WSRC-TR-2002-00235, Revision 0

Key Words:
Grout
Russian Experience
High-Level Waste Tank Closure

Retention: Permanent

RUSSIAN GROUTING EXPERIENCE (U)

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REPORT DATE: MAY 13, 2002

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Prepared for the U.S. Department of Energy Under Contract Number DE-AC09-96SR18500

This document was prepared in conjunction with work accomplished under Contract No. DE-AC09-96SR18500 with the U. S. Department of Energy.

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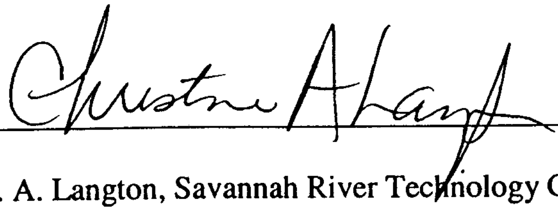
REVIEWS AND APPROVALS



5-28-02

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6/6/02

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1.0 EXECUTIVE SUMMARY

A final report documenting Russian experience in ambient temperature cement-based waste forms, in-tank waste treatment and grout/concrete decommissioning is provided in Attachment 1. The report is titled "The Review of the Russian Experience on Inorganic Binders for Waste Treatment and Tank Closure," and contains technical information concerning:

- An assessment of the properties of hardened cement materials that affect the performance of hazardous and radioactive waste forms.
- A list of additives used to modify the properties of cement-based waste forms.
- The effect of elevated temperature on hydrated portland cement as a function of time and temperatures up to 180°C.
- The effect of radiation exposure on hydrated cement materials as a function of radiation dose up to 6E+09 Rad. Radiolytic gas generation data is also presented and discussed.
- The results of an experimental investigation on the properties of special grout formulations developed as closure grouts.
- Descriptions of full–scale grouting for decommissioning vessels contaminated with radioactivity.
    - Inner tank space of the fuel storage unit on Lepse (service tanker/vessel for nuclear submarines). (Monolith for strength and contaminant immobilization).
    - In-place decommissioning of two nuclear submarine reactor compartments and associated equipment at the Russian Navy Training Center in Paldisk, Estonia. (Radiation shielding and contaminant immobilization)
- Description of in-tank waste solidification for a chemical tank using magnesium phosphate cement.

The Russian experience in aqueous waste stabilization/solidification appears to be limited. The examples discussed in the report are related to work conducted in the recent past or intended for future programs. To date, the Russians have not closed any high-level waste tanks. However, decontamination and repair of a large steel waste tank was discussed. The tank was returned to service after the repairs. In informal discussions, V. A. Starchenko stated that the Russians intend to empty and clean their high-level waste tanks and to then use them as "vaults" for storage of radioactive debris and/or packaged waste/waste forms rather than to fill the tanks with clean grout. Currently the Russians are planning for long-term storage of the low-level waste and for geologic disposal of high-level waste.

The Russian experience in decommissioning large tanks/vessels is also limited to three examples. One example involved pumping grout into the inner tank space in a Fuel Storage Unit on a tanker that serviced nuclear submarines. The concrete was a relatively high-strength concrete which was batched at a central plant and delivered to the docked tanker by truck. The concrete was pumped into the inter tank space. Approximately 6 hours was required to fill the 110 cubic meter void space.

The second example involved decommissioning two nuclear submarine reactor compartments at the Russia Navy training center in Paldisk, Estonia. Two concrete mixes were used for "conservation" of these units. A highly fluid, pumpable concrete mix was designed for filling the compartments. This concrete also contained Shungizit porous aggregate which was intended to dissipate radiolytic gases formed in the high radiation fields associated with the inside of the reactor compartments. A concrete sarcophagi was also constructed over the reactor compartments as part of the "conservation" effort. This mix contained less cement and no porous aggregate since the radiation field was much lower.

Finally, magnesium phosphate cement was used to solidify the radioactive ferrocyanide sludge in a defective tank. The tank had a volume of 3200 cubic meters and it contained 70 cubic meters of sludge with a liquid to solid ratio of 2 to 1. The tank had no mixing capabilities so the magnesium oxide and phosphoric acid were simply added on top of the sludge. As a consequence, crust formed on top of the sludge after the first addition and precluded subsequent additions of the magnesium oxide. However, the solidification of the sludge was sufficient to stop the tank from leaking. Magnesium phosphate cement was selected for this application because of the strong stabilization/fixation properties of the resulting salts (barium, tin, zirconium and thorium phosphates are very insoluble).

The Russian regulatory requirements (in Russian) are provided in Attachment 2. These regulations have been in effect since January 1, 2001. In general the Russian requirements for cement-based waste forms are similar to the US Nuclear Regulatory Commission requirements. An abridged English summary is provided in Attachment 3, in the form of slides from a presentation on "Collecting, Reprocessing, Storage and Conditioning (Treatment) of Liquid Radioactive Waste" by V. A. Starchenko.

The Russian waste form requirements include limits on radionuclides, leaching rates, referred to as water resistance, compressive strength, radiation stability, resistance to thermal cycling, and a durability requirement based on the strength of a sample immersed in water for 90 days. In addition to prohibiting waste with fire or explosive characteristics, wastes that can react with the compounds in the cement to form toxic substances such as ammonium slats are also prohibited. Complete dehydration of high-salt aqueous low-level waste solutions is prohibited per the Russian regulations in order to prevent possible exothermic interaction of the compounds in the dry residue. This sensitivity to management of dry salt waste is applicable to treatment, storage and disposal of calcined waste at DOE facilities.

Strength is used as a measure of durability and performance. Additives used to improve leaching include sodium silicate to reduce overall permeability, zeolites to improve cesium leaching and organic polymers (polymer cements including latex-modified cements) to reduce porsoity/permeability and thereby improve tritium leaching. Pozzolans were discussed for improving matrix properties and alkaline additives were discussed as set regulators specifically for borate wastes.

An interesting concept employed by the Russian grout formulators is to include a porous aggregate, "Shungizit," as a ingredient in waste forms and/or decommissioning grouts exposed to high radiation doses. The purpose of the porous aggregate is to provide for gas permeability through the aggregate. In addition, the matrix portion of these grouts/waste forms is designed to have low permeability to water. This is achieved by a low water to cement ratio in the mix. This type of mix provides a means of venting the waste form so that radiolytic gases do not accumulate while at the same time minimizing the contact between the contaminants and leachate.

The final report on Russian Grouting experience provided an opportunity for international cooperation and access to Russian grouting/waste form experience. The data on radiolytic gas generation form grout mixtures was already used in evaluation of the source of hydrogen and methane generation detected in the sampling ports around the SRS high-level waste tanks in 2002. The concept of venting the radiolytic gases from a waste form by adding porous aggregate is being considered for future cement-based TRU waste forms at SRS.

2.0 BACKGROUND

2.1 OBJECTIVE

The objectives of this work were to document the Russian experience on grouting for waste forms and tank closures or other decommissioning applications. This task was designated as Task H-4 in TFA Work Element 923, SRS TTP SR16WT51 Subtask H. The milestone designation is 923-1.5-1.

The approach for obtaining the Russian experience in ambient temperature waste treatment and in decommissioning tanks and other vessels was to issue a subcontract to the American Russian Environmental Services, Inc. (ARES) for preparation of a report on the Russian experience. ARES contracted the report to Daymos, Ltd. V. A. Starchenko from Daymos was the project manager. N. I. Alexandrov and V. P. Popik were the principal investigators. The final report from Daymos/ARES is attached.

3.0 ACKNOWLEDGEMENTS

This effort was requested and supported by L. Bustard, Sandia National Laboratory as part of the Scope of Work for the Tank Focus Area, Enhanced Grout Program.

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