Design of a TRU Waste Repackaging System

by

R. F. Fogle

Westinghouse Savannah River Company
Savannah River Site
Aiken, South Carolina 29808

D. Marzolf

B. Milling

M. Prather

A document prepared for SPECTRUM 2000 at Chattanooga, TN, USA from 9/24/2000 - 9/28/2000.

DOE Contract No. **DE-AC09-96SR18500**

Available for sale to the public, in paper, from: U.S. Department of Commerce, National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161,
phone: (800) 553-6847,
fax: (703) 605-6900
email: orders@ntis.fedworld.gov
online ordering: http://www.ntis.gov/ordering.htm

Available electronically at http://www.doe.gov/bridge
Available for a processing fee to U.S. Department of Energy and its contractors, in paper, from:
U.S. Department of Energy, Office of Scientific and Technical Information, P.O. Box 62,
Oak Ridge, TN 37831-0062,
phone: (865)576-8401,
fax: (865)576-5728
email: reports@adonis.osti.gov

Design of a TRU-Waste Repackaging System

Robert Fogle, Dale Marzolf, Michael Prather, Robert Milling
Engineered Equipment Section
Westinghouse Savannah River Company
Aiken, SC 29808

Introduction

The Solid Waste Management Division at the Savannah River Site (SRS) has responsibility for thousands of 55-gallon drums of mixed Transuranic (TRU) waste. The majority of the TRU waste is the result of routine maintenance activities performed in plutonium processing operations. Typical waste includes wipes, tape, cardboard, paper towels, gloves, bags, plastic suits, and tools. This waste is being stored at SRS while awaiting certification and transfer to the Waste Isolation Pilot Plant (WIPP) located near Carlsbad, NM. The drums must meet the WIPP waste acceptance criteria (WAC) before they can be transferred to WIPP. Unfortunately, some of this waste is commingled with unacceptable items such as resins and aerosol cans.

The Savannah River Technology Center (SRTC), the Idaho National Engineering and Environmental Laboratory (INEEL), the Pacific Northwest National Laboratory (PNNL), the Office of Science and Technology's Mixed Waste Focus Area, and the Savannah River Site's Solid Waste Management Division are working to develop a system to repackage drummed, mixed waste. The system is known as the Handling and Segregation System for 55-gallon drums (HANDSS-55). HANDSS-55 is designed to be a semi-remotely operated, modular, waste conditioning system that would open 55-gallon drums, sort and segregate the contents, repackage the acceptable waste, and process the non-compliant waste. It will be contained in a glovebox. HANDSS-55 is composed of a number of modules that perform discrete functions. The modules include (1) a drum and liner opener, (2) a visual inspection and sorting table, (3) a TRU-waste repackaging station, (4) a process waste reduction station, and (5) components for integrating the modules. The function of the drum/liner opener module is to open a 55-gallon drum and its internal liner to allow access to the drum's contents. The visual inspection and sorting table module will allow segregation of the drum's contents so that all non-compliant items are removed from the waste stream. The TRU-Waste Repackaging Module (TWRM) repackages the acceptable waste and removes it from the glovebox. The process waste reduction module will provide size-reduction of the original waste container so that it will fit into the repackaging container. Finally, the components for module integration perform a variety of functions including manipulation of the incoming 55-gallon waste drum, extricating waste stuck in the drum, and moving waste between modules. This paper addresses the work that SRTC is performing in the design, fabrication, assembly, and testing of the TWRM.

Work Description

The function of the TWRM module is to enable the removal of radioactive waste from the HANDSS-55 glovebox. The waste will be loaded directly into a high-density polyethylene, welded, leak-tight storage container free of external contamination. The process utilizes a welding and cutting operation to fuse and then separate the storage container from the glovebox while maintaining both glovebox and storage container integrity.

Engineers investigated the feasibility of adapting "split plug" bagless transfer technology in the development of the TWRM. The split plug bagless transfer system has been used at SRTC with metal cans and modified commercial welding and cutting tools for the processing of special nuclear materials.
In the split plug bagless transfer process shown in Figure 1, a waste-receiving container made of metal or a polymer is inserted through a sphincter seal into the glovebox. A hollow plug is carried into the glovebox by the container, removed from the container prior to placement of the compliant waste into the waste-receiving container and then reinserted into the waste-filled container. Welding/bonding and cutting operations are then performed outside the glovebox. The outer wall of the plug is welded (if metal) or bonded (if polymer) to the inner wall of the container. It should be noted that this bond must be hermetic to fully encapsulate any contamination that may have gotten on the inner wall of the container or outer wall of the plug. The container/plug seal is then cut horizontally around the periphery of the container at the center of the plug. The top half of the cut maintains the glovebox seal while the bottom half of the cut becomes the lid for the waste-receiving container. Since the seal between the container and plug walls is hermetic, any contamination in the cut plane is encapsulated and non-transferable. Finally, a new receiving container and hollow plug is inserted through the sphincter seal, pushing the upper portion of the previous container, which now becomes waste, into the glovebox, and the process is repeated.

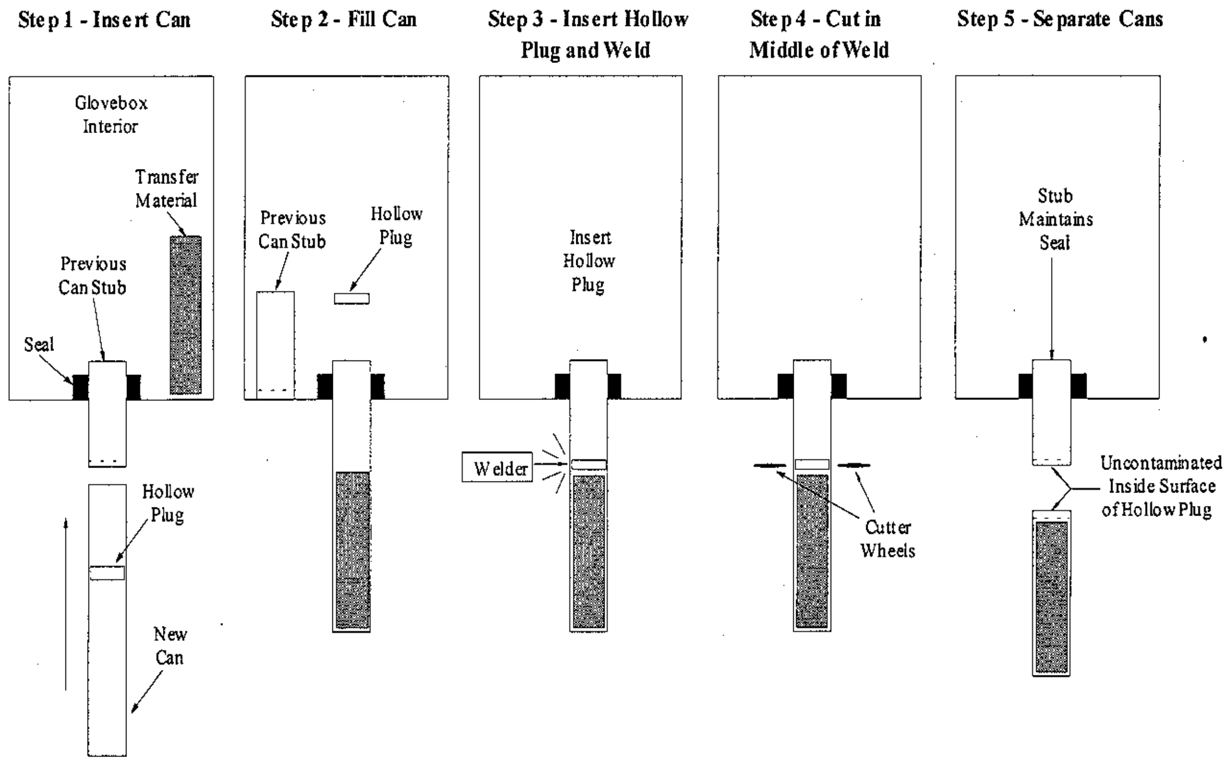


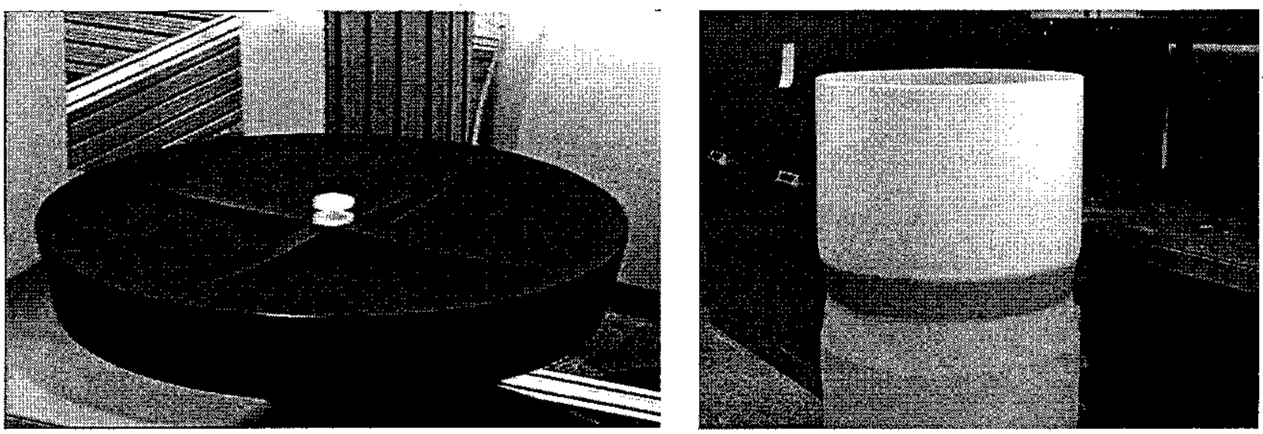
Figure 1 - "Split Plug" bagless transfer process

Discussion

The 3 main challenges in adapting the split plug bagless transfer system to the TWRM were:

- Waste container material composition, size, and shape.
- Sealing of the joint between the container wall and the hollow plug.
- Preventing migration of radionuclides outside the glovebox confinement.

Since high-density polyethylene (HDPE) drum liners have been used in the solid waste disposal process for years at SRS, HDPE was the obvious candidate of choice for the waste or repackaging container and plug. The size of the container was dictated by the fact that it had to fit into a standard 55-gallon steel drum for transportation purposes. The container is translucent and the plug is black in color as shown in Figure 2. The color selection was based on the bonding process for the container and plug. The mating walls of the container and plug were tapered at 10 degrees so that downward pressure on the plug would ensure good wall contact, also necessary in the bonding process. The plug has a knob bonded to it to permit remote handling when the plug is in the glovebox. The plug and container were produced in a rotational molding process. The container is made of a natural colored, conventional HDPE. The plug is also made of conventional HDPE with 1.5 – 2.0% carbon black added.



a) Black HDPE hollow plug b) Natural colored HDPE container with plug

Figure 2 – HDPE container and hollow plug

The second important element in split plug bagless transfer is the bond between the container and plug. This bond must be a hermetic seal over a wide enough band so that the container/plug combination can be cut through the bond. In addition, the bond must be made from the exterior of the container. A number of polymer bonding techniques including adhesives, RF or dielectric welding, induction welding, and spin welding were investigated. Most of these were found to be either ineffective or inapplicable to the process. Research led to a welding technique known as infrared or IR welding as illustrated in Figure 3. IR welding utilizes focused infrared radiation to bond translucent polymers to colored (preferably black) polymers. This explains why the container is one color and the hollow plug is another. The IR energy is passed through the translucent material and collected by the colored material. The energy is then passed back to the translucent material by conduction, causing both materials to melt and upon cooling, form a very strong bond. IR welding of polymers is fast, relatively inexpensive, and readily adaptable to containers of various sizes and shapes.

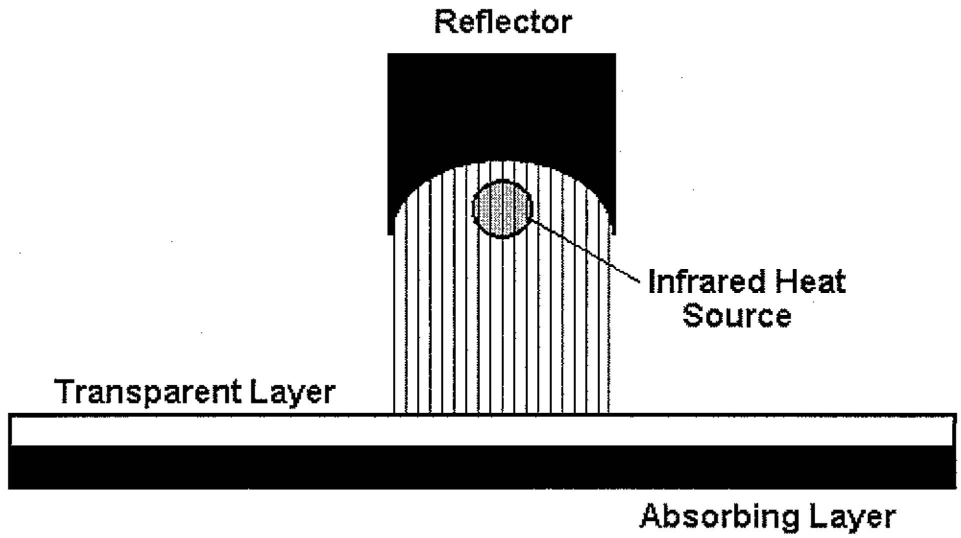


Figure 3 – Infrared bonding process

For experimental purposes, a test welder was fabricated using four parabolic reflector infrared heat lamps. The lamps were configured on an adjustable radius slightly larger than that of the container so the distance from the lamps to the container could be varied. Criteria for an acceptable weld were as follows:

1. The weld area had to be at least 1" wide.
2. The bond had to be hermetic. There can be no voids or air pockets in the welded area.
3. The bond had to be strong enough to maintain the integrity of the sealed container as it is moved from the repackaging module to the 55-gallon steel drum shipping container.

Past experience indicated that initial verification of criteria 1 and 2 above could be done visually. When a weld is made, the translucent material darkens as the black material begins to bond to it. Voids in the weld area will remain translucent and are readily visible. Numerous test welds were made, with variations in distance between the welder and container wall, voltage, lamp power (wattage), and weld time. The best results were obtained using 120 volt, 300-watt lamps at a distance of 5 centimeters. The infrared welder was oscillated to achieve a uniform welded area. An example of a test weld using the prototype welder is shown in Figure 4. Based on this work, a 48-lamp welder array was designed, fabricated and installed in the TWRM mockup as shown in Figure 5. The welder consists of 2 semi-circular halves mounted on air slides that come together around the HDPE waste container as it is positioned by the lift table. Once the weld is made, it is visually inspected. The container is then cut through at the center of the weld by a circular cutting device that separates the waste containing part of the container from the remnant that is maintaining the glovebox seal. The container is removed and placed in a 55-gallon drum. Another waste container and hollow plug are loaded on the lift table and the process continues.

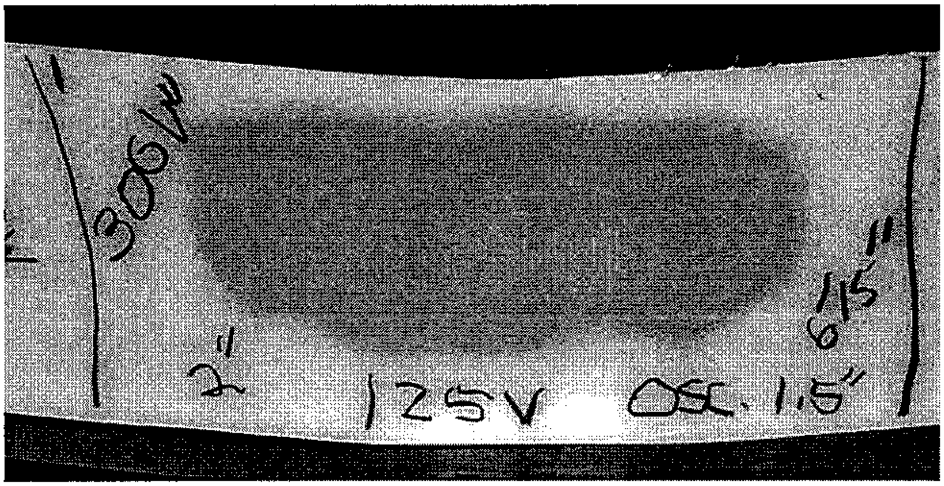
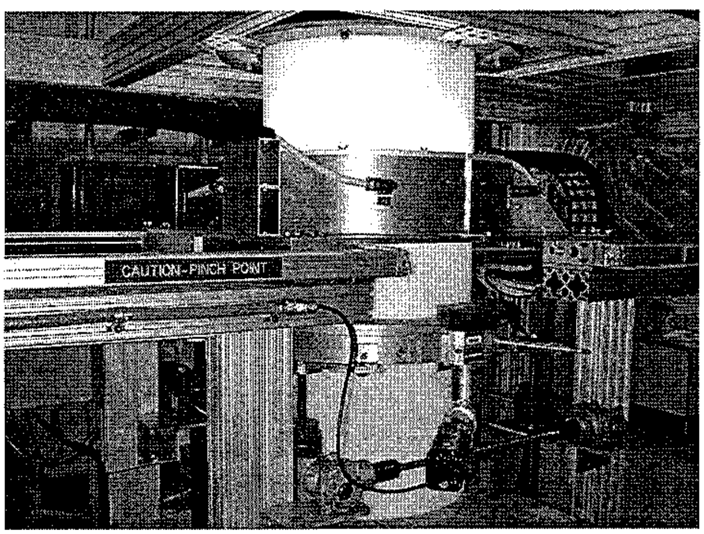
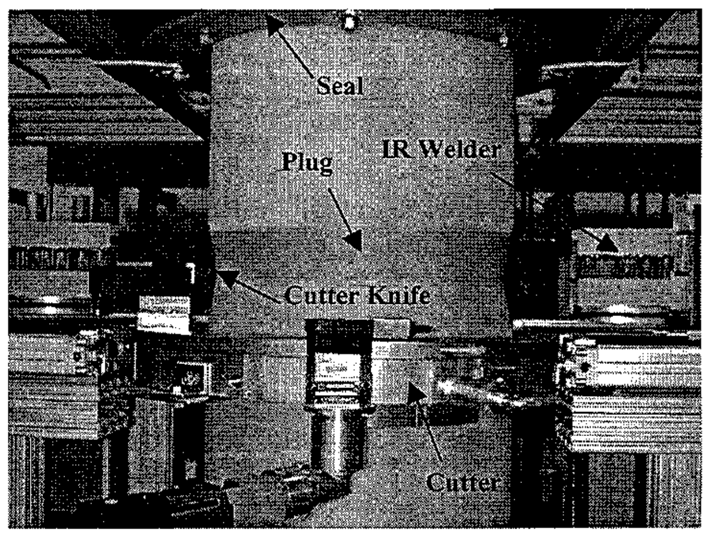


Figure 4 – Weld pattern from prototype welder



a) Waste container being welded



b) Waste container in cutting position with IR welder retracted

Figure 5 – Full-scale infrared welder

The third important element of this repackaging system is the seal. A sphincter seal is needed to prevent the release of radionuclides outside of the glovebox containing the HANDSS-55 system. Sphincter seals have been used for many years in operating facilities at the Savannah River Site for certain applications. Using a prototype seal, SRTC engineers demonstrated the viability of using a large-diameter, multi-lip seal as the interface between the TWRM and the 55-gallon HDPE containers into which waste is to be transferred. The newest version of the seal has three EPDM rubber seal lips with an inside diameter of 19-1/8". It effectively seals around a polyethylene container with an outside diameter of 22-1/8". The final design will incorporate four EPDM rubber seal lips for improved sealing. The Sphincter Seal Assembly is compiled of two parts, the Seal Ring Assembly and the Seal Sleeve Assembly shown in Figures 6 and 7 respectively. The Seal Ring Assembly consists of four EPDM seal lips separated by 1" neoprene rubber spacer rings, and pressed together between top and bottom aluminum cap rings. The cap rings are pulled together with cap screws and set-length standoffs during initial assembly. The assembly requires periodic replacement as needed, due to seal wear and contamination migration. Incidentally, because of the size of the Seal Ring Assembly, the cap rings and spacer rings are designed to be disassembled and disposed of through the TWRM load-out port, allowing 100% of the Seal Ring Assembly to be discarded without special tooling or equipment.

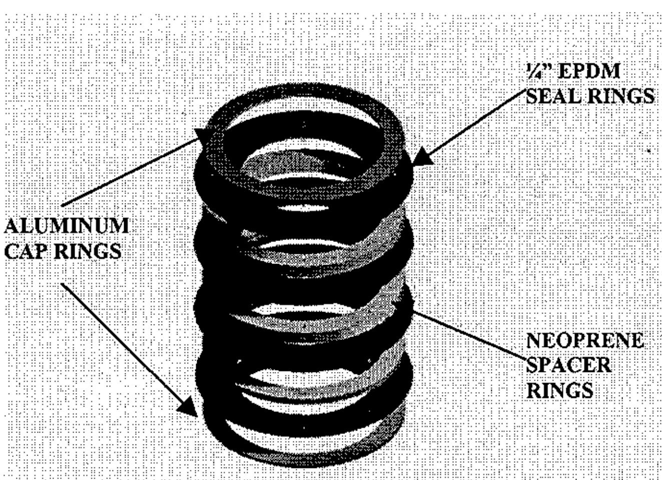


Figure – 6 Seal Ring Assembly

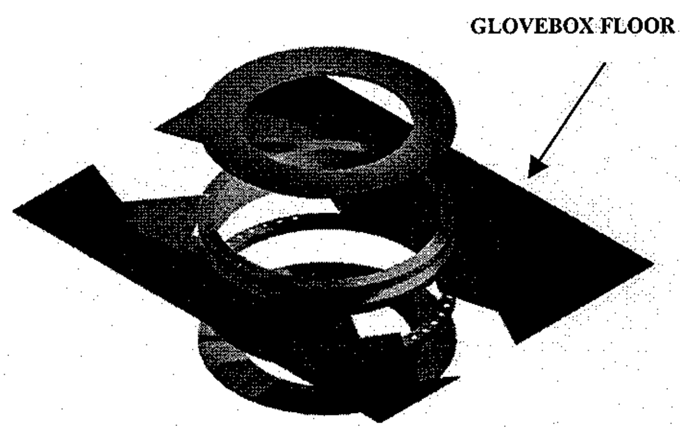


Figure – 7 Seal Sleeve Assembly

The Seal Sleeve Assembly is the housing assembly for the Seal Ring Assembly. The Seal Sleeve Assembly is a series of flanges and gaskets that bolt together through the glovebox floor for securing a stainless steel section of pipe. The pipe provides the sleeve, wall-sealing surface for the seal rings on the Seal Ring Assembly. Additional top and bottom cap flanges position, capture and squeeze the Seal Ring Assembly during final installation of the change-out process.

During the change-out process, a lift table located beneath the load-out port will be used for locating and lifting the new seal as the old seal is pushed out of the Seal Sleeve and into the glovebox. This process ensures that seal containment is not compromised. The Sphincter Seal Assembly will support the "split plug" bagless transfer method of handling radiological waste while preventing migration of radionuclides outside the glovebox confinement. Figure 8 shows a model of the final Sphincter Seal Assembly.

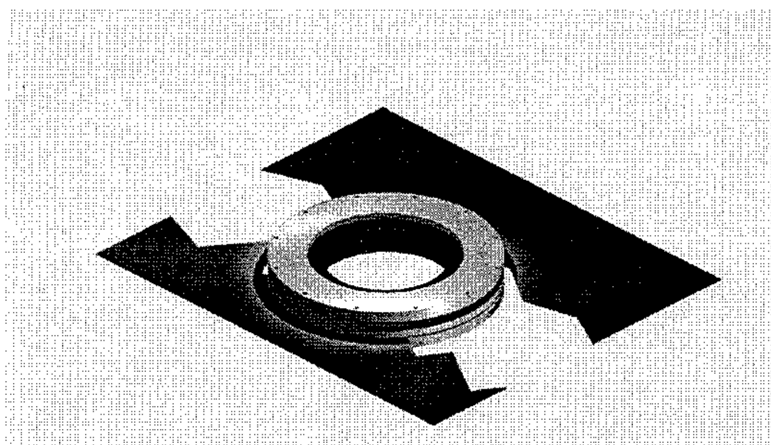


Figure 8 – Sphincter seal for 55-gallon drum

Conclusion

"Split plug" bagless transfer technology has been adapted to the repackaging of TRU-waste into 55-gallon HDPE waste containers. The infrared welding of HDPE provides a hermetic seal that encapsulates any contamination that may exist on the annulus of the container as a result of the waste loading process. Infrared welding can be adapted to various shapes and sizes of HDPE containers. Maintaining a good seal is a critical component of the TWRM system. Designing a seal for such a large diameter and pliable container was a challenge. Currently, several other uses of this waste encapsulating technology are being discussed.

OSR 14-357# (Rev 12-11-96)
Stores: 26-12801.00

DOE CONTACT: Dale Ormond 5-8013

Westinghouse Savannah River Company
Document Approval Sheet

Document No.
WSRC-MS-2000-00077, Rev 1

Field	Value
Title	Design of a TRU-Waste Repackaging System, Rev. 1
Primary Author/Contact (Must be WSRC)	Robert F. Fogle
Location	773-A
Phone No.	5-2641
Position	Engineer
User ID	T5904
Organization Code	L8160
Organization (No Abbreviations)	Engineered Equipment Section
Other Authors	Dale Marzolf, Bob Milling, Mike Prather
Deadline Date for Approval	8/14/2000

Has an invention disclosure been submitted related to this information? ☒ Yes ☐ No

Disclosure No. (If Known) SRS-98-0060 Title Plastic Container Bagless Transfer Date Submitted 6/22/98

Do you intend to submit an invention disclosure? ☐ Yes ☐ No If yes, projected date ______

Information Product Description

☐ Report Type
- ☐ Quarterly ☐ Annual ☐ Final ☐ Other ______
- ☐ Semiannual ☐ Technical ☐ Topical
- Report Dates ______ thru ______

☒ Conference Type
- ☐ Abstract ☐ Published Proceedings
- ☒ Conf Paper ☐ Other ______
- ☐ Slides

☐ Journal Article (Journal Name) ______
☐ Videotape/Multimedia
☐ External Web Page
☐ Software (Additional forms are required (ESTSC F1 and F2)).

Conference/Meeting/Presentation

Meeting Title (No Abbreviations): Spectrum 2000

Meeting Address (City, State, Country): Chattanooga, TN, USA

Meeting Date(s): 9/24/2000 (m/d/y) thru 9/28/2000 (m/d/y)

References: ☐ In Public Literature ☐ Routing Concurrently ☒ Approved for Release ☐ Other ______

Sponsor: ANS Oak Ridge/Knoxville Section in cooperation with DOE

I understand that for the information in this material to be given external disbribution, approvals by both WSRC and, as appropriate, DOE-SR are required. Distribution (verbally or published) must be in accordance with policies set forth in WSRC management requirements and procedures (MRP 3.25) and in DOE-SR orders, and the content of the external distribution must be limited to that actually approved.

[signature] Author's Signature 7/19/2000 Date

Approvals by Author's Organization

Derivative Classifier	Classification	Topic	Distribution
[signature] /URO	U-not UCNI		☒ Unlimited ☐ Limited (Explain Below)

Explanations

I understand and have considered whether any potential intellectual property rights (patents, copyrights, etc., in accordance with MP 1.09 and MRP 1.07) or any contractural barriers (CRADAs, Work for Others, etc.) may be involved before authorizing that this document be proposed for public release. If any concerns were identified, these have been discussed and resolved with General Counsel.

James W Wong — Manager's Name (Print); [signature] — Manager's Signature; 7/25/00 — Date

Classification Information (To be Completed by Classification Reviewer)

Classification (Check One for Each)

	S	C	UCNI	U
Overall	☐	☐	☐	☑
Abstract	☐	☐	☐	☐
Title	☐	☐	☐	☐

Classification Guide Topics: ☑ as Le.

WSRC Classification Officer's Name (Print): T.R. COUGHENOUR CLASSIFICATION ANALYST
WSRC Classification Officer's Signature: [signature]
Date: 7/25/00

Export Control Review (To be Completed by Export Control Reviewing Official)

Export Control Related ☐ Yes ☑ No

Export Control Reviewer's Name (Print): T.R. COUGHENOUR CLASSIFICATION ANALYST
Export Control Reviewer's Signature: [signature]
Date: 7/25/00

STI Program Use Only

UC/C Number	Routing	Editor
SC 11	EC/Class/DOE	

NOTE OSR 17-8 must be completed in addition to this form when submitting information for review and approval.

** Electronic version placed in Camelot under the title "ms200077".

DOE Contact:
Dale Ormond
5-8013

Westinghouse
Savannah River Company

P.O. Box 616
Aiken, SC 29802

July 25, 2000

WSRC-MS-2000-00077, Rev. 1
MSD-STI-2000-01185

Ms. W. F. Perrin, Technical Information Officer
U. S. Department of Energy - Savannah River Operations Office

RECEIVED
00 JUL 26 AM 9:24
S&TI

Dear Ms. Perrin:

REQUEST FOR APPROVAL TO RELEASE SCIENTIFIC/TECHNICAL INFORMATION

The attached document is submitted for classification and technical approvals for the purpose of external release. Please complete Part II of this letter and return the letter to the undersigned by 8/14/2000. The document has been reviewed for classification and export control by a WSRC Classification staff member and has been determined to be Unclassified.

Trudy Baughman for
Julie M. Bean, WSRC STI Program Manager

I. DETAILS OF REQUEST FOR RELEASE

Document Number: WSRC-MS-2000-00077, Rev 1
Author's Name: R. F. Fogle
Location: 773-A Phone 5-2641
Department: Engineered Equipment Section
Document Title: Design of a TRU Waste Repackaging System

Presentation/Publication:
Meeting/Journal: Spectrum 2000

Location: Chattanooga TN USA
Meeting Date: 9/24/2000-9/28/2000

II. DOE-SR ACTION

Date Received by TIO 07/26/2000

[X] Approved for Release
[ ] Approved Upon Completion of Changes
[ ] Approved with Remarks
[ ] Not Approved
[ ] Revise and Resubmit to DOE-SR

Remarks: ______

W. F. Perrin
W. F. Perrin, Technical Information Officer, DOE-SR

7/27/00
Date

OSR 25-82-W# (4-89)
Stores: 26-15460.00

DOE F 241.1
(7-98) p. 1 of 2
(Formerly DOE F 1332.15)
(All other versions are obsolete)

US DEPARTMENT OF ENERGY

ANNOUNCEMENT OF U. S. DEPARTMENT OF ENERGY (DOE) SCIENTIFIC AND TECHNICAL INFORMATION (STI)

OMB Control No.
1910-1400

RECORD STATUS (select one):
..... New X... Revised Data ..... Revised STI Product

Part I: STI PRODUCT DESCRIPTION

A. STI PRODUCT TYPE (select one)

..... 1. **Technical Report**
a. Type: ☐ **Topical** ☐ **Semiannual** ☐ **Annual** ☐ **Final** Other (**specify**) ....
b. Reporting Period *(mm/dd/yyyy)* .... thru ....

X.. 2. **Conference**
a. Product Type: ...... Conference Proceedings X.. Conference Paper or Other (*abstracts, excerpts, etc.*) ___
b. Conference Information (*title, location, dates*)
Spectrum 2000 at Chattanooga, TN, USA from 9/24/2000 - 9/28/2000.

..... 3. **Software Manual** (*The actual software package should be made available simultaneously. Follow instructions provided with ESTSC F 1 and ESTSC F 2.*)

...... 4. **Journal Article**
a. Type: X Announcement citation only ___ Preprint ___ Postprint
b. Journal Name ....
c. Volume ______ d. Issue ______ e. Serial identifier (*e.g., ISSN or CODEN*) ______

...... 5. **S&T Accomplishment Report**

...... 6. **Book**

...... 7. **Patent Application**
a. Date Filed *(mm/dd/yyyy)* ___/___/___
b. Date Priority *(mm/dd/yyyy)* ___/___/___
c. Patent Assignee ______

..... 8. **Thesis/Dissertation**

B. STI PRODUCT TITLE Design of a TRU Waste Repackaging System

C. AUTHOR(s) R. F. Fogle
E-mail Address(*es*):

D. STI PRODUCT IDENTIFIER
___ 1. Report Number(*s*) WSRC-MS-2000-00077, Rev. 1
___ 2. DOE Contract Number(*s*) DE-AC09-96SR18500
___ 3. R&D Project ID(s) ______
___ 4. Other Identifying Number(*s*) ______

E. ORIGINATING RESEARCH ORGANIZATION Savannah River Site

F. DATE OF PUBLICATION *(mm/dd/yyyy)* 7/27/2000

G. LANGUAGE (*if non-English*) English

(*Grantees and Awardees: Skip to Description/Abstract section at the end of Part I*)

H. SPONSORING ORGANIZATION ______

I. PUBLISHER NAME AND LOCATION (if other than research organization) ______

Availability *(refer requests to [if applicable])*

J. SUBJECT CATEGORIES *(list primary one first)* 11
Keywords Transuranic waste, WIPP, HANDSS-55

K. DESCRIPTION/ABSTRACT
This paper addresses the work that SRTC is performing in the design, fabrication, assembly, and testing of the TRU-Waste Repackaging Module.

US DEPARTMENT OF ENERGY

ANNOUNCEMENT OF U. S. DEPARTMENT OF ENERGY (DOE) SCIENTIFIC AND TECHNICAL INFORMATION (STI)

Part II: STI PRODUCT MEDIA/FORMAT and LOCATION/TRANSMISSION

A. MEDIA/FORMAT INFORMATION

1. Medium of STI product is: ...... Paper ...... Electronic document ...... Computer medium ...... Audiovisual material
2. Size of STI product ______
3. File format:
   a. If electronic document is posted at site, indicate: ☒ **html** ☐ **pdfn** ☐ **sgml** ☐ **xml**
   b. If electronic document is transmitted to OSTI, indicate: ☐ **html** ☐ **pdfn** ☐ **pdfi** ☐ **msword**
   ___ TIFFG4 ___ WP–indicate Version (5.0 or greater) ______ platform/operating system ______
   ___ MS Word–indicate Version (5.0 or greater) ______ platform/operating system ______ ___ Postscript
4. If computer medium or audiovisual material:
   a. Quantity/type (*specify*) ______
   b. Machine compatibility (*specify*) ______ c. Sound: ___ (*yes*) d. Color ___ (*yes*) e. Tables/Graphics ___ (*yes*)
   f. Other information about product format a user needs to know: ______

B. LOCATION/TRANSMISSION INFORMATION

1. STI Product is available at site: Unique URL (*of specific STI Product*) http://www.srs.gov/general/sci-tech/fulltext/ms200077r1/ms200077r1.html
2. STI Product is being transmitted to OSTI:
   a. ___ Electronically via FTP
   b. ___ Via Mail or shipment (*e.g., Federal Express*) (*Paper products, electronic documents on* CD-ROM, *diskettes, videocassettes, etc.*)
3. Information Product Filename (*of transmitted electronic format*) ......

C. ADDITIONAL INFORMATION (concerning media/format or location/transmission; for OSTI internal use only): ______

(*Grantees and Awardees: Skip to Contact section at the end of Part III*)

Part III: STI PRODUCT REVIEW? RELEASE INFORMATION

A. ACCESS LIMITATION

X..... 1. **Unlimited Announcement** (*available to U.S. and non-U.S. public*)

.... 2. **OpenNet** (*use OpenNet guidance for below*):

a. If additional source other than making it available through NTIS:
   (1) Accession Number ______
   (2) Document Location ______
b. Field Office Acronym ______
c. Declassification date (mm/dd/yyyy) ___/___/______
d. Declassification Status: ___ Declassified ___ Sanitized ___ Never classified
e. OpenNet Document Type ______
f. OpenNet Document Keywords ______
g. OpenNet Addressee ______

.... 3. **U.S. Dissemination Only**

.... 4. **Copyrighted material;** Are there any restrictions based on copyright? ____ yes ____ no. If yes, list the restrictions ______

.... 5. **Small Business Innovation Research** (*SBIR*) Release date (mm/dd/yyyy) ......

.... 6. **Small Business Technology Transfer** (*STTR*) Release date (mm/dd/yyyy) ......

.... 7. **Proprietary/Trade Secret**

.... 8. **Patent Pending**

.... 9. **Protected data** ____ CRADA ____ Other (specify) ______ Release date (mm/dd/yyyy) ......

.... 10. **Official Use Only** (*OUO*)

.... 11. **Program-Directed Special Handling** (*specify*) ______

.... 12. **Export Control/ITAR/EAR**

.... 13. **Unclassified Controlled Nuclear Information** (*UCNI*) ______

.... 14. **Classified** Classification Level/Category of:
   a. This form U...... b. The STI Product Unclassified......

15. **Other information relevant to access** (*specify; for OSTI internal use only)*) ______

B. OTHER (*information useful to include in published announcement record which is not suited for any other field on this form*)

C. CONTACT AND RELEASING OFFICIAL

1. Contact (*if appropriate, the organization or site contact to include in published citations who would receive any external questions about the content of the STI Product or the research information contained therein*)

Name and/or Position J. M. Bean, Manager STI Program & Site Support
E-mail ______ Phone (803) 725-2765
Organization Westinghouse Savannah River Company

2. Releasing Official X I verify that all necessary reviews have been completed (e.g. Patent, Copyright, ECI, UCNI, etc.)

Released by (*name*) Julie M. Bean Date (*mm/dd/yyyy*) 7/27/2000
E-Mail ______ Phone (803) 725-2765