71-9315

Department of Energy
Washington, DC 20585

NOV 24 2009

Attn: Document Control Desk
Director, Spent Fuel Project Office
Office of Nuclear Material Safety and Safeguards
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

This is a follow up to the initial DOE email sent to the NRC technical lead, Kimberly J. Hardin, on October 15, 2009 and the series of emails after that date. This is an Occurrence report concerning the ES-3100 Shipping Container, Docket No. 71-9315, USA/9315/B(U)F-96.

SUMMARY

The ES-3100 Shipping Container uses neutron absorber spacer cans for certain configurations of enriched uranium metal and alloy shipments. The absorber is a Grade B safety system. A shipment of ES-3100s containing enriched uranium contents was found to have two spacer cans with an unexpected brown "greasy" substance on their surface. The substance was determined to be iron oxide caused by moisture in the can leading to the formation of aluminum hydroxide, which is slightly caustic, and thus rusting inside the can. The iron oxide seeped out of the can through pin holes. The iron oxide, or rust, mixed with some moisture from within the can leading to the "greasy" appearance. The rust was superficial and the spacer can was not in any jeopardy of losing integrity or its ability to maintain the absorber material in the intended configuration. Thus, there were no defects in safety system; at best an inconvenience to users. In addition, the rust is not considered a defect since the safety system is actually the 277-4 neutron absorber in can, not the can itself. Nevertheless, the Department of Energy (DOE) decided to report this occurrence per 10 CFR 71.95, paragraph (a)(2).

BACKGROUND

The ES-3100 Certificate of Compliance (CoC) requires the use of neutron absorber spacer cans (spacers) for some loadings of enriched uranium metal or alloy (CoC Tables 1 and 2). Spacers are tin-plated carbon steel with cast-in-place absorber material known as 277-4. The design of spacers is specified on Drawing M2E801580A026, Rev C, as referenced in the CoC. The 277-4 neutron absorber material is specified in Appendix 1.4.5 of the ES-3100 Safety Analysis Report (SAR) document number Y/LF-717, Rev 3. By design, there is latent moisture inherent in 277-4 and, depending on how much, the acceptable density range is 100-120 lb/ft^3. All spacers in service have been inspected by Quality Assurance and meet the required drawings and specifications, including density range. Spacers have been assigned a Safety Grade B rating

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because of their impact on criticality safety for certain fissile material loadings. Figure 1 shows a normal spacer can.

On September 30, 2009, Savannah River National Laboratory (SRNL) unloaded an ES-3100 that contained nuclear material in-compliance with Table 2 of the CoC. This particular loading configuration required 2 spacers, also in compliance with the CoC. Upon unloading the container, SRNL noted that both spacers showed signs of a brownish material on their surface. This was immediately reported to B&W Y-12 Technical Services, LLC (Y-12), the design agency for the ES-3100. SRNL stopped work on this container until the material was identified. A picture of one of these spacers is attached as Figure 2.

SRNL had approximately 100 ES-3100 containers in this shipment, with each container having 2 spacers inside. Of this shipment, only 2 spacers in one ES-3100 where found in the condition shown on Figure 2. All others were found to be in normal condition (as in Figure 1).

Immediately after hearing about this occurrence, Y-12 engaged in an evaluation to determine the nature of brownish material and establish corrective actions to prevent this in the future.

There have been 1000 spacers in service at Y-12 since 2007. For the past 6 months, operations personnel have noticed a few with small amounts of visible rust. Operators were instructed to permanently remove from service any spacer with visible rust. As the appearance of rust indicated these carbon steel spacers had a limited lifetime, Y-12 did the following (this was regardless of the SRNL occurrence):

1. Initiated a procurement for 1000 new carbon steel spacers for replacement of rusted spacers in the short term.
2. Initiated a design effort that would replace all carbon steel spacer with stainless steel spacers.

These activities were on-going when Y-12 learned of the problematic spacers found at SRNL.

ANALYTICAL EVALUATION

From the inventory of out-of-service spacers at Y-12, a representative sample was chosen that had the same appearance of the SRNL spacer in Figure 2. This was sent to the Analytical Laboratory for analysis, and given sample number A092740034.

Sample A092740034 was submitted for an investigation of corrosion (rust) on spacer cans. The can is filled with a moist grey solid. The solid was identified by x-ray diffraction as aluminum trihydrate (Al_20_3 * 3 H_2O or $Al(OH)_3$). No other associated compounds were identified by x-ray diffraction. Aluminum trihydrate is insoluble in water; however this compound will slightly raise the pH of demineralized water. The carbon steel of the can is naturally susceptible to corrosion and with the added caustic condition from the moist aluminum trihydrate (forming aluminum hydroxide), contacting the can surfaces will result in corrosion.

A portion of the aluminum trihydrate was removed from the can to expose the inner can wall and bottom. Both of these areas also had corrosion.

Samples taken of the aluminum trihydrate (grey solid was powdered) and the exterior can surface corrosion areas were analyzed by inductively coupled plasma – mass spectrometry. Results were as follows:

<u>Details analytical results –</u>

	Can Contents		**Exterior Can Corrosion**	
Aluminum	63371	ug/g	173	ug/g
Iron	1575	ug/g	54464	ug/g
Barium	84	ug/g	<2	ug/g
Calcium	18495	ug/g	141	ug/g
Potassium	<8	ug/g	1135	ug/g
Sodium	200	ug/g	2575	ug/g
Tin	<4	ug/g	121	ug/g

The Y-12 laboratory determined the rust was caused by moisture in the neutron absorber material creating aluminum hydroxide and a slightly caustic environment. The caustic environment was enough to rust the carbon steel spacer can material. While most of the rust seen originated from the inside of the can and poked through the can wall, some rust is found to be forming on outside of the cans. This phenomenon is best explained by the vendor of the spacers leaving an invisible residue of 277-4 on the outside of the finished can. This residue reacts with moisture in air, causing the formation of aluminum hydroxide and eventual rusting. This type of rusting is less than that found coming from inside the cans.

SRNL OCCURRENCE

In the specific case of the SRNL cans, before that ES-3100 was loaded at Y-12, the spacer can was inspected for visible rust, broken seams, and loose lid. The cans passed the inspection. This particular ES-3100 was held up for 4 months before it was opened. Y-12 believes that the trapped environment may have been humid which would accelerate the rusting. So, iron oxide formed in the can and seeped out of the can through pin holes. The iron oxide, or rust, mixed with some moisture from within the can and in the trapped environment, leading to the "greasy" appearance of the rust.

The rust was superficial and the spacer can was not in any jeopardy of losing integrity or its ability to contain the absorber material in the intended configuration. There was no visible rust when that ES-3100 was loaded, so the rust seen in Figure 2 formed in four months. The maximum time an ES-3100 would be sealed and then shipped would be 12 months. In that time, and at the rate of rust seen in this case, the spacer can would not be rusted to the point of loosing integrity in 12 months. Thus, there were no failures of safety systems in this case.

CORRECTIVE ACTIONS

DOE is planning to replace the current carbon steel spacer cans in phases. A procurement is in place for 1000 more carbon steel spacer cans. These will be an improved version of the original spacers. Improvements to the new cans include:

1. The 277-4 will be drier so there will be less latent moisture. The acceptable density for this batch will be between 100-110 lb/ft^3. The original batch had a density of 100-120 lb/ft^3. The density reduction will be all water weight. This will slow rusting from the inside.

2. The outside of the finished cans will be cleaned with a solvent to remove as much 277-4 residue as possible. This will slow rusting from the outside.

3. Since the original spacers have been in service for 2 years, the new and improved carbon steel spacers should have a longer shelf life. Although they will only be used until a new stainless steel can is available (less than one year).

The new carbon steel spacers will be delivered in December 2009, at which time DOE will start phasing out the original spacers.

The final step will be to replace all carbons steel cans with stainless steel. DOE initiated a development effort to fabricate spacers using stainless steel cans. Stainless steel was chosen for its resistance to the caustic environment formed by the 277-4 and moisture. The SAR will accommodate the change as the spacer drawing M2E801580A026 allows carbon steel or equivalent. The new design drawing is complete and a procurement should be in place by February 2010, with delivery around May 2010. Once these stainless steel cans are in service, DOE will start phasing out the modified carbon steel cans. This phase out will occur long before any rust appears on the modified carbon steel cans.

CONCLUSIONS

The situation reported here was not a defect of a safety significant system of the ES-3100 container. It was a minor inconvenience with the use of the neutron absorber spacer cans. The brown greasy substance found on 2 spacer cans at SRNL was rust with some moisture in it. DOE evaluated the substance and gave SRNL the information they needed to get their operations back on track. While the rust was on a Grade B safety system of the ES-3100, it did not (nor would not have) compromise the safety performance of the spacer can. There was never any impact to the neutron absorber 277-4 as a result of surface rust on the can. However, to eliminate the occurrence of rust, DOE is immediately replacing the aging inventory of carbon steel spacer cans with new and improved carbon steel spacer cans. DOE will then be replacing the new carbon steel spacer cans with stainless steel spacer cans within one year. The future of spacer cans for ES-3100 use is a complete conversion to stainless steel.

An electronic copy of this letter with attachments has been sent to Kimberly J. Hardin.

If you have any questions, please contact me at 301-903-5513.

Sincerely,

James M. Shuler

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Enclosure

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Figure 1: Normal ES-3100 Neutron Absorber Spacer Can

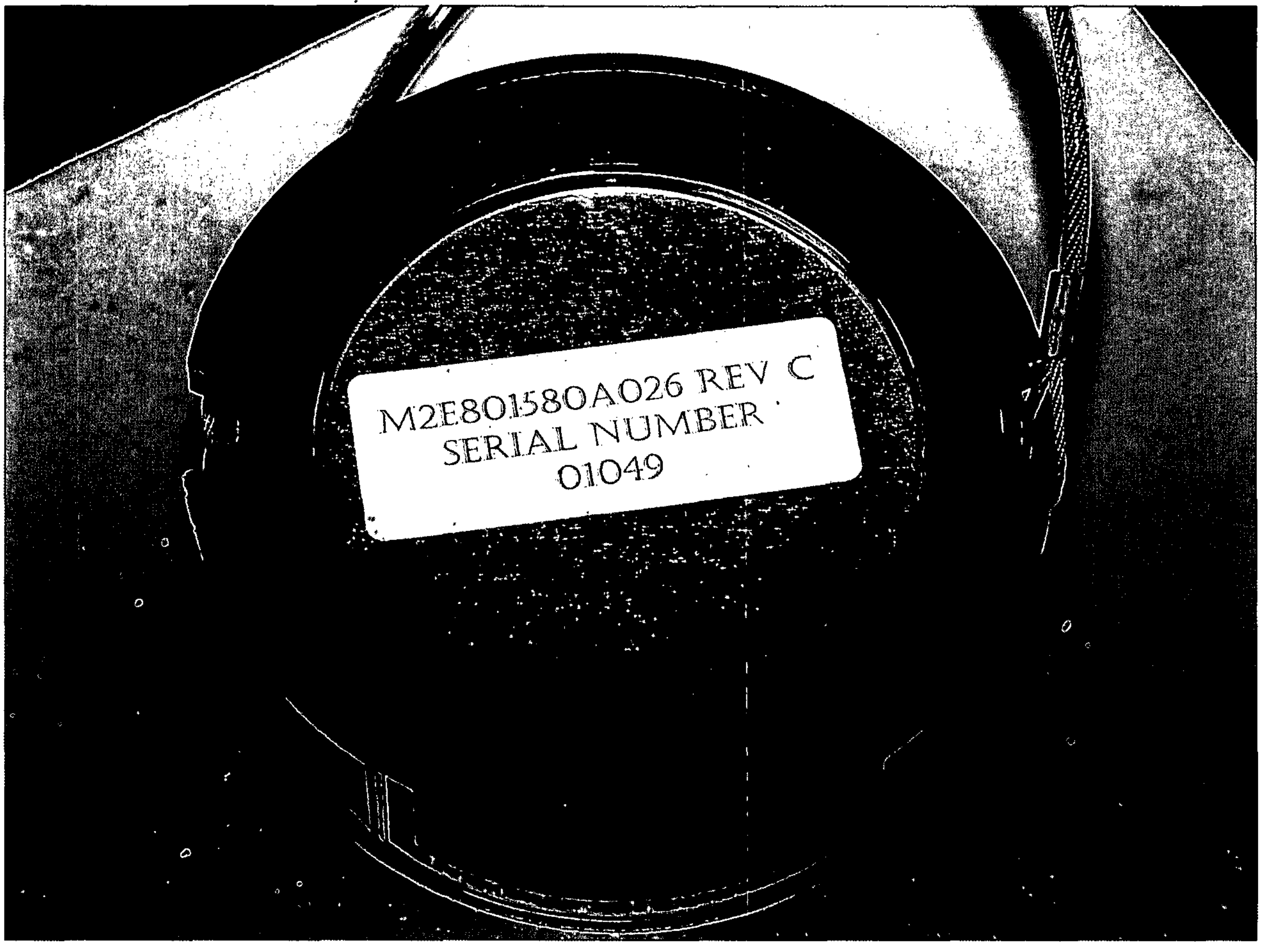

Figure 2: Problematic Spacer Can Taken Out of an ES-3100 at SRNL