

MURR MTRU Waste Management Plan

for the

Transportation and Disposal of DOE's Mixed Transuranic Wastes at the Missouri
University Research Reactor, located in Columbia, Missouri

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for approval by

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Carlsbad Area Office
and
Oakland Operations Office

Prepared jointly by

University of Missouri-Columbia
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ACRONYMS AND ABBREVIATIONS

CH-TRU	Contact-handled transuranic
DOE	Department of Energy
FGE	Fissile gram equivalents
IVC	Inner containment vessel cavity
LLW	Low-level (radioactive) waste
MTRU	mixed transuranic
MURR	Missouri University Research Reactor
NRC	Nuclear Regulatory Commission
OAK	Oakland Operations Office
QA	Quality Assurance
QAPjP	Quality Assurance Project Plan
SARP	Safety Analysis Report for Packaging
SNM	Special Nuclear Material
SOP	Standard Operating Procedure
SQS	Small Quantity Site
TAM	TRUMP-S Activities Manual
TRAMPAC	TRUPACT-II Methods for Payload Control
TRUMP-S	Transuranic Management by Pyropartitioning - Separation
TRUPACT-II	<u>Transuranic Package Transporter -II</u>
WAC	Waste Acceptance Criteria
WCP	Waste Certification Plan
WIPP	Waste Isolation Pilot Plant (DOE disposal facility for transuranic waste)

MURR MTRU Waste Management Plan

I. Introduction

This "MURR MTRU Waste Management Plan" is a comprehensive outline for the management of the mixed transuranic (MTRU) waste at the Missouri University Research Reactor (MURR). The purpose of this plan is to systematically ensure the MURR MTRU waste will ultimately be acceptable for disposal at the Waste Isolation Pilot Plant (WIPP) in Carlsbad, New Mexico. The plan describes how the requirements have been or will be met that will allow the waste to be packaged, certified, transported off-site and disposed at WIPP.

This plan is submitted to the Department of Energy Oakland Operations Office (DOE/OAK) for their review and approval. This plan is a response to the December 10, 1997 letter from the DOE/OAK Contracting Officer, Sandra Silva, to the Boeing Contract Administrator, Wayne Asp, which included a request for a MURR MTRU Waste Management Plan (Enclosure 2 of the letter, "Guidance on Packaging and Management of Mixed Waste at MURR", page 2).

The requirements that need to be met to get the MTRU waste disposed at WIPP are complex. This document is assembled in three parts:

- MURR MTRU Generator Requirements
- MURR MTRU WIPP-WAC Plan
- MURR TRAMPAC

The MURR MTRU Generator Requirements (section II, below) is a table summarizing the top-level requirements to get the waste accepted at WIPP. Note that certain of these requirements related to disposal at WIPP will be performed by another organization. For maximum cost-effectiveness, certification of the waste will be accomplished by another DOE site, under the guidance of the DOE Carlsbad Area Office.

The MURR WIPP-WAC Plan (section III, below) is a table that lists twenty seven items included in the WIPP-WAC with the applicable documentation and location that demonstrates the waste conforms to the WIPP-WAC. For ease of reference, this table is organized according to the WIPP-WAC numbering system. A column in this table lists the corresponding transportation requirements by reference to the corresponding section of the MURR TRAMPAC, which is explained below.

The MURR MTRU waste will be shipped off site, either to another DOE site or to WIPP, by Transuranic Package Transporter - II (TRUPACT-II). The requirements specific to the transportation of transuranic materials to any destination have been described in the TRUPACT-II Methods for Payload Control (TRAMPAC). The plan for how the MURR MTRU waste will meet these transportation requirements is found in the "MURR TRAMPAC" (section IV, below). The MURR TRAMPAC presents the general requirements for off-site transport of TRU waste. Each requirement is followed by a description of the compliance and verification methods used for the MURR waste to satisfy the TRUPACT-II. The Appendix section of this plan contains copies of documents, specific data and references to MURR archived documents.

The requirements for disposal of the MURR MTRU waste at WIPP are usually the same as the transportation (i.e., TRAMPAC) requirements. This motivated the presentation form of this document. In those instances where the WIPP-WAC requirements are more restrictive than the TRAMPAC, the compliance and verification methods section in the MURR TRAMPAC will show how the WIPP-WAC requirement is satisfied, as well.

II. MURR MTRU Generator Requirements

There are general requirements placed on sites that generate transuranic waste destined for disposal at WIPP. The following table is a list of the numbered references to sections of the "Generator Site Certification Guide", Revision 1, August 1997 that apply to the MURR MTRU waste.

MURR MTRU Generator Requirements

Requirement (document)	How Requirement is Met	Notes
Waste Certification Plan (WCP) (3.2.1)	1) CAO will certify the waste (as the user). The WCP is not required of MURR. 2) MURR will provide the organization certifying the waste with copies of procedures, videotape of the drum loading and certification of drum contents to minimize additional characterization requirements, or substantiate certification conclusions.	MURR will provide site-specific procedures (the "MTS Contingency Plan") as required. See the WIPP-WAC plan and the MURR TRAMPAC, below.

MURR MTRU Generator Requirements (Cont.)

Requirement (document)	How Requirement is Met	Notes
Certification QA Plan (3.2.2)	This requirement is met by the certifying organization.	(not required of MURR).
Quality Assurance Project Plan (QAPjP) (3.2.3)	The DOE facility or mobile unit provides the QAPjP. MURR provides site QA program plan documentation.	The work which generated the waste was performed under controlled procedures that serve as the MURR QA plan - documentation. An NRC license and three other site documents demonstrate the rigorous controls under which the waste has been managed: The "TRUMP-S Standard Operating Procedures" (revised 7/1/98), University of Missouri-Columbia "Hazardous Material Management Procedures Manual" (First edition, December 1, 1993), and the "Permit Modification for Container Storage of Mixed Waste for the University of Missouri - Columbia". These documents are included as Appendices A, B, and C, respectively, to this plan.
QAPD Procedures Matrix (3.2.4)	The MURR WIPP-WAC Plan, below, includes reference documents. For each WIPP-WAC and TRAMPAC requirement, the corresponding document and the location within the document is indicated.	All applicable site documents are either included as appendices to this document, or are archived as indicated in Appendix H.
Graded Approach Procedure (3.2.5)	Not required of MURR.	With 7 drums of MTRU waste, MURR is a Small Quantity Site.
Sampling Plan (3.2.6)	Required of the certifying organization.	Not required of MURR
TRAMPAC and Associated QA Plan (3.2.7)	A site-specific MURR TRAMPAC that ties directly to the WIPP TRAMPAC is included in section IV of this document.	The MURR TRAMPAC indicates how the individual TRAMPAC requirements are met for the MURR MTRU waste.
Packaging QA Program Plan (3.2.8)	TRUMP-S Standard Operating Procedures, TAM-26, "Packaging MTRU Waste", Appendix A of this plan.	This controlled document is the procedure for packaging TRU waste. It does not provide actual data, but it explains how the packaging is accomplished, how contents are documented, and what controls are required.

III. MURR WIPP-WAC Plan

The following table is a checklist reference to the sections of the Waste Isolation Pilot Plant Waste Acceptance Criteria (WIPP-WAC) (see DOE/WIPP-069, Revision 5, April 1996) and the TRUPACT-II Methods for Payload Control (TRAMPAC) (see Appendix 1.3.7 of the TRUPACT-II SARP) that require documentation. The first column is the sequence of WIPP-WAC section numbers. The second column is the corresponding section number from the TRUPACT-II SARP and is the same as the MURR TRAMPAC section number. The MURR TRAMPAC contains a summary of each TRAMPAC requirement and the compliance/verification that satisfies the conditions. This format ensures completion of all requirements and presents the information in a concise format.

MURR MTRU WIPP-WAC Requirements

WIPP-WAC Section	MURR TRAMPAC Section	Criteria	Documentation
3.2.1	8.0	Container Description	DOT Type A 55-gallon drums. See Appendix F for procurement documentation.
3.2.2	11.0	Container/Assembly Weight	Certification documents for scales are included in Appendix G. See TRAMPAC section 11.1.1
3.2.3	12.0	Removable Surface Contamination	Appendix G. MU shipping procedures and a copy of the survey form with date of instrument calibration are included.
3.2.4	---	Container Marking	DOE/CAO will provide the bar codes with shipping category number, as required.
3.2.5	13.4	Dunnage	Shipping papers and the Payload Container Transportation Certification Document. No additional WIPP requirement.
3.2.6	8.0	Filter Vents	Appendix F
3.2.7	4.0	Liquids	There are no free liquids. See MURR TRAMPAC section 4.0, and Appendix E, Section 3.
3.3.1	9.0	Nuclear Criticality	See MURR TRAMPAC section 9.0. Process knowledge and inventory records assure the mass is << critical mass. See also Appendix E, Section 1.
3.3.2	--	Pu-239 Equivalent Activity	See Appendix E, Section 1. Calculations are based on inventory records.
3.3.3	12.0	Contact Dose Rate	Appendix G, survey form.
3.3.4	10.0	Thermal Power	Inventory records; see Appendix E, Section 1.
3.3.5	---	TRU Alpha Activity	Appendix E, Section 1, shows the specific activity for each individual bag, and demonstrates that all bags exceed the 100 nCi/g limit, as required for disposal at WIPP. Alpha activity calculations are documented in the archive files. (This is a WIPP requirement, but is not required by the TRAMPAC.)

MURR MTRU WIPP-WAC Requirements (Cont.)

WIPP-WAC Section	MURR TRAMPAC Section	Criteria	Documentation
3.4.1	5.0	Pyrophoric Materials	No pyrophoric materials were used (Appendix E, Sections 2 and 3). All actinides are in a fully oxidized state.
3.4.2	5.0	Mixed Waste	Silver and cadmium are the only possible hazardous constituents (Appendix E, Sections 2 and 3).
3.4.3	6.0	Chemical Compatibility	The only potential hazardous waste components in the wastes are cadmium and silver (Appendix E, Sections 2 and 3). The experimental record is archived (see list of archives in Appendix H).
3.4.4	5.0	Hazardous Constituents	Appendix E, Sections 2 and 3, and experimental logs in archives (Appendix H).
3.4.5	5.0	Explosives, Corrosives and Compressed Gases	No explosives, corrosives or compressed gases are included. Appendix E, Sections 2 and 3, and experimental logs in archives (Appendix H).
3.4.6	5.0	PCBs Concentration	No PCBs were used in the TRUMP-S project. Appendix E, Sections 2 and 3, and experimental logs in archives (Appendix H).
3.5.1	10.0	Decay Heat	MURR TRAMPAC section 10.0; Appendix E, Section 1 for summary information, and archives for source records (Appendix H).
3.5.2	5.0	Flammable VOCs	No VOCs were used in the TRUMP-S project. Appendix E, Sections 2 and 3, and experimental logs in archives (Appendix H).
3.5.3	5.0	VOC Concentration	No VOCs were used. Appendix E, Sections 2 and 3, and experimental logs in archives (Appendix H).
3.5.4	8.0	Aspiration	Filter vents will be in place when the drums are sealed. Filter vent documentation is included in Appendix F.
3.5.5	3.0	Shipping Category	All drums are classified SQS 121C. Appendix D.
3.5.6	8.0	Confinement Layers	Appendix G, Data Collection Forms from packaging, and videotape.
3.6.1	13.0	Acceptance Data	The certifying organization will complete the CH-TRU Waste Certification Statement.
3.6.2	13.0	RCRA Data	The waste stream profile form, the Uniform Hazardous Waste Manifest and the Land Disposal Restriction notification will be completed by MURR.
3.6.3	13.0	Shipping Data	See MURR TRAMPAC section 13.0.

IV. MURR TRAMPAC

1. Summary

The purpose of this MURR TRAMPAC is to demonstrate that the TRU waste packaging and loading operations for shipping seven drums of Missouri University Research Reactor (MURR) mixed transuranic (MTRU) waste in a TRUPACT-II container have been conducted in accordance with the TRUPACT-II Authorized Methods for Payload Control (TRAMPAC), Appendix 1.3.7 of the NRC TRUPACT-II Safety Analysis Report for Packaging (SARP). The approval of this document by the DOE Oakland Operations Office (OAK) and the DOE Carlsbad Area Office (CAO) is an approval of the data contained herein, rather than an approval of the quality assurance (QA) program under which the data was generated. Payload compliance will be certified by the CAO when this TRAMPAC is approved. TRUPACT-II loading and unloading will be performed by personnel assigned by the CAO, with appropriate support by MURR.

2. Introduction

The purpose of the TRUMP-S (Transuranic Management by Pyropartitioning - Separation) program was to separate uranium and transuranics from fission products that are present in PUREX waste, the raffinate phase from reprocessing domestic spent nuclear fuel. This process is intended to be a waste management strategy that reduces the burial time for the remaining radiological active components in the PUREX waste. It is important to note that *no spent nuclear fuel was used in this research.*

The MURR TRUMP-S experimental program was designed to determine the separation factors for uranium and transuranics from fission products. Simulated PUREX waste mixtures were prepared using U, Np, Pu and Am metal to prepare actinide metal chlorides combined with commercially available rare earth metals and metal chlorides. The metal chlorides were dissolved in molten LiCl-KCl in PUREX waste proportions. The "dry" separation is accomplished using a combination of electrochemical deposition and oxidation-reduction chemistry between the molten salt and liquid metal phases (cadmium or bismuth). Silver/silver chloride reference electrodes were used in these experiments.

Samples of the molten salt and the liquid metal phases from the individual experiments were dissolved in water or nitric acid and analyzed using an

Inductively Coupled Plasma-Mass Spectrometer. The excess solutions were rendered basic with sodium hydroxide pellets and evaporated to dryness. This is the primary source of transuranics in the TRUMP-S MTRU waste and produces a dry powder with all metals in an oxidized state.

There is lab ware waste that includes glove box gloves, poly vials, glass laboratory apparatus, paper towels, tools, polyethylene bags, rubber gloves o-rings, wires, crucibles: all exposed to metallic actinides, salts containing actinides, or aqueous solutions containing actinides. The waste is double bagged in polyethylene bags with twist and tape seals.

The laboratory experiments were performed under NRC Type A Broad Scope License for Radioactive Material, No. 24-00513-32 and controlled by the "TRUMP-S Standard Operating Procedure", included in this document as Appendix A. Each procedure is assigned a TRUMP-S Activities Manual (TAM) number. Limited access to the MURR facility and Restricted Access to the Alpha Laboratory assure inventory control of the Special Nuclear Materials (SNM) (uranium, neptunium, plutonium and americium) used as reagents in the experimental program.

All experimental work at the University of Missouri is performed under control of the "Hazardous Materials Management Procedure Manual". A copy of this manual is included as Appendix B. In addition, any of the mixed waste generated in the above laboratory experiments have been managed according to the conditions of the "Permit Modification for Container Storage of Mixed Waste for the University of Missouri Columbia", Permit Number MOD 006 326 904, issued by the Missouri Department of Natural Resources (MDNR) to the University of Missouri - Columbia; a copy of the permit modification is included in Appendix C.

2.1 Purpose

The Transuranic Package Transporter-II (TRUPACT-II) is a licensed Type B packaging used by the U. S. Department of Energy waste generators and storage sites for the transportation of transuranic (TRU) waste (NRC 1997). Seven 55-gallon drums of defense MTRU waste were generated by the DOE's TRUMP-S research program and are being shipped in TRUPACT-II to another DOE site for certification, then to the WIPP site in Carlsbad, New Mexico for disposal.

The purposes of this document are to describe the acceptable methods used to prepare and characterize the Contact Handled Transuranic waste (CH-TRU)

payload prior to transport in a TRUPACT-II package, and to describe the quality controls and quality assurance measures applied to prepare the payload.

2.2 Compliance Requirements

The U. S. Nuclear Regulatory Commission granted a Certificate of Compliance for the TRUPACT-II packaging based on the approval of the TRUPACT-II SARP (NRC 1997). The Certificate of Compliance sets the conditions under which the TRUPACT-II may be used for the shipment of TRU waste. Appendix 1.3.7, "TRUPACT-II Authorized Methods for Payload Control (TRAMPAC)" of the TRUPACT-II SARP presents authorized payload contents for the TRUPACT-II. The following are compliance parameters addressed in the SARP:

1. Physical form
2. Chemical properties
3. Chemical compatibility
4. Gas distribution and pressure buildup
5. Payload container and contents configuration
6. Isotopic inventory and fissile content
7. Decay heat
8. Weight and center of gravity
9. Radiation dose rate

2.3 Organization of this Report

Appendix 1.3.7 of the TRUPACT-II SARP states that all waste containers to be transported in TRUPACT-II transporters must be assigned a single shipping category based on the physical and chemical characteristics of the waste and the configuration of the package used (Section 3.0 of Appendix 1.3.7 of TRUPACT-II SARP). This document parallels Appendix 1.3.7 of the TRUPACT-II payload parameters.

3. Payload Shipping Categories and Waste Classification

3.1 Requirement

The basis for the classification of different content codes into payload shipping categories is defined in Section 1.2.3.2 of SAR. The correlation of the content codes into shipping categories is provided for each content code in TRUCON document (U. S. DOE, "TRUPACT-II Content Code (TRUCON)", listed in the TRUPACT-II Certificate of Compliance No. 9218, DOE/WIPP 89-004, Rev. 11, August 1997).

The waste form at a generating site is assigned a content code, or, in the case of small sites, certain content codes have been designed specifically for Small Quantity Sites. The description of the TRU waste form at a site is used to establish the content code and shipping category for the waste.

3.2 Methods of Compliance and Verification

The seven drums of MTRU waste from the TRUMP-S experimental program are classified on the basis of the laboratory record. Based on the description of the MURR MTRU waste, the waste has been assigned Shipping Content Code SQ 121C (see Appendix D). The waste consists of a variety of combustible and some noncombustible organic items. The waste from experiments was packaged directly into two plastic bags and placed in 55-gallon drums and stored until packaged for shipment. During packaging, the bags are inspected, placed into filtered drum liner bags, the liner bags are sealed, and the inner layers are cut to ensure a maximum of two confinement layers within each drum (Appendix A, TAM-26). In addition, the primary shipping container is vented. The drums carry Shipping Category - 30 0340 0302. A copy of the completed Visual Examination Record for each of the drums will be placed in the laboratory archives (see Appendix H).

4.0 Physical Form

4.1 Requirement

The physical form of CH-TRU waste comprising the TRUPACT-II payload shall be restricted to solid materials. Liquid waste shall be limited to residual amounts of well-drained containers. Sharp or heavy objects shall be packaged as necessary to provide puncture protection equivalent to Type A packaging requirements. Sealed containers greater than four liters and pressurized containers shall not be allowed in the waste stream. Waste generation procedures based on the laboratory record will be used to ensure that the physical form complies with the TRUPACT-II package requirements.

4.2. Methods of Compliance and Verification

Compliance with the physical form requirements is determined by records and data base information. Appendix E includes a list of the contents of each bag; the original experimental records are located in the archives (see Appendix H). A review of this inventory, as well as the bag out procedures (Appendix A, Standard Operating Procedures TAM-14) and the shipping procedures for

radioactive materials (Appendix G) indicate that the physical form requirements have been met. There is no liquid waste. As described above in the introduction to this section, which starts on page 7, any liquid waste remaining after an experiment or activity was evaporated prior to bagging out of the glove box as waste (see Appendix A, TAM-32, "Treatment of Aqueous Residue" for the procedure used; see also Appendix C, the RCRA permit modification, page APPENDIX 4-7, section 264.13, paragraph 2, that "... all wastes are solids at room temperature, ..."). Sharp and heavy objects have been packaged to provide puncture protection equivalent to Type A packaging requirements, and there are no sealed or pressurized containers in the waste.

5.0 Chemical Properties

5.1 Requirements

The chemical properties of the waste are determined by the chemical constituents allowed in the waste material type. Specific requirements regarding the chemical form of the waste are described below (from Section 5.0 of Appendix 1.3.7 of the TRUPACT-II SARP).

- Explosives, nonradioactive pyrophorics, and corrosives as defined in TRUPACT-II SARP are prohibited from the TRUPACT-II payload.
- Pyrophoric radionuclides may be present only in residual amounts less than one weight percent.
- The total amount of potentially flammable volatile organic compounds in the head space of the payload container is restricted to 500 parts per million.

5.2 Methods of Compliance and Verification.

Compliance with the chemical form and chemical property restrictions is demonstrated through records and database information (please see Appendix E, sections 2 and 3 for chemical and physical inventory lists; laboratory notebooks are included in the archives, which are listed in Appendix H; and Appendices A, B, and C, describe process restrictions). No explosives were used in the experimental program. Lithium metal was the only non-radioactive pyrophoric used in the experiments. The excess lithium metal was oxidized in water, the solutions neutralized and evaporated to dryness. This solid was passed to the low-level waste stream. The plutonium and americium used in the TRUMP-S experimental program are contained in experimental residues in an oxidized

state and are nonpyrophoric. No volatile organic materials were used in the experimental program and volatile organics are not present in the MTRU waste. (See also Appendix C, Section F, "Procedures to Prevent Hazards", on page APPENDIX 4-9 of that appendix document.)

The list of allowed chemicals under the content code SQ 121C is shown in Appendix D, pages SQ-18 and SQ-19. Chemicals in this MTRU waste stream fall in Groups 23, 101 and Other Inorganics.

6.0 Chemical Compatibility

6.1 Requirements

Chemical compatibility of the waste with the packaging ensures that there will be no chemical reactions that might pose a threat to the safe transport of the payload in TRUPACT-II. The materials that are allowed within the seven MURR drums are those allowed under the content code SQ 121C shown in Appendix D.

6.2 Methods of Compliance and Verification

The only hazardous constituents in the waste stream have been identified as silver and cadmium (see Appendix E), which pose no possibility of a chemical reaction that would threaten the safe transport of the payload. The materials, largely laboratory debris-type materials (wipes, test tubes, gloves, etc.) conform to the allowed constituents listed in content code SQ 121C, Appendix D. These waste forms have passed the chemical compatibility analysis in TRUPACT-II SARP. In addition, please see the Hazardous Materials Management Procedure Manual (Appendix B), section 5:040, "Segregation", in the chapter on "Handling Hazardous Materials by Users", which includes a compatibility chart and specific instructions to address any compatibility concerns. This is consistent with the conditions of the RCRA permit modification (see Appendix C, page APPENDIX 4-9, sections 264.172 and 264.177). Appendix E, Sections 2 and 3 list the chemical and physical contents of the waste.

7.0 Gas Distribution

7.1 Requirement

Gas distribution and pressure buildup during transport of the MTRU waste in the TRUPACT-II Payload are restricted (see Section 7.0 of Appendix 1.3.7 of TRUPACT-II SAR).

- The gases generated in the payload will be controlled to prevent the occurrence of potentially flammable concentrations of gases within the payload confinement layers and the void volume of the inner containment vessel cavity (IVC). The hydrogen concentration within the payload confinement layers is limited to 5% by volume during the shipping period.
- The gases generated in the payload and released into the inner containment vessel cavity will be controlled to maintain the pressure within the TRUPACT-II IVC cavity below the acceptable packaging design limit of 50 psig.

7.2 Methods of Compliance and Verification

Compliance with the gas distribution and pressure buildup is achieved using the following:

- The chemicals and packaging materials present within each drum have been restricted (see Section 5.0); the contents are highly unlikely to cause build-up of gases or the accumulation of pressure even close to the design limit.
- The number of internal layers of confinement within the drums is limited to two (see Appendix A, SOPs TAM-14 and TAM-26, which describe the bagging and packaging of the waste, and Appendix D, SQ 121C, waste packaging description, page SQ-15).
- Filter vents are installed on each drum (see Appendix F for the procurement documents).
- Decay heat within the payload containers is limited to less than 0.0470 watts (see MURR TRAMPAC, section 10.2). Appendix E, Section 1 shows the calculated decay heat for each waste package, each 55-gallon drum and the total for the TRAMPAC payload.

8.0 Payload Container and Contents Configuration

8.1 Requirements

The MTRU waste drums must meet the specifications for a 55-gallon drum given in Appendix 1.3.3 of the TRUPACT-II SAR. These drums must also conform to the shipping category designation of SQ 121C, Appendix D (see also Section 8.0 of Appendix 1.3.7 of the TRUPACT-II SARP).

Each 55-gallon drum to be transported in the TRUPACT-II must have a minimum of one filter vent. The hydrogen diffusion requirements of these filters is specified by the content code SQ 121C Waste Packaging Configuration Table (see Appendix D, page SQ-15 and -16). A maximum of two inner layers of confinement of the waste in each drum is specified.

8.2 Methods of Compliance and Verification

Compliance with the payload container and contents configuration requirements is determined by visual examination and process knowledge. The MURR MTRU waste is packaged within two layers of plastic, one intact waste bag and one filtered drum liner bag. The plastic bags are closed by the twist and tape method described in Appendix 1.3.6 of the TRUPACT-II SARP (see Appendix A, TAM-14). The individual bags are placed in seven 55-gallon drums with a filter vent installed on each drum (See Appendix A, TAM-26, and Appendix H, the Visual Examination Records for each drum of waste). Copies of the procurement documents for the 55-gallon drums, lids and filters are included in Appendix F.

9.0 Isotopic Inventory and Fissile Content

9.1 Requirements

The TRUPACT-II payload compliance limits for Pu-239 fissile gram equivalents (FGE) and for decay heat require knowledge of the specific isotopic composition and the quantity of each of the radionuclides. The Pu-239 FGE limit for a 55-gallon drum is 200 FGE. The decay heat limit for shipping category 30 0340 0302 is 0.0470 watts. (see Section 9.0 of Appendix 1.3.7 of the TRUPACT-II SARP and Appendix D, page SQ-17)

9.2 Methods of Compliance and Verification

The MTRU waste was generated over eight years using a total of 3.5627 grams of Neptunium-237, 1.4701 grams of Plutonium-239, 2.4125 grams of Americium-241 and 6.097 grams of depleted Uranium (See Appendix E, Section 1). This is the total mass of each actinide assigned to MURR MTRU waste. No other fissile materials were introduced into the waste. Small quantities of these materials were dispersed in the low-level waste, as well.

The numerical values for the Pu-239 equivalent activity (FGE/g) for each isotope was obtained from Table 10.1, Appendix 1.3.7 of the TRUPACT-II SARP, and are listed in the table below. The total FGE for the payload has been calculated using a spreadsheet. Due to the precision of the calculation algorithm built into the

spreadsheet, a minor discrepancy appears between the individual isotope FGE values and the sum shown in Appendix E, Section 1, Table 1. Depleted uranium is not included because the Pu-239 equivalent activity for uranium is zero.

Table 9.2

Total Pu-239 FGE Computed for the MURR TRAMPAC Payload
(see Appendix E, Section 1)

Isotope	Mass (g)	Pu-239 (FGE/g)	Total Pu-239 FGE per Isotope
Np-237	3.5544	1.50E-02	0.0533
Pu-239	1.4703	1.00	1.4703
Am-241	2.4126	1.87E-02	0.0451

Total Payload
Pu-239 FGE 1.59

The shipping category 30 0340 0302 sets the Pu-239 equivalent activity limit at 200 FGE for each 55-gallon drum. With a total Fissile Gram Equivalent of 1.59 for the entire shipment, it is inconceivable that the 200 FGE limit per drum would be exceeded, even if there were a margin of error of 100%. U-238 is not included in the table because its contribution to the FGE is insignificant.

10.0 Decay Heat

10.1 Requirement

There are two limits for the decay heat: 1) The total decay heat from the radioactive decay of the radioisotopes within the individual payload container and 2) The total decay heat for the containers in the TRUPACT-II. The decay heat limit for the individual 55-gallon drums for shipping category SQ 121C 30 0340 0302 is 0.0470 watts per drum. The decay heat limit per TRUPACT-II payload for this shipping category is 14 times the decay heat per drum or 0.658 W (see Appendix D, page SQ-17 and Section 10.0 of Appendix 1.3.7 of the TRUPACT-II SARP).

10.2 Methods of Compliance and Verification

The most restrictive requirement for loading the drums is the limit of 0.0470 watts per drum. The mass of each isotope assigned to each of the seven drums is listed in the tables below. These mass numbers are from the total mass of each isotope computed in Appendix E, Section 1. The numerical values of the decay

heat in watts per gram for each isotope are from Table 10.1, Appendix 1.3.7 of the TRUPACT-II SARP. The computed decay heat for each isotope and the total decay heat for each of the seven drums is given in Table 10.2, below. U-238 is not included in the table because its contribution to the decay heat is insignificant (see page E-3, Appendix E, Section 1).

Table 10.2

Mass and Decay Heat per Isotope, by Drum
(see Appendix E, Section 1)

Isotope	Mass (g)	Decay Heat (Watts/g)	Decay Heat (Watts/Isotope)
Drum No. 1			
Np-237	2.1706	2.09E-05	4.537E-05
Pu-239	0.2282	1.95E-03	4.450E-04
Am-241	0.3431	1.16E-01	3.980E-02
Drum Decay Heat		(Watts/Drum):	4.029E-02
Drum No. 2			
Np-237	0.0381	2.09E-05	7.963E-07
Pu-239	0.6725	1.95E-03	1.311E-03
Am-241	0.2957	1.16E-01	3.430E-02
Drum Decay Heat		(Watts/Drum):	3.561E-02
Drum No. 3			
Np-237	0.1191	2.09E-05	2.489E-06
Pu-239	0.1036	1.95E-03	2.020E-04
Am-241	0.3469	1.16E-01	4.024E-02
Drum Decay Heat		(Watts/Drum):	4.044E-02
Drum No. 4			
Np-237	0.0199	2.09E-05	4.159E-07
Pu-239	0.1702	1.95E-03	3.319E-04
Am-241	0.3474	1.16E-01	4.030E-02
Drum Decay Heat		(Watts/Drum):	4.063E-02
Drum No. 5			
Np-237	0.4979	2.09E-05	1.041E-05
Pu-239	0.1554	1.95E-03	3.030E-04
Am-241	0.3521	1.16E-01	4.084E-02
Drum Decay Heat		(Watts/Drum):	4.115E-02
Drum No. 6			
Np-237	0.443	2.09E-05	9.259E-06
Pu-239	0	1.95E-03	0.000E+00
Am-241	0.3527	1.16E-01	4.091E-02
Drum Decay Heat		(Watts/Drum):	4.092E-02

Drum No. 7

Np-237	0.268	2.09E-05	5.601E-06
Pu-239	0.1459	1.95E-03	2.845E-04
Am-241	0.3747	1.16E-01	4.347E-02
Drum Decay Heat		(Watts/Drum):	4.376E-02

Error Assignment for Decay Heat Calculation

It is required that an error be assigned to the calculated decay heat for each payload container and to the entire payload. The error in actinide mass assigned to each waste bag is the source of error in the decay heat calculation. The inventory controls on the SNM materials used in the TRUMP-S project are the following TAM Procedures (see Appendix A).

- TAM-21 "Transfer of Actinides"
- TAM-23 "Inventory Control of Actinides"
- TAM-24 "Quality Assurance"
- TAM-25 "Mixed Actinide Inventory"

The analytical balance used in the experiments was capable of ± 0.1 mg precision. The balance was standardized to ± 1.0 mg before every transfer of actinides into the glove box (see Appendix A, TAM-24). This procedure assured the performance of the balance during experiments. This balance was used to assign actinide mass to all experimental materials assigned to waste bags at the conclusion of each experiment. Using these procedures, the SNM inventory for the eight years of the project closed to within 0.0079 g for americium, 0.0038 g for plutonium and 0.0007 g for neptunium (see Appendix E, Section 1).

Based on these procedures and the SNM inventory record, it is conservative to assume that the mass of actinide in each bag is known to ± 1.0 mg. If we further assume that all of the mass is americium, which has a significantly higher decay heat than the other actinides, the error in the decay heat calculation will be $\pm 1.16 \times 10^{-4}$ W/bag (see Appendix E, Section 1, which gives the decay heat for Am-241 as 0.116 W/g). The maximum number of waste bags assigned to any drum is six, so the maximum error in the decay heat will be 6.96×10^{-4} W/drum. Drum 7 has the highest decay heat, of 0.04376 W; with an added error of 0.000696 W, the maximum decay heat for any drum would be 0.044456W. It can be concluded that all drums are below the decay heat limit of 0.047 W/drum. Since each drum is below the decay heat, including error in the decay heat calculation, the TRAMPAC payload decay heat will also be below the payload decay heat limit. For the entire TRUPACT-II payload assembly of the seven drums of waste and seven dunnage drums (see Section 11.0), the total TRUPACT-II payload will have a decay heat value of 0.2828 watts (including error) and therefore is less than the

payload assembly limit of 0.658 watts (computed as 14 drums at 0.0470 W per drum)(see Section 1.2.3.3.8 of TRUPACT-II SARP).

11.0 Weight and Center of Gravity

11.1 Requirements

The weight limit for a 55-gallon drum is 1,000 pounds. The limit is set in Section 1.2.3.3 of TRUPACT-II SARP. The total weight of the top seven drums of the payload assembly shall be less than the total weight of the bottom seven drums (See Appendix 1.3.7 of TRUPACT-II SARP, Section 11.0).

The weight and the error of the weighing for each 55-gallon drum shall be measured and recorded in the data base for the individual containers. The weight and error of the total TRUPACT-II payload shall be calculated and reported in the TRUPACT-II payload data sheet. (see Section 13.0 below)

11.2 Methods of Compliance and Verification

Each 55-gallon drum will be loaded and sealed using TAM-26, "Packaging Mixed TRU Waste" (see Appendix A). Each 55-gallon drum will be weighed on a calibrated scale after it is filled and closed (see Appendix G). The total weight of the MTRU waste is 175 pounds (see Section 1 of Appendix E), which will be distributed among the seven drums. This does not include the weight of the drums themselves, lids and filter vents, and any other bracing material required inside the drum. When the payload data sheets are completed for the shipment, they will reflect that the total weight of each drum will be less than the 1,000 pound limit per drum.

The MTRU waste will be contained in seven drums. The filled drums will be placed in the bottom layer in the TRUPACT-II container to meet the center of gravity requirements of the TRUPACT-II payload. Dunnage drums will be placed in the top layer to complete the TRUPACT-II loading of 14 drums.

12.0 Radiation Dose Rate

12.1 Requirements

The external radiation dose rate of the drums and the loaded TRUPACT-II Payload to be shipped on a trailer must be less than 200 mrem/hour at the surface and 10 mrem/hour at two meters. The radiation dose rates for the TRUPACT-II must also comply with the requirements of 10 CFR 71.47 (see Section 12.0 of Appendix 1.3.7 of TRUPACT-II SARP).

12.2 Methods of Compliance and Verification

Compliance with the radiation dose rate requirements will be determined by surface measurements of the beta-gamma and alpha dose rates for each drum and for the TRUPACT-II payload. These measurements will be performed according to the procedures prepared for waste shipment from the MURR facility using approved Shipping Group Procedures. A copy of the measurement procedure and documentation required entitled, "Shipment of Radioactive Material NOS - Waste" is included in Appendix G. The completed survey forms will be included with the shipping papers at the time of the shipment, and filed permanently after the shipment in Archive Storage (Appendix H).

13.0 Payload Assembly Criteria

13.1 Requirements

The transportation parameters for the MURR MTRU waste must be recorded for verification of compliance prior to authorizing the 55-gallon drums for transport. The transportation parameters for the TRUPACT-II payload must also be recorded and evaluated prior to authorization for transport. Sections 1.0 through 12.0 of this MURR TRAMPAC portion of the waste management plan are designed to assure compliance with Section 1.2.3 of the TRUPACT-II SARP for the selection of the payload. The required flowcharts showing the steps for the load management of the payload are presented in Section 13.0 of TRUPACT-II SARP Appendix 1.3.7.

13.2 Methods of Compliance and Verification

The transportation parameter data for the MURR TRUMP-S MTRU waste and the TRUPACT-II payload, including dunnage drums, will be recorded in the TRUPACT-II Payload Container Transportation Certification Document and the TRUPACT-II Payload Assembly Transportation Certification Document (Tables 13-1 and 13-3 of TRUPACT-II SARP, pages 1.3.7-58 and 1.3.7-60). These documents provide closure on the provisions and procedures for packaging and documenting the preparation of the MURR MTRU waste shipment to the designated DOE site or the WIPP site.

14.0 Quality Assurance

14.1 Requirements

Typically, DOE TRU waste generator sites prepare waste certification and quality assurance programs that are submitted for the DOE/CAO for review and approval to certify the waste for transport in TRUPACT-II. For small quantity sites (SQS) this approach is not practical. In this MURR MTRU Waste Management Plan, the requirements of the TRUPACT-II SARP, Appendix 1.3.7 are satisfied by using process knowledge. The waste packaging procedures also conform to the U. S. DOE TRUPACT-II Content Code (see Appendix D) which conforms to the WIPP Waste Acceptance Criteria. These documents set the requirements for shipment of the MTRU waste to another site or to WIPP.

14.2 Methods of Compliance and Verification

The laboratory research that generated the MURR MTRU waste was performed under NRC Type A Broad License for Radioactive Material No. 24-00513-32 and controlled by the TRUMP-S Standard Operating Procedures included as Appendix A. All experimental work at the University of Missouri is performed under control of the Procedure Manual for Hazardous Waste Management, attached as Appendix B. These procedures impose limited access to the MURR Alpha Laboratory and a high level of control upon and documentation of the activities that generated the waste. Additional restrictions on the waste have been imposed by the conditions of the University of Missouri - Columbia RCRA permit, especially the modification pertaining to the storage of mixed waste at MURR (see Appendix C). This plan and appended documentation is being used to describe and quantify the TRU content, the hazardous materials content, and physical components in the matrix of the MURR MTRU waste. TRUPACT-II payload information used data extracted from the laboratory and inventory records. Appendix H is the list of records archived at the University of Missouri which will be retained and available for verification of this MURR TRAMPAC document.

REFERENCES

U.S. Department of Energy, Carlsbad Area Office, "Generator Site Certification Guide", DOE/CAO-95-2119, Revision 1, August 1997.

U.S. Department of Energy, "Waste Isolation Pilot Plant Waste Acceptance Criteria" (WIPP-WAC), DOE/WIPP-069, Revision 5, April 1996.

U.S. Department of Energy, "Safety Analysis Report for the TRUPACT-II Shipping Package," Rev. 16, U.S. Department of Energy Carlsbad Area Office, Carlsbad, New Mexico, February 1997.

TRUPACT-II Methods for Payload Control (TRAMPAC) [Appendix 1.3.7 of the TRUPACT-II SARP, above]

U.S. Department of Energy, "TRUPACT-II Content Codes (TRUCON)", Rev. 10, DOE/WIPP 89-004, U.S. Department of Energy Carlsbad Area Office, Carlsbad, New Mexico, February 1997.

U.S. Nuclear Regulatory Commission, "TRUPACT-II Certificate of Compliance", Rev. 8, Docket No. 71-9218, U.S. Nuclear Regulatory Commission, Washington, D.C., February 1997.

Appendices not scanned.

Entire document is
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