

**SORTIE DB – Source Term Integrated Environmental Management Disposal Facility Database –  
15249**

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**ABSTRACT**

The Environmental Management Disposal Facility (EMDF) in Oak Ridge, Tennessee, is a proposed U.S. Department of Energy low-level Comprehensive Environmental Response Compensation and Liability Act (CERCLA) waste disposal facility with an operational start in the early 2020s. As a DOE low-level waste disposal facility, it is subject to DOE Order 435.1, requiring a composite analysis and possibly a performance assessment. The Source Term Integrated EMDF Data Base – SORTIE DB – provides source term estimates used in these assessments. An Oak Ridge Office of Environmental Management (OREM) Federal and Contractor team developed this state-of-the-art descriptive analytics and visualization schema. DOE OREM senior management has recognized complementary beneficial uses of SORTIE DB in decisions for accelerating clean-up progress, dealing with conflicting sequencing and budget priorities, and enhancing stakeholder and regulatory interfaces. SORTIE DB is designated as an OREM planning tool. SORTIE DB contains estimated forecast waste volumes and masses for over 800 Decontamination and Decommissioning (D&D) and Remedial Action (RA) sequenced baseline packages over the next 25+ years. Available characterization data, radionuclide identification and concentrations, and data from safety basis and emergency management documents are incorporated into SORTIE DB.

**INTRODUCTION**

This paper discusses the need and the logic for the SORTIE DB – the acronym for Source Term Integrated Environmental Management Disposal Facility (EMDF) – Data Base (DB). SORTIE DB provides radiological source term information for over 800 Decontamination and Decommissioning (D&D) and Remedial Action (RA) complexes and facilities in support of U.S. Department of Energy (US DOE) Oak Ridge Environmental Management (OREM) risk-informed decisions. The EMDF is a proposed Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA) low-level waste (LLW) and mixed LLW (MLLW) disposal facility located on the Oak Ridge Reservation (ORR). The EMDF is expected to operate for 25+ years starting in the early 2020s. The EMDF will replace the existing CERCLA landfill known as the Environmental Management Waste Management Facility (EMWMF) after it reaches capacity.

SORTIE DB is developed to meet Performance Assessment (PA) and/or Composite Analysis (CA) radiological source term input requirements for DOE Order (O) 435.1, Radioactive Waste Management requirements [1]. A PA/CA is required in order to receive the EMDF Disposal Authorization Statement (DAS) to allow for construction and operation of the EMDF. The PA/CA evaluates near-field environmental impacts and associated human health effects that may be caused by the release of radionuclides from EMDF. The PA/CA radiological source term is the inventory of radionuclides permanently disposed within the EMDF landfill at its closure. The inventory of radionuclides comes from LLW/MLLW generated by Oak Ridge National Laboratory (ORNL) and the Y-12 National Security Complex (Y-12) LLW/MLLW baseline facilities or contaminated sites.

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DOE OREM, a primary SORTIE DB stakeholder, is leveraging SORTIE DB data to support EM decisions other than those directly related to the EMDF. During FY15, SORTIE DB will assess cost and schedule benefits for future low-risk low complexity D&D or RA projects. SORTIE DB data is being used in decisions for accelerating clean-up progress, dealing with conflicting sequencing and budget priorities, enhancing stakeholder and regulatory interfaces, and identifying programmatic cost savings opportunities.

During FY14, SORTIE DB was designed, developed, tested, and validated for DOE OREM by Redus and Associates LLC under subcontract to Professional Project Services, Inc. (Pro2Serve) EMDF Support tasking. SORTIE DB is being implemented in FY15 and will be updated quarterly for the foreseeable future.

### **THE NEED FOR SORTIE DB**

SORTIE DB is developed to address the following key DOE O 435.1 PA/CA questions:

1. What is the source term estimate proposed to be disposed at the EMDF?
2. What is the distribution of the source term for various waste media to include soil, debris/structural steel, debris/equipment, debris/packaged materials, and debris/unpackaged?
3. What is the distribution of the source term for the combined various waste media and for miscellaneous items or equipment (namely, other facility components that contain significantly greater quantities of contamination or holdup)?
4. What is the distribution of the source term for waste that contains contamination and waste that contains hold up?
5. What is the distribution of the source term for individual radionuclides or isotopes that contribute to the contamination or holdup?
6. What are the drivers that influence the source term?

EMDF source term is defined as the inventory of radionuclides permanently disposed within the EMDF landfill at closure; thus, it represents the stock or the supply of radionuclide activity available at “time zero” for PA/CA modeling as required in DOE O 435.1. The EMDF source term has a volume (yd<sup>3</sup> or m<sup>3</sup>) and mass (kg) capacity and an isotopic inventory (activity, Ci, per isotope) that represents the entire waste inventory. Radionuclide activity is decay corrected, as required. Drivers represent waste media, miscellaneous items or equipment, or contamination or holdup as measured in terms of volume, mass, activity, or concentration. Using the mass associated with the entire landfill waste inventory, source term may be reported in concentration units (pCi/g). The EMDF source term data serve as the input to the PA/CA, as required by DOE O 435.1, to estimate and assess the long-term protectiveness of the landfill in terms of human health and natural resources including impacts on inadvertent intruders or receptors at a well-defined point of compliance.

### **SORTIE DB BENEFITS**

SORTIE DB provides necessary input to meet DOE O 435.1 PA/CA requirements. However, one of the primary causes for D&D/RA cost and schedule drift are delays in completing and approving ORR Federal Facility Agreement primary documents (e.g., Waste Handling Plans) and completing characterization activities. OREM can use SORTIE DB to accomplish:

- Prioritization of work based on risk, cost, or footprint reduction goals etc.
- Completion of characterization well in advance of demolition activities
- Minimization of regulatory approval timeframes as an impediment to start of D&D/RA activities

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- Identification of facilities with high source term quantities
- Identification of miscellaneous items that represent significant curie quantities
- Reduced project cost and schedule risk
- Reduce the cost of sampling by competitively bidding the work
- Reduce project costs by reducing the development of individual waste handling plans
- Allow the formulation of a shovel ready D&D/RA projects list

## SORTIE DB OUTPUT

The SORTIE DB default output report is presented in Fig. 1.

| CONTACT INFORMATION  |                          | EMDF Source Term Estimate: Project or Facility Profile Sheet         |                       |                               |                      |  |                       | R1.00    |  |
|--|--------------------------|--|-----------------------|-------------------------------|----------------------|--|-----------------------|----------|--|
| DOE OREM   | Brian Dementia           | <a href="mailto:DementiaBC@emdr.doe.gov">DementiaBC@emdr.doe.gov</a> | 865-241-6182          |                               |                      |  |                       |          |  |
| RA LLC   | Kenneth Redus            | <a href="mailto:kredus@icx.net">kredus@icx.net</a>                   | 865-803-4886          | PROZSERVE                     | Susan Depaoli        | <a href="mailto:depaoli@p2s.com">depaoli@p2s.com</a> | 865-294-6065          |          |  |
| SUMMARY INFORMATION  |                          |  |                       |                               |                      |  |                       |          |  |
| DD or RA ID  | DD-ORNL-042              |  |                       |                               |                      |  |                       |          |  |
| Site   | ORNL                     |  |                       |                               |                      |  |                       |          |  |
| DD or RA   | DD                       |  |                       |                               |                      |  |                       |          |  |
| Rebaseline WBS #   | 01.21.10.50.04.12        |  |                       |                               |                      |  |                       |          |  |
| Rebaseline Complex   | 4501/4505 Complex        |  |                       |                               |                      |  |                       |          |  |
| Facility Number  | 4505                     |  |                       |                               |                      |  |                       |          |  |
| Facility Description   | Experimental Engineering |  |                       |                               |                      |  |                       |          |  |
| Program  | SC                       |  |                       |                               |                      |  |                       |          |  |
| FIMS Category  | Building                 |  |                       |                               |                      |  |                       |          |  |
| Size (ft2)   | 41469                    |  |                       |                               |                      |  |                       |          |  |
| Start FY   | 2038                     |  |                       |                               |                      |  |                       |          |  |
| Finish FY  | 2044                     |  |                       |                               |                      |  |                       |          |  |
| Process Building/Process Components  | Yes                      |  |                       |                               |                      |  |                       |          |  |
| Operational  | Yes                      |  |                       |                               |                      |  |                       |          |  |
| Mixed Waste  | TBD                      |  |                       |                               |                      |  |                       |          |  |
| Contains Miscellaneous Items   | Yes                      |  |                       |                               |                      |  |                       |          |  |
| Contains Purchased Radiological Inventory  | Yes                      |  |                       |                               |                      |  |                       |          |  |
| 4501/4505 COMPLEX, 01.21.10.50.04.12, 01.21.10.50.04.12.01 4501/4505 Complex Prep for Demolition, 01.21.10.50.04.12.10 4501/4505 Complex Demolition, Oak Ridge Environmental Management Baseline, Professional Project Services, Inc. (ProzServe®), Oak Ridge, Tennessee, Status as of September 2013, Issued: February 2014<br>Nuclide inventories are based off of Preliminary Hazard Screening for the 4501 Complex, Oak Ridge National Laboratory, Oak Ridge, Tennessee PHS-OR-4501-COMPLEX, Rev. 1 (October 2013) |                          |  |                       |                               |                      |  |                       |          |  |
| Reference:   |                          |  |                       |                               |                      |  |                       |          |  |
| C:\SORTIE DB\BDSORTIE FAC VBD\SORTIE FAC R1_00 VBD.xlsx\SORTIE FAC Crosswalk (2)   |                          |  |                       |                               |                      |  |                       |          |  |
| Media  | Type                     | Volume (%)   | Volume (CY)           | Mass (Tons)                   | Mass (kg)            | Mass (%)   | Curies (Ci), (Not DC) | Comments |  |
| <b>MEDIA</b>   |                          |  |                       |                               |                      |  |                       |          |  |
| Soil   | Contamination            | 5.0%   | 342.6                 | 531.03                        | 481,744              | 4.7%   | 1.29E-04              | None     |  |
| Structural Steel   | Contamination            | 19.8%  | 1,370.4               | 1,671.89                      | 1,516,716            | 14.6%  | 4.06E-04              | None     |  |
| Debris / Equipment   | Contamination            | 24.8%  | 1,713.0               | 1,713.00                      | 1,554,012            | 15.0%  | 4.16E-04              | None     |  |
| Debris / Packaged Materials  | Contamination            | 9.9%   | 685.2                 | 835.95                        | 758,358              | 7.3%   | 2.03E-04              | None     |  |
| Debris / Unpackaged Materials  | Contamination            | 39.6%  | 2,740.8               | 6,577.94                      | 5,967,406            | 57.6%  | 1.60E-03              | None     |  |
| <b>MISCELLANEOUS ITEMS</b>   |                          |  |                       |                               |                      |  |                       |          |  |
| Hold-up BOP, Segment 1, Segment 6  | Holdup                   | 1.0%   | 69.2                  | 84.44                         | 76,602               | 0.7%   | 1.61E-01              | None     |  |
| <b>TOTALS</b>  |                          |  |                       |                               |                      |  |                       |          |  |
| Total  |                          | 100%   | 6,921.2               | 11,414.25                     | 10,354,836           | 100.0%   | 1.64E-01              |          |  |
| <b>SUMMARY - MEDIA TYPES</b>   |                          |  |                       |                               |                      |  |                       |          |  |
| Media  | Volume (CY)              | Mass (kg)  | Curies (Ci), (Not DC) | % Total Curies (Ci), (Not DC) | SUMMARY              |  |                       |          |  |
| <b>SUMMARY - MEDIA TYPES</b>   |                          |  |                       |                               |                      |  |                       |          |  |
| Soil   | 342.6                    | 481,744  | 1.29E-04              | 0%                            | Rebaseline WBS #     | 01.21.10.50.04.12                                    |                       |          |  |
| Structural Steel   | 1,370.4                  | 1,516,716  | 4.06E-04              | 0%                            | Rebaseline Complex   | 4501/4505 Complex                                    |                       |          |  |
| Debris / Equipment   | 1,713.0                  | 1,554,012  | 4.16E-04              | 0%                            | Facility Number      | 4505   |                       |          |  |
| Debris / Packaged Materials  | 754.4                    | 834,960  | 1.61E-01              | 98%                           | Facility Description | Experimental Engineering                             |                       |          |  |
| Debris / Unpackaged Materials  | 2,740.8                  | 5,967,406  | 1.60E-03              | 1%                            | Size (ft2)           | 41469  |                       |          |  |
|  |                          |  |                       |                               | Start FY             | 2038   |                       |          |  |
|  |                          |  |                       |                               | Finish FY            | 2044   |                       |          |  |
| <b>SUMMARY - MEDIA AND CONTAMINATED ITEMS</b>  |                          |  |                       |                               |                      |  |                       |          |  |
| Media  | 6,852.0                  | 10,278,234   | 2.75E-03              | 2%                            | Total Volume (CY)    | 6,921  |                       |          |  |
| Miscellaneous Items  | 69.2                     | 76,602   | 1.61E-01              | 98%                           | Total Mass (tons)    | 84   |                       |          |  |
| <b>SUMMARY - CONTAMINATION AND HOLDUP</b>  |                          |  |                       |                               |                      |  |                       |          |  |
| Contamination  | 6,852.0                  | 10,278,234   | 2.75E-03              | 2%                            | Total Mass (kg)      | 10,354,836   |                       |          |  |
| Holdup   | 69.2                     | 76,602   | 1.61E-01              | 98%                           | Total Curies (Ci)    | 1.64E-01   |                       |          |  |

Fig. 1. SORTIE DB output report.

| RADIONUCLIDES - ACTIVITY FOR MEDIA AND MISCELLANEOUS ITEMS |  |   |  |   | SUMMARY INFORMATION OR NOTES                      |  |
|--|--|---|--|---|---|--|
| Isotope Name   | Media<br>Sum of Isotope Result Value (pCi/g), Not DC | Media<br>Sum of Isotope Result Value (Ci), Not DC | Miscellaneous Items<br>Sum of Isotope Result Value (pCi/g), Not DC | Miscellaneous Items<br>Sum of Isotope Result Value (Ci), Not DC | Total Sum of Isotope Result Value (pCi/g), Not DC | Total Sum of Isotope Result Value (Ci), Not DC |
| Ams-241  | 1.12E-03   | 2.18E-05  | 3.72E-01   | 5.21E-03  | 3.72E-01  | 5.23E-03                                       |
| Ams-243  | 6.39E-05   | 1.28E-06  |  |   | 6.39E-05  | 1.28E-06                                       |
| Cm-244   |  |   | 9.72E-08   | 1.36E-03  | 9.72E-08  | 1.36E-03                                       |
| Co-60  |  |   | 3.66E-02   | 5.12E-06  | 3.66E-02  | 5.12E-06                                       |
| Cs-134   |  |   | 5.74E-03   | 8.03E-07  | 5.74E-03  | 8.03E-07                                       |
| Cs-137   | 3.78E-03   | 2.18E-05  | 1.42E-02   | 1.99E-02  | 1.42E-02  | 2.88E-02                                       |
| Eu-154   |  |   | 8.94E-02   | 1.25E-05  | 8.94E-02  | 1.25E-05                                       |
| Mo-100   | 6.93E-05   | 1.38E-06  |  |   | 6.93E-05  | 1.38E-06                                       |
| Np-237   |  |   | 1.02E-01   | 2.54E-05  | 1.02E-01  | 2.54E-05                                       |
| Pu-238   |  |   | 1.45E-02   | 2.03E-02  | 1.45E-02  | 2.03E-02                                       |
| Pu-239   | 6.55E-04   | 1.23E-05  | 1.75E-02   | 2.45E-02  | 1.75E-02  | 2.45E-02                                       |
| Pu-240   |  |   | 5.68E-01   | 7.83E-03  | 5.68E-01  | 7.83E-03                                       |
| Pu-241   |  |   | 5.78E-02   | 8.08E-02  | 5.78E-02  | 8.08E-02                                       |
| Pu-242   |  |   | 1.14E-01   | 1.59E-05  | 1.14E-01  | 1.59E-05                                       |
| Rb-87  | 2.81E-05   | 5.28E-07  |  |   | 2.81E-05  | 5.28E-07                                       |
| Sr-90  | 1.12E-01   | 2.19E-03  |  |   | 1.12E-01  | 2.19E-03                                       |
| Tc-99  | 1.96E-03   | 3.68E-05  |  |   | 1.96E-03  | 3.68E-05                                       |
| Th-230   | 1.78E-04   | 3.35E-06  |  |   | 1.78E-04  | 3.35E-06                                       |
| Th-232   | 4.88E-04   | 8.75E-06  | 1.26E-02   | 1.76E-06  | 1.38E-02  | 1.88E-05                                       |
| U-233  | 1.81E-05   | 1.98E-07  |  |   | 1.81E-05  | 1.98E-07                                       |
| U-235  |  |   | 3.77E-03   | 5.27E-07  | 3.77E-03  | 5.27E-07                                       |
| U-238  |  |   | 1.26E-01   | 1.76E-07  | 1.26E-01  | 1.76E-07                                       |
| U-238  | 2.68E-02   | 4.88E-04  | 2.44E-01   | 3.42E-05  | 2.78E-01  | 5.27E-04                                       |
| Grand Total  | 1.47E-01   | 2.75E-03  | 1.14E-03   | 1.68E-01  | 1.14E-03  | 1.63E-01                                       |

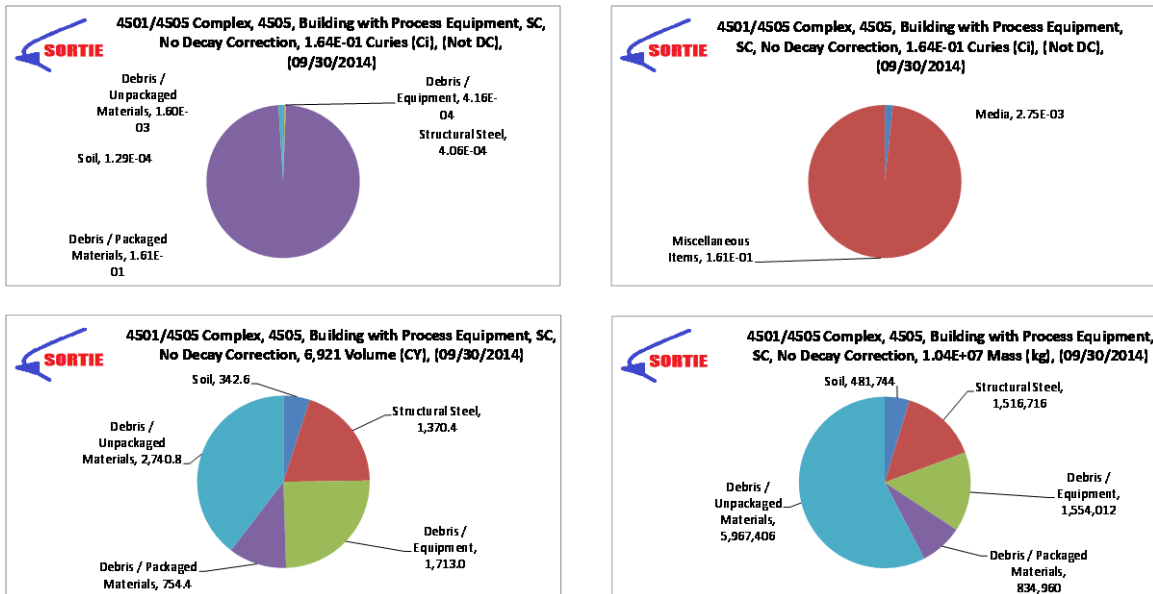


Fig. 1. SORTIE DB output report (concluded).

This example is D&D information for Building 4505 in the ORNL 4501/4505 Complex. The first output section provides summary information obtained from SORTIE FAC and includes a map of the baseline complex. Future plans are to color code the map by contamination and holdup areas. The second and third sections summarize volume, mass, and activity by media and miscellaneous items. The fourth section identifies each isotope in the facility and provides the activity and concentration. The final section is graphical output.

## **DESCRIPTION OF SORTIE DB**

### **Quality Requirements**

Implementation of DOE Order (O) 414.1D (Quality Assurance (QA)) [2] is required. SORTIE DB is not safety software and it does not require Nuclear Quality Assurance-1 (NQA-1) [3] validation; however, the Pro2Serve NQA-1 Quality Assurance Plan and Core Procedures are used as guidance documents. The SORTIE DB Project Execution Plan [4] uses a graded approach to meet QA requirements.

The SORTIE DB design is based on sound engineering judgment and practices, scientific principles, applicable orders, codes, and standards. In addition, the SORTIE DB software design process followed DOE G 414.1-2B (Quality Assurance Program Guide) [5], Institute of Electrical and Electronics Engineers (IEEE) Standards, and US Air Force approaches to control design inputs, outputs, verification, configuration, and design changes, and technical and administrative interfaces.

### **Functional and Interface Requirements**

General functional requirements include allowing and error checking data input, coloring coding specific cells based on data values, generating error messages if required, and performing look-ups if required. Validation tests on 100% of the functional, and interface requirements and data were performed. Specific functional and interface requirements include:

- Perform various unit conversions, e.g., cubic yards (yd<sup>3</sup>) to cubic meters (m<sup>3</sup>), Becquerel per cubic meter (Bq/m<sup>3</sup>) to Curies (Ci), etc.
- Distribute the total volume among the media types indicated by waste type and the percent of total volumes assigned to miscellaneous items
- Calculate volumes for each waste media type and for miscellaneous items
- Carry forward volumes and volume percentages for media types and user-identified miscellaneous items
- Calculate tons and kilograms of each media type and user-identified miscellaneous item using the as-generated densities
- Calculate the mass percentage for each media type and user-identified miscellaneous item
- Calculate volumes for each waste media type and for miscellaneous items
- Allocate Isotope Result Value (Curies, Ci) for each radionuclide to media categories (Soil, Structural Steel, Debris/Equipment, Debris/Packaged Materials, and Debris/Unpackaged Materials) based upon media type (media or miscellaneous items) and percentage allocation assumption
- Calculate the Total Ci for each media type and each miscellaneous items by summing the allocated Ci of each media type and each miscellaneous item, respectively
- Calculate the volume, mass, and activity and activity percentages for (1) five possible waste media types: Soil, Structural Steel, Debris / Equipment, Debris / Packaged Materials, and Debris / Unpackaged Materials), (2) two waste forms (media, miscellaneous items), and (3) two types of activity presence (contamination, holdup)

## Key Assumptions

Assumptions are used to develop SORTIE DB to maintain 100% auditability, ensure consistency in terms, and serve as the basis for calculations or look-up tables. Key assumption areas are:

- Definition of terms and references
- Applicable to CERCLA LLW/MLLW only
- DOE EM, SC, NE, and NNSA Programs
- Descriptive information for complexes and facilities
- Radioactive decay and ingrowth

Assumptions rely on DOE or generally accepted documentation and terms and include:

- |  |  |   |
|--|--|---|
| • As-disposed density                    | • Debris/equipment contaminated waste media          | • Project                                   |
| • As-disposed volume                     | • Debris/packaged materials contaminated waste media | • Remedial Action (RA)                      |
| • As-generated density                   | • Equipment with Holdup                              | • Soil contaminated waste media             |
| • As-generated volume                    | • Facility   | • Source term                               |
| • Baseline Facility or Complex Book      | • Infrastructure                                     | • Structural steel contaminated waste media |
| • Building or Complex                    | • Miscellaneous with Holdup                          | • Structure with Holdup                     |
| • Deactivation and Decommissioning (D&D) |  |   |

Since the EMDF is proposed to dispose only CERCLA LLW/MLLW, the following waste types are not included in SORTIE DB: (1) TRU waste, 11(e)2 byproduct waste, high-level, or spent fuel, (2) non-CERCLA waste, (4) non-radioactive waste, (4) free liquids, or (5) non-DOE generated waste.

Programmatic assumptions deal with whether the waste is managed by EM, SC or NNSA. Under DOE O 413.3B, Program and Project Management for the Acquisition of Capital Assets, OREM Baseline Critical Decision (CD)-1 baseline packages documentation is used to identify the strategy for (1) preparation for/completion of demolition and demolition activities associated with the D&D of facilities or complexes, or (2) preparation for/completion of remedial actions and remedial action activities for remedial action projects. The Facility Information Management System (FIMS) and the [Active Facilities Data Collection System \(AFDCS\)](#) are used for further descriptive facility or complex information.

Descriptive information for complexes and facilities for the facilities or complexes or remedial actions include:

- Whether the facility is a process-related building containing process-related components
- Operational status of the complex or a specific facility
- Whether the facility contains miscellaneous items or holdup
- Whether the facility contains purchased radiological inventory

Attributes for LLW/MLLW source term general media are the type of hazard, the type of media, whether the waste is packaged or unpackaged, and potential material types, Fig. 2.

| ID | Source Term General Media                       | Type of Hazard           | Type of Media  | Unpackaged or Packaged | Potential Material Types   |
|----|---|--------------------------|----------------|------------------------|--|
| A  | Soil  | Contamination            | Soil           | Packaged or Unpackaged | <ul style="list-style-type: none"> <li>• Soils</li> <li>• Sediments</li> </ul>   |
| B  | Debris/Structural Steel                         |                          | Debris         | Packaged or Unpackaged | <ul style="list-style-type: none"> <li>• Structural steel</li> </ul>   |
| C  | Debris/Equipment                                |                          | Debris         | Packaged or Unpackaged | <ul style="list-style-type: none"> <li>• Equipment</li> </ul>  |
| D  | Debris/Packaged Materials                       |                          | Debris         | Packaged               | <ul style="list-style-type: none"> <li>• Construction debris</li> <li>• Dense concrete</li> <li>• Filings</li> <li>• Insulation</li> <li>• Light concrete</li> <li>• Light metal</li> <li>• Metal that is not structural steel or equipment</li> <li>• PPE-trash</li> <li>• Roofing</li> <li>• Stored waste</li> <li>• Transite</li> <li>• Wood</li> </ul> |
| E  | Debris/Unpackaged Materials                     |                          | Debris         | Unpackaged             |  |
| F  | Miscellaneous Items (any of A through F, above) | Contamination or Hold Up | Usually Debris | Packaged or Unpackaged | <ul style="list-style-type: none"> <li>• Construction debris</li> <li>• Equipment</li> <li>• Light metal</li> <li>• Roofing</li> <li>• Structural steel</li> </ul>   |

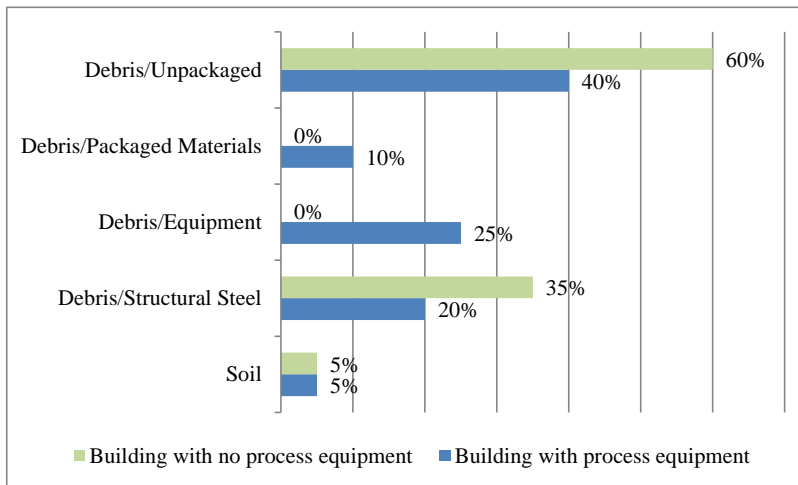
**Fig. 2. Source term waste media types.**

Further details on these attributes include:

- Type of hazard (contamination or hold-up) to ascertain whether the type of hazard is either volumetric contamination associated with a material type or residue (holdup) material left behind in a structure or in piping and process equipment.
- Type of media (debris or soil) identifies whether the media is debris-like or soil-like. Debris-like media are most common for D&D of facilities or complexes and soil-like media are most common in remedial actions.
- Packaging of the media (packaged or unpackaged) is a waste management descriptor of the source term waste media that is neither structural steel nor equipment.
- Potential material type is applicable to waste volume forecasting and D&D or remedial action planning.

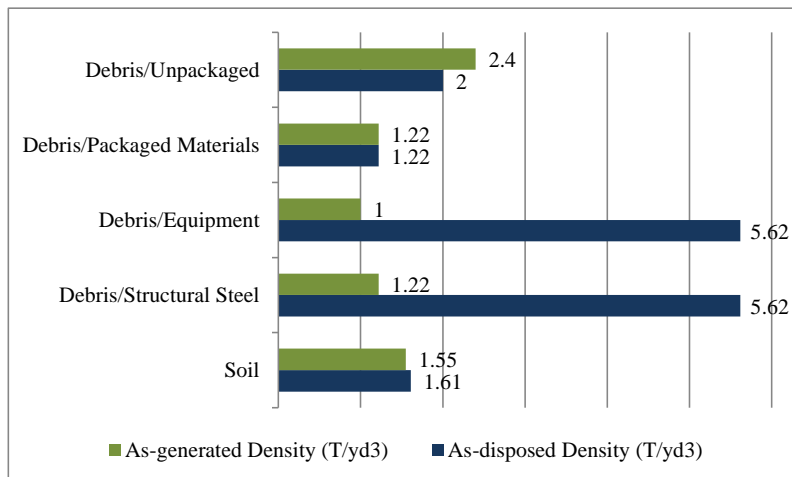
Volume information is obtained from DOE Oak Ridge Environmental Management OREM Baseline Books (FY 2013 or more recent) using information contained in appendices containing Cost Engineering and Estimating System (CEES) estimates. If volume information is not available, volumes are estimated using algorithms derived from the CEES estimating methodology.

Waste type volume uses a percentage allocation based on whether the waste from a complex or facility has, or does not have, process equipment or related components, Fig. 3. Allocations are based on past experience with D&D projects or remedial action projects that have disposed CERCLA waste at the EMWFM and professional judgment.



**Fig. 3. Waste type volume allocation (%) by building or facility characteristics.**

As-generated and as-disposed densities (measured in tons/yd<sup>3</sup>) are used to calculate as-generated volumes and as-disposed volumes, Fig. 4. As-generated (in-situ) volumes are based on excavated volumes of soils and sediments and demolished volumes of building debris. These represent volumes expected to be shipped and includes the highest amount of void spaces for all wastes. As-disposed values represent volumes of waste after disposal in the EMDF, at which point debris wastes, waste suitable for use as fill, and clean fill have been mixed and processed to meet compaction and void space mitigation requirements [6].



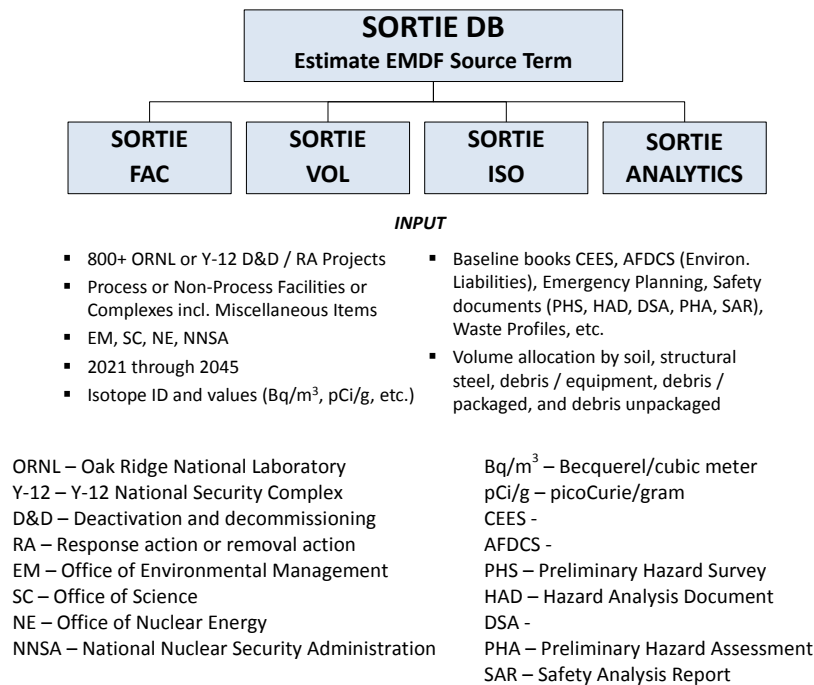
**Fig. 4. As-generated and as-disposed density values (Ton/yd<sup>3</sup>) for waste types.**



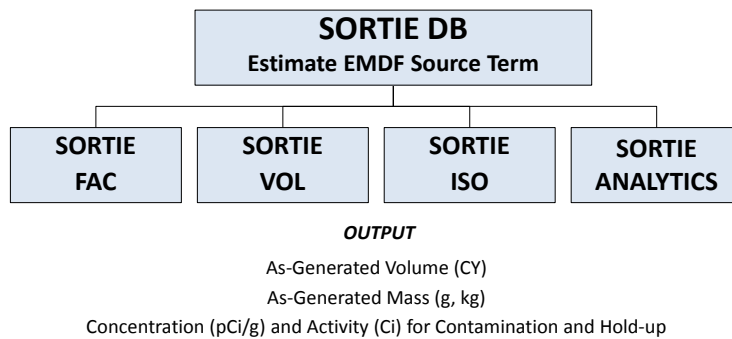
**Architecture**

The architecture of SORTIE DB is presented, Fig. 5 and Fig. 6.

- SORTIE FAC (SORTIE Facilities) contains input of relevant baseline complexes or facilities that are anticipated to ship wastes to the EMDF
- SORTIE VOL (SORTIE Volume) contains volumes of waste associated with each baseline complex or facility
- SORTIE ISO (SORTIE Isotopics) contains relevant radiological data associated with each baseline complex or facility
- SORTIE ANALYTICS uses flat files generated from SORTIE VOL and SORTIE ISO to integrate the baseline complex and facility data into a coherent form for statistical analysis and reporting



**Fig. 5. SORTIE DB Architecture and Inputs.**



**Fig. 6. SORTIE DB Architecture and Outputs.**

Data

SORTIE DB currently includes the following information to allow for initial facility/site classification:

- EM’s baseline facilities and sites at ORNL and Y-12 (over 800)
- Facility/site operational status
- Curie and concentration estimates or the lack of radiological contamination
- Pinpoints the media type/component driving the curie estimate
- Waste volume estimates
- Waste mass estimates

SORTIE DB contains data used to determine radiological contamination and hold-up from over 800 ORNL and Y-12 baseline facilities or contaminated sites. Future information to be added to SORTIE DB includes cost, CERCLA documentation, RCRA land disposal restriction information, and updated characterization data.

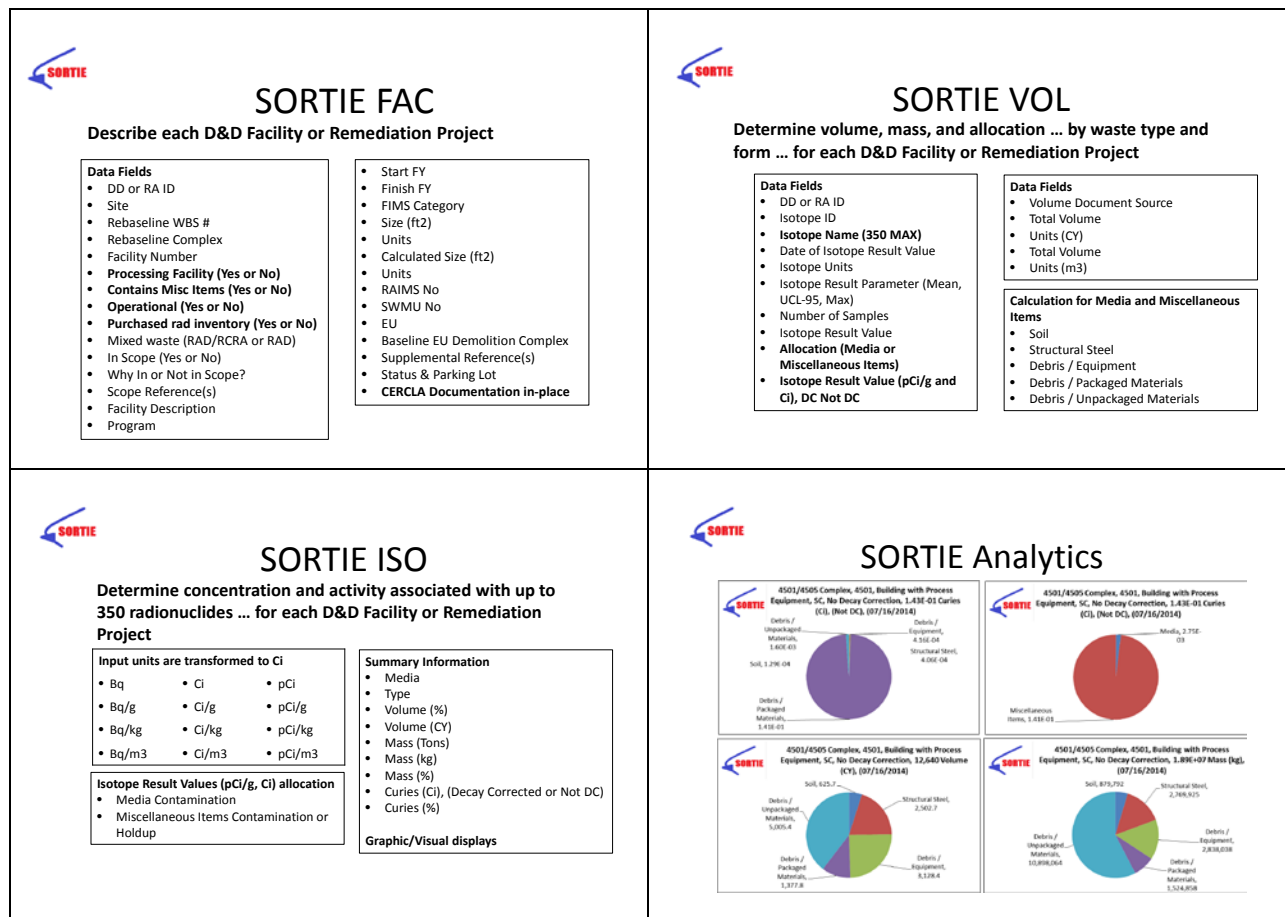


Fig. 7. Details of SORTIE DB Architecture.

### Software Validation and Verification

Extensive software validation and verification (V&V) is performed before SORTIE DB is placed into service. The SORTIE DB validation test plan required validation tests on 100% of the functional and integration requirements. All validation tests were successful and the SORTIE DB Version Baseline Delivery is fielded. The SORTIE DB Validation Worksheet is illustrated in Fig 8.

| SORTIE DB VALIDATION WORKSHEET                                       |   |                     |             |
|--|---|---------------------|-------------|
| Requirement  | I.FXX Name of Requirement   | Date                | Date        |
| Computer Program Tested  |   |                     |             |
| SORTIE DB Worksheet of SORTIE DB (e.g., SORTIE VOL ISO)              |   |                     |             |
| Module   | Module (e.g., SORTIE VOL)   | Draft version       | Name (Date) |
| Stage  | Version Baseline  | Test Date           | Date        |
| Tab  | Specific tab in Worksheet and Module  | Prepared by         | Name        |
| Subsection   | Specific subsection in Worksheet and Module   | Checked by          | Name        |
| Comment  | Functional test required  |                     |             |
| Hardware   | Common: Dell Precision M6500, 64 bit. Software - Windows 7 Professional, MS Office/Excel 2007   |                     |             |
| Simulation   | Common: No simulation models used   |                     |             |
| <b>TEST PROBLEM</b>  |   |                     |             |
| <b>TEST ID (Required tests[s] and sequence)</b>                      |   |                     |             |
| I.FX   | Succinct test identification and rationale  |                     |             |
| <b>INPUTS (Required ranges of input parameters)</b>                  |   |                     |             |
| I.X  | Specific cell identification and inputs   |                     |             |
| <b>PROCESS (Criteria for establishing and evaluating test cases)</b> |   |                     |             |
| 1  | Succinct statement of process of using inputs to create outputs.T<br><br>In general, this is described in Steps with functional form, e.g.,<br>Step 1: determine whether the media type is "media" or "miscellaneous item" and then carry forward the result into column M (for example, M34) or T (for example, T34) using the functions of the form:<br>M34 =IF(\$I34="", "",IF(\$I34="Media",\$L34,"")) for media and<br>T34 =IF(\$J34="", "",IF(\$J34="Miscellaneous Items",\$L34,"")) for miscellaneous items. |                     |             |
| <b>EXPECTED OUTPUT (Anticipated output values)</b>                   |   |                     |             |
| I.X  | Specific cell identification and outputs  |                     |             |
| <b>RESULTS/ACTUAL OUTPUT (Actual output values)</b>                  |   |                     |             |
| I.X  | Actual specific cell identification and outputs   |                     |             |
| <b>DEVIATIONS</b>  |   | <b>ACTIONS</b>      |             |
| Identifications of process or output differences and reasons why     |   | Actions to be taken |             |
| <b>RESULTS (Acceptability)</b>                                       |   |                     |             |
| I.X  | Pass or Fail  |                     |             |

Fig. 8. SORTIE DB Validation Worksheet.

### Lessons Learned

Applicable lessons learned during the review are provided below:

- Verify document and data submittal packages. Document and data submittals may be complex and involve several layers of interlocking reports or attachments. A close review will help ensure that the submitted materials are correct and up-to-date.
- Perform thorough software verification and validation using an accepted software quality assurance plan. These efforts ensure that design requirements are met and the data base performs as intended in its operational environment.
- If a facility has an individual volume provided, use this as data input. If a complex containing many facilities has only a total volume estimate, use take-off estimates or algorithms to estimate individual facility volumes.

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- Identify and define the critical data parameters prior to data collection to ensure valid results. This will also increase efficiency in the data collection phase of the process and reduce the number of quality errors.

### CONCLUSIONS

SORTIE DB contains estimated forecast waste volumes and masses for over 800 D&D or RA sequenced baseline packages to be generated over a 25+ year time frame at the ORR. Using available characterization data, radionuclide identification and concentrations are incorporated into SORTIE DB. Other data sources such as safety basis documents and surveys, supplement contaminant identification and activity or concentration estimates were utilized. Measures of random and epistemic uncertainty are also included.

SORTIE DB is applicable to any DOE site and can provide DOE managers the following benefits:

- Use SORTIE DB as a living baseline. SORTIE DB consolidates data contained in OREM Baseline Books, the FIMS and AFDCS. When the status of individual facilities change (for example, when hazard categories classes are changed, when a facility is removed from the AFDCS, or when a holdup material in a facility is removed), this information is reflected and available for management reporting. Forecasting and planning for such changes supports operational cost assessments.
- Accelerate clean-up progress at ORNL and Y-12. Using SORTIE DB search and integration capabilities, opportunities in selected baseline complexes or facilities can be identified. This is accomplished by removing small volumes of highly contaminated or holdup waste thus freeing up larger volumes of waste for D&D or RA actions. Such efforts do not impact significant Near Term Priorities such as (1) K-27 demolition, (2) U-233 direct disposition, transuranic waste processing, and (3) planning, engineering, and design efforts for the Y-12 Outfall 200 Mercury Treatment Facility, or (4) the Transuranic (TRU) Waste Processing Center Sludge Processing Facility Buildouts.
- Leverage existing disposal facility utilization. Identification of complexes and facilities with low contamination or activity acts as a “programmatic insert” to existing sequencing and budget priorities which enables continued EMWMF and Y-12 Landfills capacity utilization. Certification for waste disposal from these inserts would follow disposal facility waste acceptance requirements.
- Enhance stakeholder and regulatory interfaces. The analytics and visualization capabilities of SORTIE DB offer visually informative results to quickly evaluate baseline complex or facility waste types and related source term information. Characterization data gaps which can be easily filled to result in status changes for multiple Baseline Complex facilities and projects are included in such analytics.

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