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Sustainability Management System Model for Operating Organizations of Research Reactors

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Abstract
Operating organizations of research reactors are using management system models based on international standards of International Organization for Standardization (ISO) and International Atomic Energy Agency (IAEA), which do not include aspects of sustainability in their context. This article aims to identify the corporate sustainability requirements to be inserted in the management systems proposed by ISO and IAEA, specifically for operating organizations of research reactors. In this article we present a management system model for operating organizations of research reactors, based on a sustainability approach. For this purpose, applicable management system and sustainability standards are considered in this analysis. Four principles of sustainable development were introduced: inclusivity, integrity, stewardship and transparency. A sustainable development maturity matrix, which determines the position of the organization along a path of sustainable development, was also presented. In a country like Brazil, where nuclear activity is geared towards peaceful purposes, any operating organization of research reactor should emphasize its commitment to social, environmental, economic and institutional aspects. Social aspects include research and development, production and supply of radiopharmaceuticals, radiation safety and special training for the nuclear sector. Environmental aspects include control of the surroundings and knowledge directed towards environment preservation. Economic aspects include import substitution and diversification of production. Institutional aspects include technology, innovation and knowledge. These aspects, if considered in the management system of an operating organization of research reactor, will help with its long-term maintenance and success in an increasingly competitive market scenario.

Keywords
Management Systems, Nuclear Facilities and Activities, Research Reactors, Safety Culture, Sustainability, Sustainable Development.

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1.0 Introduction

The purpose of this article is to study within the available literature, paths for the establishment of a sustainability management system for operating organizations of research reactors.

In subsequent sections, we will make an introduction about research reactors, a common definition of management system, a literature review, the methodology used, a presentation and analysis of results and, finally, conclusions and final considerations about this study.

1.1 Research Reactors[1]

Research reactors comprise a wide range of different types that are generally not used for power generation.

The primary use of research reactors is to provide a neutron source for research and various applications, including education and training. They are small in comparison with power reactors whose primary function is to produce electricity. Research reactors power ratings are designated in megawatts and their output can range from zero (critical assembly) up to 200 MW(th), compared with 3000 MW(th), i.e., 1000 MW(e) for a typical large power reactor unit.

Research reactors are also simpler than power reactors and operate at lower temperatures. They need far less fuel, and far less fission products build up as the fuel is used. On the other hand, requires uranium with much higher enrichment, typically up to 20 % U-235, than that of power reactors (3-5%). Some unconverted research reactors still use highly enriched uranium (HEU) fuel containing a level of 93% U-235.

Research reactors also have a very high power density in the core, which requires special design features. As with power reactors, the core requires cooling, and usually a moderator is required do slow down the neutrons to enhance fission. Many research reactors use a reflector to reduce neutron loss from the core and to sustain the chain reaction.

Research reactors offer a diverse range of applications, such as neutron beam research for material studies and non-destructive examination, neutron activation analysis to measure minute quantities of an element, radioisotope production for medical and industrial use, neutron irradiation for materials testing for fission and fusion reactors, neutron transmutation doping of silicon, gemstone coloration, etc. Another important area where research reactors make a large contribution is education and training in all nuclear technology areas for operators, maintenance and operational staff of nuclear facilities, radiation protection personnel, regulatory personnel, students and researchers.

There is a much wider array of designs in use for research reactors than for power reactors, and they also have different operating modes, which may be steady or pulsed.

A common design is the pool type reactor, where the core is a cluster of fuel elements sitting in a large pool of water. Between the fuel elements are control rods and empty spaces (channels) for experiments. In one particular design, the Material Testing Reactor, a fuel element comprises several curved aluminum-clad fuel plates in a vertical box. The water moderates and cools the reactor, while graphite or beryllium is typically used for the reflector, although other materials may be employed. Circular or ellipsoidal beam tubes penetrate the reactor shielding, the vessel, and pool to access neutron and gamma beams from the core for experimental uses in the reactor hall.

The TRIGA reactor is another common design. This kind of reactor is very versatile: it can operate either at steady state or safely be pulsed to very high power levels for fractions of a second, e.g., 25000 MW (th). Other types of cores are cooled and moderated by heavy water.

Less common types of research reactors are fast reactors that require no moderator and use a mixture of uranium and plutonium as fuel.

Homogeneous type reactors have a core that acts as a tank, containing a liquid solution of uranium salts, i.e., its fuel is liquid.

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[1] Text adapted from IAEA [1].

1.2 Management Systems

According to ISO 9000:2015 [2] and IAEA GS-R-3:2006 [3], management system is a set of interrelated or interacting elements (system) for establishing policies, objectives and processes, and to achieve those objectives in an efficient and effective way.

ISO 9000:2015 [2] reports that a management system can address a single discipline or several disciplines, e.g. quality management, financial management or environmental management. The management system elements establish the organization's structure, roles and responsibilities, planning, operation, policies, practices, rules, beliefs, objectives and processes to achieve those objectives. The scope of a management system can include the whole of the organization, specific and identified functions of the organization, specific and identified sections of the organization, or one or more functions across a group of organizations.

IAEA GS-R-3:2006 [3] describes that the management system integrates all elements of an organization into one coherent system to enable all of the organization's objectives to be achieved. These elements include the structure, resources and processes. Personnel, equipment and organizational culture as well as the documented policies and processes are parts of the management system. The organization's processes have to address the totality of the requirements on the organization as established in national regulations and, for example, IAEA safety standards and other international codes and standards.

In chapter 2, we describe the standards applicable to management systems and sustainable development.

2.0 LITERATURE REVIEW

2.1 ISO 9001:2015 – Quality Management Systems – Requirements [4].

ISO 9001:2015 [4] specifies requirements for a quality management system, as shown in Figure 1, when an organization needs to demonstrate its ability to consistently provide products and services that meet customer and applicable statutory and regulatory requirements, and aims to enhance customer satisfaction through the effective application of the system, including processes for improvement of the system and the assurance of conformity to customer and applicable statutory and regulatory requirements.

ISO 9001:2015 [4] enables an organization to use the process approach, coupled with the PDCA (Plan Do Check Act) cycle and risk-based thinking, to align or integrate its quality management system with the requirements of other management system standards.

The process approach enables an organization to plan its processes and their interactions. The PDCA cycle enables an organization to ensure that its processes are adequately resourced, managed and opportunities for improvement are determined and acted on.

Risk-based thinking enables an organization to determine the factors that could cause its processes and its quality management system to deviate from the planned results, to put in place preventive controls to minimize negative effects and to make maximum use of opportunities as they arise.

The potential benefits to an organization of implementing a quality management system based on ISO 9001:2015 [4] are:

a) The ability to consistently provide products and services that meet customer and applicable
b) Statutory and regulatory requirements;

c) Facilitating opportunities to enhance customer satisfaction;

d) Addressing risks and opportunities associated with its context and objectives;

e) The ability to demonstrate conformity to specified quality management system requirements.

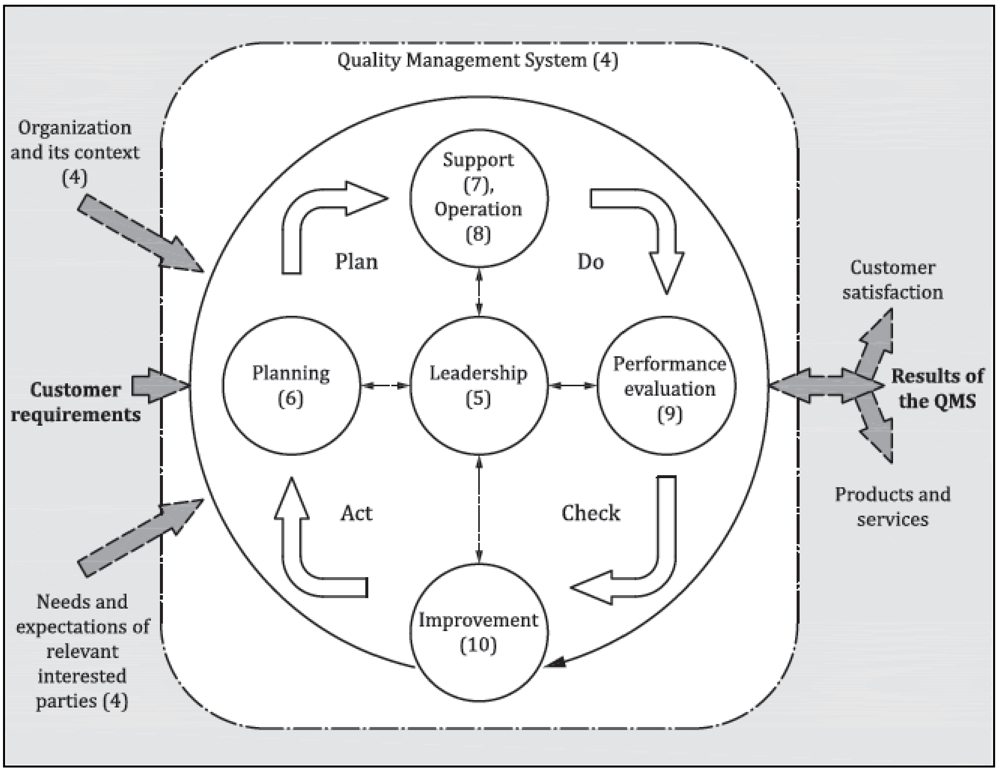

Fig. 1 Quality management system defined by ISO 9001:2015 [4]

ISO 9001:2015 [4] does not include requirements specific to other management systems, such as those for environmental management, occupational health and safety management, or financial management, but applies the framework developed by ISO Directives Part 1 [5] to improve alignment among other ISO management systems standards.

2.2 ISO/IEC Directives Part 1 and Consolidated ISO Supplement, Annex SL (normative) - Proposals for Management System Standards [5].

ISO Directives Part 1 [5] in Appendix 2 establishes high level structure, identical core text, common terms and core definitions for ISO management system standards. High level structure consists of six common requirements: context of the organization, leadership, planning, support, operation, performance evaluation and improvement.

The six common requirements should be observed in conjunction with PDCA approach (*Plan-Do-Check-Act*), that all management systems follow:

- *Plan* (P): context of the organization, leadership, planning, support;
- *Do* (D): operation;
- *Check* (C): performance evaluation; e
- *Act* (A): improvement.

Figure 2 shows the high level structure for ISO management system standards, according to ISO Directives Part 1 [5].

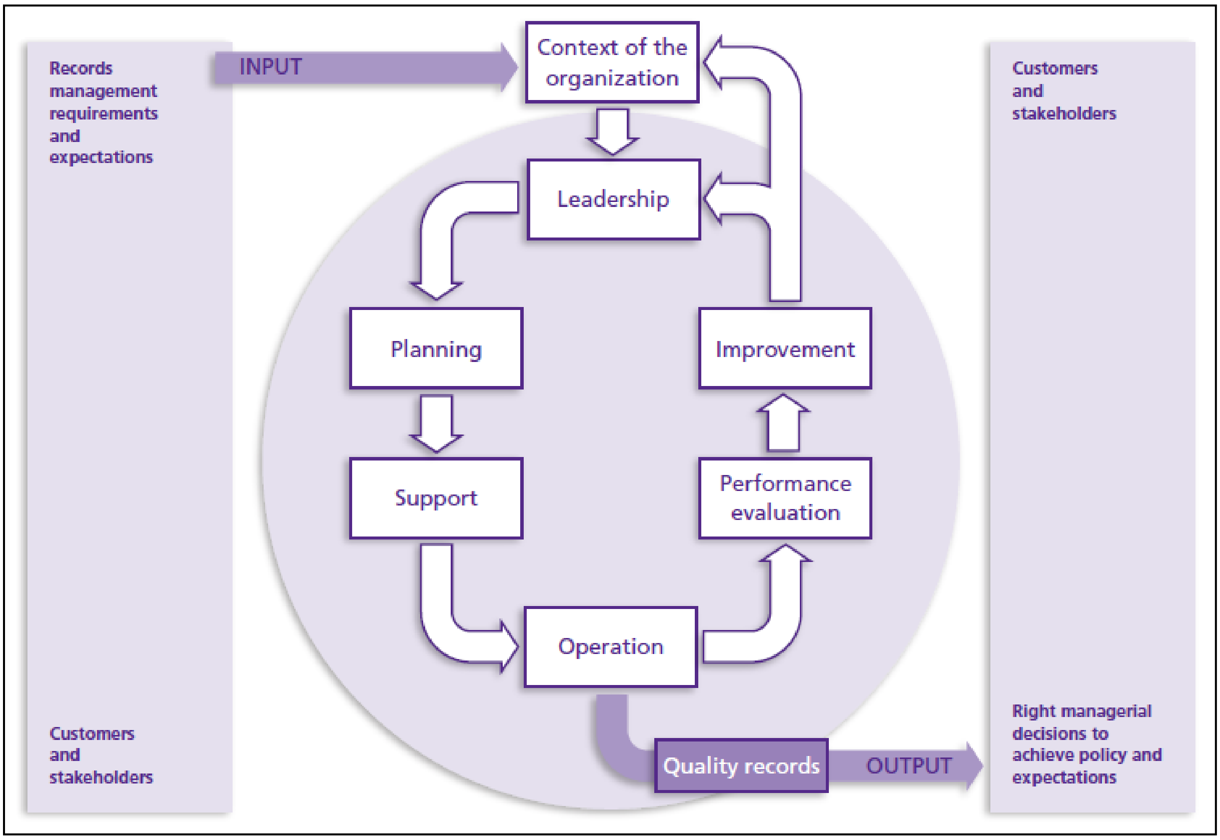

Fig. 2 High level structure for ISO management system standards [5]

2.3 PAS 99:2012 – Specification of Common Management System Requirements as a Framework for Integration [6].

PAS 99:2012 [6] enables organizations to integrate common management system requirements into one framework. Organizations using this PAS should include as input, the specific requirements of the management systems to which they subscribe, e.g. ISO 9001, ISO 14001, ISO 45001, ISO 26000, etc. This may well necessitate specialist input on the technical aspects of the individual disciplines.

PAS 99:2012 [6] helps organizations to achieve benefits from consolidating the common requirements in all management systems and from managing these requirements effectively. The benefits may include:

a) Improved business focus;

b) A more holistic approach to managing business risks;

c) Less conflict between individual management systems;

d) Reduced duplication and bureaucracy;

e) More effective and efficient audits both internally and externally;

f) Easier facilitation of the requirements of any new management systems that the organization wishes to adopt.

Many of the requirements in standards are common and these can be practically accommodated under one generic management system as shown in Figure 3. It follows that the reduction in duplication by combining two or more systems in this way has the potential to significantly reduce the overall size of the management system and improve system efficiency and effectiveness.

Figure 3 shows that as the various management system requirements can be aligned in a single structure it is possible to integrate the common requirements. This should be done in a manner that is most appropriate to the organization.

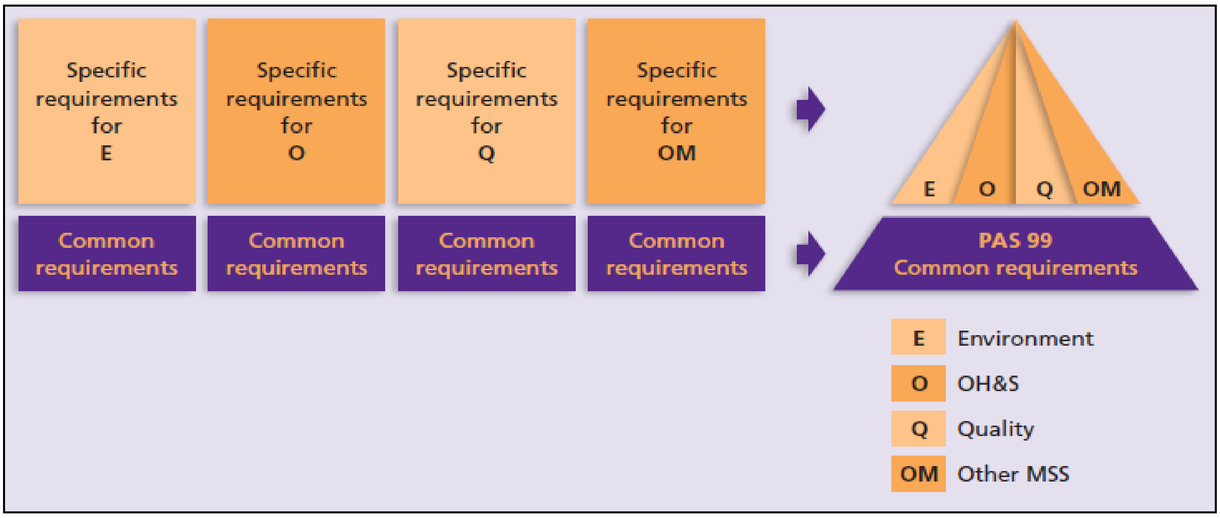

Fig. 3 Illustration of how the common requirements of multiple management system standards can be integrated into one common system [6]

PAS 99:2012 [6] is based upon the structure provided in ISO Directives Part 1 [5] and incorporates its text where appropriate to provide a future proof approach for accommodating new management systems as they are produced. This PAS structure and correlation with Plan Do Check Act approach (PDCA) are shown in Figure 4.

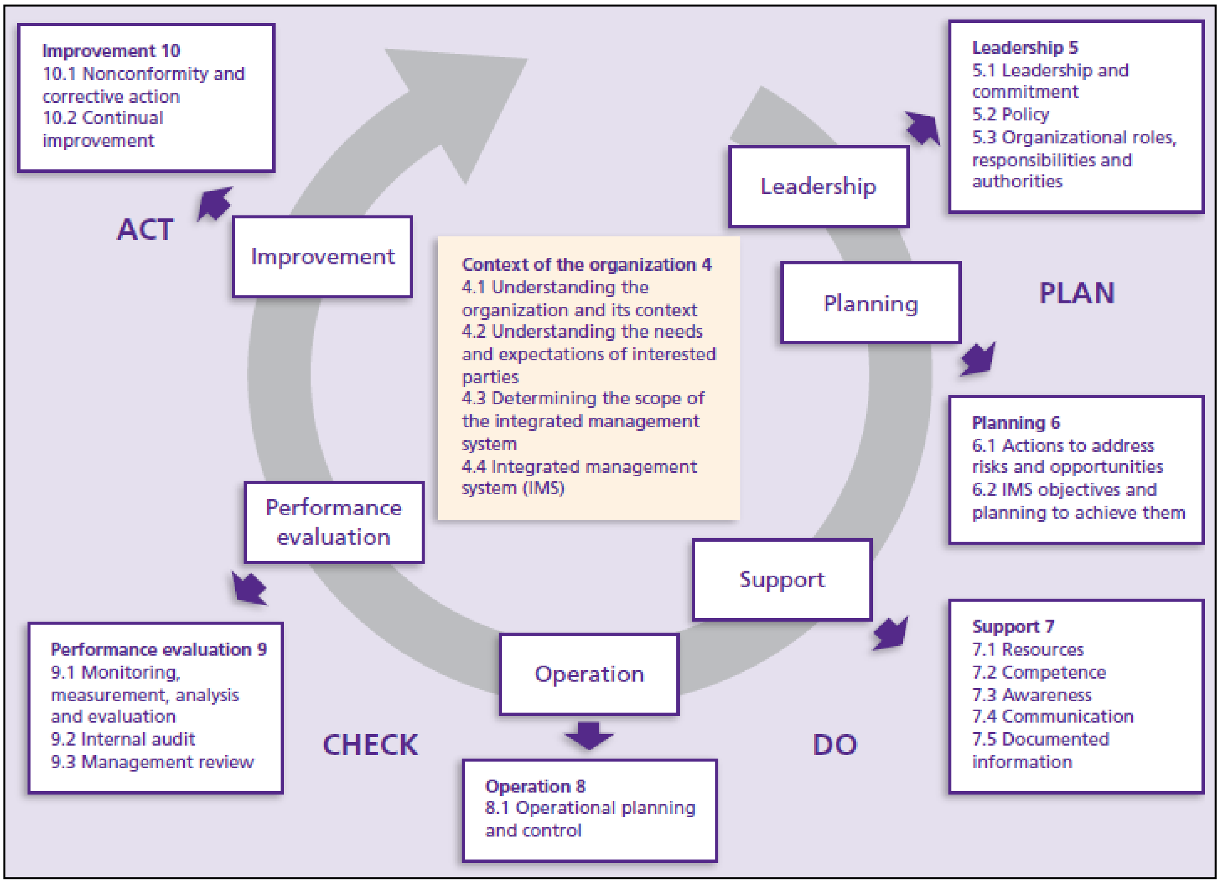

Fig. 4 PAS 99:2012 [6] structure and correlation with PDCA approach

2.4 IAEA GS-R-3:2006 - The Management System for Facilities and Activities: Safety Requirements [3].

IAEA GS-R-3:2006 [3] defines the requirements for establishing, implementing, assessing and continually improving a management system, which integrates safety, health, environmental, security, quality and economic elements, whereas safety is the fundamental principle upon which the management system is based.

IAEA GS-R-3:2006 [3] is applicable to nuclear facilities, activities using sources of ionizing radiation, radioactive waste management, the transport of radioactive material, radiation protection activities, any other practices or circumstances in which people may be exposed to radiation from naturally occurring or artificial sources, and the regulation of such facilities and activities. It is applicable throughout the lifetime of facilities and for the entire duration of activities in normal, transient and emergency situations.

Figure 5 shows IAEA GS-R-3:2006 [3] management system model. The high level structure of this system consists of four main requirements: management responsibility, resource management, process implementation and measurement, assessment and improvement. The system focuses the establishment of a strong safety culture and the achievement of high levels of performance with concern to safety.

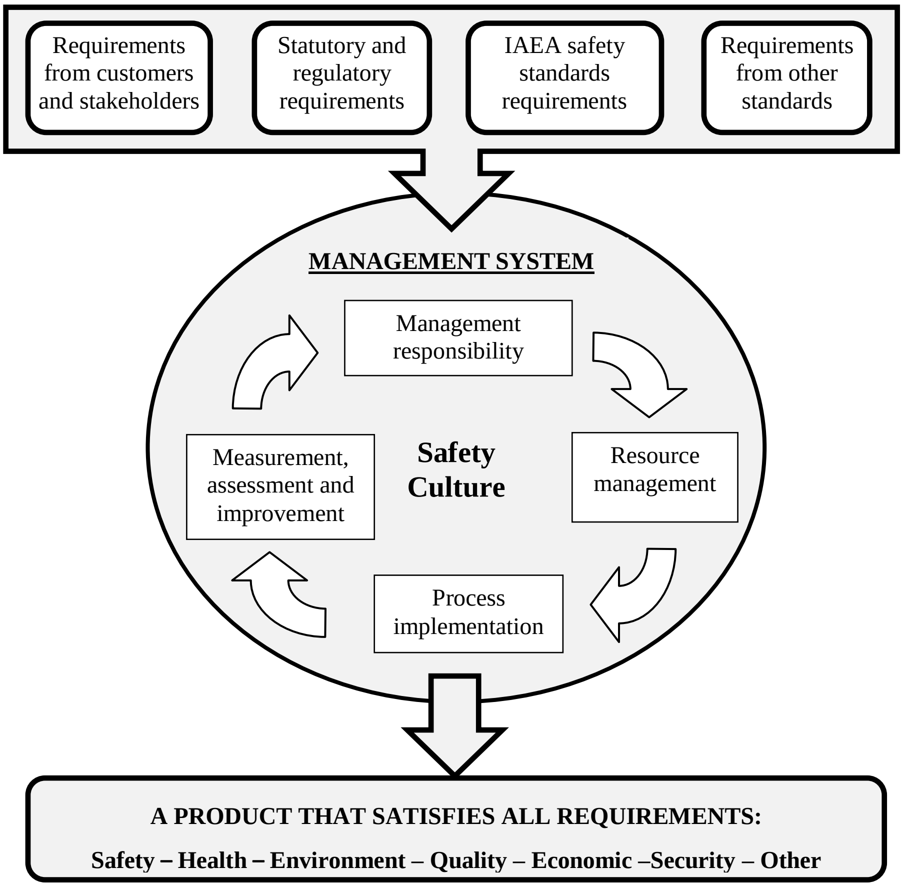

Fig. 5 IAEA GS-R-3:2006 [3] management system model

Inputs to IAEA management system model are: requirements from customers and stakeholders, statutory and regulatory requirements, IAEA safety standards requirements, and requirements from other standards.

Output from IAEA management system model is a product that satisfies all requirements: safety, health, environment, quality, economic, security and other.

2.5 IAEA SRS 75:2013 – Implementation of a Management System for Operating Organizations of Research Reactors [7].

IAEA SRS 75 [7] complements the requirements of IAEA GS-R-3 [3], in order to establish guidelines for the management system implementation in operating organizations of research reactors.

The operating organization is required to establish and implement a management system for the whole life cycle of a research reactor: siting, design, construction, commissioning, operation including utilization, modification, refurbishment and decommissioning.

The development and implementation of a management system is a basic requirement in order to ensure:

- The safety of research reactors in all stages of their lifetime in order to protect the workers, the public and the environment from undue radiation hazards;
- Compliance with regulatory requirements;
- Proper and safe modification, refurbishment and upgrading;
- Safe and effective utilization of the research reactor for a variety of experiments and training as well as for commercial services.

Key elements for the successful implementation of an integrated management system are:

- The person in the highest management position in the organization is responsible for ensuring that the management system is implemented;
- A collaborative effort by management, those performing the work and those assessing the work;
- Planning and deployment of adequate resources;
- All staff are trained to achieve proficiency and to ensure they understand the procedures that apply to the performance of their work;
- Understanding that the interactions between an organization's processes can often be complex, resulting in a network of interdependent processes;
- Inputs and outputs of these processes are often related to both external and internal customers;
- Understanding that individual working processes rarely occur in isolation. Outputs from one process typically form part of the inputs into subsequent processes;
- Matching the complexity of the activity to the complexity of the documentation. A simple activity can be covered by one procedure while a process is implemented by the application of one or several procedures and/or working instructions;
- Grouping several processes instead of implementing each process and related documents in a sequential manner to reduce the time and effort necessary for implementation;
- Performing dedicated internal audits to monitor and facilitate the implementation after the management system has been (partly) introduced;
- Assessing and reviewing the effectiveness of the management system at all stages of implementation;

– Using the information gained from assessments to achieve continuing improvements in work performance.

Figure 6 shows an overview of the management system implementation process proposed by IAEA SRS 75 [7].

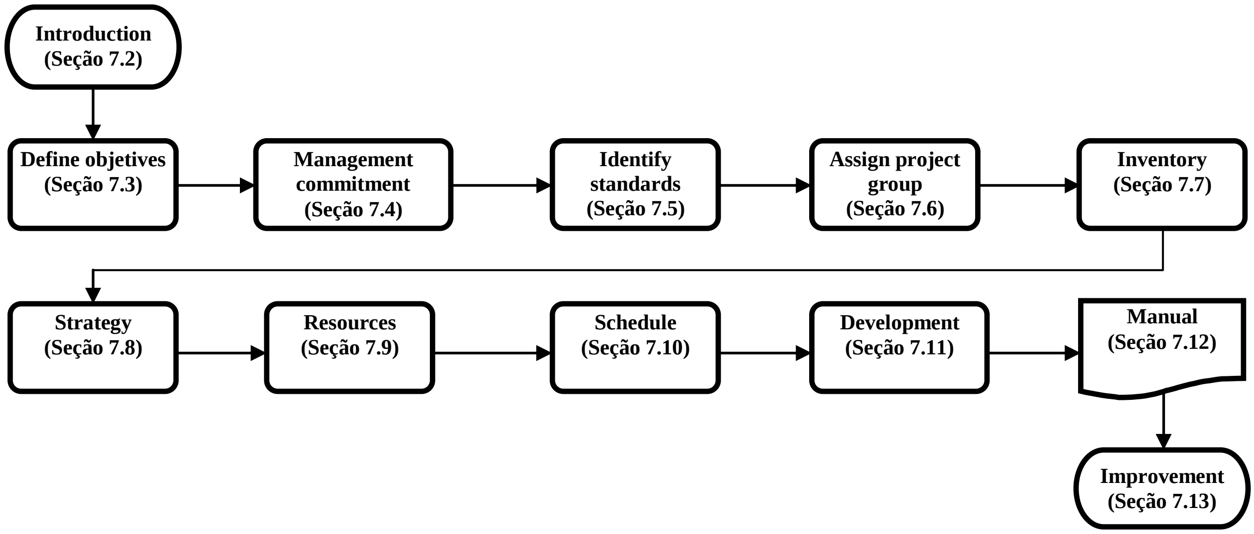

Fig. 6 Overview of the management system implementation process proposed by IAEA SRS 75

2.6 BS 8900-1:2013 – Specification of Common Management System Requirements as a Framework for Integration [8].

BS 8900-1:2013 [8] provides guidance on managing sustainable development and a framework that assists organizations to enhance performance and effectiveness.

It offers a coherent approach to managing social, economic and environmental aspects of an organization's activities. It is applicable to organizations of any size, sector and type. This standard does not specify performance criteria or explain the specific elements of social, economic and environmental impacts. In addition, it is relevant to organizations' stakeholders.

BS 8900-1:2013 [8] establishes four fundamental principles for the sustainable development of an organization:

a) Inclusivity: a clearly expressed intention or policy of including key stakeholders in the development of organizational strategy, corporate planning and direction;

b) Integrity: adherence to a set of commonly held ethical norms and law abiding behaviour;

c) Stewardship: position of accountability for managing all activities of an organization throughout all the stages of its life span;

d) Transparency: openness about decisions and activities that affect society, the economy and the environment, and a willingness to communicate these in a clear, accurate, timely, honest and complete manner.

Application of the four fundamental principles increases levels of stakeholder's confidence and helps to improve credibility and transparency of an organization's performance.

To put into practice sustainable development in organizations, BS 8900-1:2013 [8] establishes some guidelines:

a) Establish the vision of the organization, including its principles;

b) Identify the issues and stakeholder engagement;

c) Establish the capability of the organization, that is, resource allocation and competence building;

d) Establish techniques for the management of sustainable development, in accordance with the maturity level of the organization in relation to sustainable development.

BS 8900-1:2013 [8] reports that some organizations already use recognized management systems, for example in the areas of accountancy, environmental management and human resources, and sustains the possibility of including elements of sustainable development in these management systems. It offers an approach to the management of sustainable development, as below:

a) Assessing risks and opportunities:

– Identify potential issues and impacts, both positive and negative, direct and indirect, and analyses key risks and opportunities (in terms of impact and likelihood) to establish their significance;

– Prioritize actions and allocates resources to maximize opportunities and minimize risks.

b) Identifying key performance indicators:

– Identify those indicators that are key to meeting these objectives;

– Establish the chosen key performance indicators across relevant parts and functions of the organization;

– Define effective methods of assessing performance using these key performance indicators.

c) Achieving progress:

– Assign specific responsibilities to record, manage and track actual performance against the chosen objectives and indicators;

– Ensure the process is comprehensive by embedding and integrating sustainable development objectives in all areas of the organization through inclusion in job responsibilities and personal objectives;

– Measure performance equitably and ensure it is subject to the same performance management criteria as any other organizational objectives.

BS 8900-1:2013 [8] also recommends the following conducts:

a) Integration of sustainable development into the organization’s performance review and reporting processes;

b) Maintenance of the organization’s strategy for sustainable development under continual review and update it at appropriate intervals, or following a significant organizational change;

c) Sustainable development should be included in an organization’s operational review and should form an integral part of the regular planning or budgeting cycle;

d) The organization should ensure that processes and resources are in place, and that there is a will and commitment to deal with the findings of these reviews and to implement the changes required for continual improvement;

Each organization should, from time to time, determine its position along a sustainable development path. A useful tool for this purpose is the sustainable development maturity matrix shown in Figure 7.

Principles	**Practices**	**Stages of an organization's approach to sustainable development** **Maturity** →			
Inclusivity					**Additional plans and objectives to be determined by each organization may be added to the matrix.**
Integrity					
Stewardship					
Transparency					
Additional principles applicable to each organization may be added to the matrix.					

Fig. 7 Example of a sustainable development maturity matrix [8]

When an organization is developing its matrix, it is useful to involve a number of stakeholders with differing roles and responsibilities, seeking consensus on the most appropriate and meaningful practices and stages.

Each stage described in a cell of the matrix should, as far as possible, be unambiguous, objective and show clearly measurable achievements. BS 8900-1:2013 [8] includes examples of sustainable development maturity matrixes.

An organization should appraise its current position in respect of each stage, noting any which need particular attention to restore balanced progression along its sustainable development path. Specific objectives should be identified and action plans devised to secure both balance and broad general advance.

A periodic review should be conducted of the organization's position along its sustainable development path and of the continued relevance of the stages in the matrix. Adjustments to the matrix might be required to reflect changing circumstances, stakeholder priorities, regulations, etc.

The position depicted by the matrix (e.g. by shading already accomplished cells) can serve as an input to the organization's communications to stakeholders.

3.0 Methodology

The development and implementation of a management system in an organization, as well as the adoption of one or another standard for management system, are the result from a strategic decision of the senior management. IAEA GS-R-3:2006 [3] recommends that a nuclear organization develops and implements an integrated management system, having as main objective the preservation of individuals, facilities and environment safety.

Within the literature about management systems for nuclear facilities and activities we find examples of nuclear organizations, both those geared towards research as those geared towards energy production, using models of management systems based on ISO 9001:2015 [4] and IAEA GS-R-3:2006 [3], but these models do not include sustainability requirements in their context.

In order to incorporate sustainability requirements to a management system of an operating organization of research reactors, we suggest the integration of BS 8900-1:2013 [8] requirements to those requirements of ISO 9001:2015 [4] and IAEA GS-R-3:2006 [3].

Figure 8 shows, by means of a simplified scheme, the methodology used for the construction of the sustainability management system model for operating organizations of research reactors: ISO 9001:2015 [4] management system requirements, plus IAEA management systems requirements GS-R-3 [3] and SRS 75 [7], plus the definition of operating organizations of research reactors processes, plus BS 8900-1:2013 [8] requirements, sustainability policy and goals, results an integrated management system model for operating organizations of research reactors, that includes sustainability requirements.

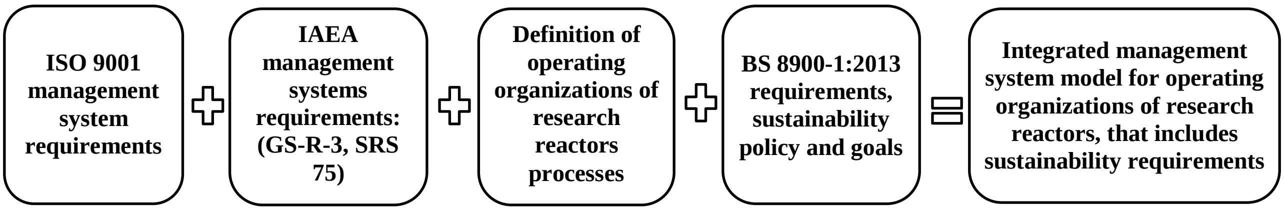

Fig. 8 Simplified scheme of methodology used for the construction of the sustainability management system model for operating organizations of research reactors

4.0 Presentation and Analysis of Results

As a result of the methodology suggested in the previous chapter, a management system model for operating organizations of research reactors based on a sustainability approach is presented in Figure 9.

The proposed integrated management system integrates elements of safety, health, environment, quality, economic, security, sustainability, statutory, regulatory, among others, as applicable, set forth by clients and stakeholders. These requirements are separated into four groups of requirements for sustainability: environment, social, economic and institutional.

We understand nuclear safety and security requirements may be addressed into the four groups for sustainability, since nuclear safety and security results from the interaction among producers, societal representatives and the public, in finding a balance between the benefits, costs and risk of nuclear products, activities or processes. An effective radiological protection control shall give support to all nuclear processes and activities.

One of the goals of an operating organization of a research reactor should be to find a balance, which is the best for most of the people in the society and at least acceptable for everybody.

In order to prevent risks to life, health, property and environment, nuclear safety and security, safeguards and radiological protection practices should be part of all processes and subprocesses at all levels of an operating organization of a research reactor.

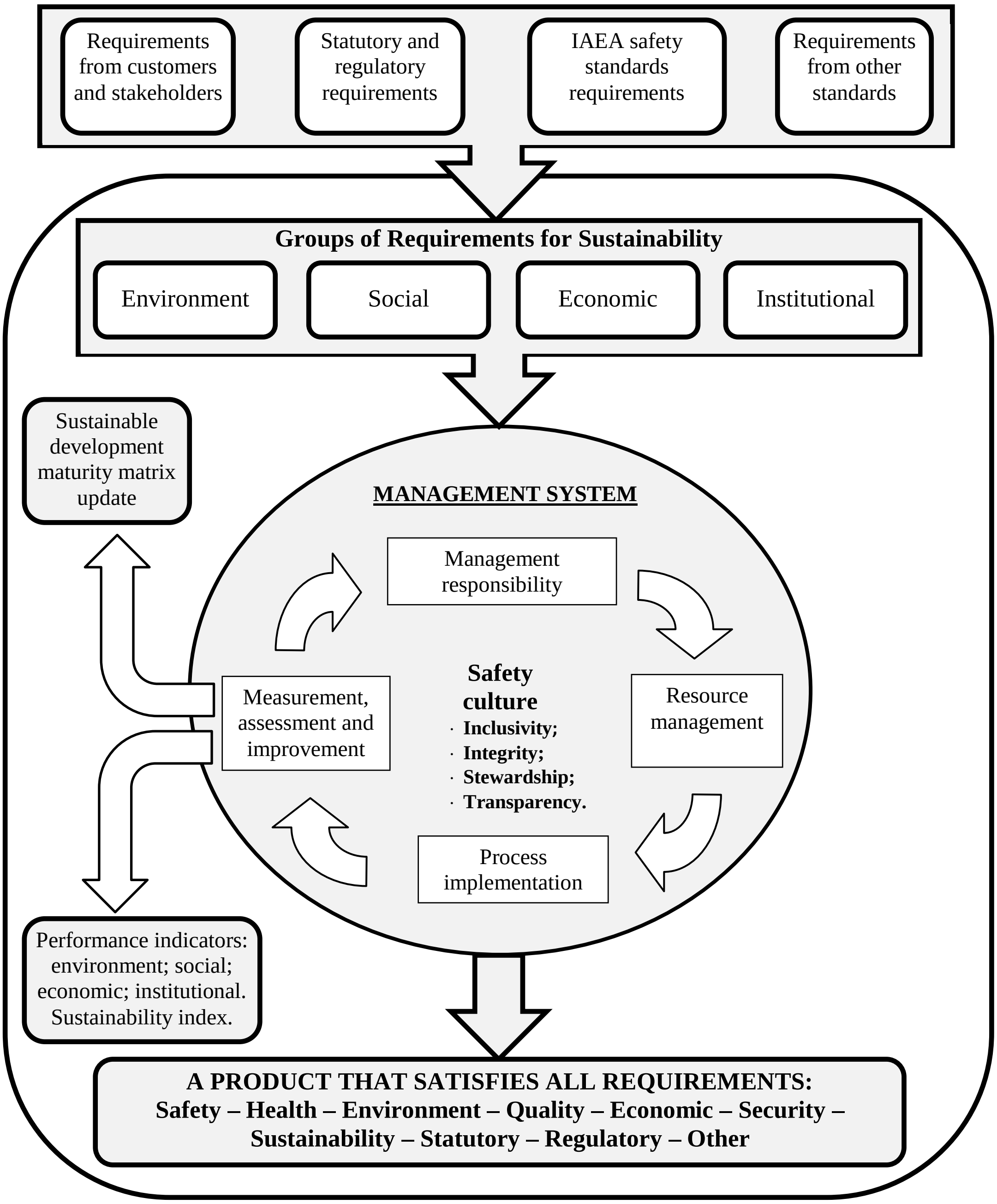

Fig. 9 Management system model for operating organizations of research reactors, based on a sustainability approach

The structure of the integrated management system is based on ISO 9001:2015 [4] and IAEA GS-R-3:2006 [3].

The integrated management system focuses on safety culture, and is supported by sustainability principles addressed by BS 8900-1:2013 [8]: inclusivity, integrity, stewardship and transparency.

The product meets all requirements: safety, health, environment, quality, economic, security, sustainability, statutory, regulatory, among others, as applicable.

Environmental, social, economic and institutional performance indicators, a sustainability index and sustainable development maturity matrix update are outputs of the measurement, assessment and improvement process, and are used by senior management to improve organizational performance along a sustainable development path.

5.0 Conclusions and Final Considerations

Operating organizations of research reactors are using management system models based on international standards of International Organization for Standardization (ISO) and International Atomic Energy Agency (IAEA), which do not include aspects of sustainability in their context.

This article presented a management system model for operating organizations of research reactors, based on a sustainability approach.
For the construction of this model, we presented the applicable standards ISO 9001:2015 [4], PAS 99:2012 [6], ISO Directives Part 1 [5], IAEA GS-R-3:2006 [3], IAEA SRS 75:2013 [7] and BS 8900-1:2013 [8].

With emphasis on BS 8900-1:2013 [8], we presented the four principles of sustainable development: inclusivity, integrity, stewardship and transparency. We also presented a sustainable development maturity matrix which determines the position of the organization along a path of sustainable development.

In a country like Brazil, where nuclear activity is geared towards peaceful purposes, any operating organization of research reactor should emphasize its commitment to social, environmental, economic and institutional aspects.

This only becomes possible when we prioritize nuclear safety and accident prevention. In this concern, some national regulations are followed, CNEN NN 2.02 [9] regulates activities with radioactive materials and CNEN Res 09/69 [10] regulates siting of nuclear installations. A nuclear accident would invalidate the social, institutional, economic and environmental commitments for the construction and operation of a nuclear research reactor.

Social aspects include research and development, production and supply of radiopharmaceuticals, radiation safety, special training for the nuclear sector. Environmental aspects include control of the surroundings and knowledge directed towards environment preservation. Economic aspects include import substitution and diversification of production. Institutional aspects include technology, innovation and knowledge.

Behind all these aspects, there is a specific legislation that deals with the handling, storage, transport, use, waste disposal and reverse logistics packaging of radioactive material. In Brazil, Comissão Nacional de Energia Nuclear – CNEN (National Commission of Nuclear Energy) is responsible for standardization, supervision and control of all activities previously described, with focus on nuclear safety, nuclear security, nuclear safeguards and radiological protection.

These aspects, if considered in the management system of an operating organization of research reactor, will help with its long-term maintenance and success in an increasingly competitive market scenario.

6.0 Acronyms and Abbreviations

ABNT – Associação Brasileira de Normas Técnicas;

BS – British Standard;

BSI – British Standards Institution;

CNEN – Comissão Nacional de Energia Nuclear

IAEA – International Atomic Energy Agency;

ISO – International Organization for Standardization;

NBR – Brazilian Standard;

PAS – Publicly Available Specification;

PDCA – Plan Do Check Act approach;

SRS – Safety Reports Series.

7.0 References

1. International Atomic Energy Agency – IAEA. Research Reactors: Purpose and future. Vienna: IAEA, 2010. Available from: <https://www.iaea.org/OurWork/NE/NEFW/Technical-Areas/RRS/documents/RR_Purpose_and_Future_BODY.pdf>. Accessed on: 17 oct. 2015.
2. International Organization for Standardization – ISO. Quality management systems - Fundamentals and vocabulary. Geneva, Switzerland: ISO, 2015. (ISO 9000:2015).
3. International Atomic Energy Agency – IAEA. The management system for facilities and activities: safety requirements. Vienna: IAEA, 2006. (IAEA GS-R-3:2006). Available from: <http://www-pub.iaea.org/MTCD/publications/PDF/Pub1252_web.pdf>. Accessed on: 19 oct. 2015.
4. International Organization for Standardization – ISO. Quality management systems – Requirements. Geneva, Switzerland: ISO, 2015. (ISO 9001:2015).
5. International Organization for Standardization – ISO. Proposals for management system standards. Geneva, Switzerland: ISO, 2015. Available from: <http://isotc.iso.org/livelink/livelink?func=ll&objId=17159827&objAction=download&viewType=1>. Accessed on: 12 sep. 2015. (ISO/IEC Directives Part 1 and Consolidated ISO Supplement, Annex SL).
6. British Standards Institution - BSI. Specification of common management system requirements as a framework for integration. London: BSI, 2012. (PAS 99:2012).
7. International Atomic Energy Agency – IAEA. Implementation of a management system for operating organizations of research reactors. Vienna: IAEA, 2013. (IAEA SRS 75). Available from: <http://www-pub.iaea.org/MTCD/Publications/PDF/Pub1584_web.pdf>. Accessed on: 19 oct. 2015.
8. British Standards Institution - BSI. Managing sustainable development of organizations – Part 1: Guide. London: BSI, 2013. (BS 8900-1:2013).
9. Comissão Nacional de Energia Nuclear – CNEN. Nuclear Material Control. Rio de Janeiro, Brasil: CNEN, 1999. (CNEN NN 2.02). Avaialble from: http://appasp.cnen.gov.br/seguranca/normas/pdf/Nrm202.pdf. Accessed on: 17 dec. 2015.
10. Comissão Nacional de Energia Nuclear – CNEN. Standards for the Siting of Nuclear Power Installations. Rio de Janeiro, Brasil: CNEN, 1999. (CNEN Res 09/69). Avaialble from: http://appasp.cnen.gov.br/seguranca/normas/pdf/Nrm168.pdf. Accessed on: 17 dec. 2015.