IMPLEMENTATION OF REVISION 19 OF THE TRUPACT-II SAFETY ANALYSIS REPORT AT ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

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ABSTRACT

The U.S. Nuclear Regulatory Commission on July 27, 2001 approved Revision 19 of the TRUPACT-II Safety Analysis Report (SAR) and the associated TRUPACT-II Authorized Methods for Payload Control (TRAMPAC). Key initiatives in Revision 19 included matrix depletion, unlimited mixing of shipping categories, a flammability assessment methodology, and an alternative methodology for the determination of flammable gas generation rates. All U.S. Department of Energy (DOE) sites shipping transuranic (TRU) waste to the Waste Isolation Pilot Plant (WIPP) were required to implement Revision 19 methodology into their characterization and waste transportation programs by May 20, 2002. An implementation process was demonstrated by the Rocky Flats Environmental Technology Site (RFETS) in Golden, Colorado. The three-part process used by RFETS included revision of the site-specific TRAMPAC, an evaluation of the contact-handled TRU waste inventory against the regulations in Revision 19, and design and development of software to facilitate future inventory analyses.

As part of the implementation process, the RFETS site-specific TRAMPAC Compliance Plan was revised to meet TRAMPAC Revision 19 requirements. Revisions consisted of modeling the RFETS TRAMPAC Compliance Plan to the TRAMPAC Revision 19 contents and tailoring appropriate sections to reflect site-specific procedures. Modification of the TRAMPAC Compliance Plan had relatively little impact on most RFETS procedural documents.

The inventory evaluation of more than 24,000 TRU waste containers identified the compliance status for each container relative to Revision 19 of the TRAMPAC. This study identified data needs, identified additional options to make containers compliant, provided a path forward for implementation of shipment options, and provided recommendations for the packaging of future waste streams.

A suite of software modules was designed for integration into the RFETS site Oracle 8i inventory database to allow for real-time container TRAMPAC compliance evaluation. These modules can be used to perform inventory analyses of container shippability and provide the user with necessary information to evaluate packaging for transportation compliance and optimize the assembly of payloads for transportation. By design, these modules may be integrated with any
Oracle database, version 8i or later, allowing their use at other waste generating sites utilizing Oracle without requiring site-specific modifications.

Each component of this process contributed to the successful implementation of the regulations of Revision 19 of the SAR and TRAMPAC with a seamless transition from Revision 18 while maintaining the shipping capability of RFETS.

**INTRODUCTION**

On July 27, 2001, the U.S. Nuclear Regulatory Commission approved Revision 19 of the TRUPACT-II Safety Analysis Report (SAR) and the associated TRUPACT-II Authorized Methods for Payload Control (TRAMPAC) published as a separate document. Revision 19 of the TRAMPAC [1] includes several payload expansion initiatives that increase the shippable portion of contact-handled transuranic (CH-TRU) waste from the U.S. Department of Energy (DOE) sites.

Implementation of TRAMPAC Revision 19 is challenging due to the complex nature of the requirements. Rocky Flats Environmental Technology Site (RFETS) in Golden, Colorado implemented Revision 19 with a three-part process that included revision of the site-specific TRAMPAC, an evaluation of the CH-TRU waste inventory against the regulations in Revision 19, and design and development of software to facilitate future inventory analyses. Implementation of TRAMPAC Revision 19 at RFETS will result in shipment of waste with higher decay heat limits, provide multiple options for meeting gas generation requirements, and decrease testing and repackaging costs associated with meeting transportation limits. These initiatives are discussed in more detail in the following sections.

**BACKGROUND**

Initiatives for gas generation requirements are the primary emphasis in Revision 19 of the TRAMPAC. The goal of the gas generation requirements is to assure that hydrogen gas does not exceed 5 percent by volume within the innermost confinement layer of any container. The initiatives include:

- Higher decay heat limits gained from smaller dose-dependent G values (i.e., lower hydrogen gas generation potential) resulting from matrix depletion,
- Headspace sampling/measurement for test category waste to determine compliance with the flammable gas/volatile organic compound (VOC) concentration limits,
- Specifications for higher efficiency filters, and
- Mixing of shipping categories within the TRUPACT-II.

**Dose Dependent G Values (Matrix Depletion)**

Under Revision 19 of the TRAMPAC, dose-dependent G values (hydrogen gas generation potential) may be used to allow the shipment of containers with higher decay heats that meet specified dose rate and age requirements. Controlled studies and experiments have quantified the reduction in the G value over time based on the total dose received by the target matrix.
When an alpha particle-generating source is dispersed in a target matrix, it will affect only that portion of the target material that is present in a small spherical volume surrounding the source particle. Over time, and with constant exposure to radiation, hydrogen is removed from the hydrogenous waste or packaging material (the matrix), thus decreasing the number of hydrogen atoms available for further radiolytic release (the matrix is depleted). As the amount of available hydrogen is reduced over time, the effective G value decreases with increasing dose to provide what is defined as the “dose-dependent G value.”

**Headspace Measurement**

Under Revision 19 of the TRAMPAC, headspace sampling/measurement can be used to qualify waste containers for shipment. Headspace measurement uses headspace gas samples to determine compliance with the flammable gas/VOC limits for non-Waste Type IV test category wastes (wastes that exceed decay heat limits or have headspace flammable VOC concentrations greater than 500 parts per million by volume [ppmv]). Under Revision 18 of the TRUPACT-II SAR TRAMPAC, containers with flammable VOC concentrations greater than 500 ppmv could not be shipped. TRAMPAC Revision 18 required the other test category waste containers (Waste Type IV or containers exceeding the decay heat limits) to undergo full-scale container testing.

**Higher Efficiency Filters**

Revision 19 of the TRAMPAC allows the use of higher efficiency filters (filters with higher hydrogen diffusivities) on the payload containers and inner packaging layers. New specifications were added for container filters and bag filters that allow credit for higher hydrogen diffusivity when higher efficiency filters are used resulting in shipment of waste containers with higher decay heat limits. For example, a drum with a 1X filter (3.7E-6 mol/sec/mol fraction diffusivity filter) and shipping category 30 0340 0114 has a decay heat of 0.1245 watts; whereas, the same drum with a 5X filter and shipping category 30 0340 0093 has a decay heat limit of 0.1526 watts.

**Mixing of Shipping Categories**

Revision 19 of the TRAMPAC allows sites to combine authorized waste types or waste material types within a TRUPACT-II with credit taken for dunnage containers and the mixing of different shipping categories. Taking credit for the void volume in dunnage containers effectively increases the analytical decay heat limit that was originally based on a full payload configuration.

**TRAMPAC COMPLIANCE PLAN**

According to Revision 19 of the TRAMPAC, Section 1.4, Methods of Compliance, each shipping site is required to document and demonstrate compliance with the TRAMPAC through either an appropriate programmatic (site-specific) or waste-specific TRAMPAC [1]. The purpose of the site-specific TRAMPAC is to document the specific methods used at the site to ensure that payloads are compliant with each requirement and are qualified for shipment. The
compliance procedures defined in the site-specific TRAMPAC require review and approval by
the DOE Carlsbad Field Office (CBFO) prior to implementation. To fulfill this requirement,
RFETS submitted to the CBFO a site-specific TRAMPAC Compliance Plan, comprising Chapter 6 of the RFETS TRU Waste Management Manual (1-MAN-008-WM-001), which was approved for use by the DOE on April 19, 2002.

When updating the TRAMPAC Compliance Plan, RFETS made revisions to reflect the contents outlined in the Revision 19 TRAMPAC and tailored each section appropriately to reflect RFETS compliance procedures. The RFETS controlling procedural documents referenced in the TRAMPAC Compliance Plan exist as stand-alone documents, which were also revised to reflect the contents of TRAMPAC Revision 19. While TRAMPAC Revision 19 required some modification to existing RFETS procedural documents to incorporate some of the payload expansion initiatives introduced in the TRAMPAC Revision 19, development of new procedural documents was not required.

The RFETS TRAMPAC Compliance Plan and the associated procedural documents were revised to reflect all payload container types authorized in the Revision 19 TRAMPAC. Text was included in the TRAMPAC Compliance Plan to indicate that not all payload containers or container configurations are currently in use at RFETS and procedures will be developed for those containers or configurations in the future, if appropriate. This allows RFETS the flexibility to use these containers or configurations in the future with minimum revision to the TRAMPAC Compliance Plan. RFETS procedural documents describing test category waste required more extensive revisions to include the Revision 19 TRAMPAC initiatives that allow for the options of headspace measurement as an alternative to full-drum testing, mixing of shipping categories, and inclusion of containers with VOC concentrations greater than 500 ppmv in the test category. Revisions were also made to address changes to container labeling requirements and matrix depletion.

For ease of use, RFETS included a TRUPACT-II Transportation Requirements Matrix for RFETS as Appendix 10 to the TRAMPAC Compliance Plan. The matrix outlines each TRAMPAC requirement, the appropriate section in Revision 19 of the TRAMPAC, and the correlating section of the RFETS TRAMPAC Compliance Plan. The matrix also includes a list of all RFETS procedural documents referenced in each of the TRAMPAC Compliance Plan sections. Including this matrix as part of the TRAMPAC Compliance Plan provides a quick and easy tool for locating site-specific compliance methods and procedures for TRAMPAC requirements and ensuring that all requirements are consistently addressed.

INVENTORY ANALYSIS

The RFETS implementation plan included an assessment of the compliance of each container of CH-TRU waste stored as of December 2001 at RFETS with the transportation requirements. A total of 24,183 containers were evaluated. Analyses were performed using data obtained from the Waste and Environmental Management System (WEMS) at the RFETS, which tracks all container data. When data were unavailable (e.g., missing headspace flammable VOC concentration data), the container was assessed against as many TRAMPAC requirements as possible. The assessment results identified the missing data. The inventory assessment
determined shippable containers under Revision 18 of the TRUPACT-II SAR [2] and the associated TRAMPAC. The containers were subsequently evaluated for compliance with Revision 19 of the TRAMPAC [1]. This assessment estimated the compliance status for each container relative to Revision 18 or 19, identified data needs, proposed additional options to make containers compliant, and provided a path forward for implementation of shipment options and recommendations for the packaging of future waste streams.

Container types included in the RFETS inventory are 55-gallon drums, 85-gallon drums, 12-inch standard pipe overpacks, direct load standard waste boxes (SWBs), metal 55-gallon bung drums, and 10-gallon drums. The metal 55-gallon bung drums and 10-gallon drums are not approved container types for shipments to the WIPP. The 85-gallon drums, each overpacking a 55-gallon drum, were assumed to be type A containers that would be overpacked in a ten-drum overpack (TDOP). The 85-gallon drums were evaluated against limits for direct shipment while acknowledging that the containers are currently approved only for shipment when they are overpacked in TDOPs. However, 85-gallon drums that meet the limits for direct shipment will also meet the limits for shipment in a TDOP. Shipments of 85-gallon drums, both overpacked in a TDOP and direct loaded into the TRUPACT-II Inner Containment Vessel (ICV) are proposed in future revisions of the TRAMPAC.

Assumptions

Assumptions were made for containers with missing or conflicting data to allow evaluation against as many requirements as possible for planning purposes. In some instances, data were not available because the container was undergoing processing during this analysis.

If data was missing from the WEMS, shipping categories for many of the containers were obtained from the TRUPACT-II Content Codes (TRUCON) [4] identified for the waste. If the TRUCON Code was not identified, then the TRUCON Code was assumed from the item description code (IDC) presented for the container using the TRUCON code with the “A” suffix for drums and the “N” suffix for SWBs and the most restrictive packaging configuration for other containers [5].

Unless otherwise indicated in the database, all filters on drums, SWBs, and metal cans are assumed to be NFT-013 compliant with a minimum hydrogen diffusivity of 3.7E-06 moles per second per mole fraction.

Discrepancies between container sampling dates, container closure dates, and container vent dates were observed in the data. For cases where the vent date listed in the database for the container was after the sample date, the vent date was reassigned the date of the first sample. The sampling procedure for containers requires that the containers be vented before or during sampling. For cases where the vent date was before the closure date, the vent date was reassigned the date of the closure.

In accordance with Revisions 18 and 19 of the TRAMPAC, containers were assumed to meet the limits for headspace flammable VOC concentration if process knowledge was available.
demonstrating that the containers had less than or equal to 500 ppmv flammable VOCs in the headspace.

The arbitrarily chosen date of February 28, 2002 was used in the evaluation of matrix depletion. Containers that satisfied the matrix depletion criteria by February 28, 2002 were evaluated against the dose dependent G value-based decay heat limits provided in Revision 19 of the TRAMPAC.

**Compliance Determination**

The evaluation of the container inventory was performed as a step-wise screening process. Each screening step categorized containers within the inventory based on compliance or noncompliance with specific criteria/requirements. During the screening process each container was evaluated against all applicable criteria/requirements where data were available. The containers identified to be eligible for other TRAMPAC Revision 19 options were also evaluated against the requirements of proposed revisions to the TRAMPAC. Revision 20 of the TRAMPAC proposes a reduced shipping period for several close proximity sites to the WIPP including RFETS. This reduced shipping period further increases the decay heat limits over TRAMPAC Revision 19. Table I presents a summary of the number and types of containers in each assessment category under the current transportation requirements of TRAMPAC Revision 19.

Containers with a non-compliant container type and/or waste type were removed from analysis due to required repackaging and/or treatment changing the packaging characteristics of the waste. Nine containers were removed from further evaluation because the waste was packaged in payload containers that were not authorized in either Revision 18 or 19 of the TRAMPAC and must be repackaged or overpacked in an authorized payload container (e.g., SWB or TDOP). Six containers were removed from further evaluation because they contained liquid waste, a waste form that is not authorized for shipment in the TRUPACT-II or disposal at the WIPP. To make this waste shippable, the waste in these containers will require treatment to solidify the liquid waste form. Two of these containers with liquid waste were also packaged in unauthorized payload containers.

About 100 of the Waste Type IV containers were missing weight or fissile gram equivalent (FGE) data; however, all other drums containing Waste Type IV waste were found to be compliant with weight and FGE requirements. Waste Type IV wastes must undergo full container gas generation testing in Revision 18 and 19 of the TRAMPAC. The 844 containers of Waste Type IV waste were removed from further evaluation against gas generation requirements.

Alternative gas generation compliance methods, including statistically based sampling/testing, are being proposed for Waste Type IV containers under future revisions of the TRAMPAC.

Out of the containers remaining after removing the noncompliant containers/wastes and the containers with Waste Type IV were evaluated, 18,778 containers (77.7 percent, Figure 1) passed the TRAMPAC Revision 18 decay heat limit evaluation and did not fail any of the other
Table I. Summary of Compliance Assessment by Container Type

<table>
<thead>
<tr>
<th>Compliance of Containers with TRAMPAC Revision 18 or Revision 19 Requirements/Initiatives</th>
<th>Container Types</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>55-gallon Drum</td>
<td>85-gallon Drum</td>
</tr>
<tr>
<td>Non-compliant Container Types and Waste Forms</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>Waste Type IV (Solidified Organics)</td>
<td>795</td>
<td>49</td>
</tr>
<tr>
<td>Pass Decay Heat Limits, Rev. 18</td>
<td>4,926</td>
<td>14</td>
</tr>
<tr>
<td>Pass Matrix Depletion Decay Heat Limits, Rev. 19</td>
<td>1,714</td>
<td>1</td>
</tr>
<tr>
<td>Pass the Flammability Assessment Methodology Program (FAMP) Rev. 19</td>
<td>56</td>
<td>0</td>
</tr>
<tr>
<td>Pass the Alternative Methods for Headspace Sampling (AltMeth) Rev. 19</td>
<td>39</td>
<td>0</td>
</tr>
<tr>
<td>Pass Container Testing with Existing Data</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>May Pass Rev. 19 Headspace Sampling based on Decay Heat</td>
<td>926</td>
<td>5</td>
</tr>
<tr>
<td>May Pass Rev. 19 Decay Heat Limits with Filter Enhancements</td>
<td>133</td>
<td>0</td>
</tr>
<tr>
<td>Fail Container FGE Limit but Have Less than 325 FGE (Pass if overpacked in a SWB or TDOP)</td>
<td>202</td>
<td>0</td>
</tr>
<tr>
<td>Greater than 325 FGE Limit</td>
<td>119</td>
<td>1</td>
</tr>
<tr>
<td>Greater than 3 Times the Decay Heat Limit</td>
<td>285</td>
<td>1</td>
</tr>
<tr>
<td>Missing Decay Heat</td>
<td>651</td>
<td>25</td>
</tr>
<tr>
<td>Insufficient Data for Analysis</td>
<td>45</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>9,900</td>
<td>96</td>
</tr>
</tbody>
</table>

aOther container types include 55-gallon metal bung drums and 10-gallon drums.
Rev. 18 = TRUPACT-II Authorized Methods for Payload Control (TRAMPAC) Revision 18.
Rev. 19 = TRUPACT-II Authorized Methods for Payload Control (TRAMPAC) Revision 19.
FGE = fissile gram equivalent

TRAMPAC Revision 18 requirements. Out of these containers, 719 55-gallon drums and 1,762 pipe overpacks required no further action. About 1,171 containers were missing closure/vent dates; 12,920 containers were missing headspace flammable VOC concentration data; and 2,206 containers were missing container weight data. These data were required to evaluate the compliance of these containers with aspiration, flammable gas, and weight requirements.

Using dose-dependent G values (matrix depletion), 1,864 containers (7.7 percent) of the containers will be eligible for shipment under Revision 19 of the TRAMPAC by meeting the revised decay heat limits. Of these containers, 191 55-gallon drums require no further data acquisition, testing, or mitigation measures. Mitigation measures may include repackaging or treatment and are costly and time consuming. Containers that meet the TRAMPAC Revision 19 decay heat limits, but are missing other data needed to complete the compliance evaluation,
include 533 containers missing container closure/vent dates, 1,072 containers missing headspace flammable VOC concentration data, and 68 containers missing weight data. These containers cannot be evaluated for compliance with aspiration and weight requirements.

Containers missing headspace flammable VOC concentration data could not be evaluated for compliance with the analytical category headspace flammable VOC limit of less than or equal to 500 ppmv. These containers may also be missing closure/vent dates. These containers will be shippable under the analytical category of Revision 19 of the TRAMPAC once compliant headspace flammable VOC concentration and aspiration data are determined. However, based on the data currently available, approximately 97 percent of the containers with headspace flammable VOC data meet the 500 ppmv limit. Applying this trend to the rest of the waste container population, a great majority of these containers is expected to meet the flammable VOC requirements without being classified as test category waste.

Unlike TRAMPAC Revision 18, failure to meet the flammable VOC limit does not necessarily disqualify a container for shipment under Revision 19 of the TRAMPAC. Instead, a container with a flammable VOC concentration greater than 500 ppmv can still be authorized for shipment after measurement of the headspace flammable gas/VOC concentrations and application of the Flammability Assessment Methodology Program (FAMP), as described in Appendix 5.8 of the TRAMPAC Revision 19 [1]. It was determined that 56 drums had total hydrogen, methane, and

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**Figure 1. Shippability Compliance for Rocky Flats Environmental Technology Site Inventory (24,183 Containers)**

[Pass Decay Heat (Rev. 18) 77.7%]

[Pass Container Testing or Headspace Measurement (Rev. 19) 0.4%]

[Containers Requiring Further Action 14.2%]

[Pass Decay Heat with Matrix Depletion (Rev. 19) 7.7%]
VOC concentrations less than or equal to the mixture lower explosive limit, thereby meeting the flammable gas generation requirements. Forty-five containers have reported flammable VOC concentrations greater than 500 ppmv but are missing required data and therefore cannot be evaluated by the FAMP. Many of these containers may be compliant once additional data are obtained. Forty-five of these containers, however, do have relatively high flammable VOC concentrations and may require mitigation.

Revision 19 of the TRAMPAC also provides a new path forward for containers of Waste Types I, II, or III with flammable VOC concentrations less than or equal to 500 ppmv and decay heats exceeding the decay heat limit. These containers can be evaluated through headspace measurement for flammable gases to calculate the actual container flammable gas generation rate (see the Alternative Method [AltMeth] methodology described in Appendix 5.8 of the TRAMPAC Revision 19 [1]). The calculated flammable gas generation rates of 39 drums are less than the flammable gas generation rate limit and can be shipped if they satisfy all other requirements.

The inventory data stored in the WEMS included full-drum testing results for some containers. Three 55-gallon drums passed drum testing and, assuming compliance with all other transportation requirements are shippable.

As shown in Figure 1, the remaining 14.2 percent of the inventory (3,443 containers) requires some further action. These actions can include the use of TRAMPAC Revision 19 initiatives of higher efficiency filters, the mixing of shipping categories, and headspace measurement to meet compliance as well as a proposed initiative of a reduced shipping period. Figure 2 presents a breakdown of the inventory requiring further action and recommended actions.

As shown in Figure 2, of the 3,443 containers requiring further action to meet compliance, 29.6 percent (1,018 containers) are expected to meet gas generation requirements by headspace measurement or full-drum testing, based on reported decay heats that are 100 – 300% greater than the permissible decay heat limits. Based on previous headspace sampling and decay heat measurements which indicate a conservative application of G values, the majority of these containers are expected to be compliant with the headspace measurement criteria or full-drum gas generation testing.

Of the containers requiring further action, 24.5 percent of the containers are Waste Type IV and require full-drum testing under the requirements of TRAMPAC Revision 19 to be shippable. Approximately 4 percent of the 3,443 containers requiring further action will likely be shippable with the implementation of higher efficiency filters. Approximately 18.9 percent of the containers requiring further action may require repackaging, overpacking, or other mitigation measures because the containers have recorded FGE values in excess of the limits, the recorded decay heats are greater than three times the limit, or the headspace flammable gas/VOC mixture exceeds the limits.

As previously discussed Revision 19 of the TRAMPAC provided several payload expansion initiatives, including the use of higher efficiency filters. This initiative was applied to the remaining containers. Based on the measured decay heats, 133 55-gallon drums would benefit
from filter enhancements by replacing the existing payload container filter with a 5X filter (a filter with a minimum hydrogen diffusivity of 1.85E-5 moles per second per mole fraction). Two SWBs would meet analytical category decay heat limits if the two NFT-013 filters were replaced with higher efficiency 5X filters. Two additional SWBs would meet analytical category requirements if four 5X filters were installed.

A proposed revision to the TRAMPAC includes a reduction in the maximum shipping period for waste generator sites within close proximity to the WIPP, including RFETS. Shipping categories for all waste TRUCON Codes for the close proximity sites were developed for a 20-day shipping period (reduced from 60 days in all former TRAMPAC revisions). The reduced shipping period increases the permissible decay heat limits and allowable gas generation rates. Under the increased decay heat limits associated with the reduced shipping period, 228 additional containers will be shippable if they met all other requirements.

The containers were also evaluated to determine the benefit of mixing shipping categories. Each container was assumed to be packaged in the TRUPACT-II ICV with all other containers being dunnage containers (i.e., 1 drum was packaged with 13 dunnage drums, 1 SWB was packaged with 1 dunnage SWB). Under TRAMPAC Revision 19, credit cannot be taken for dunnage in a TDOP; therefore, a similar analysis was not performed on the 85-gallon drums. The mixing of
shipping categories was beneficial to some containers. However, the benefits of high efficiency filters, headspace measurement, or reduced shipping periods were typically greater. Because of the shipping inefficiencies associated with this hypothetical evaluation of mixing, these other options were preferable.

Of the 24,183 containers evaluated, 1,444, including the 15 noncompliant containers/wastes, require some other path forward in order to meet payload shipment compliance. The 1,444 containers also include 357 containers that fail one or more of the TRAMPAC Revision 18 or 19 criteria (e.g., weight, FGE, decay heat, gas generation, etc.), as well as 1,072 containers that are missing the data necessary to complete a compliance evaluation.

Containers that fail to meet the individual container FGE limit of 200 grams but meet the payload FGE limit of 325 grams include 202 55-gallon drums and 12 pipe overpacks. The recommended path forward for these containers is to overpack the drums/pipe overpacks into an SWB or TDOP individually or with other low-FGE containers of the same shipping category to take advantage of the greater allowable container FGE for SWBs and TDOPs.

Containers that fail to meet the payload FGE limit of 325 grams consist of 119 55-gallon drums, 1 85-gallon drum, and 2 SWBs. No change to this requirement is expected in future revisions to the TRUPACT-II SAR. The FGE measurements for these containers should be verified to check for measurement or data input errors. If no errors are found, the only current path forward for these containers is repackaging.

About 300 containers with very high decay heats were evaluated for mixing, enhanced filters, reduced shipping periods, and other options, and none were found to be beneficial. The recommended path forward is repackaging if the container does not pass full-drum testing.

The following is a breakdown of the containers that do not presently have reported decay heats and are generally missing other data required to perform the payload compliance evaluation: 651 55-gallon drums, 25 85-gallon overpacks, one pipe overpack, and 72 SWBs. Once additional data are acquired for these containers, they can be evaluated for compliance with TRAMPAC Revision 18 or 19 requirements. An appropriate path forward can be determined at that time. Based on the total population of containers evaluated, most of these containers are expected to meet the analytical category decay heat limits for TRAMPAC Revision 18 or Revision 19 and will be shippable.

SOFTWARE DEVELOPMENT

Software modules were developed to assist RFETS with evaluations of CH-TRU waste container data for compliance with the requirements of Revision 19 of the TRAMPAC before uploading container information into the WIPP Waste Information System (WWIS). These modules were intended for use upstream of the WWIS, which performs the final and official compliance evaluation. Proper integration of these modules into the WEMS at RFETS will help streamline the processes of certifying and shipping CH-TRU waste to WIPP.
The software modules described above were programmed in Java due to the highly mathematical nature of several evaluations and installed in an Oracle database, the WEMS, as stored procedures. Oracle 8i or higher supports Java stored procedures. Nine individual modules were developed to address particular evaluations by either performing the evaluation or providing some calculated value required for an evaluation. TRAMPAC requirements addressed by the modules include the TRUCON code, aspiration time, radiological activity limits for shielded pipe overpacks, drum age criteria (DAC), and gas generation requirements. The WEMS already evaluated weight, FGE, number and type of filters, and radiation dose rate. The logic for these parameters was revised to reflect new containers types and weight limits allowed by TRAMPAC Revision 19.

The TRUCON code evaluation determines whether the content code and shipping category assigned to a container is a valid combination according to the TRUCON document. The aspiration evaluation provides the required aspiration time for containers that have been stored in an unvented condition. The radiological activity evaluation determines whether a shielded pipe overpack meets the radionuclide activity limits defined in the TRAMPAC. If a headspace measurement is required by any evaluation, the time the container has been vented must meet or exceed the DAC to ensure headspace measurement is representative of the container. The DACs are estimates of the time required for the VOCs in the headspace of a container to reach 90 percent of their steady-state concentration.

Modules for flammable gas generation requirements determine compliance with requirements in Section 5.0 of TRAMPAC, Revision 19. The matrix depletion module evaluates whether a container qualifies for a less restrictive shipping category due to the depletion of hydrogen in an organic matrix. The module returns the applicable shipping category based on the shipping category, decay heat, closure date and, date of compliance entered. If headspace measurement values show that the flammable VOC concentration exceeds 500 ppmv, the contribution of the flammable VOCs must be accounted for in the flammability potential of the container. Another module, MLEL, determines the mixture lower explosive limit and the allowable flammable gas concentration (AFGC) for the combination of the flammable VOCs, hydrogen, and methane. The AFGC determined in the MLEL module is used as input for the flammable gas generation rate (FGGR) module. If the total flammable VOC concentration is less than or equal to 500 ppmv, then the AFGC is simply the hydrogen concentration limit of 50,000 ppmv. The FGGR module calculates the FGGR from the headspace measurement concentrations and determines compliance with the FGGR rate based on the shipping category and AFGC. Alternatively, the gas generation testing program module uses the gas generation rates from full-drum testing to determine compliance with flammable gas generation rate limits.

These modules in conjunction with WEMS provide a fully functioning, integrated, and efficient system for preliminary compliance for shipment of TRU waste to the WIPP with new initiatives in Revision 19 of the TRAMPAC.
SUMMARY

Revision 19 of the TRAMPAC provided several new initiatives for payload expansion. These initiatives afford sites with several additional options for compliant shipment of TRU waste in the TRUPACT-II to the WIPP; however, implementation of these initiatives was complicated and involved and required extensive modification to site systems. RFETS revised the site-specific TRAMPAC, evaluated inventory against regulations in the TRAMPAC, and designed and developed software for future inventory analyses to facilitate implementation of the TRAMPAC Revision 19 initiatives.

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