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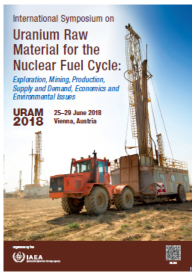


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# A New IAEA Safety Report on Occupational Radiation Protection in the Uranium Mining and Processing Industry

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INTRODUCTION

The Fundamental Safety Principles IAEA Safety Standards Series No. SF-1, together with Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards IAEA Safety Standards Series No. GSR Part 3, set out the principles and basic requirements for radiation protection and safety applicable to all activities involving radiation exposure, including exposure to natural sources of radiation and brings challenges to the regulators, operators and workers in implementing the occupational radiation protection requirements [1, 2]. There has been more than 40 years of experience in applying international radiation safety regulations at uranium mines worldwide. Even though radiation safety regulations are among the most comprehensive and stringent in many uranium producing countries, there is still scope to enhance protection of occupationally exposed workers in terms of improving mechanisms to reduce occupational exposure, achieving informed personal behaviours, and applying best engineering controls, etc.

While many uranium mining companies generally take active steps to reduce radiation doses and control exposures wherever and whenever they can, and often voluntarily adopt the most recent international recommendations on dose limits and necessary occupational radiation protection requirements before they become part of the regulations, consideration needs to be given to enhancing radiation protection of workers on an industry-wide and global basis. This is important as it supports the implementation of internationally consist standards and approaches regarding the protection of workers.

In the last 60 years uranium has become one of the world's most important nuclear fuels. It is mined and concentrated similar to many other metals. Uranium is a naturally occurring element with an average concentration of 2.8 parts per million in the Earth's crust. Traces of it occur almost everywhere. It is more abundant than gold, silver or mercury, about the same as tin and slightly less abundant than cobalt, lead or molybdenum. Natural uranium being the basic fuel for its first phase of nuclear power programme, an increase in the momentum of prospecting, mining and processing of uranium is inevitable.

There are three main methods of producing uranium - underground mines, open pit mines, and in–situ-leach (ISL) (sometimes referred to as in situ recovery or ISR). Conventional mines, either underground or open pit mines have usually associated with a mill where the ore is crushed, ground and then leached to dissolve the uranium and separate it from the host ore. At the mill of a conventional mine or the treatment plant of an ISR operation, the uranium which is now in solution is then separated by ion exchange before being precipitated, dried and packed. This product uranium oxide concentrate (UOC) is also referred to as yellowcake and mixed uranium oxides –U3O8 and/or UO4.

In addition, uranium can be recovered as a by-product from phosphate fertilizer production and from mining of other minerals including copper and gold where the ores contain economically exploitable quantities of uranium. In such situations, the treatment process to recover uranium may be more complex.

With the current interest in nuclear power, there has been an increase in uranium exploration and also in the development of new uranium mining and processing facilities in many countries. World uranium production in 2012 was 58,344 t of uranium [3]. This uranium production occurred in nearly 20 countries at approximately

50 different mining and processing facilities. As a consequence, the numbers of workers in uranium mining and processing may increase substantially within a few years. During uranium mining and processing, workers may be exposed externally to gamma rays emitted from the ores, process materials, products and tailings, and internally exposed from the inhalation of long lived radioactive dust (LLRD), radon and radon progeny, and through ingestion, injection and absorption of contamination.

OBJECTIVES OF THE SAFETY REPORT

The objective of the Safety Report is to provide detailed information that will assist regulatory bodies and industry operators in implementing a graded approach to the protection of workers against exposures associated with the uranium mining and processing. This information will also serve as the basis for creating a common understanding, based on common knowledge, between the various stakeholders —such as regulators, operators, workers and their representatives, and health, safety and environmental professionals —of the radiological aspects of the various processes involved and the ways in which these aspects can be addressed appropriately and effectively.

SCOPE OF THE REPORT

The safety report describes the various methods of production used by the uranium industry and provides practical information on the radiological risks to workers in the exploration, mining and processing of uranium, on exposure assessment, and on management of exposure based on the application of the appropriate standards and good working practices. This information has been compiled from published literature, from unpublished data provided by contributors to the report and from numerous experts with extensive experience, notably in the various sectors of the uranium mining and processing industry.

STRUCTURE

The report comprises six sections. Following the introductory section, Section 2 gives an overview of the uranium industry and the general radiation protection aspects of uranium mining and processing stages and techniques. Section 3 summarizes the radiation protection considerations that apply to the uranium mining and processing industry in general and application of the international standards in particular, including the basic radiation protection principles, the graded approach to regulation and specific aspects of radionuclides in the uranium decay series. Section 4 addresses the general methodology for control with the introduction of occupational health and safety considerations, the hierarchy of control, the radiation protection principles and exposure pathways. Section 5 deals with the requirements and dose assessment, with discussion on general dose considerations for different types of exposure pathways. Section 6 introduces the essentials of radiation protection programmes to adequately protect the workers, illustrating the process, design and operation, principal exposure pathways, control mechanisms and monitoring and dose assessment for different uranium mining and processing stages and techniques. The report is supplemented by appendices describing the findings of the International System on Uranium Mining Exposures (UMEX) survey, and the technical details of various exposure pathways.

REFERENCES

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## Country or International Organization

International Atomic Energy Agency

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