THE ADVANCED MIXED WASTE TREATMENT PROJECT FLOWSHEET

Robert GG Holmes and Rebecca A Robbins
BNFL Inc.
1970 E. 17th Street, Suite 207
Idaho Falls, Idaho 83404
Telephone: (208) 524-8484
Facsimile: (208) 524-4442
Email: rholmes@bnflinc.com
rrobbins@bnflinc.com

ABSTRACT

The contract for the Advanced Mixed Waste Treatment Project (AMWTP) was let in 1996. At that time, waste was to be prepared for shipment to the Waste Isolation Pilot Plant (WIPP) however, since WIPP was not receiving waste at that stage it was also necessary to prepare the waste to meet Land Disposal Restrictions (LDR). Meeting LDR would produce a compliant waste form, should WIPP not be available to accept the waste. These requirements resulted in an evolution of the flowsheet, in which the waste was immobilized. As a consequence of WIPP accepting waste, Department of Energy, Idaho Operations Office (DOE-ID) relaxed the contract LDR requirement for WIPP bound waste. In addition, public concern about a process step, incineration, that was largely installed for the facilitation of meeting LDR, resulted in a further flowsheet change to accommodate the deletion of the incinerator.

This paper describes the changing constraints against which the flowsheet was devised and details the final manifestation of the flowsheet to satisfy the current requirements.

INTRODUCTION

The contract for AMWTP was let to BNFL Inc. in December of 1996. The contract was to retrieve, characterize and treat a quantity of waste, 54,000 m$^3$, from beneath an earthen berm together with a stored volume of ca 11,000 m$^3$ located at the Radioactive Waste Management Complex (RWMC) at the Idaho National Engineering and Environmental Laboratory (INEEL), for shipment to WIPP. The team that was selected to carry out this task included BNFL Inc. as the prime contractor, together with Morrison Knudsen (MK, now Washington Group International WGI), Science Applications International Corporation (SAIC), GTS Duratek, Rocky Mountain Remediation Services (RMRS) and BNFL Engineering Limited (BEL).

The purpose of the project is to facilitate Department of Energy (DOE) meeting its Tri-party Settlement Agreement with the US Navy and the State of Idaho. DOE is committed to commence shipping waste, from the 65,000 m$^3$ of material, to WIPP starting 1 April 2003, and completing the task unequivocally by the Settlement date of 2018 whilst attempting to meet a target date of 2015. The contract also contained provision for up to 120,000 m$^3$ of additional waste to be processed providing suitable waste could be identified.
THE WASTE

The 65,000 m$^3$ of waste requiring treatment comes from across the DOE complex, although the larger proportion, in excess of 90%, originates from Rocky Flats. The waste was shipped to Idaho from the early 1970s through the 1980s. The waste was initially emplaced on asphalt or concrete pads and later was covered with tarpaulin, plywood and a layer of soil. In the 1990s, this buried waste was covered by a building, the Transuranic Storage Area, Retrieval Enclosure (TSA-RE), which was constructed to facilitate retrieval. A smaller proportion of the waste is located in stores, designated Type II Storage Modules.

The waste itself is contained in two generic container types, boxes and drums. The boxes are of a variety of types (e.g. Fiberglass Reinforced Plywood (FRP) boxes and metal boxes), whilst the drums are predominantly 55-gallon drums although some of these drums have been overpacked in 83-gallon drums. A relatively small number of drums are contained in boxes or bins. The types and number of containers are shown in Table 1. The volume distribution of the waste is 51% is contained in boxes while 49% is contained in drums. The box storage configuration is 18% of the boxes are stored in Type II Storage Modules while 82% is placed in the earthen berm. The configuration for drum storage is 20% of the drums are stored in Type II Storage Modules while 80% is placed in the earthen berm.

<table>
<thead>
<tr>
<th>Container Type</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bin</td>
<td>550</td>
</tr>
<tr>
<td>Drum</td>
<td>127,690</td>
</tr>
<tr>
<td>Box (cardboard)</td>
<td>1</td>
</tr>
<tr>
<td>Box (wood)</td>
<td>8,800</td>
</tr>
<tr>
<td>Box (metal)</td>
<td>2,356</td>
</tr>
<tr>
<td>Other</td>
<td>27</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>139,424</strong></td>
</tr>
</tbody>
</table>

The waste itself consists of a variety of materials typically contaminated trash or scrap (metal, paper, rags, plastic, rubber, etc.) together with immobilized or stored process liquors and contaminated solvents. This latter category is referred to as sludge or non-debris whilst the former is referred to and defined as debris under the Toxic Substances Control Act (TSCA).

The waste, when shipped to INEEL was all designated as transuranic (TRU) which at the time was waste with greater than 10 uCi/g Pu. Subsequently the regulatory definition of TRU has become waste containing greater than 100 nCi/g Pu, resulting in an estimated 60% of the AMWTP waste being TRU waste under the current definition, with the residual being a low-level waste (a-LLW). Additionally, a proportion of the waste is or is suspected of being, contaminated by toxic materials, as defined by TSCA, usually in the larger proportion (ca 98%) potentially falling into the mixed waste category. The distribution of waste types is depicted in Fig. 1.
HISTORY

When the contract was let in 1996, it was planned to pre-treat (segregate) the waste and then treat the organic waste with a thermal desorption process. The resultant product combined with the inorganic waste would then be vitrified resulting in a major proportion of the waste, ca 70%, as a vitrified product consigned for shipment to WIPP. The TRU waste metal debris was to be processed by metals encapsulation with the resultant product being shipped to WIPP. Processes such as metal surface decontamination were considered to enable recycle or reuse of the metal. A representation of this flowsheet is shown in Fig. 2.
The reliance on thermal processes to destroy toxic organics such as poly-chlorinated biphenyls (PCBs) and to produce a vitrified waste form to immobilize both toxic and radiotoxic metals resulted in a careful review of the process. By early 1997, it was established that the debris portion of the waste did not require any treatment prior to encapsulation. It was therefore elected that the debris waste, after pretreatment would be supercompacted and the resultant compacts emplaced in puck drums and grouted to meet LDR. The residual waste was to be incinerated and the resultant ash vitrified. Again, concerns about the use of two high temperature processes (incineration and vitrification) and worries about both the complexity of vitrification together with fears that supercompaction and vitrification might compromise the ability of the project to meet the contractual 65% volume reduction requirement resulted in the adoption of micro-encapsulation of the incinerator ash using a grout matrix (see Fig. 3).

By 1999, WIPP opened and was routinely receiving waste. This prompted a re-evaluation of the need for a LDR complaint TRU waste form. WIPP does not itself demand LDR compliance although on-site storage of TRU waste does invoke the need to meet LDR. Confidence that WIPP would accept TRU waste and a view that shipment of unnecessary grout resulted in a relaxation of LDR for WIPP bound waste.

At this stage the permitting of the facility (AMWTF) had raised concerns by groups of the public, who formed a group called Keep Yellowstone Nuclear Free (KYNF) who expressed strong reservations about the use of an incinerator. These reservations fuelled a lawsuit challenging the process by which the contract was let.

The LDR relaxation and the public pressure resulted in a re-examination of the waste requiring treatment (incineration). LDR relaxation resulted in the WIPP Waste Acceptance Criteria (WAC) and Transportation Regulations to become the key requirement drivers for treatment. Although the nature of the waste is, in detail uncertain, there is sufficient data to suggest that a relatively small amount of waste, ca 2% will require treatment. This low volume ca 1,500m³ enables the treatment to be deferred to the later stages of the project. Furthermore the low volume also allows technologies other than incineration to be considered. The TSCA identifies
incineration for treating PCBs (one component of the waste) as the Best Demonstrated Available Technology (BDAT) but the United States Environmental Protection Agency (EPA) makes provision for an equivalent or superior technology to be employed. The deferral of treatment, facilitated by the lower volume, allows a demonstration of alternative technologies to be carried out.

These assessments allowed the DOE to make a further Settlement Agreement with KYNF, which deferred treatment and set up a panel, known as the Blue Ribbon Panel, whose task was to debate alternatives to incinerating the small volume of waste requiring treatment. This panel is due to pronounce its findings in December of 2000.

A flowsheet was devised that addressed all but the 2% of waste falling under the auspices of the Blue Ribbon Panel.

**CONSTRAINTS**

With the LDR relaxation for WIPP bound waste the constraints placed on the project are the time scales previously described and a move from volume reduction of 65% to a number of shipments to WIPP, to be agreed with the DOE. Each shipment will be based on combinations of TRUPACT II containers and half TRUPACTs on the basis of weight. Our assessment is that the optimum configuration to maximize the weight and volume of our waste to be shipped is two TRUPACT II containers and one half TRUPACT although other combinations will undoubtedly be used (eg 3 TRUPACT II containers), 2 TRUPACT II containers per shipment etc.

The other constraints are derived from the WIPP WAC (1) and United States Department of Transportation (DOT) regulations (2, 3). The loading may be modified by the wattage of the waste (2,3) but will be limited by those criteria that exclude waste from acceptance at WIPP or shipment. These includes waste having the following characteristics:

- > 50 ppm PCBs
- > 1% Free Liquid
- > 5% H₂ in container headspace
- >500 ppm flammable VOCs in container headspace
- Reactives

**FLOWSHEET**

The flowsheet to meet these criteria is shown in Fig. 4. Key features of this flowsheet are described below.
Waste retrieved or in the Type II storage modules will be characterized to build up an inventory of feed to the facility. The characterization steps are:

- Real Time Radiography (RTR) to establish the nature of the waste or to confirm the contents of the container.
- Assay of drums and boxes by Passive and Active neutron interrogation coupled with high-resolution gamma spectroscopy to establish the fissile content of the waste.
- Head gas sampling to identify VOC drums and those that have generated significant levels of radiolytic hydrogen. It is assumed that boxes will not sustain significant concentration of volatiles.
- Coring and sampling 'sludge' drums to establish their contents.

Characterized containers will be stored until they can be sequenced through the facilities for shipment. Characterized drums will be consigned to the supercompactor for size reduction, although a proportion of the drums will be sent to the facility to be inspected to confirm the waste type ascribed to the drum by RTR. These drums will be drawn exclusively from the debris moiety of the drummed waste. Debris waste drums that have been overpacked because the integrity of the primary drum is suspect will be introduced into the facility to prepare the waste for supercompaction (either by removing the 83-gallon drum or repacking the waste in a 55-gallon compaction drum).

Boxes will be introduced to the facility for the contents to be transferred to 55-gallon drums for supercompaction. The empty boxes will be packaged for disposal as low-level waste. The compacted waste will be placed in 100-gallon puck drums. The pucks will be placed in these drums such that the volume and weight capacity of the puck drums is maximized and the puck drum meets the definition of TRU waste (> 100 uCi/g).
The waste that cannot be treated currently, subject to the pronouncements of the Blue Ribbon Panel will be stored awaiting an appropriate treatment route.

The remainder of the sludge, or non-debris, will be placed in intact drums, into primary containers called Ten Drum Overpacks (TDOPs). These containers accept 10 x 55-gallon drums or 6 x 83-gallon drums. A TRUPACT II will accept 1 x TDOP.

Containers with proscribed items or items requiring special treatment (liquid mercury, PCB containing ballast for electric lights, gas cylinders, aerosol cans, free liquids, etc.) will be opened and their contents transferred to storage (proscribed items) or to a jobbing box (Special Case Waste) for treatment.

All free liquids will be sorbed in 55-gallon drums and maintenance waste or protective clothing in 55-gallon drums will be treated as non-debris or debris respectively.

POSSIBLE TREATMENT ROUTES

The small volume of waste that will require treatment is currently being considered by the Blue Ribbon Panel. The waste might be dealt with in a number of ways. These include:

- Treatment by an appropriate technology
- Relaxation of disposal criteria
- Treatment along with other mixed wastes

The project made no provision in its current flowsheet, as of November 2000, for this small volume of waste. From assessments made within the project it is clear that there are technologies the Blue Ribbon Panel might choose to identify as candidate alternatives to incineration. A typical candidate is steam reforming although others might suggest themselves (eg solvated electron technology, molten salts, roasting techniques). It is also possible to envisage a range of technologies might be used in concert eg sorption for wet wastes coupled with steam reforming for organic destruction. It is not envisaged that recourse to incineration will be required.

CONCLUSIONS

AMWTP has an effective flowsheet to treat the majority of the waste covered by the contract with DOE. The evolution of this flowsheet has required a careful assessment of the key drivers and changing criteria influencing the project. This process has been achieved by detailed dialogue with the customer, DOE Idaho, to ensure the optimal process has been used. The plant is currently being constructed to this flowsheet.
REFERENCES


2. Safety Analysis Report (SAR) for the TRUPACT II Shipping Package Docket Number 71-9218, Revision 18, August 1999

3. DOT Transport Regulations, 49 CFR revised October 1, 1999
   49 Code of Federal Regulations 171, General Information, Regulations, and Definitions
   49 Code of Federal Regulations 173, Shippers -- General Requirements for Shipments and Packages
   49 Code of Federal Regulations 177, Carriage by Public Highway
   49 Code of Federal Regulations 178, Specifications for Packaging
   49 Code of Federal Regulations 180, Continuing Qualification and Maintenance of Packaging