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EXPANDING THE TRUPACT-II PAYLOAD ENVELOPE

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ABSTRACT

The Transuranic Package Transporter - II (TRUPACT-II) is a Type B packaging (specialized shipping container). It was developed primarily for the shipment of contact handled (CH) transuranic (TRU) waste from various U.S. Department of Energy (DOE) sites to the Waste Isolation Pilot Plant (WIPP), near Carlsbad, New Mexico, USA. Each TRUPACT-II has a capacity of fourteen 208-liter (55-gallon) drums. The average payload weight of a single TRUPACT-II is approximately 2,855 kg (6,280 pounds). Up to three TRUPACT-IIs may be shipped on a trailer with a combined payload weight of approximately 5,950 kg (13,090 pounds). The TRUPACT-II was certified by the U.S. Nuclear Regulatory Commission (NRC), in 1989, as meeting the requirements of Title 10, Code of Federal Regulations, Part 71.

The main problem encountered when describing CH-TRU waste is to provide the NRC provide sufficient detail to ensure shielding, containment, and sub-criticality are maintained without overly restricting the contents. All CH-TRU waste is assigned to one of four waste types based on physical and chemical composition. The waste is further assigned to a shipping category to ensure chemical compatibility during transport. Wattage limits and packaging configuration limit potentially flammable gasses to less than 5% in the innermost layer of confinement. Fissile material was originally limited to not more than 325 grams of plutonium-239 fissile gram equivalent (Pu-239 FGE). This limit has been raised to 2,800 Pu-239 FGE by the use of a pipe component as part of the packaging design which is incorporated into a payload container.

Since 1989 seventeen applications for revision to the SAR have been submitted to the NRC. These applications have resulted in many approvals for expansion of the authorized contents that may be shipped in the TRUPACT-II. This paper discusses the activities associated with the

preparation and submittal of the applications for payload expansion. The paper also discusses plans for continuing the payload expansion until all of the CH-TRU waste in the DOE complex can be shipped to the WIPP for safe permanent disposal. The WIPP is a deep geological repository in ancient salt beds approximately two-thirds of a kilometer (2,150 feet) below the earth's surface.

BACKGROUND

The Transuranic Package Transporter-II (TRUPACT-II) was developed for the U.S. Department of Energy (DOE) primarily to ship contact-handled transuranic (CH-TRU) waste from DOE generator/storage sites to the Waste Isolation Pilot Plant (WIPP) near Carlsbad, New Mexico, for disposal. The TRUPACT-II will also be used for inter-site and intra-site shipments to facilitate the consolidation of the waste for characterization, certification, repackaging, or treatment purposes. The TRUPACT-II is a U.S. Nuclear Regulatory Commission (NRC)-approved Type B packaging. It was granted Certificate of Compliance (C of C) No. 9218 by the NRC in 1989, based on the Safety Analysis Report (SAR) submitted for the TRUPACT-II packaging (1,2). The C of C specifies limits on the authorized contents (payload) in a TRUPACT-II to ensure safety during normal conditions of transport and hypothetical accident conditions.

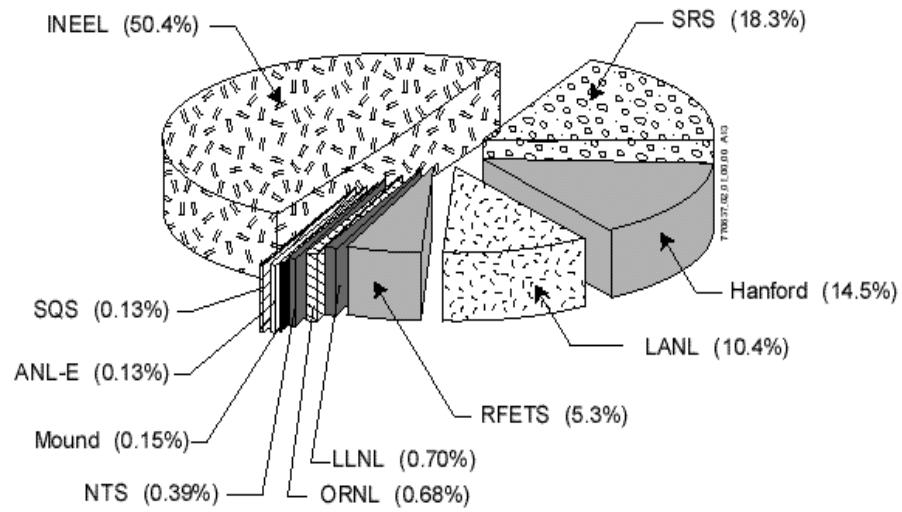
The WIPP facility is currently scheduled to open in March 1999. The DOE Carlsbad Area Office (CAO) developed the National Transuranic Waste Management Plan (3) to integrate TRU waste management activities throughout the DOE complex and ensure the efficient, sustained, and cost-effective disposal of transuranic waste at WIPP. The distribution of CH-TRU waste is shown in Figure 1. At the present time, a significant fraction of the CH-TRU waste inventory does not meet all of the limits in the TRUPACT-II C of C and therefore cannot be shipped. Filling the WIPP pipeline is a complex problem dependent on regulatory and technical drivers as well as priorities and capabilities at the DOE sites. Ensuring the shippability of all the CH-TRU waste inventory to WIPP will require significant TRUPACT-II payload expansion efforts.

PURPOSE AND SCOPE

The purpose of this report is to provide a comprehensive plan of the activities needed to fill the WIPP pipeline by expanding the TRUPACT-II payload envelope to ensure that all CH-TRU waste in the DOE system is ultimately shippable to the WIPP.

The scope of this report is the CH-TRU waste inventory at the major DOE sites and small quantity sites (SQS), currently slated for disposal at the WIPP (3). This plan encompasses applicable NRC and U.S. Department of Transportation (DOT) regulations governing the shipment of CH-TRU wastes between sites and to the WIPP. Waste characterization and other regulatory requirements will be addressed as they relate to the shipment of CH-TRU waste in the TRUPACT-II and other Type B packagings. The limits in the TRUPACT-II C of C are based on regulatory safety concerns with respect to shielding, sub-criticality, and containment (4). Since these issues are the regulatory drivers for all Type B packagings (required for the shipment of CH-TRU wastes), this report should be applicable to any shipments of CH-TRU waste within the DOE complex.

Figure 1
CH-TRU Waste Inventory



FACTORS DETERMINING WASTE SHIPPABILITY (THE PROBLEM)

Assuming that the CH-TRU waste is otherwise characterized to meet the WIPP Waste Acceptance Criteria and the TRUPACT-II C of C requirements, the key factors that determine CH-TRU waste shippability to the WIPP are the following:

Size and Shape Limits on the Payload Containers: The containers that are currently shippable in a TRUPACT-II are 55-gallon drums, standard waste boxes (SWB), and ten-drum overpacks (TDOP). Wastes in other types of containers are not shippable at this time. Other payload containers used at DOE sites for packaging CH-TRU wastes include oversized wooden and metal boxes (4 by 4 by 7 feet), 85-gallon drums, and other odd-sized containers. Payload containers that cannot be shipped in the TRUPACT-II must be either repackaged or be shipped in a new packaging.

Weight Limits on the Payload Containers and the Packaging(s): The TRUPACT-II C of C specifies weight limits per payload container, per payload assembly (of 14 55-gallon drums or two SWBs), per shipment (of up to three TRUPACT-IIs), and an 80,000-pound DOT limit for shipments by road. Depending on the payload and shipment configuration, one or more of these limits could be limiting.

FGE Limits on the Payload Containers and the Packaging(s): In order to ensure sub-critical conditions during transportation, the TRUPACT-II C of C specifies FGE limits per payload container and per packaging. While the payload container limits are 200 grams (g) FGE per drum and 325 g per SWB, the limit per TRUPACT-II is only 325 g FGE. For a payload consisting of 14 55-gallon drums, this translates to an average of 23 g FGE limit per drum. The shippability of waste forms that contain radionuclides in high concentrations per container will usually be limited by the TRUPACT-II FGE limits if plutonium (Pu-239) is the predominant radionuclide.

Gas-Generation and Decay Heat Limits on the Payload Containers and the Packaging(s): In terms of shippability, one of the key requirements of the TRUPACT-II (and other Type B packagings) is control of the concentrations of flammable gases; specifically, maintaining the concentration of hydrogen below 5 percent during the 60-day shipping period. The methodology used to show compliance with the flammable gas concentration limits for CH-TRU waste shipment in a TRUPACT-II is described in the TRUPACT-II SAR (2). Hydrogen generation during transport is primarily due to the radiolysis of the waste or packaging materials, with the "G value" quantifying the gas generation potential of a waste material. CH-TRU wastes are grouped into "waste material types" based on their gas generation potential. Waste types I, II, and III have known G-values, but the G-value for waste type IV is unknown. The resistance to gas release is based on the type and maximum number of layers of confinement used to package the waste. The balance between the gas generation potential of the waste and the resistance to hydrogen release determines a unique decay heat limit for each payload container to demonstrate compliance with the 5 percent limit on hydrogen. These analytic limits preclude the shipment of payload containers that have a potential for the generation of significant amounts of flammable gases. Payload containers that exceed the decay heat limit, or contain waste type IV, belong to

the “test category” and must be tested to demonstrate that the actual rate of gas generation is less than the allowable rate.

Authorized Content Limits Based on Descriptions in the TRUCON Document: The TRUCON document is a compilation of site-specific CH-TRU waste contents, with descriptions of how each code complies with the requirements of the TRUPACT-II SAR. Only CH-TRU wastes described in the TRUCON document are authorized contents of the TRUPACT-II. Waste forms that are not described in the TRUCON document or that do not conform to the descriptions in the TRUCON document are not part of the shippable inventory. A summary of the dominant factors determining waste shippability and the CH-TRU waste inventories impacted by these factors is presented in Tables 1 and 2.

Table 1. Dominant Factors Determining Waste Shippability

WASTE CHARACTERISTIC	SHIPPABILITY PARAMETER				
	Size and Shape	Weight	FGE	Gas Gen. / Decay Heat	TRUCON Codes
85-Gallon Drums	✓				
Oversized Boxes	✓				
Other Odd-Sized Boxes	✓				
Heavier Payloads (Table 3)		✓			
Higher Pu-239 Concentrations			✓	✓	
Pu-238 Waste				✓	
Waste Type IV				✓	
>23 FGE per Drum (average)			✓		
Need New TRUCON Codes					✓

Table 2. Factors Determining CH-TRU Waste Shippability by Site

WASTE CHARACTERISTIC	DOE SITE										
	A N L - E	I N E E L	L A N L	L L N L	M O U N D	N T S	O R N L	R F E T S	S Q S	S R S	W H C
85-Gallon Drums		✓	✓			✓	✓			✓	✓
Oversized Boxes		✓	✓			✓		✓			✓
Other Odd-Sized Boxes	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Heavier Payloads (Table 3)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Higher Pu-239 Concentrations								✓			✓
Pu-238 Waste			✓							✓	
Waste Type IV		✓		✓				✓			
>23 FGE per Drum (average)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Need TRUCON Code(s)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

PAYLOAD EXPANSION INITIATIVES (THE SOLUTION)

This section summarizes the payload expansion initiatives to address the factors impacting shippability that were discussed above. The goal of these initiatives is to establish the technical basis for amendments and applications to the NRC that will result in a larger envelope of shippable waste that can be used to fill the WIPP pipeline once the facility is operational. The initiatives in terms of the shippability factors are described below.

Size and Shape and Weight Limitations: The CH-TRU Waste Packaging Optimization Study (6) performed a detailed evaluation of the available options for the transportation of CH-TRU wastes that cannot be efficiently transported in a TRUPACT-II due to size and shape or weight constraints. Table 3 presents the results of the evaluations in the CH-TRU Waste Packaging Optimization Study. For a TRUPACT-II shipment of three TRUPACT-IIs each containing 14 drums, the average maximum weight of a payload container is 312 pounds. Heavier payloads cannot be shipped in a TRUPACT-II without suitable load management (matching heavier and lighter drums in a payload) or transporting less than three TRUPACT-IIs per shipment.

Based on the recommendations from this study, the HalfPACT program has been initiated by CAO to facilitate the shipment of heavier payloads and 85-gallon drums. The HalfPACT is designed to be a Type B packaging similar to the TRUPACT-II but shorter in size. As shown in Table 3, payloads with average weights up to 1,000 pounds can be transported in shipments of

three HalfPACTs. The CH-TRU Waste Packaging Optimization Study showed that savings in excess of \$20 million will result from designing a transportation fleet that consists of TRUPACT-IIs as well as HalfPACTs. The HalfPACT underwent prototype testing in 1997, and the HalfPACT SAR is expected to be submitted to the NRC in 1998. In addition to the efficient shipment of heavier payloads, the HalfPACT can be used to ship payloads of four 85-gallon drums.

In August 1997, an amendment (Rev. 17) to the TRUPACT-II SAR was submitted to the NRC requesting the use of the TDOP for overpacking six 85-gallon drums. When approved, the TRUPACT-II can also be used for shipping 85-gallon drums in this configuration.

Table 3. Average Maximum Payload for Shipments (6)

Packages per Trailer	Drums per Packaging	Drums per Shipment	Payload per Shipment (lbs.)	Payload per Package (lbs.)	Drum Average (lbs.)
3 TRUPACT-IIs	14 (3)	42	13,090	4,363	312
2 TRUPACT-IIs	14 (2)	28	12,560	6,280	449
2 TRUPACT-IIs	7 (2)	14	11,720	5,860	837
3 HALFPACKs	7 (3)	21	21,205	7,068	1,010

FGE Limits: The TRUPACT-II FGE limit per payload is 325 g, except for configurations using the pipe overpack. A recent amendment to the TRUPACT-II C of C (1) allows the shipment of 14 drums at 200 g FGE each, provided the pipe overpack configuration is used. A schematic of the pipe overpack is shown in Figure 2. With the approval of the pipe overpack by the NRC in February 1997 (Revision 16 of the TRUPACT-II SAR), shipment of 2,800 FGE per TRUPACT-II is now feasible for inorganic waste forms packaged in the pipe overpack. An amendment (Rev. 17) has recently been submitted to the NRC proposing the use of the pipe overpack for other waste forms in addition to inorganic solids, thereby allowing the shipment of up to 2,800 FGE in all shipments of CH-TRU waste using the pipe overpack. A recent evaluation (7) also indicates that it may be possible to increase the TRUPACT-II FGE loading from the current limit of 325 g for specific CH-TRU waste forms such as cemented and vitrified wastes without the use of the pipe overpack. Based on the physical and chemical nature of these waste forms under normal conditions of transport and hypothetical accident conditions, it appears that sub-criticality can be maintained at higher FGE loading as well.

Gas Generation And Decay Heat Limits: The most critical parameters impacting CH-TRU waste shippability are gas generation and decay heat limits, which severely restrict the shipment of high-loaded Pu-238 wastes, Pu-238 wastes, and Waste Type IV wastes. The TRUPACT-II Gas Generation Test Program (Program) was established by DOE in 1992 to facilitate the shipment of test category waste that is currently restricted from shipment due to concerns of potential flammable gas generation. The current initiatives under the Program are described in

the annual report for the Program and in the minutes of the annual meeting (8, 9). The ultimate goal of these initiatives is to provide the technical basis for TRUPACT-II SAR amendments that will allow payload expansion and facilitate the filling of the WIPP pipeline. Each of these initiatives was evaluated with respect to status, schedule, potential issues, and action items at a recent TRUPACT-II payload initiatives meeting (10). Minutes from this meeting and worksheets developed for each of the initiatives are provided in Appendix 1. A summary of the status of each initiative is provided below:

- Development of a Unified Flammable Gas Test Procedure: Currently, the TRUPACT-II SAR contains a test plan for quantifying the gas generation rates of test category waste. The status of this plan is that it has been implemented at Idaho National Engineering and Environmental Laboratory and Rocky Flats Environmental Technology Site, with implementation being planned at Lawrence Livermore National Laboratory, Los Alamos National Laboratory (LANL), and Savannah River Site. Experience to date has indicated the need for a more rigorous procedure that encompasses limits on hydrogen as well as flammable volatile organic compounds (VOC) and total gas. Two related initiatives that have been undertaken are (1) flammability assessment testing to evaluate the lower flammable limit of mixtures of hydrogen, methane, and VOCs, and (2) an alternate method should be developed to determine compliance with the limit on hydrogen concentration. Phase 1 of the flammability assessment has been completed and includes experimental results for lower explosive limits of different mixtures of hydrogen and VOCs. The mathematical model for the alternate method has also been completed. The goal of this initiative is to develop a methodology for flammable gas testing that covers existing and planned testing for shipping test category waste, and consolidates the existing test plan, the flammability assessment methodology, and the alternate method of headspace sampling.
- Development of a Methodology for Mixing Shipping Categories: The TRUPACT-II SAR currently mandates that all containers making up a payload belong to the same shipping category (i.e., have the same waste form and packaging configuration). The purpose of this initiative is to allow unlimited mixing of shipping categories in a payload so that sites can mix and match waste containers as needed (lighter drums with heavier drums, etc.). The status of this initiative is that the mathematical analysis has been completed and documented. An implementing procedure for the SAR needs to be developed to submit an application to the NRC.
- Development of Better Filters: The key to higher wattage limits is more efficient gas release from layers of confinement. The aim of this initiative is to develop filters with increased hydrogen diffusion rates for use in bags and payload containers in order to increase decay heat limits. While it is expected that filters with increased hydrogen diffusion rates are in use already at some of the sites, no formal test data have been collected for these filters. Once test data are collected and evaluated, the SAR can be revised to add these more efficient filters in the filter specification. A related effort needed is the development of a standard method for the performance testing of filters. Although it is not a TRUPACT-II issue, the release of VOCs from the payload containers will also be addressed as part of this initiative.

- Gas Getters: This initiative consists of studying the effectiveness and feasibility of using getter materials that combine with hydrogen, thereby reducing the hydrogen concentrations during transportation. It is proposed that the use of getter material be limited to the packaging inner containment vessel cavity initially. The status of this initiative is that an experimental setup has been established at LANL to test the effects of potential poisons on the getter material.
- Matrix Depletion Program: The goal of the Matrix Depletion Program is to evaluate and quantify the reduction in G values with dose to revise the conservative G values used in the SAR. The Matrix Depletion Program has been ongoing at LANL, with a status report issued in September 1997. A final report, with results from additional experiments, is expected by August 1998.
- Authorized Contents In TRUCON: Shippability of wastes that are not part of the TRUCON can be achieved by revising the TRUCON document to add new codes (or amend existing codes) and obtaining NRC approval for the revision to TRUCON. A comprehensive revision of the TRUCON document was recently submitted to the NRC with Revision 17 of the TRUPACT-II SAR. Future applications will include additional TRUCON Codes until all of the CH-TRU waste at the sites has been assigned to a specific Code.

RECOMMENDATIONS FOR FILLING THE WIPP PIPELINE (IMPLEMENTATION)

The previous sections described the key factors that determine shippability of CH-TRU waste and the initiatives underway to expand the allowable payload and ensure shippability of all CH-TRU waste to the WIPP. The NRC has approval authority over all CH-TRU payload expansion, in the form of amendments to the SAR and the C of C for the TRUPACT-II and any other packagings used. This section summarizes the path forward to resolve each of the issues associated with shipment of all of the CH-TRU waste inventory.

- Higher concentrations of Pu-239 wastes can be shipped by means of gas generation testing, use of better filters, allowing credit for matrix depletion, and the use of gas getters. FGE loading per TRUPACT-II can be increased through the use of the pipe overpack and by revising the criticality analysis for specific waste forms such as cemented and vitrified wastes.
- Pu-238 wastes can be shipped by means of gas generation testing, use of better filters, allowing credit for matrix depletion, the use of gas getters, and, as needed, repackaging or treatment.
- Waste Type IV (organic sludge) can be shipped by means of gas generation testing and by the use of better filters and gas getters. (Matrix depletion may not be applicable because of the homogeneous and solidified nature of these wastes.)

- Payloads with an average loading of more than 23 g FGE can be shipped at higher loading through the use of the pipe overpack and a revised criticality analysis for specific waste forms, and by establishing a methodology for mixing shipping categories.
- Payloads that are not part of the authorized TRUCON codes can be shipped by revising the TRUCON document to add or amend content codes and obtaining NRC approval for the changes.
- Wastes packaged in 85-gallon drums can be shipped in the HALFPACK packaging or by overpacking in a TDOP once these configurations are approved by the NRC.
- Wastes packaged in oversized boxes and other odd-sized containers can be repackaged or shipped in new packagings designed to fit the oversized items if sufficient characterization data exist.
- Heavier payloads can be shipped efficiently in the HALFPACK packaging, and by establishing a methodology for mixing shipping categories.

A timeline sequence was developed for the individual activities needed for these TRUPACT-II SAR amendments, based on the Payload Expansion Initiatives Meeting (10). Based on experience the activities will require approximately three years to complete. However, due the NRC's sensitivity about "applicants scheduling review time" no dates are provided. The actual schedule will depend upon resources (manpower and budget) and the NRC review and approval cycles. The sequence of payload expansion activities may be updated as additional inventory details become available and NRC positions regarding applications are made known.

CONCLUSION

This plan for TRUPACT-II payload expansion will ensure that sufficient CH-TRU waste is shippable to support the WIPP ramp-up schedule. Assuming the waste is characterized and certified for disposal, the pipeline to WIPP will be full.

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Figure 1
CH-TRU Waste Inventory

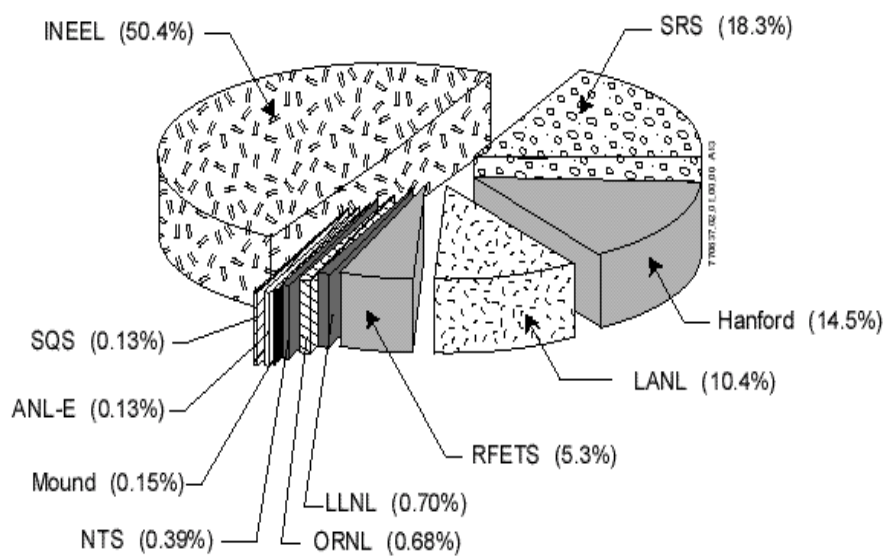
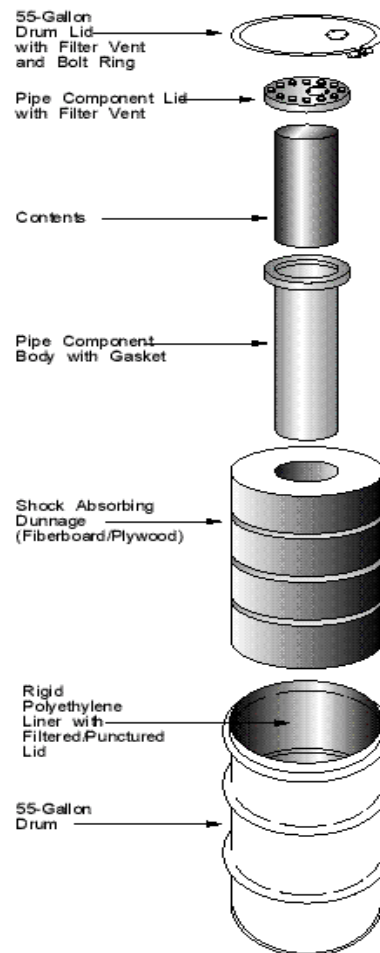


Figure 2
Pipe Overpack



NOT TO SCALE

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