

EPA's "Cement and Concrete Containing Fly Ash; Guideline for Federal Procurement" as published in the Federal Register / Vol. 48, No. 20 / Friday, January 28, 1983 / Rules and Regulations:

Regarding hazards of using flyash in concrete:

"Findings to date indicate that little, if any, fly ash exhibits characteristics defined as hazardous in the Federal regulations. Therefore, Subtitle C regulations will have no significant impact of the use of fly ash in cement and concrete.

A few commenters suggested that EPA limit the use of fly ash in concrete, restricting its use in potable water sources or in storage areas for food. The rationale given for these suggestions was the potential for leaching of trace metal elements out of the fly ash. The commenters provided no documentation as to the likelihood or extent of leaching when fly ash is used in concrete.

While it is true that fly ash contains trace amounts of certain elements, which can be toxic in larger concentrations, it is unlikely that fly ash as used in concrete would exhibit leaching characteristics. First, the permeability of concrete containing fly ash is negligible compared to the permeability of fly ash as typically disposed. This reduced permeability prevents water or other liquids from penetrating concrete and providing a leaching medium through which contaminants could travel.

Second, when used in concrete, fly ash becomes an integral part of the final product. The surface area of individual fly ash particles, from which leaching of trace constituents takes place, is so greatly reduced in this application as to be almost nonexistent. It is not possible through conducting leaching tests or raw fly ash to estimate the leaching, if any, which would take place in a concrete containing fly ash. Thus, the commenters suggestion that dams and pipes not be constructed using fly ash appears to have no technical basis.

(c) Radioactivity Issues. At the same time as original proposal of the hazardous waste regulations (December 18, 1978), EPA issued an advance notice of proposed rulemaking that it was considering establishing 5 picocuries per gram [pCi/g] of radium-226 as a criterion for listing wastes as hazardous. The notice also requested comment on other criteria which might tend to affect the radiation hazard. Among these is the emanation rate of radon from the waste. The agency has, at this date, taken no further action on this proposed rulemaking to establish general criteria for hazardous radioactivity levels in wastes.

Where resource recovery is practiced, an important consideration in assessing the hazard is the proposed use of the waste material. While some proportion of fly ash generated in the U.S. has more than 5 pCi/g of radium-226, the physical structure of fly ash is such that its contribution to radiation exposure is probably less than that of most normal constituents of concrete which generally fall below this level. This is explained below.

A few commenters expressed concern to EPA that fly ash used in the construction of habitable structures could pose a threat to public health due to radioactivity. The source of the radiation threat is due to radium-226, a radioactive isotope which occurs naturally in soil, sand, and mineral deposits as well as in fly ash. The radium-226 content of soil generally ranges from .2 to 3 pCi/g. Limited measurements of radioactivity in cement show that the radium-226 content of cement can be as high as 5 pCi/g, but typically averages close to 1 pCi/g. Limited measurements of fly ash presently generated in the U.S. show a radium-226 content ranging from 1 to 8 pCi/g with an average of roughly 4 pCi/g.

There are two pathways of radiation exposure from radium-226 in building materials. The pathway of primary concern is from inhalation of radon-222 and its short-lived decay products. Radon-222, an inert gas with a radioactive half-life of 3.8 days, is the first generation decay product of radium-226. Because it is an inert gas, it can readily migrate from the building material into the indoor air of a home. Although the rate at which radon is created within a building material is proportional to its radium content, the intrinsic structure of the material may, in some cases, prevent most of the radon from escaping. When air containing radon and its radioactive decay products is breathed for long periods of time, a person's risk of lung cancer is increased.

Gamma radiation from radium-226 and its decay products is the other exposure pathway. The amount of gamma radiation emission from a building material is proportional to its radium content, but the total exposure a person receives will also depend on other factors such as shielding, distance from the material, and exposure time. Exposure to gamma radiation results in an increased risk of many types of cancer.

When fly ash is used as a partial cement replacement in concrete, the fly ash content of the final concrete product is between 2 and 3 percent (assuming a 15-25 percent cement replacement rate and an 8 to 1 ratio of aggregate and water to cementitious material). Since the average radium-226 content of fly ash exceeds that of cement by a few pCi/g, the use of fly ash as a cement replacement in habitable structures will, on the average, result in a slight increase in the gamma radiation exposure to people (less than a milliroentgen per year). However, in some instances, where fly ash with a lower than average radium content replaces a cement with a higher than average radium content, the result would be less gamma radiation exposure.

The use of fly ash as a cement replacement will also affect the quantity of radon emitted by the building material. Although the rate at which radon is created is directly proportional to the radium content, other factors may inhibit radon emanation from a material. Because fly ash is produced at high temperatures, it has a glassy structure which keeps most of the radon from escaping. The fraction of radon which escapes from fly ash (emanation fraction) has been measured at no more than a few percent. In contrast, typical soil and soil like materials tend to have an emanation fraction in the neighborhood of 20 percent. Thus, although fly ash on the average, has a greater radium content than the cement it replaces, the use of fly ash as a partial cement replacement is likely to reduce the radon gas contribution of the final concrete product.

During the proposal period for this guideline EPA has been investigating this issue more thoroughly. Tests recently conducted for EPA substantiate the conclusions above, i.e., that the radon emanation rate of fly ash in its raw state and as used in concrete is only a few percent compared to the absolute radium concentration. Thus, while fly ash use in cement would, on the average, result in a small increase in gamma radiation exposure, this small increase in gamma exposure is likely to be offset by a decreased radon exposure. In light of this, EPA believes that the use of typically-occurring fly ash in concrete does not constitute a significantly different radiation risk, than the risk from the cement it replaces, and neither of these is significantly different from the radiation risk posed by common soil."