The ITER cryogenic system consists of three main subsystems: the Cryoplant, the Cryo-distribution (CD), as well as the system of Cryo-pumps and Warmlines (WL) systems. The CD and WL subsystems are part of the in-kind supply from India.

The cryoplant provides the required cooling power for the clients, namely, the superconducting magnet system, Cryo-pumps and thermal shield for the main cryostat.

The CD system controls and manipulates the different operational scenarios of ITER and the CS system communicates the two way communication of the required flow of cryogen as per the ITER cryogenic process with the structured network of multi (two to eight) and simple process pipe cryoplants.

ITER Cryoplant System

**Planning and Scheduling – Development of Prototype Cryoplant**

Major Technical specifications of ITER Cryoplants and PTCL

<table>
<thead>
<tr>
<th>OPV Size</th>
<th>DN 100 to DN 1000</th>
<th>DN 600</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of process pipes</td>
<td>1 to 9</td>
<td>1 to 7</td>
</tr>
<tr>
<td>Length</td>
<td>~ 3000 m</td>
<td>27 m</td>
</tr>
<tr>
<td>Number of segments</td>
<td>3 to 16</td>
<td>2</td>
</tr>
<tr>
<td>Quality Class</td>
<td>QC 1, QC 2, QC 3</td>
<td>QC 1</td>
</tr>
<tr>
<td>Service Quality</td>
<td>SCI 1, SCI 2, SCI 3</td>
<td>SCI 1</td>
</tr>
<tr>
<td>Safety Class</td>
<td>S 1-D, S 2-D, S 3-D</td>
<td>S 1-D</td>
</tr>
<tr>
<td>Temperature levels</td>
<td>4.0 K, 50 K, 80 K, 300 K</td>
<td>4.0 K, 300 K</td>
</tr>
<tr>
<td>Pressure of process fluid</td>
<td>Max. 21 bar</td>
<td>21 bar (design), max. 6.5 bar (cold test)</td>
</tr>
</tbody>
</table>

**Cluster of PTCL**

- OS: OPV Segment
- CS: Compressor Station
- ST: Stopping Tank
- ACB: Atmospheric Condensation/Boiler
- CBC: Condensation/Boiler Cold Condenser
- STP: Stopping Tank Plant
- CS: Compressor Station
- ST: Stopping Tank
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**Cryoplant Installation**

- OS: OPV Segment
- CS: Compressor Station
- ST: Stopping Tank
- ACB: Atmospheric Condensation/Boiler
- CBC: Condensation/Boiler Cold Condenser
- STP: Stopping Tank Plant

**Integration of PTCL**

- OS: OPV Segment
- CS: Compressor Station
- ST: Stopping Tank
- ACB: Atmospheric Condensation/Boiler
- CBC: Condensation/Boiler Cold Condenser
- STP: Stopping Tank Plant

**Cryopipe Factory**

- OS: OPV Segment
- CS: Compressor Station
- ST: Stopping Tank
- ACB: Atmospheric Condensation/Boiler
- CBC: Condensation/Boiler Cold Condenser
- STP: Stopping Tank Plant

**Cryopipe Factory**

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**Technical risk mitigation and Value**

- Cold Circulating Pumps and Systems

Cold Circulating Pumps (CCP)

- A part of the technical specification is to keep in mind the first freeze, pressure, and variation in input conditions (i.e. P & T) in all the manufacture and purchase inclusive of 110 % of mass flow, more than 70 % of cold test requirements.
- By optimization of the position of the thermal shield on the cryogen pipe and the flange, it has been possible to increase the temperature from 189 K to 369 K satisfying the requirement.

Test CCP (FACE)

- Developed taking in account the technical requirements of the main components such as CCPs, valves, heat exchangers, instrumentation, etc.
- CODES: Cryodistribution systems, Cryo-pipes & equipment
- Interfaces: Codes & Heater一行 - CODES: Cryodistribution systems, Cryo-pipes & equipment
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**Conclusion**

- Very high and high rates brought down to medium and low levels with implementation of prototyping both in CD and CL.
- The success of the development of two CCPs by two industrial collaborations - a blessing towards the further development.
- Know how planned and actual implementation as well as value engineering has enabled ITER-India to enter in to the level of industrial development for the ITER system.

References


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