Naturally Occurring Radioactive Material (NORM VI)

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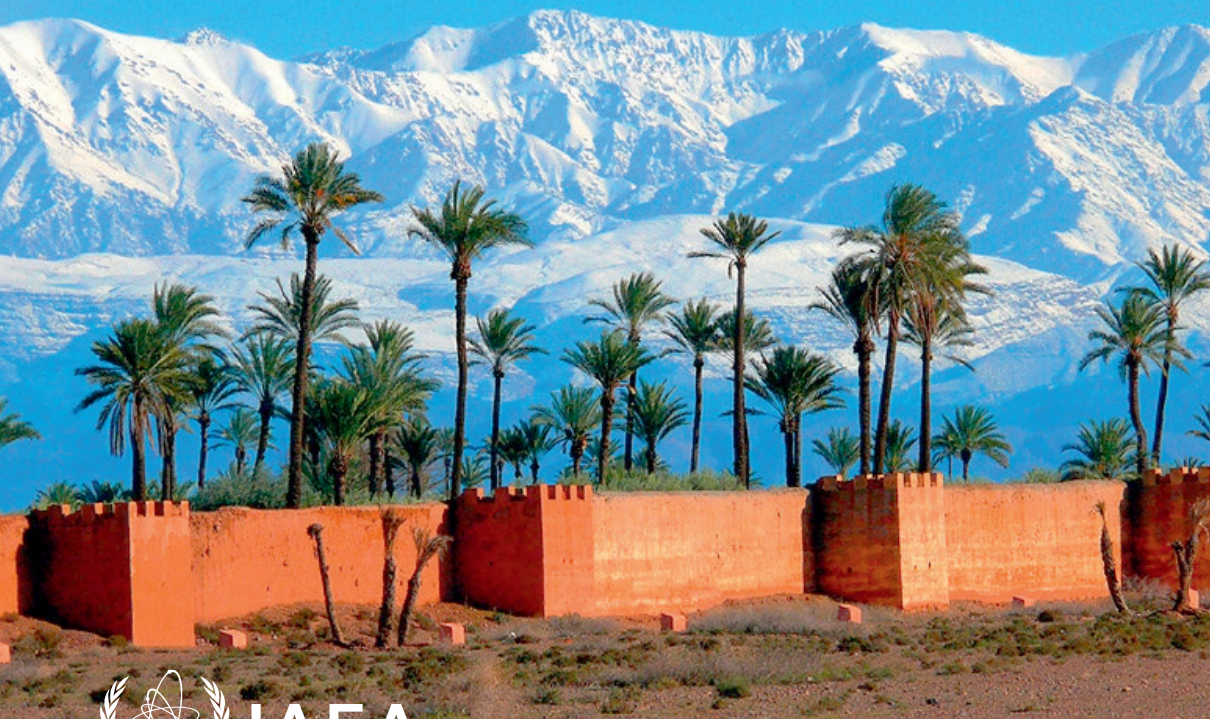

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IDENTIFICATION OF NORM FACILITIES IN BULGARIA — METHODICAL APPROACH AND RESULTS

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Abstract

Bulgaria has been a member of the European Union since 2007. Consequently, the European standards and regulatory framework have to be implemented in the Bulgarian legislative system. As part of this process, the basic safety standards in the field of radiation protection (EU BSS), as laid down in the Council Directive 96/29/Euratom, have to be implemented. Title VII of the EU BSS concerns natural radiation sources and related work activities. Its implementation requires that each Member State ensure the identification of work activities that may be of concern regarding naturally occurring radioactivity. This identification has to be done by surveys or other appropriate methods. Guidance concerning the methods of such investigations is given in the recommendations contained in the European Commission report RP88, as well as in the pertinent literature describing the occurrence of radioactivity in industrial facilities. But practical experience has shown that a comprehensive overview of the radioactivity of NORM or TENORM in an individual facility is difficult to obtain in a single survey. Furthermore, even if an industry is not radiologically relevant today, it may become so after changes of feed materials, as well as changed or new technologies (for example, installation of dust filters). This necessitates an approach that takes into account the processes that may lead to the formation of NORM and thus allows the anticipation of the occurrence of radiologically relevant materials in the future. In order to comply with the requirements of Title VII of the EU BSS, desktop research and field investigations were carried out and the evaluated, the results of which were used to enable the Bulgarian Nuclear Regulatory Authority to complete the surveys and obtain a comprehensive picture of the situation concerning NORM

industries in Bulgaria. Based on the findings in the field, a regulatory framework to address work activities and materials involving natural radioactivity was developed also. In the paper, the methodical approach for the survey and the results obtained are described. The results of this investigation have allowed the competent authority to decide on the level of the necessary regulatory regime of NORM related activities in Bulgaria. The method has turned out to be practicable and can be applied to regions or countries in which a systematic investigation of naturally occurring radioactivity in industrial sectors is necessary.

1. INTRODUCTION

Bulgaria, in the Balkans in south-eastern Europe, covers an area of 111 910 km² with a population of 7.6 million. In 2007 Bulgaria became a Member State of the European Union. Currently, there are no specific regulations to detail the general requirements related to radiological safety of NORM activities in Bulgaria. In order to assist with the implementation of Title VII ("Significant increase in exposure due to natural radiation sources") of the basic safety standards in the field of radiation protection (EU BSS), as laid down in the Council Directive 96/29/Euratom [1], into Bulgarian legislation, a project funded from the PHARE programme of the European Commission (EC) was launched. This project, the beneficiary of which was the Bulgarian Nuclear Regulatory Agency (BNRA), was aimed at identifying work activities involving natural radiation sources and NORM materials on a national level, which require regulatory attention, and to develop a regulatory framework for such work activities and materials. According to Article 40 of the EU BSS, the identification of work activities that may be of concern regarding naturally occurring radioactivity has to be done by surveys or other appropriate methods.

The methodical approach applied for this purpose included the following steps:

(1) Pre-check of industry sectors based on the list of industry sectors from the IAEA [3] and the 'positive list' of the EC [4];
(2) Identification of waste types of potential concern from a process analysis;
(3) Selection of available and accessible facilities or sites and preparations for a fact finding mission;
(4) Fact finding mission with in-situ measurements and sampling;
(5) Evaluation of results with exposure estimations and conclusions regarding a national positive list.

Based on the results of the surveys and an analysis of the existing Bulgarian legislation, a new regulatory document for work activities and residues was drafted. The project was successfully completed in December 2009 [2].

2. SURVEYS

Surveys should enable a screening of the sites and industrial activities that may require further and detailed investigations. The methodology of the site investigations and the assessments of the results should be in line with the concepts of exemption and clearance.

As a first step, a preliminary list of industries was developed, which may be relevant in the context of NORM or TENORM. This list was based on a 'macro-economic approach', that is, using national industry statistics and other publicly available information on the Bulgarian economy. This information was checked against the list published by the IAEA and the 'positive list' proposed by the EC and served as a first selection criterion for the size and relevance of the industries that may be investigated. Soon, however, it became clear that due to the structural changes of the Bulgarian economy over the last two decades a significant part of the former industries in Bulgaria had gone out of operation. These changes affected in particular the resource and basic industries, namely those that are most likely to need regulation. For instance, the only Bulgarian pig iron producer near Sofia was shut down a few years ago.

As the project duration was restricted to one year, the goal of a comprehensive survey of the national situation concerning NORM related work activities and residues would be illusionary. Rather, the survey had to be restricted to exemplary investigations, which provide the methodology for further investigations and demonstrate the general relevance of a given industrial sector for radiation protection in the country.

In preparation for the site visits, practical issues such as the availability of management representatives to grant access and logistical accessibility played a decisive role. The selection of the sites of intended visits was therefore an iterative process involving the competent authority (BNRA), the consultants and the respective plant operators. Table 1 lists the sites which were selected for exemplary investigations.

Even though uranium mining and milling is not commonly regarded as a NORM industry but is typically seen as a licensed practice as part of the nuclear fuel cycle, some uranium mining and milling sites such as Eleshnitsa were also included in the survey, due to the radiological and technical similarities with more conventional NORM sites.

TABLE 1. SITES SELECTED FOR EXEMPLARY INVESTIGATIONS

Site	Industry
Pernik/Blagoevgrad	Drinking water utility
Eleshnitsa	Former uranium mine, treatment of mine effluent
Mezdra	Ceramics production using zircon and zirconia
Varna (Agropolihim)	Phosphate fertilizer production
Maritsa-Radnevo	Coal fired power plant
Asarel-Medet, Panagyurishte	Copper ore mining and smelting
Ihtiman	Production of thoriated welding rods
Momin Prohod Hisarya, Narechenski Bani	Mineral water springs and spas
Dolni Dabnik, Pleven	Oil and gas production

3. FACT FINDING MISSION

Following the selection of exemplary sites to be investigated, the site visits were planned in the following way:

(a) Detailed 'industry fact sheets' were prepared and sent in advance to the site operators. They contained information about the technological processes that typically lead to the formation of NORM, the types of radiation (γ, β) encountered and a motivation letter describing why radiation protection may be an issue in the industry.
(b) As a methodical tool for the inspection teams, checklists and instructions regarding on-site sampling equipment, sample storage and transportation (solid, liquid), use and calibration of radiation measuring devices, as well as health and safety instructions were prepared.

Further hints concerning the methods of such investigations are given in the European Commission report RP88 [5], as well as numerous papers and guidelines [6] describing the occurrence of radioactivity in industrial facilities. The fact finding mission was carried out in March and April 2009. Site inspection teams consisted of the consultant and representatives of the competent authority, as well as the site operator, typically the health and safety officer. It was notable that the awareness of NORM issues among the industry representatives was very low, even in industries which are widely known for the occurrence of NORM. At the sites, measurements were made at the relevant points of the technological processes, and solid and liquid samples were taken where material was available.

All samples were radiochemically analysed by a laboratory certified according to ISO 17025.

The experience gained in several years of NORM surveillance, including a predecessor project with similar objectives in Romania in 2008, had shown that the identification of sites and facilities which are typically contained in the positive lists is not sufficient to draw conclusions on the need for regulatory control of that industry as a whole, and may even be misleading. Therefore, the following supplementary aspects must be taken into consideration:

(1) A plant may not be operational at the time of the investigation, but temporarily shut down for maintenance. Raw materials and residues may therefore not be available for sampling.
(2) Raw materials used at the time of the site visit may coincidentally not be representative. In particular, their radiological properties may be untypical.
(3) Raw materials and processes may change. For example, a phosphate fertilizer plant may import raw phosphate from different sources with varying radionuclide concentrations. Dust filters may be installed in the future, which minimize airborne discharge of dust but necessitate the management of filter dust rich in ^{210}Pb and/or ^{210}Po.
(4) The level of radioactivity in the raw materials may vary significantly between individual sites. This is particularly true for mineral water springs and spas, and natural oil or gas production sites. Therefore, even if a particular site shows no elevated level of radioactivity, this is not sufficient to draw a firm conclusion for the entire industrial sector in the country.

Moreover, the usual positive lists of NORM-industries are very general and do not give sufficient advice regarding the degree of radionuclide enrichment in an individual process stream of a certain facility. These problems may at least be partially overcome using a process-based approach as described in Ref. [7], for example. It gives the opportunity to:

(i) Identify the relevant parts of an operation based on general physical or chemical considerations;

(ii) Select the appropriate radiation detectors (for example, beta sensitive devices if furnace dust dominated by ^{210}Pb is expected);
(iii) Give detailed instructions to the laboratory to which samples are sent, to use appropriate spectrometry equipment (for example, to take account of the 46 keV energy peak for ^{210}Pb);
(iv) Draw conclusions on the age of residues (for example, from the activity ratio of ^{228}Ra and ^{228}Th).

4. RESULTS OF THE FACT FINDING MISSION

The data collected during the site investigations, partly complemented by information from the available literature, were used to carry out dose assessments for workers and members of the public. As no binding dose assessment guidelines are presently available in Bulgaria, the German guidelines [8] were used, having proven to be rather practicable. However, it must be noted that the dose estimates are sometimes beset with great uncertainties. Therefore, assumptions have been made and model parameters have been used which reflect a likely exposure scenario or, if no information was available, describe a conservative approach. As a general rule, the following approach was applied to the dose calculations:

(a) If the site visits have revealed activity concentrations and other radiologically relevant material properties which are comparable with international literature data, and if consequently they lead to exposure of members of the public or workers which cannot be neglected from the radiation protection point of view, the results of the dose calculations are taken as the basis for the assessment.
(b) If, for any reason (such as those mentioned above) the dose estimates do not lead to any elevated exposures at the existinglocation, values of the radiological properties from the literature have been used for hypothetical scenarios which may happen in the future. In this case, the scenario for the existing situation and the hypothetical scenario for future activities are both taken into account for deriving the conclusions on the radiological relevance of a particular work activity or material.

While raw data from individual sites are usually treated with confidentiality, the aggregated results are summarized in Table 2. The dose estimates have revealed the following facts:

(1) The overall level of natural radioactivity, which is not particularly high compared with other countries in Europe [9], is reflected in a small number of sites and industries that deserve immediate attention.
(2) Industries processing raw materials that originate in Bulgaria are unlikely to lead to significantly elevated levels of radioactivity in their residues or other process streams. However, if raw materials are imported, such as phosphate rock from deposits known for their radiological relevance, regulatory oversight may be warranted.
(3) Some industries that were not operational during the project implementation may be revived when economic conditions improve. Repeat measurements should then be carried out to confirm or dispel radiological concerns.