



Waste to Energy System

Determination for TENORM analysis

1 EXECUTIVE SUMMARY

Denver Zoo was asked to address the potential for generation of Technologically Enhanced Naturally Occurring Radioactive Materials (TENORM) in the ash byproduct from the Waste to Energy System. Based on our consideration of this potential, DZF was asked to determine if TENORM sampling analysis would be required for future waste determinations on the ash byproduct.

Provided below is a summary of DZF's technical review, supporting DZF determination to not include TENORM analysis as part of our ash sampling protocols.

2 TECHNICAL SUMMARY

DZF does not predict a potential to create TENORMs in our waste to energy system.

Naturally Occurring Radioactive Materials (NORMs) are ubiquitous in soil, rock, and soil latent fuel such as coal. Technology Enhanced Naturally Occurring Radioactive Material (TENORM) may occur as byproducts of particle accelerators, nuclear power plants, and as a result of processes that concentrate trace amounts of naturally occurring radionuclides, such as heavy elements belonging to the radioactive series headed by the three long-lived isotopes uranium-238, uranium-235, and thorium-232. Uranium is ubiquitous to soil in average concentrations of 3 – 4 ppm (for every millions pounds of soils, there is 3 – 4 pounds of uranium).

Coal will not be included in the Denver Zoo waste management fuel stream.

The production of ash is 6 – 18% according to tested and simulated calculations. At 430 lb/hr of fuel, the rate of ash production has a maximum potential to generate 130 lb/hr. About 45% of most soil is comprised of minerals. NORM's reside in the mineral portion of the soil. The conversion of minerals to ash is about 90%, making the overall conversion of soil to ash about 40.5% by mass. It would require more than 130 lb/hr of soil (>10 – 30% soil to fuel ratio) for the overall ash content to be above ubiquitous soil levels. The residual soil/sand attached to typical herbivore waste accounts for less than 4% by mass. Given the maximum portion of herbivore waste in the fuel stream at 30% (as a percentage described within "Mixture of biomass and operations waste" in EDOP table 11.23. (A-2)), the result of soil in the fuel stream is nearly 1.20%. The operational values of soil to fuel ratio is at least 20 times below that required to keep the NORM levels at their naturally occurring levels."



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Additionally, the definition of "TENORM" does not include: ...the natural radioactivity of rocks or soils..." (6CCR 1007-1). The fact is that DZF's Waste to Energy system will not be creating any NEW radioactive sources.

After further review of 6CCR 1007-1, DZF has determined it will not be contributing any radiation exposure (mrems) to individual members of the public beyond the annual background values established by the USEPA and NRC.

Additionally, DZF will not be handling any of the following terms defined in Section 1.2 (6CCR 1007-1, Part 01): "discrete sources", ore, TENORMs, "classified materials", "byproduct material", "source material", tailings, or "special nuclear material".

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