# MBRAUN Press Releases

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**The Tritium Recovery System**

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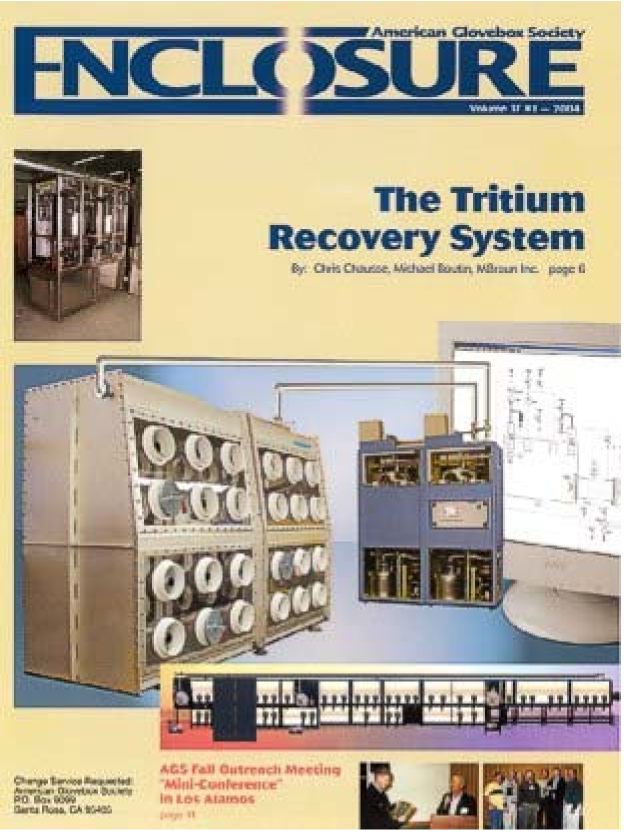


"ENCLOSURE" Magazine

### Introduction

Since 1974 MBRAUN has been designing, manufacturing, and installing glove boxes and gas purification systems for its customers all over the world. In addition to this experience and expertise, MBRAUN also offers a full line of Tritium Recovery Systems not only for its own glove boxes but also for those customers that may have existing glove box systems that contain tritiated chemical elements.

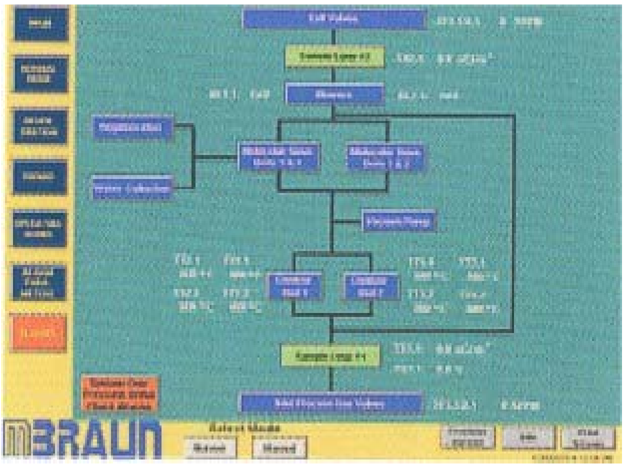
Tritium Recovery Systems (TRS) convert all tritiated chemical species (principally elemental, oxide and hydrocarbon) in the process stream to the oxide form (HTO) and remove the tritiated water by absorption on molecular sieve beds. The processed gas stream is then returned to the glove box environment or released to an exhaust duct. Tritiated water that is recovered from the molecular sieve beds during bed regeneration cycles is then chemically analysed before disposal to a waste container for long-term storage. On-line instruments in TRS continuously measure tritium concentrations in the inlet and outlet gas streams, gas flow rates and pressures, and component temperatures throughout the system.

MBRAUN was recently under contract with The Idaho National Engineering and Environmental Laboratory (INEEL) to design, fabricate, and install a fully functional Tritium Recovery System in the Safety and Tritium Applied Research (STAR) facility. The TRS had to remove tritium and tritiated compounds from glove box atmospheres in addition to experiment process gases to a tritium concentration level of no more than 50uCi/m3 before sending those gases to a single exhaust system.

The approved supplier not only had to have "knowledge of environmental laws and policies, interaction of tritium with materials, uranium storage bed technology, and expertise with reactive metal getter beds of various types (molecular sieve desiccant beds, catalytic oxidation systems) but also had to have experience with radioactive gas storage and handling, tritiated gas holding systems and tritium detection and measurement.

In addition to the above mentioned experience the following guidelines had to be met:

1. All welding and inspections for this project had to be completed in accordance with ASME B31.3 Category "D".



TRS on the computer screen

Tritium Oxidizing System (TOS)

2. Human factors design considerations had be performed in accordance with the American Glove box Society Guidelines for Glove boxes, AGS-G001.
3. Material and material fittings had to be per ASTM national standard.
4. Helium leak rate shall be at most 1 x 10-6 standard cubic centimetres per second.

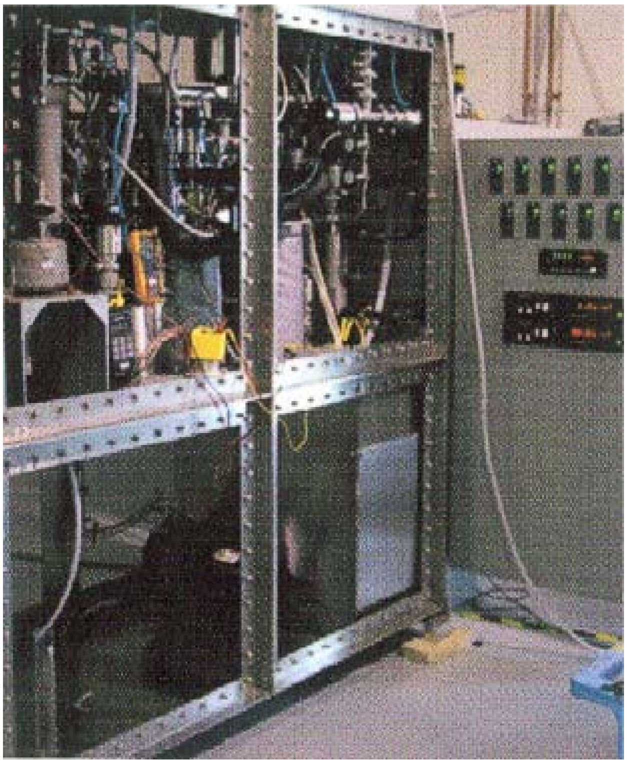
One of the challenges for MBRAUN was to take its commercially available unit and fit it inside the customer supplied containment assembly. The physical footprint of the containment assembly was 81" tall x 74" wide x 36" deep. The upper portion of the system housed the purification portion of the unit while the lower portion of the assembly housed the waste drum container. Modelling the system in PRO ENGINEERING was a big adventure to accommodate this customer's request.

**System requirements of the TRS for the STAR Facility**

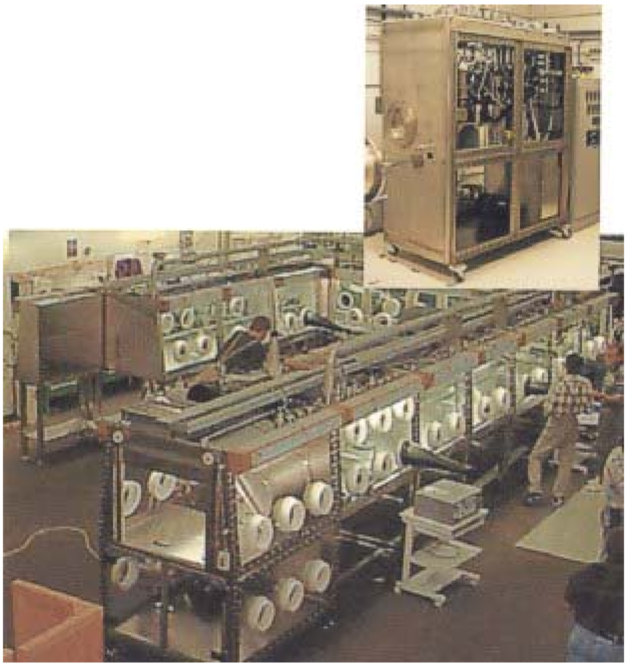
The Tritium Recovery System takes gases purged through glove boxes and gaseous effluents from experiments and processes them. The gas constituents consist of any combination of Nitrogen (0 - 100%), Helium (0 - 100%), Hydrogen (0 - 100%), Halides (traces, less than 100 ppm), Argon (0 - 100%), Air (0 - 100%), Water (0 - 20%), and Tritium (0 - 5 %). The TRS processes the incoming flow of gas at a nominal steady flow rate ranging from 4-200 litres/min. The input process gas stream is mixed with dry air converting hydrogen and tritium chemical species to the oxide form (tritiated water). The system uses a catalytic process to make this conversion. The tritiated water from the catalysts is then removed from the process stream by adsorption on redundant molecular sieve beds. During the regeneration cycles of the molecular sieve beds the tritiated water is pulled off the columns into the waste drum. Lastly, the processed (de-tritiated) gas passes through a single outlet valve to the STAR exhaust system. Measuring tritium concentrations in the inlet and outlet process streams is done continuously.

The Tritium Management System is comprised of the following main parts:

- Containment System (ventilated Glove box and Hood), supplied by Ineel
- Tritium Oxidizing System (Catalytic Oxidizing Beds)
- Water Capture System (Molecular Sieve Beds)
- Water Collection and Disposal System (Waste Container)
- Control Interface and Data Logging



Water Collection and Disposal System



Water Collection and Disposal System

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**Containment System**

The containment system houses all the components of the TRS except for the controller and operator console. The Containment System comprises a ventilated glove box that houses the TRS assembly and an attached ventilated Hood housing the waste disposal drum. A pass box provides the means to transfer materials from the ventilated hood to the Glove box interior. This system protects workers from inadvertent tritium exposure during normal and maintenance operations. The connection with the disposal drum is located beneath the fume hood portion of the containment system.

A means of transferring the water from the measurement station to the disposal drums minimizes the release of HTO vapors. The closed-head Stainless Steel Drums are General Containers N430HF18-CU.

**Tritium Oxidizing Subsystem**

Tritium Recovery Systems (TRS) combine gases flowing from experiment processes and connected glove box atmospheres prior to transferring these gaseous effluents to the Tritium Oxidizing Subsystem (TOS). A manual valve and a mass flow device control the introduction of dry air for optimal conversion of hydrogen/tritium species to the oxide form.

The Tritium Oxidizing System uses a catalytic process to convert all hydrogen and tritium species in the input gas stream to the oxide form (tritiated water). The TOS is made up of a redundant catalytic oxidizer system (one bed in service, one bed in standby mode). Monitoring and controlling the bed temperatures enable an optimal operating efficiency for conversion of elemental and organic tritium gas to water vapor. The monitoring of these beds is crucial to the application. The Oxidizing System is equipped with an automatic switch operation. In the event of Oxidizing System inlet flow is detecting alarm levels of tritium concentration at the exit flow ion chamber. Each bed is capable of converting elemental and organic hydrogen isotopes to water with sufficient efficiency in a gas stream of up to 200 litres/min with tritiated molecule concentrations. Visual indication at the control terminal is provided so that the user is aware of which bed pair is in process use and which bed pair is in a regeneration/idle state. Visual alarms indicate failure conditions in this sub-assembly.

**Water Capture System**

The water capture system consists of a parallel arrangement of two molecular sieve bed pairs with each pair consisting of a main bed and a polisher bed. This subsystem removes the moisture in the process stream from the oxidizer bed subsystem. This subsystem is made up of a parallel redundancy of main and polisher beds (one bed pair in standby mode or regeneration while other pair is on-line). Due to the high temperature of the process gas after oxidizing, the gas stream is then cooled to a temperature compatible with the molecular sieve beds optimizing the removal of HTO. Each molecular sieve bed is capable of holding 1 liter of water at 60% capacity at ambient temperature. Monitoring water concentration in the process gas between main and polisher bed for each bed pair is continuous. When the water concentration at the exit of the main sieves reaches 5% above the value measured at the start of bed service, a signal to initiate regeneration is activated. This is considered to be a break-through.

Upon reaching this designated sorption loading a bed pair is regenerated by a reverse purge of the bed train with dry nitrogen while the bed is heated to sufficient temperatures releasing the absorbed water and restoring the beds to the original dry condition. Lastly, during molecular sieve bed regeneration the water is then transported from this subsystem to the water collection subsystem.

**Water Collection and Disposal System**

The Water Collection and Disposal System collects the water extracted from the molecular sieve bed subsystem during bed regeneration and provides the means to transfer the water to a waste disposal drum. This subsystem consists of a gas/water stripper unit, a water collection vessel equipped for sample extraction, and a means to transfer water to a waste disposal drum.

Manually operated valves and interconnecting plumbing provides for the transfer of tritiated water from the water collection vessel to the waste disposal drum without exposing water to the TRW Containment System or laboratory environment. Samples are removed from the collected water and its tritium activity is measured by scintillation counting. The collected waters volume is then measured to an accuracy of 2mL. This removal and collection accounts for at least 90% of the water in the nitrogen process stream from the regenerating molecular sieve beds.

**Instrumentation and Control**

Instrumentation and Control for the TRS included all sensor/monitoring devices, control devices, programmable logic/software control hardware, user interface software and hardware and all associated cabling and wiring necessary to meet the monitoring and control requirements for the TRS, all its subsystems, and TRS interfaces. The real time data logging package that MBRAUN uses is a Siemens Win CC package.

The Operator Console provides a graphical interface for viewing the TRS, monitoring device stated and manipulating the TRS control devices.

The levels for Tritium, Moisture, and Hydrogen along with the complete physical P&ID layout of the system (including all monitoring and controlled devices, plumbing, and relative physical locations), are displayed on the graphical interface allowing the end user to monitor and log:

1. The concentration of Tritium in gas upstream of the Oxidizer System and downstream of Water Capture System.
2. Bed temperatures of both the Tritium Oxidizing System and Water Capture System.
3. Pressures indicating a delta-P calculation across the Tritium Oxidizer Bed and the Sieve Bed assembly.
4. Water concentration in process gas between main and polisher bed for each bed pair.
5. Electropneumatic valves which are operated with dry nitrogen gas. Electronic indicators allow the facility data system to interrogate and record the status of each valve at any time through a standard electrical interface (e.g., RS232 or similar). Normally-open and normally-closed valves shall be selected such that, in the event of an electric power or gas supply failure, process gases will be confined to the TRS and not allowed to leak into the glove box or the room or back into the experiments from which they originated.

The interface includes a data archiving function that provides users the means to store any/all monitored device values and(or controlled device states automatically at a user selectable sampling rate of 1, 5, 15, 30, or 60 seconds, continuously and indefinitely, or at a rate of "no sampling'" (i.e. infinite seconds). All sampled data is archived in discrete records, each record representing a sample collection time.

**Additional Criteria**

1. Connections to the manifold carrying glove box atmospheric gases and the manifold to the exhaust system from the TRS fit 2-inch 304L stainless steel pipe..
2. The TRS is in a default "safe" state in the

event of loss of electrical power for controls, other devices, or both. A "safe" state is defined as maintaining control of all gas and liquid concentrations and pressures within the TRS with no leakage to the surrounding containment atmosphere.

3. Provide monitoring and controls necessary to maintain process gas stream hydrogen concentrations below 2%, half the LEL (Lower Explosive Limit), throughout the TRS while controlling the valves directing flow into or around the TRS through a bypass path into the facility exhaust system.
4. Controls to isolate and stop flow into/out of TRS in the event of TRS failure.
5. All replaceable components that contain tritium are double-valve isolated to prevent tritium release during maintenance or replacement activities.
5. A dry pump evacuates the TRS process loops to an ultimate pressure of less than 1 mbar by discharging into the STAR exhaust system duct at ambient pressure.

**Summary**

Whether it is Oxygen, Moisture, Nitrogen, Tritium, or other contaminates that give you problems, give MBRAUN a call. We have the solution. It is with our passed experience with facilities such as the Idaho National Engineering and Environmental Laboratory (INEEL), Savannah River (SRS), The Tritium Lab-Karlsruhe (TLK), and others that MBRAUN is able to offer a total solution.