

Investigation of Drugstore Beetles and Their Effects within Radioactive Material Shipping Packages

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ABSTRACT

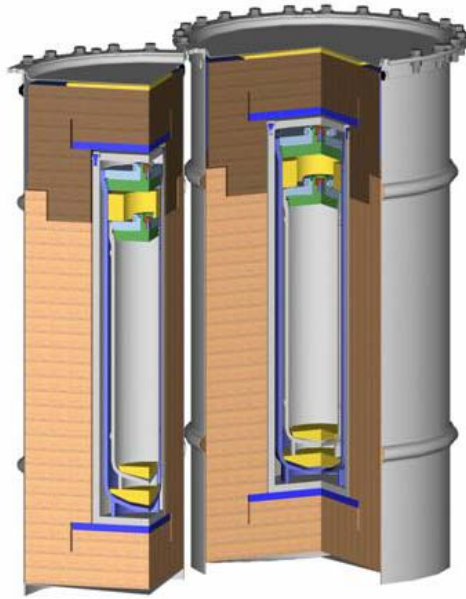
During normal operations at the Department of Energy's Hanford Site in Richland, WA, drugstore beetles were found within the fiberboard subassemblies of two 9975 Shipping Packages. Initial indications were that the beetles appeared to be feeding on the cane fiberboard within the package. The cane fiberboard in the 9975 Shipping Package is Celotex. Celotex is incorporated in various radioactive material packages serving as both a thermal insulator and an impact limiter for normal conditions of transport and for hypothetical accident conditions. The Department of Energy's Packaging Certification Program (EM-45) is directing a thorough investigation to determine if the drugstore beetles are causing damage that would be detrimental to the safety performance of the Celotex. The Savannah River National Laboratory is conducting the investigation with entomological expertise being provided by Clemson University. This paper will provide details and results of the ongoing investigation.

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 in June, 2007, 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.



0458

Figure 1. A Picture of a Model 9975 Shipping Package with cutaway and the 9975 Lower Celotex™ Assembly.

Drugstore Beetle (*Stegobium paniceum* (L.))

A paper presented at the 2008 INMM Annual Meeting [3], 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 a variety of foods.

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-45) 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 exterior 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™.



Figure 2. A Drugstore Beetle on the Celotex™ Assembly (an ink pen is at the left for reference) and Drugstore Beetle bore holes in the 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 [4, 5].

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.

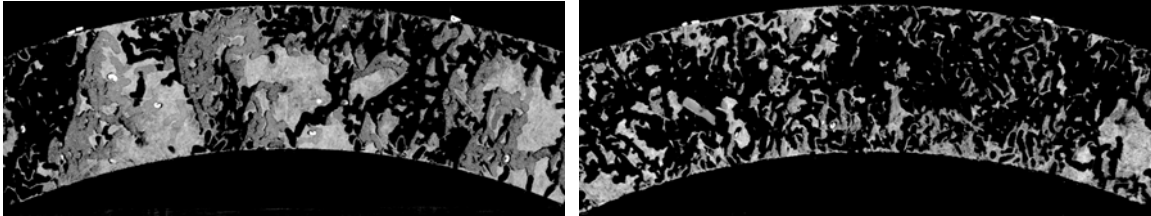


Figure 3. The two images are from the CT scan and are of the glue boundary layers.

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.

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.



Figure 4. A photograph of the 02711 Upper Celotex™ Assembly taken 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.

RECOMMENDATIONS FOR 9975 02711

It is recommended that the population of drugstore beetles in 9975 02711 continue to be allowed to grow and that the investigation should continue. Long-term changes within the package may lead to new discoveries about the drugstore beetle and the 9975 package. It is also recommended that, once the beetle investigation is complete, the Celotex™ be destructively tested to determine if there was a loss or change in the properties important to the safety of the package as was done for 9975 02662.

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

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