

## MANAGEMENT INFORMATION SYSTEM ON RADIATION PROTECTION

**Pablo Andrade Grossi<sup>1</sup>, Leonardo Soares de Souza<sup>2</sup>, Geraldo Magela Figueiredo<sup>3</sup>**

Centro de Desenvolvimento da Tecnologia Nuclear  
Campus UFMG - Pampulha – Caixa Postal 941  
30123-970, Belo Horizonte, MG, Brazil  
[pabloag@cdtn.br](mailto:pabloag@cdtn.br), [lss@cdtn.br](mailto:lss@cdtn.br), [gmf@cdtn.br](mailto:gmf@cdtn.br)

### ABSTRACT

Considering the flux complexity and the multisource information of all radiation protection activities on nuclear organizations, an effective management information system based on technology, information and people is necessary to improve the safety on all processes and operations subjected to radiation risks. An effective management information system is an essential tool to highlight the strengths and weaknesses and identify behaviors and trends on the activities requiring radiation protection programs. Such kind of distinct knowledge is useful to reach an effective management and support the human decision-making on nuclear organization. This paper presents a management information system based on Brazilian directives and regulations on radiation protection. Due to its generic characteristics, this radiation protection control system can be implemented on any nuclear organization by reediting the non restricted parameters which could differ considering all facilities and laboratories expected on-site with diverse technologies applications. This system can be considered as a powerful tool applied on the continuous management of radiation protection activities on nuclear organizations and research institutes as well as for long term planning, not only indicating how the safety activities are going, but why they are not going as well as planned where that is the case.

Key words: radiation protection, management information system, nuclear organizations, health and safety.

### 1. INTRODUCTION

An effective and reliable control of nuclear activities on commercial organizations or research institutes focusing radiation protection issues and requirements is a critical point to assure the radiation safety on-site and the requirements of regulatory body for operational licensing.

Having in mind that all radiation protection subjects on such organizations has an interactive and intricate flux from several sources of information, an effective management information system based on technology, information and people is necessary to improve the safety on all processes and operations subjected to radiation hazards or risks.

The highlights of the strengths and weaknesses and the identification of behaviors and trends on the activities requiring radiation protection programs can be performed and powered by an effective management information system as an aiding tool on this essential tasks.

Such kind of distinct knowledge control is a valuable management information aiding the decision-making regarding to health and safety aspects on nuclear organizations.

This paper presents a management information system based on Brazilian directives and regulations on radiation protection [1] required by the regulatory body.

The management information system under development performs a generic approach to all relevant radiation protection issues and tasks. This radiation protection control system can be implemented on any nuclear organization by reediting the non restricted parameters which could differ considering all facilities and laboratories expected on-site with diverse technologies applications.

This system can be regarded as a powerful tool applied on the continuous management of radiation protection activities on nuclear organizations and research institutes as well as for long term planning, not only indicating how the safety activities are going, but why they are not going as well as planned where that is the case.

The goals of this paper are to present the developed structure of this management information system and the contents of its main screens.

## **2. MANAGEMENT INFORMATION SYSTEM ON RADIATION PROTECTION**

### **2.1. Bases and framework**

The structure of the proposed management information system was based on the Brazilian regulatory framework for radiation protection services [1] and some other national and international standard and recommendations were also considered [2, 3, 4, 5, 6, 7].

By this means, the system adopted the following organizational management information structure:

- Workers Control;
- Restricted Areas Control;
- Environment and Public Radiation Control;
- Radiation Sources Control;
- Radioactive Waste Control;
- Equipment Control;
- Workers Training;
- Registers and Record Keeping.

The utilization of the above structure will meet the requirements of the Brazilian regulations for radiation protection activities and assure the continuous management of the performed activities as well as for long term management planning.

These main topics are accessed by search tools to reach the sub screens. The core database is structured on previewing several interactions for these secondary level and stratified screens. On these screens the data can be added, edited, loaded, accessed, actualized, excluded, compared, assessed, copied, moved and transferred. The core database system also previews interaction to grab (import) and transfer (export) information from and to external databases.

Interactive search and editing tools allows an effective and easy interaction of the user with the software database, where the searches and editions can be done in a multidirectional and cross linked way attribution. The data can be managed by a net structure where the same data/information can be reached by several logical ways.

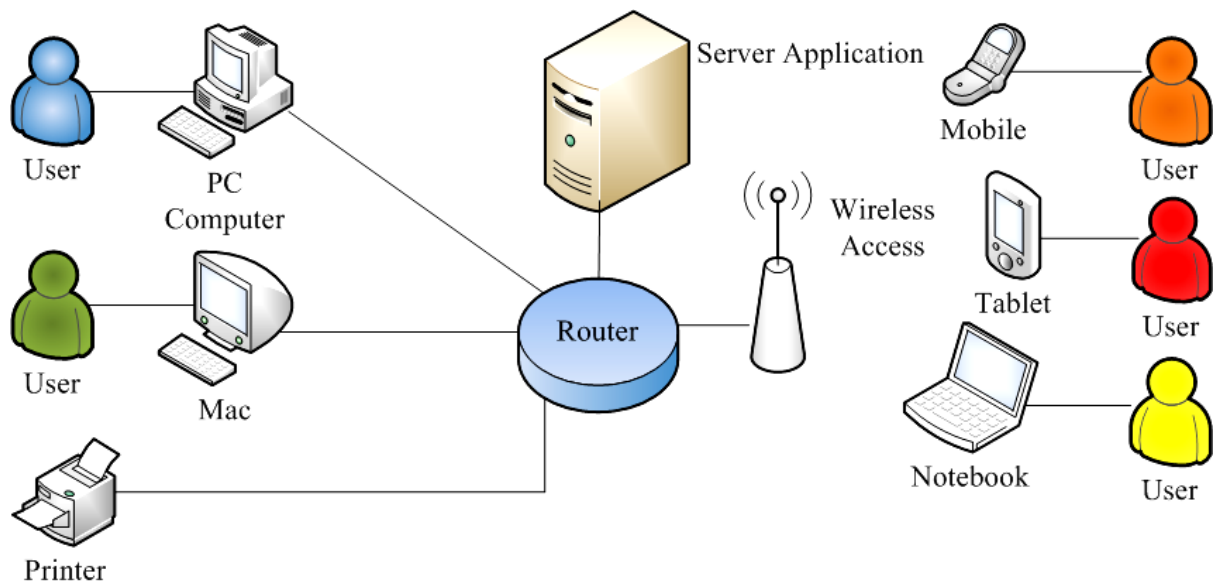
## 2.2. Computational technologies employed

The computational technology adopted by the management information system is based on SQL Database and application of PRAXIS [8] methodology for software development. The PRAXIS is an object-oriented programming that implements Unified Modeling Language, UML, drawing and assessment notation under Institute of Electrical and Electronics Engineers, IEEE, conformities.

For the scenarios, this development methodology is essential and joins all documentation phases regarding to conception, elaboration, construction and transition, avoiding design errors and bad definition of the scope.

This solution is planned to be implemented on web system (PHP language, Hypertext Preprocessor: Personal Home Page) and compatible to SQL database. By this means, an easy flux of information will be guaranteed by applying adequate and effective technology solutions.

The Fig 1 represents the multidirectional data and information fluxes previewed on the management information system.



**Figure 1. Flux of data and information on the management information system.**

### 2.3. The main screens and its contents

In this section will be present the main screens and some of its functionalities and contents.

The Fig. 2 shows the worker editing screen which includes additional links assigning its individual dose and intake monitoring (detailed on Fig. 3), training, areas with authorized access, notes, attachments, health certificates and other relevant information.

**Cadastro de trabalhador** [X]

Nome:

CPF:  Matricula:

Endereço:

Cargo:  Função:

Inserir foto

Telefones:

links para ver e editar e apagar

- radioproteção( dosímetro doses e tal)
- dados de treinamentos
- areas de acesso autorizado
- atestados de saúde ocupacional (ASO)
- notificações
- anexos

Cancelar Salvar

**Figure 2. Worker editing screen.**

**Monitoração individual** X  
Operador: Nome do operador autenticado no SIGLIG Data e Hora

Nome:  Número dosímetro:

Período de utilização do dosímetro:  Período  Mês

Início:   :   Tempo total: hh:mm

Fim:   :

Exposição externa:

Equipamento:

Dose equivalente inicial:   Dose equivalente total:

Dose equivalente final:

Exposição externa e interna:

Análise de sangue:

Exame com contador de corpo inteiro:

Análise de excreta:

Condição de exposição:  Rotina  Emergência  Acidente

Observação:

**Figure 3. Individual dose and intake monitoring editing screen including reports and record keeping.**

The Fig. 4 presents the restricted area control editing screen which includes its identification, assessment of related safety conditions, drawings, maps, radiological survey, attachment of safety related documents as safety assessment report, operating license, list of people with authorized access and responsible radiation safety officer or adviser.

A detailed restricted area access control editing screen is presented on Fig. 5 that includes the registry of individual dose monitoring during the access, total duration and responsible for the access authorization.

**Cadastro de área**

Nome da instalação, laboratório ou área:

Classificação da área:  Supervisionada  Controlada  Livre Prédio:  Sala:

**Sinalização ocultar e expandir tela de sinalização**

- Presença de radiação com o símbolo de radiação na entrada e saída da área, e nos locais onde existem fontes de radiação
- Identificação e classificação das áreas, perfeitamente visíveis na entrada e saída das mesmas
- Identificação das fontes de radiação e dos rejeitos nas embalagens, recipientes e blindagens
- Presença do valor das taxas de dose e datas de medição em pontos de referência próximos as fontes de radiação
- Identificação de vias de circulação, entrada e saída para condições normais de trabalho para situações de emergência
- Localização de equipamentos de segurança e instrumentos de medição para radioproteção
- Aviso sobre presença e identificação de contaminação e altos níveis de radiação, com atas de medição
- Presença de procedimentos a serem obedecidos em situações de acidentes ou emergência
- presença e identificação de sistemas de alarmes sonoros e visuais para situações de acidentes de emergência, ou para condições de

Observação

**Monitoração**

inserir monitoração radiológica  Histórico de monitorações  Mapa com os pontos de monitoração

Relatório de análise de segurança

Autorização para operação

Pessoas com autorização de acesso:

Responsável pelas autorizações de acesso:

**Figure 4. Restrict area control editing screen.**

The screenshot shows a web application window titled "Controle de Acesso" with a close button (X) in the top right corner. The form contains the following fields and controls:

- Instalação:** A dropdown menu with the value "nome da instalação cadastrada".
- Nome:** A dropdown menu with the value "Pablo Andrade Grossi".
- Procedência:** A dropdown menu with the value "CDTN - LIG".
- Motivo:** A dropdown menu with the value "Trabalhador do LIG Ocupacionalmente Exposto".
- Data:** A date input field with a calendar icon.
- Entrada:** A time input field with the format "hh:mm".
- Saída:** A time input field with the format "hh:mm".
- Tempo permanência:** A time input field with the format "hh:mm".
- Dose equivalente inicial:** A numeric input field followed by a dropdown menu with the value "Sv".
- Dose equivalente total:** A numeric input field followed by a dropdown menu with the value "microSv".
- Dose equivalente final:** A numeric input field followed by a dropdown menu with the value "microSv".
- Responsável:** A dropdown menu with the value "Pablo Andrade Grossi".
- Observações:** A large text area for notes.
- salvar:** A button at the bottom center of the form.

**Figure 5. Restrict area access control editing screen.**

The Fig. 6 shows the function points related to radioactive waste management and control, based on the regulatory body requirements [3].

**Controle de Rejeitos** X

**Descrição dos rejeitos:**

Instalação:

Responsável pela radioproteção:

Identificação do rejeito:

Quantidade:

Estado físico:

compactáveis     não compactáveis  
 orgânicos     inorgânicos  
 putrecíveis     patogênicos  
 explosividade     combustibilidade     inflamabilidade  
 pirofórico     corrosivo     tóxico

radionuclídeos presentes: novo com lista de nuclide e campo atividade: resposta uma lista os radionuclídeos novos vem de uma tabela no banco

Meia vida:

link para tabela de radio nuclídeos

Natureza da radiação:

Nível de radiação:

concentração: página 5 norma de acordo com o estado físico, alfa ou beta/gama aparece o select com contaminação alta, média e baixa com descrição de valores máximo e mínimo na fórmula sólido gama concentração vira taxa de exposição

atividade: 6d Bq  verificada em: / /  através de:  medida  estimativa

Localização:

**Figure 6. Radioactive waste control editing screen.**

Fig. 7 presents the Radiation Sources Control editing screen.

The equipment, including its main functional characteristics, applications, status, maintenance, calibration and other historical information are presented on Equipment Control editing screen, Figs. 8, 9, 10 and 11.

Environmental and Public Radiation Control is also approached by this management information system. The control of the doses to the public, adopted methodologies, measurement techniques, established limits for releases, surveillance programs and countless related information can be easily accessed and edited by authorized personnel.



**Controle de Fontes de Irradiação** X

Operação: Edição de dados cadastrados no SIO/2011 Data e Hora:

**Descrição das fontes:**

Fonte:  um pra cada fonte

Localização:  outro cadastra em área foto do equipamento em baixa resolução clica tamanho normal

Radiosótopo:

Aplicação:

Atividade:  Bq na data de aquisição

Data de aquisição:

Código da fonte:

Medida campo de radiação externa a 1 metro:

Medida campo de radiação externa a contato:

**Inspecção**

Fonte em uso:  sim  não

Existência de contaminação e vazamento

A sua presença em local correto, devidamente sinalizada

Condições corretas de uso, blindagem, acondicionamento, segurança, transporte e armazenamento

Certificados e procedimentos para uso, manuseio, acondicionamento, transporte e armazenamento de fontes de radiação

Supervisor ou responsável pela radioproteção:

**Figure 7. Radiation sources control editing screen.**

**Cadastro de tipo de equipamento de radio proteção** X

Equipamento:

Tipo:

Sigla do tipo ou eqpto:

Fabricante:

Descrição:

Faixa de medição: min:  max:

Período de calibração:

Ativo?:

Padrão?:

**Figure 8. Equipment control editing screen**

**Manutenção** X

Código: 9082080 Data:

Tipo de Manutenção: **Preditiva** Status: **Cadastrada**

Item de Manutenção: **Equipamento 1** Responsável pelo equipamento

Descrição:

Observações:

Data inicio:  Data: término:

**Anexos**

Arquivo anexado 1  
 Arquivo anexado 2  
 Arquivo anexado 3

envio de email para responsável do eqpto na abertura e no término da manutenção.

Responsável pela manutenção:

**Figure 9. Equipment maintenance screen including record keeping.**

**Gestão de Calibração** X

**dosímetro** : **DO797964** Data:   
mostrar o responsável pelo equipamento.

**Certificados de calibração**

Arquivo anexado 1  
 Arquivo anexado 2  
 Arquivo anexado 3

Vencimento da calibração:  em tantos dias.  supervisor de radioproteção ou responsável cliente automático e presente na exibição do equipamento

Outras informações sobre a calibração:

**Figure 10. Equipment calibration control editing screen including record keeping.**

**Figure 11. Equipment inspection control editing screen including record keeping.**

The workers training control is presented on Fig. 12 that includes the main subjects and training course contents, instructor, duration, description, validity and type of training. Fig. 13 presents the training record keeping including the list of trainees.

**Figure 12. Workers training control editing screen, including registers and record keeping.**

**Figure 13. Training courses control editing screen, with registers and record keeping.**

Fig. 14 presents system screen to deal with incidents and accidents including full assessment, corrective and predictive actions, record keeping and access to related reports.

**Figure 14. Incidents and accidents control editing screen including full assessment, corrective and predictive actions, record keeping and access to related reports.**

### 3. DISCUSSIONS AND CONCLUSIONS

The intention of this work is to present and share the achievements of this powerful tool to improve and implement an effective operational radiation protection programme considering all protection factors that are relevant to all expected working situations on nuclear organizations and research institutes.

The developed information system allows the continuous management of radiation protection activities on nuclear organizations and research institutes as well as for long term planning, not only indicating how the safety activities are going, but why they are not going as well as planned where that is the case.

Such kind of distinct knowledge is useful to reach the managerial objectives and support the human decision-making on nuclear organizations.

This overall view of the regulatory requirements can also facilitate internal and external inspections, aiding the identification of weakness points and what is needed to put into action a successful radiation protection control.

### REFERENCES

1. CNEN – NE – 3.02 - Serviços de Radioproteção, <http://www.cnen.gov.br/seguranca/normas/mostra-norma.asp?op=302> (1988) Access in July 2011.
2. CNEN – NN – 3.01 – Diretrizes Básicas de Radioproteção, <http://www.cnen.gov.br/seguranca/normas/pdf/Nrm301.pdf> (2005) Access in July 2011.
3. CNEN – NE 6.05 - Gerência de Rejeitos Radioativos em Instalações Radiativas, <http://www.cnen.gov.br/seguranca/normas/pdf/Nrm605.pdf> (1985) Access in July 2011.
4. INTERNATIONAL ATOMIC ENERGY AGENCY, Basic Standards for Radiation Protection. Safety Series No. 9, IAEA (1982).
5. INTERNATIONAL ATOMIC ENERGY AGENCY, Operational Radiation Protection: A Guide to Optimization. Safety Series No. 101, IAEA (1988).
6. INTERNATIONAL ATOMIC ENERGY AGENCY, Recommendations for the Safe Use and Regulation of Radiation Sources in Industry, Medicine, Research and Teaching. Safety Series No. 102, IAEA (1990).
7. INTERNATIONAL ATOMIC ENERGY AGENCY, International Basic Safety Standards for Protection Against Ionizing Radiation and for the Safety of Radiation Sources. Safety Series No. 1115, IAEA (1996).
8. PAULA FILHO, Wilson de Pádua: Processo Praxis. Disponível em <http://homepages.dcc.ufmg.br/~wilson/praxis/> Access in July 2011.