

## **7.1 GENERAL**

### **7.1.1 SCOPE**

The Works to which this section shall apply include all mechanical auxiliary systems for the converter station. The main systems to be provided are:

- a) Cooling systems for HVDC converter equipment.
- b) Valve module handling & transportation equipment.
- c) Water distribution System for Sanitary Services, if required.
- d) Hoists/Chain pulley Blocks, as applicable, for installation and maintenance of indoor equipments.
- e) Suitable maintenance tools and arrangement for lifting heavy equipments in valve cooling system/room
- f) Emergency diesel generator sets

The further details are specified in the following clauses.

### **7.1.2 GENERAL REQUIREMENTS**

All mechanical works shall satisfy the general technical requirements specified in Section 3 and shall be designed to operate in the ambient/system conditions specified in Section 2.

The following requirements shall be met by the equipment supplied by the Contractor:

The equipment shall be designed and constructed for safe, proper and continuous operation under all conditions described or implied in the Specification, without undue strain, vibration, corrosion or other operating difficulties.

Parts shall be designed and supported to permit free expansion and Contraction without causing leakage, distortion or excessive strain on the equipment.

Parts subject to wear, corrosion or other deterioration or requiring adjustment, inspection or repair shall be readily accessible and capable of easy removal for repair or replacement.

All heavy components shall be provided with convenient means for slinging or handling during installation and maintenance.

Within a system, stand-by and/or duplicate equipment shall be provided with a minimum of two for each major component such as, pumps, heaters, strainers, fans or operationally separate cells of cooling towers or heat exchangers. Thus, loss of a single element of auxiliary plant shall not result in any loss of converter rating under any combination of load and ambient conditions.

Duplicate and/or stand-by equipment shall automatically, based on a predetermined cycle, be brought in the system such as to allow an equal

wear and tear.

Unless otherwise specified, all equipment serviced by a duplicate or stand-by shall, on detection of failure, get automatically isolated. The corresponding duplicate or stand-by equipment shall automatically take over the failed equipment.

Loss of any equipment or system shall automatically be alarmed at operation control centre with display of events in SCADA system.

The principles detailed above need not be applied to systems upon which the conversion equipment does not depend for operation.

No mechanical equipment shall be installed on the roof of the converter building, i.e. valve halls and service building.

### **7.1.3 ELECTRICAL POWER SUPPLY FREQUENCY/VOLTAGE VARIATIONS**

The power supplies to mechanical auxiliaries may experience transient, over and/or under frequency and voltage conditions which may cause over-speeding or slowing down of motors and driven equipment.

All mechanical equipment supplied for the works shall be capable of operating satisfactorily through supply variations in terms of voltage and frequency disturbances - for AC input voltage variation of +10%, frequency variation of +5%, a combined voltage and frequency variation of +10%. No reduction of the HVDC power transmission capability shall be allowed during these disturbances.

## **7.2 Not used**

### **7.3 VALVE COOLING SYSTEMS**

#### **7.3.1 GENERAL**

The Contractor shall provide reliable and efficient cooling systems for the HVDC converter valves. The design of valve cooling system shall be reviewed by the Employer and / or by its consultants and the Contractor shall provide all relevant information as required for the review of the design.

For cooling of valves, the Contractor shall use a closed water-cooling system without any secondary cooling. Operation of Valve cooling system and its subsystems shall be fully automatic with facility for manual operation also. The control and protection cubicles for valve cooling system shall be located in clean air-conditioned environment. The valve cooling control system shall be protected against external electromagnetic interference.

#### **7.3.2 RELIABILITY CRITERIA**

The following general requirements shall apply to the design of the cooling system:

- a) The Pole 1 shall have its own cooling system independent of all other

cooling systems.

- b) Cooling towers shall be dry type for fine water system.
- c) Storage shall be provided so that failure of a feeder pipe or piece of equipment shall not lead to loss of capacity, if the pipe or equipment is repaired within 24 hours.
- d) Where a number of units (e.g. fans) serve a multiplicity of other units (e.g. valve assemblies), the Contractor shall demonstrate to the satisfaction of Employer by model tests or other means that, with any likely selection of units operating, satisfactory cooling conditions shall be provided for all the units so served.

The system shall be so designed that in case of auxiliary power failure up to two minutes, no shutdown of plant or power transmission would be required. For this purpose, a UPS / UMD shall be provided which should be capable of running the valve cooling system for at least two minutes. With UPS / UMD in service, the converter should not trip or reduce the transmission capability upon loss of auxiliary power supply for the duration the changeover to redundant power supply.

The technical specification for three phase UPS along with technical particulars to be furnished as per Annexure-I. For UMD bidder standard solution shall be acceptable. However, the same shall comply to the Annexure I to the extent possible. The UPS/ UMD for valve cooling system shall be in parallel redundant configuration. Each of the redundant UPS/UMD shall have its own independent battery system.

### **7.3.3 DESCRIPTION OF COOLING SYSTEM**

#### **7.3.3.1 Fine Water Circuit**

The fine water circuit shall consist of a main circuit and a water treatment circuit.

The cooling medium in the fine water circuit shall be deionised water with low conductivity.

#### **7.3.3.2 Main Water Circuit**

The main cooling circuit shall consist of water within the thyristor valves, a de-aeration vessel/venting valve, pumps and filters.

The main circuit shall be provided with an expansion vessel with level transducers and pressurized with nitrogen (if applicable). The level transducers shall be used for control of the makeup water for the system and for detection of leakages.

One of the two water pumps shall circulate the water through the main cooling circuit and the water treatment circuit. The other pump shall be included for redundancy purpose. The operation shall be automated and arranged into alternative days between these two pumps. Upon failure of

the unit in service, the redundant shall be automatically activated.

#### **7.3.3.3 Water treatment circuit**

A part of the main flow shall be circulated in the water treatment circuit. The water treatment circuit shall consist of oxygen removers (if required), ion exchangers and mechanical filter. Sensors shall be provided for measuring conductivity of the water, both in the main cooling circuit and in the treatment circuit at the exit side of the ion-exchanger.

The water treatment circuit shall be provided with a makeup pump and associated valves and strainers.

The water pipe for fine water make up shall be connected to main fine water circuit through the water treatment circuit.

#### **7.3.3.4 Air cooled liquid coolers**

The air-cooled liquid coolers shall cool the water from the thyristor valves. One redundant unit shall be provided by the Contractor over and above the quantity required to achieve the operating temperatures for rated power. The coolers shall be dry type. Each cooler shall consist of cooling fans with separated air channels. Suitable protection against corrosion, oxidation etc. shall be provided for all cooling equipment's.

#### **7.3.3.5 Mechanical Design**

The cooling system shall be pre-fabricated. There shall be three main parts:

- fine water pump unit;
- air cooled liquid coolers;
- Piping.

The fine water pump unit shall be mounted on a frame and shall be placed in the valve cooling room. The air-cooled liquid coolers shall be placed outdoors, near to the valve cooling rooms. The piping shall be especially designed stainless steel and adapted to the station building.

#### **7.3.3.6 Control equipment**

The valve cooling control equipment shall be specially designed for application to the cooling system for thyristor valves. There shall be two computer-based control systems such that either both are in ACTIVE mode, or when one system is in ACTIVE mode the other system shall be in ACTIVE STANDBY mode. Each computer-based system shall be self-checking and an automatic changeover to the other system shall take place automatically in the case of failure of the active system.

The control cubicle shall be tested along the main water-cooling circuit, excluding air cooled cooler, at manufacturer's plant.

#### **7.3.3.7 Design Criteria for The Cooling System**

Features to ensure high reliability, proper function and prolonged life time for the cooling system and thyristor valves shall be included. The following main components shall be supplied with redundancy in order to increase the availability:

- main circulation water pump
- one air cooled cooler (N + 1 Coolers, totally)
- bypass valves,
- transducers
- nitrogen bottles, if applicable

#### **7.3.3.8 Design Cooling Requirements**

The cooling system shall be designed to cool the heat generated in both 12-pulse group of thyristor valves for converter station which is per Pole design.

Cooling system shall be capable to operate and guarantee the design temperature range of cooling water for two hours and five seconds overload conditions, up to max specified design dry bulb ambient temperature.

#### **7.3.3.9 Ambient Conditions**

Ambient Conditions are specified in Section 2 of the specification.

#### **7.3.3.10 Materials**

The materials in contact with the cooling water as well as for manufacturing of the air-cooled liquid cooler shall be selected in order to minimize the risk of corrosion. All frames cover and tubes shall be of stainless steel and the cooling fins shall be of aluminium.

#### **7.3.3.11 Measure Against Water Leakage**

The design of the valve cooling system shall be made to minimise leakages. The following precautions shall be taken to minimize the risk of water leakage from the system.

- choice of water pipe joint
- number of water pipe joints in the system shall be kept as low as possible, particularly in the thyristor valves;
- velocity of deionised water in the pipes and in the thyristor heat sinks shall be kept low
- water circulation within the pipes shall be free from trapped air bubbles

#### **7.3.3.12 Valve Cooling Control and Monitoring**

The valve cooling control systems shall be redundant and be equipped with an integrated data collecting unit that is connected by serial links to the station sequential event recorder system.

#### **7.3.3.13 Cooling Capacity Control**

The water temperature to and from the thyristor valves are used as an input to the cooling capacity control. In order to avoid condensation at the pipe lines within the thyristor valves the inlet fine water temperature shall be kept in an appropriate range. Dew point monitoring inside the valve hall shall be provided and alarm/trip shall be initiated in case of risk of condensation in the valve Hall.

#### **7.3.3.14 Protections**

The following protections/monitoring shall be included:

- Temperature of the water from the valves
- Temperature of the water to the valves
- Water flow through the valves
- Water level in the expansion vessel
- Conductivity of the water from the water processing unit
- Conductivity of the water in the main circuit
- Pressure in the expansion vessel if required
- Pressure in the nitrogen bottle, if required

#### **7.3.3.15 Leakage Detection**

There shall be three leakage detection methods used in parallel by the cooling control system. These methods can, depending on the nature of the leakage, generate trip of the converter and cooling system. However, one of the methods of leakage detection shall generate a leakage alarm if volume of leakage exceeds the reference volume, during the last 24 hours.

Besides these detection methods alarms for frequent make up and for long make up when automatic make-up of cooling water is used, generated by the cooling control programme shall be provided. The total schematic of valve cooling system with valve position, flow, temperature, make up details, conductivity, pump running etc shall be made available to the SCADA system of HVDC terminal.

#### **7.4 ENVIRONMENT CONTROL:**

Air conditioning and / or other environmental control systems shall be provided for the Valve Hall to ensure satisfactory operation of the HVDC system under the range of climatic conditions to which the station may be subjected. These systems shall provide equipment operational reliability. The details of the existing Valve Hall Ventilation and Air Condition Systems are provided as Annexure\_VH Environment Control. The bidder may consider this existing system for the replacement of valve hall equipment. Bidder shall provide detailed heat load calculation for checking the

adequacy of existing air conditioning and ventilation system of valve hall. This shall include solar and transfer gain from wall, roof, glass partition, floor, people, light and equipment load. Details of equipment heat load from all equipment including but not limited to valve, bus-bar, instrumentation and transformer turrets shall be provided. In case additional HVAC requirement envisaged by Contractor over and above of existing system, then the additional air condition/ ventilation systems shall be included in the present scope of work to maintain the Valve Hall environmental parameters within the requirement limits of the replaced valve hall equipments. The specifications for the Environment Control is attached as Annexure\_Ventilation. Any dismantling, erection/reerection/ decommissioning/recommissioning required to make the above requirement is part of scope

#### **7.5 FIRE DETECTION AND PROTECTION:**

Suitable UV/Infrared (IR) detector to detect the flashover inside the Valve Hall shall be provided. The total numbers and locations of UV/IR detectors within the valve hall shall be decided during detailed engineering. However, contractor must ensure that sufficient quantities of detectors are provided and strategically placed within the valve hall so as to cover valve hall equipments fully especially thyristors valves, bushings etc. Contractor to demonstrate the coverage through 3D modelling to the satisfaction of the employer during detailed engineering.

#### **7.6 BUILDING MANAGEMENT SYSTEM: NOT USED**

#### **7.7 OIL HANDLING SYSTEM: NOT USED**

#### **7.8 Oil storage: NOT USED**

#### **7.9 Valve Module Handling and Transporting Equipment**

The Contractor shall supply suitable handling and transporting equipment for erection and maintenance of the valve modules. These shall include electrically operated hoists, collapsible elevating platforms or similar equipment as appropriate for the design of the valve, to remove, install or service modules in the valve and to transport modules to the maintenance areas and storage areas.

1 no. scissor lift (hydraulic and electrically maneuverability) for such equipment shall be provided.

#### **7.10 Water Treatment Plant**

**1.0** Existing Water Supply & Treatment System may be used by the bidder by augmenting the piping distribution to the new locations (if any).

##### **7.10.1 PUMPING SYSTEM**

**Not used.**

## **7.11 ADDITIONAL GENERAL REQUIREMENTS**

### **7.11.1 TESTS**

The Contractor shall perform all tests and inspection necessary to ensure that the material and workmanship conform to the approved design drawings and that such tests are adequate to demonstrate that the equipment shall comply with the requirements of the Specification & relevant standards. The Contractor shall test the component parts at his plant or his Sub-Contractor's plant, prior to packaging and shipping, to determine that the performance requirements have been met. All testing shall be in accordance with the Standards related to the piece of work.

### **7.11.2 PUMPS**

#### **7.11.2.1 General**

Where pumps are supplied as part of the Equipment covered by the Specification they shall comply with the following requirements unless otherwise specified/ approved by the Employer.

- a) Each pump and motor shall be mounted on a hot dipped galvanised steel base with drip rim and tapped drain connection.
- b) All pumps shall be provided with air cocks.
- c) Each pump shall be connected to its motors with a flexible coupling. All couplings shall be protected with guards.
- d) Rotating parts of all pumps and drivers shall be statically and dynamically balanced.
- e) A centrifugal pump shall have an impeller with a diameter not greater than 90% of the maximum that could be installed.
- f) The materials of pumps shall be selected with due regard to operating conditions. Higher grade materials than specified may be proposed by the Contractor if considered more suitable.
- g) Pump rotation shall be as indicated on approved shop drawings.
- h) All motors shall be selected to handle the run-out conditions of the pump at a service factor equal to or greater than 1.0.
- i) The equipment code number shall be shown on the nameplate of the equipment.
- j) All pumps shall have metallic seals between housing and pump shaft to prevent leakage.

### **7.11.3 PIPING**

#### **7.11.3.1 General**

The Contractor shall supply the piping for all the station systems wherever required. The main piping systems shall include, but not be limited to, the following:

- Valve Cooling systems

Piping shall be defined as pipe, valves, fittings, bolting and jointing materials and thermo- welds, pipe hangers & supports and other related material. In case of bends (90°) only prefabricated bends shall be used.

#### **7.11.4 HOISTS & LIFTING ARRANGEMENTS**

Not used.