# Tritium Metering, Assay, Recovery and Storage(T-MARS) at KEPRI Tritium Lab.

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## 1. Introduction

The Wolsong Tritium Removal Facility(WTRF) was designed to process 100 kg/h of heavy water and to produce ~700 g of tritium as $T_2$ per year at the feed concentration of 0.37 TBq/kg. The recovered tritium will be made available for industrial uses and some research applications in the future. The Tritium Assaying and Dispensing Facility(TADF) at KEPRI is infrastructure to support the tritium research activities and to support the tritium control system for tritium export in Korea. The TADF has been designed to safely measure, assay and store tritium for commercial use. The TADF is classified as a radioisotope handling facility and is restricted to process total inventory less than 11.5 PB of tritium. For the tritium accountancy for all shipments in and out at the facility, a dedicated calorimeter was installed and demonstrated at KEPRI tritium laboratory. This paper describes the design features of the TADF and the initial activities with a focus on the development, testing and integration of the tritium infrastructure.

## 2. Tritium Assay and Dispensing

### *2.1 General Description*

The KEPRI Tritium Assay and Dispensing Facility (TADF) is being installed to safely handle large quantities of tritium and expand experimental activities. Fig. 1 shows the general view of the TADF at KEPRI. Because the TADF is classified as a radioisotope handling facility, the design of the TADF should meet the safety requirements based on the philosophy of containment and confinement. Therefore, the secondary boundaries of glove box(GB) and air purged enclosure(APE) should be provided to contain tritium in leak-tight.

The TADF comprises a multi-boundary complex in a single room. Providing about 88 $m^2$ of working area for experiments and engineering tests, the facility is equipped with conventional laboratory infrastructure and tritium infrastructure as follows; a tritium assay and dispensing system(TADS), tritium loading in and out systems, a tritium recovery system(TRS) to purify the GB atmosphere, a purge gas recombiner system(PGRS) to process APE atmosphere effluent and experimental gaseous effluent, inert gas GBs and APEs, tritium monitoring systems, a gas chromatograph(GC) and a dedicated tritium calorimeter. The tritium containing GBs and APEs are typically located inside ventilated room which is connected to the stack to prevent tritium from being spread into the facility. The tritium removal of room air not really required.

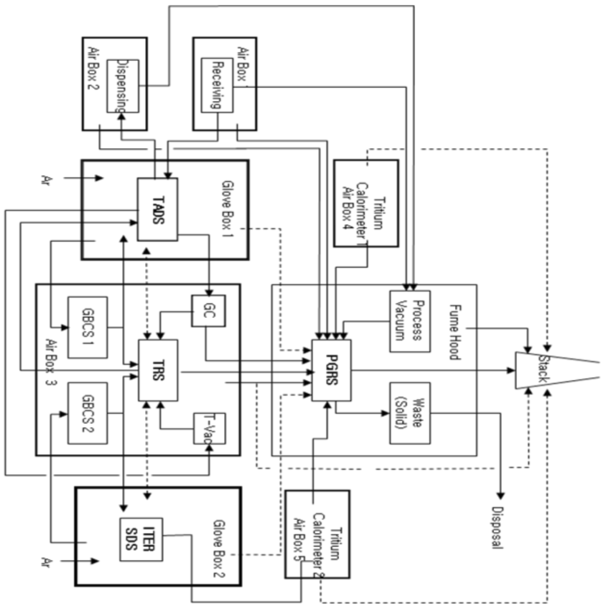


Fig. 1. General view of tritium handling facility

### *2.2 Tritium Metering, Assay and Dispensing*

The TADS, as a key element of the TADF, has four major functions: (1) receiving and holding tritium, (2) metering and assay, (3) dispensing, and (4) recovering tritium residual of process equipment. As presented in Fig. 2, the TADS comprises the followings: a vacuum manifold equipped with electro-pneumatic and manual valves, three metering vessels, three depleted uranium getter beds, pressure sensors, temperature sensors, metal bellows pump and the GC. Most of components and equipment of the TADS are located inside the inert gas GB. The vacuum pumping equipment and the GC is exceptionally located inside the APE.

Three uranium getter beds were proposed for all tritium storage and transfer vessels to store tritium from outside and to recover the tritium residual of process equipment in the TADS. Each uranium getter bed has 550g of depleted uranium to store 3.7 PBq of tritium. As presented in Fig. 3, the uranium bed is doubly contained pressure vessel with purge annulus and flow-through type having inlet/outlet of the inner vessel. The uranium bed must be made as compact as possible as glove box space and air purged enclosure space are limited. Thermocouples and heaters must be fitted with plugs, and process line connections must be fitted with easily detectable fittings for easy removal of the bed.

It was assumed to dispense and load the tritium by batch transfers to limit exothermic heat and consequences due to malfunctions. Tritium assay is based on accurate pressure-volume-temperature(PVT) measurements and GC analysis. Three metering vessels, 25 ㎖, 250 ㎖ and 2500 ㎖ in volume, were designed to measure 0.37 TBq to 185 TBq of $T_2$ gas at sub-atmospheric pressure.

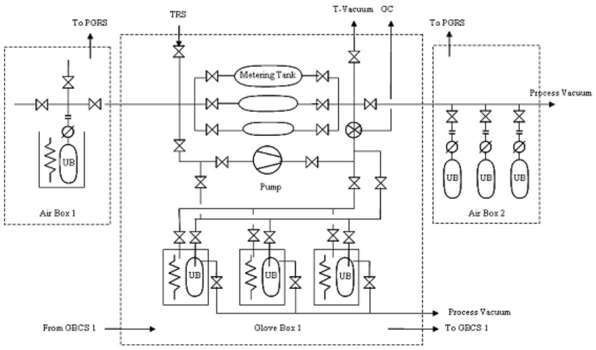


Fig. 2. Tritium assay and dispensing system

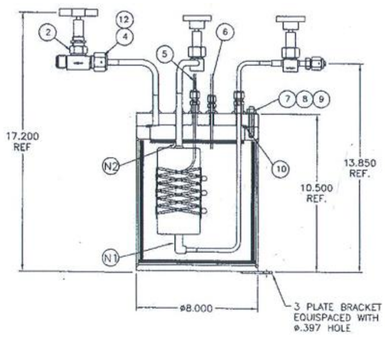


Fig. 3. Uranium Getter Bed of 100kCi

It is essential to provide composition analysis by the GC. A 1/8" O.D, 3 meters long column packed with FeOH coated activated alumina should be installed to be capable of separating all six hydrogen isotopes($H_2$, $D_2$, $T_2$, HD, HT, DT) and He-3 sufficiently. The column allow for quantification of separate components in a gas mixture containing hydrogen isotopes and He-3 at liquid nitrogen temperature. The minimum detection limit is 1,000 ppm or better for hydrogen and the accuracy is within ± 3% at high tritium levels(>99%). Carrier gases for the GC are Ne for analysis operation and He for standby, respectively.

### 3. Tritium Recovery

A metal getter based inert gas glove box purification system has also been designed. Fig. 4 shows a flow schematic of the TRS. The TRS consists of two trains, in which each train uses a uranium getter bed in conjunction with a ZrFe bed and is located in the APE. The uranium getter bed has 100g of depleted uranium to store 555 TBq of tritium and the ZrFe getter bed has about 1,000g to store 18.5 TBq of tritium.

Gaseous tritiated effluent from the GBs and associated equipment is processed by the TRS. The uranium bed can quickly remove bulk quantities of tritium before passing the gas stream through the ZrFe bed. The uranium bed is much easier to regenerate, and has a greater tritium capacity and a much longer operating life, as well as being less expensive. Using the uranium bed ahead of the ZrFe bed limits the amount of tritium deposition on the latter, and so keeping it more effective as a final polishing step. However, the uranium bed do not remove tritium to as low a level as the ZrFe bed so that the ZrFe bed can remove the residual to achieve the low discharge level. The regeneration operation is quite similar for both beds, so there is no additional operational complexity.

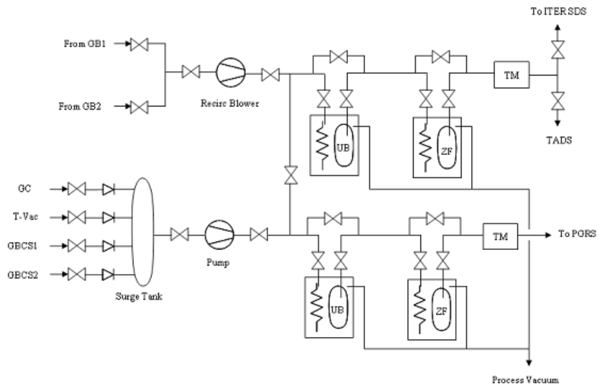


Fig. 4. Schematic of tritium recovery system

### 4. Conclusions

KEPRI is pushing the tritium application program to build up the laboratory infrastructure to support the tritium related R&D activities, and the tritium control and accountancy for tritium export. The TADF has been designed to meet the safety requirements based on the philosophy of containment and confinement and to process the total inventory less than 11.5 PBq of tritium. The TADS, TRS and GC are is being developed to assay, dispense and store tritium. The TADF is scheduled to start operation in 2010 and KEPRI is looking forward to contributing tritium related R&D activities in Korea.

### REFERENCES

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