RADIATION PROTECTION AND THE NATURALLY OCCURRING RADIOACTIVE MATERIALS (NORM)

Anselmo S. Paschoa[1] and Peter MacDowell[2]
[1] Pontificia Universidade Católica do Rio de Janeiro (PUC-Rio)
Departamento de Física, C.P. 38071, Rio de Janeiro, RJ 22452-970, Brazil
[2] St. Helen's Trading, Ltd, P.O. Box 911, Azusa, CA 91702-911, U.S.A

There are many industries dealing with naturally occurring radioactive materials (NORM), some of them without knowing that their industrial processes and/or their regular wastes involve radioactivity. However, an increasing number of industries that produce NORM wastes are being sued, wherever there is a legal framework to do so. In particular, NORM wastes produced for a long time by the oil industry became foci of legal battles in the United States and elsewhere. The ripple effect of these judicial battles will influence the decision making processes of NORM wastes producing industries, mostly because of the costs incurred by remedial and preventive actions concerning NORM contamination. The regulation of NORM will occur sooner or later, and such actions may become mandatory. A foreseeable consequence of such regulation is a change in attitude concerning the sources and materials associated with NORM. Among those industries likely to be affected one can mention: niobium; rare earth processing; oil production; phosphate; uranium mining and milling; zircon; water treatment; and waste water treatment. The paper will briefly review data on exempt concentration activities, as suggested by the Basic Safety Standards based on realistic environmental and dosimetric models. These activity concentrations are compared with those found in a number of extractive industries, and may be used to establish derived limits from a pre-established dose limit.

INTRODUCTION

When one reads sections 1.4 (14) and (15) of the 1990 Recommendations of the International Commission on Radiological Protection, better known as ICRP Publication 60 (1), one can reasonably interpret that, according with the ICRP, the main goal of radiation protection is to protect human beings from unnecessary exposure by establishing standard of protection which takes into proper account the beneficial aspects of the practices leading to radiation exposure. In addition, there is concern with the environment to the extent that transfer of radionuclides through environmental compartments may affect the radiological protection of humans. In so being, the practices leading to releases of naturally occurring radioactive materias (NORM) into the environment can be easily justifiable, by and large, from the view point of taking into proper account the beneficial aspects of most such practices. However, because one needs to be concerned with the environment in which NORM releases may affect the radiological protection of humans, one cannot just ignore such releases.

A number of well respected international organizations — the Food and Agriculture Organization (FAO), the International Atomic Energy Agency (IAEA), the International Labour Organization (ILO), the Nuclear Energy Agency of the Organization for Economic Co-operation and Development (OECD/NEA), the Pan American Health Organization (PAHO) and the World Health Organization (WHO) — recently sponsored the International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources (BSS) (2). The BSS was approved by the IAEA's Board of Governors in 1994. The NORM issue was not specifically contemplated in the BSS, however, exempt activity concentrations and exempt activities of radionuclides were established based on the following general principles (2,3):

"(a) the *radiation risks* to individuals caused by the *exempted practice* or *source* be sufficiently low as to be of no regulatory concern;

(b) the collective radiological impact of the *exempted practice* or *source* be sufficiently low as not to warrant regulatory control under the prevailing circumstances; and

(c) the *exempted practices* and *sources* be inherently safe, with no appreciable likelihood of scenarios that could lead to a failure to meet the criteria in (a) and (b)."

Table 1 lists the exempt activitiy concentrations established in the BSS for ^{222}Rn (plus ^{218}Po, ^{214}Pb, ^{214}Bi, ^{214}Po), ^{224}Ra (plus ^{220}Rn, ^{216}Po, ^{212}Pb, ^{208}Tl -36%-, ^{212}Po -64%), ^{226}Ra (plus ^{222}Rn, ^{218}Po, ^{214}Pb, ^{214}Bi, ^{214}Po, ^{210}Pb, ^{210}Po, ^{210}Pb), ^{228}Ra (plus ^{228}Ac), ^{228}Th (plus ^{224}Ra, ^{220}Rn, ^{216}Po, ^{212}Pb, ^{208}Tl - 36%-, ^{212}Po -64%), Th-nat (including ^{232}Th and progeny), ^{230}U (plus ^{226}Ra, ^{222}Rn, ^{218}Po, ^{214}Po), and U-nat (including the ^{238}U progeny), which are the most relevant radionuclides in the case of NORM releases, and activity concentrations found in some selected extractive industries..

Table 1. Exempt activity concentrations for the most relevant radionuclides (plus their progeny) in the case of NORM releases, as established in the Basic Safety Standards and activity concentrations found in selected extractive industries.

RADIONUCLIDE	ACTIVITY CONCENTRATION (kBq/kg)	
	Exempt (3)*	Extractive industries
Rn-222	10	
Ra-224	10	
Ra-226	10	2.7 (zircon sand - 4) — 658 (radioactive scale - 5)
Ra-228	10	368 (radioactive scale - 6)
Th-228	1	1.1 (zircon sand - 4) — 200 (radioactive scale - 6)
Th-natural	1	0.7 — 111(zircon sand - 4,7)
U-230	10	
U-natural	1	3 — 30 (zircon sand - 4,7)

*Reference numbers are within parenthesis.

EXTRACTIVE INDUSTRIES

As an anticipated consequence of the 1991 ICRP recommendations (1) and the adoption by national authorities of any one version of the rules suggested in the BSS (2) , many extractive industries will have to adjust their practices to more stringent limits to take care of NORM releases and the exposure of individuals in the workplace. The heavy fraction of rutile, ilmenite, zircon or monazite rich mineral sands usually have high ^{232}Th and ^{238}U, resulting not only in exposure of individuals in the workplace, but also in NORM releases.

The radioactive scales in oilfield tubulars can be considered unwanted byproducts of some operations in the petroleum industry. The concentration levels found in some radioactive scales can be much higher than the exempt activity concentrations listed in Table 1. As an example, ^{226}Ra and ^{228}Ra activity concentrations as high as 1×10^3 kBq/kg have been reported in the literature (5,6,8,9). Inhalation of ^{222}Rn and ^{220}Rn plus exposure to other alpha emitting natural radionuclides occur in

workplaces of the petroleum industries, as well as discharge into the environment of huge amounts of NORM wastes.

The phosphate fertilizer industry is another example of industry that produce NORM with enriched levels of ^{238}U and ^{226}Ra (10,11). Exposure of individuals in the workplace and environmental effects due to NORM occur also in the phosphate fertilizer industry.

There are many other industries that produce NORM wastes and expose individuals in the workplace. In some cases the exposed individuals and their managers are unaware of NORM . Radiation protection needs to be urgently implemented in such places. Because litigation tends sometimes to precede regulation strict liability claims concerning NORM have been on trial in the United States

CONCLUSIONS

1. The BSS does not contemplate the NORM issue directly, but can be used as a guidance for establishing rules to be adopted at national and international levels.
2. Individual exposure in the workplace and environmental effects resulting from NORM should be taken into proper account by the international radiation protection community.
3. The license of an extractive industry containing NORM should contain radiation protection and radioactive waste management plans to be approved based on well established rules adopted by the competent national authority.

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