

Sludge Handling and Encapsulation Plant at UKAEA Winfrith WETP

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WOMAD EAST Outline Objectives of the Project

- Sludge retrieval and encapsulation project
- Aim is to retrieve, condition, cement encapsulate and export stabilised sludge for interim storage ahead of final disposal
- There is approximately 330m³ of sludge, delivering up to 950 product drums
- Construct the WETP facility which will have a 2 year operating life
- Additional stabilisation of Thorium metal added to project

SGHWR Reactor: Archive Photographs



WOMAD EAST Views of Site with WETP Facility & EAST Building



WOMAD EAST EAST Tanks – before and after enclosure

- Sludge arising from the Steam Generating Heavy Water Reactor (SGHWR) operations – stored in
- External Active Storage Tanks
- Originally open to the elements
- Closed for receipt of effluents around 1991
- In 1996 enclosed within building to provide containment



WOMAD EAST NUKEM-developed 500 litre stainless steel drums



WOMAD EAST Process Overview

- EAST TANKS
 - Storage of sludge
 - Homogenisation of sludge

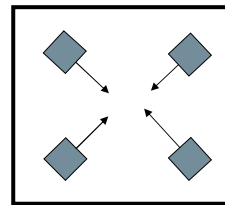
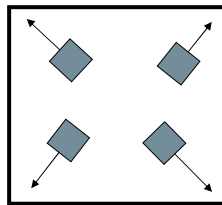
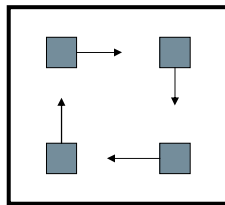
- WOMAD EAST Treatment Plant (WETP New building)
 - Sludge receipt from EAST and conditioning
 - Encapsulation into Drums
 - Capping and lidding
 - Monitoring and export to TRS (Treated Radwaste Store)

WOMAD EAST Sludge Conditioning

- Encapsulation formulation developed by UKAEA
 - Requires sludge to be 24% to 28% w/w solids (tank dependent)
- Settling and decanting of supernatant liquid now used to condition sludge to required specification
- Sampling and analysis of delivered sludge for inventory and demonstrating product quality

WOMAD EAST Sludge Retrieval

- Following conditioning, sludge exists as settled bed in a flat bottomed square tank with overlaying supernatant liquid
- Four submersible 'Flygt' mixers are used to suspend and homogenise sludge prior to retrieval
- Development of improved stirring regimes has significantly reduced the time to homogenise and gave improved consistency of retrieved sludge



WOMAD EAST Sludge Transfer Conditions

- Recovery and transfer of sludge is via a peristaltic pump
- Waste is filtered to 2mm to prevent recovery of debris that may block the transfer pipes
- Typical batch size of 10m³ of sludge
- Transfer at 22 - 30% w/w solids into WETP receipt tank
- Sludge is sampled and analysed for solids concentration upon receipt into WETP

WOMAD EAST Cement Handling Equipment

- A dry BFS:OPC blend (encapsulation) and wet PFA:OPC (capping grout) are produced
- BFS = Blast Furnace Slag
- PFA = Pulverised Fly Ash
- OPC = Ordinary Portland Cement
- Bulk powders held in external silos
- Mass control via loss-in-weight and gain-in-weight feeders
- Delivered and mixed by pneumatic conveying system
- Cement powders delivered to $\pm 2\%$ accuracy



WOMAD EAST Drum Movement Facilities

- Drums handled within the Cell line by In-Cell Drum Transporter (ICDT) and Buffer-Store Drum Transporter (BSDT)
- ICDT and BSDT are virtually identical
 - ICDT operates in 'dirty' end of cell with BSDT in 'clean' end
 - Rail mounted bogies
 - Side shift palletiser arms to pick and place drums
- Facility is divided by shield / containment doors
 - In the event of failure an engineered recovery of doors and transporters is in place



WOMAD EAST Drum import conveyor and Fill Station



- Drum import conveyor position with second drum on a fill station during commissioning
- Note first internal shield door

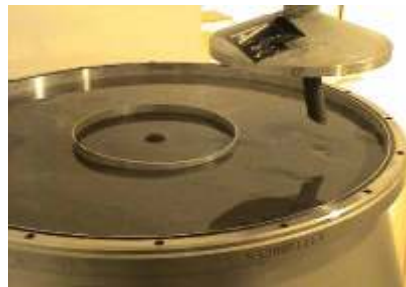
WOMAD EAST Encapsulation procedure

- Client (UKAEA) defined the encapsulation formulation
 - $\pm 2\%$ accuracy
- Sludge metering by peristaltic pump (350 litres)
- Drum Fill Head
 - Drum clamped and sealed in position, suspended from load cells
 - In drum mixing process, using 'lost paddle' technology
 - 9:1 BFS:OPC



WOMAD EAST Grout Capping

- PFA:OPC grout is added as a cap to the drum following initial curing of the encapsulated waste product
 - 3:1 PFA:OPC
- NIREX requirements specify a minimum and maximum grout depth
 - **Grout provides an inactive protective layer between the waste product and the lid**



WOMAD EAST Lidding, Swabbing and Monitoring

- Following setting of the grout cap the drum is lidded
- Bolts (12) are torqued up by pneumatic tooling
- Swabbing confirms the absence of external contamination
- If drums are contaminated they are swabbed clean with using a manipulator
- Dose rates are monitored on contact and at 1m distance



WOMAD EAST Bolting station and shield door



- Drum bolting station and transfer bogie during commissioning with view of internal shield door

WOMAD EAST Swabbing and Monitoring Station

- After the drum is lidded it is moved to the swabbing station
- Drum is placed upon a turntable for swabbing
- Drum is rotated and swabbed for surface contamination levels
- Drum mass is recorded at this station
- Drums failing the swab tests are moved to the re-work station for attention (To date - none).
- Completed drums are moved through the shield doors to a monitoring station



WOMAD EAST Drum Storage & Export

- Finished drums are loaded into shielded overpack for transport to TRS
- Movement of IP2 Containers across Licensed Site



WOMAD EAST Drum Export

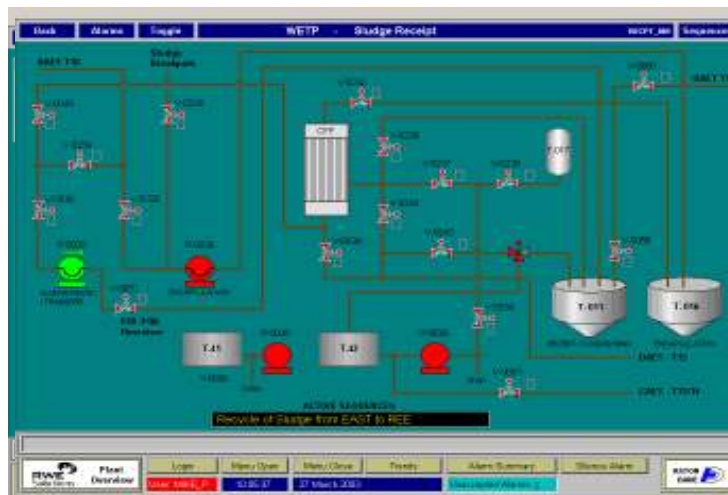
- Formal handover of waste package to Client (UKAEA)
- Drums moved by heavy duty stack truck across Winfrith Site to TRS facility
- Drums loaded into storage tubes inside TRS by programmed crane



WOMAD EAST Process Control System

- PLC based control (8 PLCs)
- SCADA system for operator interface
 - All operations undertaken via pre-programmed sequences
 - Level of access determined by position and SQEP status
- Waste Tracking System (database)
 - Drum recognition system
 - Track drum position in cell during production
 - Build up necessary inventory and process data for individual drum records (supporting NIREX requirements)

WOMAD EAST SCADA Screen Samples



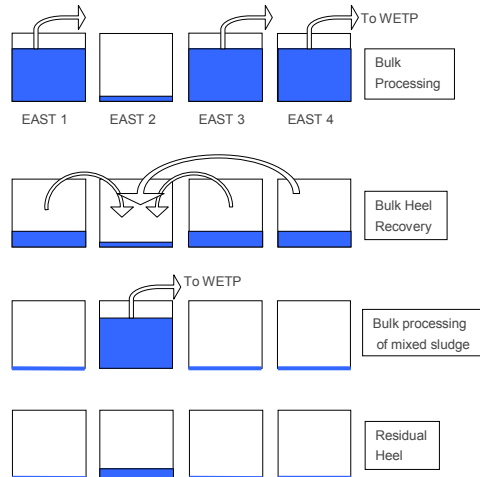
WOMAD EAST WETP Operations

- 10 hour working day, 5 day working week
- Up to 6 drums can be produced per day (2 tonnes waste)
- 644 Drums processed, 70% complete (Feb 08)
- Bulk emptying of the three tanks completed in January 2008
- Tank 3 will hold the 'final heel' from other three tanks

WOMAD EAST Heel Recovery

- Heel is an unrecoverable portion of sludge at depth of about 40cm and lying below installed stirrers range
- Heel material is excluded from the original LoC
- Concept is to combine heels to create one larger volume, suitable for processing using the existing equipment
- Recently obtained NDA RWMD acceptance (LoC) following cementation research to allow stabilisation of 'bulk heels'

WOMAD EAST Planned Heel Recovery Sequence



Typical Items of Recovered Tank 1 Debris



WOMAD EAST Forthcoming Challenges

- Thorium Encapsulation
- Post Operational Clean Out
 - Management of residual sludge
- EAST Decommissioning
 - Waste volume incentives in contract
 - Depth of contamination into concrete?
 - Experience from A59 Active Handling Facility decommissioning
- Return site to Green Field
 - Land remediation

SUMMARY

- Bulk sludge recoveries from EAST tanks completed successfully
- Bulk heel recoveries now in progress and proceeding well
- WETP Plant operating at high availability and drum movements to store proceeding well
- Project objectives being met successfully
- Success to date has been achieved by teamwork and simple safe solutions to the challenges that have been met.