Contract No:

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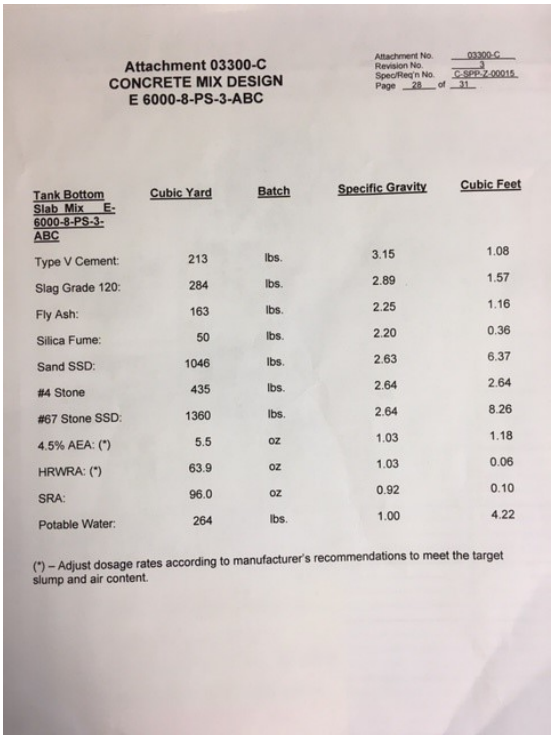
JAEA Alpha Spectrometry and Radiolysis Measurements

Savannah River National Laboratory conducted a series of radiological measurements on plutonium-239 laden materials to measure the alpha attenuation rates. Samples of concrete of a known composition (Figure 1.) were ground to a fine powder.



Attachment 03300-C
CONCRETE MIX DESIGN
E 6000-8-PS-3-ABC

Attachment No. 03300-C
Revision No. 3
Spec/Req'n No. C-SPP-Z-00015
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Tank Bottom Slab Mix E-6000-8-PS-3-ABC	Cubic Yard	Batch	Specific Gravity	Cubic Feet
Type V Cement:	213	lbs.	3.15	1.08
Slag Grade 120:	284	lbs.	2.89	1.57
Fly Ash:	163	lbs.	2.25	1.16
Silica Fume:	50	lbs.	2.20	0.36
Sand SSD:	1046	lbs.	2.63	6.37
#4 Stone	435	lbs.	2.64	2.64
#67 Stone SSD:	1360	lbs.	2.64	8.26
4.5% AEA: (*)	5.5	oz	1.03	1.18
HRWRA: (*)	63.9	oz	1.03	0.06
SRA:	96.0	oz	0.92	0.10
Potable Water:	264	lbs.	1.00	4.22

(*) – Adjust dosage rates according to manufacturer's recommendations to meet the target slump and air content.

Figure 1. Concrete Mix Design Vendor Specifications

The powder was then sieved to a series of 4 particle-size bins. The particle size bins were <74 microns, 74 – 88 microns, 88 -125 microns, and 125 – 149 microns. Sub-samples from each bin were uniformly contaminated with a standardized solution of Pu-239. Each sample was dried under an infrared heat lamp and mixed to homogenize. A layer of contaminated material was applied in a thin layer to an adhesive surface on a stainless steel planchet (Figure 2).

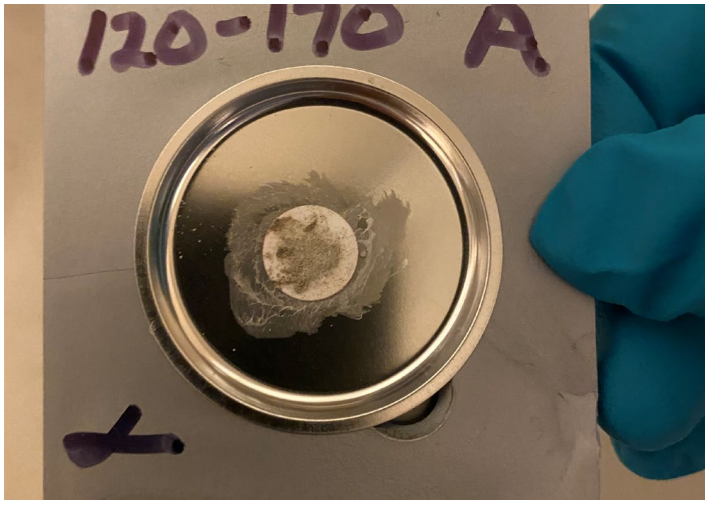

Figure 2. Powdered Concrete Mount

Three samples from each size bin were prepared in this fashion. Each planchet was assayed using a Mirion Industries Alpha Analyst passively-implanted-silicon spectrometer (PIPS) based alpha spectrometry system for a period of 50,000 seconds. Spectra from the 8 measurements are provided in Figure 3.

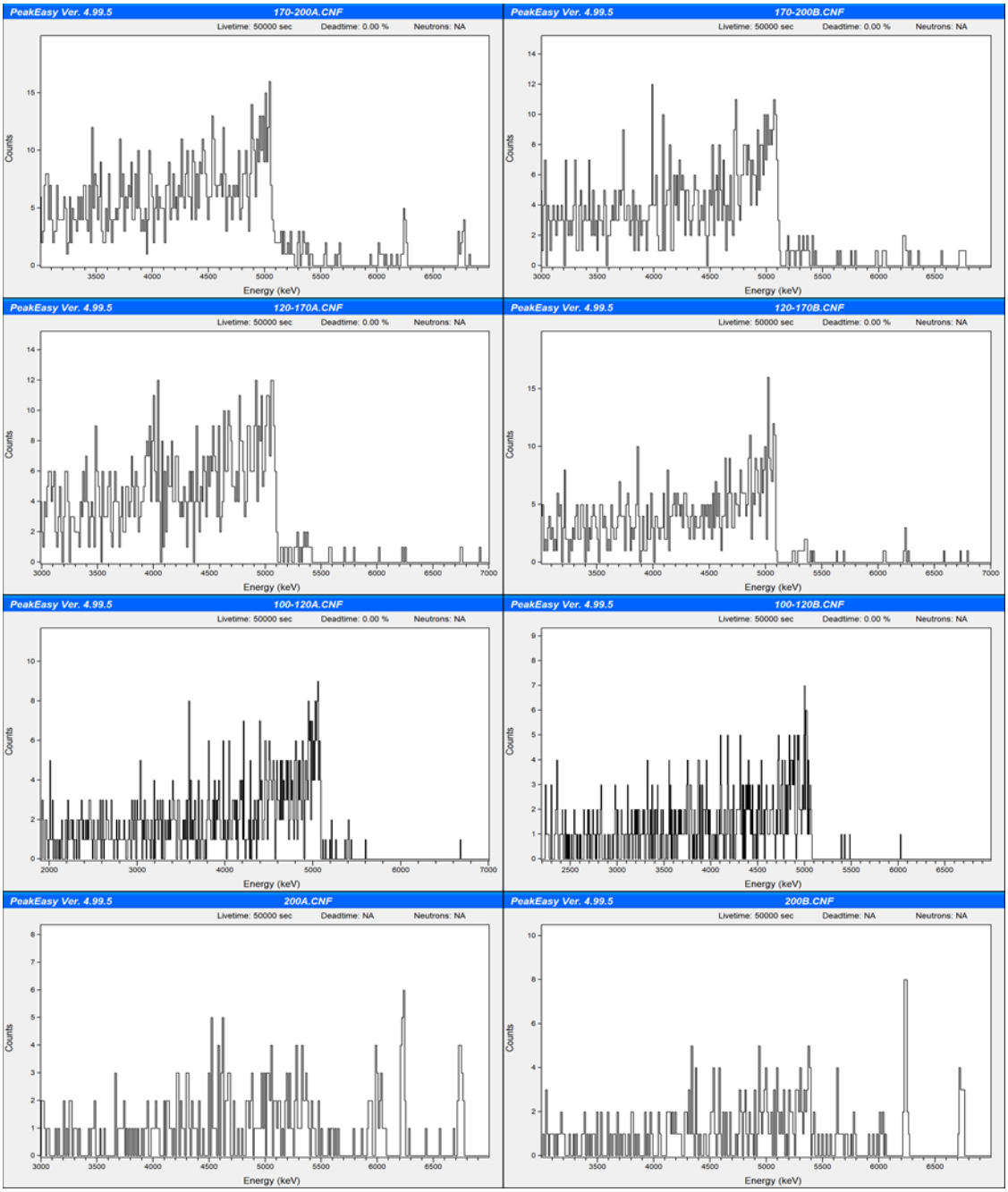

Figure 3. Alpha Spectra of Pu-239 Contaminated Concrete Powders

At JAEA's request a sample of plutonium oxide was also analyzed by alpha spectrometry. Several grains of a 94:6 mass ratio Pu-239:Pu-240 plutonium oxide sample were mounted on a scanning electron microscopy stub and analyzed by alpha spectrometry. An electroplated Pu-239 standard was also analyzed on the same detector and is provided for comparison. Figure 4

depicts the electroplated alpha spectrum (top left), the plutonium oxide spectrum (bottom left), and a picture of the SEM mount (right).

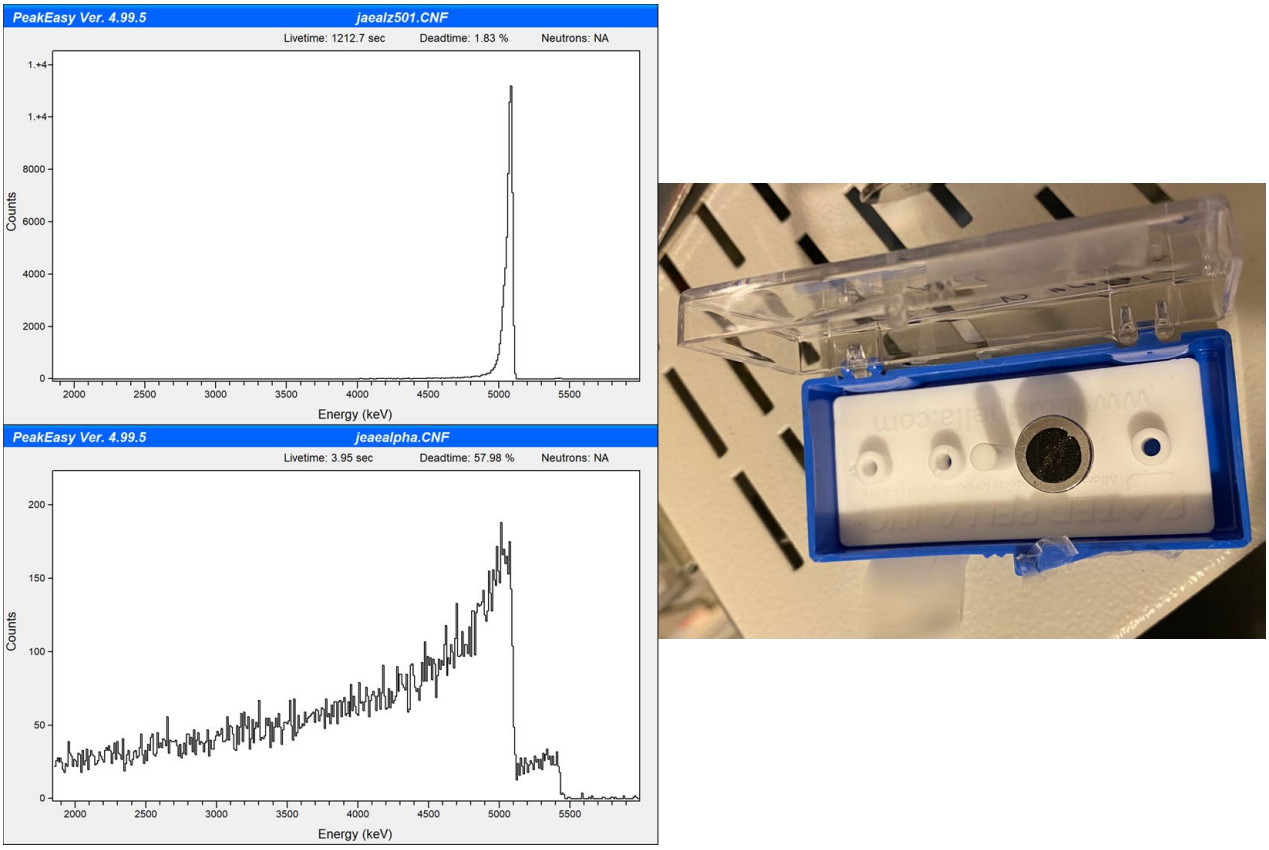

Figure 4Alpha Spectra of Pu Oxide, electroplated Pu-239, and the SEM Pu oxide mount.

The mount was then analyzed by scanning electron microscopy (SEM) to get an idea of the size of the plutonium oxide particles on the mount. The particles appeared to range from ~100 microns to less then 0.5 microns. Figure 5 contains images at different magnifications taken with the SEM. Scales of the image magnification are provided in the images, ranging from 200 um to 1 um, and can give one a feel for the particle size distribution of the particles in the alpha spectrometry mount.

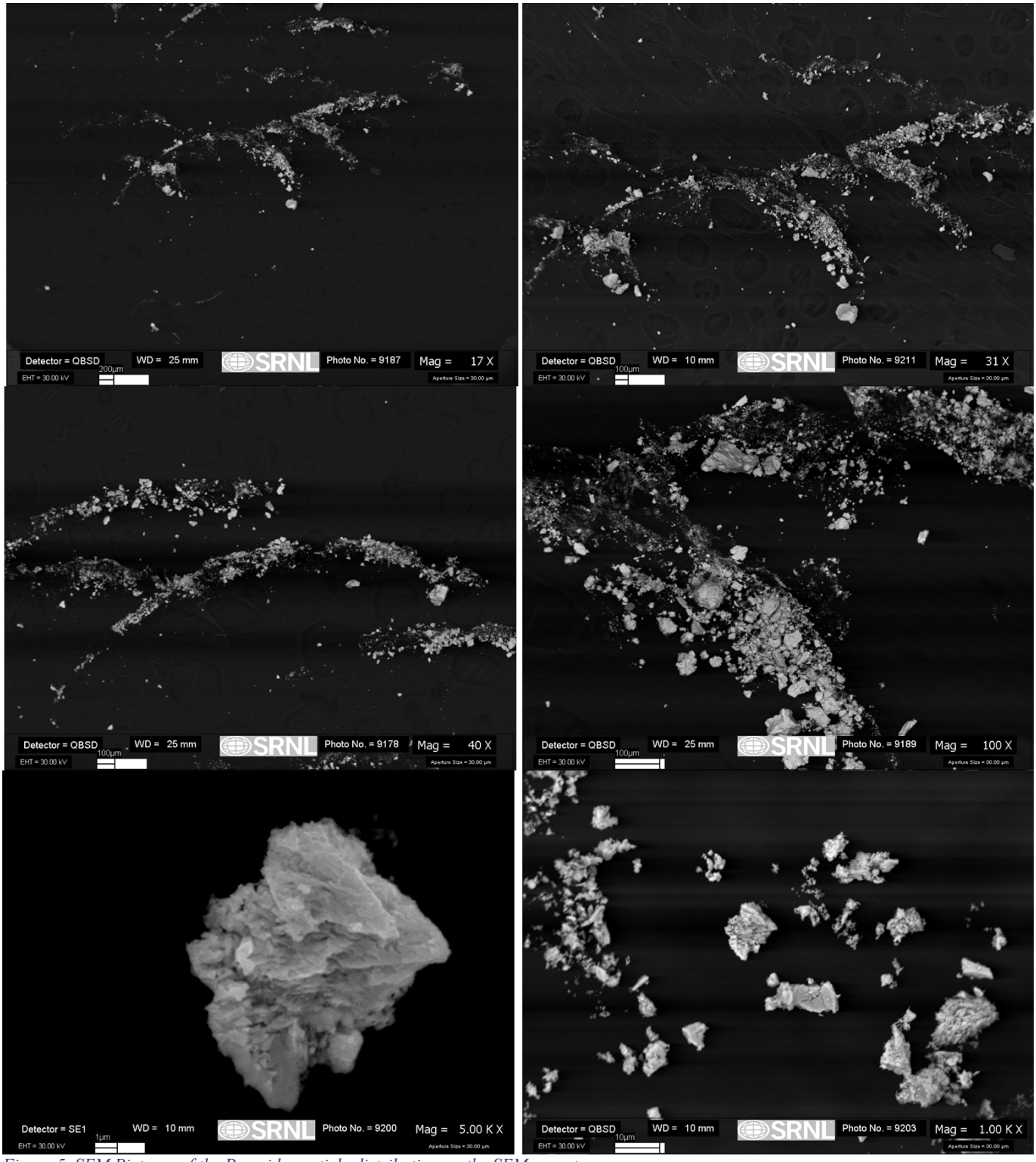

Figure 5. SEM Pictures of the Pu oxide particle distribution on the SEM mount

There wasn't time left in the fiscal year to fine tune these measurements. For future work, SRNL could isolate individual plutonium oxide particles with a microscope and take alpha spectra of those particles. Also, SRNL could increase the contamination levels of the concrete particles, mount discrete particles on alpha planchets and measure the degradation of the alpha spectra obtained from measuring these discreet particles. As there are many components to concrete (cement, aggregate, etc…) a discussion should be held between SRNL and JAEA as what discreet particle component of concrete should be contaminated. Also, as aggregate used in Japanese concrete is of a different composition than aggregate used in the southeastern states of the US, perhaps some Japanese aggregate should be used for some of these tests.

There also was no time left in the fiscal year to conduct radiolysis measurements on plutonium contaminated concrete. However, as part of a different research program, SRNL had already conducted extensive radioloysis measurements on hydrogen generation rates from contaminated concrete. The alpha spectrometry data in this report and the alpha radiolysis data from the previous report can be used to fine tune the experiments going forward in this collaboration in the future.