

## **21 (6.2.E.06) 3.3 kV Power Supply Structures**

### **21.1 Functions, Basic Configuration, and Interfaces**

#### **21.1.1 Functions**

The 3.3 kV power supply (light-weight) structures house the switchgear for electrical loads up to 400 kW. The primary functions performed by the structures are to house, support, protect, provide a suitable environment, and to provide and control access to the equipment and processes, which are located inside. The following sections describe the functions in more detail.

##### **21.1.1.1 Protect Materials and Equipment from External Hazards**

The structures protect against anticipated wind, snow, and other environmental loads, as well as resist seismic loads, consistent with the protection of health and safety of workers (UBC requirements - see section 21.2.1.2).

##### **21.1.1.2 Provide Required Building Services**

The 3.3 kV power supply structures provide for the internal distribution of site services such as low voltage electricity for service and welding requirements, grounding (earthing) connections, compressed air for services and instruments and portable CO<sub>2</sub> extinguishers. They also provide for the collection of rain water, which is discharged to the site-wide run-off drainage system. Self-contained support systems include access control, lighting, fire detection, alarm, and mitigation systems, and communications. Design requirements for each of these aspects are described in section 21.2.

##### **21.1.1.3 Provide Heating, Ventilation, and Air Conditioning (HVAC)**

The structures must provide air quality sufficient to meet the requirements set by the systems and functions located within. All of these systems and functions are not safety importance classification (non-SIC); therefore these requirements can be met by using conventional HVAC system equipment.

#### **21.1.2 Basic Configuration**

There are two 3.3 kV power supply structures (PSB), 44-1 and 44-2. PSB 44-1 is adjacent to and west of the cryoplant compressor building (52). PSB 44-2 is located south of the diagnostic building (74). Switchgear is located along the edge of each of the structures, with the central aisle kept clear for handling and the movement of equipment. Concrete walls separate the transformers and switchgear along buildings walls. Two power transformers for each structure, are located outdoors on foundations which incorporate oil catch basins and fire/blast separation walls. The secondary side conductors penetrate the walls of the structures for connection to the switchgear. Services must include a ventilation system, suitable for the equipment located in the structures, lighting and service power, fire protection, access control and roof drainage. The single-level structural design requires a simple foundation with a steel frame structure. The roof on each structure is structurally flat

to provide a slope to drain points.

Each of the 3.3 kV power supply structures is a single-level structure. There are no large open or clear spans; it is a structural steel, column and beam configuration. Equipment is located at grade and on the roof. Large doors at grade allow the installation and removal of equipment using portable equipment. HVAC equipment located on the roof (+ 4.7 m) will be placed using road cranes from grade. The foundation of the structures shall be set below grade so that the finished floor level matches the grade level.

### **21.1.3 Interfaces**

The 3.3 kV power supply structures have interfaces with the following WBS elements:

| <b>WBS</b> | <b>Title</b>                               |
|------------|--|
| 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.D      | Sewage (Sanitary and Industrial)           |
| 6.6.A      | Compressed Air                             |

## **21.2 Specific Requirements**

### **21.2.1 Design Requirements**

The requirements for the 3.3 kV power supply structures are derived from the functions of the structures (section 21.1.1). The requirements below are not complete because equipment designers continue to provide new interface information. However, they identify all the requirements which control the overall configuration and general design concept of the structures.

#### **21.2.1.1 General**

##### **21.2.1.1.1 Switching**

The 3.3 kV power supply structures shall accommodate the switches and all other relevant components used to provide electrical loads up to 400 kW. Two power transformers are located outside each of the structures and their secondary side conductors penetrate the walls of the structures for connection to the switchgear.

##### **21.2.1.1.2 HVAC and Building Service Space**

The structures shall provide space for the HVAC system and other similar services.

##### **21.2.1.1.3 Access and Maintenance Space**

The structures must provide space for normal maintenance. Good access to all electrical

equipment within the structures is needed. The structures shall have large aisles and two doors for the movement of large objects.

#### 21.2.1.2 Seismic

The 3.3 kV power supply structures shall be non-safety importance class (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.

#### 21.2.1.3 Structural

##### 21.2.1.3.1 Components Supported by the Structures

The structures shall support their own weight as well as the weight of all installed equipment.

##### 21.2.1.3.2 Live Loads

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

##### 21.2.1.3.3 Lifting and Materials Handling Devices

The structures shall not be provided with bridge cranes or other lifting devices. Portable equipment will be used to move power conditioning equipment on the floor at grade.

##### 21.2.1.3.4 Thermal Loads

The structures 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.

##### 21.2.1.3.5 Wind Loads

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

##### 21.2.1.3.6 Snow Loads

The structures will withstand snow loading conditions of up to 300 kg/m<sup>2</sup>.

#### 21.2.1.4 Electrical

##### 21.2.1.4.1 Lighting Service

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

#### 21.2.1.4.2 Electrical Service

The structures shall provide low-voltage (~ 100 - 230 V and ~ 400 V welding power) electrical service to all areas where needs for this service are anticipated.

#### 21.2.1.4.3 Electrical Grounding

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

#### 21.2.1.4.4 Lightning Protection System

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

#### 21.2.1.5 Potable Water and Drainage

The structures shall not be provided with potable water. The structures shall have roof drains that connect to the yard drain system.

#### 21.2.1.6 HVAC Systems

The structures do not contain any spaces which are normally worker occupied. The electrical bay in the structures shall be provided with HVAC equipment to protect equipment and busbars from freezing, and to limit peak air temperatures to < 40°C. The unducted air handling units will be augmented with roof-mounted fans to provide air refreshment at a rate of approximately 0.5 air changes per hour. The entire level of the structures are enclosed by lightweight covers, able to resist wind, snow loads and protect equipment from dirt and condensation. No requirements are placed on the air change rate, dust, or humidity conditions.

#### 21.2.1.7 Fire Protection

The structures shall provide fire detection, alarm, and mitigation systems commensurate with the occupancy and fire risk loading. The alarms will interface with the CODAC system, and their status will be available in the control building.

#### 21.2.1.8 Internal Communication

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

#### 21.2.1.9 Access Control

The structures and outdoor areas shall be subject to access control to prevent unauthorised entry and to prevent worker exposure to electrical power hazards. Access control will be accomplished with 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.

#### 21.2.1.10 Materials

##### 21.2.1.10.1 Structural

There are no special requirements for construction materials. The 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 roof structures will be flat, with built-up insulation material to provide slopes to drainage points.

##### 21.2.1.10.2 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.E.06) -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                      |

##### 21.2.1.11 Cranes, Lifts and Materials Handling

The structures will not be provided with bridge cranes. Floor-supported moving aids (e.g. air cushion pallets), fork lifts, and temporary rigging will accomplish installation and maintenance relocation of heavy equipment. Grade access at the structures must be suitable for the entry and operation of mobile equipment. The doors must provide 2.5 m vertical clearance.

#### 21.2.1.12 Instrumentation and Control

Support systems, including HVAC, access, control 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.

### 21.2.2 **Operation and Maintenance**

The operations and maintenance (O&M) requirements for the 3.3 kV power supply structures are derived from the systems which occupy the building, and from the functions of the structures.

#### 21.2.2.1 Operation and Control of Building Services

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 protection systems. Operation and control of support systems will be centralized in control panels located within the structures. Status of support systems will be provided to the CODAC system. However, no support system will be directly controlled from the ITER main control room.

#### 21.2.2.2 Maintenance of Building Services

There are no specific 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. HVAC systems will include sufficient installed redundancy that at least 50% of normal service can be maintained while one unit is removed from service for maintenance.

### 21.2.3 **Surveillance and In-Service Inspection**

There are no surveillance and in-service inspection requirements for the structures apart from usual, annual, visual inspections of the structures 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 service equipment such as the fire detection, alarm, and mitigation systems.

### 21.2.4 **Corrosion Protection and Control**

The 3.3 kV power supply structures shall be painted and provided with passive corrosion protection features (galvanizing) 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.

### 21.2.5 **Quality Assurance (QA)**

There are no quality assurance requirements for the 3.3 kV power supply structures beyond

those established by the uniform building code (or equivalent).

### **21.2.6 Reliability Assurance**

There are no special reliability requirements for the 3.3 kV power supply structures. Support 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. HVAC components and equipment shall be designed, procured, and installed in accordance with industrial codes and standards. There are no additional reliability assurance requirements.

### **21.3 Codes and Standards**

The 3.3 kV power supply structures 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.