# REGULATION OF WORK WITH NORM FOLLOWING IMPLEMENTATION OF THE EUROPEAN BSS: PRACTICAL EXPERIENCE FROM THE UK.

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## 1 ABSTRACT

The requirements of the European Basic Safety Standards Directive (96/29/EURATOM) for work with NORM were implemented in the UK by the Ionising Radiations Regulations 1999 (IRR99). These regulations apply to work activities from which effective doses to workers or other persons are likely to exceed 1 mSv per year. Where the work is subject to regulatory control, employers must comply with similar requirements to those applied to practices involving artificial radionuclides.

This paper describes the practical experience gained to date in implementing IRR99 in relation to the use of NORM in UK workplaces. Specifically, it includes:

- a description of the methods used to estimate radiation doses from different exposure pathways, the limitations associated with these methods, and how improvements might be made;
- a summary of the estimated occupational doses and the implications in terms of regulatory control; and
- examples of how the requirements of IRR99 have been applied in practice to NORM workplaces.

## 2 INTRODUCTION

An overview of NORM industries in the UK was presented at NORM I[(1)], and the radiological and waste disposal issues at one particular factory were presented at NORM II[(2)]. Since then, the regulations governing occupational radiation exposures in the UK have been revised in response to the European Basic Safety Standards Directive (BSS)[(3)]. As well as producing changes in the regulatory requirements, this has also resulted in the use of updated dose coefficients for calculating internal radiation exposures.

NRPB acts as Radiation Protection Advisor (RPA) for several UK factories that handle and process NORM materials. This paper considers the assessment of occupational exposures in such workplaces under the new regulatory regime. Practical experience from implementing the new regulations in these workplaces is also presented.

## 3 REGULATORY BACKGROUND

The previous UK regulatory framework for NORM, and potential impact of implementing the BSS were described at NORM II[4]. Occupational exposures from NORM were previously subject to the Ionising Radiations Regulations 1985 (IRR85)[5]. To implement the BSS, these have been replaced by the Ionising Radiations Regulations 1999 (IRR99)[6], which came into force on 1 January 2000. Some of the changes introduced by IRR99 for work with NORM are summarised below:

- The regulations apply to work where annual effective doses to workers or other persons are likely to exceed 1 mSv (the equivalent figure under IRR85 was 5 mSv).
- Under IRR85, guidance on NORM activity concentrations (in Bq $g^{-1}$) that would require regulatory control was provided. This is not the case under IRR99; the emphasis is on likely doses, rather than the radioactive content of the material.
- For work subject to the regulations, a prior assessment of the radiological risks from normal work and from accidents is required to determine the necessary radiation protection measures.
- Controlled areas should be designated where special procedures are needed to restrict exposures, or where annual effective doses are likely to exceed 6 mSv (previously 15 mSv). Supervised areas should be designated where radiological conditions need to be kept under review, or where annual effective doses are likely to exceed 1 mSv (previously 5 mSv).
- Internal exposures are to be calculated using the dose coefficients in the BSS (values in IRR85 were based on ICRP Publication 30[7]).

## 4 METHODS OF ASSESSING OCCUPATIONAL EXPOSURES

As indicated above, a prior radiological risk assessment is required for any work that is subject to IRR99. However, because the application of the regulations depends on dose, in practice some form of assessment is required for all work activities involving NORM. The assessment methods used for different exposure pathways, and their limitations, are discussed below.

### 4.1 External radiation

Although dose rates from NORM can be calculated, a radiological survey is normally undertaken to determine the pattern of gamma dose rates throughout the workplace. Instruments capable of measuring dose rates in the range 0.1 – 10 μSv $h^{-1}$ are required, and such surveys are normally undertaken by the RPA. In estimating doses, the main uncertainty is working patterns; typical UK workers undertake a variety of tasks and rarely occupy set positions. Assumptions have to be made, and the natural tendency is to be pessimistic, i.e. to overestimate doses. Consequently, personal dosimetry is increasingly being used to refine dose estimates. Preliminary results suggest that estimated doses of the order of 1 mSv $y^{-1}$ are reduced to 0.2 – 0.4 mSv $y^{-1}$ when assessed by personal dosemeters. To date, passive dosemeters (TLDs) have been used, although in future it is expected that electronic devices will be preferred due to their improved accuracy at low doses and their ability to provide task-dose information.

### 4.2 Inhalation of dust

Most NORM workplaces already have measurement programmes for assessing "nuisance" dust (in mg $m^{-3}$) using personal air samplers. The results can also be used to estimate internal radiation doses, provided the activity concentration of the airborne dust is known. In practice, it is either assumed to be the same as in the main process material, or is determined from analysis of accumulated dust on ledges, etc. In some cases, air filters are analysed by x-ray fluorescence (e.g. for Zr content) and the results can provide a better indication of the composition of airborne dust. In principle, direct measurement of radioactivity (e.g. by alpha counting air filters) is the best technique. In practice, however, problems with self-absorption, and the pre-existence of the techniques described above, mean that this is rarely used on a routine basis.

The particle size distribution of airborne dust is usually unknown, and inhalation doses are calculated for a default (5 μm) aerosol. Although studies[8] have suggested that this is a reasonable default value, it may not always be appropriate, especially where fine grade materials are handled.

### 4.3 Ingestion

Significant exposures via this pathway are not normally possible, and a simplistic assessment based on a nominal daily intake (usually 10 mg $d^{-1}$[9]) is usually sufficient to confirm this.

### 4.4 Radon

Under IRR85, the activity concentrations of most NORM materials used in the UK were considered to be too low for radon to be a significant source of exposure[8]. Under IRR99, the need to consider doses of 1 mSv $y^{-1}$ or less means that this is no longer the case.

To date, most assessments have relied on generic exposure models[9] to derive broad estimates of doses from radon. More data on the radon levels in individual NORM workplaces is needed. In the UK, workplace radon levels and individual doses are both usually assessed using passive track-etch dosemeters. These devices are not, however, suitable for accurately measuring low radon concentrations, i.e. equivalent to annual doses of 1 mSv or less. In addition, it is difficult to effectively discriminate between radon arising from work with NORM and that from background sources. At present, workplace surveys using equipment capable of providing sensitive measurements of short-term radon concentrations are currently being considered.

## 5 OCCUPATIONAL DOSE ESTIMATES

Assessments carried out to date for various NORM work activities have produced estimated annual effective doses to workers in the range 0.1 to 3 mSv. For large-scale plants (usually processing heavy mineral sands), estimated annual doses have typically been 1 to 2 mSv. Typical results are shown in Table 1.

Table 1. Risk assessment results for a typical mineral sand processing plant.

| Exposure route | Estimated annual (committed) effective dose to workers(mSv) |
|---|---|
| External exposure | 0.6 |
| Inhalation | 0.4 |
| Ingestion | 0.01 |
| Radon inhalation | 0.5 |
| TOTAL (rounded) | 1.5 |

Due to the pessimistic nature of most assessments, actual doses may be lower than shown in Table 1. Consequently, it is often difficult to be certain whether the IRR99 “application level” of 1 mSv $y^{-1}$ is likely to be exceeded.

In nearly all cases, estimated doses to workers are significantly lower than under IRR85. In some cases, the reduction in exposures has occurred because of a deliberate switch to materials with lower activity concentrations. This is a relatively recent phenomenon and reflects the increasing awareness of radiological issues within the UK industry. In most cases, however, the change in dose coefficients has been the most significant factor in reducing estimated doses. For example, in workplaces processing zircon sand, inhalation doses have typically reduced by an order of magnitude.

## 6 PRACTICAL EXPERIENCE

In providing an RPA service to NORM industries, NRPB has been able to gauge the main practical effects of implementing IRR99. These are summarised below.

- There is no evidence to suggest that the number of work activities subject to regulatory control has substantially changed. However, the number of risk assessments required has increased, i.e. to determine whether IRR99 apply.
- Although risk assessments are now an accepted part of safety management in the UK, and are often useful in their own right, some guidance in terms of the NORM activity concentrations that might require regulatory control would still be very helpful.
- NORM work areas are typically designated on the basis of annual doses, unlike practices involving artificial radionuclides where the need for special working procedures or periodic review are usually the main criteria. There are now less controlled areas; indeed these are quite rare. Instead, supervised areas are normally designated wherever IRR99 are deemed to apply. Warning signs for supervised areas are optional, and this is reflected in their irregular use in practice. Written working procedures (local rules) and appointed (radiation protection) supervisors are, however, quite common. Supervised areas require periodic monitoring and this typically comprises a quarterly dust measurement programme (with PAS) and annual dose rate surveys.

- Dose rates are relatively low in most workplaces, and simple measures to control external radiation hazards (e.g. storing bulk materials in areas that are not frequently occupied) are often sufficient.

Dust inhalation is now of equal or less importance than external radiation, in most situations. Control of internal radiation hazards is achieved mostly through good industrial hygiene practice (inspection and maintenance of dust control plant, cleaning programmes for surfaces, etc).

- Workers are not expected to receive annual doses above 6 mSv, and the designation of classified persons has not (so far) been required.

# 7 CONCLUSIONS

Work with NORM in the UK was subject to regulatory control prior to the BSS and implementation has resulted in evolutionary, rather than revolutionary, changes. The main conclusions from the issues discussed in this paper are:

- In the absence of any activity concentration "screening levels", all work with NORM requires some assessment of the radiation doses that arise.
- Estimated worker doses are generally lower than before, mostly due to the lower dose coefficients used for estimating internal exposures from dust inhalation.
- Estimates of annual worker doses range from well below 1 mSv to a few mSv. Uncertainties in dose estimation methods often make it difficult to be certain whether regulatory control is strictly necessary.
- Increased use of personal dosemeters (especially electronic devices) is expected to enable more accurate determinations of external dose.
- Existing methods of measuring airborne dust in the workplace can be used to estimate internal radiation doses from inhalation. The use of default ICRP dose coefficients is, however, a source of uncertainty.
- More work is required on assessing radon exposures from work with NORM. The normal (passive) methods of radon dosimetry are unlikely to be viable due to problems with sensitivity and background subtraction. Instead, alternative (workplace) measurement techniques need to be explored.
- For most workplaces, effective radiation protection can be achieved through a combination of good industrial hygiene practice and the sensible segregation of bulk materials

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