Atmosphere detritiation as tritium confinement system at ITER

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During operation with tritium plasma the ITER fuel cycle will process unprecedented flow of deuterium-tritium mixtures. Gaseous effluents from the primary tritium processing systems of the tritium plant, such as Storage and Delivery, Tokamak Exhaust Processing, cryogenic distillation Isotope Separation, Water Detritiation, and purge gas of the tokamak vacuum vessel will be processed by the atmosphere Detritiation System (DS) for the tritium removal from gaseous streams prior to their discharge to the atmosphere. However tritium processing systems present a risk of exposure to tritium for workers and public and contamination of the environment in event of incidental/accidental tritium release to the rooms of the tritium plant. Similar risks exist in tokamak building during movement of components removed from the vacuum vessel to the Hot Cell Facility. To mitigate the impact of tritium release, the affected room will be isolated from HVAC and connected to the DS. DS then provides tritium confinement in the affected room by maintaining sub-atmospheric pressure and by detritiating gases prior to their discharge to the environment. The equipment designated to provide the confinement function has to be available all the time it is needed and as such has been classified as safety important components (SIC).

Components removed from the vacuum vessel will be very much contaminated with tritium. They will be handled and stored in the Hot Cell Facility (HCF). Tritium out-gassing from these components presents a large chronic source of airborne tritium. To prevent this tritium release into the environment, HCF will be equipped with its own HCF-DS. The HCF-DS will continuously provide sub-atmospheric pressure in HCF rooms classified at the level of contamination class C4 and shall process gas used for continuous purge of those rooms. In addition HCF-DS will provide confinement in rooms of other contamination class if they are affected by incidental/accidental tritium release.

The ITER's atmosphere detritiation system's design and operation are very different than other tritium handling facilities because they are designated for providing tritium confinement in very large rooms with tritium inventory at risk. The design is based on the combination of two different technologies for gaseous detritiation and a modular design which incorporates redundancy allowing availability required for safety important components in normal operations and in incidental/accidental events, such as fire or earthquake.

In DS the removal of tritium from gaseous streams is based on catalytic oxidation of tritium in hydrogen-containing species followed by removal of produced water vapour by either adsorption in molecular sieve driers or by isotopic exchange with liquid water in scrubber columns. The failure rate analysis demonstrated that because of nature of the technology molecular sieve driers can not reach the target of availability required. Therefore modules based on driers are designated to cover normal operations only and are not designed to meet requirements for accidents or incidents (SIC). All abnormal operations will be covered by modules based on technology of scrubber columns.

This paper will present concept and design of ITER DS and results of experimental studies on application of scrubber columns for gases detritiation.