

## Fact Sheet Attachment

### Technical Justification for the 0.4 pCi/gm Soil Concentration Increase Limit Associated with the Land Application of Water Treatment Residuals or Sewage Treatment Sludges Containing Naturally Occurring Radium Proposed in an Amendment to 32 IAC 330.40

The first step in determining the maximum allowable increase in radium soil concentration is to establish a maximum dose attributable to the land application of sludge or water treatment residuals containing radium. There are no existing exposure limits directly applicable to land applying water treatment residuals or sewage sludge. Existing regulations apply to the exposure associated with the licensed use of radioactive material, either during operation or post-closure leaving residual material on-site.

There must be a justification for exposing the public to radiation and those exposures must be kept as low as reasonable achievable. The ALARA principle is keeping exposure or dose to the public As Low As Reasonably Achievable. In the case of the land application of sewage sludge or water treatment residuals, the beneficial use relates to the agricultural nutrients present in the sludge or residuals. The radium is a contaminant for which there is no agricultural benefit.

The range of potential exposure has an upper bound of the public exposure limit of 100-mrem/yr annual effective dose from all manmade sources not including medical care.<sup>1</sup> In applying this dose limit, consideration of justification and ALARA must be made. In addition, if the dose is estimated to exceed 25 percent of this dose, a study must be completed to ensure that the public dose from all manmade sources will not exceed the regulatory limit.<sup>2</sup>

On the other end of the exposure spectrum is the negligible individual dose. This negligible dose of 1 mrem/yr represents a risk level that does not warrant any efforts to

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<sup>1</sup> The 100 mrem/yr limit can be found at 32 Ill. Adm. Code 340.310 and 10 CFR 20.1301.

<sup>2</sup> NCRP Statement No. 6, NCRP Report No. 116

reduce to a lower level.<sup>3</sup> In between these endpoints are several regulatory limits that are described below.

The NRC has issued guidance for decommissioning facilities that includes a dose of a “few millirems” per year from onsite disposal.<sup>4</sup> NRC defines a “few millirems” as 0 – 5 mrem/yr and does not include radon exposure. Since radium, the precursor to radon is included in the water treatment residuals and sewage sludge, any exposure limit considered as part of the Memorandum of Agreement between IEMA and IEPA must consider potential radon exposure.

The U.S. Environmental Protection Agency has established a 15-mrem per year effective dose equivalent exposure limit under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA).<sup>5</sup> This dose limit corresponds to an excess lifetime cancer risk of approximately  $3 \times 10^{-4}$  and includes exposure to radon. It does not include the dose due to the groundwater pathway which has a different dose limit of 4 mrem/yr.

An additional standard to consider is an allowable dose of 25 mrem/yr, which corresponds to the release of a site from the licensed use of radioactive material for unrestricted use.<sup>6</sup> This dose standard does not include radon. However, in the case where naturally occurring radionuclides are present, radon must be evaluated to determine its effects on the reasonable future use of the site where the licensed activities occurred.

Using the NRC’s “few millirems” as a basis, a dose limit of 2.5 mrem/yr (the mid-point of the 0 – 5 mrem/yr range) not including radon and a 10 mrem/yr including radon can be justified as appropriate for the land application of materials containing radium even though it may not be consistent with ALARA. Using the 2.5 mrem/yr radiation dose

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<sup>3</sup> IAEA Safety Series 89; IAEA-TECDOC-855 & NCRP #116

<sup>4</sup> NRC NUREG-1757, Rev. 2, pg. 15-32

<sup>5</sup> US EPA Office of Solid Waste and Emergency Response, OSWER No. 9200.4-18

<sup>6</sup> 32 Ill. Adm. Code 330.325, 10 CFR 20.1402

limit (not including radon) in RESRAD yields a residential exposure scenario single radionuclide soil guideline of 0.40 pCi/gm for Ra-226 and 0.48 pCi/gm for Ra-228. Since both radionuclides are present in the sewage sludge or water treatment residuals, the sum of the fractions rule must be applied. Assuming that Ra-226 and Ra-228 are present in equal proportions, the equation to calculate the total radium increase is:

$$\frac{0.5X}{0.40} + \frac{0.5X}{0.48} = 1,$$

where X = total additional radium in pCi/gm. Solving for X yields:

$$X = \frac{2(0.40)(0.48)}{(0.40 + 0.48)} = 0.4 \text{ pCi/gm}$$

Using the 0.4 pCi/gm increase as input to RESRAD to evaluate the dose when the radon pathway is considered yields a dose of 9.2 mrem/yr which is less than the 10 mrem/yr dose limit discussed above.

Using the 10 mrem/yr dose limit including radon in RESRAD yields a residential exposure scenario single radionuclide soil guideline of 0.24 pCi/gm for Ra-226 and 1.87 pCi/gm for Ra-228. Using the sum of the fractions rule, the equation to calculate the total radium increase is:

$$\frac{0.5X}{0.24} + \frac{0.5X}{1.87} = 1,$$

where X = total additional radium in pCi/gm. Solving for X yields:

$$X = \frac{2(0.24)(1.87)}{(0.24 + 1.87)} = 0.4 \text{ pCi/gm}$$

Achieving the same resultant allowable increase in total radium soil concentration using both dose limits reinforces the appropriateness of the concentration increase limit of 0.4 pCi/gm.

## Recommendations

Based on the varying factors inherent in the field application process of water treatment residuals and sewage sludge such as application methods, radium concentrations, application rates, application intervals for an individual field and the uncertainty of future land use or use of the amended soil, a 2.5 mrem/yr dose above background standard not including radon or a 10 mrem/yr dose above background including radon is recommended. This limit results in a total radium soil concentration increase limit of 0.4 pCi/gm and is a 300% increase over the 0.1 pCi/gm limit in the current Memorandum of Agreement. The 2.5 mrem/yr dose (not including radon) is within the range of NRC's "few millirems". The 10mrem/yr dose including radon recommendation is one-tenth of the public dose limit of 100 mrem/yr used in radiation safety regulations and is a practical choice when comparing the apparent benefits and cost effectiveness of sludge disposal options for the treatment plant operators. These dose limits also assures that residuals applied over the long term do not result in creating de facto disposal sites that could require future cleanup or remediation. In addition, no restrictions on the use of removed topsoil would be required. The allowable increase falls within the range of natural variation of background radium concentrations. Compliance could be demonstrated through calculations given the conservativeness of model parameters used. No field sampling would be necessary.