# A Common Approach for Management systems

# DEVELOPMENT FOR NEWCOMER COUNTRIES

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**Abstract**

Newcomer countries invariably struggle to develop their management systems when initiating new nuclear programmes. They often do not have the background in nuclear design, construction and operations to anticipate the numerous issues that must be addressed. Furthermore, national regulatory environments are frequently not developed early enough to provide strong and effective guidance regarding what the national regulators require within a nuclear management system.

The paper aims to develop a problem statement concerning this issue. It suggests ways in which new nuclear organizations, technology vendors and the IAEA can work to address this important area for both small- and medium-sized reactor (SMR) and large reactor deployments.

## Introduction

Jurisdictions new to new power production face significant challenges when implementing a nuclear power programme. The IAEA Milestones approach [1] and related assist missions (e.g., [2–6]) provide excellent guidance on the issues to be addressed, including the need to develop an integrated management system during Phase 2.

Despite this assistance, newcomer jurisdictions often struggle with management system development. With no detailed models to follow, limited experience with nuclear design, procurement, construction, commissioning and operations, often with an inexperienced regulator and non-existent or few national nuclear regulations having been developed, and often with limited financial resources, these jurisdictions regularly take extended periods of time to build their management system. Initial efforts can end up not being fit for purpose.

This situation poses a problem for the planet: efforts to combat climate change or a lack of energy infrastructure needed to raise living standards take longer or don’t happen at all. The paper intends to provide some suggestions to address this issue.

## Publically Available Information

There is a wide range of publicly available information on management systems from the IAEA, international nuclear regulators, and standards organizations. Some of this information is nuclear-specific, while others are not. Table 1 lists selected sources from the IAEA, ISO and three traditional experienced nuclear technology vendor countries (Canada, the USA and Germany). The IAEA maintains a comprehensive list of National Laws and Regulations and Commonly Used Standards within its Management System Network of Excellence (<https://nucleus.iaea.org/sites/connect/MSNpublic/SitePages/Home.aspx>). Some of this information is widely available (e.g., IAEA publications, most national regulations), while others may be restricted commercially (typically standards produced by commercial standards-making organizations).

Table 1. Selected Management System Guidance Documents

| **Source** | **Type** | **Title** | **Reference** |
| --- | --- | --- | --- |
| IAEA | Safety Standard | GSR Part 2 Leadership and Management for Safety | [7] |
| IAEA | Safety Standard | GS-G-3.1 Application of the Management System for Facilities and Activities | [8] |
| IAEA | Safety Standard | GS-G-3.5 The Management System for Nuclear Installations | [9] |
| IAEA | Guidance Document | NG-T-1.3 Development and Implementation of a Process Based Management System | [10] |
| IAEA | Guidance Document | TECDOC-2013 Experiences of Regulatory Bodies and Owner/Operator Organizations in Developing Management Systems for New Nuclear Power Programmes | [11] |
| IAEA | Guidance Document | Quality Assurance and Quality Control in Nuclear Facilities and Activities: Good Practices and Lessons Learned | [12] |
| ISO | Standard | ISO 9001:2015 Quality Management Systems — Requirements | [13] |
| ISO | Standard | ISO 19443:2018 Quality management systems — Specific requirements for the application of ISO 9001:2015 by organizations in the supply chain of the nuclear energy sector supplying products and services important to nuclear safety (ITNS) | [14] |
| Canada | Regulation | REGDOC-2.1.1 Management Systems | [15] |
| Canada | Standard | CSA N286-12 Management Systems | [16] |
| USA | Standard | ASME NQA-1: 2022 Quality assurance requirements for nuclear facility applications | [17] |
| Germany | Standard | KTA 1401 (2017-11) General Requirements Regarding Quality Assurance | [18] |
| Germany | Standard | KTA 1402 (2017-11) Integrated Management Systems for the Safe Operation of Nuclear Power Plants | [19] |

## What is Missing

Several items are often not readily available to many newcomer countries when they may be ready to start management system development:

* A stable, well-established nuclear regulatory regime;
* Cost-free access to commercial standards;
* Specific examples of typical management system governance.

Each of these will be discussed in turn.

### Nuclear Regulatory Regime

Countries with new nuclear power programmes typically are in regulatory flux. Often, when a new national nuclear regulator is established, staff are hired, the organization goes through a difficult process of training and developing personnel and then starts developing national nuclear regulations. This process places potential nuclear operating organizations in a difficult situation. They need to develop a management system to meet national regulatory requirements that are not yet written or are continually being revised. Furthermore, in the absence of a technology decision, national regulations can be difficult to write since newcomer countries often rely on regulations within the vendor country. The current lack of active SMR deployments (i.e., with construction or operation licenses) within many jurisdictions also means that the regulatory regime in vendor countries related to SMRs can also be in flux.

The IAEA has recently (2023) embarked on a Nuclear Harmonization and Standardization Initiative (NHSI), intending to align regulations related to SMR deployments. The NHSI aims to facilitate the development of common regulatory positions without compromising nuclear safety and national sovereignty. Newcomer countries will benefit from this initiative if it succeeds in aligning international regulations related to SMRs.

Even if national nuclear regulations are well-defined, either through the adoption of IAEA Safety Standards and the outputs of the NHSI initiative, adopting the regulatory framework from a proposed technology vendor’s country, or through the development of jurisdiction-specific standards, such regulations rarely are specific enough to answer the “How?” question of what is the most efficient and effective way is to meet the published regulations.

### Commercial Standards Access

While national nuclear regulations are typically publicly available, they often reference international consensus standards to provide more detail on acceptable methods to address national regulations. Commercial nuclear standards-making organizations (e.g., ASME, ANS, CSA, AFCEN and others) often protect the content of their standards behind paywalls or otherwise charge for access to their documents. These costs are not a large impediment for organizations within middle- and high-income countries. However, for new organizations in lower-income countries, lack of access to such standards can impede staff learning and management system development.

### Examples of typical management system governance

Newcomer countries rarely have access to specific examples of management system governance, that is, the policies, processes, programs, procedures, and forms produced by current nuclear operating organizations to manage their business. Most established organizations have taken years to refine and develop such governance and treat such material as valuable intellectual property. However, the market for such material is limited, so its commercial value may be overstated. Such material would be written uniquely to the established organization’s history, regulatory framework and needs, and other established organizations would see little benefit in purchasing such material. Some bartering or sharing of specific processes between mature operating organizations invariably occurs, but such information is not widely shared.

Notably, the management systems of mature organizations are typically not optimized for the early stages of a nuclear programme since those stages are irrelevant to them. They may not contain processes for siting, environment assessment and similar activities that occur early in a programme’s life. So, examples from newer operating organizations may contain useful information that is not part of a mature organization’s management system.

### Access to experienced experts

Lower-income newcomer countries have limited access to experienced nuclear personnel, with distance and cost being major hindrances. The IAEA, through its Technical Cooperation program and other projects through the Nuclear Infrastructure Development Section, supports newcomer countries for a host of infrastructure issues aligned with its Milestones Approach [1]. Such activities, which include guidance publications, workshops, training, expert missions, and review missions, prove valuable to newcomer countries in understanding how to begin and progress management system development. This author has personally participated in such activities and can attest to their value.

Despite these efforts, IAEA involvement is limited in time and scope, and daily support is often lacking. As a result, the inexperienced staff within the country’s organization responsible for developing the management system produce documents that would frequently need significant revision before being acceptable to an experienced operator or regulator. Moreover, these documents often take longer than necessary to create, potentially delaying the nuclear programme. Processes and training associated with implementing such management system processes (e.g., change management, human performance tools, document revision control, etc.) can also be lacking.

## Potential solutions

Newcomer organizations, thus, are presented with the problem of needing a management system for their nuclear project to proceed but not having access to the resources, tools, and examples to do so. The following sub-sections propose some potential solutions.

### Potential IAEA Initiatives

The IAEA can provide additional support to newcomer countries in the following areas. Each of these will be further described.

* Continue to pursue the NHSI initiative to harmonize nuclear regulations for SMRs;
* Provide sample management system governance that aligns with IAEA Safety Standards and major international nuclear regulatory regimes and standards;
* Fund a management system mentor program for lower-income countries.

#### Continue NHSI Initiative

Differing national regulations continue to hinder the expansion of nuclear power, adding cost and complexity to nuclear programmes and technology providers worldwide. The NHSI initiative intends to produce harmonized standards related to SMRs. Once these standards are available and adopted by national regulators, creating management system governance that would apply to multiple jurisdictions should be possible.

#### Sample Management System Governance

The IAEA currently provides several toolkits (e.g., the Nuclear Contracting Toolkit [20]) that assist Member States in understanding specific items related to nuclear programs. Each toolkit provides examples of sample documents that newcomer countries can adapt and use according to their particular circumstances. A similar suite of management system governance documents, aligned with IAEA Safety Standards, the NHSI initiative, and typical nuclear standards, could provide a good start for newcomer countries in developing their management systems.

The IAEA can facilitate the production of such a suite of governance through a consultancy process per the typical process hierarchy described by the IAEA (see Fig. 1). Level 1 and Level 2 processes would be prioritized initially, with Level 3 documents produced where deemed valuable. Experienced management system developers and newcomer country representatives would provide input to this process.

A diagram of a level of management

Description automatically generated

*FIG. 1. IAEA Management System Process Hierarchy (from* [10]*)*

#### Management System Mentor Program

As described in Section 3.4, lower-income newcomer countries can often struggle to access resources to guide them through the development of their management system, and current IAEA support is typically occasional, with interactions occurring once or twice per year. A mentorship program, whereby newcomer countries could access a management system expert more frequently (e.g., one day per week or more), could assist them in developing quality documents faster, allowing for more one-on-one coaching of staff. The IAEA could consider funding for such mentorships as an extended expert mission and thus align with current IAEA structures.

### Leveraging Artificial Intelligence

The advent of Artificial Intelligence Large Language Models (LLMs) promises to revolutionize many activities, including those in the nuclear sector. LLMs can aid in designing and modelling the processes required for nuclear management systems. They can analyze existing processes, identify inefficiencies or gaps, and suggest optimized process flows. LLMs can also help create visual representations like process maps, flowcharts, and diagrams. They can also help translate documentation into different languages, improving accessibility to non-English speakers.

A project to develop an LLM for nuclear management system development, trained with appropriate IAEA and international standards, regulations, and best practices, could thus prove valuable to industry and newcomer countries. This effort would improve consistency, reduce errors, and save time compared to manual efforts. The limitations of LLMs and AI in critical nuclear applications should be noted. Subject matter experts will need to review and approve the outputs of the LLMs before they are published.

Training LLMs for nuclear management system development would require domain-specific data, including:

* Regulations, standards, and guidelines from national regulators and international organizations like IAEA, ICRP, and WENRA;
* Technical documents, manuals, and procedures from experienced nuclear operators and vendors;
* Industry best practices, lessons learned, and operational experience reports;
* Academic literature and research papers on nuclear safety, quality assurance, and management systems.

Obtaining access to this data, especially proprietary information from commercial entities, could be challenging. Data quality, consistency, and completeness are also crucial for effective training.

The IAEA or a group of interested organizations could pilot and lead such an effort. Key inputs would be existing management system documentation from experienced operating organizations. Participating organizations should be required to provide their management system documentation in exchange for access to the trained LLM. A framework for addressing potential intellectual property concerns related to sharing such management system documentation will need development.

### A Role for Technology Vendors

Technology vendors may have a role in expediting management system development. A potential sales differentiator for a vendor could be the provision to the purchasing country of a management system and associated frameworks that meet the IAEA requirements and typical international regulations for constructing, commissioning, operating, and maintaining the applicable reactor technology. This provision would only apply once a technology decision has been made and contracts signed, so it would not assist newcomers in their initial stages of management system development (e.g., siting processes and pre-technology selection processes). Thus, the other recommendations in this paper in Sections 4.1 and 4.2 should take precedence. Technology vendors would be encouraged to participate in developing the generic management system documents in Section 4.1.2 and could customize those outputs for their particular technology and target markets.

## Conclusions

As the world needs rapid expansion of nuclear power, whether through SMRs or large reactors, to meet climate change and energy availability goals, nuclear organizations, technology vendors, and the IAEA should work to expedite the production of management system governance by nuclear newcomer countries. The paper proposes several initiatives these groups can take to facilitate this work, including continuing the IAEA’s NHSI initiative, producing a sample set of generic management system documents, establishing a mentoring program, leveraging large language models, and providing a role for technology vendors within the process.

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