AN INTEGRATED MANAGEMENT SYSTEM (IMS) FOR JM-1 SLOWPOKE-2 RESEARCH REACTOR IN JAMAICA: EXPERIENCES IN DOCUMENTATION

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Abstract

Since the first criticality in March 1984, the Jamaica SLOWPOKE-2 research reactor at the University of the West Indies, Mona located in the department of the International Centre for Environmental and Nuclear Sciences (ICENS) has operated for approximately 52% of the lifetime of the existing core configuration. The 20kW pool type research reactor has been primarily used for neutron activation analysis in environmental, agricultural, geochemical, health-related studies and mineral exploration in Jamaica. The involvement of the JM-1 reactor for research and teaching activities has segued into commercial applications which, coupled with the current core conversion programme from HEU to LEU, has demanded the implementation of management systems to satisfy regulatory requirements and assure compliance with internationally defined quality standards. At ICENS, documentation related to the Quality Management System aspect of an Integrated Management System (IMS) is well underway. The quality system will incorporate operational and nuclear safety, training, maintenance, design, utilization, occupational health and safety, quality service, and environmental management for its Nuclear Analytical Laboratory, NAL. The IMS is being designed to meet the requirements of the IAEA GS-R-3 with additional controls from international standards including: ISO/IEC 17025:2005, ISO 9001:2008, ISO 14001:2004 and OHSAS 18001:2007. This paper reports on the experiences of the documentation process in a low power reactor facility characterized by limited human resource, where innovative mechanisms of system automation and modeling are included to increase productivity and efficiency.

1. Introduction

The International Centre for Environmental and Nuclear Sciences (ICENS) is a complex of multi-disciplinary research laboratories on the Mona campus of the University of the West Indies in Kingston, Jamaica which covers a diverse range of the geochemical, environmental and nuclear sciences. The 20kW pool type Jamaican SLOWPOKE-2 research reactor, the powerful analytical tool in the Nuclear Analytical Laboratory (NAL) at ICENS, has been in operation since 1984 and is used primarily for neutron activation analysis in environmental, agricultural, geochemical, health-related studies and mineral exploration in Jamaica.

The NAL embarked on the implementation programme of a Quality Management System (QMS) based on the realisation that with the opening of national borders in the last few decades, the need for global exchange of products and services would have intensified [1,2], ushered in by

severe competitiveness as a result of greater consumer awareness. Benoliel [3] suggested that the implementation of a quality system increases productivity due to improved organizational practices leading to greater profitability and enhanced outlook based on technical competence.

A prerequisite for the management of a research reactor is the satisfaction of all the requirements of interested parties, including safety constraints, security, environmental and occupational health requirements and the efficiency and effectiveness of the delivery of those services [4]. Faced with the imminent core conversion programme of the JM-1 Slowpoke-2 from HEU to LEU, in order to continuously improve the quality and safety of reactor management and accomplishing the requirements of interested parties [12], ICENS decided on the implementation of an integrated management system in accordance with IAEA GS-R-3 (The Management System for Facilities and Activities) and the International Quality Standard ISO 9001 (Quality Management System Requirements) among others through a systematic approach. This paper shares the experiences of the documentation activities, that is hoped, will lead to the standardization of all processes in safe reactor operation and maintenance, enhanced with the application of innovative mechanisms, in this low power reactor facility.

2. Integrated Management Systems (IMS)

The International Atomic Energy Agency (IAEA) recommends for nuclear facilities that "a management system shall be established, implemented, assessed and continually improved" [5]. The development and implementation of an IMS is basic requirement in order to ensure, *inter alia*, safe operation and effective utilization of a research reactor. This is because an IMS integrates all aspects of managing a nuclear facility incorporating safety, health, quality, environment, security and economic aspects into one coherent management system [5].

The implementation of an IMS ensure clear goals, policies, strategies and objectives whilst providing organisational alignment, clear tasks, responsibilities verification and enforcement of requirements through periodic assessment and review [5]. Additionally, the IMS establishes administrative controls in specifications on the lines of communication, in respect of work delegated to external organisations, and the interfaces between internal and external organisations. It facilitates understanding, co-ordination of work and information which helps to do the activities "right the first time", enhancing effectiveness and improved motivation towards a culture of safety. Through the implementation of an effective IMS, challenges that may be encountered can be better assessed, monitored, managed and even partially solved.

The challenges associated with the implementation of any quality management system are discussed in literature, some of which include: (1) QMS not taking precedence; (2) provision of testing services is not priority; (3) high attrition rate among staff; (4) staff functions being diverse and diffuse; (5) staff performance as a measure of publications or other activities [2, 6-8]. Notwithstanding the limitations, there are a number of advantages associated with QMS implementation, and subsequent accreditation/certification according to specified standards: (1) increased customer satisfaction; (2) increased reliability of results and staff qualifications; (3) international recognition of products and services; (4) increased profitability of organization [9].

The implementation of the IMS in the Nuclear Analytical Laboratory at ICENS according to specified standards came at a time when greater demands are being placed on the establishment of standards in the nuclear sector. Cemented in the IAEA's Statute is the authorization for the institution of "safety standards to protect health and minimize danger to life and property ……" in relation to "nuclear and radiation safety" [5]. Several considerations were taken into account prior to the beginning of activities that would lead to the implementation of the IMS; (1) the existing culture of the organization; (2) staff knowledge in regards to adhering to quality; (3) external (international, national) pressure; (4) time and resources available; (5) current status of organization in relation to specified standards [2]. These considerations all contributed to the approach taken in the documentation process in setting the guidelines for operations within the NAL leading to the implementation of an IMS.

3. Implementation of the Quality System: Documentation

The task of senior management in the implementation of a management system is to "establish goals, strategies, plans and objectives that are consistent with the policies of the organization" [10]. Several phases were identified to be used as general guidelines for the development of the IMS in the NAL: planning, document preparation and control and monitoring [2]. The developmental process started with the mission and vision of the organization, which segued into the definition of tasks and responsibilities for action and the interaction with other processes for a well managed and clearly communicated IMS. Plans and activity schedules were established to cover staff training and sensitization, coordination meetings, documentation sessions and procedural examinations enabling the advancement of quality documentation towards the implementation of the IMS.

3.1. Requirements of the standards

The IMS was designed to meet the requirements of the IAEA GS-R-3 with additional controls from international standards including: ISO 9001:2008, ISO/IEC 17025:2005, OHSAS 18001:2007 and ISO 14001:2004. This allowed for the integration of operational and nuclear safety, training, maintenance, design, utilization, occupational health and safety, quality service, and environmental management [10]. Each document generated in the quality system fulfilled the requirements of the standards having unique identification codes, numbered pages, revision numbers, valid effective dates and formal authorizations as stipulated in the standards.

The 2005 version of the ISO/IEC 17025 standard was used as the basis for writing the system documents as it was applicable to all organizations performing tests and or calibrations, such as the NAL, regardless of the number of personnel or the extent to which the activities were carried out. The system requirements (management and technical) of ISO/IEC 17025 standard expressly incorporated those requirements of ISO 9001:2008, relevant to the scope of the services in the NAL, which further extended to the requirements of ISO 14001:2004 (environmental management) and OHSAS 18001:2007 (occupational health and safety management requirement). The latter standards corresponded closely to ISO 9001 allowing for a high level of integration. Recognizing that the IAEA safety standards often needed to be complemented by industry standards for practical effect, the IAEA GS-R-3, which is management requirements for the establishment of management system for nuclear facilities and activities for operating

organizations, was compared to ISO 9001 and requirements incorporated at applicable levels of the documentation system.

3.2. Overview of documentation system

Documentation needed for a quality management system is very diverse and detailed. All factors affecting the quality and/or traceability must be recorded [10]. Benoliel [3] suggested that the quality manual (QM) represented the platform for laboratory accreditation, serving to describe the quality system and such methods utilized to fulfill the requirements of the specific standards. The formats of documentation were deemed to be varied, contingent on the following factors: (1) human resources; (2) associated costs (3) timelines; (4) organizational culture; (5) operational logistics [10]. These formats included procedures or working instructions, manuals, logs, forms, computer files, computer programmes, text books, publications, reports, posters, minutes, *inter alia*.

For the purposes of documentation in the NAL at ICENS, four levels were identified (see Figure 1).The quality system classified documents into various levels that served to delineate functions in a hierarchical structure.

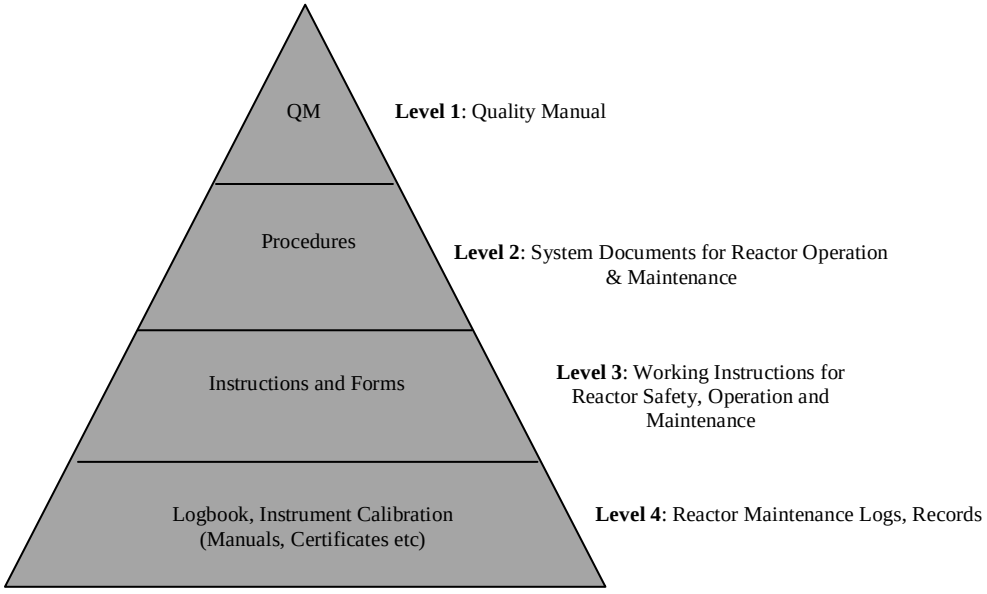

Figure 1: Levels of documentation in implementation of IMS in NAL

Outlined in the quality manual (QM), found at Level 1 in the *figure 1*, is the quality policy along with descriptive of the quality system of the laboratory - the QM or the Annexes directly linked to the requirements requested in the different sections of the specified standards, covering all applicable points of the standard. The QM is being prepared on an ongoing basis, and will be made available to clients (on request), accreditation bodies, regulatory and licensing bodies.

The number of procedures at Level 2 could vary, depending on the activities of the laboratory. The system documents at this level were written as procedures outlining how the requirements of IAEA GS-R-3 and other international standards were met, in order to ensure controls on reactor

safety operation and maintenance. For the purposes of the implementation of the IMS in the NAL, the procedures were structured to focus on the issues of safety in reactor maintenance and operation, licensing, regulatory, monitoring and assessment activities identified as requirements of the in the IAEA GS-R-3 standard, incorporating aspects of additional standards for which policies and procedures were so required [10].

Level 3 of the document classification in the quality management system consist of the bulk of the documents [4]. The documents at level 3 in the NAL included work instructions, forms, validation records, test reports, internal quality control procedures, among others, providing support for some level 2 documents. Typically technical, (some external) supportive documents associated with equipment and instruments have been reserved for level 4. Within the NAL, level 3 documents have been relegated to specified storage areas (including electronic, since some documents are generated by specific computer programmes) while level 4 can be found in close proximity to equipment to ensure immediate extraction should the need for their use arise.

3.3. Structure for documentation system

It is a requirement of the base standard (ISO/IEC 17025:2005) that every document and form shall have a unique identification code [11]. Within the NAL, the following format was used to identify documents:

NAL_PR-OP_123

NAL identified the Nuclear Analytical Laboratory, PR-OP indicated that the document was a level 2 operational procedure system document and 123 represented the series of numbers assigned in sequence.

Coding of documents in the NAL depended entirely on the needs of the laboratory and was not prescriptive, but based on consultation with staff and also with management agreement. Documents relating to quality management such as system documents, standard operating procedures, method validation, proficiency testing, inter alia, were uniquely coded to identify specific tasks. Documents relating to job management were also coded to reflect use. Those types of documents were identifiable for reference purposes, as many were opened for only a short period of time; including quotes, tenders and analytical tasks. Forms being used for various purposes in the NAL provided the opportunity for scheduling work tasks and general laboratory management. Forms generated for various activities, including sample request and submission, test reports, audit plans, complaints from clients, internal QC and non-conformance are now being incorporated for daily use.

3.4. Scope of the documentation system

Prior to embarking on the programme of implementing an IMS, a list of documents utilized by staff for reactor operation and management was already existing including prescriptive documents and operating instructions. One of the first tasks to deal with was the inventory of the existing documental system and the analysis of how the management system could embody and integrate it. The process, in order to fulfill its purpose, required the development of new documents that could integrate, interact and complete the existing documental system. Job descriptions, individual files in training and qualification records of personnel, maintenance

schedules, training materials, operating manuals, standard operating procedures, files on internal QC, were all included in the documentation system.

Since, initially, the NAL had no official documentation system in place, the option of building the system around the framework of the ISO/IEC 17025 was taken, in order to address the clauses in the standard with a corresponding paragraph. The quality manual, which presented the quality policy of the laboratory, has attempted to address the pertinent clauses of the standard, which at this stage of the documentation process is in draft phase with the initial design and composition being carried out in close cooperation with laboratory management and personnel.

It was prudent to make provisions for a wide array of topics within the documentation system for the implementation of the IMS in the NAL. The manner in which the clauses of the standard were assigned to the quality manual and the level 2 documents depended on the needs and preferences of the NAL. To date, several systems have been designed to assist with the identification of these supporting systems. These include: systems to manage routine and non-routine analytical task – job identification, data storage, job planning – to control the design of new documents and forms, for sample management, to handle deviations, for training and qualification, for internal QC, procurement, subcontracting, among others. These systems have been so designed to be able to meet the requirements of the standards. Within the NAL, there was also the establishment of radiological management and radiological surveillance programmes which included radiation survey, safety evaluation of new methods, control over radioactive material, personnel monitoring and dosimetry.

Level 3 documents describing the standard operating procedures (SOP) for analytical tests in the NAL were prepared according to an established preferred style. The SOPs were all outlined with the pertinent information that gave the title, purpose, materials, instructions and references. An inventory of all the analytical methods was taken as a starting point and all have been reworked into the standard work instruction form. Since the SOPs were required to be training materials to guide new staff, the information was quite comprehensive and was presented in roughly the same order in which the user would need it, divided into a number of logical units. Little or no use of acronyms and jargons were included. Each form used in the NAL was complete with revision number, page number, logo and name of the organization.

Given the limited human resources available within the NAL, owing to several prevailing factors including attrition, promotion, reassignment, *inter alia*, the NAL had to implement unique methods of preparing and maintaining the documentation system as required by the international standards and other interests, such as regulatory and oversight bodies, suppliers and customers. Increasingly, forms and working instructions relating to reactor maintenance (logs, calibrations, etc.) were being generated by special computer programmes designed for those specific purposes. Reactor operations were modeled and generated reports were stored electronically – accessible only to designated personnel.

3.5. Document and record control

The ISO/IEC 17025 standard as the base standard required that all documents be stored in a safe and secured location [11]. A collaborative arrangement was established for an integrative service that covered records for completed analytical tasks, manuals for all instrument, personnel records, safety reports, inter alia. As required by the standard, only the current revision of documents remained in circulation with the establishment of a system to keep track of obsolete documents replaced with revised copies. Control measures have been put in place to prevent personnel making uncontrolled copies of documents in circulation.

The availability of computer technology has improved the process of documentation, resulting in the NAL gradually moving away from paper based management. The reliance on sophisticated software has resulted in the processing and archiving of large numbers of instructions documents and forms, storage and codification of spectral data for trackability. Due to the limited human resource in the NAL, system automation and modeling have been two innovative techniques employed in the documentation procedures. Time taken for processing documents or tracking work progress has been significantly reduced and electronic archiving of generated data in the NAL, according to documented procedures and codification, have improved work flow and overall efficiency in addressing issues of safety and management. Output data can be easily modeled in an effort to improve productivity. Secured alternative storage will be implemented to protect against system corruption.

Future design of the documentation system operating on minimum paper, with the distinct advantage of there being immediate access to current edition of documents and forms, will improve the IMS. Other advantages include: protection against unauthorized modifications, having mechanisms in place to inform users of updates, timely revision of forms and documents and judicious withdrawal of obsolete documents and forms. As regards the release of new documents, the first version that is written by selected individual according to the policy of the laboratory, is distributed electronically and peer reviewed by colleagues and the quality coordinator/manager. The author revises the manuscript, taking into consideration the suggestions, following which the manuscript is sent out for a second review. The author and other nominated individuals check the document before final authorization, prior to release of the document for use. Copies of the approved document are then made available to persons on the distribution list. Mechanisms have been put in place to ensure names will be added as time progresses and for continuous revision of existing documents.

4. Conclusion

Documentation activities that will lead to the development of an Integrated Management System in the Nuclear Analytical Laboratory at ICENS are well underway. The process is being undertaken by all staff in the NAL, augmented by system automation capabilities. It is envisaged that the IMS will become fully operational during the first half of 2015, providing that designated staff in the NAL dedicate approximately 5% of the work week to the documentation of procedures.

In this the thirtieth year of SLOWPOKE-2 operation within the NAL at ICENS, the focus will be on identifying the contributions that the institution has made to teaching, research and commercial activities, with the realization of any and all benefits to be had by the implementation of an IMS. Coupled with the scheduled HEU to LEU core conversion, which is expected, will extend the lifetime of the fuel, the institution will be positioned to continuing its promotion of peaceful uses of nuclear technology, operating according to established international standards in the wider Caribbean region and beyond.

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