May 18, 2023

**TO:** Residents of Erwin, TN and surrounding communities

**SUBJECT:** Attic dusts reveal past atmospheric contamination from Nuclear Fuel Services plant

In this study, a sample was collected by vacuuming dust from an attic of a residence located within Erwin, located between 0.75 and 1.25 miles from the Nuclear Fuel Services (NFS) facility. The sample was processed by sieving with a "200 mesh" stainless steel sieve, in order to obtain material of smaller than ~ 75-micron particle size.

The sieved material was subjected to two types of chemical testing: i) the radioisotopes $^{239}$Pu and $^{240}$Pu were measured in two ~ one-gram samples of the sieved dust; and ii) total uranium concentrations and the isotope ratios $^{234}$U/$^{238}$U, $^{235}$U/$^{238}$U, and $^{236}$U/$^{238}$U were measured in three ~ 100 milligram samples of the sieved dust. Scientifically valid, legally defensible testing methods were used by the author, who has more than twenty years of experience in this subject matter, with an extensive record of relevant peer-reviewed scientific publications (e.g., search "Ketterer" and "plutonium" in scholar.google.com).

The results of the tests are as follows:

**Plutonium activity and isotope ratio results**

**Trial #1:** $^{239+240}$Pu activity = 4.91 +/- 0.14 Bq/kg $^{240}$Pu/$^{239}$Pu atom ratio = 0.140 +/- 0.007

**Trial #2:** $^{239+240}$Pu activity = 3.79 +/- 0.14 Bq/kg $^{240}$Pu/$^{239}$Pu atom ratio = 0.160 +/- 0.007

**Uranium concentration and isotope ratio results**

**Trial #1:** $^{234}$U/$^{238}$U = 0.000218 +/- 0.000010 $^{235}$U/$^{238}$U = 0.0217 +/- 0.0001
$^{236}$U/$^{238}$U = 0.000052 +/- 0.000003 Contains 3.6 +/- 0.1 micrograms U / gram dust

**Trial #2:** $^{234}$U/$^{238}$U = 0.000171 +/- 0.000004 $^{235}$U/$^{238}$U = 0.0180 +/- 0.0001
$^{236}$U/$^{238}$U = 0.000043 +/- 0.000002 Contains 4.3 +/- 0.1 micrograms U / gram dust

**Trial #3:** $^{234}$U/$^{238}$U = 0.000276 +/- 0.000004 $^{235}$U/$^{238}$U = 0.0278 +/- 0.0001
$^{236}$U/$^{238}$U = 0.000072 +/- 0.000002 Contains 4.1 +/- 0.1 micrograms U / gram dust

**Findings.** The key findings of this study are as follows:

1. Attic dust collected from the residence contains enriched uranium, defined herein as material exhibiting a $^{235}U/^{238}U$ ratio that systematically exceeds the natural value of 0.00725. Three independent preparations of the attic dust all revealed uranium isotope ratios disparate from Nature. In addition to exhibiting elevated $^{235}U/^{238}U$, $^{234}U/^{238}U$ atom ratios were also found to be elevated vs. the expected naturally occurring $^{234}U/^{238}U$ of 0.000055. An elevated $^{234}U/^{238}U$ is also consistent with the presence of enriched uranium in the dust.

2. The attic dust contains the isotope $^{236}U$, an isotope which is nearly exclusively of synthetic origin. Uranium-236 is well-known to be present in "recycled uranium" feed materials recovered from Pu production reactors. Previous work by the author has also identified the isotope $^{236}U$ in association with NFS-derived contamination found in offsite locations. The presence of the $^{236}U$ in the attic dust cannot be explained by any other sources besides the NFS facility.

3. It is beyond question, based on the enriched $^{235}U/^{238}U$ and $^{234}U/^{238}U$ signatures, the proximity of the residence to NFS, and the presence of $^{236}U$, that NFS is the responsible contamination source that explains why these uranium isotope signatures have been found in the Erwin attic dust sample.

4. The attic dust also exhibits an elevated concentration of total U; three independent preparations of the attic dust resulted in a U concentrations ranging from 3.6 to 4.3 micrograms per gram, which is slightly elevated in comparison to the ~ 3 micrograms per gram expected as an Earth crustal baseline U concentration. The presence of an elevated U concentration in a medium such as attic dust indicates that an airborne U source has to be contributing to the dust's composition. The NFS plant is the imputed, obvious source of these elevated total U concentrations; the dust contains a mixture of naturally occurring uranium, and enriched uranium specifically derived from NFS's atmospheric emissions.

5. The attic dust sample was also found to contain the isotopes $^{239}Pu$, and $^{240}Pu$. The $^{240}Pu/^{239}Pu$ atom ratios are systematically lower than expected for plutonium originating from global (stratospheric) fallout, which is known to a $^{240}Pu/^{239}Pu$ atom ratios of 0.180 +/- 0.014 (two standard deviations), as reported by Kelley *et al.* (1999) for northern Hemisphere mid-latitude weapons test fallout. These results indicate that the plutonium in the attic dust is comprised of a mixture of at least two sources, one of which is 1950's-1960's nuclear weapons testing fallout. However, the lower ratio points to a contribution from an additional Pu source, having lower $^{240}Pu/^{239}Pu$.

6. The Pu atom ratio results are consistent with the second plutonium source being from "mixed oxide" or MOX fuel fabrication activities, conducted at NFS during the Cold War era. Plutonium derived from NFS's MOX operations has previously been detected by this

author in sediments from the Erwin Linear Trail pond, exhibiting a $^{240}Pu/^{239}Pu$ of ~ 0.1. Accordingly, the NFS plant's previous MOX fuel operations are the probable second source of plutonium that is responsible for the systematically low $^{240}Pu/^{239}Pu$.

***7.*** The findings clearly indicate that the Erwin community has been affected by atmospheric contamination (fugitive dusts, aerosols) emanating from the NFS facility. This contamination has been slowly taking place and accumulating over decades of plant operation. A similar pattern of enriched uranium and MOX contamination can be expected in other Erwin residences. ***Additional studies should be conducted to more closely define the geographic pattern and extent of the NFS-originating uranium and plutonium contamination.***

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**Reference cited**

Kelley, J.M.; Bond, L.A.; Beasley, T.M., "Global Distribution of Pu Isotopes and $^{237}Np$", The Science of the Total Environment **1999**, 237/238, 483-500.