APPLICABILITY OF DOE-STD-5506 TO EPHA ANALYSIS

EXECUTIVE SUMMARY

This document was developed to highlight the key areas of the U.S. Department of Energy (DOE) Standard *Preparation of Safety Basis Documents for Transuranic (TRU) Waste Facilities*, and provide a recommendation regarding the possible use of the data in Emergency Planning Hazards Assessments (EPHA) analyses. The DOE-STD-5506-2007 (referred to as the "TRU Standard") provides analytical assumptions and methods, as well as hazard controls to be used when developing Safety Basis (SB) documents for TRU waste facilities in the DOE Complex. The main focus of this paper is on the Identification and Evaluation of TRU Waste Events and TRU Waste ST Analysis sections of the TRU Standard and the potential applicability of the data to EPHA analyses. These topics are the most appropriate for use within EPHA analysis because these areas are the most similar between the two types of documents. Based on the data presented in the TRU Standard, it appears that not only could this information be used in the development of an EPHA, but it could also be applied to facilities outside of TRU waste, assuming basic assumptions used in the derivation of the presented analytical parameters are met. The data compiled within the TRU Standard provides an excellent reference and could be used to justify a great number of decisions during the ST development process. As a result, the TRU Standard could be used as another potential source of information for producing improved, technically sound EPHAs consistent with currently available guidance.

INTRODUCTION

With the issuance of *Preparation of Safety Basis Documents for Transuranic (TRU) Waste Facilities*, DOE-STD-5506-2007, the question began to form as to the applicability of this standard to analysis performed in Emergency Planning Hazards Assessments (EPHAs). Per the *Technical Planning Basis Emergency Management Guide*, DOE Guide 151.1-2, to the extent practicable and available, the hazards and accident analysis results from current facility Safety Basis (SB) documents should be used to ensure consistency of the emergency technical planning basis with the facility authorization basis. Careful consideration to use of safety analysis information can both enhance the quality of the EPHA and greatly reduce the effort required for its preparation. Specifically, the scenarios and corresponding source terms analyzed in current facility safety analysis documents should be incorporated into the EPHA if consistent with emergency planning requirements and needs (e.g., do not result in overly conservative and unrealistic results). While the evaluations typically performed in support of emergency management do share certain commonalities with safety basis documents, there are a few prominent differences in the required analysis that prevent the automatic conclusion that guidance may be generally applicable to both types of calculations. The purpose of this document is to highlight the key areas of this U.S. Department of Energy (DOE) Standard and provide a recommendation regarding the possible use of the data in EPHA analyses.

BACKGROUND

The DOE is responsible for safe handling, packaging and ultimate disposal of Transuranic (TRU) wastes at the Waste Isolation Pilot Plan (WIPP) located near Carlsbad, New Mexico. Much of this waste, which is a result of legacy operations supporting the U.S. nuclear weapons mission, is now stored at numerous DOE sites located across the Unites States. These wastes can present significant hazards to workers, the environment, and the public if not adequately controlled.

The DOE-STD-5506-2007 (referred to as the “TRU Standard”) provides analytical assumptions and methods, as well as hazard controls to be used when developing SB documents for TRU waste facilities in the DOE Complex. It also provides supplemental technical information that is specific to TRU waste operations, so that contractors can formulate, implement, and maintain safety bases for TRU waste operations in a consistent manner that is compliant with 10 CFR Part 830, Subpart B, requirements.

The TRU Standard was created to document the expectations for analyzing and controlling TRU waste hazards and promote a consistent approach across the DOE Complex. DOE collected hazard analysis and control data from all of its major TRU waste sites. This information was used to provide a baseline against which analytical methods and proposed controls could be evaluated, compared, and selected.

Based on the evaluation of existing SB information and input received from TRU waste operations personnel, analysts and DOE SB reviewers, the TRU Standard focuses on topics related to hazard analysis, hazard controls, SB implementation, and the DOE review process. These topics are addressed in a level of detail that supports the existing framework of nuclear facility SB requirements and standards. The information contained in the TRU Standard is intended for use by all DOE and National Nuclear Security Administration (NNSA) sites and all contractors for DOE and NNSA owned or leased, Hazard Category 1, 2, or 3 nuclear facilities or nuclear operations that involve retrieval, handling, storage, and processing of TRU waste containers.

SCOPE, CONTENTS, AND APPLICABILITY

Specific topical areas covered in the Standard are as follows:

- Identification and Evaluation of TRU Waste Events—discusses the types of hazards expected during TRU waste operations, defines a minimum set of accidents to be evaluated in the SB documents, and addresses provisions for addressing incidents that are inherent to normal operations such that operational impacts from their occurrence are appropriately minimized

- TRU Waste Source Term (ST) Analysis—defines analytical methods and assumptions related to unmitigated analysis, Material at Risk (MAR), Damage Ratios (DRs), and Airborne Release Fractions (ARFs)/Respirable Fractions(RFs)

- Consequence Analysis—addresses assumptions supporting qualitative evaluations of facility workers, as well as dispersion analysis assumptions supporting quantitative evaluations of onsite worker populations and offsite receptors

- TRU Waste Hazard Controls Selection and Standardization—provides guidelines for standardizing the hazard control selection process and gives specific controls that are appropriate for TRU waste operations

- SB Review and DOE Risk Acceptance—clarifies expectations for SB review and acceptance of risks

- Verification of SB Implementation—describes general expectations for ensuring that new/revised SB documents are properly implemented

For the purposes of this document, the main focus will be on Identification and Evaluation of TRU Waste Events and TRU Waste ST Analysis. These topics are the most appropriate for use within EPHA analysis because these areas are the most similar between the two types of documents. Consequence Analysis performed for EPHAs is usually unique to emergency management and the processes applied for SB documents are not necessarily appropriate [i.e., meteorological conditions used may be those specified in the DOE Emergency Management Guide (EMG) *Technical Planning Basis*, DOE Guide 151.1-2, and the dispersion modeling codes used are typically those found in the Emergency Operations Center, which are often different than those used in SB documents]. In addition, Consequence Analysis in the EPHA is performed to determine the appropriate initial response and often times may not include some of the more precisely derived parameters that may be used in the analysis performed in SB documents. The remaining topics are particular to SB documents and do not apply to EPHA analysis. The following sections summarize the discussion presented in the pertinent sections of the TRU Standard.

IDENTIFICATION AND EVALUATION OF EVENTS

The TRU Standard provides the minimum set of accident events that must be addressed in the SB hazard evaluation when the hazard identification indicates the presence of potential initiators that could lead to the accident event. The set of accident events presented addresses those events with the potential for consequences that could be significant enough to warrant explicit technical safety requirements. Accident events are presented according to broad categories that include fires, explosion events, loss of confinement/containment, direct radiation exposure, criticality, externally initiated events, and natural phenomena events.

The TRU Standard provides an acceptable set of accident scenarios that in most cases would also be considered for inclusion in an EPHA. Different types/sizes of events and their applicability to different types of facilities are addressed. In addition, criteria are presented for determining whether a waste container deflagration should be considered, which is often one of the more bounding events evaluated for TRU waste facilities. While this discussion does provide a rather comprehensive list of potential events, because it is designed for SB analysis, it does not include many initiators that are required to be addressed in an EPHA (e.g., malevolent acts). For this reason, while the events described in the TRU Standard may provide an excellent starting point for event determination in an EPHA, the analysts should be careful to ensure that all required events are covered.

SOURCE TERM ANALYSIS

The TRU Standard defines assumptions for unmitigated analyses and provides guidance on ST development. The discussion generally involves the unmitigated analysis which means that no credit is given to preventive and mitigative controls to reduce the frequency or consequence of potential accidents. While the EPHA analysis may credit certain active safety features such as ventilation, filtration systems, and process controls, this unmitigated analysis provides an excellent starting point for ST determination. The major portions of the ST development covered in the TRU Standard, MAR, DR, and ARF/RF, are discussed in more detail in the sections below.

Material At Risk

The amount of hazardous material that is assumed to be at risk from a postulated accident scenario, or MAR, will directly impact the doses to both workers and the public. The purpose of determining MAR estimates during SB analysis is to identify a bounding value for the scenario being evaluated. The quantities of TRU material determined appropriate as the bounding MAR limits follow the general algorithm that a single container scenario assumes the presence of the single maximum loaded container (including instrument uncertainty), while multiple container accident scenarios assume the presence of some combination of containers containing the maximum container value, the 99th percentile value, the 95th percentile value, and the mean value quantities of TRU material, from the population of containers being evaluated.

However, it is generally accepted that the maximum anticipated inventory of hazardous materials, as opposed to the bounding inventory, is often times the most appropriate amount of material to be used in the MAR determination for EPHA analysis. Even though the methodology presented in the TRU Standard for determining MAR for specific events utilizes bounding inventories, it is still consistent with the EPHA expectations of analyzing more realistic amounts of materials. The TRU Standard method provides a reasonably conservative approach to determining consequences for TRU waste events and ensures that 1) events involving small numbers of containers will be conservatively estimated and 2) events involving larger numbers of containers will not be unnecessarily conservative (i.e., more realistic analysis).

As discussed in the DOE Order 151.1C Frequently Asked Question (FAQ) approved on 12/03/10, subject to the exception discussed below, the basic statistical MAR approach specified in the TRU Standard is an acceptable means for limiting conservatism in accident consequence estimates for TRU waste facility EPHAs and achieving results that are consistent with the “more realistic than bounding” principle as described in the EMG. However, the analyses suggested in the TRU Standard should be used with caution because the assumptions and methodology applicable to the intended purposes may not be fully compatible with emergency management planning needs. A specific example of such an incompatibility is related to the multi-container MAR estimates for an inventory of containers not fully characterized, in which the use of the suggested MAR values can produce counter-intuitive results and pose obvious problems for emergency planning and response. As a result, slight modifications may need

to be made to the algorithm to develop MARs that provide a sound basis for planning and response to accidents involving multiple containers. See the FAQ for additional information and guidance for MAR development for these exceptions.

While the methodology in the TRU Standard presents a very reasonable approach to the MAR determination, the characterization of the waste required to develop such inventories may not be available and it is not reasonable to assume that such characterization would be performed for the purpose of an EPHA analysis. Therefore, it is suggested that the analyst should use the MAR amounts in the TRU Standard, in accordance with the published FAQ, if the data exists (which will mostly likely only be for TRU waste facilities) and employ engineering judgment or other available information to develop MAR amounts for those facilities without such extensive data.

Damage Ratio

The DR is defined in DOE-HDBK-3010-94 as the "fraction of the MAR actually impacted by the accident-generated conditions." The DR is estimated based upon engineering analysis of the response of structural materials and materials-of-construction for containment to the type and level of stress/force generated by the event. Standard engineering approximations are typically used. These approximations often include a degree of conservatism due to simplification of phenomena to obtain a useable model, but the purpose of the approximation is to obtain, to the degree possible, a realistic understanding of potential effects.

When purchased, TRU waste containers are certified to DOT specifications. However, containers can degrade over time, and DOT certification is only effective for one year after packaging. Legacy TRU waste containers greater than one year, therefore, have lost their DOT certification, but have not stopped performing their intended function. It is not reasonable to assume that the structural capability of drums, exceeding one year, has diminished significantly or that these containers will split open upon any impact. During storage, handling, and movement, TRU waste containers may be punctured, crushed, toppled, or dropped, causing failure of the container and release of material. Legacy container performance and the degree of damage from these accident stresses are largely dependent on the structural integrity of the container. The WIPP Contact Handled Waste Acceptance Criteria recognizes that most TRU containers are legacy and, therefore, provides an inspection checklist to document that a container meets the DOT 7A criteria. The use of DRs specified in the TRU Standard that are based on containers with sound integrity (i.e., DR < 1) must meet these criteria. Further it can be extrapolated that any container meeting these criteria could similarly have these DRs applied. So, assuming that the containers are of sound integrity, the DRs discussed in the TRU Standard can generally be applied to any container.

The TRU Standard discusses the appropriate DRs for a number of different types of events, including deflagration, fire, mechanical insults, and natural phenomena hazards. The data presented for these events is discussed below.

Deflagration. The DRs presented for deflagrations are based on the material being released to the environment from three accident stresses: during the flexing in air, from assumed unconfined burning of a fraction of the material ejected, and from assumed burning of the remaining materials inside the drum. The DRs presented can be adjusted based on the types of waste within the container (i.e., combustible vs. non-combustible). In addition, values are given for both a single drum deflagration and a two-drum, sympathetic deflagration. These DRs are given for a number of different containers and, assuming the container is of sound integrity and the materials within the container are similar, it seems that these values could be applied to material other than TRU waste.

Fires. Two different types of fires are discussed in the TRU Standard, a flammable liquid pool fire and an ordinary combustible fire. As with the deflagration, the DR can be adjusted based on the types of waste within the container. The DRs suggested depend on the number of drums expected to eject their contents and the number of containers expected to only have seal failure. In addition, the values account for placement of the containers within the facility (i.e., proximity to fire) and the height of container stacking, if any (e.g., drums stored on the bottom row will not eject contents). A flow sheet is presented in the TRU Standard to explain the suggested DRs for both types of fires accounting for the storage configurations. Again, assuming the containers are of sound integrity and the materials are similar, the DRs given in the TRU Standard for fires could be applied to other materials.

Mechanical Insults. DRs are presented for a number of different mechanical insults to three different types of containers. These accidents include minor stresses, punctures and drops to vehicle crashes and more catastrophic events. The DRs given also account for stacking of the containers and the effect that has on the amount of damage inflicted (i.e., a drum falling from the third or fourth tier of a storage configuration will experience more damage than that falling from the second tier). Because these DRs are specific to the container and accident almost exclusively, these values can be applied in other situations, assuming that the container is of the same type discussed here and is of sound integrity.

Natural Phenomena Hazards. Because high winds and other events will have results similar to the mechanical insults, this section in the TRU Standard focuses primarily on seismic events. DRs are presented for both code of record events (i.e., facility expected to withstand) and building collapse events. The DRs are developed in two steps, considering 1) the number of containers impacted as determined by the type of building construction (i.e., heavier construction facilities, such as those with concrete, will cause greater damage than lighter construction facilities, such as RUBB tents) and 2) the damage done to those impacted based on container type. Again, because these values are based on container and facility type, there is no reason that they could not be applied in situations other than TRU waste facilities.

Airborne Release Fraction/Respirable Fraction

The ARF and RF are key factors in estimating the amount of airborne materials generated from accidents involving solids, liquids, gases, or surface contamination. ARF and RF values vary according to the form of material and type of accident stress. A breakdown of TRU waste forms and accident types is discussed and the suggested ARF/RF values from DOE-HDBK-3010-94 as applied to TRU waste accidents are given in the TRU Standard.

Because of the nature of SB analysis (i.e., develop controls to reduce risk to workers and public), the ARF/RF values given are the most conservative values applicable to each form of material. The use of the values given in the TRU Standard will provide a conservative estimate of the overall ST; however, as discussed in the DOE Order 151.1C Frequently Asked Question (FAQ) dated 11/24/2008, the overall analysis approach that is encouraged throughout the ST section of the EMG is more “realistic” than bounding. The FAQ goes on to state that “use of ARF/ARR and RF median values from the handbook instead of bounding values in EPHA analyses may be justified on the basis of experimental data or on the analyst’s assessment of conservatism already embodied in the modeling of a particular scenario.” As a result, the decision to use bounding versus median values, where available, is left to the analyst based on the other assumptions and use of the TRU Standard applied throughout the document. In any case, it is advisable to use the types (i.e., form and accident type) provided for events similar to those discussed in the TRU Standard.

CONCLUSIONS

Based on the data presented in the TRU Standard, it appears that not only could this information be used in the development of an EPHA, but it could also be applied to facilities outside of TRU waste. The most universal data presented is the development of DRs for various events. For the most part, as long as the container meets the requirements for sound integrity presented in the standard, the majority of the values are applicable, regardless of the material within the container. For deflagration and fire events, the type of material within the container is important; however, as long as the material of concern is waste of some sort, the TRU Standard provides different methods for adjusting the DRs to account for the waste composition. A great benefit to the TRU Standard is the extensive background and justification included within the document, which provides the analysts with sufficient information to justify using (or discounting) the data based on the specific details of the event. In addition, the suggestions for events, MAR, and ARF/RFs can be used in many cases with the discretion of the analyst. The data compiled within the TRU Standard provides an excellent reference and can be used to justify a great number of decisions during the ST development process. As a result, the TRU Standard could be used as another potential source of information for producing improved, technically sound EPHAs consistent with currently available guidance.