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INFORMATION AND COMMUNICATION TECHNOLOGIES FOR APPROPRIATE COMMUNICATION IN THE WORKPLACE

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ABSTRACT

Brazil is one of the 5th largest countries on earth. It is geopolitically divided into five regions, with large between-country distances and plenty of radioactive facilities throughout the country. Professional continuing education is a must and a challenge. This paper discusses a web-based project designed to provide effective communication about occupational exposure, using creative, innovative and practical Internet solutions to link geographically distant workers to high-quality reliable information. This web-based-project counts on concepts, definitions and theory about radiological protection issues, such as optimization programs and ionizing radiation monitoring procedures. Moreover, the content presents discussions related to national and international recommendations, such as potential exposure, which is currently one of the most important research fields in radiological protection. Only few publications develop expressively the issue and there is still lack of knowledge and uncertainties. Risk definition itself can assume different meanings, even among scientific community. To respond to this challenge, this project discusses potential exposures through question-and-answer topics addressing particular attention to effective actions towards safety which can be incorporated into labor practice in the workplace. For discussions to be effective, all content is based on ICRP and IAEA valid recommendations and official reports, in addition to scientific papers published in major international congresses. This project aims to provide radioactive facilities reliable updated communication, to inform as many people as possible, contributing to develop workers´professional skills and to improve safety culture in workplace.

RESUMEN

Brasil es uno de los 5 países más grandes del mundo. Se divide geopolíticamente en cinco regiones, con grandes distancias entre estados y muchas instalaciones radiactivas en todo el país. La formación continua profesional es una necesidad y un desafío. Este artículo discute un proyecto basado en la Web diseñado para proporcionar una comunicación efectiva sobre la exposición ocupacional, utilizando soluciones creativas, innovadoras y prácticas de Internet para ofrecer a los trabajadores geográficamente distantes una información fidedigna y de alta calidad. Este proyecto basado en la web cuenta con conceptos, definiciones y teoría sobre cuestiones de protección radiológica, como programas de optimización y procedimientos de monitoreo de radiación ionizante. Además, el contenido presenta discusiones relacionadas con recomendaciones nacionales e internacionales, como la exposición potencial, que es actualmente uno de los campos de investigación más importantes en protección radiológica. Sólo pocas publicaciones desarrollan expresamente el tema y todavía hay falta de conocimiento e incertidumbre. La propia definición del riesgo puede asumir diferentes significados, incluso entre la comunidad científica. Para responder a este desafío, este proyecto discute las exposiciones potenciales a través de variados temas con preguntas y respuestas con especial atención a las acciones efectivas hacia la seguridad que se pueden incorporar a la práctica laboral. Para que las discusiones sean efectivas, todo el contenido se basa en las recomendaciones válidas de la CIPR y el OIEA y sus informes oficiales, además de artículos científicos publicados en los principales congresos internacionales. Este proyecto tiene como objetivo proporcionar a las instalaciones radiactivas una comunicación fiable y actualizada, para informar a tantas personas como sea posible, contribuyendo a desarrollar las habilidades profesionales de los trabajadores y mejorar la cultura de seguridad en el lugar de trabajo.

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1. INTRODUCTION

Brazil is a federative republic formed by the union of 26 federal states, besides the Federal District. The country is divided into five regions (North, Northeast, Midwest, Southeast and South) with 3 time zones. It is the largest country of Latin America, with 8.5 million square kilometers and one of the world's most populous countries. In our country facilities involving ionizing radiation are divided into nuclear and radioactive facilities. Nuclear installations cover the entire nuclear fuel cycle, which comprises nuclear materials mining, including power reactors and research, the production of radioisotopes for use in several human activities and also the reprocessing of fuel elements of nuclear reactors. Moreover, the radioactive facilities are those that make use of ionizing radiation in other peaceful applications of nuclear energy like in the industry, medicine, agriculture, environmental protection, among others. This division is due to the fact that the entire nuclear fuel cycle, including reactors, are government monopoly, while all other human activities involving ionizing radiation can be developed and used by the public under government supervision. In Brazil, the national government entity, linked to the IAEA and under the Ministry of Science and Technology, is the National Nuclear Energy Commission (CNEN)[2]. This committee has issued a series of standards for radioactive facilities in the country, with programs that are adequate and effective to remain in operation for radiological protection. In January 2018 the official website of CNEN counted on 1807 licensed radioactive facilities. As an example, there are 660 facilities for industrial applications, among which 472 radioactive facilities for Nuclear Measurement Devices operating in 21 different states in the country[3] [1].

In order to establish a Radiological Protection Plan or a Radiological Emergency Plan, Brazilian facilities should take into account all procedures based on both national and international standards, guidelines and recommendations. This information can be found in various documents published by different organizations over the past decades: the International Commission on Radiological Protection (ICRP), International Atomic Energy Agency (IAEA) and National Nuclear Energy Commission in Brazil (CNEN). The ICPR provides international guidelines to protect the environment and individuals of the ionizing radiation harmful effects. Its recommendations are based on the reports of the “United Nations Scientific Committee on the Effects of Atomic Radiation” (UNSCEAR) and reports of the "Biological Effects of Ionizing Radiations" (BEIR). The IAEA brings together the countries that use ionizing radiation and are affiliated to the United Nations. The IAEA publishes its recommendations based on the ICRP reports, providing guides to meet ICRP requirements. The IAEA has more than two thousand publications about safety and security, including the Safety Series collection, with more than 150 publications, and the Technical Report Series collection. Many of the above-mentioned publications concern radiological protection. Moreover, the National Nuclear Energy Commission, who establishes the national requirements for radiological protection periodically reviews and updates Brazilian national laws. Changes come fast. Professional continuing education is a must and a challenge in this large extension country with huge geographic distances and radioactive facilities spread all over the country. This paper discusses a web-based project designed to provide effective communication about occupational exposure, using creative, innovative and practical Internet solutions to link geographically distant workers to high-quality reliable information.

[2] In Portuguese: Comissão Nacional de Energia Nuclear - CNEN

[3] Information collected in CNEN´s official website on 20th January 2018.

2. METHODOLOGY

UNIPRORAD is a web-based instructional program to improve professional development, providing Brazilian radioactive facilities a complete repository in Portuguese for research, consultation and information about recommendations and standards for Radioactive Facilities in Brazil [2]. This web-based project works informatization of Radiological Protection Programs according to the positive tree published by IAEA in Safety Series No. 102, the most generic and complete tree for an appropriate and effective radiation protection program[4] [3].

The web-based-project counts on Information and Communication Technologies (ICTs) and the best didactics and pedagogical practices to explain concepts, definitions and theory about radiological protection issues, such as optimization programs and ionizing radiation monitoring procedures. Optimization programs present and discuss valid publications and recommendations from IAEA, ICRP and CNEN, as well as full papers published by scientific journals or international congresses. To assure a high-quality professional learning, all materials presented in the website are fully referenced with the path to the original publications. The content includes optimization programs, help decision making techniques, information related to protection costs, radiation doses and detriment. Furthermore, users count on a simulator with the 5 decision making techniques described in ICRP Publication 55, which allows each user to learn, compare and simulate each one of the decision-making techniques [4].

Ionizing radiation monitoring policy and techniques are also fully discussed, integrating and interrelating elements of optimization and monitoring programs. The website presents the criteria used for control of occupational exposures, discussing normal and potential exposures, authority and responsibility, classification of work areas, practical implications and engineering controls, operational procedures, reference levels, types of monitoring and its functions. The system provides detailed information about workplace monitoring (monitoring for external radiation, monitoring for surface contamination and monitoring for air contamination) and individual monitoring (monitoring of external exposure and monitoring of internal exposure and monitoring for skin and clothing), discussing objectives, routine monitoring, task-related monitoring, special monitoring and interpretation of results for each type of monitoring program. Problem-based training exercises about external radiation and air contamination are given, helping users to develop necessary skills for achieving higher performance in workplace.

In 2017 this research team for potential exposures of the Nuclear and Energy Research Institute (IPEN-CNEN/SP) started to disseminate through the website reliable information about potential exposure, discussing not only the collection and interrelationship of existing information in the several publications (IAEA and ICRP), but also new approaches from some recommendations, due to the fact that only few publications develop expressively the issue and, even though they provide fundamental theory, there is still lack of knowledge of failure probabilities, which currently constitutes a broad research field in radiological protection. The information program offered by UNIPRORAD proposes the development of fault trees and the analysis of different scenarios. As an example, our team re-discusses the fault trees

[4] Even tough IAEA Publication 102 is superseded, the recommendations regarding a tree for an appropriate and effective radiation protection program are not repeated in the newest publications of this entity.

presented in ICPR Publication 76, suggesting different paths to quantify probabilistically the occurrence of potential exposures [5].

3. DISCUSSION AND RESULTS

ICRP has published more than a hundred publications and IAEA has more than 2,000 official reports. Many of them are superseded but contain valid recommendations which were not rewritten in the newest publications. A significant example is the monitoring programs for air contamination described in ICRP Publication 75, which – according to the International Committee of Radiological Protection – replaces entirely ICRP publication 35. It occurs that Publication ICRP 75 brings new recommendations about the most convenient structure about air contamination without describing the information about the general structure. This vital and still valid information is only available in a superseded publication [6 - 7].

Indeed, the system UNIPRORAD brings together information from different publications comparing similarities, explaining differences and analyzing discrepancies among the several valid recommendations. This is especially important to Brazilian Radioactive facilities, where Radiological Protection Plans and Radiological Emergency Plans should take into account all procedures based on both national and international standards, guidelines and recommendations. Let us take as example the investigation level. IAEA and ICRP suggest different values for the investigation level for individual effective dose in monitoring procedures. The IAEA [8] recommends 6 $mSvy^{-1}$, which means 3/10 of maximum average annual limit. Nevertheless, the value of the investigation level suggested by the ICRP [9] is 1/10 of the maximum permissible annual limit, which means 5 $mSvy^{-1}$. In Brazil, according to CNEN [10], the level of investigation is 6 $mSvy^{-1}$.

The content has been developed and structured to provide answers to all questions that should be reasonably asked to plan a Radiological Protection plan according to each user's specific situation. Considering the above example, the question could be: "How to achieve compliance with ICRP and CNEN to define the investigation level of individual effective dose in the case of internal contamination monitoring?" To answer to this question, the website UNIPRORAD brings the specific recommendations of ICRP, IAEA and CNEN analyzing and explaining the variations. According to CNEN the level of investigation is 6 $mSvy^{-1}$ or 1 mSv in a single month. The ICRP suggests 5 $mSvy^{-1}$ / n where n has the same meaning of CNEN rules and the investigation level is the recording level itself [9 - 10].

Moreover, discrepancies among the several publications are not limited to recommendations themselves. Regarding potential exposures, it is essential to take into account the concept of "risk", which seems to assume a great variety of meanings. The impasses to communicate the concept of risk for radiological protection purposes, can be given by the following examples:

ICRP 64 - (section 7)
"Before ICRP 60, the Commission used the term "risk" as a synonym for the probability of a harmful effect (fatal cancer or severe hereditary damage). Nevertheless, outside radiation protection field, "risk" has several meanings, including the common sense in everyday language, meaning an undesirable event, including both the probability and the nature of an event. In nuclear safety, "risk" is mostly defined as the mathematical expectation of the magnitude of the undesirable consequence, which means: the product of the probability and

the consequence of the event. In this sense, risk becomes a physical quantity characterized by a magnitude expressed by a unit with no dimension when risk means probability, but with a certain dimension if it means the mathematical expectation of the consequence. This publication already recognized that these different meanings of the word causes considerable confusion in interdisciplinary communications" [11].

INSAG 9 - (section 6)
"The word "risk" has several meanings, even though to all of them there is an associated idea of probability. In a number of publications, "risk" is used as synonym of "an event probability with undesirable consequences". In nuclear safety, it is often employed meaning a combination of probability and consequences, sometimes presented as a product of the probability of an event and the magnitude of its consequence. This product is the mathematical expectation of the consequences" [12].

NEA / OECD N84 – (section 4.1)
"The word "risk" can be used in a variety of ways and be given several meanings. In the common loose meaning of everyday language, it is the thread of an undesirable outcome, e.g. death or adverse economic consequences. Two common definitions of risk used in technical work are: (a) the probability of a defined unwanted consequence, and (b) the mathematical expectation of consequences, i.e. the annual probability of an accident multiplied by a measure of the consequences if the accident occurs" [13].

Indeed, different publications suggest different definitions and interpretations to describe nature and magnitude of risk, making "risk" one of the key terms of particular concern [14]. As a matter of fact, one of the major problems is that terminologies employed by different specialists, groups and organizations in different contexts assume different meanings and lead to different understandings, resulting in poor communication, even among specialists, about potential exposure concepts and issues [13]. Regarding the issue, the web-based program UNIPRORAD offers a further approach among several publications, discussing and explaining their concepts, definitions and recommendations, in order to provide answers to most frequently asked general questions regarding workers' understanding about the concept of risk related to potential exposures. All content can be acceded free of costs and the system is used by radioactive facilities and students. From December 1st 2017 to January 30th 2018, the website had registered 594 page views from 7 different Brazilian states.

4. CONCLUSIONS

In a large-extension country like Brazil, with radioactive facilities all over the country, it is a must and a challenge to provide workers accessible trustful information about occupational exposure in normal and emergency situations in industrial, medical and research contexts. UNIPRORAD is a web-based instructional program with free content distribution system to improve professional development and stimulate appropriate actions to be incorporated into labor practice responsible actions towards safety [15].

The work includes the informatization of the monitoring policy and techniques, interrelating information currently scattered in several documents, providing Brazilian radioactive facilities a complete repository for research, consultation and information. A user with a standard

internet connection is able to experience a good-quality access, even through low-peed connection. All content is fully referenced, offering users the links to the original sources for specific researches or further information.

This educational program aims to offer trustful communication, providing relevant, adequate, accurate and understandable information enabling workers to improve their knowledge and actively participate of the decision-making processes and actions that contribute for their own safety and security. It is our aim to spread information wherever it is needed and to make this system a reference for all Portuguese spoken countries.

5. REFERENCES

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