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Ageing Management Program Revision for the Pavia TRIGA MK II Research Reactor

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ABSTRACT

The Laboratory of Applied Nuclear Energy (LENA) is an interdepartmental service center of the University of Pavia in which, since 1965, a 250 kW TRIGA Mark II research reactor is in operation. Since 2014, the center implemented an aging management program submitted to the Italian regulatory body and finally approved in 2019. The result was a combination of the existing management system based on ISO 9001 requirements (implemented in 2010) with aging concepts such as the aging mechanism and the safety classification of structures, systems, and components. During the last few years, new legal obligations needed a revision phase that started on two main cornerstones: the continuation of safety culture promotion and the definition of a strategic plan for the practical control of aging. This phase was done to manage all the practical aspects and to verify compliance with IAEA and mandatory requirements. In this paper, a description of the revision process and both the activities carried out and those to be planned, will be provided.

1 INTRODUCTION

LENA is an interdepartmental center of the University of Pavia, and it is part of the Cravino Nuclear Pole, which includes the radiochemistry area, the sub-critical SM1 complex, and the environmental monitoring laboratory. In this center a TRIGA Mark II nuclear reactor, a 250kW light water moderated facility aimed for isotope production, training, and general-purpose research is present. Moreover, LENA is equipped with a cyclotron IBA CYCLONE® 18/9, an Rx generator Gilardoni MT 350 / 6-12, and a Cobalt-60 2.91 TBq (78 Curie) source [1].

The University of Pavia is the TRIGA MK II operator since its first criticality on November 15th, 1965. In more than a fifty-year-old facility, to counteract aging effects and to deal with the need to adapt instrumentation and documentation to more stringent regulations, the board of the center decided in 2010 to implement a management system. This decision

allowed us to monitor issues such as the obsolescence of documentation, measurement traceability, and changes in mandatory requirements. In 2014, to integrate the management system with aging considerations, the center adopted an aging management program, revised until final transmission and acceptance to the Italian control body in 2019 [2].

In this article, we will present the evolution of the aging management program following the most recent developments, such as new regulations, the effects of the pandemic on the working environment, and the results of continuous improvement within the organization. Special attention has been given to better integrating the maintenance program with the strategic plan and implementing these documents in daily activities.

2 REVISION OF THE AGEING MANAGEMENT PROGRAM

In the last version of the plan in 2019, it was highlighted that the program was based essentially on two milestones. The first one was the IAEA guideline SSG-10 which includes categorizing Structures, Systems, and Components (SSCs) and identifying the aging mechanism with the SSG-10 codification. The second was the management system based on ISO 9001:2015 which gives the concept of the process approach, the Deming Cycle (Plan-Do-Check-Act), and risk-based thinking.

All these things were merged into the aging management plan, a practical document to improve both maintenance and surveillance programs and counteract aging effects. This plan was applied to the LENA organization during the last years, with the definition of various activities to counteract aging and its effects [3]. The program application resulted in a general improvement of the middle-term maintenance, which was classified and planned for the next years. However, after discussing with maintenance managers and operators during the plan application, was immediately clear that the program was dedicated only to maintenance, without considering crucial concepts of aging like personnel and documentation. Moreover, due to the document's nature, a possible lack of resources for the activities required by the plan.

Nevertheless, in the last two years, many changes occurred:

- the transposition of law 2013/59/Euratom as Italian Legislative Decree 101/2020
- change due to the pandemic effect
- new disposition of License Operator, the University of Pavia
- new limits for measurement
- the use of digital systems as a possible replacement for paper ones and, therefore, informatics sharing systems.

All these things lead to a general revision of the entire program focusing on the safety culture promotion and the involvement of the top management in the application of the program.

2.1 Development of the share drive and pandemic effect

In over the past two years, our organization, as well as all others, faced the effects of the pandemic on work, material, and resource management [4].

In particular, the organization was forced to deal with problems and daily tasks in a different way compared to the past. That situation gave us the impulse to implement and optimize our management systems, especially those aspects related to documentation. The reorganization of the pre-existing shared drive made it possible to create documentation usable quickly and effectively, facilitating the exchange of ideas and advice among staff.

Not to be underestimated is also the process of preserving documentation; digital storage allows one to keep track of all the changes made over time. Furthermore, with a digital signature, obsolete management system processing times are optimized, and operators in the various services always have the latest version of the documentation needed to perform the different tasks.

This results on a practical level in the increased quality and safety of all operations carried out, agreed upon, and discussed with the organization's management.

3 PROMOTING THE SAFETY CULTURE

The promotion of culture for safety is one of the main aspects highlighted by the IAEA in many publications. The implementation of this point should include the contribution of all the elements of the organization at any level. To do so, a key role is played by the senior management to improve the common awareness of the risk and hazards related to the working environment, focusing on the radiation-related risks.

A well-organized team structure, with clear roles and well-defined responsibilities, allows any kind of failure to be reported efficiently. In combination with a more practical revision of the documentation, the reaction time can be reduced, and more effective actions undertaken by anticipating a possible failure rather than correcting it [5].

Staff knowledge and skills are also key aspects of enhancing the safety culture, therefore the organization is promoting participation in safety training events and knowledge sharing.

This allows instilling of a culture of safety, especially in all maintenance processes. For this reason, a common policy of action is created, and safety is no longer a goal but a milestone of the organization.

3.1 ISO 9001

To grow the safety culture in our organization, an excellent starting point appears to be ISO 9001 itself. Within this document, one can find many useful guidelines for the optimal management of resources, personnel, and documentation, as well as key concepts such as the Deming cycle.

Applying these guidelines to plant maintenance as well as the aging process, we realize that the many safety-related guidelines are automatically met, with good overall management. The limitation of ISO 9001, however, is that it is very general and applicable to many different areas and types of organizations. This leads to negligence of some specific problems related to the management of facilities such as nuclear research reactors [6].

3.2 IAEA SGR-2

A step forward from implementing the aging plan by following ISO alone is SGR-2, which is much more specific and dropped within the context of an organization like ours.

This Safety Requirements publication establishes requirements that ensure safety, relying on the related concepts of:

(a) Leadership for safety: by establishing and integrating the organization's vision, goals, strategies, plans, and objectives; by endorsing individual commitment to the protection of people and the environment from harmful effects of ionizing radiation; and by supporting the application of the fundamental safety principles, establishing behavioral expectations, and fostering a strong safety culture.

(b) Management for safety: this includes establishing and applying an effective management system. This system must integrate all management elements so that safety requirements are well defined and applied, coherently with other requirements (including those of personnel performance, quality, and safety). In doing so, safety is not compromised by the need to meet other needs or demands. Safety measures and security measures must be designed and applied in an integrated manner. The management system also must ensure the fostering of a strong safety culture, the regular assessment of safety performance, and the application of lessons from experience. [5].

3.3 INTERNAL AUDIT AND RISK ANALYSIS

Internal audits have been a widely used tool for internal organizational enhancement for several years. Following GSR-2 dispositions, they allow setting goals, strategies, and programs

for the future in a way that is in line with the principles of the organization, concrete, and will actively involve all members.

They also enable managers to keep track of the improvement measurably, with periodic reviews focusing on potential safety hazards.

To keep track of the progress in the implementation of the requirements drafted in GSR-2, monitor the progress of current operations, and plan for future ones, a checklist as shown in Figure 1 has been implemented and is compiled and updated periodically.

LENA Laboratory of Applied Nuclear Energy		Check-list GSR Part 2
Rev. 1	IAEA Safety Standards for protecting people and the environment Leadership and Management for Safety General Safety Requirements	
Requirement: #	**Description:**	**Analysis and undertaken actions:**
§ 1: Achieving the fundamental safety objective	**The registrant or licensee — starting with the senior management — shall ensure that the fundamental safety objective of protecting people and the environment from harmful effects of ionizing radiation is achieved.**	HOW? (Procedures, Modules, check list) Evidences? (Registrations if required) Measurement and instrumentation if needed: Non-conformities:

Figure 1: Example of a checklist for IAEA GSR-2

This document together with the annual audits required for the above-mentioned management system allows all members to be involved in the continuous improvement of the organization. This process enables any critical issues to be highlighted and resolved as well as possible, always focusing on forecasting and preventing possible sources of risk.

The second tool that was used to keep under control all the organization's processes was the risk analysis compliant with the Failure Mode and Effect Analysis methodology (FMEA), which helps the management in the evaluation of problems, sources of risk, and improvement opportunities.

4 THE SCIENTIFIC COMMITTEE AND THE STRATEGIC PLAN

The implementation of a management system and the control of the various processes facilitated the implementation of the mission identified by the Center's Technical Scientific

Committee (CTS), the governing body of the Laboratory, made up of members identified among the academic staff with competence in the activities carried out at LENA. The tasks of the CTS are:

- to propose to the Owner of the License, the modifications of the Safety requirement to be submitted to the approval of the National Inspectorate for Nuclear Safety and Radiation Protection (ISIN)
- to express an opinion, about the modifications of the human resources for the operation of the TRIGA Mark II reactor
- identify, the necessary availability of means and personnel for the operation of the TRIGA Mark II reactor
- evaluate the multiannual and annual program of operation of the TRIGA Mark II in accordance with the LENA director.

The CTS, therefore, appears to be an entity with great responsibility and decision-making power, particularly regarding the center's prospects, and mid/long-term goals. Despite this, it was evident from the various internal audits that it is still too detached from the daily life of the center, devoting itself, especially to the overall vision. To enable the members of the CTS to be more involved in the needs and shortcomings of the center, it was decided to establish a more intensive and detailed communication relationship with the purpose of internal audit reports approval and the acknowledgment of maintenance reports.

Assessing the resources and personnel needs for medium-term maintenance, aging, and its management, was, for the first time added a complete chapter in the strategic plan of the organization. This document highlights strategic objectives set by the management for the LENA, rationalize and achieves the effectiveness and efficiency of all the processes, describe all the communication with interesting parts as the regulatory body

5 CONCLUSIONS AND FURTHER PERSPECTIVE

Since the aging management program was submitted and approved, our center has continued its efforts to improve it and meet the new needs driven by the social and political environment and the new guidelines.

As we went on to investigate in more detail how the aging plan acts on the organization, it became clear that some adjustments were needed to better integrate it with daily operations.

The aging plan up to this point was mainly focused on maintenance systems, identifying major sources of risk so that possible failures could be predicted.

The following Table 1 shows the identified issues and the mitigation actions that have been proposed during the work

Table 1: improvement plan for the aging programgingprogram

Detected Issue	Mitigation Action
Budgeting process and nonconformity handling.	Management communication improvement and bureaucratic processes optimization.
Maintenance processes and daily activities planning information sharing difficulties.	Creation and improvement of a cloud drive in which all relevant information could be easily shared, as a document, results of the internal audit and upcoming activities.
Limited involvement of CTS in the planned aging management aspects activities.	Addition of aging the management activities chapter to the organization's strategic plan, to evaluate sources as operators and budget. Inspection audit report approval.
Understanding of the current situation of the organization, regarding compliance with Italian and European regulations (GSR-2 and Legislative Decree 101/2020) and the next actions to be taken.	Creation of a checklist periodically updated with the implemented actions.

All these changes will be included in the aging management program, which will be re-discussed at the end of the present year.

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