Dynamic simulation of performance and control of ITER Atmosphere Detritiation System

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The atmosphere detritiation is a final part of the tritium confinement system at ITER. It has to provide cascade of pressures permanently or on demand in those sectors of the nuclear buildings that handle tritium, such as Tritium Plant, Tokamak building and the Hot Cell facility. The Detritiation System (DS) undertakes gases detritiation prior to their discharge to the atmosphere. The number of DS clients is large. For example, more that 50 confinement sectors in the Tokamak building and the Tritium Plant have a connection to DS. These sectors are different in many aspects, such as dimensions and volume, air leak tightness, sub-atmospheric pressure to be provided and air flow to DS under various scenarios of operation. Additionally, the confinement sectors which shall be served by DS on demand are connected to HVAC (Heating, Ventilation and Air Conditioning) during normal operations and maintenance. Therefore in providing sub-atmospheric pressures DS shall inteface in sophisticated way with HVAC to provide correct pathway for gases to be discharged.

The combination of HVAC and DS is a unique feature of ITER as a tritium handling facility. Another feature of the ITER DS is a very large and widely distributed network of pipes and gas collectors. This complex, distributed arrangement is required to have a high standard of operability, reliability and availability to maintain air flow rate under steady state and upset conditions during normal and abnormal operation.

The design of the DS distributed network (piping network and associated controls) has been modelled using a dynamic simulation code. This simulation has been used to develop, verify and validate the design in terms of the arrangement and component sizing under steady state and upset conditions. The targets of the simulation were to check the design and demonstrate that switching a sector's connection from HVAC to DS or increasing flow from a given sector to DS does not unbalance the overall pressure cascade. Market software for nuclear ventilation application has been selected to test different conceptual designs for the distributed network and associated control.

This paper will outline the challenges in controlling the flow and pressure to provide confinement for a large amount of clients permanently served by DS and, in addition, for a room affected by an incident or accident. As an example, a part of distributed network to serve the Tokamak Port Cells will be described. More than 50 Port Cells are connected to a common manifold and maintained at a lower pressure in a cascade so that air flows into the Port Cells from the low contamination gallery areas. The method used to define the size, location and control strategy to avoid unbalance of the pressure cascade during maintenance or incident/accident scenarios will be presented. The model also takes into consideration the influence on the control system caused by the high magnetic field environment in which parts of the distributed system are located. Finally, a sensitivity study is presented to identify those parameters of the distributed network that may influence the effectiveness of the DS for gas detritiation.