

Contract No:

This document was prepared in conjunction with work accomplished under Contract No. DE-AC09-08SR22470 with the U.S. Department of Energy.

Disclaimer:

This work was prepared under an agreement with and funded by the U.S. Government. Neither the U. S. Government or its employees, nor any of its contractors, subcontractors or their employees, makes any express or implied: 1. warranty or assumes any legal liability for the accuracy, completeness, or for the use or results of such use of any information, product, or process disclosed; or 2. representation that such use or results of such use would not infringe privately owned rights; or 3. endorsement or recommendation of any specifically identified commercial product, process, or service. Any views and opinions of authors expressed in this work do not necessarily state or reflect those of the United States Government, or its contractors, or subcontractors.

Ongoing Investigation of the Effect that Drugstore Beetles have on Celotex Assemblies Found within Radioactive Material Packagings

Bradley M. Loftin¹, James M. Shuler²

¹Savannah River National Laboratory, ²U. S. Department of Energy, Packaging Certification Program

ABSTRACT

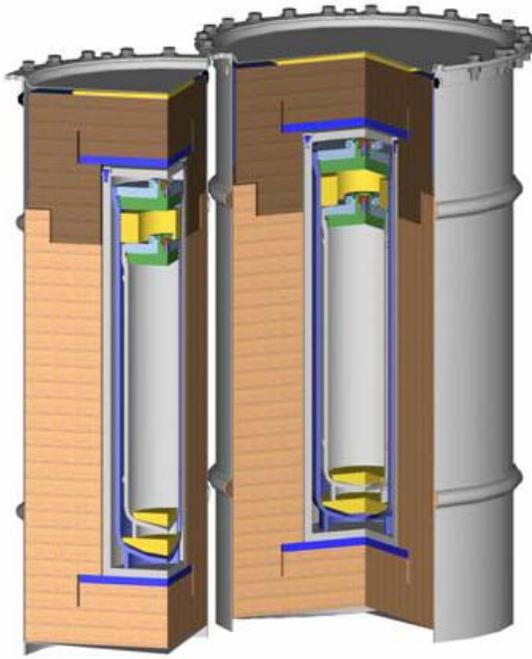
During normal operations at the Department of Energy's Hanford Site in Hanford, WA, drugstore beetles were found within the fiberboard subassemblies of two 9975 Shipping Packages. The Department of Energy's Packaging Certification Program (EM-60) directed a thorough investigation to determine if the drugstore beetles were causing damage that would be detrimental to the safety performance of the Celotex. The Savannah River National Laboratory is continuing to conduct the investigation with entomological expertise being provided by Clemson University. The outcome from the investigation conducted over the previous year was that no discernible damage had been caused by the drugstore beetles. One of the two packages has been essentially untouched over the past year and has only been opened to visually inspect for additional damage. This paper will provide details and results of the ongoing investigation of that package.

INTRODUCTION

The Model 9975 is a Type B radioactive material (RAM) shipping package designed and certified to meet the standards and requirements specified in the Code of Federal Regulations, 10 CFR 71 ^[1]. The 9975 design incorporates an outer stainless steel drum, Celotex™ fiberboard, a lead shield, and double containment through nested high-integrity containment vessels. Two 9975 packages were discovered to have beetles subsisting within the Celotex™ fiberboard assemblies. It was initially postulated that over long periods of time the beetles could consume enough of the fiberboard such that the Celotex™ could not perform its intended safety design function.

BACKGROUND

During unloading operations at the Plutonium Fabrication Plant at the Hanford Site, two 9975 Shipping Packages were found to contain live insects that were later identified by Dr. Robert Bellinger of Clemson University as drugstore beetles, (*Stegobium paniceum* (L.) Coleoptera: Anobiidae) ^[2]. It was determined after the initial investigation that the beetles were consuming the glue boundary layers between the Celotex™ layers in the assemblies.



Model 9975 Shipping Package



9975 Lower Celotex™ Assembly

Drugstore Beetle (Stegobium paniceum (L.))

A paper presented at the 2008 INMM Annual Meeting, gave description and insight as to the feeding habits and range of the drugstore beetle. The beetle remains a worldwide pest and continues to consume the same variety of foods.



Drugstore Beetle on Celotex™ Assembly
(ink pen at left for reference)

DISCUSSION

Test Plan and Relocation of Packages

A test plan was developed for an investigation to determine the damage being caused by the drugstore beetle on Celotex™ material. The Department of Energy's Packaging Certification Program (EM-63) remains as the source of funding for the investigation and the Savannah River National Laboratory (SRNL) is still serving as the principal

investigator. Clemson University continues to provide the support of an entomological expert as needed.

Review of the Investigation and Results Through the Summer of 2008

Computed Tomography

During the October 2007 a computed tomography (CT) unit was set-up for use in developing digital images of the Celotex™ from one of the 9975 Shipping Packages. 9975 Shipping Package 02662 was placed into the CT unit for examination for beetle bore holes. After examining the image reconstructions and looking in the areas that were known to have beetle bore holes, SRNL was unable to definitively identify any beetle bore holes. The CT scan did, however, confirm that the beetles were not consuming Celotex™ within concentrated areas of the 9975 Shipping Package

Initial Opening of the Packages at SRNL

It was decided in the development of the test plan that one of the packages containing drugstore beetles was going to be opened, disassembled, and destructively examined in order to determine the effects of the beetles on the package. The second package was going to be used to “grow” the beetle population in a favorable environment so that the effects of continued use of an infested package could be determined. The package being used to “grow” the population will be opened initially to establish a baseline on the damage to the Celotex™ and then on regular intervals to determine additional damage on the Celotex™.

9975 02662

—This package was used for destructive examination and was the package sent to the CT unit.

There were numerous beetle bore holes seen on the sides of the upper Celotex™ subassembly and on the internal face of the lower Celotex™ subassembly. It was discovered that there was a concentration of bore holes at the glue layers bonding the layers of Celotex™. The lower Celotex™ assembly contained numerous bore holes on the external of the assembly and there was a large amount of frass (beetle excrement) left inside the package. There was no evidence of any live beetles within the package or the Celotex™.



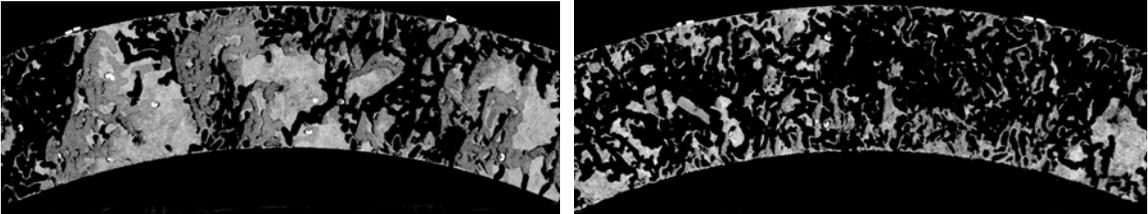
Drugstore Beetle Bore Holes in Celotex™ Lower Subassembly

Test Results

Dimensions were taken on the Celotex™ from package 02662 and it was weighed in order to determine if the bulk density of the Celotex™ had been affected by the presence of the drugstore beetles. The density of the Celotex™ assemblies was 17.5 lbs/ft³. This density is within the range listed in the 9975 SARP. The Celotex™ was then sectioned and tested for compression strength, heat capacity, and thermal conductivity. The results of these tests were all within the SARP design parameters for the Celotex™ materials [6,7].

Computed Tomography of a Slice of Celotex™

A small slice, approximately 6 inches long, was cut out of the lower Celotex™ subassembly from package 02662 and a CT scan was performed on it. The results of the CT scan showed that the beetles are selectively consuming the glue layers between the Celotex™ layers. The images below show damage at two glue boundary layers between the Celotex™ layers.



9975 02711

—This package is being used to “grow” the beetle population. There were quite a few beetle bore holes in the Celotex™ and glue layers bonding the layers of Celotex™ in the region around the interface between the two Celotex™ subassemblies. Three or four live beetles were seen crawling inside of the package at the initial opening. This package was opened again on May 21, 2008 for a second examination. Differences in the amount of damage to the Celotex™ within the package were minimal, however there was a significant growth of the beetle population as approximately two dozen live beetles were seen crawling inside of the package and many dead beetles were found on top of the upper and lower Celotex™ subassemblies.



02711 Upper Celotex™ Assembly 12/07

02711 Upper Celotex™ Assembly 05/08

Package 02711 opening in June 2009

9975 02711 was opened again on June 1, 2009. The package has remained in a controlled environment for the duration of the testing and had not been disturbed nor opened since May 2008. The Celotex™ did not have any more discernible damage and there was not a significant increase in the number of holes in the glue boundaries. It was anticipated, after seeing the increase in the beetle population in the previous opening, that the beetle population would be even greater and that the beetles would have consumed even more of the Celotex™ subassemblies. However, the beetle population seemed to have decreased since the last opening. The beetles may have just been dormant due to a lack of light. It was noted that once the package was opened for about five minutes, a few live beetles were seen crawling within the package.



02711 Upper Celotex™ Assembly 06/09

The Celotex™ Assembly had similar damage and did not look to be any worse than before. A piece of Celotex™ was attached to the top of the upper assembly, but it was not evident which part of the package the piece came from. There was not any significant accumulation of frass on top of the upper assembly. There was no additional accumulation of lead carbonate and the amount of dead beetles did not appear to increase significantly since the last opening.



02711 Lower Celotex™ Subassembly 06/09



Dead Drugstore Beetles on top of the Lead Shield (9975 02711 06/08)

RECOMMENDATIONS FOR 9975 02711

It is now recommended that the drugstore beetles in 9975 02711 be eradicated as required by the initial permit to bring the beetles into the state of South Carolina. This should be done by initially freezing the package, then removing the lead shield and containment vessels. Freezing the package should eliminate all of the beetles, but as an additional measure, the package without the lead should be able to be placed into a CT scan and valid data gathered. Once the package has been through the CT scan, it can be frozen again without the lead and containment vessels to ensure that all of the beetles have been killed. Then it is recommended that the Celotex™ be destructively tested to determine if there was a loss or change in the properties important to the safety of the package.

CONCLUSIONS AND FUTURE TESTING

The investigation shows that the Celotex™ has not been damaged to an extent such that it could not perform its intended safety function. Future examination and testing of 9975 02711 will provide additional insight into the effects, over time, of the drugstore beetle on fiberboard assemblies.

CONTRACT NUMBER AND DISCLAIMER

Contract Number

This document was prepared in conjunction with work accomplished under Contract No. DE-AC09-08SR22470 with the U.S. Department of Energy.

Disclaimer

This work was prepared under an agreement with and funded by the U.S. Government. Neither the U. S. Government or its employees, nor any of its contractors, subcontractors or their employees, makes any express or implied: 1. warranty or assumes any legal liability for the accuracy, completeness, or for the use or results of such use of any information, product, or process disclosed; or 2. representation that such use or results of such use would not infringe privately owned rights; or 3. endorsement or recommendation of any specifically identified commercial product, process, or service. Any views and opinions of authors expressed in this work do not necessarily state or reflect those of the United States Government, or its contractors, or subcontractors.

REFERENCES

1. Code of Federal Regulations, Title 10, Energy, Part 71, Packaging and Transportation of Radioactive Material, 10 CFR 71.
2. Bellinger, Robert G., Letter from Clemson University to Glenn Abramczyk at the Savannah River National Laboratory identifying drugstore beetles, October 4, 2007.
3. Investigation of the Presence of Drugstore Beetles within Celotex Assemblies in Radioactive Material Packagings.
4. Triplehorn, C.A and Johnson, N.F., *Borer and Delong's Introduction to the Study of Insects*. Brooks/Cole, 2005.
5. Mallis, A., *Handbook of Pest Control*. Eighth Edition, Mallis Handbook and Technical Training Company, 1997.
6. Daugherty, William L., *Material Properties of Beetle-Infested Fiberboard from Package 9975-02662*, SRNL-MST-2008-00015, January 23, 2008.
7. Abramczyk, G. A., Blanton, P. S., and Houghtaling, T. K., *Safety Analysis Report for Packaging Model 9975 B(M)F-85*, WSRC-SA-2002-00008, Revision 0 and Addendum 1, Revision 1, April 2005.