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

Technology Information	
Area	2 (Select the number from "Areas of Technologies Requested")
Title	BENTONITE ABSORBER BLOCKS
Submitted by	SMITH ENGINEERING (GB) LTD

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

Bentonite Absorber Block (BAB): Summary of Technical Specifications.

The BAB is a high-precision, engineered cement-based radionuclide absorbing and retaining system. An alternative name for the BAB is radionuclide ***getter*** because the material actively sorbs, and subsequently retains, radioactive cations within the structure of the BAB by three different groups of physico-chemical mechanisms:

1. Wettability, Porosity and Capillarity
2. Depressed radionuclide solubility and transport due to elevated pH
3. Cation lattice retention

Taking each of these in turn:

1. Wettability, Porosity and Capillarity

The key to understanding the performance of the BAB is that the Bentonite is extensively shear mixed in the initial manufacturing stage of the cement-based block. This energy intensive process is crucial in hydrating and uniformly dispersing the Bentonite at the microscopic level within the pre-cure slurry.

Curing the BAB requires a special process in which the cementitious material is progressively cured as the Bentonite is de-hydrating. Too fast a cure results in a block with low porosity (less than 40% pore space) which will not dry adequately for use. Too fast a cure will result in a friable, weak block unable to support its own weight. In addition to controlling the cure-time, it is essential to regulate the cure-temperature during the manufacture.

When correctly cured, the BAB has a remarkable porosity, typically in the range 68% to 70% of the block volume. The cured BAB material is engineered to be strongly water-wetting. The exceptionally high pore volume (>68%) is highly interconnected at the microscopic scale. This combination of strong hydrophilic (water wetting) characteristic and inter-connected microstructure therefore exerts very high capillary pressures on any accessible aqueous media. In simple terms, the BAB sucks up and retains water – and dissolved cations – like a sponge.

2. **Depressed radionuclide solubility and transport due to elevated pH**

Once the BAB has imbibed (become fully saturated) with an aqueous fluid, the cement chemistry rapidly increases the pH of the pore fluids to values around
pH 12. This dramatically reduces the solubility of all radionuclides (except halides), thereby reducing potential for subsequent transport (release) out of the BAB.

3. **Cation lattice retention**

Radionuclide cations are sorbed and incorporated structurally within the molecular lattice of the re-hydrated Bentonite molecule. Radionuclide cations are therefore retained within the BAB by three independent and synergistic mechanisms – high capillary pressure, elevated pore fluid pH (resulting in reduced solubility) and one-way cation exchange into the Bentonite molecular structure.

To date, British Nuclear Fuels has used tens of tons of BAB to sorb low level waste for permanent disposal at the UK's licensed nuclear waste repository at Drigg, near Sellafield. BAB is a safe, proven and cost effective system for sorbing and retaining radioactive water. Its inorganic chemistry ensures that numerical modelling of radionuclide transport over the long-term is not hampered by complex and unknown organic decomposition reactions. Behaviour of BAB is simple, safe and predictable.

The manufacture of BAB has two crucial steps. These are pre-cure shear mixing and subsequent control of the cure process. The full process can be replicated abroad under licence to manufacture BAB on site. Alternatively, BAB continues to be manufactured in the UK and is available for export.

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1. Notes (Please provide following information if possible.)
- Technology readiness level (including cases of application, not limited to nuclear industry, time line for application)
TRL 5

- Challenges
- The existing blocks are 4.7 litres and will absorb 3.5 litres of liquid.
A 200 litre drum filled with blocks will absorb 140 litres of liquid.
- The procedure would be to fill the drums with discs of blocks and pour the liquid on to

the blocks. The liquid is absorbed fairly quickly, and will be in a no leak condition. For example tritiated waste could be made leak proof until such time that the tritium would have decayed sufficiently for landfill. The low level pcm waste liquid is locked using this material at some disposal sites in the UK.

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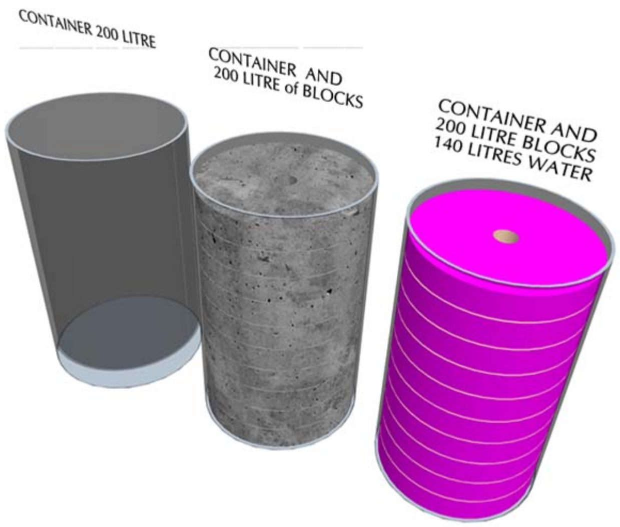

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- Others (referential information on patent if any)
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【Areas of Technologies Requested】

(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