

Russian Pulsating Mixer Pump Deployment at Oak Ridge National Laboratory

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Russian PMP - Background

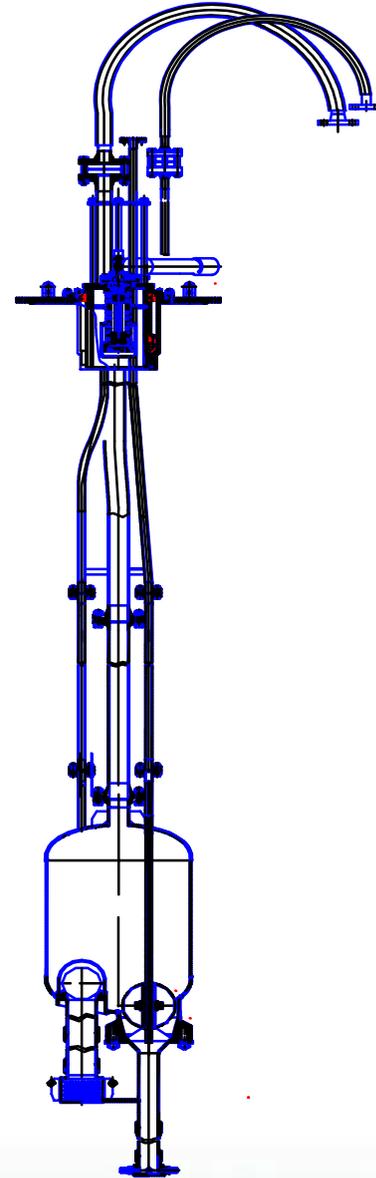
- **FY 1996** – The Russian PMP was identified during a technical exchange between the U.S. Department of Energy (DOE) Tanks Focus Area Retrieval and Closure Program, the DOE Environmental Management International Programs Office, and delegates from the Russia Ministry of Atomic Energy.
- **FY 1997** – Prototype PMP provided by the Russian Mining and Chemical Combine at Zheleznogorsk to Pacific Northwest National Laboratory for evaluation.
- **FY 1998** – PMP technology selected for deployment at the Oak Ridge National Laboratory Gunite and Associated Tanks (GAAT).
- **FY 1999** – PMP design was defined and fabrication initiated.
- **FY 2000** – Fabrication of three PMPs was completed, the units delivered to ORNL, and the initial cold testing completed.
- **FY 2001** – First deployment of Russian made equipment in an environmental restoration activity in the US – planned for October 2000 in GAAT TH-4.

Mixer System Description

- **The mixer system for deployment at GAAT TH-4 consists of the following major subsystems**
 - Russian PMP assembly
 - Tank riser interface (TRI)
 - Decontamination spray ring (DSR)
 - Transport cradle
 - Waste transfer system
 - HEPA ventilation system
 - Support platform

Russian PMP Assembly

- Air distribution via internal slide valve
- Rotary motion via air cylinder
- Air eductor for vacuum supply with discharge inside TH-4
- Pressure vessel fill control via internal level sensor or timers
- Check valve inside pressure vessel
- Flexible hoses for air and water supplies
- Maximum working pressure 230 psi
- PC based Lab View control system interface
- Pressure, flow, level, and position sensors to monitor operation
- Will fit through 22.5-in. diam opening
- Three units fabricated



PMP Fabrication

- **Approval to fabricate to Russian standards**
 - Top level crosswalk of Russian standards to ISO 9000 standards and ISO 9000 standards to ASME standards
 - Detailed crosswalk with ASME standards to Russian standards was not feasible
- **Site visits**
 - Tour/inspection of fabrication shop in Zheleznogorsk
 - Fabrication inspection
 - Witness acceptance testing

PMP at Cold Test Facility

- The PMP is installed in TRI on a platform above the test cell.
- Flexible hoses are used to connect the PMP with air and water feed valves.
- The PMP is shown here suspended above a 20-ft diam. plastic lined cinder block test tank.
- The test tank is used to contain surrogate waste and is prototypic of tank TH-4



Tank Riser Interface (TRI)

- The TRI is constructed of modular aluminum channels (Bosch).
- Mounting plate and elevation table for PMP height adjustments.
- Aluminum and Plexiglas™ panels provide personnel protection and weather protection.
- The control system and valving are on the left side of the photograph.
- Access is provided via two doors on the front and one on the end.
- An electrical disconnect for the drive table and control system is on the end opposite the control system.



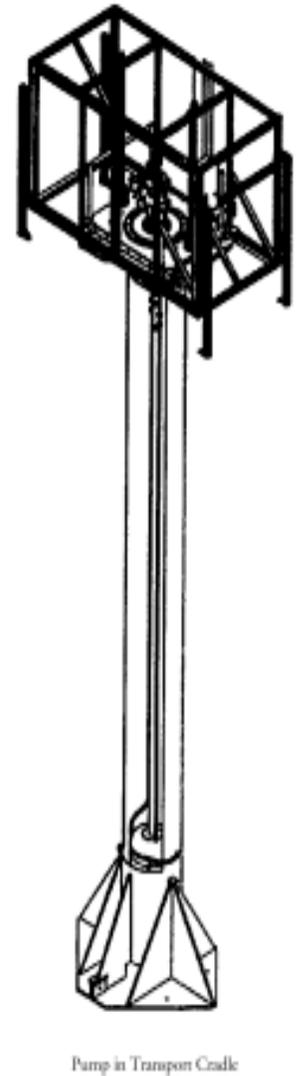
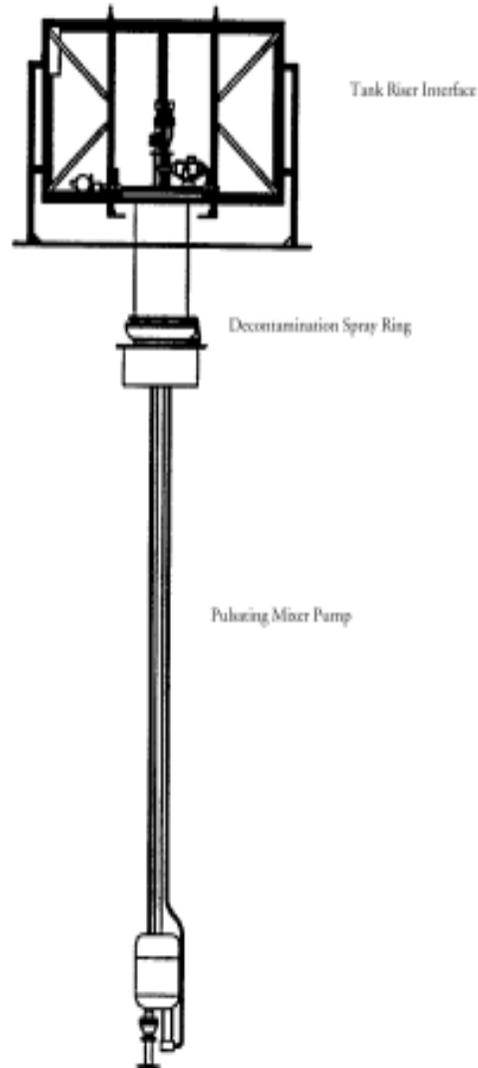
Decontamination Spray Ring (DSR)

- The DSR is mounted on the tank riser.
- Six spray nozzles are installed perpendicular to PMP.
- The system is designed for a maximum operating pressure of 2,500 psi.
- A flexible bellows is used to seal DSR to TRI.



Transport Cradle

- Used to transport PMP and TRI to and from tank site.
- Transport cradle is anchored to base and locked in vertical position.
- TRI and PMP lifted as a single unit and placed in transport cradle.
- Transport cradle pivoted to horizontal orientation for lift onto transport trailer.
- Simplifies handling of PMP while out-of-tank.

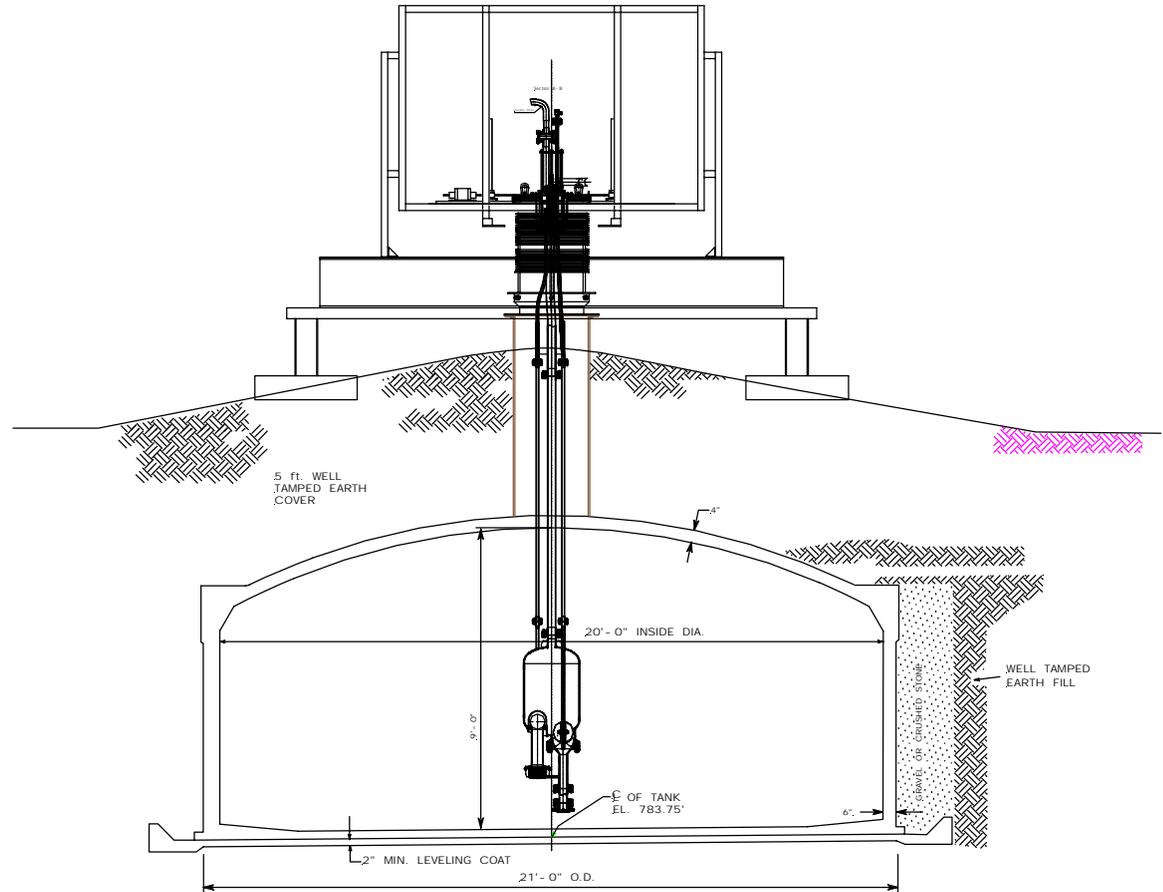


Transport Cradle at Cold Test Facility



PMP Installation at TH-4

- Tank TH-4
 - 20-ft diameter
 - Gunite tank
 - 6.5-ft side walls
 - 2.6-ft dome height
 - ~6-ft overburden
 - Multiple tank risers
 - 14,000 gal capacity
- About 5,500 gal of sludge
- Primarily Th, U, Cs, Sr
- 4 to 6 Ci total activity estimated
- To be installed in October 2000



Participants

- **Equipment fabrication and procurement**
 - **American Russian Environmental Services - Integration subcontractor**
 - **PMP: Mining and Chemical Combine at Zheleznogorsk, Russia**
 - **TRI: Battelle Inc.**
 - **DSR: Battelle Inc.**
 - **Transport cradle: Battelle Inc.**
- **Testing and evaluation**
 - **PNNL – Prototype PMP**
 - **ORNL – PMP for TH-4 application**
- **Deployment and dispositioning**
 - **Bechtel-Jacobs LLC**

Cold Test Plan

- **Pre-Test Inspections**

- Assess the quality of fabrication of system components through review of fabrication documentation, visual and ultrasonic analysis, materials composition analysis, and hydrostatic tests.

- **Functionality Tests**

- Assess the overall functionality of the TRI, DSR, control system components, transport cradle, support fixtures, and contamination control features.

- **Performance Tests**

- Assess the performance of the system relative to debris tolerance, mixing efficiency, decontamination effectiveness, and tank cleaning radius.

Pre-Test Inspection Results

- **In general, the equipment was well designed and fabricated to the required specifications.**
- **The following are examples of items that required resolution prior to testing:**
 - **Weld repairs on the pressure vessels for PMPs 2 and 3 were needed due to undetected weld defects**
 - **Clean-up of weld slag on PMP 1 level sensor thimble**
 - **Replacement of level switches on TRI elevation table**
 - **Replacement of broken and loose components on TRI and PMP 1**
 - **Installation of grease fittings on Transport Cradle pivot points**
 - **Rewiring of TRI drive motor brake**

Functionality Test Results

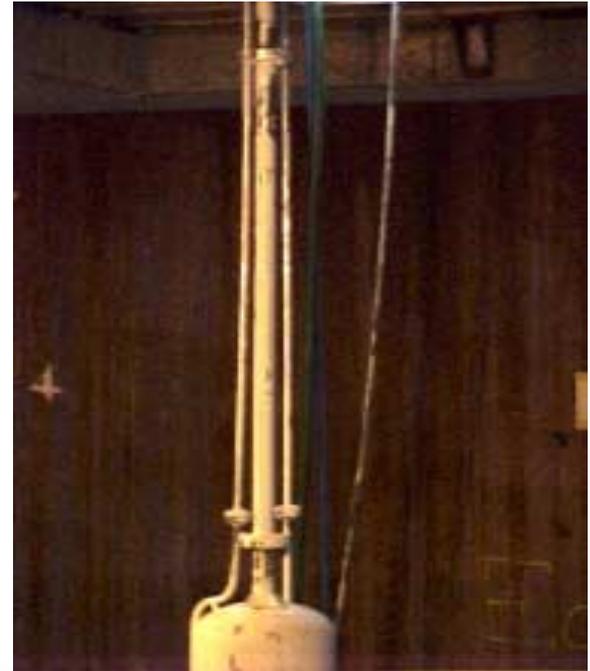
- **All hardware components performed satisfactorily with some minor modifications and replacement of select components to improve operation and reliability.**
 - Added relays to control modules
 - Added emergency stops
 - Moved lift points for TRI
 - Replaced limit switches on TRI
- **Control system programming required rework to improve functionality and simplify operation.**
- **Hoisting and Rigging for removal and installation of the combined PMP and TRI as a single unit can be accomplished.**

Performance Tests

- **DSR operation**
- **Debris tolerance**
- **Cleaning radius**
- **Sludge surrogate mobilization**
- **Mixing/Removal performance**

DSR Operation Results

- Tested up to 1,500 psi.
- An operating pressure of 500 psi appears to be adequate.
- Oriented six nozzles perpendicular to PMP.
 - Flow rate ~2.5 gpm/nozzle for high pressure nozzles
- The DSR can be configured for either low pressure (100 psi) or high pressure (2,500 psi) operation.



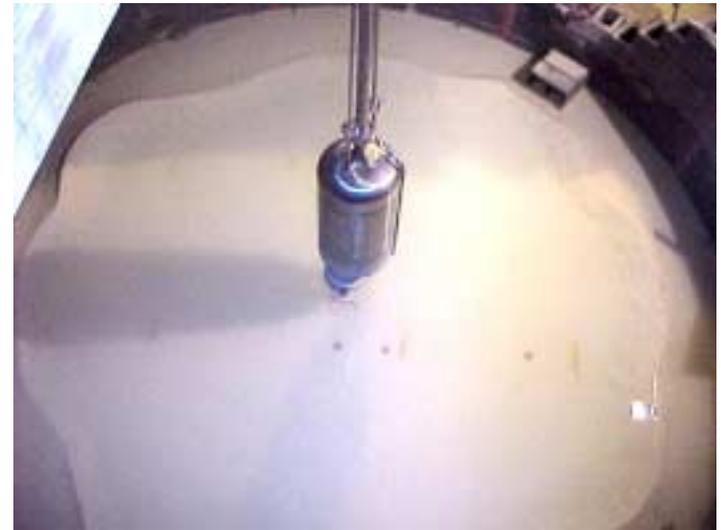
Debris Tolerance

- The PMP was successfully operated for several hours with a variety of debris present in the test tank.
- The debris consisted of items previously observed in waste tanks including the following:
 - 4 plastic bags
 - 12 pair rubber gloves
 - 4, 50-ft lengths nylon rope
 - 100, 12-in. tie wraps
 - 12, 3-ft lengths of wire gauges 10, 12, 14, 18, 22, 24, 28, etc.
 - 12, 2-ft strips of yellow tape



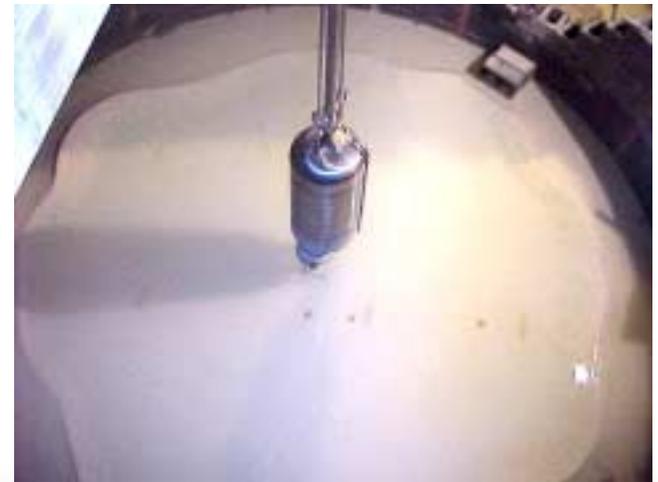
Cleaning Radius Results

- Cleaning radius measurements using 11 and 16 mm diam. nozzles were similar.
- Cleaning radius generally ranged from ~7 to 8 ft with the PMP operating with a 90 psig air supply and stationary.
- Characteristic patterns are formed during 90° rotation with average cleaning radius similar to stationary tests.
- Various materials were used in these tests, including:
 - Medium grain sand (1 to 2.4 mm diam)
 - 0.5-in. gravel
 - Kaolin clay



Surrogate Mobilization Results

- Kaolin clay and sand were used in mobilization tests.
- Various water depths (~11 to 36 in.) and amounts of clay (up to 2,450 lb) and sand (~500 lb) were used with the PMP positioned ~1-in. from the floor of the test tank.
- The clay-sand mixtures were easily mobilized to the outside walls of the test tank.



Mixing/Removal Performance

- A positive displacement diaphragm pump (70 to 100 gpm) was used to successfully remove the slurry during mixing.
- Recycled clay-sand surrogate was used in this test.
- Samples were taken at various depths during mixing using a long-reach sampler.
- Sample analysis is in progress.
- Visual observation of the samples indicate maximum mobilization and mixing after ~45 min.
- Very little surrogate remained in the test tank. Quantitative estimates are underway.



Further Evaluation

- **Performance evaluation with hard sludge surrogates.**
- **Performance evaluation at various PMP elevations.**
- **Performance evaluation at various operating pressures, up to the maximum allowable working pressure.**
- **Development of bag out procedures for retrieval and storage of the PMP.**
- **Assessment of the effects of plugged discharge nozzles.**
- **Measurement of vibration and stress during operation.**

Conclusions

- **The Russian PMP is capable of mobilizing and mixing soft sludge surrogates similar to the material anticipated in waste tank TH-4.**
- **The modified PMP control system provides improved stability and reliability.**
- **A cleaning radius of more than 8 ft can be achieved for medium grain sand with the PMP operating at 90 psi and positioned 1-in. from the tank floor.**
- **Debris does not seem to be problematic to the operation of the PMP.**
- **The TRI and PMP can be lifted as a single unit.**
- **The DSR is capable of clearing gross accumulations of sludge surrogate from the PMP at an operating pressure of 500 psi.**