Tenorm legislation — theory and practice

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Abstract. Processing of minerals often increases concentrations of naturally occurring radioactive materials (NORM) in mineral concentrates, products and waste streams. This so-called TENORM (Technologically Enhanced Naturally Occurring Radioactive Materials) phenomenon can result in usually very small increases of radiation exposures to workers and the public. However, proposed international radiation protection standards are likely to bring the TENORM issue into the realm of regulatory concern. Verbatim adoption by the national legislation's of the radiation protection standards like those proposed in the IAEA's 1996 Basic Safety Standards (BSS) would present enormous practical problems. Many industries and industrial practices would, for the first time, become subjected to the provisions of radiation protection legislation. Consequently, registration, licensing, occupational and environmental monitoring, statutory reporting, appointment of appropriately qualified staff, new approaches to the management of minerals and waste labeled as "radioactive", etc. would be required. This would be mirrored by corresponding demands on the regulatory authorities, needing to provide an increased radiation protection regulatory control. In response to new Australian and other national radiation protection legislation that have incorporated the BSS criteria, this paper illustrates their impact on a number of industries that historically have not been considered as dealing with radioactive materials. The paper also proposes a number of initiatives that could be considered. Nationally, those initiatives should aim at adopting radiation protection legislation that is commensurate with the nature of the minerals industry operations, national circumstances, conditions and interests without compromising rational radiation protection practices. Otherwise, non-judicious application of the BSS would result in major diversions of resources from well recognized occupational health and safety issues towards the less important end of the OH&S risk spectrum throughout the minerals industries worldwide.

1. Introduction

This presentation is a synopsis of the large and detailed report on this topic, which is available on the "World Collection of Radiation Links" Internet site [1]. The following text was prepared especially for the verbal presentation.

1AEA Basic Safety Standards [2] propose that a single practice can be exempted from regulatory control if it contributes to individual doses of no more than 10 microSv per year.

For each individual radionuclide there are two exemption levels: the first one is a concentration in Becquerels per gram (Bq/g), the second one — a Total Activity of a given nuclide present on the premises. Even if concentrations of 'common' NORM elements uranium or thorium are below the exemption limit of I Bq/g, the material could become 'regulated' due to the existence of the 'total activity' limit. These exemption values are [lot necessarily applicable for mining and minerals processing. The main aim of this presentation is to attract the attention of national regulatory agencies to the fact that IAEA Basic Safety Standards must not be adopted verbatim, without prior assessment of health, economic and

legal aspects of the TENORM issue, particularly in the mining and minerals processing industries.

It is appropriate to discuss if these Standards prescribe appropriate control measures for the Technological Enhancement of Natural Radioactivity.

2. Legislative inconsistencies

There are several inconsistencies in the current and proposed radiation protection legislation.

2.1. Action levels for the exposure to radon

The action levels proposed for radon in IAEA BSS are associated with an annual exposure of' about 3–5 mSv for a member of the public and 6 mSv for an employee. These values are extremely high when compared to 0.01 mSv/year "exemption" limit for the exposure of a member of the public proposed in the same document for 'other than radon' radiation exposure. The explanation is that practices and work activities are planned and are *adding* to the radiation exposure of a person; radon exposure *is natural,* and if one is going to decrease it, it will be an *intervention.*

Radon exposure limits of 3–5 mSv/year and the simultaneous promotion of the 'exemption limit of 0.01 mSv/year' coupled with the differences between 'nuclear' and 'non-nuclear'. 'normal practice' and 'intervention', 'work activity' and 'practice' are only complicating the application of radiation protection principles, which is already complicated sufficiently enough.

If international and national regulatory bodies are to be truly consistent we should have two options: Either use the exemption limit of 0.01 mSv/year for radon exposures for members of the public, which leads to the ridiculous situation when almost everybody on this planet would be 'well above the threshold' with an obvious result that the Earth is too hostile for us and we should move somewhere else, or to recognize that there is no point whatsoever in regulating radiation exposure at levels practically indistinguishable from natural background.

2.2. Artificial separation of 'nuclear' and 'non-nu*clear' activities*

There is no difference between radiation dose of 3 mSv received by a uranium miner and a dose of 3 mSv for an operator of a tin smelter. The argument that in the case of uranium mining and processing "radiation is beneficial for the product" and in 'other' mining "radiation is an unwanted impurity" is, from the general radiation protection point of view, irrelevant. Extracted uranium concentrate is the same naturally occurring radioactive material, with its uranium concentration being technologically enhanced.

Let us consider the following example: Both radium–226 ions that were washed off from the pile of fertilizer on a farm into a stream nearby and radium–226 ions that were discharged from a 'nuclear facility' upstream into the same river are exactly the same. However, in the first instance radium in water is the result of a 'work activity' and in the second one is the result of a 'practice'. Therefore, radium ions from a 'nuclear installation' are gaining some special magic powers to harm a farmer much more than the ones from the fertilizer.

2.3. Application of legislation to consumer products

In some legislative proposals specific exemptions are being made for 'consumer goods' and 'retail products' containing NORM. Raw materials and semi-products are not, however, included in these proposals. Let us consider the possibility of the same material being ‘radioactive' and 'non-radioactive' on different stages of processing:

Mining and concentrating: The separation of the mineral zircon from mineral sands ore is achieved by purely physical means (gravimetric, electrostatic and electromagnetic separation). Therefore, the product ready for shipping is in exactly the same chemical and physical form as found in the natural environment. The specific activity of zircon (due to natural thorium and uranium content) is typically around 4 Bq/g. Therefore, the material is currently not considered 'radioactive', but would be classified as such in accordance with IAEA 1996 BSS.

Transport: The special provision for 'natural' material in IAEA Transport Safety Regulations STA [31 raises the exemption level by a factor of ten. There are, however, two potential problems, which are yet to be solved. Firstly, different methods are currently used to calculate specific activity due to the differences in including daughter radionuclides in the calculations. An operator or an appropriate authority could potentially classify zircon as 'radioactive material' due to the simple 'mix-up' of numbers. Secondly, due to the differences between possible definitions of a 'natural material' the transport of zircon could also become the transport of 'radioactive' material in some countries.

Processing: Let us take, for example, a zircon 'micronising' operation, where grains of the mineral (150–200 microns in diameter) are milled to produce the product called 'zircon flour' with a fineness of about 3 microns. The chemical properties of the material do not change during the processing. Due to the potential differences in the interpretation of the term 'natural' and the fact that small 'zircon flour' particles could be more easily inhaled than mineral grains, the following situation may result: A zircon mill will be receiving a 'non-radioactive' raw material from which it will be producing a 'radioactive' product for further applications in other industries.

Manufacture of a 'consumer product': Zircon flour is used as an opacifier In ceramic glazes. An interesting situation, which is directly opposite to the one described above may result: A facility manufacturing ceramic tiles will be receiving a 'radioactive' material which will be used in the production of 'non-radioactive' 'consumer products'.

3. Possible outcomes from adopting IAEA BSS verbatim

Let us estimate what effect would be caused by the verbatim adoption of IAEA Basic Safety Standards in a country without a thorough investigation of potential health, economic and legal consequences. Such a country would have an immediate need for:

(a) sufficient amount of suitably qualified and experienced radiation protection specialists in order to ensure that all materials which will be classified as 'radioactive' are being handled in accordance with new legislation at the place where they are produced, transported, stored and processed;

(b) a significant increase in the number of personnel in 'radiation protection' branches of the government to deal with 'newly appeared' work activities, including licensing, approvals, review of statutory reports, site inspections, verification monitoring and so on;

(c) numerous 'low level radioactive waste' storage and disposal facilities for millions of tons of waste which will be generated each year and will require appropriate disposal.

Another item which will require immediate attention is the 'saleability' of the locally mined and processed minerals, semi and final products on the international markets. The 'radioactive content' of a product could become a decisive factor in market negotiations. It would be comparatively difficult to sell products that contain NORM in concentrations higher than, say, a 'world average'.

Thus, the TENORM issue ceases to be theoretical. An established mining or mineral processing industry in a given region or country could simply cease to exist due to the perceived risks of radiation exposure from TENORM.

4. Practical suggestions

The study of national and international radiation protection legislation, which is presented in full on the Internet site mentioned earlier, lead to the following practical suggestions may be considered by radiation protection professionals, appropriate authorities and potentially affected industries.

4.1. Radiation protection professionals

It is expected that the demand for radiation protection professionals will increase because it number of industries where natural radioactivity is technologically enhanced will require radiation monitoring programs, authorizations, notifications and so on. It is likely that the appointment of a 'Radiation Protection Officer' will be required at many facilities. Therefore, mutual recognition of radiation protection education and experience between different countries will be very desirable. The proposal put forward by the German–Swiss Radiation Protection Association [4] deserves attention from other radiation protection societies.

Suggestion 1: Regional and international programs relevant to the mutual recognition of radiation protection education and experience, eventually leading to the signing of some international agreements should be considered by national radiation protection societies and IRPA.

Only about 15% of the human exposure to ionizing radiation come from man–made sources. The remaining 85% of the annual dose is the result of the exposure to 'natural' radiation, but this fact is generally unknown to the public.

Suggestion 2: Different ways of communicating information about natural radiation directly to the general public should be examined.

Suggestion 3: Public education initiatives such as Science Teachers' Workshop Program by the Baltimore–Washington Chapter [5] of the Health Physics Society should be encouraged and expanded.

Suggestion 4: The liaison between radiation protection societies and other professional bodies (such as engineering institutions, environmental protection groups and societies, medical associations and unions of journalists) should be encouraged.

Suggestion 5: Biased reports in mass media should be vehemently opposed and not left to 'die by themselves', as it is often the case.

The concept of a 'controllable dose' proposed by ICRP Chairman R. Clarke [6] is so far the most convenient solution for eliminating the inconsistencies in radiation protection.

Suggestion 6: The 'controllable dose' concept should be discussed and, hopefully, results of the discussion implemented in practice. The simplification of the protection philosophy, associated with this concept, represents obvious benefits for radiation protection.

There are many radiation protection Journals and Bulletins dedicated to the exposure to the man–made sources of ionizing radiation. Surprisingly, there is not a one solely dedicated to the NORM/TENORM issues.

Suggestion 7: Publication of a dedicated TENORM Journal should be considered in order to provide an opportunity for researchers to communicate their findings and solutions.

Suggestion 8: A special TENORM e-mail exchange list has been created on the Internet [7]. Informal instant communications between researchers iii different countries are now possible.

4.2. National regulatory authorities

National regulatory authorities may consider the following suggestions regarding an adoption of IAEA BSS.

Suggestion 9: The magnitude of potential problems associated with the local TENORM industries must be assessed by an appropriate authority.

Suggestion 10: The creation of a separate task force at IAEA and within national government departments dedicated solely to NORM and TENORM should be considered.

Suggestion 11: After the draft of the regulations has been completed, the assessment of its possible economical impact and legal implications both for a regulatory authority and for affected parts of the local industry should be made. It is suggested that this process is carried out in co-operation with all industries that may become 'regulated' and different industry committees (such as, for example, a chamber of mines), and other government bodies (departments of environmental protection, minerals and energy, resources and development and so on).

Suggestion 12: If, after the consultations with the industry and the public, the decision is made to adopt 1AEA Basic Safety Standards in full, different methods of a 'gradual' adoption of the legislation could be considered. The degree of the regulatory control should be proportional to the potential exposure of the member of the public.

4.3. TENORM industries

The following suggestions may be taken on board by TENORM industries.

Suggestion 13: The potential problems associated with TENORM within an industry should be identified and solutions should be found before the local regulations will come into force. Studies carried out in other countries should be taken into account, as it is quite possible that problems, which seem to be impossible to solve by the local industry, were already rectified some time ago in another country.

Suggestion 14: The potential implications of radiation protection legislation should be communicated within an industry and to appropriate authorities. Workshops, seminars and conferences on TENORM must address not only studies of radiation exposure but also potential economic and legal consequences of bringing natural radioactivity under regulatory control.

Suggestion 15: Co-operation with appropriate authorities in the development of relevant radiation protection regulations should be an aim for industries, which are sometimes just a passive target for the already promulgated legislation.

Suggestion 16: National and international co-operation between producers and downstream processors of NORM–containing products should be encouraged.

The general public is mainly not aware of the presence of naturally occurring radioactive materials in the surrounding environment. Biased reports by different 'interest groups' in mass media could severely damage the sound reputation many TENORM industries enjoy in regards to the safety in the workplace and the preservation of the environment.

Suggestion 17: Industries should be proactive in communications with the general public and try to open a dialogue with the 'interest groups'. The creation of 'media watch' and 'public consultation' groups for TENORM industries could be suggested.

Suggestion 18: The co-operation between TENORM industries internationally will result in obvious benefits. For example, if there are several committees dealing with radiation protection in a given TENORM industry, the creation of a working group that will coordinate the activities of these committees will be very beneficial for an industry in all countries. Similar guidelines would be streamlined to the practicable extent and the identical research activities would be evenly distributed between experts in different counties.

In some industries, for example in the phosphate industry, the co-operation is very well developed; in others, such as in the mineral sands mining and processing industry, the co-operation is only rudimentary.

Some of the suggestions above could be very practical, other ones possibly would be described as 'out of phase with reality'.

5. Conclusion

The main conclusion made on the basis of the information presented above is:

International Atomic Energy Agency Basic Safety Standards should not be adopted into a national radiation protection legislation verbatim, without a thorough investigation of health, economic and legal implications for the many industries where natural radioactivity is technologically enhanced.

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