Impact of ARPANS-like legislation on minerals industry in Australia – the TENORM issue

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Abstract

Processing of minerals results in increased concentrations of naturally occurring radioactive materials (NORM) in mineral products and/or process wastes, relative to those in the source materials. Due to the current legislative trends this technologically enhanced naturally occurring radioactive material (TENORM) phenomenon may bring mineral processing practices, including disposal of NORM-elevated wastes, into the realm of regulatory concern for practically all mineral-processing operations in Australia.

The 1999 Australian Radiation Protection and Nuclear Safety (ARPANS) legislation has been based on the 1996 International Basic Safety Standards (BSS) recommended by the International Atomic Energy Agency (IAEA). As such, it contains very restrictive exemption criteria from the provisions of the legislation.

ARPANS legislation is binding upon the Commonwealth entities only, which incidentally, do not include minerals industry operations. The legislation has been incompatible with the nature of the minerals industry. However, the legislative developments already in place have been aimed at imposing this legislation onto states. If this happens, and the current ARPANS legislative exemption criteria are not rationalised, major radiation safety-related impacts on the Australian minerals industry will occur. They will result in a marked burden to the national economy for yet to be clearly identified health and safety benefits.

It is thus recommended that, without compromising rational radiation protection principles and practices a revised legislation commensurate with the nature of the minerals industry operations, national and state circumstances, conditions and interests be adopted by the states. Only such legislation would follow the spirit of the IAEA 1996 recommendations.

Introduction

In February 1999 the Commonwealth Government has proclaimed the Australian Radiation Protection and Nuclear Safety Act 1998 (1). Its aim has been to regulate activities involving both ionising and non-ionising radiation. The Act has adopted the ionising radiation protection standards described in the publication of the International Atomic Energy Agency (IAEA) "International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources" (BSS) published in 1996 (2). The BSS, in turn, encompass the radiation protection philosophy recommended by the International Commission on Radiological Protection (ICRP) in their Publication No. 60 (3). Respective Regulations under the Act were issued in March 1999 (4).

The Act is binding only the Commonwealth bodies. However, a combined Federal/States National Reference Group for Introduction of a Uniform National Framework for Radiation Protection and Control has been created. Its aim is to facilitate a uniform transfer of the ARPANS legislation into all state/territory legislations. A National Radiation Protection Directory, intended to provide nationally uniform radiation protection requirements is being currently developed.

What are NORM and TENORM?

Virtually all matter, including minerals, contain naturally occurring radioactive materials (NORM). During processing of minerals changes in concentrations of their components do occur. This also leads to an increase in NORM concentrations in mineral products and/or product wastes. Such phenomenon has been called Technologically Enhanced Naturally Occurring Radioactive Materials (TENORM).

The TENORM phenomenon could result in increased radiation exposures to workers, members of the public and the natural environment. Such exposures may bring the issue of workplace conditions and work practices, including mineral processing and disposal of NORM-elevated wastes, into the realm of regulatory concern.

What makes the TENORM issue so important now?

In the past several years a strong trend has developed to extend radiation protection regulations to cover the impact of NORM, and therefore TENORM. This development has been facilitated by gradually more restrictive international radiation protection standards being recommended by the ICRP and the IAEA.

The importance of the latest IAEA standards, reflected in the ARPANS legislation, lie in the fact that the exemption criteria from those standards are very restrictive. Therefore, many industries and industrial practices are likely to become, for the first time ever, subjected to the provisions of radiation protection legislation. Consequently, notification, registration, licensing, occupational and environmental monitoring, statutory radiation safety reporting, the need to appoint radiation safety staff etc. would be required. This would not only constitute a major "culture shock" but would result in ongoing financial and logistic burden to the affected operations. In extreme cases this could also spell an end to some operators. The corresponding demand on increased radiation protection regulatory control would also be required.

Who would be affected?

The industries which would be affected by the current ARPANS-style legislation include among other power production from coal, phosphate ore processing, oil and gas production, metal smelting, processing of copper, bauxite, tin, tantalum, niobium ores, production of building materials, titanium pigment production, zircon processing and so on. The impact would not be limited to the technological aspect of the issue. It could include litigation that, in turn, would generate disputes between insurers and policyholders over whether standard liability policies provide coverage for claims of property damage or bodily injuries from exposures to TENORM-s (5).

How do ARPANS exemption criteria translate into practice?

Regulations 6 and 38 contain clauses that are relevant to the minerals industry. They spell out the conditions that define, respectively, the so-called "Prescribed radiation facility" and "Prescribed dealings (source licence)". Any facility or dealing classified as such is subject to the provisions of radiation protection legislation (notification, registration, licensing, occupational and environmental monitoring, statutory radiation safety reporting, the need to appoint radiation safety staff, etc.)

A source or a practice may be exempt if it fulfils conservative criteria spelled out in the ARPANS Regulations. The latter mirror the exemption criteria recommended in the IAEA's BSS. The criteria refer to the limitation of both, the radiation doses to individual members of the public and the collective doses to the population[1]. For reasons of regulatory expediency those criteria have been translated into two sets of numerical exemption levels for over 300 different radionuclides, including NORM-s. For each individual radionuclide the exemption levels specify both, the maximum exempt *Activity Concentration* (in Bq/g) and the maximum exempt total *Activity* (in Bq) of that isotope in a given source material.

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1 From IAEA BSS 1996, "Schedule I – Exemptions":

- the resulting dose to an individual member of the public does not exceed 10 μSv/y (microsieverts per year), and
- collective dose to exposed population (including workers) does not exceed 1 manSv

Table 1 illustrates an impact of the ARPANS Regulations on a number of industries which, historically, have been perceived as “non-nuclear industries”. One should note that in case of handling unsealed sources (the situation typical for the minerals industry operations) under the Regulation 6 the numerical values of the exempt Activity levels have been relaxed by a factor of 10^6 (one million) relative to the BSS exempt Activity levels. Therefore, under that Regulation the values of the “Maximum exempt mass of the material” have, correspondingly, increased by the same factor.

Despite the latter, the data in Table 1 demonstrate that even if material would comply with the activity concentration criterion, it would be unlikely to comply with the total activity criterion due to the sheer volumes of materials typically handled by the minerals industry. The maximum exempt mass would be of the order of 100 tons for some waste from petroleum & gas production and tin smelting, and for phosphate rock as well as most mineral sands products. It would be between few thousand and few tens of thousands of tons for certain coal power production waste, bauxite ore, iron/steel and copper processing waste. Furthermore, it would be of the order of few hundred thousand tons for coal and for building materials based on mineral by-product feedstock.

Conclusions and recommendations

Under the ARPANS-like legislative scenario, the minerals industry would, almost universally, become subject to the provisions of radiation protection legislation. Such incompatible with the nature of the minerals industry legislation would impose a marked burden on the national economy for yet to be clearly identified occupational health and radiation safety benefits. Consequently the States, being the direct regulator of the minerals industry, should not be adopting the ARPANS-like legislation *verbatim.*

Without compromising rational radiation protection principles and practices, the state radiation protection legislation should contain provisions for exemptions that are commensurate with the nature of the processes and the impacts typical for the minerals industry. Therefore, a judicious assessment of the suitability of the ARPANS-like exemption criteria for the minerals industry should take place. This is especially important in the light of the already commenced reappraisal of the current ICRP Recommendations (6), which form the philosophical basis of the IAEA’s BSS, hence of the ARPANS legislation itself.

It is thus recommended that, without compromising rational radiation protection principles and practices a revised legislation commensurate with the nature of the minerals industry operations, national and state circumstances, conditions and interests be adopted by the states. Only such legislation would follow the spirit of the IAEA 1996 Recommendations.

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TABLE 1 Examples of the impact of ARPANS exemption criteria on the minerals industry

Material	Activity Concentration (Bq/g)	Exempt activity Concentration (Bq/g)	Exempt Activity (Bq)	Maximum exempt mass of the material (x 1000 t)
BAUXITE ORE PROCESSING (7),(8)				
Bauxite ore	Th-nat 0.4 – **2.3** U -nat 0.2 – 0.7	1 1	10^9 10^9	**0.4 – 2.5** **1.4 - 5**
Sand (waste)	Th-nat 0.4 – **2.4** U -nat 0.1 – 0.5	1 1	10^9 10^9	**0.4 – 2.5** **2 - 10**
Mud (waste)	Th-nat 0.4 – **6.2** U -nat 0.4 – **1.4**	1 1	10^9 10^9	**0.2 – 2.5** **0.7 – 2.5**
BUILDING MATERIALS PRODUCTION (9)				
Natural feedstock	Ra-226 0.02 – 0.1 Th-nat 0.02 – 0.2	10 1	10^{10} 10^9	**100 – 500**
By-product/waste feedstock	Ra-226 0.1 – 1.5 Th-nat 0.04 – 0.2	10 1	10^{10} 10^9	**6.6 – 100** **5 - 25**
Building materials	Ra-226 0.02 – 0.5 Th-nat 0.02 – 0.12	10 1	10^{10} 10^9	**20 – 500** **8 - 50**
COPPER PRODUCTION (9)				
Slag	Ra-226 0.8 – 1.5 Pb-210 0.4 – 1 Po-210 0.4 – 1 Th-232 0.05	10 10 10 1 (?)	10^{10} 10^{10} 10^{10} 10^9 (?)	**6.6 – 12.5** **10 – 25** **10 – 25** **20 (?)**
Sludge	Ra-226 1.1 Pb-210/Po-210 **27** Th-232 0.02	10 10 1 (?)	10^{10} 10^{10} 10^9 (?)	**9.1** **0.4** **50**
Roast product	Ra-226 0.3 Pb-210/Po-210 **21**	10 10	10^{10} 10^{10}	**33** **0.5**
METAL SMELTING (9) **Tin smelting**				
Slag	Pb-210/Po-210 **10**	10	10^{10}	**1**
Fumes	Po-210 **200**	10	10^{10}	**0.05**
Bismuth metal	Po-210 **100**	10	10^{10}	**0.1**
Special alloys	Pb-210/Po-210 **~ 10**	10	10^{10}	**~1**
Tellurium dross	Po-210 **20**	10	10^{10}	**0.5**
Iron/steel production				
Slag	Th-232 0.15 U –238 0.15	1 (?) 1	10^9 (?) 10^9	**6 (?)** **6**
Sludge	Pb-210 **30 – 100**	10	10^{10}	**0.1 – 0.3**
Coal tar	Pb-210 0.1 Po-210 0.3	10 10	10^{10} 10^{10}	**100** **30**
Dust scales	Pb-210/Po-210 **~ 200**	10	10^{10}	**~0.05**
Dust	Pb-210 **10** Po-210 5	10 10	10^{10} 10^{10}	**1** **2**
Niobium steel production				
Slag	Th-232 **80** U-238 **10**	1 (?) 1	10^9 (?) 10^9	**0.01 (?)** **0.1**

MINERAL SANDS (10)					
Min sands ore	Th-nat	0.04 - 0.12	1	10^9	**8 - 25**
	U -nat	0.08	1	10^9	**12.5**
HMC	Th-nat	0.6 - 0.8	1	10^9	**1.25 - 1.6**
	U -nat	<0.25	1	10^9	**4**
Ilmenite	Th-nat	0.4 - **4**	1	10^9	**0.25 - 2.5**
	U -nat	<0.25 - 0.8	1	10^9	**1.25 - 4**
Leucoxene	Th-nat	0.6 - **6**	1	10^9	**0.17 - 1.6**
	U -nat	0.5 - **1.3**	1	10^9	**0.75 - 2**
Rutile (SR)	Th-nat	< 0.4 - **3**	1	10^9	**0.3 - 2.5**
	U -nat	<0.25- 0.5	1	10^9	**2 - 4**
Zircon	Th-nat	**1.2 - 2**	1	10^9	**0.5 - 0.8**
	U -nat	**3.5 - 8**	1	10^9	**0.13 - 0.3**
OIL & GAS PRODUCTION (9)					
Scale (waste)	Ra-228	**100**	10	10^{11}	**1**
	Ra-224	**100**	10	10^{11}	**1**
	Th-228	**100**	1	10^{10}	**0.1**
	Ra-226	**200**	10	10^{10}	**0.05**
	Pb-210	**50**	10	10^{10}	**0.2**
	Po-210	**50**	10	10^{10}	**0.2**
PHOSPHATE ORE PROCESSING (9), (11)					
Phosphate rock	Th-nat	0.01 – 0.5	1	10^9	**2 – 100**
	U –nat	0.1 – **10**	1	10^9	**0.1 – 10**
	Ra-226	0.03 – 4.8	10	10^{10}	**2 - 333**
Phosphate fertiliser	U-238	4	10	10^{10}	**2.5**
	Ra-226	1	10	10^{10}	**10**
POWER PRODUCTION FROM COAL (9)					
Coal	Th-nat	0.002 – 0.5	1	10^9	**2 – 500**
	U -nat	0.002 – 1.1	1	10^9	**1 - 500**
Fly-ash	U-238	0.2	10	10^{10}	**50**
	Pb-210	2.4	10	10^{10}	**4.1**
	Po-210	4	10	10^{10}	**2.5**
TITANIUM PIGMENT PRODUCTION (10)					
Residue slurry (waste)	Th-nat	**2.5**	1	10^9	**0.4**
	U -nat	0.75	1	10^9	**1.3**
Filter cake (waste)	Th-nat	**1.9 - 2.9**	1	10^9	**0.3 – 0.5**
	U -nat	0.75 - **1**	1	10^9	**1 – 1.3**
Material	**Activity Concentration (Bq/g)**		**Exempt activity Concentration (Bq/g)**	**Exempt Activity (Bq)**	**Maximum exempt mass of the material (x 1000 t)**