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C3Or4C-02: The final design and manufacturing of cryogenic valve boxes for ITER

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As part of the ITER vacuum system's front end cryo distribution system, 12 complex cryogenic valve boxes (CVBs) and a warm regeneration box (WRB) are required to supply the torus, cryostat (T&C) and neutral beam (NB) cryogenic pumps. This cryogenic distribution system has to operate in a demanding environment within ITER's main Tokamak building where they will experience high magnetic fields, ionizing radiation and need to cope with abnormal events such as seismic activity. In addition, this distribution system has to fit in a very limited space, be maintainable, highly reliable and integrate with many other systems. Uniquely, the CVBs cryogenic circuits operate over a wide temperature range between 4 K and 500 K during cryopump operation and regeneration. The process and operating environment has given particular challenges for material and instrument selection and implies that many standard cryogenic components, such as cryogenic valves, temperature sensors and pressure relief devices, have had to be adapted.

Each of the CVBs presented consists of a vacuum vessel with a diameter of about 1.8 m and a height of 1.9 m, an internal thermal radiation shield, 23 to 30 cryogenic valves, 10 to 20 pressure relief valves, 4 bursting discs, a flow meter, more than 80 temperature sensors and various optical pressure transducers and is mounted on a support frame equipped with maintenance platforms. The design includes smart features such as a manhole and optimized piping to allow access to internal components. Currently, the final design of the WRB and CVBs and the manufacturing of the WRB and eight T&C CVBs have been completed. The manufacturing phase of the NB CVBs has just started. The work described is performed on behalf of Fusion for Energy (F4E, OPE-843, OPE-1249), the European organisation managing Europe's contribution to ITER.

This paper summarises the challenges of the design, manufacturing and assembly of the WRB and CVBs taking into account the unique environment and stringent ITER requirements. In particular, it provides an overview of the final designs, the materials used, modifications and further developments of standard cryogenic components and instrumentation.

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