21 (6.2.A.06) Diagnostic building & TF Fast Discharge Resistors and Capacitors

21.1 Functions, Basic Configuration and Interfaces

21.1.1 Functions

The main functions of the diagnostic building are the following;

- House and support the systems, and provide space.
- Provide a suitable environment for the system and personnel.
- Provide radiation shielding around the neutron test area.

21.1.1.1 House and Support the Systems, and Provide Space

The diagnostic building must have space for the systems located within the building, space for their operation and maintenance, and must have enough strength to support the systems. The diagnostic building must resist external hazards, including seismic events, extreme weather (hurricanes, tornadoes, rainfall, snow, etc. as specified in the PDS) in order to prevent failure of the systems.

21.1.1.2 Provide a Suitable Environment for the Systems, Equipment, and Personnel

For a suitable environment, the following systems must be provided;

- lighting, service power
- fire detection and suppression
- service fluid distribution system
- drainage systems
- grounding system
- heating, ventilation, and air conditioning (HVAC) system
- access control and personnel escape system
- communication system

Many of these systems are commonly found in large industrial buildings, but there are some special features of the plant that generate some uncommon requirements;

- a robust grounding system
- an access control system

21.1.1.3 Provide Shielding

Neutrons will be generated from test equipment in the neutron test area, and there will be some gamma activity from activation products. The walls, slabs, and doors around this room provide shielding.

21.1.2 Basic Configuration

The main system accommodated in the diagnostic building are the diagnostic systems, the TF coil fast discharge resistors and capacitors, and the power supplies to the coils. Each system requires services, such as power supply, cooling water, etc. Thus, cables and pipes have to be

installed in the diagnostic building, to be connected to the site infrastructure.

The diagnostic building has four stories above grade and one below. The number of floors and the floor-to-floor height are determined by the relation between the tokamak complex and the diagnostic building, because many of diagnostic cables or waveguides cannot accept many changes in directions. The TF coil fast discharge resistors are located on the third floor. An area for routing the busbars between the tokamak complex and the MPSSN building shall be located at the north and the south ends of the building, also on the third floor.

The major systems to be installed in the diagnostic building are shown in Table 21 (6.2.A.06) -1:

Table 21 (6.2.A.06) -1 Major Systems installed in the Diagnostic Building

System	Components
Diagnostic system	Divertor Thomson Scattering, X-point, Spectrometers, Neutron Test Area, Polarimeter, Lidar, Toroidal Interferometer/Polarimeter, ECE, Reflectometry, Edge Thomson Scattering.
Cubicles for diagnostics	
TF coil fast discharge system, and magnet power supply busbars	TF Discharge Resistors, Counterpulse Capacitors, Busbars

21.1.3 Interfaces

The diagnostic building interfaces with the following WBS elements:

WBS	Title
2.6.O	Component Cooling System
2.6.P	Chilled Water Systems
4.1.D	Switching Networks and Fast Discharge Circuits
4.5	CODAC
4.6	Interlocks System
5.5	Diagnostics
6.1.A	Site General Layout
6.2.A	Tokamak Buildings
6.2.S	Utility Tunnels & Site Improvements
6.5	Liquid Distribution, Including Water
6.6	Gas Distribution and Compressors

21.2 Requirements

21.2.1 General

The requirements for the diagnostic building are derived from DRG1 and section 21.1.1, above. The requirements listed below are not complete as some equipment is still being designed. However, all the requirements for the overall configuration and general conceptual design of the building have been identified.

21.2.1.1 Systems, Components, and Connections in the Diagnostic Building

The diagnostic building shall accommodate the systems listed in Table 21 (6.2.A.06) -1, and must provide space for their operation and maintenance.

21.2.1.2 Seismic

The diagnostic building is not safety importance class (SIC) but shall withstand SL-2 seismic conditions with peak horizontal and vertical accelerations as specified in the PDS. The TF coil fast discharge system shall maintain operational capabilities in case of sequential accidents after an SL-2 seismic event. Small amounts of damage may result, such as minor cracks in the concrete, without impairing the capability of TF coil fast discharge system.

21.2.1.3 Structural

21.2.1.3.1 Dead Loads and Equipment Loads

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

21.2.1.3.2 Live Loads Supported by the Slabs

The building shall support the weight and forces of all movable and active components, systems, and structures located on the slabs or walls of the building.

21.2.1.3.3 External Hazard Loads

The structure shall resist the force exerted by seismic activity, wind, snow and soil and ground water pressure, as defined in the PDS.

21.2.1.4 Nuclear

The building shall provide sufficient shielding around the neutron test area.

21.2.1.5 Testing

The diagnostic building will be constructed to appropriate codes and standards, which will include requirements for the testing of materials during construction and commissioning, welding, piping systems, electrical systems and other active building components. In addition to construction-related inspection and testing, the diagnostic building must be designed to accommodate functional testing of building systems such as the fire detection, alarm, suppression and mitigation systems.

21.2.1.6 Electrical

21.2.1.6.1 Building Lighting Service

The building shall be provided with appropriate permanently installed electrical lighting which shall include an emergency lighting circuit.

21.2.1.6.2 Building Electrical Service

The buildings shall distribute low voltage power for services and welding to points within the buildings.

21.2.1.6.3 Building Electrical 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.

21.2.1.6.4 Lightning Protection System

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

21.2.1.7 Potable Water and Drainage

The building shall provide potable water and sanitary drainage systems for lavatories. The building shall have roof drains that connect to the yard drain system.

21.2.1.8 HVAC

The building HVAC systems shall provide air quality (temperature, humidity, purity, freshness) sufficient to meet the requirements of the personnel and equipment located in the building.

21.2.1.9 Fire Protection

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

21.2.1.10 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.

21.2.1.11 Access Control

The diagnostic building shall provide access control to prevent unauthorised entry to control centres and equipment halls, and to prevent worker exposure to electrical and other hazards (e.g. a radiation hazard from the neutron test area). Access control will be accomplished through the use of badges or other identification which must be inserted into readers 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.

21.2.1.12 Materials

21.2.1.12.1 Structural

The building shall be constructed with structural steel and reinforced concrete as required in the codes specified in section 21.3.

21.2.1.12.2 Electrical

All cables will be made with copper and should have the 15 kV, 6 kV and 0.6 kV rated insulation voltage for 11 kV. 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.A.06) -3 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

21.2.1.13 Cranes, Lifts and Material Handling

The building shall provide a hoist crane, whose capacity is 10 t, for switchgear maintenance activities and for initial installation. The building shall provide space and routing for fork lifts and other material handling devices.

21.2.1.14 Instrumentation and Control

Building support systems 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 Operations and Maintenance

The operations and maintenance (O&M) requirements for the diagnostic building are derived from the DRG1 and the functions of the building (as given in section 21.1.1, above).

21.2.2.1 Operation and Control of Building Services

Building services shall incorporate appropriate instrumentation and control subsystems to manage system operation. Manual control over lighting, power distribution, and fluid supply is expected to be adequate. Manual control with safety interlocks will be provided for the crane. Building systems with no safety or radiation control function (compressed air distribution, industrial drainage, grounding, etc.) will be equipped with appropriate instrumentation and control to operate in stand-alone mode. Operation and control of these building support systems will be centralised in building control panels located within the building. Status of these building systems will be provided to the CODAC system. However, the diagnostic building support systems will not be directly controlled from the main control room.

Fire protection systems in the diagnostic building will be equipped with automatic controls with manual override capability. These systems will initiate alarms and signals used by CODAC system, and will report the system status to the CODAC system, but these systems will not be controlled directly from the main control room.

21.2.2.2 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.

21.2.2.3 Specific Maintenance for Structures

The buildings materials which may be degraded by corrosion shall have prevention and control measures which may be maintained over the life of the project including decommissioning and dismantling.

21.2.3 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 mitigation systems.

21.2.4 Quality Assurance (QA)

The diagnostic building shall be designed and constructed in compliance with the ITER QA program. The building is non-SIC but shall be designed and constructed in accordance with American concrete institute (ACI) - 349 (or equivalent) and all the quality assurance and inspections contained therein, plus any additional requirements specified by the ITER QA program.

21.2.5 Reliability Assurance

There are no special reliability assurance requirements for the diagnostic 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.

21.3 Codes and Standards

The diagnostic building shall be designed and built in accordance with the American concrete institute (ACI) - 349 code (or equivalent).