

23 (6.5E) Steam/Condensate/Demineralized Water

23.1 Functions, Basic Configuration and Interfaces

23.1.1 Functions and Basic Configuration

The function performed by the steam and condensate system (S&CS) is to generate and distribute steam to buildings which require heating and/or contain components and systems such as HVAC and freeze protection equipment which require steam heating. This subsystem also collects condensate from steam users and returns it to the steam raising equipment. Together, the steam and condensate system is a closed fluid body. Heat is added to the steam raising equipment in a (gas or oil) fired boiler. This system may include coolers or condensers to reduce the energy content of the fluid stream after it has been utilized by the client systems.

The function of the demineralized water system (DWS) is to create demineralized water from potable water; store it; and supply and distribute it to client systems for process use or as make-up to closed cooling water loops.

23.1.2 Interfaces

Systems which require interfaces with the S&CS and DWS are:

- 2.4.E VV Pressure Suppression System
- 2.4.F Cryostat Venting & Overpressure Protection System
- 2.6.A Primary First Wall and Blanket Heat Transfer System
- 2.6.D Divertor Primary Heat Transfer System
- 2.6.E Vacuum Vessel Primary Heat Transfer System
- 2.6.E Test Blanket Modules Primary Heat Transfer System
- 2.6.F Additional Heating Primary Heat Transfer System
- 2.6.K Chemical & Volume Control Systems (CVCSs)
- 2.6.O Component Cooling System
- 2.6.P Chilled Water Systems
- 3.2.E Water Detritiation
- 3.2.F Atmosphere Detritiation
- 6.1.A Site General Layout
- 6.2.A Tokamak Buildings
- 6.2.B Hot Cell Building
- 6.2.E Auxiliary Buildings
- 6.2.G Radwaste and Personnel Building
- 6.2.H Laboratory Office Building
- 6.2.J Cryoplant Buildings
- 6.2.K Control Building
- 6.2.L Emergency Power Supply Building
- 6.2.M Site Services Building
- 6.2.S Utility Tunnels & Site Improvements
- 6.3.D Low Level Waste Processing

23.2 Design Requirements

23.2.1 Specific

23.2.1.1 Site Elevation

The S&CS and DWS must be designed to operate at elevations up to 500 m above sea level.

23.2.1.2 Temperature Range

Portions of the S&CS and DWS which are outdoors must be designed to operate from -25°C to 35°C (for one hour) and -15°C to 30°C (for 24 hours).

23.2.1.3 Maximum Humidity

Portions of the S&CS and DWS which are outdoors must be designed to operate at up to 90% relative humidity (24 hour average).

23.2.1.4 Thermohydraulic Requirements

23.2.1.4.1 Steam Pressure

The nominal steam pressure shall be saturated at 0.5 MPa (152°C) at the interface points with the buildings.

23.2.1.4.2 Steam Capacity

The S&CS shall be able to supply about 30,000 kg/h steam for consumption by ITER client systems as shown in Table 23 (6.5.E) -1.

Table 23 (6.5.E) -1 Steam Load List

Interfacing Systems	Required Heat kW(th)	Steam Flow kg/h	Remarks
Tokamak Buildings	4,576	7,075	HVAC use
Hot Cell Building	1,307	2,020	HVAC use
Radwaste Building	279	431	HVAC use
Personnel Building	43	67	HVAC use
Cryoplant Compressor Building	268	415	HVAC use
Cryoplant Cold Box Building	299	462	HVAC use
During PF Coil Fab in Cryoplant Buildings	2,509	3,880	HVAC use
Magnet Power Supply Building	144	223	HVAC use
Magnet Power Conversion Building	331	511	HVAC use
Laydown, Assembly & RF Heating Building (and Tokamak Crane Hall)	534	826	HVAC use
NB Power Conversion Building	8	12	HVAC use
Emergency Power Supply Building	102	158	HVAC use
Laboratory Office Building	298	460	HVAC use
Control Building	174	270	HVAC use
Site Services Building	335	517	HVAC use
Water Detritiation		3,150	Process use
Freeze Protection etc.		5,400	Equipment Protection
Distribution Loss ~10%		3,015	
Total	12,133	30,424	

23.2.1.4.3 Demineralized Water Capacity

The DWS shall be designed to provide a maximum flow rate of 300 m³ /day at a pressure of 1 MPa.

23.2.2 General

23.2.2.1 Mechanical

All components shall be of standard quality for these types of systems.

23.2.2.2 Electrical

All electrical components shall operate at standard IEC nominal voltages. In order to limit the number of step-down transformers, preference shall be given to 11 kV for large equipment (> 1,000 kW) and to 3.3 kV for (150-1,000 kW).

23.2.2.3 Chemical

Table 23 (6.5.E) -2 contains the nominal specifications for the DWS water quality.

Table 23 (6.5.E) - 2 DWS Water Quality

Characteristic		Limit	Unit
pH at 25 °C		6 to 8	
Conductivity		< 1.0	m-mho/cm
Conc. of dissolved	Oxygen	< 0.1	ppm
	SiO ₂	< 0.02	ppm
	Chlorine	< 0.1	ppm
	Mineral	< 0.01	ppm

23.2.2.4 Seismic

The system is non-safety importance class (non-SIC), therefore seismic class 0 is applied.

23.2.2.5 Construction

23.2.2.5.1 Configuration

The S&CS and DWS shall be configured to meet the needs of the ITER project at the lowest overall cost. The design shall be evaluated to determine compliance with this requirement. Centralized steam raising, water treatment, storage, and circulating or delivery equipment shall be used unless compelling cost or operational requirements dictate otherwise.

23.2.2.5.2 Operational Capability During Construction

The S&CS and DWS shall be designed to support operation of the PF coil fabrication in the cryopant buildings and other ITER systems (including HVAC) which will be placed in operation during construction.

23.2.2.6 Testing

Field performance tests with no heat load shall be in accordance with ASME performance test code PTC-9-1970 or the ITER site equivalent.

23.2.2.7 Instrumentation and Control

23.2.2.7.1 General Instrumentation and Control

The steam, condensate, and demineralized water systems shall be designed to include all necessary instrumentation and controls. The operation of the systems shall be independent of any other signal generation and processing system.

23.2.2.7.2 CODAC Interface

The S&CS and DWS shall be designed to accept supervisory control from CODAC, and shall conform to all signal and command protocol standards established by CODAC. It shall provide status reporting signals to CODAC.

23.2.2.8 Grounding, Insulation

All S&CS and DWS electrical equipment will be firmly grounded to the site grounding grid.

23.2.2.9 Materials

23.2.2.9.1 Materials of Construction

The DWS shall be made from 304 stainless steel, and the steam and condensate subsystem shall be made from carbon steel, unless compelling cost or operational requirements dictate otherwise.

23.2.2.9.2 Corrosion Allowance

Carbon steel components shall be sized to include a suitable corrosion allowance.

23.2.2.9.3 Electrical Insulation

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

Table 23 (6.5.E) -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

23.2.3 **Operations and Maintenance**

23.2.3.1 Built-in Redundancy

The S&CS and DWS shall be designed with sufficient built-in redundancy to allow for maintenance of all active components (particularly pumps and flow control valves) without removal of the entire system from service.

23.2.3.2 Duty Cycle

The S&CS and DWS shall be designed to be available 100% of the time.

23.2.4 **Surveillance and Inspection**

23.2.4.1 Surveillance

Water conductivity, ionic content and pH must be determined periodically. Conductivity limits are specified in Table 23 (6.5.E) - 2.

23.2.4.2 Inspection

Inspection of pipes and equipment shall be possible during long term maintenance states. The general inspection procedures will be described in the maintenance section of the 6.5.E DDD and include visual and electro-mechanical inspections.

23.2.5 **Quality Assurance (QA)**

All S&CS and DWS components are non-SIC, therefore, only industrial product level QA is required from the vendors and constructors.

23.2.6 **Reliability Assurance**

The S&CS and DWS together shall not contribute to greater than 0.1% unavailability of the ITER plant for its planned operation schedule. This requirement shall be met by a combination of redundancy, planned maintenance and inspection, ease of repair and availability of spare parts.

23.2.7 **Other**

The S&CS system requires heat insulation for worker safety.

23.3 **Codes and Standards**

23.3.1 **Mechanical**

Piping shall comply with ANSI B31.3 and heat exchangers shall comply with ASME section VIII. Other applicable codes and standards will be determined after site selection.

23.3.2 **Electrical**

All electrical components shall comply with IEC standards. Other applicable codes and standards will be determined after the site selection.