UPDATES TO

DOE-STD-5506-2007, *Preparation of Safety Basis Documents for Transuranic (TRU) Waste Facilities*

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DOE-STD-5506-2007, Preparation of Safety Basis Documents for Transuranic (TRU) Waste Facilities

- Issued in April 2007
- Unique standard that prescribes analytical assumptions and controls specific to the DOE Transuranic Waste mission
- Standard provides:
  - Analytical assumptions and methods for hazard analysis and accident analysis
  - Hazard controls to be used when developing TRU facility safety basis documents
  - Supplements the applicable 10 CFR 830 Subpart B "safe harbor method" such as DOE-STD-3009-94
- Overall, Standard has received very positive feedback from DOE complex

Why an Update?

- Past the sunset review period
- DNFSB Tech Report-43 (Deficiencies in DOE-STD-5506-2007)
- Sandia Container Testing
- Years of Lessons Learned and Feedback on Specific Topics in the Standard
- Events at TRU Waste Facilities…WIPP 2014 radiological release, INL ARP V
- Updates/linkages to other DOE standards (DOE-STD-3009-2014, DOE-STD-1104-2016, others)

Activities to Date

- Writing Team assembled, revision initiated in June 2019
- Multiple meetings between Writing Team, DNFSB and SMEs
- Quality draft released for SME review (major DOE sites) in December 2019
- Writing Team is currently working through comments received in January 2020
- Draft expected for REVCOM review in April-May 2020

Writing Team

- Dr. Robert C. Nelson, Team Lead
- Brenda Hawks, Chief of Nuclear Safety
- Terry Foppe, Link Technologies, Inc
- Jeff Woody, Link Technologies, Inc
- Ray Sprankle, Savannah River Nuclear Solutions
- David Pinkston, Lawrence Livermore National Laboratory
- Bill Walker, Oak Ridge National Laboratory
- Mukesh Gupta, Amentum
- Dr. David Compton, PEC, supporting AU-30 HSS
- Caroline Garzon, is liaison for support from AU-30 HSS

Primary Updates to the Standard

- Deletion of guidance addressed in recent updates to DOE directives (e.g., challenging Evaluation Guideline, consequence analysis, DOE safety basis review topics)
- Clarification of MAR Statistical Approach guidance/appendix
- Incorporation of guidance on chemical reactions (new events, source term guidance, new appendix, new controls)
- Clarifications to damage ratios (DRs) and airborne release fractions (ARFs) used in certain accidents and containers (e.g., latest testing data, clarifications to improve current guidance)
- Minor changes to the 2007 control selection table for preferred and alternate controls

Topics Deleted from the Standard

- 4.2. Definition of Unmitigated Analysis
- 5.2 Facility Worker Consequences
- 5.3 Collocated Worker and Public Consequences
- 6.2. Risk Ranking and Control Selection Guidelines
- 6.3. Clarification of What Challenges the Evaluation Guidelines
- 7. Safety Basis Review and DOE Risk Acceptance
- 8. Verification of Safety Basis Implementation

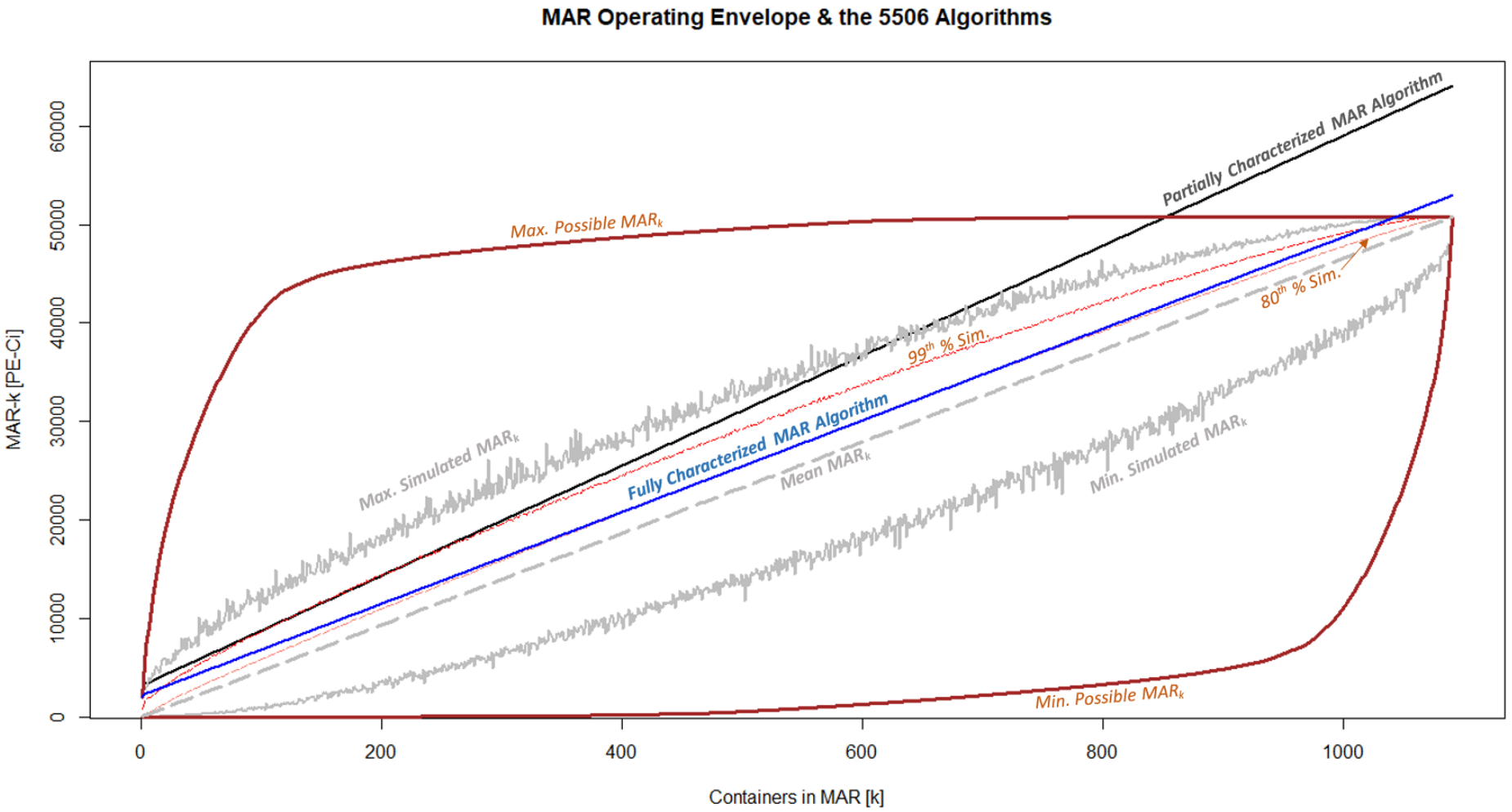
Material-at-Risk (MAR) Statistical Approach

- Statistical analysis conducted to analyze DNFSB concerns identified in Tech Report-43
- Errors Corrected in TABLE 4.3.2-1 “Bounding MAR Limits for TRU Waste Operations”
  - Upper tolerance limit (UTL_{95}) changed to upper confidence limit (UCL_{95}) involving accidents > 4 containers using the mean
  - Removed “or median” from Table entry applicable to accidents involving 3 containers
- Applicability of 20% uncertainty factor expanded from max to all containers for skewed data (i.e., when MAR for single container can exceed MAR for multiple container accidents)
- Clarified implementation guidance (e.g., no bias toward waste characteristic and use of MAR administrative controls to protect assumptions
- Major revision of Appendix A…more emphasis on methodology

Analysis of Statistical MAR Approach

- Two Statistical MAR Algorithms:
  - Partially-Characterized MAR Inventory
  - Fully Characterized MAR Inventory
- Algorithms require equiprobable hazard conditions w.r.t. population of containers
  - ${}_nC_k$ → # Combinations of "k" waste containers out of a population of "n" waste containers
  - All combinations must be equally probable of being directly affected by hazard
- Concept of the MAR Operating Envelope is great tool for visualizing performance of the Algorithms

Analysis of Statistical MAR Approach



New Guidance on Chemical Reactions

- New Event 27, *Chemical Initiated Events*, added to Section 3.3, *TRU Waste Operations Minimum Set of Accidents*
- New Section 4.5*, Chemical Reaction Source Term,* that discusses DRs and ARFs/RFs
- New Appendix E, *Energetic Events*, that discusses the WIPP exothermic runaway event and ARP V overpressure event and derives source term recommendations

Overview of Chemical Initiated Event Guidance

- Use WIPP WAC certification tools during DSA development: DOE/WIPP-17-3589, *Basis of Knowledge for Evaluating Oxidizing Chemicals in TRU Waste*; EPA-600/2-80-076, *A Method for Determining Compatibility of Hazardous Waste*
- Many chemical reactions can be modeled in accordance with recommended release fractions for fires, deflagrations, or overpressures in Table 4.4-1 (i.e., chemicals are just another initiator)
- Composite source term for highly energetic reactions (large quantities of oxidizing chemicals absorbed on light, easily dispersed organic material) should use WIPP DSA derived value of 0.205

Other Changes in Source Term Guidance

- All subsections on deflagrations, fires, and spills are being significantly clarified regarding DRs
- Corresponding Appendices B and C are also being clarified, or new test results are being added
- Adding bases from DOE-HDBK-3010 or clarifications for the renumbered Section 4.4 and Table 4.4-1 on ARFxRFs for various waste forms and accident stresses

Other Changes in Source Term Guidance (cont.)

- Section 4.3.2 Deflagration Damage Ratios
  - Clarify/Revise Section 4.3.2 in response to comments on direct-loaded drum deflagrations, and other container deflagrations
  - Source term assumptions invalidated by liquid or large quantities of VOCs because of limited experimental data – standard assumes small quantities, based on 250 cm^3 from LLNL experiment discussed in Appendix B, Section B.2.4
  - Fire section stated that an overpack prevents lid loss modeled with 0.1 DR and 5E-4 ARF*RF for “confined” burning – add that basis for deflagration since lid loss does not occur
  - Clarify Appendix B regarding previous tests, and add SwRI/WIPP H_2 deflagration testing and INL drum pressurization tests to determine lid loss

Other Changes in Source Term Guidance (cont.)

- Section 4.3.3 Fire Scenario Damage Ratios
  - Revise pool fire analysis methodology based on new data in *SFPE Handbook of Fire Protection Engineering*, 5th ed.
    - Unconfined pool fire size based only on 2.9 mm spill depth
    - Eliminate lid ejection for hydraulic fluid pool fire
    - More explicit criteria for “critical flux” to remote containers
    - Graphic analysis of container damage based on pool size
    - Metered leak pool fires to include tire involvement for damage requiring long duration thermal stress (i.e. structural column)

Other Changes in Source Term Guidance (cont.)

- Section 4.3.3 Fire Scenario Damage Ratios (continued)
  - Add results of POC/CCO testing at Sandia National Labs.
    - New filter design permits combustibles in POC
    - CCO equivalent to POC (except with combustible payload)
  - Clarify basis for 0.1 DR for fires with overpacked container when lid prevents ejection, based on the Appendix B Section B.2.4 LLNL fire test results for confined burning
  - Revise Appendix C, Section C.1 on fire tests, to support changes in Section 4.3.3

Other Changes in Source Term Guidance (cont.)

- Section 4.3.4 Spills/Loss of Confinement Damage Ratios
  - Clarify/Revise Section 4.3.4, DR Table 4.3.4-1, and Appendix C.2 in response to comments
  - Add new Figure 4.3.4-1, “Comparison of Drum DR and ARFxRF for Contaminated Solids in Drops, Falls, and Vehicle Crashes”
  - Add guidance on vehicle crash with follow-on pool fire and example calculation

Other Changes in Source Term Guidance (cont.)

- Add new Type A Containers to DR and ARFxRF sections and appendices
  - Criticality Control Overpack (CCO)
  - Standard Large Box – 2 (SLB2)
  - Shielded Container Assembly (SCA)
- New Section 4.6 Consequence Analysis replaces previous Section 5
  - Referenced DOE-STD-3009-2014 and DOE-HDBK-1224-2018, *Hazard and Accident Analysis Handbook*, for guidance
  - Retained minimal guidance that is specific to TRU waste accidents

Conclusions

- Overall feedback on DOE-STD-5506 has been very positive
- Implementation has provided insights and lessons learned that should be incorporated into an update of the standard
- Updates will further improve clarity, enhance implementation, and ensure consistency with latest DOE nuclear safety policies and positions
- DOE field sites can benefit from ongoing communications and sharing their implementation experiences
  - Presenters appreciate past questions and encourage future interactions with DOE field sites regarding implementation
- Suggestions and opinions are strictly those of the authors, not official DOE position
- Any Comments/Questions???