21 (6.2.J.02) Cryoplant Coldbox Building and Poloidal Field Coil Fabrication Building #1

21.A Poloidal Field (PF) Coil Fabrication Building #1

21.A1 Functions, Basic Configuration, and Interfaces

21.A1.1 Functions

The PF coil fabrication building #1 is dedicated to industrial manufacturing processes associated with the on-site construction of the ITER poloidal field coils PF3 & PF4. Large circular PF coils are required, finished diameter about 25 m, and weighing up to 385 t. Compared to the PF coils, the correction coils consist of fewer turns of conductor, and have compound curvature, or "saddle" shapes.

The building provides space for worker accommodation in the form of offices, lavatories, and a rest room. The building provides some general services such as HVAC, lighting, power, drainage, fluids, and lifting capability. The following sections describe the functions of the building in more detail.

21.A1.1.1 Accommodate Materials and Equipment

The PF coil fabrication building #1 provides support and space for the equipment and operations which are assigned to this structure and include the following:

- potable and fire water service
- hot water service
- chilled water
- low pressure steam distribution
- compressed air
- electrical load distribution
- parts storage for operations

21.A1.1.2 Protect Materials and Equipment from External Hazards

The building provides the resistance for anticipated wind, snow, and other environmental loads. The building also provides protection against extremes in temperature and humidity as dictated by the fabrication process and worker health and safety. The building isolates the materials, equipment and coils from dirt, debris, and other contaminants, which may be present at the construction site that could interfere with fabrication or degrade the finished coil.

21.A1.1.3 Provide Required Building Services

The PF coil fabrication building # 1 provides internal distribution of services provided by the site such as potable water, steam, cooling fluids, low and medium-voltage electricity for service and welding requirements, grounding (earthing) connections, compressed air for services and instruments, and fire fighting water. It also provides collection of rain water and floor drainage, which are discharged to site-wide disposal systems. Self-contained building

systems including access control, lighting, fire detection and alarms, and communications. Design requirements for each of these aspects are described in section 21.A2.1.

21.A1.1.4 Provide Heating, Ventilation, and Air Conditioning (HVAC)

The building provides air quality sufficient to meet the requirements set by the systems and functions located within the building. All of these systems and functions are non-safety importance class (non-SIC), therefore these requirements can be met by using conventional HVAC equipment.

During assembly of the PF coils, the building atmospheric environment will be maintained within specifications for the coils. The PF coil fabrication building HVAC systems provide heat, ventilation, and cooling to all building areas. These systems maintain a relative positive pressure within the building to minimise inleakage and associated dust. The large, open bays in the building will be equipped with wall- or ceiling-mounted, un-ducted air handling units. These air handling units will be augmented with bi-directional roof-mounted fans. The worker-occupied region will be served with a ducted system capable of providing two to three air changes per hour, and maintaining temperature and humidity within human comfort zones. Air exchanges are consistent with the building occupancy and internal processes. The HVAC system is connected to the site steam and chilled water services.

21.A1.2 Basic Configuration

The PF coil fabrication building is a single-level structure with a space for mechanical and electrical services. The building footprint is sufficient to provide for the fabrication of one large coil. The height of the building is controlled by the height of the winding operation plus room for pancake and module handling tools, crane, and roof truss depth. The foundation of the building is set below grade so that the finished floor level matches the paved grade level at the entrances to the building.

All coils manufactured on site will be made using niobium-titanium (NbTi) conductor. This conductor will be manufactured off-site and delivered to the site wound on drums 5 m in diameter. In addition to the superconductor, a structural "jacket" or support piece is required. This piece is also manufactured off-site and delivered as straight sections or wound on drums. The jacket has two halves, which, when joined by welding, form a square cross-section with an interior hole matching the diameter of the superconductor. The conductor and jacket are formed using rollers, joined together, and bent to the correct curvature for the coil. Each PF coil consists of a number of "pancakes". Each pancake consists of single piece of conductor, wound into two layers, so that the ends of the conductor are at the outside of the coil. Several pancakes are stacked together to form a module, and several modules are stacked together to form a finished coil. The tools, jigs, and winding fixtures needed for the largest coil determine the space requirements for the building. The heaviest module determines the crane capacity. The manufacturing process involves the application of epoxy insulating and bonding materials, vacuum impregnation steps, and preparation of conductor joints. The process requires cleanliness, lighting, and environmental control, which are similar to aircraft manufacture.

After the coil fabrication campaign, the PF coil fabrication building #1 will be converted to the cryoplant coldbox building.

21.A1.3 Interfaces

The PF coil fabrication building #1 has interfaces with the following WBS elements:

WBS	Title
1.1 - 1.3	Magnet System
2.6.P	Chilled Water Systems
4.3.C	Steady State Electrical Power Distribution
4.5	CODAC
4.6.C	Access Control
6.1.A	Site General Layout
6.2.S	Utility Tunnels & Site Improvements
6.5.C	Potable & Fire Water
6.5.D	Sewage (Sanitary & Industrial)
6.5.E	Steam/Condensate/Demineralized Water
6.6.A	Compressed Air
6.6.C	Nitrogen, Helium, etc.

21.A2 Requirements

21.A2.1 Design

The requirements for the PF coil fabrication building #1 are derived from the systems within the building, and from the functions of the building. The primary functions performed by the building are to house, support, protect, provide a suitable environment, and to provide and control access to the materials, equipment and processes, which are located inside the building. The requirements below are not complete because equipment designers continue to provide new interface information. However, these requirements shall control the overall configuration and general design concept of the building.

21.A2.1.1 General

21.A2.1.1.1 PF Coils

The building shall accommodate the fabrication materials and the finished PF which will be fabricated in this building. The fabrication building provides the storage of the last two finished PF coils. The finished PF coils except the last two coils shall be stored in the tokamak building or outdoors in a protected environment.

21.A2.1.1.2 Systems and Components for Coil Fabrication

The building shall accommodate the equipment and systems which are used to fabricate the PF coils. For example, layer winding system, inspection system, insulation system, and so on.

21.A2.1.1.3 Coil Transporter

The building shall accommodate the coil transporter to move the coils from the building in which they are fabricated to the tokamak assembly area. The transportation of all coils will be accomplished with the conductors in a horizontal orientation using multi-wheeled carriers.

21.A2.1.1.4 Access, Maintenance, and Parts Storage Space

The building shall provide space for normal maintenance and parts storage, and good access to all equipment within the building is needed. The building shall provide large aisles and doors for the transport of large objects (for parts storage and waste handling) by truck.

21.A2.1.2 Seismic

The PF coil fabrication building #1 will be non-SIC and shall withstand SL-0 seismic conditions with peak horizontal and vertical accelerations as specified in the PDS, or UBC and industrial health and safety requirements, which provide for a minimum of 0.05 g horizontal seismic force.

21.A2.1.3 Structural

21.A2.1.3.1 Component Support

The building shall support its own weight as well as the weight of all installed equipment in the building.

21.A2.1.3.2 Live Loads

The structure shall support the weight and forces of all movable and active equipment, systems, and structures located on the slabs.

21.A2.1.3.3 Lifting and Materials Handling Devices

The buildings shall support the weight and forces of all lifted loads, including the lifting devices over the full range of their travel. Structural deflection under such loading shall be consistent with the required precision of the lifting devices.

21.A2.1.3.4 Thermal Loads

The structure shall either resist stress induced by expansion and contraction due to changes between the as-built temperature and the maximum expected structure temperature excursions, or allow movement through the use of expansion joints.

21.A2.1.3.5 Wind Loads

The PF coil fabrication building #1 shall withstand horizontal wind conditions of up to 140 km/h defined at 10 m above grade.

21.A2.1.3.6 Snow Loads

The PF coil fabrication building #1 shall withstand snow loading conditions of up to 300 kg/m^2.

21.A2.1.4 Construction

After the coil fabrication campaign, the PF coil fabrication building will be converted to the cryoplant coldbox building.

21.A2.1.5 Assembly

Apart from the requirement to produce the PF coils for assembly, and to provide a path for delivery of them to the assembly staging area, there are no further assembly requirements.

21.A2.1.6 Electrical

21.A2.1.6.1 Lighting

The building shall be equipped with normal and emergency lighting. Lighting standards to be applied will be similar to those used for industrial process plants.

21.A2.1.6.2 Electrical Services

The building shall provide low-voltage (~ 100 - 230 V and ~ 400 V welding power) electrical services to all areas of the building where needs for these are anticipated. Service outlets will be provided approximately every 15 m along the north and south edges of the building.

21.A2.1.6.3 Grounding

The building shall have an electrical grounding grid with connections to the plant-wide grounding grid network, and shall have robust grounding terminals at specified locations inside the building.

21.A2.1.6.4 Lightning Protection

The building shall have lightning protection systems with connection to specified grounding grid terminals.

21.A2.1.7 Potable Water and Drainage

The building shall provide potable water and sanitary drainage systems for offices, drinking fountains and lavatories. Shower facilities will not be included in the building, but will be provided by use of temporary support buildings or trailers, which will supply additional lavatory services for the PF coil construction forces.

21.A2.1.8 HVAC

It is expected that the PF coil manufacturing process will require temperature control to

23 ± 3°C from 0 to 3 m above the building floor, low humidity (40% max), and control of dust. These conditions will not need to persist when the large doors are opened. The HVAC system should recirculate air to provide at least 3 air changes per hour. Fresh air will be added to the building to maintain a positive relative pressure. Intake air will be filtered, dehumidified, and heated or cooled to match building conditions. At least two HVAC trains shall be provided to assure that conditions can be maintained during maintenance activities on HVAC components. Areas dedicated to full time worker occupation (offices, lavatories, shop, etc.) shall be equipped to maintain temperatures at 22 ± 5°C. Relative humidity in these areas shall be maintained below 85% and particulate matter will be filtered. The remainder of the PF coil fabrication building #1 shall be equipped with roof-mounted exhaust ventilation fans that provide a minimum of 1 air change per hour. It shall also be equipped with distributed space heaters suitable to prevent the minimum temperature from going below 10°C.

21.A2.1.9 Fire Protection

The building shall provide fire detection, alarm, and mitigation systems commensurate with the occupancy and fire risk loading of the building.

21.A2.1.10 Internal Communication

The building shall provide an internal communication system, including distribution of telephone connections, a public address system, and appropriate warning systems (plant emergency, crane movement, fire, etc.). Telephone access points will be provided with noise shields where necessary.

21.A2.1.11 Access Control

The PF coil fabrication building #1 will not contain any safety-related systems or equipment, nor any radiological exposure hazards. Entry conditions are not affected by the operating state of the tokamak or any other plant systems. Furthermore, it will be equipped with truck doors. However, it shall be provided with worker access control on all entrances. Access control shall consist of local barriers equipped with access control devices, and shall provide an inventory of all staff within the building (in case of emergency).

21.A2.1.12 Materials

21.A2.1.12.1 Structural

There are no special requirements for construction materials. The building foundation will be a cast-in-place reinforced concrete mat, locally thickened to provide stiffness and point load bearing, and the superstructure will be prefabricated structural steel. Siding and roofing will be metallic, with integral insulation where appropriate. The building roof structure will be flat, with built-up insulation material to provide local slopes to drainage points.

21.A2.1.12.2 Electrical

All cables will be made with copper and should have appropriate insulation level according to nominal voltage of equipment to be supplied. Cable insulation should meet the following

requirements:

- insulation material XLPE preferred, PVC not accepted;
- max. permissible temperature of conductor:
  - continuous 90°C,
  - under short circuit conditions 250°C;
- acid gas content zero halogen, according to IEC-754;
- fire retardancy according to IEC-332-3

Table 21 (6.2.J.02) -1 IEC Relevant Material

IEC #	Technical Committee	Title
332-1 to 3	SC 20C	Test on electric cables under fire conditions
728	SC 12G	Cable distribution systems
754	SC 20C	Tests on gases involved during combustion of electric cables
840	SC 20A	Test on electric cables 30 kV to 150 kV

21.A2.1.13 Cranes, Lifts and Materials Handling

The building shall provide one bridge crane with main hook capacity of 50 t, with coverage adequate to serve the entire coil fabrication area and parts storage areas. The crane shall provide 3 degrees of motion (x, y, z) and provide positional repeatability to 15 mm. Grade access at both ends and various points along the side of the building must be suitable for the entry of trucks and other mobile equipment. The building doors shall provide 10 m vertical clearance to allow conventional highway trucks to pass.

21.A2.1.14 Instrumentation and Control

Building systems, including HVAC and any other subsystems which have actively controlled components shall comply with ITER plant standards for control and communication protocols, and shall provide appropriate interfaces to CODAC system.

21.A2.2 Operation and Maintenance

The operation and maintenance (O&M) requirements for the PF coil fabrication building #1 are derived from the systems which occupy the building, and from the functions of the building.

21.A2.2.1 Operation and Control of Building Services

Building service systems shall incorporate instrumentation and control to manage system operation. Manual control over lighting, power distribution, large doors, and fluid supply is expected to be adequate. Manual control with safety interlocks will be provided for building cranes and lifting devices. Automatic controls with manual override capability will be installed for the operation of HVAC and fire detection, alarm, and suppression systems.

Operation and control of building systems will be centralised in building control panels located within the building. Status of building systems will be provided to the CODAC system. However, no PF coil fabrication building #1 support systems will be directly controlled from the ITER main control room.

21.A2.2.2 Maintenance of Building Services

There are no specific building system maintenance requirements apart from periodic inspection and repair or system correction during or after these inspection periods. Operation of most systems may be interrupted for maintenance activities.

21.A2.3 Surveillance and In-Service Inspection

There are no surveillance and in-service inspection requirements for the building apart from usual, annual, visual inspections of the building for noting the status of the overall condition, and for monitoring for any deterioration. In addition, there may be legal inspections for some of the building service equipment such as lifts, and the fire detection, alarm, and suppression systems.

The PF coil fabrication building #1 will be painted and provided with passive corrosion protection features (galvanising) where appropriate to assure that the design life of the structure is at least 30 years, the expected combination of ITER construction and operating periods.

21.A2.4 Quality Assurance (QA)

There are no QA requirements for the PF coil fabrication building #1 beyond those established by the “Uniform Building Code” (or equivalent).

21.A2.5 Reliability Assurance

There are no special reliability requirements for the PF coil fabrication building #1 structure. Building systems shall be designed to meet all functional requirements with the lowest overall lifetime cost, including effects of unavailability and cost of maintenance and repair.

21.A2.5.1 HVAC Components and Equipment

HVAC components and equipment shall be designed, procured, and installed in accordance with industrial codes and standards. There are no additional reliability assurance requirements.

21.A2.5.2 Lifting Equipment

Cranes and lifting devices shall comply with classification system, design practices, and safety factors established by the crane manufacturers associations of America (CMAA), or equivalent. The usage of the PF coil fabrication building #1 cranes will be "class D - heavy service use".

21.A3 Codes and Standards

The PF coil fabrication building #1 shall be designed in accordance with the 1994 uniform building code (or equivalent). Good engineering practice, as expressed in the "Ninth Edition of the American Institute of Steel Construction (AISC) Manual of Steel Construction", shall also be employed.

21.B Cryoplant Coldbox Building

21.B1 Functions, Basic Configuration, and Interfaces

21.B1.1 Functions

After the coil fabrication campaign, the PF coil fabrication building will be converted to the cryoplant coldbox building.

The cryoplant coldbox building is dedicated to the refrigeration-liquefaction part of the ITER cryoplant equipment and contains cold process boxes of the LHe plant, subsystem, helium loop of 80K tokamak thermal shields and external helium purification unit.

The primary functions performed by the building are to house, support, protect, provide a suitable environment, and to provide and control access to the materials, equipment and processes, which are located inside the building.

The building includes space for worker accommodation in the form of offices, lavatories, and a rest room. The building provides some general services such as HVAC, lighting, power, drainage, fluids, and lifting capability. The following sections describe the functions of the building in more detail.

21.B1.1.1 Accommodate Materials and Equipment

The cryoplant coldbox building provides support and space for the equipment and operations which are assigned to this structure and include the following:

- potable and fire water service
- hot water service
- chilled water
- low pressure steam distribution
- compressed air
- electrical load distribution
- parts storage for operations

21.B1.1.2 Protect Materials and Equipment from External Hazards

The building provides the resistance for anticipated wind, snow, and other environmental loads. The building also provides protection against extremes in temperature and humidity as dictated by the fabrication process and worker health and safety. The building isolates the materials, equipment and coils from dirt, debris, and other contaminants, which may be present at the construction site that could interfere with fabrication or degrade the finished coil. The building also must resist seismic loads (UBC requirements – section 21.B2.1.2).

21.B1.1.3 Provide Required Building Services

The cryoplant coldbox building provides internal distribution of services provided by the site such as potable water, steam, cooling fluids, low and medium-voltage electricity for service and welding requirements, grounding (earthing) connections, compressed air for services and instruments, and fire fighting water. It also provides collection of rain water and floor drainage, which are discharged to site-wide disposal systems. Self-contained building systems including access control, lighting, fire detection and alarms, and communications. Design requirements for each of these aspects are described in section 21.B.2.

21.B1.1.4 Provide Heating, Ventilation, and Air Conditioning (HVAC)

The building provide air quality sufficient to meet the requirements set by the systems and functions located within the building. All of these systems and functions are non-safety importance class (non-SIC), therefore these requirements can be met by using conventional HVAC equipment.

The cryoplant cold box building HVAC system provides heat, ventilation, and cooling to all building areas except the mechanical equipment room. The large, open bays in the building will be equipped with wall- or ceiling-mounted, un-ducted air handling units. These air handling units will be augmented with bi-directional roof-mounted fans. The worker-occupied region will be served with a ducted system capable of providing two to three air changes per hour, and maintaining temperature and humidity within human comfort zones. Air exchanges are consistent with the building occupancy and internal processes. The HVAC system connects to the site steam and chilled water services.

21.B1.2 Basic Configuration

The cryoplant coldbox building is a single-level structure with clear span. The building provides space for process equipment and is serviced by an overhead main 50 t bridge crane and a 5 t bridge sub-crane, suitable for servicing and assembly and disassembly of the helium coldboxes. To maintain stability, the crane columns are built-up with an effective width of 2.5 m, resulting in 35 m between crane rails. The maximum hook height for the crane is 18 m. The east-west aisle is used for interior truck access and routing of services, both overhead and in a below-grade utility trench. Large doors are provided at one end of the building.

The space for mechanical and electrical services, parts storage and personnel areas such as local control room, offices, lavatory, and other worker support functions will be provides at the east end of building.

Additional cryoplant equipment, includes helium storage tanks located in the main tokamak building, and LHe-LN2 tanks and large He storage, which are located outdoors.

The foundation of the building is set below grade so that the finished floor level matches the paved grade level at the entrances to the building.

The cold process boxes contain series of counter flow regenerative heat exchanges, cold

turbines and valves. The streams of compressed helium and nitrogen supply these cold boxes from the cryoplant compressor building.

21.B1.3 Interfaces

The cryoplant coldbox building has interfaces with the following WBS elements:

WBS	Title
2.6.O	Component Cooling System
2.6.P	Chilled Water Systems
3.4	Cryoplant and Cryodistribution
4.3.C	Steady State Electrical Power Distribution
4.5	CODAC
4.6.C	Access Control
6.1.A	Site General Layout
6.2.S	Utility Tunnels & Site Improvements
6.5.C	Potable & Fire Water
6.5.D	Sewage (Sanitary & Industrial)
6.5.E	Steam/Condensate/Demineralized Water
6.6.A	Compressed Air
6.6.C	Nitrogen, Helium, etc.

21.B2 Requirements

21.B2.1 Design

The requirements for the cryoplant coldbox building are derived from the systems within the building, and from the functions of the building. The requirements below are not complete because equipment designers continue to provide new interface information. However, these requirements shall control the overall configuration and general design concept of the building.

21.B2.1.1 General

21.B2.1.1.1 Pre-Cooling Heat Exchanger

The cryoplant coldbox building shall accommodate the pre-cooling heat exchangers for the compressors.

21.B2.1.1.2 Helium Coldboxes

The cryoplant cold box building shall accommodate a set of helium coldboxes which contain the helium refrigerators and other related equipment.

21.B2.1.1.3 Helium Purification System

The cryoplant coldbox building shall accommodate the equipment and system for helium purification.

21.B2.1.1.4 Compressed Air Station

The cryoplant coldbox building shall provide space for a compressed air station.

21.B2.1.1.5 Access, Maintenance, and Parts Storage Space

The building shall provide space for normal maintenance and parts storage, as well as good access to all equipment within the building. Parts storage will involve transport of heavy objects by truck, hence large aisles and doors are needed.

21.B2.1.1.6 Outdoor area

The building area shall allow for the 80K He quench tank, warm low pressure helium storage tanks, LN2 storage tanks, He gas heaters storage tanks.

21.B2.1.2 Seismic

The cryoplant coldbox building shall be non-SIC and shall withstand SL-0 seismic conditions with peak horizontal and vertical accelerations as specified in the PDS.

21.B2.1.3 Structural

21.B2.1.3.1 Component Support

The building shall support its own weight as well as the weight of all installed equipment in the building.

21.B2.1.3.2 Live Loads

The structure shall support the weight and forces of all movable and active equipment, systems, and structures located on the slabs.

21.B2.1.3.3 Lifting and Materials Handling Devices

The buildings shall support the weight and forces of all lifted loads, including the lifting devices over the full range of their travel. Structural deflection under such loading must be consistent with the required precision of the lifting devices.

21.B2.1.3.4 Thermal Loads

The structure shall either resist stress induced by expansion and contraction due to changes between the as-built temperature and the maximum expected structure temperature excursions, or allow movement through the use of expansion joints.

21.B2.1.3.5 Wind Loads

The cryoplant coldbox building shall withstand horizontal wind conditions of up to 140 km/h defined at 10 m above grade.

21.B2.1.3.6 Snow Loads

The cryoplant coldbox building shall withstand snow loading conditions of up to 300 kg/m^2.

21.B2.1.4 Electrical

21.B2.1.4.1 Lighting

The building shall be equipped with normal and emergency lighting. Lighting standards to be applied will be similar to those used for industrial process plants.

21.B2.1.4.2 Electrical Services

The building shall provide low-voltage (~ 100 - 230 V and ~ 400 V welding power) electrical services to all areas of the building where needs for these are anticipated.

21.B2.1.4.3 Grounding

The cryoplant coldbox building shall have an electrical grounding grid with connections to the grounding grids from plant-wide network and with robust grounding terminals at electrical service power outlet locations inside the building.

21.B2.1.4.4 Lightning Protection

The building shall have lightning protection systems with connection to specified grounding terminals.

21.B2.1.5 Potable Water and Drainage

The building shall provide potable water and sanitary drainage systems for lavatory and drinking fountains.

21.B2.1.6 HVAC

The cryoplant coldbox building shall be equipped with two separate types of HVAC service.

The worker-occupied control areas (offices, lavatories, shop, etc.) shall be served with a ducted system capable of providing three air changes per hour, and maintaining temperature at 22 ± 5°C and humidity below 85% within human comfort zones. Fresh air shall be added to recirculation systems at a rate equal to about 30% of the recirculation rate to maintain a positive relative pressure. Fresh air shall be filtered and heated or cooled to match zone conditions.

The large, open bays in the cryoplant coldbox building shall be equipped with ceiling-mounted, unducted air handling units, able to heat or cool the building over a range suitable for the processes contained in the building. These unducted air handling units shall be augmented with bi-directional roof-mounted fans to provide air refreshment at a rate of approximately 0.5 air changes per hour. Additional temporary clean zones will be established during the disassembly of delicate machinery such as turbo-expanders. This

activity will take place in the maintenance laydown area and be restricted to a local region for the device under maintenance.

The remainder of the cryoplant coldbox building shall be equipped with roof-mounted exhaust ventilation fans that provide a minimum of 1 air change per hour. It shall also be equipped with distributed space heaters suitable to prevent the minimum temperature from going below 10°C.

21.B2.1.7 Fire Protection

The building shall provide fire detection, alarm, and mitigation systems commensurate with the occupancy and fire risk loading of the building.

21.B2.1.8 Internal Communication

The building shall provide an internal communication system, including distribution of telephone connections, a public address system, and appropriate warning systems (plant emergency, crane movement, fire, etc.). Telephone access points will be provided with noise shields where necessary.

21.B2.1.9 Access Control

The cryoplant coldbox building will not contain any safety related systems or equipment, nor any radiological exposure hazards. The building shall provide access control to prevent unauthorized entry and to prevent worker exposure to electrical and other hazards. Access control will be accomplished through the use of badges, or other identification, which must be read by installed equipment to allow doors to be opened. The system will provide for automatic tracking of the individuals and total number of workers within each controlled space. In addition, some areas will be fenced or otherwise controlled within the cryoplant buildings. Interior barriers will be locked and door status alarmed.

21.B2.1.10 Materials

21.B2.1.10.1 Structural

There are no special requirements for construction materials. The building foundation will be a cast-in-place reinforced concrete mat, locally thickened to provide stiffness and point load bearing, and the superstructure will be prefabricated structural steel. Siding and roofing will be metallic, with integral insulation where appropriate. The building roof structure will be flat, with built-up insulation material to provide local slopes to drainage points.

21.B2.1.10.2 Electrical

All cables will be made with copper and should have appropriate insulation level according to the nominal voltage of equipment to be supplied. Cable insulation should meet the following requirements:

- insulation material XLPE preferred, PVC not accepted;
- max. permissible temperature of conductor:

- continuous 90°C,
- under short circuit conditions 250°C;

· acid gas content zero halogen, according to IEC-754;
· fire retardancy according to IEC-332-3

Table 21 (6.2.J.02) -2 IEC Relevant Material

IEC #	Technical Committee	Title
332-1 to 3	SC 20C	Test on electric cables under fire conditions
728	SC 12G	Cable distribution systems
754	SC 20C	Tests on gases involved during combustion of electric cables
840	SC 20A	Test on electric cables 30 kV to 150 kV

21.B2.1.11 Cranes, Lifts and Materials Handling

The building shall provide one bridge crane with main hook capacity of 50 t, with coverage adequate to serve the entire cold box area and parts storage areas. Grade access at both ends and various points along the side of the building shall be suitable for the entry and operation of trucks and other mobile equipment. The building doors shall provide 10 m vertical clearance to allow conventional highway trucks to pass.

21.B2.1.12 Instrumentation and Control

Building systems, including HVAC and any other subsystems which have actively controlled components shall comply with ITER plant standards for control and communication protocols, and shall provide appropriate interfaces to the CODAC system.

21.B2.2 Operation and Maintenance

The operation and maintenance (O&M) requirements for the cryoplant cold box building are derived from the systems which occupy the building, and from the functions of the building.

21.B2.2.1 Operation and Control of Building Services

Building service systems shall incorporate instrumentation and control to manage system operation. Manual control over lighting, power distribution, large doors, and fluid supply is expected to be adequate. Manual control with safety interlocks will be provided for building cranes and lifting devices. Automatic controls with manual override capability will be installed for the operation of HVAC and fire alarm and suppression systems. Operation and control of building systems will be centralized in building control panels located within the building. Status of building systems will be provided to the CODAC system. However, no cryoplant cold box building support systems will be directly controlled from the ITER main control room.

21.B2.2.2 Maintenance of Building Services

There are no specific building system maintenance requirements apart from periodic inspection and repair or system correction during or after these inspection periods. Operation of most systems may be interrupted for maintenance activities.

21.B2.3 Surveillance and In-Service Inspection

There are no surveillance and in-service inspection requirements for the building apart from usual, annual, visual inspections of the building for noting the status of the overall condition, and for monitoring for any deterioration. In addition, there may be legal inspections for some of the building service equipment such as cranes, lifts, and the fire detection, alarm, and suppression systems.

The cryoplant coldbox building will be painted and provided with passive corrosion protection features (galvanising) where appropriate to assure that the design life of the structure is at least 30 years, the expected combination of ITER construction and operating periods.

21.B2.4 Quality Assurance (QA)

There are no QA requirements for the cryoplant coldbox building beyond those established by the uniform building code (or equivalent).

21.B2.5 Reliability Assurance

There are no reliability assurance requirements for the cryoplant coldbox building structure. Building systems shall be designed to meet all functional requirements with the lowest overall lifetime cost, including effects of unavailability and cost of maintenance and repair.

21.B2.5.1 HVAC Components and Equipment

HVAC components and equipment shall be designed, procured, and installed in accordance with industrial codes and standards. There are no additional reliability assurance requirements.

21.B2.5.2 Lifting Equipment

Cranes and lifting devices shall comply with classification system, design practices, and safety factors established by the crane manufacturers associations of America (CMAA), or equivalent. The usage of the cryoplant coldbox building cranes will be "class D - heavy service use".

21.B3 Codes and Standards

The cryoplant coldbox building shall be designed in accordance with the 1994 uniform building code (or equivalent). Good engineering practice, as expressed in the "Ninth Edition of the American Institute of Steel Construction (AISC) Manual of Steel Construction", shall also be employed.