Automated and intelligent waste segregation technologies – the US experience

Featuring Scanning Spectroscopy Technology
Waste hierarchy

- Avoid...producing LLW
- Minimise...amount of LLW produced
- Recycle/re-use ...materials which may otherwise be consigned as LLW
- Divert exempt waste away from LLWR
- Agree exempt limits and averaging volumes with regulators
Sustainable LLW disposal?

- LLW inventory 3 million m$^3$ (2008 – 2129)
- LLWR capacity ~ 0.7 million m$^3$ scheduled in LTP
- 40% is LLW, 60% is HVVLLW
- 33% of LLW is soil & rubble
- 63% of VLLW is soil & rubble
- So over 50% of projected LLW inventory is suitable for application of waste segregation technology
How Does it Work?

- MACTEC’s ORION\textsuperscript{SM} Radiological Soil Sorting Survey System uses
  - Large volume spectroscopy grade solid-state detectors
  - MACTEC’s advanced Scanning Spectrometer software, \textit{SPARTAN}\textsuperscript{SM}
- Detects gamma-emitting radionuclides as the soil on the belt moves past the active area of the detector
How Does it Work?

- Multiple detectors are arrayed above material conveying equipment to provide real time radiological data and material sorting.
  - A variety of material conveying equipment can be used to handle most common waste forms.
  - Supports multiple gamma spectrometers of any size
  - Up to 12 auxiliary detectors (radiological or otherwise) provide additional material characterization and control
How Does it Work?

- Additional inputs/outputs help manage the process
- Belt speed, depth, density, and weight are monitored for consistency
- Audio and visual alarms for system status
- Control of additional material conveyors
Soil Sorting Operation at the Saxton Nuclear Power Station
How Does it Work?

- Software Automates and Controls the Measurement and Sorting Processes
  - Real time system status available over WiFi
  - Uses real-time spectral stripping to improve the signal-to-noise ratio in a region of interest
  - Monitor multiple isotopes simultaneously
  - Evaluate radiological concentrations against multiple volumes simultaneously
  - Auto-generated process summary reports
  - Automated QA measurements and reporting
Established Technology & Performance

SS Series technology has been proven and accepted by:

- U.S. Nuclear Regulatory Commission (NRC)
- U.S. Environmental Protection Agency (EPA)
- Various State Agencies

Approved on-site waste acceptance

- Reduced transportation risk exposure and waste acceptance uncertainty to site owner
Project Time Line

- Procurement Lead Time
  - Typically 30-90 days from order

- Mobilization
  - Onsite set-up, integration, and calibration typically requires a setup time of \(~5\) days

- Demobilization
  - Disassembly, decontamination, preparation for transportation typically requires \(~5\) days
Production Rate

- Dependent upon:
  - Isotopes, limits, and applicable volumes

- Example 1
  - Cs-137, 0.074 Bq/g (2 pCi/g), 900 kg monitoring volume
  - Production Rate ~90,000 kg/hr

- Example 2
  - Thorium or Uranium at 0.11 Bq/g (3 pCi/g), 900 kg monitoring volume
  - Production Rate ~90,000 kg/hr
Key Advantages

- **ORION** SM Soil Sorting System
  - Minimization of waste disposal costs
  - Industry leading process rates
  - Large volume detectors provide superior sensitivity
  - Isotope specific measurements
  - Spectral stripping dramatically improves accuracy
  - System
Soil Sorting Technology System Data Output

- MACTEC’s SPARTAN℠ Processing software generates a variety of output files, including:
  - Total run summary data
  - Summary data for each pile (diverted and normal)
  - Auto-generated summary reports for each pile to client or regulator
  - Auto-generated QA/QC
  - Client specific web page with survey reports or summaries for offsite review
  - Consolidation reports for combining multiple survey batches
Sample Data Output Record

SS-Series Volumetric Sorting Record
Radioactive Characteristic Sorting Profile

<table>
<thead>
<tr>
<th>Survey Area</th>
<th>Contaminated Stockpile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Survey Unit</td>
<td>0016</td>
</tr>
<tr>
<td>Survey Equipment</td>
<td>ORION M302</td>
</tr>
<tr>
<td>Survey Operator</td>
<td>Javid Kelley</td>
</tr>
<tr>
<td>Material Surveyed</td>
<td>Soil</td>
</tr>
<tr>
<td>Criteria</td>
<td>5.2 pCi/g</td>
</tr>
<tr>
<td>Number of Measurements</td>
<td>7107</td>
</tr>
<tr>
<td>Total Tons Processed</td>
<td>499.24 (998,480lbs)</td>
</tr>
<tr>
<td>Number of Diversions</td>
<td>7</td>
</tr>
<tr>
<td>Total Tons Diverted</td>
<td>1.15 (2,305lbs) (0.23 % of Total)</td>
</tr>
</tbody>
</table>

Table 1. Below Criteria Volumetric Concentration Reported in pCi/g

<table>
<thead>
<tr>
<th>Isotope</th>
<th>Mean ± 95% Confidence</th>
<th>Median</th>
<th>Maximum</th>
<th>Minimum</th>
<th>2-Sigma Population Variance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net Cs-137</td>
<td>0.0 ± 0.01</td>
<td>0.1</td>
<td>1.5</td>
<td>-1.5</td>
<td>0.7</td>
</tr>
</tbody>
</table>

Table 2. Diverted Volumetric Concentration Reported in pCi/g

<table>
<thead>
<tr>
<th>Isotope</th>
<th>Mean ± 95% Confidence</th>
<th>Median</th>
<th>Maximum</th>
<th>Minimum</th>
<th>2-Sigma Population Variance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net Cs-137</td>
<td>0.1 ± 0.05</td>
<td>0.1</td>
<td>3.0</td>
<td>-0.8</td>
<td>0.8</td>
</tr>
</tbody>
</table>
Sample Automated QA/QC Control Chart

Detector 4 Source Response Checks

- QC Values
- Mean
- +2 Sigma
- -2 Sigma
- +3 Sigma
- -3 Sigma
- + 20%
- - 20%
- PBC Set
- Det Cable Change
- Temp
- Det Change
- PreAmp Change
- Zero Adjust

Measurements vs Degrees (Far.)

M.A.C.T.E.C
Soil Sorting Technology

WorleyParsons
resources & energy
Contaminant of Concern

- Cs-137 0.2 Bq/g

Monitoring Volume

- 80 kg

Production Rate

- 145,150 kg/hr (160 tons/hr)
One month into Full Production, MACTEC has sorted ~25 million kg of Soil Material
Conclusion

- MACTEC’s ORIONSM Soil Sorting System is the most technologically advanced and the most cost-effective solution for radioactive waste segregation on the market.

- MACTEC and WorleyParsons are committed to providing cost-effective solutions of the highest quality and best value.

- Our unique expertise and experience in soil screening & sorting technology enables us to provide clients with unparalleled flexibility and cost savings over a wide range of commercial, NDA, MoD, and other radiological decontamination and decommissioning challenges.
Like to Know More?

MACTEC, USA

- **Steve Rima, Vice President, Radiological Services Division**
  751 Horizon Court, Suite 104
  Grand Junction, Colorado 81506
  Phone: 970.243.2861
  Fax: 970.256.7356
  email: sdrima@mactec.com

- **Jeffrey Lively, Business Line Manager**
  751 Horizon Court, Suite 104
  Grand Junction, Colorado 81506
  Phone: 970.243.2861
  Fax: 970.256.7356
  email: jwlively@mactec.com

WorleyParsons, UK

- **Dr. Joe Toole**
  35 St Ninians Road
  Stirling FK8 2HE
  United Kingdom
  Phone: +44 (0) 1786 477 320
  Fax: +44(0) 1786 477 329
  email: joe.toole@worleyparsons.com

- **Mark Liddiard**
  35 St Ninians Road
  Stirling FK8 2HE
  United Kingdom
  Phone: +44 (0) 1786 477 320
  Fax: +44(0) 1786 477 329
  email: mark.liddiard@worleyparsons.com