Form 2 (to be reported to Committee on Countermeasures for Contaminated Water Treatment and to be disclosed to public)

Technology Information

Area: (2) Treatment of Contaminated Water (Tritium, etc.)

Title: "The Solution to the Problem of the Tritiated Water"

1 Overview of the Technologies (features, specifications, functions, owners, etc.)

<u>The Solution to the Problem of the Tritiated Water</u>

The Canadian designed CANDU power reactors have been built and operating safely in many countries around the world since the late 1960's. This design inherently produces tritium during normal operation. As a result, a number of companies in Canada have become experts at various technologies to safely isolate and contain tritium. They have studied the various methods available, and the suitability for use in similar-scale projects for contaminated ground water. They have determined that a process called Combined Electrolysis and Catalytic Exchange (CECE) is the most proven, most practical, most cost effective and the safest technology available to purify large quantities of water, that is contaminated with tritium.

This CECE process has been refined over many years and successfully employed in numerous facilities around the world.

Although much of the foundation for the technology, the basic research etc., was developed by AECL at Chalk River, Tyne has worked with AECL to develop and design practical, large scale industrial size facilities for the removal of tritium from light water.

In fact, the first commercial facility using the CECE process, which is still operating today, was designed and built by Tyne Engineering Inc. in Texas, U.S.A. A light water detritiation facility with a many times larger capacity was subsequently designed by Tyne in collaboration with AECL. This larger facility is ready for immediate construction and is recommended as the first module of the proposed facility. This provides the fastest possible path to the start removing tritium from the contaminated water at Fukushima.

In order to complete the clean-up in the shortest time possible and with the minimum risk, the entire facility will be built of independent modules. As soon as each module is built, it will go into operation and increase the rate of processing, until the facility can process a total of 400 tons/day. This approach will start decreasing the volume of contaminated water at the earliest possible date and achieve complete detritiation of the accumulating water in the shortest time possible. The CECE process is relatively easy to modularize.

While the first module is being built, the design and manufacture of subsequent modules will be ongoing.

The facility does not release the tritium to the atmosphere, nor bury it, nor hold it as a liquid in tanks that might eventually leak. Instead, the final step will lock the tritium in metal hydrides that do not release the tritium even if exposed to the atmosphere or water. Essentially, the tritium will become an intrinsic part of a metal. It can only be 'driven' out of the metal hydride with extreme heat. This is the same process used around the world to store tritium for shipment by road or rail.

The entire tritium content of the contaminated water can be stored in a small number of standard, stainless steel containers that are easy to store securely. The canisters of tritium hydrides do not need any cooling (since there is miniscule decay heat generated by the tritium) and the residual radiation given off is a type of radiation (beta) that is easily blocked by any thin layer of metal.

The vault will be built as an integral part of the Fukushima Tritium Removal Facility so that transportation of the canisters is not required.

The entire tritium removal facility can be built on the Fukushima site, or beside it, so that transportation of the contaminated water is not required.

The process itself does NOT employ any dangerous or toxic chemicals, which might possibly be released into the environment. The CECE process itself is designed to release only oxygen to the air.

The other emissions from the facility to the environment will be mainly CO2, since the facility is designed to supply the power required for it's operation through turbine generators (TGs). But the emissions are minimized because the turbines will use the hydrogen created by the electrolyzers for fuel. Burning hydrogen creates only water vapour. Some additional fuel, such as natural gas, will be required to supplement the hydrogen fuel, so the exhaust from some of the TG sets will be scrubbed to meet local pollution standards.

The CECE process does not require high temperatures, since electrolyzers are used to turn the water into gases, nor does it require high pressures.

The process is fundamentally quite simple. Electrolyzers split the water into oxygen and hydrogen. The hydrogen carries the tritium with it, which is then passed over a catalyst. This concentrates the tritium, until it can be isolated and eventually passed through the getter beds where it is trapped as a solid hydride in a metal. The hydride material is then stored in small containers, which require no cooling and give off no radiation.

In summary:

- This well proven process has been used commercially and construction can start immediately.
- The design can be scaled to reach the maximum required rate of processing required (400 tons /day).
- There will be no harmful chemical or radioactive emissions, (other than some CO2 which is also minimized).
- It will be built to meet all local conventional and nuclear codes applicable, including radiological, seismic, environmental, etc.

- It is inherently safe process, but will be built to nuclear standards with numerous safety features.
- It will maximize returns to the local economy, since we will partner with a large Japanese company for manufacture and construction.
- It will result in the safe storage of the tritium trapped in a metal which cannot be released even if exposed to air.
- The metal hydrides with the tritium will be in stainless steel containers rated to withstand impacts, and which give off NO radiation (they block the beta radiation from the tritium) and do NOT require cooling.
- The containers will be stored in a vault the size of a small room.

2 Notes (Please provide following information if possible)

-Technology readiness level (Including cases of application, not limited to nuclear industry, time line for application)

The technology has been studied and used in the Canadian nuclear industry for years and has been applied at a number of industrial size facilities. There is a plant operating in Texas, U.S.A. which utilizes this technology, and other, larger plants have been designed.

-Challenges

The technology is known. A facility can be built. The challenge is to do so as quickly as possible.

-Others (referential information on patents, if any)