A. See drawing M-4 for fan locations. See drawings M-2 and M-5 for louver locations. See drawing M-14 for fan schedule
T-121.06.03-C011	F-121.06.03-A003	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.	See E-15 and Basis of Design Report
T-121.06.03-C012	F-121.06.03-A003	The CBS shall include 480V, 60-amp welding receptacles sized and located to accommodate standard Fermilab welding machines and cord lengths.	Spaced at 80' to accommodate a 40' cord as shown on E-4
T-121.06.03-C013	F-121.06.03-A003	The CBS shall include one (1) 208V, 20-amp receptacle at each column line.	See E-4
T-121.06.03-C014	F-121.06.03-A003	The CBS shall include one (1) 120V, 20-amp receptacle at each column line.	See E-4
T-121.06.03-C015	F-121.06.03-A003	The CBS shall be provided with general lighting to achieve an average of 30 foot-candles.	Lighting design provides average of 40.7 fc. See Lighting Calculations
T-121.06.03-C016	F-121.06.03-A003	The HVAC system in the CBS shall be designed to accommodate a combined 15 kW of heat load rejected to air.	Trace Calculation Room Input Page 2

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Requirement ID	FRS Reference	Requirement Statement	Response
T-121.06.03-C017	F-121.06.03-A003	The CBS shall provide space/infrastructure for one (1) <b>Distribution Box</b> and related 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</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>This equipment shall be supported by the platform/stairs installed as part of the Cold Box.</li> <li>Identifier: <b>FEQ-01C</b></li> </ul>	See drawing A-2 for location of FEQ-01C
T-121.06.03-C019	F-121.06.03-A003	The CBS shall include cable tray at the perimeter of the building from the network room. The cable tray will include space for a 4"x4" plastic tray with cover (Panduit FR4X4BL6) to be installed by Fermilab	Cable tray is shown on T-3
T-121.06.03-C020	F-121.06.03-A003	The CBS shall provide space/infrastructure for one (1) <b>Evaporator</b> and related equipment with the following characteristics: <ul style="list-style-type: none"> <li>5.3 feet (1.6 m) long by 5.3 feet (1.6 m) wide</li> <li>Weight: 5,000 pounds distributed equally over the footprint listed above</li> <li>Single largest piece for installation shall be 5,000 pounds.</li> <li>Identifier: <b>FEQ-04</b></li> </ul>	See drawing A-2 for location of FEQ-04
<b>Warm Compressor Station</b>			
T-121.06.03-D001	F-121.06.03-A004	The Warm Compressor Station (WCS) 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 27 feet above finished floor;</li> </ul>	25 ton capacity crane indicated. See SS-1 and Spec 412213
T-121.06.03-D002	F-121.06.03-A004	The WCS shall include at grade loading dock space to accommodate a standard 55-foot-long semi-trailer.	See A-2 for loading dock location
T-121.06.03-D003	F-121.06.03-A004	The WCS shall include, as a minimum, a 16-foot-wide by 16-foot-tall overhead door;	See A-12 and Door Schedule on A-47
T-121.06.03-D004	F-121.06.03-A002	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.	See Structural Concrete Note 35, sheet S-1
T-121.06.03-D005	F-121.06.03-A002	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.	Isolation occurs at column line 5 and 6. See drawing SC-2 and related drawings
T-121.06.03-D006	F-121.06.03-A002	The WCS shall provide space/infrastructure for two (2) <b>MyCom Compressors and associated oil removal skids</b> each with the following characteristics: <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 477 amps at 480 volts per compressor</li> <li>CHW: none</li> <li>ICW: See T-121.06.03-D030</li> <li>Identifier: <b>FEQ-08</b></li> </ul>	See drawing A-2 for location of FEQ-08
T-121.06.03-D007	F-121.06.03-A002	The WCS shall provide space/infrastructure for one (1) <b>Sub Atmospheric Pressure (SP) Skid</b> with the following characteristics: <ul style="list-style-type: none"> <li>26.2 feet (8 m) long by 8.2 feet (2.5 m) wide by 19.7 feet (6 m) tall</li> <li>Weight: 77,162 pounds (35,000 kg) distributed equally over the footprint listed above</li> <li>Weight of single largest piece for installation shall be 77,162 pounds (35,000 kg)</li> <li>Electrical: 400 kW at 4160 volts</li> <li>CHW: none</li> <li>ICW: See T-121.06.03-D030</li> <li>Identifier: <b>FEQ-15</b></li> </ul>	See drawing A-2 for location of FEQ-15
T-121.06.03-D008	F-121.06.03-A002	The WCS shall provide space/infrastructure for one (1) <b>Low Pressure (LP) Skid</b> with the following characteristics: <ul style="list-style-type: none"> <li>26.2 feet (8 m) long by 8.2 feet (2.5 m) wide by 19.7 feet (6 m) tall</li> <li>Weight: 77,162 pounds (35,000 kg) distributed equally over the footprint listed above</li> <li>Weight of single largest piece for installation shall be 77,162 pounds (35,000 kg)</li> <li>Electrical: 550 kW at 4160 volts</li> <li>CHW: none</li> <li>ICW: See T-121.06.03-D030</li> <li>Identifier: <b>FEQ-13</b></li> </ul>	See drawing A-2 for location of FEQ-13
T-121.06.03-D009	F-121.06.03-A002	The WCS shall provide space/infrastructure for two (2) <b>High Pressure (HP) Skid</b> each with the following characteristics: <ul style="list-style-type: none"> <li>26.2 feet (8 m) long by 8.2 feet (2.5 m) wide by 19.7 feet (6 m) tall</li> <li>Weight: 77,162 pounds (35,000 kg) distributed equally over the footprint listed above</li> <li>Weight of single largest piece for installation shall be 77,162 pounds (35,000 kg)</li> <li>Electrical: 1800 kW at 4160 volts</li> <li>CHW: none</li> <li>ICW: See T-121.06.03-D030</li> <li>Identifier: <b>FEQ-11</b></li> </ul>	See drawing A-2 for location of FEQ-11
T-121.06.03-D010	F-121.06.03-A002	The WCS shall provide space for two (2) <b>Gas Management Panels</b> each with the following characteristics: <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</li> <li>Weight of single largest piece for installation shall be 3,750 pounds (1,700 kg).</li> <li>Electrical: none</li> <li>CHW: none</li> <li>ICW: none</li> <li>Identifier: <b>FEQ-16</b></li> </ul>	See drawing A-2 for location of FEQ-16
T-121.06.03-D011	F-121.06.03-A002	The WCS shall provide space for one (1) <b>Oil Absorber Skid</b> with the following characteristics: <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</li> <li>Weight of single largest piece for installation shall be 8,160 pounds (3,700 kg)</li> <li>Electrical: 30 kW at 480 volts</li> <li>CHW: none</li> <li>ICW: none</li> <li>Identifier: <b>FEQ-09</b></li> </ul>	See drawing A-2 for location of FEQ-09
T-121.06.03-D012	F-121.06.03-A002	The WCS shall provide space for one (1) <b>Oil Coalescer Skid</b> with the following characteristics: <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> <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: none</li> <li>CHW: none</li> <li>ICW: none</li> <li>Identifier: <b>FEQ-17</b></li> </ul>	See drawing A-2 for location of FEQ-17
T-121.06.03-D013	F-121.06.03-A002	The WCS shall provide space for one (1) <b>Oil Dryer Skid</b> with the following characteristics: <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: 84 kW at 480V, 125A</li> <li>CHW: none</li> <li>ICW: none</li> <li>Identifier: <b>FEQ-29</b></li> </ul>	See drawing A-2 for location of FEQ-29
T-121.06.03-D014	F-121.06.03-A002	The WCS shall provide space for two (2) <b>High Pressure Oil and Gas Skids</b> each with the following characteristics: <ul style="list-style-type: none"> <li>32.8 feet (10 m) long by 8.2 feet (2.5 m) wide by 19.7 feet (6 m) tall</li> <li>Weight: 33,069 pounds (15,000 kg) distributed equally over the footprint listed above</li> <li>Weight of single largest piece for installation shall be 33,069 pounds (15,000 kg)</li> <li>Electrical: 83 kW at 480 volts per skid</li> <li>CHW: none</li> <li>ICW: see T-121.06.03-D030</li> <li>Identifier: <b>FEQ-10</b></li> </ul>	See drawing A-2 for location of FEQ-10

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T-121.06.03-D015	F-121.06.03-A002	The WCS shall provide space for one (1) <b>Low Pressure Oil and Gas Skid</b> each with the following characteristics: <ul style="list-style-type: none"> <li>32.8 feet (10 m) long by 8.2 feet (2.5 m) wide by 19.7 feet (6 m) tall</li> <li>Weight: 33,069 pounds (15,000 kg) distributed equally over the footprint listed above</li> <li>Weight of single largest piece for installation shall be 33,069 pounds (15,000 kg)</li> <li>Electrical: 83 kW at 480 volts per skid</li> <li>CHW: none</li> <li>ICW: see T-121.06.03-D030</li> <li>Identifier: <b>FEQ-12</b></li> </ul>	See drawing A-2 for location of FEQ-12																																																																																																																											
T-121.06.03-D016	F-121.06.03-A002	The WCS shall provide space for one (1) <b>Sub Atmospheric Pressure Oil and Gas Skid</b> each with the following characteristics: <ul style="list-style-type: none"> <li>32.8 feet (10 m) long by 8.2 feet (2.5 m) wide by 19.7 feet (6 m) tall</li> <li>Weight: 33,069 pounds (15,000 kg) distributed equally over the footprint listed above</li> <li>Weight of single largest piece for installation shall be 33,069 pounds (15,000 kg)</li> <li>Electrical: 83 kW at 480 volts per skid</li> <li>CHW: none</li> <li>ICW: see T-121.06.03-D030</li> <li>Identifier: <b>FEQ-14</b></li> </ul>	See drawing A-2 for location of FEQ-14																																																																																																																											
T-121.06.03-D017	F-121.06.03-A002	The WCS shall provide space for one (1) <b>SP and LP Control Cabinet</b> with the following characteristics: <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: 2,200 pounds (1,000 kg) distributed equally over the footprint listed above</li> <li>Weight of single largest piece for installation shall be 2,200 pounds (1,000 kg)</li> <li>Electrical: 16 kw at 480 volts, 120V, 20A on UPS Back-up</li> <li>CHW: none</li> <li>ICW: none</li> <li>Identifier: <b>FEQ-19</b></li> </ul>	See drawing A-2 for location of FEQ-19																																																																																																																											
T-121.06.03-D018	F-121.06.03-A002	The WCS shall provide space for one (1) <b>High Pressure Control Cabinet</b> with the following characteristics: <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: 2,200 pounds (1,000 kg) distributed equally over the footprint listed above</li> <li>Weight of single largest piece for installation shall be 2,200 pounds (1,000 kg)</li> <li>Electrical: 120V, 20A on UPS Back-up</li> <li>CHW: none</li> <li>ICW: none</li> <li>Identifier: <b>FEQ-18</b></li> </ul>	See drawing A-2 for location of FEQ-18																																																																																																																											
T-121.06.03-D019	F-121.06.03-A002	The WCS shall provide space for one (1) <b>Inventory Control Manifold</b> with the following characteristics: <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: 1,000 pounds (455 kg) distributed equally over the footprint listed above</li> <li>Weight of single largest piece for installation shall be 1,000 pounds (455 kg)</li> <li>CHW: none</li> <li>ICW: none</li> <li>Identifier: <b>FEQ-07</b></li> </ul>	See drawing A-2 for location of FEQ-07																																																																																																																											
T-121.06.03-D020	F-121.06.03-A002	The WCS shall provide space for one (1) <b>Purifier Skid</b> with the following characteristics: <ul style="list-style-type: none"> <li>3.0 feet (0.9 m diameter by 9.8 feet (3.0 m) tall</li> <li>2,200 pounds (1,000 kg) distributed equally over the footprint listed above</li> <li>Weight of single largest piece for installation shall be 2,200 pounds (1,000 kg)</li> <li>Electrical: none</li> <li>CHW: none</li> <li>ICW: none</li> <li>Identifier: <b>FEQ-06</b></li> </ul>	See drawing A-2 for location of FEQ-06																																																																																																																											
T-121.06.03-D021	F-121.06.03-A002	The WCS shall provide space for two (2) <b>Air Compressor Systems</b> each with the following characteristics: <ul style="list-style-type: none"> <li>(2 qty) Air Compressor 125HP @ 112" L x 72" W x 80" H (each) <ul style="list-style-type: none"> <li>Each air compressor weight: 5,500 lbs</li> <li>Electrical 150 HP, 480V</li> <li>Design Basis: IR Rotary Screw R110ne, 780 cfm @ 100 psig</li> </ul> </li> <li>(2 qty) Desiccant Dryer @ 78" L x 59" W x 80" H each <ul style="list-style-type: none"> <li>Each Dryer weigh 3,767 lbs</li> <li>Electrical 115V</li> <li>Design Basis: IR Heatless Desiccant Dryer HB10000</li> </ul> </li> <li>(1) Oil Water separator 60 gallons capacity, 31" L x 35" W x 39" H,</li> <li>(1) Air Receiver Tank, 1,550-gallon capacity, 54" DIA x 166" H</li> </ul> <p>CHW: none ICW: 47-51 gpm each compressor; 50-115F supply temperature; ~13F delta T. Only one (1) air compressor/dryer will be operated at a time. Note: This equipment will be located in the building mechanical space and will provide compressed air to the WCS, CBS and LCW and Linac Complex.</p>	See drawing A-3 (FEQ-29 and FEQ-30) for equipment location in mechanical bay																																																																																																																											
T-121.06.03-D022	F-121.06.03-A002	The WCS shall have a heating and ventilation system capable of achieving the following parameters: <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>	Basis of Design Report includes operating parameters. See Mechanical, 2.B.b																																																																																																																											
T-121.06.03-D023	F-121.06.03-A002 F-121.06.03-A001	The WCS shall have a louvers, dampers and fans to accommodate ODH mitigation with the following capabilities: <ul style="list-style-type: none"> <li>Upper portion: 50,000 cfm</li> <li>Lower portion: 10,000 cfm</li> <li>Minimum 4 fans, see preliminary ODH Assessment (EN03241)</li> </ul>	Basis of Design Report includes operating parameters. See Mechanical, 4.A. See drawing M-4 for fan locations. See drawings M-2 and M-5 for louver locations. See drawing M-14 for fan schedule																																																																																																																											
T-121.06.03-D024	F-121.06.03-A002	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.	See E-15 and Basis of Design Report																																																																																																																											
T-121.06.03-D025	F-121.06.03-A002	The WCS shall include 480V, 60-amp welding receptacles sized and located to accommodate standard Fermilab welding machines and cord lengths.	Spaced at 80' to accommodate a 40' cord as shown on E-4																																																																																																																											
T-121.06.03-D026	F-121.06.03-A002	The WCS shall include one (1) 120V, 20-amp receptacle at each column line.	See E-4																																																																																																																											
T-121.06.03-D027	F-121.06.03-A002	The CBS shall include one (1) 120V, 20-amp receptacle at each column line.	See E-4																																																																																																																											
T-121.06.03-D028	F-121.06.03-A002	The WCS shall be provided with general lighting to achieve an average of 30 foot-candles.	Lighting design provides average of 40.2 fc. See Lighting Calculations																																																																																																																											
T-121.06.03-D029	F-121.06.03-A002 F-121.06.03-A003	The WCS shall be acoustically isolated from the Cold Box Station.	Seperation wall is shown on A-2. Wall properties are shown on A-46 (Type M)																																																																																																																											
T-121.06.03-D030	F-121.06.03-A002	The ICW for the WCS shall meet the following characteristics: <i>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.</i> <table border="1" data-bbox="554 2470 1038 2905"> <thead> <tr> <th rowspan="2">Description</th> <th rowspan="2">Unit</th> <th colspan="2">Vendor 1</th> <th>Vendor 2</th> </tr> <tr> <th>Open loop</th> <th></th> <th></th> </tr> </thead> <tbody> <tr> <td>Electrical conductivity</td> <td>[µS/cm]</td> <td>400-800</td> <td></td> <td>10 - 500</td> </tr> <tr> <td>pH value</td> <td></td> <td>8.3 - 9.0</td> <td></td> <td>7.5 - 9.0</td> </tr> <tr> <td>m-alkalinity</td> <td>meq/l</td> <td>2.0 - 4.0</td> <td></td> <td></td> </tr> <tr> <td>Calcium</td> <td>mg/l</td> <td>30 - 60</td> <td></td> <td></td> </tr> <tr> <td>Chloride (Cl)</td> <td>[mg/l]</td> <td>&lt; 50</td> <td></td> <td>&lt; 150</td> </tr> <tr> <td>Sulphate (SO<sub>4</sub>)</td> <td>[mg/l]</td> <td>&lt; 100</td> <td></td> <td></td> </tr> <tr> <td>Ammonium (NH<sub>4</sub>)</td> <td>[mg/l]</td> <td>&lt; 5</td> <td></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> <td></td> </tr> <tr> <td>Suspended Solids</td> <td>mg/l</td> <td>&lt; 5</td> <td></td> <td></td> </tr> <tr> <td>COD (chemical oxygen demand)</td> <td>mg/l</td> <td>&lt;20</td> <td></td> <td></td> </tr> <tr> <td>Solids (particle size)</td> <td>mm</td> <td>&lt; 0.1</td> <td></td> <td>&lt; 0.1</td> </tr> <tr> <td>Antifreeze/Glycol</td> <td>%</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></td> <td>&lt; 1.0</td> </tr> <tr> <td>Sulphate (SO<sub>3</sub>)</td> <td>mg/l</td> <td></td> <td></td> <td>&lt; 1.0</td> </tr> <tr> <td>Dissolved iron (Fe)</td> <td>[mg/l]</td> <td></td> <td></td> <td>&lt; 0.2</td> </tr> <tr> <td>Hydrogen Carbonate (HC03)</td> <td>mg/l</td> <td></td> <td></td> <td>70 - 300</td> </tr> <tr> <td>HC03 / SO<sub>4</sub></td> <td></td> <td></td> <td></td> <td>&gt; 1.0</td> </tr> <tr> <td>Dissolved manganese (Mn)</td> <td>[mg/l]</td> <td></td> <td></td> <td>&lt; 0.1</td> </tr> <tr> <td>Dissolved aluminum (AL)</td> <td>mg/l</td> <td></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></td> <td>&lt; 100</td> </tr> <tr> <td>Hydrogen Sulfate (H<sub>2</sub>S)</td> <td>mg/l</td> <td></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></td> <td>&lt; 5.0</td> </tr> <tr> <td>Algae</td> <td></td> <td></td> <td></td> <td>0</td> </tr> </tbody> </table>	Description	Unit	Vendor 1		Vendor 2	Open loop			Electrical conductivity	[µS/cm]	400-800		10 - 500	pH value		8.3 - 9.0		7.5 - 9.0	m-alkalinity	meq/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 Solids	mg/l	< 5			COD (chemical oxygen demand)	mg/l	<20			Solids (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 (HC03)	mg/l			70 - 300	HC03 / 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	See PIP-II-doc-155 for results of ICW quality testing
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## Requirements vs. Design Comparison

WBS: 121.06.03 - Cryo Plant Building  
Source: Technical Requirements Specification (ED0006719), VC

Requirement ID	FRS Reference	Requirement Statement	Response
T-121.06.03-D031	F-121.06.03-A002	The ventilation system in the WCS shall be designed to accommodate a combined 200 kW of heat load rejected to air.	Trace Calculation Room Input Page 15
T-121.06.03-D032	F-121.06.03-A002	Industrial Cooling Water (ICW): <ul style="list-style-type: none"> <li>1438 gpm (required) but pipe sized for 2000 gpm.</li> <li>Maximum 18F C delta T; 43-145 psi supply pressure, 36-88 F supply temperature</li> </ul>	Basis of Design, Item 4.3 page 18
T-121.06.03-D033	F-121.06.03-A002	The WCS shall include cable tray at the perimeter of the building from the network room. The cable tray will include space for a 4"x4" plastic tray with cover (Panduit FR4X4BL6) to be installed by Fermilab	Cable tray is shown on T-3
<b>Support Space</b>			
T-121.06.03-E001	F-121.06.03-A006	The Support Space (SS) shall provide space/infrastructure for a <b>Commissioning Space</b> that will accommodate four (4) work stations, monitors and related equipment.	Space for four (4) work station Commissioning Space is shown on drawing A-57. Furniture is additive option 04
T-121.06.03-E002	F-121.06.03-A006	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. If needed, this space can be provided in a future phase.	Space for eight (8) person team room is shown on drawing A-57. Furniture is additive option 04
T-121.06.03-E003	F-121.06.03-A006	The SS shall provide space/infrastructure for <b>Open Office Space</b> with cubicles to house four (4) people and associated spaces.	Space for four (4) open office cubicles shown on drawing A-57. Furniture is additive option 04
T-121.06.03-E004	F-121.06.03-A006	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 (~24" wide x 48" long x 96" high)</li> <li>Two (2) 42 "U" Cryogenics specific networking racks (~24" wide x 48" long x 96" high)</li> <li>Each networking rack above 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>One (1) ODH Control Rack (24" wide x 48" long x 96" high) with one (1) 20-amp 120V circuit (this will feed a power strip mounted on the rack. This rack must be located on the end of the row to allow for end access</li> <li>One (1) Data Acquisition Rack (24" wide x 32" long x 96" high) with one (1) 20-amp 120 V circuit fed from generator backed UPS power for each rack.</li> <li>The racks and equipment shall have access to a grounding bar connected to the overall building ground.</li> </ul>	Main Network Room is shown on drawing A-43. Space is provided for racks noted is shown on A-43. Electrical is shown on E-6.
T-121.06.03-E005	F-121.06.03-A006	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	Lighting design provides average of 47.2 fc in Commissioning Space, 47.5 in Open Office and Team Room. See Lighting Calculations
T-121.06.03-E006	F-121.06.03-A006	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>	Basis of Design Report includes operating parameters. See Mechanical, 2.B.c
T-121.06.03-E007	F-121.06.03-A003 F-121.06.03-A006 F-121.06.03-A001	The CBS shall have an HVAC system that can pressurize the space to reduce the oxygen deficiency hazard of the space relative to other portions of the CPB.	Basis of Design Report includes operating parameters. See Mechanical, 2.C
<b>Exterior Space</b>			
T-121.06.03-F001	F-121.06.03-A003	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. Identifier: <b>FEQ-22</b>	Space for seven (7) tanks shown on drawings C-7, SC-1, SC-3, SC-7, A-1, and A-3
T-121.06.03-F002	F-121.06.03-A003	The ES shall provide space for standard garbage and recycling containers.	Concrete pad east of Warm Compressor Station and south of overhead door. See drawings C-7, SC-2, A-2
T-121.06.03-F003	F-121.06.03-A003	The ES shall provide space and foundation for one (1) 34,000-liter (9,000 gallon) liquid nitrogen Dewar, fill station and related piping. Identifier: <b>FEQ-20</b>	Dewar foundation is east of Warm Compressor Station. See drawing C-7, A-2 and A-3
T-121.06.03-F004	F-121.06.03-A003	The ES shall provide space for one (1) trailer mounted mobile purifier. Identifier: <b>FEQ-24</b>	Trailer parking space north of gaseous helium storage tanks. See drawing C-7
T-121.06.03-F005	F-121.06.03-A003	The ES shall provide parking for one (1) tube trailer.	Trailer parking space north of gaseous helium storage tanks. See drawing C-7
T-121.06.03-F006	F-121.06.03-A003	The ES shall provide space for maneuvering of standard 55-foot-long semi-trailers and nitrogen deliveries.	See drawing C-7
T-121.06.03-F007	F-121.06.03-A001	The ES shall provide parking spaces for minimum of eight (8) vehicles.	33 parking spots provided in base scope. Additional 22 provided in Option 10. See drawing C-7
T-121.06.03-F008	F-121.06.03-A001	The ES shall be provided with general lighting to achieve an average of 2 foot-candles.	Lighting design provides 1.4 to 3.4 fc at the exterior of the building. See Lighting Calculations