Project Basis for Automation of a Quality Assurance System in Radioactive Waste Management - 17317

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ABSTRACT

A low- and intermediate-level radioactive waste management facility is required to comply with Regulation 1.16 of the Brazilian National Nuclear Energy Commission "Quality Assurance for the Safety of Nuclear Power Plants and Other Facilities". However, the text of this regulation is very generic and does not address the more specific controls necessary for the management of quality. Therefore, the objective of this paper is to identify such detailed controls in all applicable activities of the facility and to provide an implementation plan in the form of flowcharts, for further development of an automated system. This work takes as a basis the recommendations of the International Atomic Energy Agency and the rules and procedures implemented by the U.S. Department of Energy's Office of Civilian Waste Management related to Quality Assurance. In such way, we intend to provide a more reliable implementation system of quality assurance for the management of radioactive waste in Brazil.

Keywords: radioactive waste; quality assurance; automated system.

INTRODUCTION

Brazil is currently planning to construct the Brazilian Multipurpose Reactor - RMB, a nuclear research reactor with power of 30MW [1] intended for the production of radioisotopes, nuclear and materials research, among other additional scopes of research. When in operation, the facility will generate radioactive waste that will be treated, and safely and securely stored on site until it may be disposed of in an appropriate facility for final disposition of radioactive waste yet to be sited and constructed in Brazil. This paper deals with the management of this waste.

The term "management" is to be understood as a set of operational and administrative activities related to handling, characterization, processing, transportation, and storage of waste [2]. The operations to be performed in the waste management processes that are common to all wastes, include: a) waste storage; b) sampling of different waste streams; c) radiochemical analysis of waste samples; d) radiometric measurements of waste packages; and e) transportation of waste packages. In addition, specific process operations for each waste type include: a) compaction of compactable solid waste; b) fragmentation and encapsulation of non-

compactable solid waste in cement grout; c) chemical preconditioning of liquid waste; d) volume reduction of wastewater by evaporation; and e) immobilization of liquid waste in cement.

In Brazil, the National Nuclear Energy Commission – CNEN is the agency responsible for controlling and regulating all processes related to nuclear energy. As a result, the design, construction, and operation of a low- and intermediate-level radioactive waste treatment facility must comply with the requirements of CNEN-NN-1.16 Regulation "Quality Assurance for Safety in Nuclear Power Plants and other Facilities". Furthermore, Brazil is one of the signatories of the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, sponsored by the International Atomic Energy Agency (IAEA), internalized in the national legal framework by Decree No. 5935 of October 19, 2006 [4]. Therefore, Brazil must comply with the provisions of Article 23 of the Convention, which states that "each Contracting Party shall take the necessary steps to ensure that appropriate quality assurance programs concerning the safety of spent fuel and radioactive waste management are established and implemented" [5].

One problem with the implementation of CNEN quality assurance regulation is that it applies to any type of nuclear facility, so it is quite generic and requires a more detailed set of actions needed to ensure compliance with applicable regulatory requirements– more specifically, the application of a quality assurance system in a radioactive waste treatment and storage facility.

Therefore, the objective of this study is to provide a list of actions in the form of flowcharts, for development of an automated system, which can assure compliance with the Brazilian Regulation. The recommendations of the IAEA Safety Standards and Technical Reports [7-15], as well as the rules of the U.S. Department of Energy (DOE) "Quality Assurance Requirements and Description, rev.21" from the Office of Civilian Radioactive Waste Management (OCRWM) [6] were used as guides for detailing the actions required. In this way, we intend to provide suggestions for a more efficient quality assurance system for the management of radioactive waste in Brazil.

METHODS

The main effort in developing the management tool is to identify and detail each of the processes that will be controlled by the system, setting the input data, the unit operations of each process, output data and control points of the process, the types of reports, and other system components, focusing particular attention to the Items Important to Safety (IIS). The primary source of information is the experience of the Working Group at the Radioactive Waste Management Department (GRR) of the Nuclear and Energy Research Institute - IPEN / São Paulo, Brazil. The description of

the items were detailed enough in order to enable the preparation of a set of unit operations that together will perform the control actions required by the system.

The result of this detailing process is translated into algorithms, represented by process flowcharts. These algorithms describe the unit operations performed in the waste management facility. The operations included in the scope of this work are those necessary to control and register the Quality Assurance actions, in order to demonstrate that the regulatory requirements were met.

The IAEA recommendations [7-15] and the items of the DOE OCRWM quality assurance document [6] were analyzed and the requirements set out in those documents were correlated with the CNEN-NN-1.16 requirements. The correlation between the Brazilian regulation requirements and the requirements of those other documents is intended for detailing as much as possible the regulatory requirements. The CNEN-NN-1.16 document is by nature generic in the scope of the items that should be controlled and the actions for quality assurance. Nevertheless, this work respected the structure of the Brazilian regulation.

Every list of unit operations is associated with a logical flowchart that visually represents the processes, actions or events that start the processes, inputs and outputs, control points (logical errors), the databases required by the system, etc. The consistency between the various process-flow diagrams were checked before accomplishing the work.

RESULTS

The requirements of CNEN NN-1.16 regulation may be divided into the following twelve categories:

1. Document Control
2. Design Control
3. Procurement Control
4. Control of Materials
5. Control of Processes
6. Inspection and Test Control
7. Control of Nonconforming Items
8. Corrective Actions
9. Quality Assurance Records
10. Audits
11. Systems and Quality Assurance Programs
12. Organization

For illustrative purposes, the steps to carry out the quality assurance actions for one sub-item of the item “2. Design control” above, has been chosen and is presented

below. This item corresponds to the Section 4.5 – 'Design Control' of the CNEN regulation, and can be presented, in a free translation, as:

> "4.5 DESIGN CONTROL
> 4.5.1 General Requirements
> 4.5.1.1 - design control policies should be established and documented to ensure that the applicable design requirements, such as design bases, CNEN standards and requirements, are properly incorporated in the specifications, computer design codes, drawings, procedures or instructions. "[3]

When analyzing the literature [6, 8], the set of detailed actions needed to be included in the computerized quality assurance system, in order to allow verification and change evaluation of design decisions, with reference to the "design bases" of the subsection 4.5.1.1, should become the following:

"4.5.1.1 – (a) Control of Design Input Data

A. Identification, documentation and approval of design input data.
B. Previous qualification of data resulting from scientific investigation.
C. Identification and tracking of unqualified data until they are qualified.
D. Justification, documentation, control and approval of design changes.
E. Identification and tracking of data based on assumptions until they are confirmed."

Subsequently, the unit operations for controlling the "design input data" are translated into the following set of procedures:
"Access to the 'design input data' page"
System page: "Design Input Data"
- User name (designer), date and time of access;

1. *Choose a "structure" from the list, or enter a new one;*
   - Inbox "Structure" to select from the list of structures already included in the database, and a button "Add Structure" that opens a blank text box, for inclusion of new item; the same structure is repeated for:
   - Inbox "Component";
   - Inbox "Element";
   - Inbox "Value";
   - Inbox "References";

   After completion of the input of data, the system asks the data status:
   - Inbox "Provisional" (Y or N);

   Then the system exhibits a text box with list of newly added values;

2. Click "Save." The system checks whether there any blank field. If so, it displays the message "Blank fields are not allowed"; if not, it displays the message "Do

you want to include more references?". If Yes, the system saves in Input Data Table, clears "References" and "Provisional?" fields, copies data "Structure", "Component", "Element" and "Value" from the newly recorded item and returns to the starting point;

3. If not, it saves data in Input Data Table, displays message "Do you want to include more elements?". If Yes, saves in Input Data Table, clears "Element", "References" and "Provisional?" fields. Copies data "Structure", "component" from the newly recorded item; returns to the starting point;

4. The same routine is repeated for components and structures. A click on “Exit” shuts down the system.

Design Input Data Table fields:

- Structure number;
- Login;
- Access number;
- Structure;
- Component;
- Element;
- Value;
- Reference;
- Provisional? (Y/N).

Each Structure Number has only one Login; only one Access Number; only one Structure; each Structure has one or more Components; each Component has one or more Elements; each Element has only one value; each Value has one or more References; each reference has an Y or N if provisional. Each Structure Number has an Y or N if it is the latest version.

The system sends a notification to the person identified in the system as the 'Reviewer'; a new sequence of unit operations is initiated with the reviewer accessing the system page "Input Data Review", and ends it with the reviewer 'accepting' the values entered into the system by the designer. Reviewer’s unaccepted data prompt the system to notify the designer. The 'approval' by the person identified as the one who approves the input data ends the last sequence of operations. These three sequences are required to comply with requirement "A" in the subsection 4.5.1.1(A) above: “Identification, documentation and approval of design input data”.

Finally, this list of operations is translated into a process flowchart which facilitates consistency checking, e.g., if the decision points - the logical deviations represented by diamonds in the following figure - or if the data inputs and outputs are properly displayed (Figure 1).

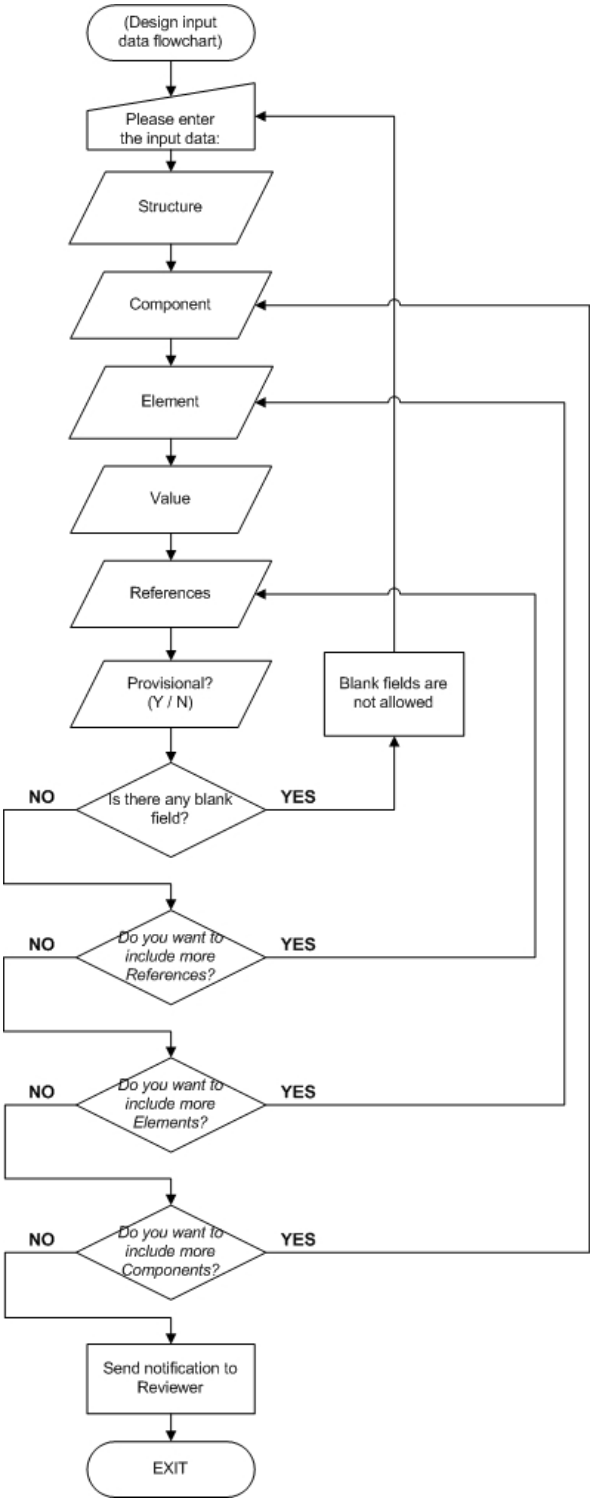

Fig.1 – Design Input Data Flowchart

CONCLUSION

This paper was developed basically as a suggestion for guidance to fulfill the regulatory requirements specified in the National regulation related to Radioactive Waste Management. Extensive research was performed and over 150 pages were written with descriptions and flowcharts needed to implement the twelve regulatory requirements specified in CNEN-NN-1.16 [16]. All of the requirements were reviewed and detailed, and many of the more specific requirements related to radioactive waste management were included. Thirty-four flowcharts give a stepwise procedure to assure that the design, construction and operation of a radioactive waste management facility comply with the requirements of a robust quality assurance system.

Quality assurance is a continuous improvement process, and the professionals involved in the area need to be aware of the current specifications, best practices, and all a variety of situations in order to better perform their jobs; after all, there is no assurance without knowledge. The idea of presenting different approaches on the same procedures may provide a better understanding toward the improvement of regulations. The optimization of quality assurance, allied to the clearness and organization of procedures and control requirements, will ultimately demonstrate that an organization is actually able to deploy nuclear resources safely and efficiently.

REFERENCES

[1] SBPMAT, Brazilian Multipurpose Reactor: a national laboratory of neutrons for the Materials research community. Retrieved from http://sbpmat.org.br/en/ reator-multiproposito-brasileiro-um-laboratorio-nacional-de-neutrons-para-a-comunidade-de-pesquisa-em-materiais (2016).

[2] INTERNATIONAL ATOMIC ENERGY AGENCY, Radioactive Waste Management Glossary. IAEA, Vienna, Austria (2003).

[3] NATIONAL NUCLEAR ENERGY COMMISSION, *Quality Assurance for the Safety of Nucleoelectric Plants and Other Facilities (CNEN-NN-1.16).* CNEN, Rio de Janeiro, Brazil (2000).

[4] BRAZIL. *Decree no.5935 (October 19, 2006),* Promulgates Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (2006).

[5] INTERNATIONAL ATOMIC ENERGY AGENCY, *Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management*. IAEA, Vienna, Austria. Retrieved from

https://www.iaea.org/publications/documents/conventions/joint-convention-safety-spent-fuel-management-and-safety-radioactive-waste (1997).

[6] OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT, *Quality Assurance Requirements and Description (DOE/RW-0333P, Revision 21).* OCRWM, USA. (2009).

[7] INTERNATIONAL ATOMIC ENERGY AGENCY, Radioactive Waste Management Information Systems - Radioactive Waste Management Registry (RWMR). IAEA, Vienna, Austria. Retrieved from https://www.iaea.org/OurWork/ST/NE/NEFW/Technical-Areas/WTS/information-RWMR.html (2015).

[8] INTERNATIONAL ATOMIC ENERGY AGENCY, *Application of Quality Assurance to Radioactive Waste Disposal Facilities (IAEA-TECDOC-895).* IAEA, Vienna, Austria (1996).

[9] INTERNATIONAL ATOMIC ENERGY AGENCY, *The Management System for Facilities and Activities – Safety Requirements (Safety Standards Series No. GS-R-3)*. IAEA, Vienna, Austria (2006).

[10] INTERNATIONAL ATOMIC ENERGY AGENCY, *Manual on Training, Qualification and Certification of Quality Assurance Personnel (Technical Reports Series 262)*. IAEA, Vienna, Austria (1986).

[11] INTERNATIONAL ATOMIC ENERGY AGENCY, *Manual on Quality Assurance for Computer Software Related to the Safety of Nuclear Power Plants (Technical Reports Series 282)*. IAEA, Vienna, Austria (1988).

[12] INTERNATIONAL ATOMIC ENERGY AGENCY, *Regulatory Inspection of the Implementation of Quality Assurance Programmes: A Manual (Technical Reports Series 296).* IAEA, Vienna, Austria (1989).

[13] INTERNATIONAL ATOMIC ENERGY AGENCY, *Implementation of Quality Assurance Corrective Actions: A Manual (Technical Reports Series 317).* IAEA, Vienna, Austria (1990).

[14] INTERNATIONAL ATOMIC ENERGY AGENCY, *Grading of Quality Assurance Requirement: A Manual (Technical Reports Series 328).* IAEA, Vienna, Austria (1991).

[15] INTERNATIONAL ATOMIC ENERGY AGENCY, *Quality Assurance Integrated Training Packages: A Manual (Technical Reports Series 340).* IAEA, Vienna, Austria (1992).

[16] SMITH, R. and VICENTE, R., *Quality Assurance in the Management of Radioactive Waste at the Brazilian Multipurpose Reactor Enterprise* (in Portuguese). IPEN, Sao Paulo, Brazil. Retrieved from http://repositorio.ipen.br:8080/xmlui/bitstream/handle/123456789/26821/22669.pdf?sequence=1&isAllowed=y (2016).

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