INFORMATIZATION AND INTEGRATION OF RADIOLOGICAL PROTECTION OPTIMIZATION PROGRAMS

Levy, Denise S.[2,3]; Sordi, Gian-Maria[1,2]

[1]Atomo – Radioproteção e Segurança Nuclear S/C Ltda, São Paulo, SP, Brazil
[2]Instituto de Pesquisas Energéticas e Nucleares – IPEN-CNEN/SP, São Paulo, SP, Brazil
[3]Ômiccron Programação Gráfica, Atibaia, SP, Brazil
info@uniprorad.com.br

ABSTRACT

In order to develop a radiation protection program, Brazilian radioactive facilities should consider national and international standards, guidelines and recommendations from the International Commission on Radiological Protection (ICRP), International Atomic Energy Agency (IAEA) and Comissão Nacional de Energia Nuclear (CNEN). This project aims the informatization of the radiological protection optimization programs in a single system in order to offer unified programs and inter-related information in Portuguese, providing Brazilian radiaoctive facilities a complete repository for research, consultation and information in a quick, integrated and efficient way, enabling complex queries with reduced response time. The content includes concepts, definitions and theory in addition to the optimization programs, help decision making techniques, information related to protection costs, radiation doses and detriment. This project uses the combination of multiple technologies, maximizing the resources available in each technology in order to achieve our goals.

Key words: radiological protection optimization; ALARA principle; Information and Communication Technology; informatization of radiological protection

1 Introduction

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, namely: the International Commission on Radiological Protection (ICRP), International Atomic Energy Agency (IAEA) and Comissão Nacional de Energia Nuclear (CNEN).

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.

The ICPR provides international guidelines aimed to protect the environment and individuals to the harmful effects produced by ionizing radiation. Its recommendations are grounded in 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) and they are based on their own policy of protection. In his publications, the ICRP also provides the reasons that led to present their recommendations. This entity currently has had 107 published reports, although not all remain active.

The IAEA brings together the countries that use ionizing radiation and are affiliated to the UN. This committee issued its own recommendations, based on the ICRP recommendations and its policy. The IAEA does not provide the reasons for these recommendations, but provides guides to meet all their requirements. Currently, the IAEA has more than 2,000 (two thousand) publications about safety and security, but for the radiological operational protection there is the collection Safety Series, with more than 150 publications, but not all active. They also have the collection Technical Report Series and the technical documents series known as Tec-doc.

Every country affiliated with the IAEA issues its national rules and regulations, based on international recommendations, because each country has a governmental or regulatory body in permanent contact with the IAEA. In Brazil, the national government entity, linked to the IAEA and under the Ministry of Science and Technology, is the Comissão Nacional de Energia Nuclear (CNEN). This committee has issued a series of standards [01-15] for radioactive facilities in the country, programs that are adequate and effective to remain in operation for radiological protection, but does not give a guide to follow, as does the IAEA. Although the Basic Guidelines Protection [01], in his article 5.3.8, inform the subject that a Radiation Protection Plan should contain, it is not in a logical sequence, nor have detailed and specific comments, which makes for similar radioactive installations to have different descriptions of the programs to the approved plans.

This project aims the informatization of the radiological protection optimization programs in a single system in order to offer unified programs and inter-related information in Portuguese, providing Brazilian radiactive facilities a complete repository for research, consultation and information in a quick, integrated and efficient way, combining computer technology and radiological protection in order to enhance the best benefits from information technology.

2 Methodology

2.1. The information of optimization programs

The use of information technology for the radiological protection program for human activities shall help greatly the radioactive facility that requires such use and who needs to implement the program. The main purpose of the use of information technology in the process is to provide the corporate public a complete vehicle that allows detailed research related to optimization, and allows to size optimization efforts by technology, enabling them to be effective and justified.

In order to meet both national standards of CNEN [1-15] and international recommendations of ICRP [16-17] and IAEA [18, 19] within the scope of this work, the development of this project started from concepts, definitions and theory, aside from the detailed survey of the optimization

program contents in order to inter-relate information, currently scattered in various publications and documents, in a consistent and appropriate manner. The servers processing power added to the technology of relational databases allow to integrate information from different sources, enabling complex queries with reduced response time. We conducted a comprehensive job of perception about each program contents, its real dimension (avoiding under or oversizing), identifying and detailing the vital parts of programs, opportunities for inter-relationship of information, development of search engines according to different structures created and their indexing criteria.

Furthermore, we carried out a research work regarding the possibilities of access to the Information and Communication Technology (ICT) in companies throughout the country. This research work has enabled the collection of quantitative and qualitative data about our target public profile. That allowed us to define the best interfaces tools and resources according to the study of inter-relationship and unification of radiological protection programs.

According to a publication held by the Comitê Gestor da Internet no Brazil [20] who conducted a survey in all Brazilian States, there was an important advance in the use of IT in Brazilian companies. This research makes use of methodological standards proposed by the United Nations Conference on Trade and Development (UNCTAD), described in the Manual for the Production of Statistics on the Information Economy, produced in partnership with the Organization for Economic Co-operation and Development (OECD), European Commission of Statistics (EUROSTAT) and together with the Measuring ICT for Development, a coalition of various international organizations aiming the harmonization of key indicators on IT research (Information Technology and Communication) [20].

In Brazil, between years 2006 to 2008 there was a significant decrease in the use of the dial-up internet from 14% to only 5% [21]. Besides, there was significant progress regarding internal wireless network in corporations, that included only 14% of companies in 2005. Nevertheless, in 2009 41% of Brazilian companies already claimed to have wireless network. These are only few examples that demonstrate the rapid evolution of events and trends of the business market to track the latest technological trends in order to benefit as fully as possible the advances of information technology [20].

The most recent publication of this entity up to this date [20] shows that 97% of Brazilian companies with more than 10 employees use computers, and this percentage increases to 100% in the case of companies with more than 50 employees. The average percentage of employees, who use computers in the workplace, are equivalent to 45%. Among Brazilian companies that have a computer, 96% have Internet access, a percentage that reaches 99% if one considers only companies with 50 or more employees, and the proportion of employees who use computers connected to the internet is 38%. When each region is studied separately, access to internet are led by South and Southeast regions with a percentage of 40%, and the Midwest, which has the highest average rate with 43% of employees who use the Internet in workplace [20]. Among the predominantly activities performed by employees in Brazilian companies, stands in third place the search for information and research activities. 86% of Brazilian companies make great use of those activities. [20]

Given these data, we were able to start the design of the system intelligence and the development of information technology models of radiological protection. The pilot project was implemented in a web environment, using the Web 2.0 tools and resources that allow the entire

organizational structure, that would enable the inter-relationships and joints needed for proper use of information technology in radiological protection.

We developed platform whose range of features and functionality suits the needs of the corporate public. Our challenge involved the ability to create a robust and effective, but at the same time flexible system, allowing one to adapt it to future technological innovations.

The system is developed in a modular structure, that allows to integrate interrelated elements on both search and research basis. Also, we developed updating models where each information is recorded in its most current form in a single record without redundancy, even though it can be found in different subjects or modules. Each module is developed independently and can be inserted, adapted, updated or deleted separately, without prejudice of the other ones. This will allow the program adjusts over time according to the needs identified during the next years. Different search engines are being developed for each process step. The correct indexing of contents guarantees that search engines will find the desired information in the shortest time possible.

This project uses the combination of multiple technologies, for both development and infrastructure issues, maximizing the resources available in each technology in order to achieve our goals.

Taking into account this is an original project with the prospect of long-term use, it was considered the HTML (XHTML1 STRICT) patterns, according to the W3C (World Wide Web Consortium) recommendations. [22]. Considering an infrastructure that supports an average volume of service access, we chose the Linux operating system and MySQL server database [23]. Whether during the implementation phase or hereafter the server has to be rescaled to increased demand, our team can easily migrate the database to a server MSQL Server [24].

This WEB 2.0 concept project makes extensive use of CSS (computer language), allowing it to be easily adapted to new possibilities of media, like mobile access, feeds of content and information sharing. There is still a great concern for SEO (computer language) to ensure that the information is well-indexed in the best way possible in the Internet search engines.

For the server language development, we chose PHP [25], as it is a widespread technology, well documented with an extensive and active community, and especially for being a dynamic and flexible language, and it is to maintain. Other more modern technologies, up to this date, still have several points of concern regarding the maintenance of source code and flexibility for future development. Also, this the conception of this project involved the graphical development of the site, its visual identity and appropriate navigation layout (wireframe).

The technologies mentioned are current pattern programs for this type of development project but shell be constantly revised and may change according to the constant innovations in the information and communication technology that certainly will change in coming years.

2.2. Delineation of the project

The development of this research and implementation of the proposed computerization work of radiological protection program is a long and difficult task which implies working complex content through relational database, as well as the inter-relationship of all related information

concerning the optimization. The content includes concepts, definitions and theory in addition to the optimization programs, help decision making techniques, information related to protection costs, radiation doses and detriment. For now we intend to begin an initial core working only the optimization program, which in the near future could be extended to other fields of radiological protection, according to the positive Porphyrian Tree, published by IAEA [26] in 1990, the more generic and complete tree for an appropriate program of radiation protection. The project involves the creation of computerized models that comprise the various aspects of optimization:

a. Concepts and definitions whose terminology will follow the definitions provided by the ICRP publications [27-29] and IAEA [30].

b. Structured models for optimization projects of radiactive facilities and models for the facility operation, according to guidance provided by ICRP [29].

c. The three basic principles of radiological protection, namely: justification, optimization and dose limitation system, according to guidance provided by ICRP [27].

d. Quantitative decision making techniques, according to the ICRP publications [27-29] and some examples through interactive virtual components, so the user can quantify and sense the extent required in practical situations. These interactive components are original and have been exclusively created for this purpose.

e. Estimates of the alpha value and the international and national examples according to the guidance provided by the IAEA [30] and the publication of the Commission of European Communities [31].

f. The factors that could be quantified according to the guidance given by ICRP [29], which includes the methodology necessary to implement the optimization procedure for both the project and the operation of the radiactive facility.

g. The construction of the optimization process, given its features, the stakeholders and the choice of the optimal options, which means the analytical solution, and the distribution of doses over time and space, inserting the matrix of collective dose to the decision making according to publication of the ICRP [32] and following the methodology suggested by it.

h. The procedures for evaluation of exposure situations, and the basic guidelines, showing the actual dimensions of each situation.

i. The principles and means of reducing exposure that will keep the actual dimensioning of each situation.

j. The global components to be considered to define and implement an ALARA Program.

3. Conclusion

The unification of radiological protection optimization programs implies working on vast and complex content, identifying the most appropriate functional structure in order to develop a project that allows effective access to information and research. The computerization requires a careful research on content optimization that refers to laws and regulations available in various

publications or from different sources (ICPR, IAEA, CNEN). The task of inter-relating all that information is accomplished taking into account established criteria for the development of database relational systems and the features of the information. The relational database allows the inter-relationship of all relevant co-related information, which are not available in a linear structure or in the same publications, such as laws and regulations under country each local authorities, which may be more (or less) restrictive than international recommendations.

For dimensioning the work of informatization and developing the WEB platform according to the needs of the target public, we have conducted an extensive research regarding the possibilities of Information and Communication Technology (TIC) access in companies throughout the country. The data obtained allowed to mark the effectiveness of this work, such as the proportion of companies using computers, number of computers per company, the proportion of employees who use computers or who have remote access to the system, the proportion of companies with network (LAN, intranet, extranet), activities with the corporate mobile phone, the proportion of companies using the internet, the proportion of employees with internet access at work, average download speed provided by the host service, type of activity performed by the companies using the internet, the proportion of companies with policies access restriction. These data should be periodically reviewed, so that the system is in accordance to the corporate profile.

Still, due to constant technological innovations, our team intends to lead a constant research work and monitoring of new related technologies that may be useful for the development of this project, which uses the combination of multiple technologies, maximizing the resources available in each one of them in order to achieve our goals.

References

[1] CNEN – NN – 3.01, **Diretrizes Básicas de Proteção Radiológica**, 2005
[2] CNEN – NE 3.02, **Serviços de Radioproteção**, 1988
[3] CNEN – NN 3.03, **Certificação da Qualificação de Supervisores de Radioproteção**, 1999
[4] CNEN – NN 3.05, **Requisitos de Radioproteção e Segurança para Serviços de Medicina Nuclear**, 1996
[5] CNEN – NE 3.06 - **Requisitos de Radioproteção e Segurança para Serviços de Radioterapia**, 1990
[6] CNEN - NN 4.01 - **Requisitos de Segurança e Proteção Radiológica para Instalações Mínero-Industriais**, 2005
[7] CNEN – NE 5.01 - **Transporte de Materiais Radiativos**, 1988
[8] CNEN – NE 5.02 - **Transporte, Recebimento, Armazenagem e Manuseio de Elementos Combustíveis de Usinas Nucleoelétricas**, 2003
[9] CNEN – NE 5.03 - **Transporte, Recebimento, Armazenagem e Manuseio de Itens de Usinas Nucleoelétricas**, 1989
[10] CNEN – NN 6.01 - **Requisitos para o Registro de Pessoas Físicas para o Preparo, Uso e Manuseio Fontes Radiativas**, 1998
[11] CNEN – NE 6.02 - **Licenciamento de Instalações Radiativas**, 1998
[12] CNEN – NN 6.04 - **Funcionamento de Serviços de Radiografia Industrial**, 1989
[13] CNEN – NE 6.05 - **Gerência de Rejeitos Radiativos em Instalações Radiativas**, 1985
[14] CNEN – NE 6.06 - **Seleção e Escolha de Locais para Depósitos de Rejeitos Radiativos**, 1989
[15] CNEN – NN 6.09 - **Critérios de Aceitação para Deposição de Rejeitos Radiativos de Baixo e Médio Níveis de Radiação**, 2002

[16] ICRP, 1991. 1990 **Recommendations of the International Commission on Radiological Protection**. ICRP Publication 103, Ann. ICRP 21 (1-3)
[17] ICRP, 2007. **The 2007 Recommendations of the International Commission on Radiological Protection**. ICRP Publication 94, Pergamon Press, Oxford and New York (2007)
[18] **International Basic Safety Standards for Protection Against Ionizing Radiation and for the Safety of Radiation Sources**, Safety Series n.115, International Atomic Energy Agency, Viena, 1995
[19] **IAEA Safety Standards for Protecting People and the Environment "Radiation Protection and Safety of Radiation Sources: International Safety Standards"**, Interim Edition. General Safety Requirements, Part 3, No GSR Part 3 (interim), 2011
[20] Comitê Gestor da Internet no Brasil, **Pesquisa Sobre o Uso das Tecnologias da Informação e da Comunicação no Brasil 2009**, http://www.cetic.br/tic/2009/index.htm, acessado em 18 de agosto de 2010
[21] Comitê Gestor da Internet no Brasil, **Pesquisa Sobre o Uso das Tecnologias da Informação e da Comunicação no Brasil 2008**, Núcleo de Informação e Coordenação do Ponto BR, São Paulo: 2009
[22] **World Wide Web Consortium**, http://www.w3.org/ - acesso em 22 de agosto de 2010
[23] **Improving MySQL Query Analyser – Performance Optimization**, http://www.mysql.com/ - acesso em 22 de agosto de 2010
[24] **Sqlserver, Net Solutions**, http://www.sqlserver.com/ - acesso em 22 de agosto de 2010
[25] **Php**, http://www.php.net/ - acesso em 22 de agosto de 2010
[26] IAEA – Safety Series n. 102: **Recommendation for the Safe Use and Regulation of the Radiation Source in Industry, Medicine and Teaching**, 1990
[27] **Implications of Commission Recommendations That Dosis Be Kept as Low as Readily Achievable**, International Commission on Radiological Protection, publicação 22 (1973)
[28] **Cost-Benefit Analysis in the Optimization of Radiaction Protection**, International Commission on Radiological Protection, publicação 37 (1983)
[29] **Optimization and Decision-Making in Radiological Protection**, International Commission on Radiological Protection, publicação 55
[30] IAEA – Safety Report Series n. 21: **The optimization of the Radiation Protection in the Control of Occupational Exposure**, 2002
[31] Report EUR 13796EN: **Radiation Protection: ALARA from Theiry Towards Practice**, Commission of the European Communities, Luxemburgo, 1991
[32] ICRP - Publication n. 101, Part 2: **The optimization of the Radiological Protection: Broodening the Process**, 2006