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

Technology Information	
Area	5, 6 (Select the number from “Areas of Technologies Requested”)
Title	**CONTROLLING GROUNDWATER FLOW AT THE FUKUSHIMA SITE WITH A NATURAL MINERAL BARRIER CAPABLE OF IMMOBILISING STRONTIUM AND CAESIUM**
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1. Overview of Technologies (features, specification, functions, owners, etc.)

Australian Government

ansto

EARTH SYSTEMS
Environment | Water | Sustainability

CONTROLLING GROUNDWATER FLOW AT THE FUKUSHIMA SITE WITH A NATURAL MINERAL BARRIER CAPABLE OF IMMOBILISING STRONTIUM AND CAESIUM

Prepared for

INTERNATIONAL RESEARCH INSTITUTE FOR NUCLEAR DECOMMISSIONING (IRID)

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INTRODUCTION

The Australian Nuclear Science and Technology Organisation (ANSTO), an Australian Federal Government agency, in collaboration with Earth Systems Pty. Ltd., an Australian environmental technology and consulting company, are pleased to submit this preliminary proposal to introduce IRID to a new groundwater flow control technology that may have application at the site of TEPCO's Fukushima Daiichi Nuclear Power Station.

NEUTRAL BARRIER TECHNOLOGY (NBT)

The technology is referred to as Neutral Barrier Technology or NBT. It involves the preparation of a proprietary mixture of solids into a low-viscosity slurry, controlled injection of this slurry into an aquifer and strategic neutralisation of the slurry with a gas mixture. Barrier formation is instigated at the zone of slurry-gas interaction and is comprised of natural carbonate and silicate minerals which progressively occlude porosity in the aquifer. As porosity is lowered, fluid flow (liquid and gas) is focused in residual pathways, thereby **providing the barrier technology with a self-seeking, self-sealing capacity.**

Horizontal and vertical groundwater barriers may be constructed in-situ with minimal reagent consumption.

APPLICATION OF NBT TO FUKUSHIMA

Having the ability to control groundwater flow provides many benefits at the Fukushima site. Initially, it is envisaged that the NBT could be deployed to prevent groundwater inflow to the reactor buildings, by installation within the aquifer up hydraulic gradient of the reactor buildings. Using the barrier to direct groundwater flow to an extraction zone or even a permeable reactive barrier zone, could dramatically simplify current groundwater management strategies. Simply using the barrier to constrain water while up-gradient extraction bores direct flow to storage tanks or eventually a treatment plant could also lower risk and management costs.

Several other applications of NBT can be considered, particularly as a longer-term, low cost replacement to the proposed groundwater ice wall encapsulating the reactor buildings.

BENEFITS OF NBT

The NBT offers many benefits over conventional groundwater barrier systems. These include:

- Lower cost implementation in many situations;
- Can be installed in both consolidated and unconsolidated geological formations;
- Low number of injection wells required is faster to deploy than close spaced drilling required for grouting;
- Low reagent consumption;
- Horizontal injection bores can be used for the gas mixture injection in many situations;
- When a barrier starts to form, groundwater flow diminishes thereby forcing flow to adjacent areas where further reaction and barrier formation occurs - the self seeking principle;
- Aquifer definition requirements are much less than grouting because of self seeking NBT formation;
- TEPCO's Fukushima site may offer the potential to install and operate injection wells quite remote from the barrier installation site, thereby minimising the exposure of operators;
- Radiogenic strontium can be induced to precipitate as a carbonate mineral during the barrier installation process;
- Reactive compounds can be added to the proprietary solids mixture to ensure that radiogenic Cs can also be immobilised in the aquifer, particularly proximal to the groundwater barrier.
- The NBT can also be adapted to create a reactive barrier if required, to remove radiogenic Sr and Cs from groundwater;
- Recirculation of low activity groundwater by irrigation & evaporation on 35m plateau to reduce water volume for treatment & storage,
- In the longer term, it may be possible to replace the ice wall technology with an inert mineral barrier (NBT) that has no ongoing costs.

2. Notes (Please provide following information if possible.)

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

ANSTO worked with Earth Systems during the laboratory research stage of technology

development, and Earth Systems subsequently took the technology and conducted full-scale field implementation at a contaminated site and a mine site in Australia. In spite of successful field demonstrations, the groundwater control technology has yet to be commercialised.

- **Challenges**

  - Scaling the existing field demonstration to the large scale necessary at Fukushima.
  - Choosing an optimal reagent injection configuration.

- **Others (referential information on patent if any)**

http://earthsystems.com.au/research-and-development/neutral-barrier-technology/
Patent No.: US 6,648,551 B1
Key application know-how is further supported by in-house knowledge and expertise developed during the full scale field demonstrations.

【Areas of Technologies Requested】

(1) Accumulation of contaminated water (Storage Tanks, etc.)
(2) Treatment of contaminated water (Tritium, etc.)
(3) Removal of radioactive materials from the seawater in the harbor
(4) Management of contaminated water inside the buildings
(5) Management measures to block groundwater from flowing into the site
(6) Understanding the groundwater flow