Proceedings of the 19th International Symposium on the Packaging and Transportation of Radioactive Materials
PATRAM 2019
August 4-9, 2019, New Orleans, LA, USA

Issues in Applying Transport Exemption Levels to NORM

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ABSTRACT

The International Atomic Energy Agency (IAEA) and U.S. Department of Transportation (DOT) regulations for the transport of radioactive material do not apply to "natural material and ores containing naturally occurring radionuclides" whose activity concentrations do not exceed 10 times the otherwise applicable exempt material activity concentration limits. Several issues have been noted on how to apply this exemption to various materials. Some have interpreted this to apply to all material with naturally occurring radionuclides; applying it to materials such as water from fracking operations, drilling mud, and water treatment media. However, the transport regulations do not include the terms Naturally Occurring Radioactive Material (NORM) or Technologically Enhanced Naturally Occurring Radioactive Material (TENORM) so it is not a matter of simply applying the increased exemption levels to anything that contains natural occurring radionuclides. This paper will provide a background on the basis for the IAEA and DOT regulations on the increased exemption levels for natural material and ores containing naturally occurring radionuclides. A summary of interpretations of the applicability of the exemptions to various materials will be provided.

INTRODUCTION

The International Atomic Energy Agency (IAEA) and U.S. Department of Transportation (DOT) regulations for the transport of radioactive material do not apply to "natural material and ores containing naturally occurring radionuclides" whose activity concentrations do not exceed 10 times the otherwise applicable exempt material activity concentration limits. Several issues have been noted on how to apply this exemption to various materials. The transport regulations do not include the terms Naturally Occurring Radioactive Material (NORM) or Technologically Enhanced Naturally Occurring Radioactive Material (TENORM) and it is not a matter of simply applying the increased exemption levels to anything that contains natural occurring radionuclides.

REGULATIONS

Paragraph 107 of the IAEA Regulations [(1)] states, "These Regulations do not apply to any of the following: … (f) Natural material and ores containing naturally occurring radionuclides, which may have been processed, provided the activity concentration of the material does not exceed 10 times the values specified in Table 2, or calculated in accordance with paras 403(a) and 404–407. For natural materials and ores containing naturally occurring radionuclides that are not in secular equilibrium the calculation of the activity concentration shall be performed in accordance with para. 405."

Three conditions need be present for this exemption to apply; (1) the material is natural material or ore, (2) it contains only naturally occurring radionuclides, and (3) does not exceed 10 times the Table 2 exemption values. The previous editions of the IAEA regulations also included the condition that the material be, "either in their natural state, or have only been processed for purposes other than for extraction of the radionuclides, and which are not intended to be processed for use of these radionuclides". As stated in the IAEA advisory material [(2)], "Following the conclusion of the IAEA Coordinated Research Project (CRP) on Regulatory Control for the Safe Transport of Naturally Occurring Radioactive Material (NORM), it was agreed that this exclusion does not depend on the prior or intended use of the material, i.e. whether it is to be used for its radioactive, fissile or fertile nuclides or not." However, the U.S. Department of Transportation Regulations in 49 CFR §173.401 still retains the prior IAEA restriction on intended use.

The IAEA advisory material [(2)] paragraph 107.4 notes that, "For ores and other natural or processed materials containing natural occurring radionuclides of the uranium–radium and/or thorium decay chain, the basic nuclide values for exempt activity concentration as given in Table 2 for U(nat) and Th(nat) can only be used if the radionuclides are in secular equilibrium. If this is not the case, this means that owing to processing activities such as chemical leaching or thermal treatment, the natural radioactive equilibrium state does not exist and the formula for mixtures of radionuclides according to para. 405 has to be applied to calculate the exempt activity concentration." It gives the example of "scale" that deposits on crude oil and gas pipelines in the form of barium sulphate where the parent nuclides do not appear and so the deposits are not in secular equilibrium.

The IAEA coordinated research report in NORM [(3)] noted that, "A wide range of materials from NORM industries were reviewed in the studies, including tantalite and tin slag, phosphate, potash, zirconium (zircon sands) and other materials for the ceramics industries, scales from oil and gas extraction industries, coal and coal ash, residues from waterworks, wastes from rare earths extraction, ore and waste material from uranium mines." However, the regulations do not spell out how they apply to those materials.

The basis for the IAEA adoption of the 10 times levels is not well documented, however it was driven by concerns from industries involved with the mining of raw materials that contain natural

radionuclides. As to what types of materials that might be of concern, an IAEA report [4] notes that, "The following industry sectors have been identified, roughly in descending order of priority, as being the most likely to require some form of regulatory consideration:

(1) Extraction of rare earth elements;
(2) Production and use of thorium and its compounds;
(3) Production of niobium and ferro-niobium;
(4) Mining of ores other than uranium ore;
(5) Production of oil and gas;
(6) Manufacture of titanium dioxide pigments;
(7) The phosphate industry;
(8) The zircon and zirconia industries;
(9) Production of tin, copper, aluminum, zinc, lead, and iron and steel;
(10) Combustion of coal;
(11) Water treatment.

However, the regulations do not specify the materials from these activities which are eligible for the higher exemption levels.

In the 2004 rulemaking for the U.S. regulations [5], the background stated, "Examples of such materials are cement, coal, fertilizers, non-radioactive metals, gypsum, residues from mining and smelting processes, etc. In general these materials present a very low radiological hazard." The notice of proposed rulemaking stated, "Certain of these radionuclides, such as natural uranium and natural thorium, are widespread in nature and found in almost all ores, such as coal, phosphate, gypsum, or a large variety of metals or other minerals. Application of the new exemption values to the radioactive material in these ores would result in bringing under the scope of the regulations enormous amounts of material that have until now not been subject to those regulations, and whose specific activity level presents a very low hazard." However, as in the IAEA regulations, the particular materials are not listed in the regulation itself.

Absent any regulatory definition of "natural material and ores", one can look for standard definitions for the terms. Wikipedia says that "A natural material is any product or physical matter that comes from plants, animals, or the ground. Minerals and the metals that can be extracted from them (without further modification) are also considered to belong into this category. Natural materials are used as building materials and clothing. Types include:

- Biotic materials
  - Wood (rattan, bamboo, bark, etc.)
  - Natural fiber (silk, wool, cotton, flax, hemp, jute, kapok, kenaf, moss, etc.)
- Inorganic material
  - Stone (flint, granite, obsidian, sandstone, sand, gems, glass, etc.)
  - Native metal (copper, iron, gold, silver, etc.)

    - Composites (clay, plasticine, etc.)
- Other natural materials.
    - Soil”

Wikipedia’s ore definition is, “An ore is an occurrence of rock or sediment that contains sufficient minerals with economically important elements, typically metals, that can be economically extracted from the deposit. The ores are extracted from the earth through mining; they are then refined (often via smelting) to extract the valuable element, or elements.” How much refining or processing can be done before you have a product that is no longer a natural material? The regulations apply to natural materials that may have been processed, but is there a limit to the amount of processing?

LETTERS OF INTERPRETATION

In the United States, DOT’s Pipeline and Hazardous Materials Safety Administration (PHMSA), Office of Hazardous Materials Safety (OHMS) provides written clarifications of the Hazardous Materials Regulations (HMR; 49 CFR Parts 100-185) in the form of interpretation letters. These letters reflect the agency's current application of the HMR to the specific facts presented by the person requesting the clarification. There have been several requests to provide clarification on the exception for natural material and ores.

In 2006 [(6)], PHMSA was asked, “Does the exception for "natural materials" in§ 173.401(b)(4) include naturally occurring zeolite water treatment medium that have absorbed naturally occurring radionuclides from public drinking water supplies and are intended to be managed as waste?”. The interpretation letter’s response is, “The answer is no. The term "natural materials" in§ 173.401(b)(4) means materials and radionuclides existing in nature, not those produced by humans. Radionuclides addressed by § 173.401 (b)(4) do not include those contained in filters used in removal of radionuclides from drinking water, produced in nuclear reactors, or by other technological means. In the scenario described in your letter, the naturally occurring radionuclides in public drinking water supplies are absorbed onto zeolite medium through a water treatment process. Therefore, these radionuclides, while naturally occurring in the pre-treatment drinking water, are not naturally occurring in the zeolite medium since they are transferred from another medium (i.e., the water). If the zeolite medium contains naturally occurring radionuclides prior to its use as a filtering medium, the exception in§ l 73.401(b)(4) is applicable. However, after the drinking water is processed through the zeolite medium and additional radionuclides are absorbed, § 173.401(b)(4) does not apply.” The zeolite water treatment medium after use is not a material that would be found in a natural state.

In 2010 [(7)] the 2006 interpretation was challenged and the submitter said, “PHMSA' s conclusion is apparently based on a belief that transferring naturally occurring radionuclides from a medium where they are found in nature to another natural medium where they are not causes the radionuclides to lose their "naturalness" and become equivalent to radionuclides "produced in nuclear reactors or by other technological means." The submitter also referenced two other

letters of interpretation in his argument. The interpretation letter's response is, "As your request does not involve "natural material" (due to the man-made processing involved) or "ores containing naturally occurring radionuclides" our previous response to you is not inconsistent with the other letters you reference." The DOT position was not that the nuclides were not naturally occurring, but they were not found naturally found in the zeolite.

In 2013 [8], DOT was asked if the exception for natural material and ores applies to the waste material generated in an industrial process that contains Radium-226 and -228 in the form of a solidified sludge from a fracking water collection pit or a filter cake from treatment and recycling of fracking water. The response stated, "The answer is no. The exception does not apply to the NORM-containing waste material generated from the industrial process you describe in your letter. Moreover, the waste material you describe is no longer considered "natural material" because of the industrial processing. The term "natural material" in § 173.401 (b)(4) means material existing in a form as it would otherwise in nature, not in a form manipulated by human application. The fracking water is not a natural material nor is the radionuclide-containing solidified sludge from the fracking water collection pit or the radionuclide-containing filter cake from treatment and recycling of the fracking water. One state reported that 25% of the fracking sludges they were seeing were above the exemption levels and would thus be regulated.

In a 2014 interpretation request [9], it was noted that DOT had modified the regulations at 173.401(b)(4) to state: "Natural material and ores containing naturally occurring radionuclides which are either in their natural state, or which have only been processed for purposes other than for extraction of the radionuclides, and which are not intended to be processed for the use of these radionuclides, provided the activity concentration of the material does not exceed 10 times the exempt material activity concentration values specified in § 173.436, or determined in accordance with the requirements of § 173.433." The questioner asked if TENORM from flowback and produced water wastes associated with unconventional well drilling would now be eligible for the 10 time limits since they were products of processing. DOT's response was that these were still not considered to be natural material or ore.

A 2017 interpretation request [10] asked **i**f drilling mud would be exempt from the HMR under the Naturally Occurring Radioactive Materials (NORM) exception in§ 173.401. The answer was no; drilling mud was not defined in the request letter.

For those materials which are not eligible for the higher exemption levels and which are regulated, many could be shipped in excepted packages, as LSA-I material in IP-1 packages, or as unpackage. While the requirements for the shipment of such packages are not extensive, shippers would need to have appropriate training and are concerned about potential denial of shipments by carriers.

CONCLUSIONS

Clearly, there is a desire in the regulated community to apply the higher exemption levels to a broader scope of materials than DOT has adopted in these interpretations. The DOT position has been that for the 10 times exemption levels to apply, the material in question should be something that would be found in a natural state, although some limited processing may have been done to it. A clearer understanding of which materials are appropriate for the application of the 10 times exemption levels is needed to avoid confusion and misapplication of the regulations.

REFERENCES

(1) International Atomic Energy Agency, "Regulations for the Safe Transport of Radioactive Material," *IAEA Safety Standards for Protecting People and the Environment, Specific Safety Requirements*, SSR-6 (2012 Edition)

(2) International Atomic Energy Agency, "Advisory Material for the IAEA Regulations for the Safe Transport of Radioactive Material (2012 Edition) Specific Safety Guide No. SSG-26"

(3) International Atomic Energy Agency, "Regulatory Control for the Safe Transport of Naturally Occurring Radioactive Material (NORM), Report of a Coordinated Research Project, 2007–2010" (IAEA-TECDOC-1728)

(4) International Atomic Energy Agency, "Assessing the Need for Radiation Protection Measures in Work Involving Minerals and Raw Materials", IAEA Safety Reports Series No. 49, 2006.

(5) U.S. Department of Transportation Docket No. RSPA–99–6283 (HM–230), Federal Register Vol. 69, No. 16, 1/26/2004.

(6) U.S. Department of Transportation Letter of Interpretation 06-0003, https://www.phmsa.dot.gov/regulations/title49/interp/06-0003

(7) U.S. Department of Transportation Letter of Interpretation 10-0106, https://www.phmsa.dot.gov/regulations/title49/interp/10-0106

(8) U.S. Department of Transportation Letter of Interpretation 13-0157, https://www.phmsa.dot.gov/regulations/title49/interp/13-0157

(9) U.S. Department of Transportation Letter of Interpretation 14-0159, https://www.phmsa.dot.gov/regulations/title49/interp/14-0159-

(10) U.S. Department of Transportation Letter of Interpretation 17-0114, https://www.phmsa.dot.gov/regulations/title49/interp/17-0114