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FOR
IMMOBILIZING HAZARDOUS WASTES

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The Cement and Concrete Applications Group (CCAG) at the Oak Ridge National Laboratory (ORNL) has developed versatile and inexpensive processes to solidify large quantities of hazardous liquids, sludges and solids. Using standard "off the shelf" processing equipment, these batch or continuous processes are compatible with a wide range of disposal methods, such as above-ground storage, shallow-land burial, deep geological disposal, sea-bed dumping, and bulk in-situ solidification. Because of their economic advantages, these latter bulk in-situ disposal scenarios have received the most development.

The ORNL's experience has shown that tailored cement-based formulas can be developed which tolerate wide fluctuations in waste feed compositions and still maintain mixing properties that are compatible with standard equipment. The 20-year operational history of the ORNL Hydrofracture Facility has demonstated this resilience and reliability with a spectrum of waste feeds that bracket the developmental history of the nuclear fuel cycle. These bulk in situ solidifications were successfully accomplished using just two cement-based dry-solids blends. The ORNL Hydrofracture process has disposed of over 3 million gallons of intermediate level radioactive liquids and sludges.

Waste streams are usually complex mixtures of elements and compounds, which strongly influence the mix rheology, cementation reactions and final products' durability. Tailoring the dry solids-blend to form a processable grout with adequate performance when it solidifies is necessary.

In addition to cements, these grouts contain pozzolans, clays and other additives to contol the flow properties, set-times, phase separations and impacts of waste stream fluctuation. These additives enhance the waste loadings and decrease the permeability of the re-sulting solidified grouts. These additives also lower the leachability of nuclides and hazardous elements and compoumds. The CCAG has demonstrated the feasability of developing cement-based waste forms with durabilities sufficient to comply with the performance requirements of the DOE 5820 and NRC regulations. Recently, they have begun to examine formulations that would address the "DELISTING" of toxic fly ashes, pickling liqour sludges, stack-scrubber solids and oils contaminated with PCB's, PNA's and pesticides.

Once a fluid, pumpable grout is formulated, there are several disposal scenarios that can take advantage of the economics of the bulk handling of voluminous waste streams. One of these is the ORNL Hydrofracture process that injects the fluid grout into a massive, impermeable Cambrian shale below the reservation. In this process, the grout creates its own disposal space and solidifies in situ within the shale's bedding planes. If the disposal space already exists, the fluid grout would be poured into it and allowed to solidify. Therefore, mines, tanks or even shallow trenches can be utilized in bulk grouting disposal scenarios. These solid grouts have been developed to be impermeable, strong monoliths and resistant to leaching.

The durability of cementitious materials has been demonstrated in millenia of environmental exposures, some of them include 2000 to 3000-year old aquaducts and cisterns. Concrete foundations and tunnel liners have been placed in contact with wide variety of geological formations and geochemical settings. Therefore, there is generally a long environmental exposure history for a proposed grout/host-rock disposal scenario. At ORNL, the examination of 15-year old hydrofracture cores shows no adverse interaction between the solidified grout sheets and the host shale and no measurable diffusion of nuclides from the grout.

In addition to the above scenarios in which the waste and solids are mixed and then pummped into the final disposal configuration, there are three remedial action techniques that use cementitious materials. First, the dry-solids can be pneumatically transfered to decommissioned sludge pits, and the grouts can be mixed with augers to achieve in situ mixing and solidification. In the case where the pit is in an acceptable geological setting, this process can effectively solidify some pit sludges for less than $.10 per gallon. Two other applications are to: 1) inject clean grouts to form an impermeable curtain against ground water flow and 2) inject clean grouts to fill the voids in a collapsing trench, stabilizing its subsidence and supporting its cap.

The cements, fly ashes and other grout components are readily available in bulk quantities and the solids-blends typically cost less than $.05-.15 per waste gallon. Depending on the disposal scenario, total disposal costs (material, capital, and operating) can be as low as $.10-.50 per gallon.