

What should a radiation regulator do about naturally occurring radioactive material?

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Abstract—The standard regulatory framework of authorisation, review and assessment, inspection and enforcement, and regulation making is directed principally towards ensuring the regulatory control of planned exposure situations. Some mining and industrial activities involving exposures to naturally occurring radioactive material (NORM), such as uranium mining or the treatment and conditioning of NORM residues, may fit readily within this standard framework. In other cases, such as oil and gas exploration and production, the standard regulatory framework needs to be adjusted. For example, it is not sensible to require that an oil company seek a licence from the radiation regulator before drilling a well. The paper discusses other approaches that a regulator might take to assure protection and safety in such activities involving exposures to NORM, including the use of conditional exemptions from regulatory controls. It also suggests some areas where further guidance from the International Commission on Radiological Protection on application of the system of radiological protection to NORM would assist both regulators and operators.

Keywords: NORM; Exposure situations; Regulation

1. NORM, OIL AND GAS AND THE SYSTEM OF RADIOLOGICAL PROTECTION

Early in the life of the United Arab Emirates (UAE) Federal Authority for Nuclear Regulation (FANR), the Abu Dhabi National Oil Company (ADNOC) asked if FANR needed or proposed to regulate exposures to naturally occurring

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radioactive material (NORM) in ADNOC's operations. The answer given was – no, or at least, not yet.

Sometime later, ADNOC approached FANR with a proposal to construct a treatment and disposal facility to deal with the NORM residues arising from the activities of its operating companies engaged in oil and gas production in the Emirate of Abu Dhabi and offshore. Here, FANR's response was clear that both the system of radiological protection and the UAE's nuclear law required that the NORM facility be licensed by FANR in order to operate.

Are these two answers consistent with the system of radiological protection and the UAE's regulation of exposures to radiation?

The production of oil and gas in general creates an exposure situation. Radioactive material, principally Ra-226, is brought to the surface and the consequent exposure of workers in the production facilities may arise. Should this exposure be characterised as an existing exposure situation or a planned exposure situation?

There are arguments for either characterisation. Certainly the radioactive material is existing, and exposure is incidental to another purpose and, in this sense, is not at all planned. On the other hand, the likelihood of exposures arising from the activities involved in oil and gas production is known in advance and can be planned for.

The answer does matter for a regulator. A planned exposure situation should be regulated. The scope for regulation of a planned exposure situation includes authorisation or licensing, which follows from review and assessment of an application undertaken before the activity leading to the exposure can begin. One can expect to see application of the principle of optimisation of protection and safety through the use of dose constraints, and application of dose limits for individuals.

An existing exposure situation is one that does not usually benefit from full regulation because the limited controllability of the source and exposure does not lend itself to meeting firm regulations. An existing exposure situation may be better dealt with through regulatory guidance. In particular, the guidance should offer a graded approach in the context of some accepted and acceptable reference level of dose arising from the exposure situation.

2. THE UAE SYSTEM FOR REGULATION OF RADIOACTIVE MATERIAL

The UAE Federal Law by Decree No. 6 of 2009 concerning the Peaceful Uses of Nuclear Energy (UAE Nuclear Law; available at www.fanr.gov.ae) establishes the regulatory framework for radioactive material. Any person is prohibited from undertaking 'regulated activity' with 'regulated material' unless they are licensed to do so by FANR. Regulated activities with regulated material include possession, use, manufacture or handling, import or export, transportation, storage, and disposal.

Regulated material is defined in the UAE Nuclear Law as including radioactive material. In turn, radioactive material is defined as 'material designated by the Authority (FANR) as being subject to regulatory control because of its radioactivity'.

Is NORM captured by this definition? In its 'Basic Safety Standards for Facilities and Activities Involving Ionizing Radiation other than in Nuclear Facilities' (FANR-REG-24; available at www.fanr.gov.ae), FANR adopted the international exemption levels as being the dividing line above which material requires regulatory control because of its radioactivity. Effectively, this means that with regard to NORM, any material with an activity concentration of any radionuclide in the uranium and thorium decay series exceeding 1 Bq g^{-1} is defined as 'regulated material'.

The UAE Nuclear Law allows FANR, consistent with international commitments and agreements, to exempt certain facilities and activities from licence requirements, provided that they do not represent a substantial threat to achieving the priorities and objectives of the UAE Nuclear Law.

It seems clear that the activity of gathering together material containing NORM residues (at least those above 1 Bq g^{-1}), processing it, and disposing of conditioned NORM residues is an exposure situation that is planned in advance and, in terms of the UAE Nuclear Law, involves several regulated activities with regulated material (possession, handling, transport, storage, and disposal). The proposals for a NORM facility thus require review and assessment, licensing, and inspection of a programme of radiation protection involving the optimisation of protection and safety, and the limitations of individual dose. The degree of regulatory control imposed should, of course, reflect the assessed hazard.

Dealing with exposures to NORM arising from oil and gas production activities seems much less clear in regulatory terms. The exposures arising from these activities are probably better characterised as existing exposure situations. It can certainly be argued that oil and gas production does not involve any regulated activity with regulated material, in that the activities have an entirely different purpose and the exposure is incidental to that other purpose, rather than the intended purpose of the activity being to apply the regulated material to achieve a certain end (such as a medical diagnosis).

3. EXPOSURE OF AIR CREW – IS IT LIKE EXPOSURE OF OIL AND GAS PRODUCTION WORKERS?

The exposure of air crew to cosmic radiation is the most studied occupational existing exposure situation, apart from occupational exposure to radon. The International Atomic Energy Agency in its recently revised Basic Safety Standards (IAEA GSR Part 3; available at www.iaea.org/standards) lays out an approach for the protection and safety of air crew, which is treated as an existing exposure situation, as follows:

5.30 The regulatory body or other relevant authority shall determine whether assessment of the exposure of air crew due to cosmic radiation is warranted.

5.31. Where such assessment is deemed to be warranted, the regulatory body or other relevant authority shall establish a framework which shall include a reference level of dose

and a methodology for the assessment and recording of doses received by air crew from occupational exposure to cosmic radiation.

5.32. *In accordance with Para. 5.31:*

- (a) *Where the dose of aircrew members is likely to exceed the reference level, employers of air crew:*
 - (i) *shall assess doses and keep records;*
 - (ii) *shall make records available to aircrew members;*

- (b) *Employers:*
 - (i) *shall inform female aircrew members of the risk to the embryo or fetus due to exposure to cosmic radiation and of the need for early notification of pregnancy;*
 - (ii) *shall apply the requirements of Para. 3.114 in respect of notification of pregnancy.*

The four elements of this regulatory approach are:

- a decision as to whether assessment of exposure is warranted;
- where warranted, the establishment of a framework by the regulatory body to include a reference level of dose, a dose assessment, and recording methodology;
- employers to assess doses, keep dose records, and make them available to workers where doses are likely to exceed the reference levels; and
- a general duty of care of employers towards pregnant workers.

The major difference between the exposures of air crew and the exposures of oil and gas production workers is that the radiation dose expected to arise from any given flight can be found through readily available software. The quantities of NORM, and hence the resulting exposures to oil and gas production workers, differ widely from field to field. However, it is hoped that measurement of activity concentrations of NORM in any field, and generic modelling of the behaviour of workers, will allow average exposures to be assessed.

Following this approach, a possible mode for the control of exposures in the oil and gas industry is that the regulatory body, after consultation with the industry, establishes (through a regulatory guidance document) a reference level of dose and a methodology for dose assessment.

The consequent obligations on employers can be achieved through a regulation or a conditional exemption from regulatory control requiring:

- the operator to make an exposure assessment using the determined methodology and data derived from measurements of activity concentrations of NORM in local conditions;

- if the assessed dose from the exposure assessed is below the reference level, there is no need for any further action, other than the duty of care towards pregnant workers; and
- if the assessed dose is above the reference level, the employer shall implement a scheme for assessment and recording of the doses assessed for individual workers, with the information to be made available to workers.

Otherwise, prudent occupational health and safety measures can be assumed to assure the optimisation of protection and safety.

4. WHAT SHOULD ICRP DO?

As a general comment, there is a need for further analysis and exploration by the International Commission on Radiological Protection (ICRP) of existing exposure situations. Currently, the concept is dealt with briefly, with the notable exception of exposures to radon in workplaces and dwellings.

A vital piece of work to be undertaken is exploration of the concept of reference levels, from which further guidance may come on the basis for choosing a certain reference level for a regulatory scheme for NORM, such as proposed in this paper. Is there a one-size-fits-all generic reference level that should be applied to all industrial activities that result in exposure to radiation from NORM? Or should a reference level be set at a level that represents a low/average/higher level of exposure occurring in a particular industry? Or is there some other way?

Finally, ICRP needs to advocate pragmatism and flexibility, supported by radiation protection principles, when it comes to NORM.