Implementation of Title VII of the European Union Basic Safety Standards Directive in Ireland

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1 ABSTRACT

The European Union Basic Safety Standards Directive has been incorporated into Irish law by Ministerial Order. The Order covers work activities involving significant exposure to natural radiation sources. Following the adoption of the new regulations, the Radiological Protection Institute of Ireland (RPII), the national agency with regulatory responsibility for ionising radiation, initiated a programme to introduce controls on such work activities. This programme is focused on three areas: radon in underground workplaces, radon in above ground workplaces and work activities involving exposure to natural terrestrial sources other than radon.

The RPII has identified a range of underground workplaces, such as mines and show caves, where it is necessary to measure radon. Employers responsible for these workplaces have been contacted by RPII and directed to carry out radon surveys. To date the highest levels have been found in show-caves and initial indications suggest that some of these workplaces have radon levels, which cannot be disregarded from a radiation protection point of view.

The RPII has previously completed a geographically based survey of radon in Irish dwellings. Based on the results of this survey, the RPII has identified geographic regions of the country where high radon concentrations in aboveground workplaces are most likely to be found. The RPII has commenced a programme of notifying employers responsible for workplaces in these areas.

The RPII has identified types of industry currently active in Ireland, which on the basis of the literature are considered liable to involve work activities resulting in exposure to naturally occurring terrestrial radiation sources other than radon. These include oil and gas extraction, the use of thoriated products, bauxite processing, the use of titanium dioxide in the pigment industry and peat milling connected with power production. Companies actively involved in each of these industry types have been identified using sources including Integrated Pollution Control licences and commercial databases. The RPII has initiated a programme to look at each industry type and to define appropriate risk assessment methodologies and codes of practice.

2 INTRODUCTION

The European Union Basic Safety Standard (BSS) Directive [1] is revised in line with scientific developments approximately every 10 to 15 years. The most recent revision, which took place in 1996, includes special provisions concerning exposure to natural sources of ionising radiation. Title VII of the revised Directive sets down a framework for controlling work activities where the presence of natural radiation sources leads to a significant increase in exposure to workers or members of the public, which cannot be disregarded from the radiation protection point of view. The implementation of Title VII resulted in significant legal changes in Ireland; previously the national radiation protection regulations did not explicitly cover work activities involving exposure to natural sources.

This paper sets out the measures taken in Ireland to give effect to Title VII and covers both the transposition of the relevant provisions into Irish Law and the implementation of control measures by the national regulatory agency, the Radiological Protection Institute of Ireland (RPII). The initial assessment made by the RPII of the scale of the problem in Ireland is presented and the progress achieved in implementing control measures one year after the commencement of Irish Regulations is described.

The first systematic study of radon in Irish buildings was undertaken by McLaughlin and Wasiolek [2], who completed a population-weighted survey of radon in domestic dwellings between 1985 and 1989. This study identified certain western counties as being particularly radon prone and estimated that, nationally, 4% of the housing stock exceeded 200 Becquerels per cubic metre (Bq/m^3). In 1990 the Irish Government adopted a national Reference Level of 200 Bq/m^3, for long-term exposure to radon in domestic dwellings, above which remedial action should be considered. Between 1989 and 1992 Madden *et al.* [3] carried out detailed follow-up studies in selected radon prone areas identified in the earlier survey. This study provided more detailed information on the extent of the problem in the west of Ireland and showed that that in certain areas up to 30% of houses had radon levels exceeding the Reference Level.

In 1992, the RPII initiated the National Radon Survey, a comprehensive geographically based survey of radon in domestic dwellings [4]. The geographic unit chosen for this survey was the 10 x 10 km Grid Square based on the Irish National Grid. Householders, selected at random from the electoral register, were invited to participate and during the course of the survey valid measurements were completed in 11,319 dwellings, a sampling rate of 1 in 93 dwellings. The results of this survey were used to predict the percentage of dwellings in each grid square in which the radon concentration is in excess of the national domestic Reference Level. Grid squares where this percentage is greater than 10% were designated High Radon Areas. This study estimated that 7% of the national housing stock had radon concentrations exceeding the Reference Level.

In 1998, the RPII initiated a survey of radon levels in Irish primary and post primary schools. This survey, which is scheduled to be completed late in 2001, involved approximately 40,000 radon measurements in 3,500 schools. Results complete to date indicate that in approximately 8% of the schools surveyed one or more occupied ground offices or classrooms had radon levels in excess of 400 Bq/m^3, the national Reference Level for workplaces [5].

In 1993, Duffy *et al.* [6] surveyed radon levels in 4 commercial show-caves operating in Ireland. In 1996, Madden [7] conducted follow up studies in these caves, which included personal monitoring of cave guides. Between 1992 and 1993, Ellis *et al.* [8] investigated radon levels in three wild cave systems in the Burren area in the west of Ireland used by professional caving instructors. These studies indicate that, while in all cases the dose received by a member of the public visiting a show cave is small, cave guides, instructors and maintenance staff working in some caves may receive an annual effective dose from radon in excess of 6mSv.

A limited number of studies have been carried out looking at occupation exposure in Ireland arising from natural terrestrial sources other than radon. O' Grady [9] surveyed fertiliser handling practices in Ireland and estimated doses to workers involved in manufacture, **transport** and storage, to farm workers and to members of the public. This study concluded that, since the cessation of phosphoric acid production in Ireland in 1981, the dose to the most exposed individual is unlikely to exceed 100 μSv per year and, on average, is well below this. Turvey *et al.* [10] investigated the radiological impact of a large coal fired power station in the west of Ireland. The results of this work indicated that the off site radiological impact was negligible and that, while there was some enhancement of radon concentrations on the site, the levels were significantly below the national Reference Level for workplaces.

3 LEGAL MEASURES

In Ireland the Radiological Protection Act, 1991 [11] establishes the legal basis for regulations to protect the health of the general public and workers against the dangers of ionising radiation. The Act authorises the making of radiation protection regulations, establishes the RPII and sets down the statutory functions of the RPII and other agencies.

The Act provides for the implementation of future European Union legislation in the area of radiation protection by means of Ministerial Order. On 13th May 2000 the necessary laws and regulations to comply with the revised BSS Directive were brought into force by the "Radiological Protection Act, 1991 (Ionising Radiation) Order, 2000" [12], hereafter referred to as the Order. The Order establishes national radiation protection regulations covering both practices and other work activities not considered as practices but where the presence of natural radioactivity leads to the risk of significant increase in exposure to workers or members of the public.

The main provisions of Title VII are implemented in Part 6 of the Order, which deals with:

- identification of work activities involving a significant increase in exposure to radon;
- identification of work activities involving a significant increase in exposure to natural terrestrial radiation sources other than radon;
- remedial measures in workplaces found to have significant levels of radon;
- implementation of a system of protection where exposures cannot be reduced.

In the case of radon, the Order establishes a national Reference Level of 400 Bq/m^3 averaged over a three-month period. For other natural sources, the Order requires that a system of radiation protection be implemented where work activities result in an effective dose to workers or members of the public in excess of 1 mSv in any continuous 12-month period.

With regard to work activities liable to result in increased exposure to natural radiation sources, Part 6 of the Order gives particular powers to the RPII. The RPII may direct an employer or person responsible for a workplace either to measure radon in the workplace or, in the case of other natural terrestrial sources, to investigate the extent of any exposure of workers or members of the public. Employers must, where practicable, submit the results of such assessments to the RPII within 6 months.

The Order identifies radon prone workplace types as:

- all underground workplaces, including mines and show caves;
- above ground workplaces in High Radon Areas;
- other workplaces which may be identified by the RPII as being liable to have radon concentrations in excess of the workplace Reference Level.

The Order defines a High Radon Area on the basis of the National Radon Survey as an area in which it is predicted that more than 10% of domestic dwellings have radon concentrations in excess of 200 Bq/m^3.

Where radon concentrations in a workplace are found to exceed the Reference Level, the undertaking is required to evaluate if remedial measures are justified and where this is shown to be the case must implement such measures without delay. Where radon levels are not reduced and result in significant exposure, then the undertaking is required to implement a system of radiological protection equivalent to that for practices.

4 RADON IN UNDERGROUND WORKPLACES

Following the introduction of the Order, the RPII commenced a programme to, firstly, identify underground workplaces and, subsequently, to direct employers responsible for such workplaces to measure radon. The types of underground workplace identified include working mines, major road tunnel construction, show-caves and underground heritage centres such as disused mines or vaults.

Basement and sub ground floors in buildings of normal construction were treated with aboveground workplaces and were not included in the underground workplace programme. The underground workplaces already identified by RPII together with initial survey results are summarised in Table 1.

Table 1 Underground workplaces in which radon levels are currently under investigation

Workplace type	No. of workplaces identified	Range of Measured Radon Concentrations (Bq/m^3)	No. of workplaces found to exceed the Reference Level
Working mines	3	40 – 280	0 (3 surveyed)
Show caves	4	260 – 19,000	4 (4 surveyed)
Caves routinely used by professional caving instructors	3	170 – 21,000	3 (3 surveyed)
Heritage centres	6	20 – 40	0 (2 surveyed)
Major road tunnel construction	2	Measurements on-going	-
Power generation pump storage station	1	Measurements on-going	-

There are currently 3 working mines in Ireland, all of which extract lead/ zinc. Screening measurements were undertaken in these mines during 2001. As long-term area measurements are impractical in working mines, radon levels were assessed using a combination of active surveys and personal monitoring. For each mine all measured radon concentrations were found to be below the workplace Reference Level. The mean value per mine ranged between 30 and 100 Bq/m^3, while the highest recorded value was 280 Bq/m^3. The relatively low radon concentrations found are not surprising given the high ventilation rates typical of these workplaces.

It is clear from earlier studies that high radon concentrations occur in a number of Irish show caves. Assessing radon exposure to staff in caves is, however, complicated by a number of factors including the seasonal nature of the work, intra cave variation in radon concentrations and differences in the amount of time spent in different parts of the cave system when conducting tours. Madden and McGarry [13] looked at techniques for assessing exposure to cave guides and concluded that personal monitoring using passive radon detectors is a practical and appropriate technique for this purpose.

In January 2001, the RPII contacted employers responsible for all four commercial show-caves operating in Ireland and for an outdoor education centre running caving courses and directed that they assess occupational

exposure to radon. The employers were advised that they should implement a programme of personal monitoring covering one full season in order to assess the extent of radon exposure to staff. It was made clear that all cave workers (cave guides, instructors, service personnel, etc), who routinely work underground during the monitoring period, were to be included in the programme. These monitoring programmes are ongoing and results are expected early in 2002.

Once personal exposures have been measured over a complete season, employers must assess the maximum radon exposure which any individual is likely to receive. This assessment should take into consideration any reasonably predictable changes to work practices likely to influence the exposure in the future. Where this assessment indicates that any individual worker receives or is likely to receive an exposure greater than 800 $kBq.h.m^{-3}$ in any continuous 12-month period, the employer must evaluate if remedial measures are justified taking into consideration the saving in exposure together with economic, social and environmental factors.

5 RADON IN ABOVEGROUND WORKPLACES

Indoor radon levels vary greatly from one building to another and in some aboveground workplaces radon may be a significant source of occupational exposure. Because the number of workplaces potentially affected is large it is necessary to have a defined survey strategy, which prioritises workplaces with the highest risk. In general, for aboveground workplaces the nature of the building and the type of work activity do not give a reliable indication of the potential for radon problems. It is to be expected, however, that the probability of finding high radon levels in aboveground workplaces will follow a similar geographic variation to that for houses and so a survey strategy was adopted which targets aboveground workplaces located in areas identified as radon prone by the National Radon Survey.

The implications of different survey strategies on the size of the geographic area involved and on the number of workplaces to be surveyed were considered. Two strategies based on different target criteria are discussed here. Both strategies involve targeting radon measurements at aboveground workplaces in areas where the National Radon Survey predicts that more than 10% of dwellings have indoor radon gas concentrations in excess of an action level. In strategy one the action level was 200 Bq/m^3, the domestic Reference Level, while for strategy two the action level was 400 Bq/m^3, the national Reference Level for workplaces. The number of workplaces to be surveyed was estimated using a commercially available business database GeoDirectory [14], which gives the number of commercial addresses per Grid Square. Where a large town straddled the border of two Grid Squares, one of which had a predicted value greater than 10%, both squares were included. Table 2 presents the number of Grid Squares involved and the estimated number of workplaces for the two strategies.

The RPII has already carried out radon measurements in approximately 3,500 Irish schools. While schools are a particular type of workplace and so care

must be taken when extrapolating these results to workplaces in general, they do give some indication of the effectiveness of different survey strategies. The number of schools with one or more measurements above the workplace Reference Level located within the area bounded by each survey strategy was calculated as a percentage of the total number of schools located within the same area. These data are presented in Table 2. Of the schools located in the two survey areas considered, 16% and 38% respectively were shown to have radon concentrations in excess of the workplace Reference Level. It is important to note also that 5% of the schools in areas not targeted by either survey strategy had radon concentrations exceeding the workplace Reference Level.

Table 2 Impact of survey strategies on the number of workplaces to be measured

Action level	No. of Grid Squares	No. of workplaces	% of schools <u>in</u> survey area measured to be above 400 Bq/m^3	% of schools <u>outside</u> survey area measured to be above 400 Bq/m^3
200 Bq/m^3	234	36,676	16%	5%
400 Bq/m^3	45	11,460	38%	6%

Taking into account the need prioritise areas at greatest risk, the RPII has decided, in the first instance, to target workplaces located in Grid Squares where it is predicted that more than 10% of dwellings have radon concentrations in excess of 400 Bq/m^3. Using the powers given it under Part 6 of the Order the RPII has commenced a programme to direct employers responsible for workplaces in these areas to measure radon in the workplace. Using the commercially available databases GeoDirectory and Kompass, names and addresses for employers are obtained by Grid Square and employers are then contacted by mail and told that they must measure radon and submit the results to the RPII within 6 months. This letter is accompanied by an information pack, which covers employers' responsibilities under the new legislation, health effects of radon, radon measurement procedures and remediation options.

In July 2001, the RPII initiated a pilot aboveground workplace programme when it wrote to 1,500 employers responsible for workplaces in one Grid Square in the west of Ireland directing them to measure radon. The issue of these letters in July was accompanied by local press releases, radio interviews and a public meeting, all of which aimed to improve employers' awareness of radon. Employers who do not respond to this initial letter will be sent follow-up letters. It is planned to extend this programme to two further Grid Squares in the southwest by the end of 2001 and following this the pilot programme will be evaluated. This evaluation will address a range of issues including: the

reliability of the workplace databases, response rates, media strategy and the effectiveness of the target strategy.

6 TERRESTRIAL SOURCES OTHER THAN RADON

6 Following the introduction of the Order, the RPII commenced a programme to identify work activities liable to result in significant exposure to naturally occurring terrestrial radiation sources other than radon. Sources of this type are commonly referred to as NORM sources. In the first instance, types of industries were identified, which are currently active in Ireland and which on the basis of the literature are considered liable to involve exposure to NORM sources. Companies actively involved in each of these industry types have been identified using a variety of sources including Integrated Pollution Control licences and commercial databases such as Kompass. The list of industry types identified is presented in Table 3.

Table 3 Industries active in Ireland liable to involve NORM

NORM Category	Industry
Discrete sources	use of thoriated products (TIG welding, etc),
	metal recycling,
Diffuse sources	oil and gas extraction,
	power industry – peat combustion/ flyash
	power industry – handling of coal flyash
	bauxite processing,
	the use of Titanium dioxide in the pigment industry,
	cement production,
	bulk handling/ use of zircon sands
	Handling of fertiliser

The discrete sources identified as being important in an Irish context include thoriated products and natural radioactivity in scrap, which turns up at metal dealers. Thorium is used as an additive in a number of industrial processes to improve heat stability of metal alloys. In the aircraft industry thoriated nickel, a dispersion of thorium oxide particles in pure nickel, is used in some jet engines as heat shield material. In the welding industry thorium is added to electrodes used in tungsten inert gas (TIG) welding to facilitate arc starting and to increase arc stability. TIG welding has particular advantages in stainless fabrication work and is widely used in Ireland for this purpose. Ludgwig *et al.* [15] in a field study of German miners showed that in some cases the exposure to operators involved in welding and grinding can exceed 1 mSv/y. Following an incident involving the scrapping of a radiocaesium source in the early nineteen nineties, portal monitoring was installed at the only steel plant operating in Ireland at that time [16]. Up until the closure of the plant in May 2001, radioactive sources in scrap metal where regularly identified, the majority of which were found to be NORM materials. The RPII was notified of alarm activations approximately once a month.

There is a range of industries active in Ireland liable to produce or use diffuse NORM sources. These include oil/ gas extraction, fossil fuel power production and a range of industrial processes which use bulk materials with enhanced levels of natural radioactivity. There are two offshore gas fields located in Irish waters. The Kinsale field, the smaller of the two, is due to be decommissioned within ten years while the Corrib field, which is currently under development, is scheduled to start supplying the grid in 2003. There are currently five electricity generating stations using milled peat and one using coal as a fuel supply. The peat stations typically use of the order of one million tons of peat per year, which is dried and ground into a fine dust before it enters the combustion cycle. O'Dea and Dowdall [17] found that the U-238 and Ra-226 concentrations in Irish peat ranged from 2.7 to 788 and 4 to 479 Bq/kg respectively. The largest bauxite processing plant in Western Europe is located in the west of Ireland, which produces approximately 1,000,000 tonnes of alumina annually from 2,000,000 tonnes of bauxite. In addition, there are industries involved in the use and transport of zircon sands, titanium dioxide and phosphate fertilisers.

The RPII has initiated a programme to investigate the extent of exposure for each of the industry types identified. Because there are wide differences in the nature of the industrial processes involved, it is necessary to adopt sector specific approaches to risk assessment and this is reflected in the RPII programme.

7 DISCUSSION

The implementation of Title VII in Ireland required significant legal changes as previously work activities resulting in a significant increase in exposure to natural sources were not explicitly covered in national regulations. As a result of the new regulations controls must be introduced in a number of workplaces, which previously would not have fallen within the scope of radiation protection regulations.

In Ireland the number of underground workplaces is small and the identification of these workplaces has been relatively straightforward. Significant radon concentrations have been found in show-caves, while the working mines investigated to date have been shown not to have a radon problem.

The number of aboveground workplaces with radon concentrations above the Reference Level is potentially large and consequently radon exposure in these workplaces is likely to account for the largest number of work activities involving significant exposure to natural radioactivity. Because of the extreme variability in radon concentrations in buildings, it is necessary to have a clearly defined survey strategy, which prioritises workplaces with the highest risk. Radon levels in aboveground workplaces are likely to follow a similar geographic pattern to that for houses. The survey strategy adopted by RPII targets workplaces located in areas identified as radon prone through the National Radon Survey.

The new Regulations require assessments of NORM exposure to be carried out in a range of industries, many of which had previously not been subject to

radiological controls. These industries vary considerably in type and nature and it is necessary to adopt a sector specific approach when dealing with them.

8 REFERENCES

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