TECHNOLOGIES FOR THE TREATMENT OF TRU WASTE IN THE ADVANCED MIXED WASTE TREATMENT FACILITY

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ABSTRACT

BNFL together with a number of organizations is designing and building the Advanced Mixed Waste Treatment Facility (AMWTF) at the Idaho National Engineering and Environmental Laboratory (INEEL), Idaho Falls, Idaho. It will treat alpha mixed low-level waste and transuranic waste that is currently stored on the INEEL site. Using proven technology, the plant will treat specified wastes but will retain the flexibility to treat other wastes from the INEEL or elsewhere in the US Department of Energy (DOE) Complex. The plant will produce a final waste form compliant with the waste acceptance criteria (WAC) for disposal at the Waste Isolation Pilot Plant (WIPP) in New Mexico.

BACKGROUND

From the early 1970’s until the mid 1980’s, alpha mixed low-level waste (alpha-MLLW) and transuranic (TRU) mixed waste were sent to the INEEL for retrievable storage in the Radioactive Waste Management Complex (RWMC). A volume of approximately 65,000 m^3, of which approximately 40,000 m^3 is designated TRU mixed waste, is stored either in Type II storage modules or above ground in earth berms. The waste is either stored in drums (mostly conventional 55-gallon) or in boxes. The boxes are typically fiberglass-reinforced plywood, although a small number are wood or metal. The Type II storage modules are purpose built stores in which the waste containers are stacked and readily accessible.

The waste itself contains a wide range of material such as debris, paper, plastics, rubber, cloth, sludges and miscellaneous components. Most of the waste is designated as mixed waste, ie it contains both RCRA hazardous waste constituents and radionuclides. Some of the wastes are also contaminated with chemically toxic materials such as polychlorobiphenyls (PCBs), mercury and asbestos that are TSCA-regulated materials.

In 1995, a Settlement Agreement between the State of Idaho, the DOE and the US Navy set the schedule for the removal of 65,000 m^3 of waste from Idaho. With a target date of 2015, the settlement mandates completion of treatment for disposal by no later than 2018. Consequently, the DOE Idaho Operations Office began planning the project to prepare the waste for shipment and disposal. This ultimately resulted in procurement for a privatization project, which BNFL Inc was awarded in December 1996. The award consists of three phases:

- Phase I: Obtaining the necessary preliminary permits and approvals (scheduled for completion April 1999).
- Phase II: Detailed design, development of equipment, manufacture of equipment and construction of a new facility at RWMC (scheduled for completion December 2002).
- Phase III: Retrieve waste and process to the final wasteform. The bulk of the waste will be disposed of at WIPP (to commence March 2003).

The team that will carry out this task has BNFL Inc as the prime contractor working with BNFL Engineering Ltd, Morrison Knudsen, GTS Duratek, Science Applications International Co (SAIC) and Rocky Mountain Remediation Services (RMRS).

AMWTF PROCESS

The basic flowsheet, shown schematically in Figure 1, gives an approximate proportion of the waste going through each unit process.

CAPABILITY

The plant must be capable of processing the original inventory of 65,000 m^3, plus an additional 20,000 m^3, by the year 2015. The start up date is 2003, which means the facility will have an average throughput of 7,000 m^3 per year. The treatment process selected must achieve a volume reduction, against the incoming waste, of 65% to fulfil the contract requirements. The TRU waste will be shipped to WIPP for disposal after certification to meet the WIPP WAC.

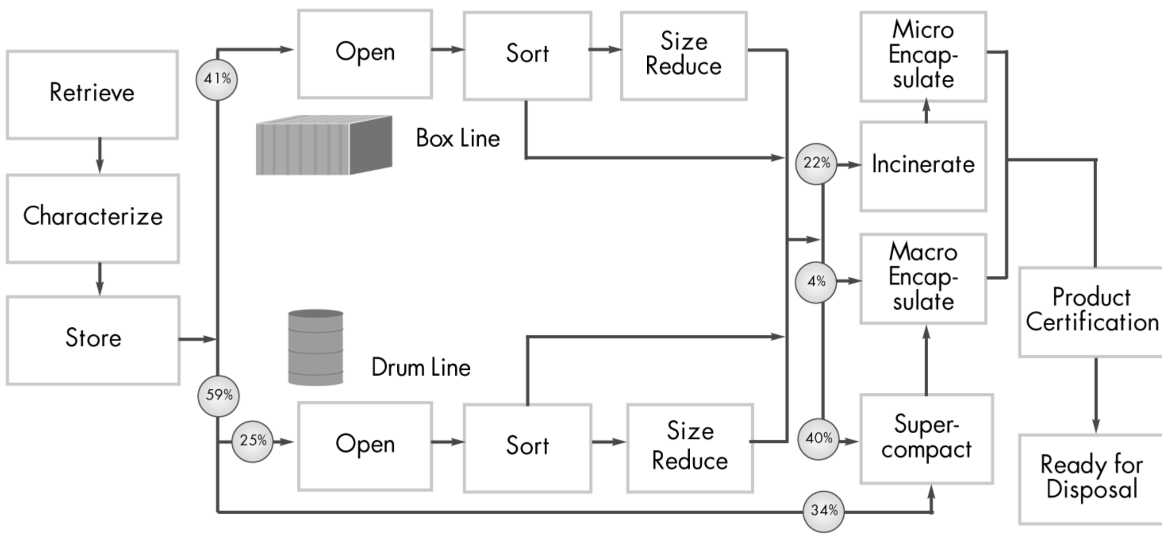
Since the outset of the project, the technologies in the AMWTF flowsheet have been reviewed and modified.

The broad technology areas incorporated into the flowsheet are now as follows:

- Retrieval to recover waste packages from earth berms and removal of containers from the Type II storage modules.
- Characterization to determine contents (metal, plastics etc) and radionuclide inventory.
- Storage of characterized material in boxes and drums to be campaigned through the facility.
- Box opening, storage, size reduction and repackaging in drums.
- Drum opening, where appropriate, to sort and treat.
- Supercompaction of drums of waste.
- Shredding, in advance of incineration, to destroy organics.
- Micro-encapsulation of ash.
- Thermal treatment off-gas control.

The philosophy of technology selection was to employ well-established or proven techniques and avoid the 'invention' of new technologies. Consequently, technology development is restricted to proving the viability of a concept or a piece of equipment for a specific application in the AMWTF.

Figure 1.
AMWTF Schematic Flowsheet



PROCESS STEPS

<u>Retrieval</u>

Of the 65,000 m^3 of waste in the RWMC awaiting treatment by the AMWTF, approximately 11,700 m^3 is stored in a Type II storage modules with the remainder being stored under an earth berm. The waste in the storage area will be recovered with simple and proven equipment, as the containers are expected to be in good condition. To recover the remaining 53,300 m^3 of earth covered drums and boxes, the soil overburden will be sampled (to ascertain its level of contamination) and then excavated. Following excavation, the residual soils will be removed using a vacuum system. This process draws heavily on proven technologies but will require a short program of tests to confirm the performance of the chosen systems.

<u>Characterization</u>

The 85,000 m^3 of TRU and alpha-MLLW to be treated by the AMWTF consists of 254 waste streams that can be divided into a number of categories (see Table I.).

The first step, characterization confirms the content of containers, assists with sorting decisions to prepare the wastes for disposal, particularly those that are going directly to the supercompactor. Drums will undergo real-time radiography (RTR) to confirm their contents. Next radio-assay systems will measure the radionuclide and fissile material (gram equivalents of ^{239}Pu). In addition, the headspace of drums will be sampled and analyzed to detect flammable or explosive gases.

Table I
Waste Types to be Treated by the AMWTF

Process	**Waste type**
Supercompaction	Metal debris, inorganic debris, graphite, ceramics, brick, concrete, organic debris (trash)
Macro-encapsulation	Metal debris (massive items), drum compacts
Incineration	Organic homogenous solids, inorganic homogenous solids, soils
Micro-encapsulation	Ash, recovered salts
Ad Hoc Treatment	Special case and secondary wastes

Whilst some drums can be routed directly to the supercompactor, all boxes will be opened and re-packed in 55-gallon drums. Again, RTR will be employed to gain evidence of the box contents and radiometric assay used to determine the fissile material content.

Further analysis of individual items and packets can be achieved with a x-ray unit. Additional analysis can be carried out for material from both boxes and opened drums, for example, x-ray fluorescence and sampling for analysis in a separate facility.

Storage

The characterized containers may be placed in storage to await campaigning through the plant, or fed directly to the plant. The drums will be campaigned through the plant to facilitate the operation of downstream processes.

Box Opening

Box opening is common practice at a number of locations, including the Waste Treatment Complex at BNFL’s Sellafield site. This plant routinely treats TRU waste in both drums and boxes.

The boxes will be opened and waste transferred to 55-gallon drums with a power manipulator and master slave manipulator equipped box line. Where necessary, the waste will be size-reduced to fit the smaller container. The box itself will be treated in a similar manner.

Supercompaction

Supercompaction is a relatively well-known process for treating drummed waste. The 55-gallon drums selected for compaction will be fed, via a control conveyer system, to the supercompactor. A bolster, marginally larger in diameter than the drums themselves controls the diameter of the compacts. The drums will be compacted using a hydraulic press, operating with enough force to avoid significant spring-back of the compacted waste. The volume reduction depends very much on the contents of the drum (type of material, degree of packing etc) but an average reduction of 5:1 or 80% is anticipated. The compacted drums are placed in the disposal container and moved by conveyor to the encapsulation process area.

Shredding and Incineration

The incineration process for AMWTF will differ from the conventional concept of an incinerator in that it will not burn material of variable composition with high calorific value (eg paper, plastics, rubber etc). Instead, this type of material will tend to be consigned to the supercompactor. Therefore, the major feed component to the incinerator will be either wet or dry sludges.

The first stage, shredding, reduces the feed to manageable dimensions, especially where dried material is to be incinerated. It will reduce the size of larger items such as drum liners and will allow massive items (eg spanners that have found their way into sludges) to be removed. Incineration (pyrolysis) will be carried out and overheads treated in a secondary combustion chamber and ultimately, an off-gas system. The ash or residue produced will be consigned to a hopper.

Encapsulation

Macro-encapsulation surrounds the compacts in their final disposal container and will in-fill any free space. Macro-encapsulation will also be used to immobilize un-compactible, massive items that are placed directly in 55-gallon drums.

Micro-encapsulation is employed to immobilize the incinerator ash and is a blend of Ordinary Portland Cement (OPC) and fly ash that is mixed with water and piped to the drum fill station. The detailed composition and settling times will be determined against a body of data generated to support the encapsulation plants at BNFL's Sellafield site. Drums will be allowed to cure (ie the grout to set), then lidded and transported out of the encapsulation area to a product certification are.

Macro-encapsulation may be regarded as a space-filling around massive items (compacted drums etc) while micro-encapsulation contains the waste (ash in this case) in the grout matrix.

It should be noted that it was originally intended to vitrify the incinerator ash (Ref 1). However as the envelope of waste to be incinerated was narrowed (due to the introduction and use of supercompaction) grouting or micro-encapsulation was selected to immobilize this waste stream.

Thermal Treatment of Off-Gas

In addition to the conventional ventilation for a plutonium facility, the thermal incineration process also presents special challenges such as high temperature, potentially corrosive off-gases etc. The AMWTF will implement a conventional off-gas arrangement to ensure compliance with the discharge regulations. The facility will produce a clean gaseous product (sent to the stack) and a residual solid product. The incinerator’s gaseous product is treated in a secondary combustion chamber to remove particulates and reduce the concentration of EPA- regulated gases (HCl, SO_x, and NO_x) to below their regulatory limit. The unit processes are filtration, quenching and scrubbing, followed by monitoring of the gas before discharge from an elevated stack.

The secondary incinerator wastes (liquid) that are generated by the air pollution control system will be treated in the brine reduction system to form a dry salt product. This salt product is then sent to micro-encapsulation.

TECHNOLOGY REVIEW

The choice of the appropriate technology is the key to the success of the AMWTF. The flowsheet has been reviewed as follows:

- Review by the project team including the DOE Idaho.
- Review by external technical experts with appropriate experience.
- Value engineering studies (ie is this the best way to achieve the objectives?)

A development or demonstration program (as opposed to a Research and Development Program) underpins the flowsheet, since only well-understood processes are being used. The development program is aimed at providing data for process operation and detailed design to support safety and permitting issues.

The development work is targeted at well-defined technical risks, as identified in the Project Risk Register (along with other potential risks) and all development is aimed at mitigating these risks.

SUMMARY

The overall AMWTF mission, which is shared by the team is compatible with the customer's (DOE Idaho) mission, is:

"*As a responsible member of the Community the BNFL team is committed to the safe, timely, profitable and efficient management of the Advanced Mixed Waste Treatment Project, which will prepare waste for shipment from the INEEL.*"

All aspects of this mission are underpinned by technology selection and a development program to ensure each selection is fully justified.

REFERENCES

1. G. HARROP, 'The Advanced Mixed Waste Treatment Facility', Proceedings of Spectrum '98, Denver, Colorado, USA (Sep 13-18 1998).