Title: The PEACE PIPE - Recycling Nuclear Weapons Into a TRU Storage/Shipping Container

Authors: Dennis Floyd (MSC), Keith Biddle (BNFL Inc.), Carl Edstrom (MSC), Rick Geinitz (Safe Sites of Colorado), Kevin Keenan (DOE-RFFO), Ray Orlowski (BNFL Inc.), Mike Rivera (SAIC/LATA)

ABSTRACT

This paper describes results of a contract undertaken by the National Conversion Pilot Project (NCPP) at the Rocky Flats Environmental Technology Site (RFETS) to fabricate stainless steel "pipe" containers for use in certification testing at Sandia National Lab, Albuquerque to qualify the container for both storage of transuranic (TRU) waste at RFETS and other DOE sites and shipping of the waste to the Waste Isolation Pilot Project (WIPP). The paper includes a description of the nearly ten-fold increase in the amount of contained plutonium enabled by the product design, the preparation and use of former nuclear weapons facilities to fabricate the components, and the rigorous quality assurance and test procedures that were employed. It also describes how stainless steel nuclear weapons components can be converted into these pipe containers, a true "swords into plowshares" success story.

ACKNOWLEDGMENTS

This work was performed under Cooperative Agreement DE-FC34-94RF00733 between DOE and the project contractor, Manufacturing Sciences Corporation (MSC). BNFL Inc. served as the principal subcontractor. The authors gratefully acknowledge the support of the DOE Rocky Flats Field Office (RFFO) as well as the contribution of the entire 72-person NCPP team. Special recognition is due Elaine Nix (DOE-RFFO) for Project Management, and Frank Yaklich (MSC) and Mark Haupt (BNFL Inc.) for overall contract execution.

OBJECTIVE

The purpose of this paper is to describe the process used to produce and qualify the PEACE PIPE as a TRU storage container for RFETS. In order to qualify the PEACE PIPE for storage uses, DOE-RFFO recently placed a contract with the NCPP to produce a dozen each of two sizes, 6-inch and 12-inch. These pipe containers were then subjected to a variety of drop and fire tests at Sandia National Laboratory Albuquerque (SNLA).[1] The designation "PEACE PIPE" results from the fact that production quantities of these pipe containers are expected to be made from metal ingots derived from nuclear weapons components that have been declassified by melting and from radioactively-contaminated scrap metal (RSM) arising from the decontamination and decommissioning (D&D) of RFETS and other DOE sites.

The mission of the NCPP is *"to demonstrate, at the RFETS, the feasibility of economic conversion of DOE sites"*. Under this agreement, MSC and BNFL Inc. are cleaning and refurbishing four major manufacturing facilities at RFETS that were formerly used to produce nuclear weapons components.

The intent is that these facilities can be leased to a private company and used, for example, to manufacture products from RSM. To demonstrate that needed products can be made with the refurbished equipment, a "process verification" activity is included as part of the NCPP mission, and the present work was performed under this aegis. The workers performing this work are former RFETS workers hired by MSC to initially perform the cleanup and later to produce recycle products from RSM.

BACKGROUND

The concept for the "PEACE PIPE" can be traced to a desire at RFETS to reduce the radiation dose emanating from certain forms of TRU waste which contain high concentrations of Plutonium 239 and Americium 241. These materials, referred to as "residues", pose an unique problem for the DOE complex because they normally contain higher concentrations of radioactive materials than more traditional TRU waste. The notion was that if these waste forms were placed within a standard 6-inch Schedule 40 pipe, its quarter-inch wall thickness would attenuate the radiation dosage enough that such waste could be contact-handled when prepared for shipment to the Waste Isolation Pilot Project (WIPP) for disposal. A similar 12-inch Schedule 20 pipe provides additional capacity with the same steel wall thickness and would allow for maximum loading of the drums. Analyses show that, for americium-contaminated residues, use of the PEACE PIPE would reduce the number of drums destined for WIPP from ~23,000 to only 2,900.[2]

As this concept was further studied, it became apparent that it could also provide important benefits for other TRU waste forms at RFETS that did not require radiation attenuation. These benefits result because use of the pipe container increases the amount of plutonium that can be transported to WIPP in a single shipment within the standard TRUPACT-II shipping container. Without use of the PEACE PIPE, such waste would be packed in a standard 55-gallon drum and 14 such drums shipped within a given TRUPACT-II. Owing to the possibility that the drums could open in an accident and allow the contents to agglomerate and reach a critical mass if the fissile content were too high, a maximum of 325 total fissile grams equivalent (fge) is allowed in these drums. This is only about 23 fissile grams per drum (325 fge/14 drums). However, since the PEACE PIPE will not open in a worst-case accident, up to 200 grams may be stored in each.[1] The pipes can then be placed within a 55-gallon drum and 14 of them included in a TRUPACT-II container. Thus, the total fissile content can be 14 times 200, or 2,800 grams versus only 325 grams without the pipe component. This is nearly a factor of ten increase in the amount of plutonium that can be included in a given shipment. A shipment consists of three TRUPACT-IIs.

In response to concerns raised by the Defense Nuclear Facilities Safety Board (DNFSB) regarding the storage of potentially dispersible residue materials in non-seismic qualified nuclear buildings[3], Rocky Flats can either:

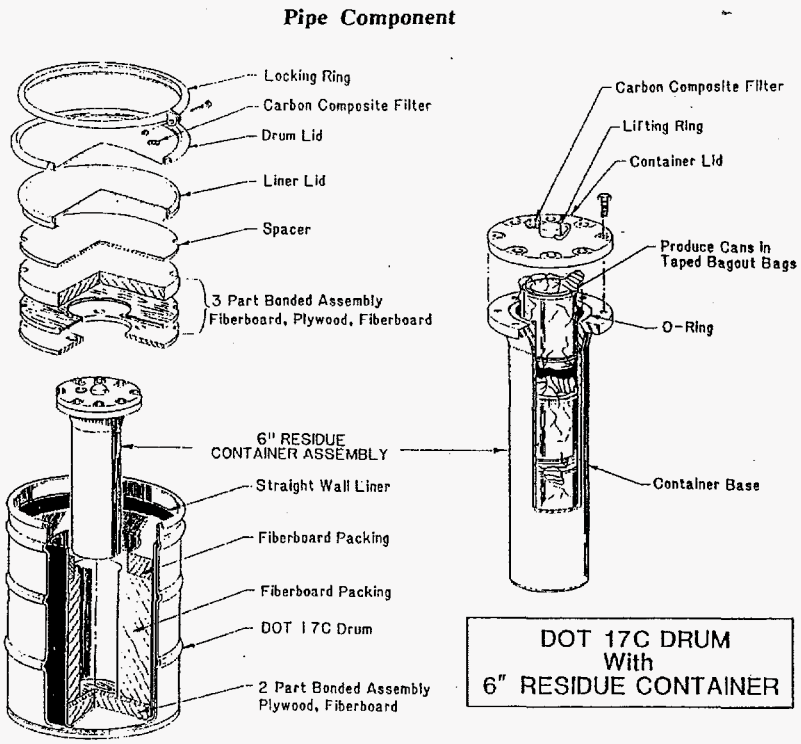
1) Build or upgrade seismic-qualified buildings,
2) process these residues to non-dispersible forms (essentially immobilization), and/or
3) store these residues in a Type-B container.

Even though the PEACE PIPES cannot be qualified as a Type-B because they are vented and only provide single containment, it was recognized that the robustness of the PEACE PIPE could enable it to be qualified as an enhanced storage container. By utilizing the PEACE PIPE rather than build new or upgrade existing buildings, process the residue, or store it in expensive Type-B containers, the cost to

address DNFSB concerns would be significantly reduced. Since the PEACE PIPE will be an enhanced disposal package, an additional advantage to utilizing the PEACE PIPE to store these residues is that they can be shipped to WIPP without any additional handling, thus reducing worker exposures as well as cost. In addition, once the residues are packaged in the PEACE PIPE, in many cases they can be moved out of the high security "Protected Area", reducing mortgage costs of maintaining former production buildings.

DESIGN

The PEACE PIPE is a nominally 24-inch long, 6-inch diameter Schedule 40, or 12-inch diameter Schedule 20, Type 304-L stainless steel pipe. A schematic drawing of the PEACE PIPE and its standard 55-gallon drum packaging container is presented in Figure 1 along with selected payload data.



Pipe Size Diameter	Outside Diameter - inches	Inside Diameter - inches	Wall Thickness - inches	Inside Height - inches	Inside Volume - liters	Pipe Wt Empty - lbs	Payload Net Wt. - lbs	Drum & Liner Wt. - Lbs	Fiberboard Wt. - lbs	Total Wt. - lbs
6 inch	6 1/2	6 1/8	3/8	25 1/8	~12	88	66	77	97	328
12 inch	12 7/8	12 1/3	1/2	25 7/8	48	195	167	77	65	504

Figure 1. Drawing of a 6-inch PEACE PIPE and its 55-gallon overpack drum.

The design specifies a bolted, gasketed lid to provide positive assurance that the contents remain within, even in the event of a worst-case accident. The lid includes a nuclear filter that prevents internal

pressure buildup without allowing the radioactive contents to escape. The pipe body may be made by welding a bottom to pipe containing a welded longitudinal seam. Alternatives are to weld a bottom to a seamless tube or to produce a one-piece, seamless body by deep-drawing and shear-spinning. In all cases, the flange is welded to the body to provide the mating surface for the lid. The 6-inch PEACE PIPE weighs 88 pounds empty, while the 12-inch size weighs 195 pounds.

MANUFACTURE

The basic approach selected by the NCPP team to manufacture the 24 PEACE PIPES was to produce a seamless body. This approach utilized a variety of equipment, helping fulfill the objective of verifying that the equipment works suitably to manufacture real products that might some day be needed by the DOE. A combination of metal working methods is employed including rolling, press-forging, forming, shear-spinning, back-extrusion and machining. A schematic view of the sequence of operations is presented in Figure 2.

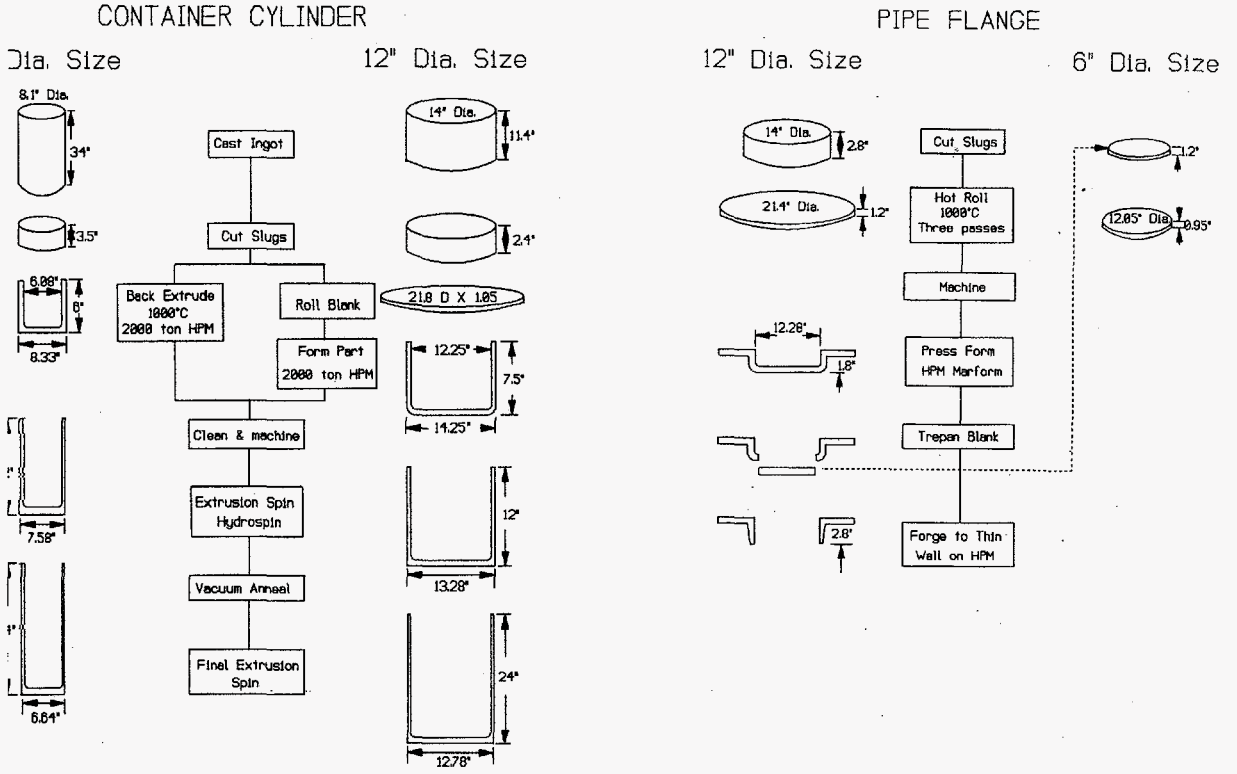


Figure 2. Schematic View of the operations used to produce the seamless body (left) and the flange (right) for the PEACE PIPE.

The other major components, the lids, were produced by machining them from rolled plate. The metal used to produce these components was not RSM, because SNLA preferred to test non-radioactive metal.

However, the process selection was done in such a way that RSM feed would be suitable. A photograph of components of the 12-inch PEACE PIPE shown in various stages of manufacture is presented in Figure 3.

Figure 3. Photograph of 12-inch pipe components in various stages of manufacture.

In addition to the seamless body, the NCPP team produced several bodies for PEACE PIPES using welded pipe with welded ends. These were included in the final delivery and in the qualification tests.

The manufacture of these PEACE PIPES was done under a comprehensive Quality Assurance and Process Control regime. All purchased and internally manufactured materials were tested and certified to applicable specifications of the product design.

TESTING

To qualify the pipe component as an enhanced TRUPACT-II payload container and to take credit for its inherent shielding properties, the NRC required the package to be subjected to a series of tests. Since the pipe component would be transported in the TRUPACT-II, which is currently an approved Type-B package, it was not necessary to subject the PEACE PIPE to the complete Type-B testing regime.

The objective of the testing program was to prove to the NRC that the containment provided by the PEACE PIPE would not be compromised during a TRUPACT-II accident scenario. It was determined that these packages be subjected to drop testing as follows:

1) Two drums, each containing one 6-inch pipe, were strapped together and dropped from 30 feet onto an unyielding surface;
2) two drums, each containing one 12-inch pipe, were strapped together and dropped 30 feet;

3) two drums, one containing a 6-inch pipe and one containing a 12-inch pipe, were strapped together and dropped 30 feet; and
4) one 30-foot side drop of a TRUPACT-II Inner Containment Vessel that housed seven drums, each containing one 6-inch pipe, and seven drums, each containing one 12-inch pipe.

Helium leak tests conducted subsequent to the drop tests showed that all of the PEACE PIPES remained leak tight. Shipments with both sizes of PEACE PIPES in one TRUPACT-II are now permissible because testing of both sizes of pipes in combination was done.

In order to use the PEACE PIPE as a mitigative system to address the DNFSB concerns regarding the storage of potentially dispersible residues, the Rocky Flats on-site safety organization determined that they would require the PEACE PIPE package to be subjected to several additional Type-B Package type tests. An International Atomic Energy Agency dynamic crush performed demonstrated how the package would behave during a postulated earthquake scenario. This test requires a package to survive the dropping of a 1,100-pound steel plate on top of the package from a height of 30 feet. A 30-minute fire test was used to determine how the package would stand up under a postulated worst-case accident involving an airplane crashing into the storage facility and causing a fuel fire. This test requires a package to be placed in the middle of a pool of fire, fueled by jet fuel, for 30 minutes.

Rocky Flats is currently storing approximately 5,000 55-gallon drums of TRU waste and an approximate additional 4,000 55-gallon drums of residues. Currently, Rocky Flats is experiencing waste drum storage limitations, especially in the protected area. When the required stabilization of the residue inventory takes place, the number of waste drums that must be stored will increase by an additional 30,000 to 50,000 drums. One recommendation to help reduce the required storage space needed is to temporarily store the PEACE PIPES in racks rather than the traditional 55-gallon drums. To accommodate this possibility, it was requested that the PEACE PIPE, without the 55-gallon drum and spacing material, be dropped from 10 feet (the height of the top shelf) to simulate an accident which could occur during the placement of the pipe into the top shelf.

Even though not specifically requested by the safety organization, the Rocky Flats packaging engineers decided to have SNLA perform a computer simulation to determine the potential consequences of the "mad forklift driver" accident. The model will determine the consequence of the tine of a forklift at a speed of ten miles per hour impacting the PEACE PIPE contained in a 55-gallon drum pinned against an unyielding wall.

Last year, Rocky Flats contracted with SNLA to perform the NRC-required tests on the original design of the PEACE PIPE. The pipe component successfully passed these tests. With the support of MSC, Rocky Flats once again contracted SNLA to repeat the NRC-required tests and to perform the additional tests required to qualify the pipe as a safe interim storage package. These tests were performed on the original design as well as a modified design which was recommended by MSC. The new design could potentially reduce the cost of these units. Both the original and modified units were shown to have survived all required tests. Rocky Flats is now in the process of obtaining approval for the utilization of the PEACE PIPE as an enhanced storage and TRUPACT-II payload container.

Photographs of the tests are shown in Figure 4.

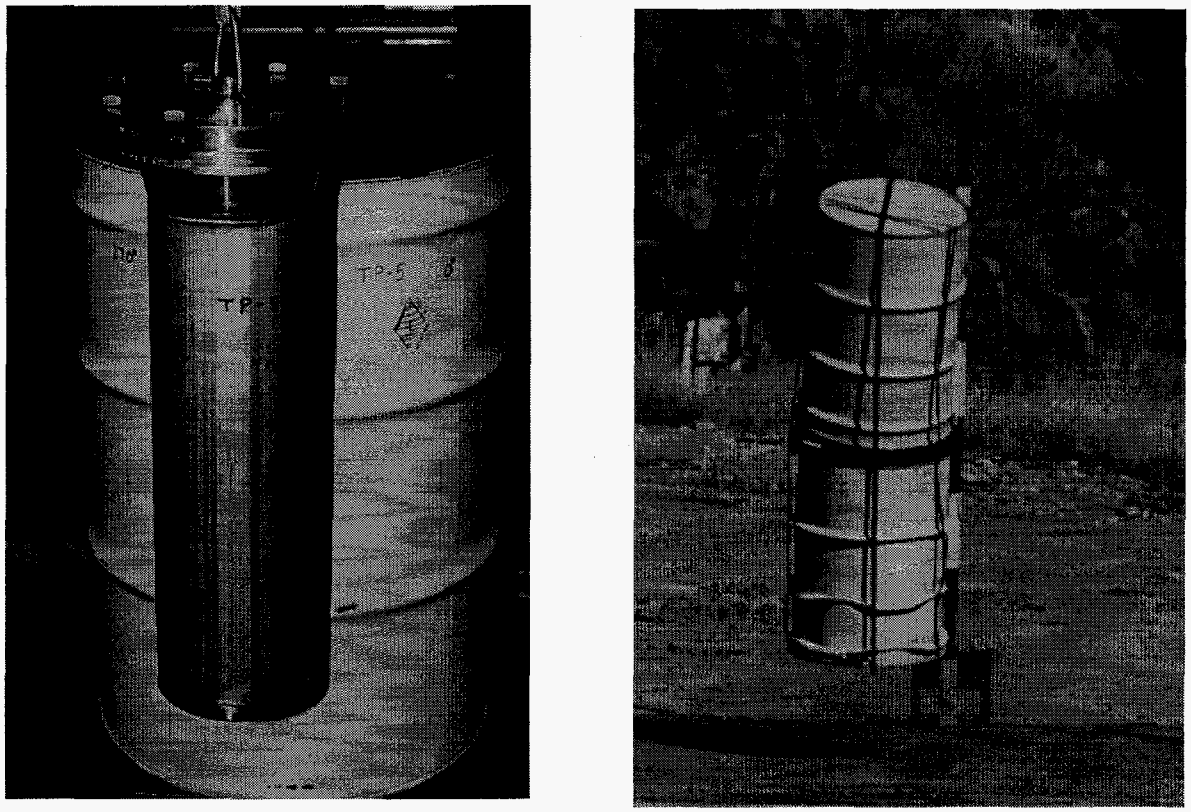


Figure 4. Photographs of a PEACE PIPE being tested at SNLA.

DISCUSSION

The contract to produce 24 PEACE PIPES was successfully completed . All of the PEACE PIPES were delivered on time and met the product specifications. All performance tests at SNLA were passed. In the course of producing these components, the NCPP learned that some of the refurbished manufacturing equipment needed further work. Some modifications were made to enable the work to proceed. Others have been identified and will be made in the future. A need for additional equipment was also identified, particularly machine tools, to expedite lengthy machining operations.

The implications of using the PEACE PIPE to achieve a higher quantity of plutonium per shipment are very significant. It means that the number of shipments from RFETS to WIPP, as well as the disposal volume required at WIPP, can be reduced dramatically, in one analysis from 5,600 down to only 435.[1] Since statistically-based risk analyses often reveal that highway accidents pose the greatest

environmental risk, reducing the number of shipments will have a highly beneficial environmental impact. Also, reducing the volume disposed will reduce the disposal cost and free up space for other wastes.

FUTURE WORK

It seems apparent that RFETS will require a substantial number of the PEACE PIPES to meet the requirement for safe and cost effective storage, transportation and disposition of TRU residuals and certain other forms of TRU waste. Other sites with TRU waste are also expected to make use of this new container, including Los Alamos National Laboratory, Hanford and Savannah River.

The opportunity to use radioactive scrap metal to fabricate the PEACE PIPE also exists.

REFERENCES

(1) "TRUPACT-II Safety Analysis Report", Revision 15, 1996, Westinghouse, Waste Isolation Division; and "Testing in Support of On-Site Storage of Residues in the Pipe Overpack Container" (Draft), December 9, 1996, Sandia/Albuquerque.
(2) "Residue Pipe Component", Rocky Flats Citizen's Advisory Board Presentation, July 16, 1996, by Kevin Keenan, DOE-RFFO, Nuclear Materials Group.
(3) DNFSB Recommendations 94-1 and 94-3.