21 (6.2.E.04) NB Power Supply Building

21.1 Functions, Basic Configuration, and Interfaces

21.1.1 Functions

The neutral beam (NB) power supply building is dedicated to housing the NB power supplies. The primary functions performed by the building 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 building. This building houses the rectifiers and power-conditioning parts of the NB power supply circuits. The NB heating and current drive system is used to heat the tokamak plasma and to drive the plasma current by injecting a beam of neutral atoms. The NB power supplies provide 1 million volts for the acceleration grids of the injector systems. The power supplies are mostly outdoor equipment, except for sensitive switchgear. This switchgear is housed in the NB power supply building. The building also provides office and restroom facilities for personnel support. The building provides general services such as HVAC, lighting, power, drainage, fluids, and lifting capability.

The following sections describe the functions of the building in more detail.

21.1.1.1 Accommodate Equipment

The NB power supply building houses the rectifiers and power conditioning parts of the NB power supply circuits. Since each power supply consists of five, 200 kV stages, and a power supply for the diagnostic neutral beam will have one, 200 kV stage, sixteen sets of switchgear are anticipated. Rectifiers and power-conditioning equipment are located along the edge of building, with a central aisle kept clear for handling and movement of equipment. Rectifiers and power-conditioning equipment are floor-supported. Transformers associated with various power supply circuits are located outdoors on foundation structures which incorporate oil catch basins and fire/blast separation walls. Shop, office, local control, and other personnel support areas are located on the second floor of building.

21.1.1.2 Protect Materials and Equipment from External Hazards

The building provides the resistance for anticipated wind, snow, and other environmental loads. The building also must resist seismic loads, consistent with protection of health and safety of workers (UBC requirements - see section 21.2.1.2).

21.1.1.3 Provide Required Building Services

The NB power supply building provides internal distribution of services 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 support systems including access control, lighting, fire detection, alarm, and mitigation systems, and communications. Design requirements for each of these aspects are described in section 21.2.1.

21.1.1.4 Provide Heating, Ventilation, and Air Conditioning

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 (heat, ventilation and air conditioning) system equipment. The spaces dedicated to worker occupancy (offices, lavatories, break room, etc.) will be heated, cooled, and ventilated using requirements set for worker comfort.

21.1.2 Basic Configuration

The NB power supply building is a two level structure. There are no large open or clear spans in the building, and it is a structural steel, column and beam configuration. Equipment is located at grade, on an intermediate floor, and on the roof. Large doors at grade, and on an intermediate floor (at + 6 m) allow the installation and removal of system equipment using portable equipment. Equipment (primarily HVAC) located on the roof (+ 11 m) will be placed using road cranes from grade, although horizontal movement at the two internal levels will be accomplished using air pallets, fork lifts, or similar devices. The foundation of the building shall be set below grade so that the finished floor level matches the grade level. The roof is structurally flat, with built-up roofing to provide a slope to drain points.

21.1.3 Interfaces

The NB power supply building has interfaces with the following WBS elements:

WBS	Title
2.6.O	Component cooling buildings system
2.6.P	Chilled water systems
4.1	Coil power supply and distribution
4.2.C	NB H&CD system power supplies
4.3.C	Steady state electrical power system distribution
4.5	CODAC
4.6.C	Access control
6.1.A	Site general layout
6.5.C	Potable & fire systems water
6.5.D	Sewage (sanitary and industrial)
6.5.E	Steam/condensate/demineralized water
6.6.A	Compressed air

21.2 Requirements

21.2.1 Design

The requirements for the NB power supply building are derived from the functions of the building. The requirements identified below are not complete because equipment designers continue to provide new interface information. However, this section identifies all the requirements which control the overall configuration and general design concept of the building.

21.2.1.1 General

21.2.1.1.1 Switching Network

The NB power supply building shall accommodate the switches and all other relevant components used to provide plasma initiation.

21.2.1.1.2 Local Control Room

The building shall provide space for the power supply local control room.

21.2.1.1.3 HVAC and Building Service Space

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

21.2.1.1.4 Access and Maintenance Space

The building shall provide space for normal maintenance and good access to all equipment within the building. The building shall also provide for materials handling, including the handling of large objects, which may require wide aisles and a door.

21.2.1.2 Seismic

The NB power supply building shall 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.

21.2.1.3 Structural

21.2.1.3.1 Components Supported by the Building Structure

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

21.2.1.3.2 Live Loads

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

21.2.1.3.3 Lifting and Material 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, and of other materials handling equipment, such as fork lift vehicles. Structural deflection under such loading must be consistent with the required precision of the handling devices.

21.2.1.3.4 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.

21.2.1.3.5 Wind Loads

The NB power supply building 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 NB power supply building shall withstand snow loading conditions of up to 300 kg/m^2.

21.2.1.4 Electrical

21.2.1.4.1 Building Lighting

The building must 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 Building Electrical Service

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

21.2.1.4.3 Building Electrical Grounding

The NB power supply 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.

21.2.1.4.4 Lightning Protection

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

21.2.1.5 Potable Water and Drainage

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

21.2.1.6 HVAC Systems

21.2.1.6.1 HVAC for Electrical Equipment Areas

The NB power supply building does not contain any spaces, which are normally occupied. The large electrical bays in the building shall be provided with HVAC equipment to protect

water-cooled equipment and busbars from freezing, and to limit peak air temperatures to > 40°C. The entire level of the building shall be enclosed by a lightweight cover, 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.

21.2.1.6.2 HVAC for Personnel Areas

Spaces at the south end of the building which are occupied (with office, lavatory, shop, etc.) shall be served with a ducted recirculating system capable of providing two to three air changes per hour, and maintaining temperature and humidity within human comfort zones. Fresh air will be added to recirculation systems at a rate equal to about 30% of the recirculation rate to maintain a positive relative pressure. Fresh air will be filtered and heated or cooled to match zone conditions.

21.2.1.7 Fire Protection

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

21.2.1.8 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.

21.2.1.9 Access Control

The NB power supply building shall provide 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 provides 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 building. Interior barriers will be locked and door status alarmed.

21.2.1.10 Materials

21.2.1.10.1 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.

21.2.1.10.2 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.E.04) -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 NB power supply building shall not be provided with bridge cranes. Floor-supported moving aids (e.g. air cushion pallets) and temporary rigging will accomplish installation and maintenance relocation of heavy equipment in this building. The building shall provide a transportable crane with a hook capacity of 5 t, for lifting the equipment to the 2nd floor. Grade access at the building must be suitable for the entry and operation of mobile equipment. The building doors shall provide a minimum of 4.2 m vertical clearance.

21.2.1.12 Instrumentation and Control

Building 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 NB power supply building are derived from the systems within the building, and from the functions of the building.

21.2.2.1 Operation and Control of Building Services

Building 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 lifting devices. Automatic controls with manual override capability will be installed for the operation of HVAC and fire protection systems. Operation and control of building support systems will be centralized in building control panels located within the building. Status of

building support systems will be provided to the CODAC system. However, no building support systems will be directly controlled from the ITER main control room.

21.2.2.2 Maintenance of Building Services

There are no specific building system maintenance requirements. Operation of most systems may be interrupted for maintenance activities, however, 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 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 the fire detection, alarm, and suppression systems.

21.2.4 Corrosion Protection and Control

The NB power supply building 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 QA requirements for the NB power supply building beyond those established by the uniform building code (or equivalent).

21.2.6 Reliability Assurance

There are no reliability requirements for the NB power supply building structure. Building 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.

21.2.6.1 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.

21.2.6.2 Lifting Equipment

Lifting devices shall comply with the classification system, design practices, and safety factors established by the crane manufacturers associations of America (CMAA), or equivalent.

21.3 Codes and Standards

The NB power supply 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.