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Mapping Organizational Competencies in Nuclear Organizations

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MAPPING ORGANIZATIONAL COMPETENCIES IN NUCLEAR ORGANIZATIONS

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IAEA NUCLEAR ENERGY SERIES No. NG-T-6.14

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FOREWORD

The IAEA's statutory role is to "seek to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world". Among other functions, the Agency is authorized to "foster the exchange of scientific and technical information on peaceful uses of atomic energy". One way this is achieved is through a range of technical publications including the IAEA Nuclear Energy Series.

The IAEA Nuclear Energy Series comprises publications designed to further the use of nuclear technologies in support of sustainable development, to advance nuclear science and technology, catalyse innovation and build capacity to support the existing and expanded use of nuclear power and nuclear science applications. The publications include information covering all policy, technological and management aspects of the definition and implementation of activities involving the peaceful use of nuclear technology.

The IAEA safety standards establish fundamental principles, requirements and recommendations to ensure nuclear safety and serve as a global reference for protecting people and the environment from harmful effects of ionizing radiation.

When IAEA Nuclear Energy Series publications address safety, it is ensured that the IAEA safety standards are referred to as the current boundary conditions for the application of nuclear technology.

A high level of competency is needed for safe and efficient use of nuclear energy. This applies to all phases of the nuclear power and fuel life cycle and to both the development and the sustained use of nuclear technology. Operating organizations and countries that are experiencing a change in the industry, with prospects for new nuclear power plants or plans to phase out existing programmes, need to realign their organizational competencies to meet future demands. For newcomers to nuclear power, organizational competencies need to be built according to the demands of nuclear technology.

This publication aims to help in the development of organizational competencies in both countries with an existing nuclear power capability and those wishing to embark on a nuclear power programme. It considers the competency needs of organizations that are required to successfully deliver programmes from initial concept through to the design, construction, operation and final decommissioning of the nuclear power plant, as well as the storage and disposal of nuclear and radioactive waste.

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CONTENTS

1. INTRODUCTION

1.1. BACKGROUND

The nuclear industry is going through a period of expansion and change. Many countries with a long history of nuclear power generation are looking to build new nuclear power plants to match growing energy demands without increasing carbon emissions. Some countries are planning a nuclear power programme for the first time, while others are phasing them out. In all cases, the countries and their nuclear organizations seek help from the IAEA, reactor technology vendors and technical support organizations to deliver such programmes.

A high level of competency is needed for safe and efficient use of nuclear energy. It applies to all phases of the nuclear power and fuel life cycle and to both the development and sustained use of nuclear technology. Operating organizations and countries that are experiencing a change in the industry, with prospects for new nuclear power plants or plans to phase out existing programmes, need to realign their organizational competencies to meet future demands. For newcomers to nuclear power, organizational competencies need to be built according to the demands of nuclear technology.

Mapping organizational competencies is a process that enables an organization to identify its needs, develop an action plan and achieve its objectives. Mapping can identify missing resources and assess the risk of competency and knowledge loss (see Ref. [1]). The benefits of mapping organizational competencies for an organization include:

— Determining which human resource capacity exists to deliver objectives;
— Identifying areas of strength and weakness within an organization;
— Developing corrective action plans to address systematically the weaknesses identified;
— Informed decision making to help in the prioritization of funds and other resources.

The competencies of operating organizations in the nuclear sector vary considerably due to factors such as:

— The current status of the national nuclear programme;
— Social, economic and infrastructure conditions;
— The size and structure of the organization, and the amount of nuclear business;
— The extent of the support base provided by vendors and technical support organizations;
— The current maturity of the organization;
— The number of competing organizations performing similar functions.

1.2. OBJECTIVE

This publication aims to help in the development of organizational competencies in both countries with an existing nuclear power capability and those wishing to embark on a nuclear power programme for the first time. It considers the competency needs of organizations that are required to deliver successfully programmes from initial concept through to the design, construction, operation and final decommissioning of the nuclear power plant, as well as the storage and disposal of nuclear and radioactive waste.

1.3. SCOPE

This publication outlines the concepts and models of organizational competency, and summarizes the necessary processes to map competencies and the techniques used to assess them. Competency frameworks for individual job positions and their assessment are not within the scope. This publication is intended for decision makers, advisors and senior managers in organizations such as government nuclear organizations and regulators, owners and operators of nuclear plants, technical support organizations, R&D organizations, and nuclear

education and training institutes. It applies to countries undergoing a change of competency needs at national and organizational levels, including:

— Newcomer countries embarking on a new nuclear programme;
— Countries with an existing programme but no plans for expansion;
— Countries with a well established nuclear programme and plans to build new plants.

This publication will help organizations to determine their competency needs based on strategic and corporate objectives and business processes, and to identify their existing success factors. Guidance provided here, describing good practice, represents expert opinion but does not constitute recommendations made on the basis of a consensus of Member States.

1.4. STRUCTURE

In Section 2, organizational competencies are described in terms of intellectual capital. Essential components for managing organizational competencies and connections to the overall management system are discussed in Section 3. Methods and approaches to mapping organizational competencies are explored in Section 4. Some practical techniques for assessing organizational competencies are described in Section 5 and key ideas are summarized in Section 6. Three case studies are presented in the annexes.

2. ORGANIZATIONAL COMPETENCIES

Organizational competencies are the abilities of an organization to meet its objectives effectively and efficiently through the interaction of people having the appropriate explicit, implicit and tacit knowledge and skills, behaviours and culture, processes, procedures, systems and technology and organizational structure in its given environment. Organizational competencies can be described using an intellectual capital model, which is typically classified into three broad categories: human, structural and relational capital.

2.1. INTELLECTUAL CAPITAL

Intellectual capital exists at different levels in an organization in the form of strategic core competencies (or the organization's key success factors), collective competencies and individual competencies and is thus representative of organizational competencies. The model described in Fig. 1 is based on an intellectual capital model presented in Ref. [2].

Carson et al. [2] define human, structural and relational capital as follows:

(a) Human capital refers to competencies embedded in people and groups. More specifically, this refers to tacit and implicit knowledge that people and groups possess, and their ability to generate new knowledge, along with values, attitudes and aptitudes.
(b) Structural capital refers to an organization's policies, processes, data and information, culture, communities and networks, and is divided into informal and formal elements. Informal structural capital is generated from group processes, such as interactions within work groups and group task related skills and competencies. Formal structural capital is the policies, procedures and formal manifestations of interactions within and between work groups. Like human capital, structural capital encompasses competencies such as task related skills, including tacit and implicit knowledge, soft skills and personal attributes.
(c) Relational capital refers to the relationships an organization has with other organizations and individuals, such as vendors and retired experts.

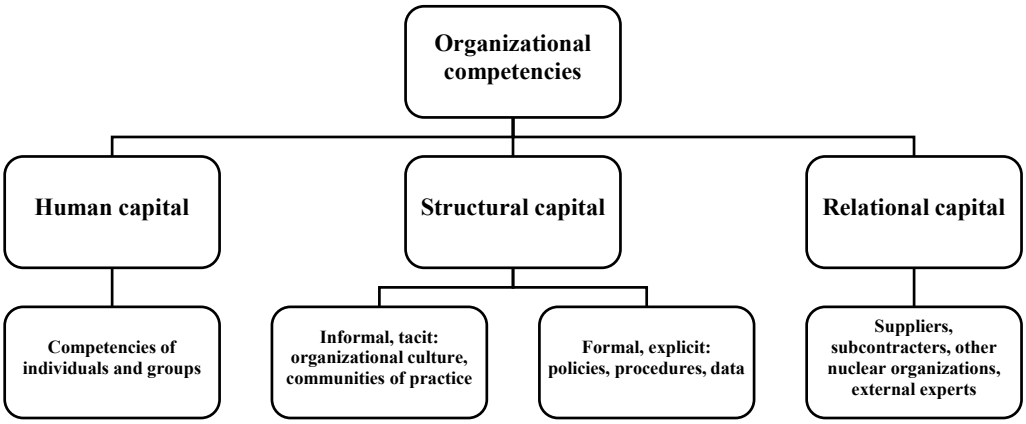

FIG. 1. Components of organizational competencies.

Organizational competencies can be interdependent, for example group attributes depend on the human capital in the group [2]. Similarly, structural capital contributes to human capital by enabling the transfer of knowledge of procedures and processes [2]. Informal structural capital includes knowledge processes that affect human capital, and the processes for managing human capital (e.g. qualification requirements) are also part of the formal structural capital. Lastly, relational capital also affects structural capital through information transfer from other organizations, for example maintaining the design basis information and transferring it from design organizations to the operating organization. Relational capital can also increase human capital through cross-organizational networks.

2.2. CORE, COLLECTIVE AND INDIVIDUAL COMPETENCIES

Each component of organizational competencies described in the previous section can appear on different levels in an organization. Figure 2 depicts a model presented in Ref. [3] in which organizational competencies are described in terms of strategic core competencies, collective competencies and the competencies of individuals.

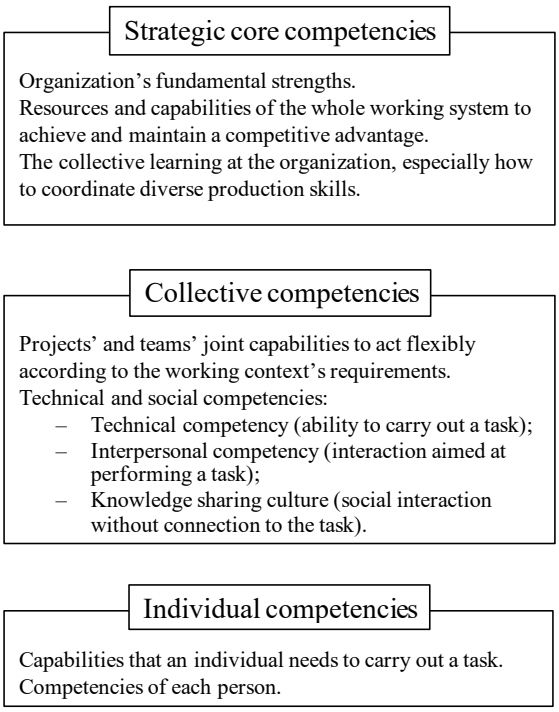

FIG. 2. Strategic, core and individual competencies [3].

The categories of strategic core competencies, collective competencies and individual competencies are defined as follows:

(a) Strategic core competencies are an organization's underlying key success factor. They are the business functions or operational activities that a company does best — its fundamental strengths — and include competencies that enable good performance, for example the processes through which an organization learns, coordinates its tasks and utilizes its competencies, including: technical superiority; good customer relations management; and highly efficient processes. In terms of intellectual capital, strategic core competencies include any combination of human, structural and relational capital.
(b) Collective competencies are team level competencies and include the technical competencies relating to the team's tasks and the interpersonal competencies relating to collaboration required to achieve them. They also refer to the knowledge sharing culture that builds trust in and between teams. Examples include: (i) how work is coordinated; (ii) the manner in which a team utilizes individual competencies; and (iii) the way team members communicate with each other and with the rest of the organization. This is closely related to the shared space concept introduced in Ref. [4]. Good shared space can help to build trust and respect and is necessary for improving safety culture through social interactions. The shared space concept focuses on the nature of interactions between individuals, teams, departments and external organizations, understanding how the interactions influence collective engagement, information sharing and the integration of effort. Utilizing teams with diversified competencies is of the utmost importance for continual safety improvement, and their composition allows for both divergent and convergent thinking [4].
(c) Developing individual (or role based) competencies is a prerequisite for developing core and collective competencies. However, managing individual competencies is not within the scope of this publication (see Refs [5–7]).

The competency levels in Fig. 2 are not independent of each other. Developing strategic core competencies will set the needs for the development of collective and individual competencies. Individual competencies follow from the core and collective competencies of the team or organization. Group or individual level competencies can also affect upper level competencies. For example, the competencies of a person experienced in nuclear power plant processes can be the basis of collective competencies (people who act as connectors between different groups). In an R&D organization, distinctive individual competencies can be the basis for the success of the whole organization.

2.3. COMBINED MODEL

The two models of organizational competencies view the same phenomena from different perspectives. Each component of intellectual capital can consist of core, collective or individual competencies (see Fig. 3).

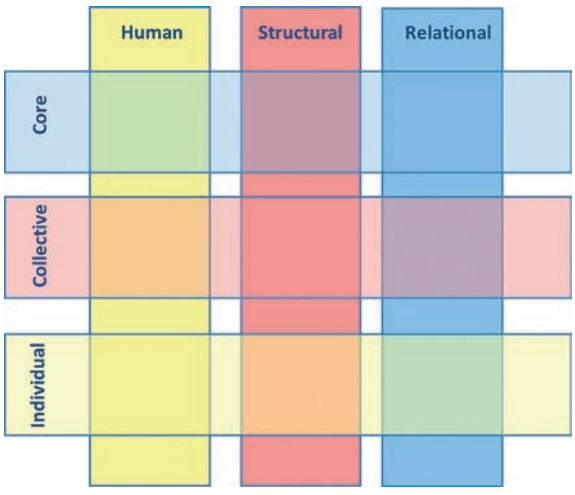

FIG. 3. Organizational competencies model.

3. MANAGEMENT OF ORGANIZATIONAL COMPETENCIES

The management of organizational competencies constitutes processes used to identify and evaluate an organization's current strengths and weaknesses, to predict its future needs, and to identify and implement the required corrective and anticipative actions. It can be incorporated into the overall management system of an organization and involves integrating individual and organizational competencies with the main business processes of an organization.

3.1. MANAGEMENT OF ORGANIZATIONAL COMPETENCIES WITHIN THE OVERALL MANAGEMENT SYSTEM

Many nuclear organizations integrate all the elements of the organization into one coherent management system to meet their objectives more efficiently. The management of organizational competencies can also be integrated into such a system, which is summarized in Fig. 4 (developed based on Ref. [8]).

For an organization to meet its business objectives, its competencies need to be aligned with its mission, vision and strategy. This also necessitates that processes relating to the management of organizational competencies and their key performance indicators are aligned with the overall business objectives.

3.2. ESSENTIAL COMPONENTS FOR MANAGING ORGANIZATIONAL COMPETENCIES

The 11 essential components for managing organizational competencies in nuclear organizations, many of which are embedded in human resource management policy, strategy and processes, require an organization:

(1) To align competencies with the mission, vision, strategy and business processes;
(2) To align competencies with external requirements and regulations;
(3) To support organizational change and transformation;
(4) To understand organizational capability;
(5) To address knowledge loss risk;
(6) To manage externally sourced competencies;

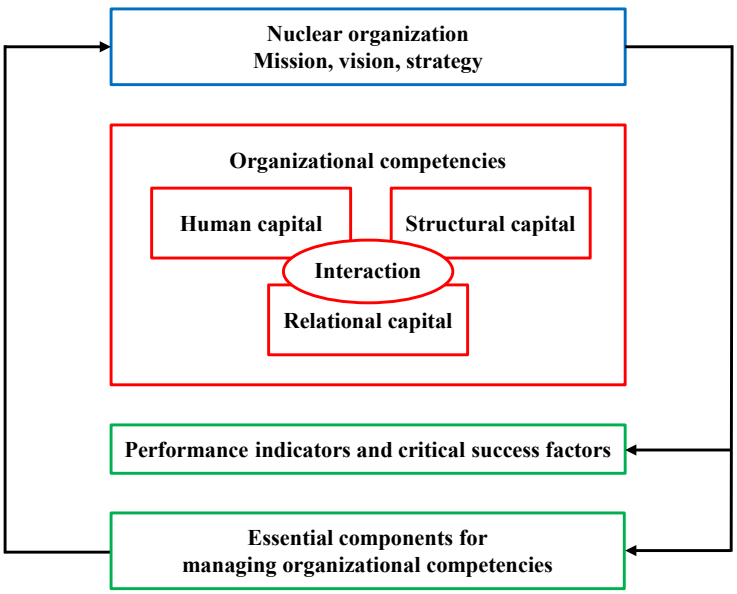

FIG. 4. Management of organizational competencies within the overall management system.

(7) To develop managerial, technical and functional competencies;
(8) To build teams;
(9) To develop a recruitment strategy;
(10) To improve organizational competencies through benchmarking;
(11) To develop organizational performance metrics.

How to construct a map of competencies and methods for managing them is presented in Section 5.

3.2.1. Align competencies with the mission, vision, strategy and business processes

Organizational competencies can be aligned with the mission, vision, strategy and business processes of an organization. This is achieved by creating a scheme of competencies and a long term plan consistent with the mission, vision and strategy.

3.2.2. Align competencies with external requirements and regulations

Organizational competencies can be aligned with external requirements and regulations. This is typically accomplished by forming an independent governance and oversight committee, integrated quality management system and nuclear safety committee, as well as by maintaining and reviewing the minimum staffing required for safe operation (nuclear baseline) and implementing a change management process.

3.2.3. Support organizational change and transformation

Organizational change and transformation can be supported by aligning competencies with new requirements. This includes developing a forward looking business plan, employee development policy, strategy plan and change management plan (see Ref. [9]).

3.2.4. Understand organizational capability

Competencies can help an organization to understand its own capability by utilizing different methods for developing and accessing this (e.g. maturity based methods, which assess organizational capability development, or coverage based methods, which focus on the acquisition of best practices). Creating and maintaining a human capital index can also assist in this regard by measuring how well an organization makes use of the ability of an individual or team to perform and create shareholder value through competencies and knowledge.

3.2.5. Address knowledge loss risk

An essential part of managing organizational competencies is addressing knowledge loss risk, for example by creating a map of competencies and knowledge loss risks for different levels of the organization (department, business unit or function) and a risk based competency retention plan. This is followed by knowledge retention and transfer actions, a long term workforce and succession plan, as well as a short term substitution plan.

3.2.6. Manage externally sourced competencies

Organizations can manage their externally sourced competencies by maintaining the capability to outsource and by managing the risk of outsourced competencies. This can also include the capability to ‘insource’ if the outsourced risk is believed to be high. The typical methods used to achieve this include developing ‘intelligent customer’ roles and a policy to manage outsourced competencies (see Annex II for more information on intelligent customer roles).

3.2.7. Develop managerial, technical and functional competencies

An organization can also develop its managerial, technical and functional competencies. The typical methods to accomplish this include:

— Performing job task analysis as part of a systematic approach to training;
— Maintaining role and training profiles;
— Establishing a process for performance assessment and appraisal;
— Analysing learning needs;
— Utilizing experience feedback;
— Reviewing changes (organizational and technical) for their impact on competency requirements;
— Evaluating the impact of learning;
— Creating a competency development programme which includes, for example, coaching, mentoring, training and directed reading.

3.2.8. Build teams

An organization can build teams and team level competencies. The methods to achieve this can be based on role and process requirements reflected in the organizational structure. It includes preserving and using the organizational structure chart, creating and maintaining individual and team roles and task descriptions, creating and promoting networks and communities, and using the business unit plans.

3.2.9. Develop a recruitment strategy

The organization also needs to develop a recruitment strategy to support the acquisition of new competencies, such as developing a recruitment process and plan and having procedures in place for reassignment, redeployment and job rotation. This process need not be centralized; rather, it can be decentralized but in a coordinated manner.

3.2.10. Improve organizational competencies through benchmarking

Organizations also improve competencies through benchmarking. The typical methods used to achieve this include improving job descriptions and role profiles and restructuring posts, processes and systems based on established good practices.

3.2.11. Develop organizational performance metrics

Developing organizational performance metrics is a way to evaluate the effect of competencies on performance. The typical methods used to achieve this include developing performance assessment and evaluation methodologies.

3.3. MANAGEMENT OF INDIVIDUAL COMPETENCIES

For nuclear organizations, demonstrating employee competencies to regulators and clients is a very important management practice, and there are IT tools available to support the process of maintaining and improving competencies throughout an entire organization. The functionality of most systems currently available enables:

— The management of personnel data (e.g. name, address, job position, qualifications, certifications, experience);
— The creation of competency frameworks and models;
— The allocation of competencies to roles;
— A recording of individual competencies;
— The allocation of training requirements and maintenance of training records;

— Role and task information to be captured;
— Gap analyses.

The advantages of implementing such systems include:

— Providing a means of measuring and improving competencies in a systematic manner;
— Enabling expert competencies to be identified and made available to others in the organization;
— Demonstrating tangibly employee competencies to clients and regulators, thus assuring regulatory compliance;
— Enabling cost effective planning of training across an organization;
— Providing automatic warnings of the validity periods for refresher training.

More details on the assessment of individual competencies can be found in Refs [10–12].

3.4. COMPETENCY LOSS RISK MAPPING

Once the current organizational competencies are identified, competency loss risk mapping can be conducted to develop a strategic plan to address potential competency loss for the organization and to apply corrective actions, and includes the following:

— Establishing a list of prioritized competencies at risk;
— Detecting critical positions;
— Determining key experts and their critical knowledge and competencies at risk;
— Developing a succession plan for key employees leaving the organization;
— Establishing individual development and mentoring plans for knowledge transfer;
— Performing knowledge risk assessment for critical knowledge identification in accordance with Section 4.

4. MAPPING ORGANIZATIONAL COMPETENCIES

4.1. PRESENTING THE RESULTS

Mapping organizational competencies can provide an organization with the information needed for effective competency management and help it to align its competencies with its strategy and business goals, as well as requirements for nuclear safety and regulatory compliance. It can address the components of competency management and identify the requirements. Mapping can be performed in varying amounts of detail and at any organizational level (e.g. whole organization, department or team), based on priority and purpose. It represents actual and desired competencies in the form of diagrams, graphics, lists, databases and other collections of data.

4.2. UNDERSTANDING THE CONTEXT

It is important to understand the context in which competency mapping is to be performed in order to support competency management. The organizational units within a nuclear organization have different missions and strategies, along with varying roles and core competencies in executing them. The mapping approach needs to reflect this.

Figure 5 illustrates a framework for mapping possible types of essential organizational competencies based on the role of an organization or unit to be mapped. The framework can be used for designing an appropriate mapping approach. It characterizes the possible forms of organizational competencies depending on the novelty

TASKS \ INTERACTION	INDEPENDENT Contribution from key individuals	INTERDEPENDENT Collaboration between roles
SPECIFIABLE Routine: focus on familiar problems	I. Organization can be seen as a sum of individual roles. Organizational competence is role based competence applied in the organization's context. Typically, human capital and formal structural capital. Examples: Operations, maintenance.	II. Organization is individuals + communication (the interaction required between the roles). Organizational competence is role based individual competence applied in the organization's context + the interaction required between the roles. Typically, human capital and formal structural capital. Examples: Operations, maintenance, design, collaboration between units.
NON-SPECIFIABLE Non-routine: focus on novel problems	III. Organization is a sum of individuals. Organizational competence is individual competence and learning in the organization's context. Typically, human capital and formal and informal structural capital. Examples: Research institutes, educational institutes, R&D.	IV. Organization is individuals, communication and culture. Organizational competence is structural capital (including networks and communities). Typically, human capital and formal and informal structural capital. Examples: R&D, design.

FIG. 5. Characterization of competencies when designing the mapping approach.

of the problem to be solved in an organization and the interdependency of different tasks and roles. This type of quadrant model is typically used in the knowledge management literature [13, 14].

If the typical tasks of an organization can be specified, or are routine, and the tasks and roles are independent of each other (Quadrant I in Fig. 5), it is then possible to define the tasks and roles based on prescribed processes. This is the 'routine' part of running an operating organization. Here, an organization can be seen as a sum of its individual roles, and organizational competencies are largely individual competencies and mainly part of human capital. In an organization with these types of task, mapping can focus on how an organization manages and utilizes its individual competencies.

In organizations belonging to Quadrant II, the tasks are still considered routine and can be prescribed, but they require the collective effort of several roles. Here, an organization is not just the sum of individuals — communication and collaboration also play key roles. In addition to the management of individual competencies, the mapping of organizational competencies can focus on the interdependencies of individual roles, communication and the collective competency building that enable collaboration. For example, these can be the overlapping competencies in different design areas or networks and communities inside and outside an organization.

Organizations which belong to Quadrants III and IV are fundamentally different from those in Quadrants I and II, and regularly need to solve novel problems. The tasks of these organizations usually do not repeat themselves. Although the responsibilities of the organization can be clearly defined, the tasks and problems it may encounter are novel and cannot be defined in advance. Most tasks of technical support organizations and R&D and design organizations typically belong to Quadrants III and IV, as do organizations operating in abnormal and emergency situations. In an organization where the roles are mainly independent (Quadrant III), key experts and their competencies can be an essential part of the overall organizational competency and strategic core competencies. The focus of the mapping here can be on identifying the competencies of key experts to allow for appropriate management and knowledge transfer. In organizations where collaboration is needed to complete tasks (Quadrant IV), structural capital and informal networks can be important parts of the organizational competencies and may need to be the central focus of the mapping process.

4.3. METHODS AND APPROACHES

After an organization has established the context of the mapping and areas which, based on its strategy and business goals, are to be the core focus, the process can be designed in detail. Table 1 presents a practical approach based on the elements of competency management, and identifies the essential components of effective management of organizational competencies (what is required to manage competencies well), typical methods for managing each component (practical solutions) and the information required to construct a map that informs the methods and solutions.

TABLE 1. METHODS FOR MANAGING EACH COMPONENT AND THE INFORMATION REQUIRED

Essential components	Typical methods for managing each component	Information required for constructing the map
1. Align competencies with the mission, vision, strategy and business processes	Scheme of competencies Long term workforce plan National workforce plan	What is the vision/mission/strategy? What are the short, medium and long term business plans? Which competencies are required to complete the business plan? What are the international or national trends in the workforce? What are the qualifications and experience?
2. Align competencies with external requirements and regulations	Independent governance and audit committee Integrated quality management system Nuclear baseline (minimum safety staffing) Change management process Nuclear safety committee	What are the regulatory requirements? What are the site licence conditions? What are the permitting regulations? What are the legal requirements? What are the environment, and health and safety requirements? Do current or planned competencies meet the requirements? How is compliance demonstrated (e.g. records)?
3. Support organizational change and transformation	Forward looking business plan Employee development policy, strategy and plan Change management plan	What is the end state? What is the difference or gap between where the organization is now and where it needs to be? Which new competencies are required to fill the gap? How can the new competencies be gained (e.g. invest in exiting resources or recruit)? Can existing employees adapt or do they need to develop new competencies? Which old or surplus competencies are no longer required? Who are the change agents?
4. Understand organizational capability	Human capital index as well as maturity based and coverage based methods (see Section 2.1)	What are the organization's demographics? What are the skills, qualifications, flexibility, mobility and professions? What are the individual competencies, including essential roles, latent competencies and experience profiles? What are the costs of employment?
5. Address knowledge loss risk	A map of competency loss risks at organization levels (department, business unit, function) A risk based competency retention plan followed up by knowledge retention and transfer actions Long term workforce plan Substitution plan (short term) Succession plan (long term)	What are the current and future critical competencies? What are the consequences of losing each competency? What are the required and actual levels of competency in each case? What are the required and actual levels of codification for each competency? How many competent people are required and are currently in the role? Is there enough time to mitigate the risks of competency loss? Is there enough time before the knowledge is lost (through people leaving or lack of practice)?

TABLE 1. METHODS FOR MANAGING EACH COMPONENT AND THE INFORMATION REQUIRED (cont.)

Essential components	Typical methods for managing each component	Information required for constructing the map
6. Manage externally sourced competencies	Intelligent customer roles Policy to manage outsourced competencies	Which activities are critical for safety? What do regulations require? How is work packaged for the supply chain? Which competencies are outsourced? What is the capability of the supply chain? What is the supplier's life cycle? What is the availability of the supplier? What do supply chain companies do to ensure competencies are maintained?
7. Develop managerial, technical and functional competencies	Job/task analysis Role and training profiles Performance assessment and appraisal Learning needs analysis Learning impact evaluation Competency development programme (e.g. coaching, mentoring, training, directed reading)	What are the competency requirements for the roles and tasks? What are the learning needs? What are the costs and benefits? How can new competencies be gained (e.g. invest in existing resources or recruit)?
8. Build teams	Organizational structure chart Individual and team role and task descriptions Networks and communities Business unit plans	Which competencies are required to deliver the scope efficiently and effectively? Are competencies and resources available to meet the requirement? How can new competencies be gained (e.g. make, train, recruit)? Which social and network interactions exist and how can they be built? What are individual competencies, including role essential, latent competencies and experience profiles (e.g. team working)?
9. Develop a recruitment strategy	Recruitment process and plan Reassignment, redeployment and job rotation	What is our current demographic profile? What is our current and future need? What are the incoming individuals' competencies compared to the organizational requirements? (Include the questions required in the risk management section above)
10. Improve organizational competencies through benchmarking	Improved job descriptions and role profiles Restructured posts, processes and systems	What do other organizations do? What are the benefits to the organization? Why are they structured as they are? How did they derive their model?
11. Develop organizational performance metrics	Performance assessment and evaluation methodology	What are the performance requirements? What are current standards? How do existing competencies affect performance?

4.3.1. Hierarchical competency mapping

In hierarchical competency mapping, an organization analyses the functions of the whole or a part of an organization to determine the tasks relating to those functions. The individual competencies, or knowledge, skills and attitudes (KSAs), associated with each task are identified and relative weights are assigned according to the relevance to a specific task (see Fig. 6).

Competency profiles can be produced to link a function to the required competencies. They can also be formed, for example, at a divisional level by combining the required competencies and their weights with the tasks

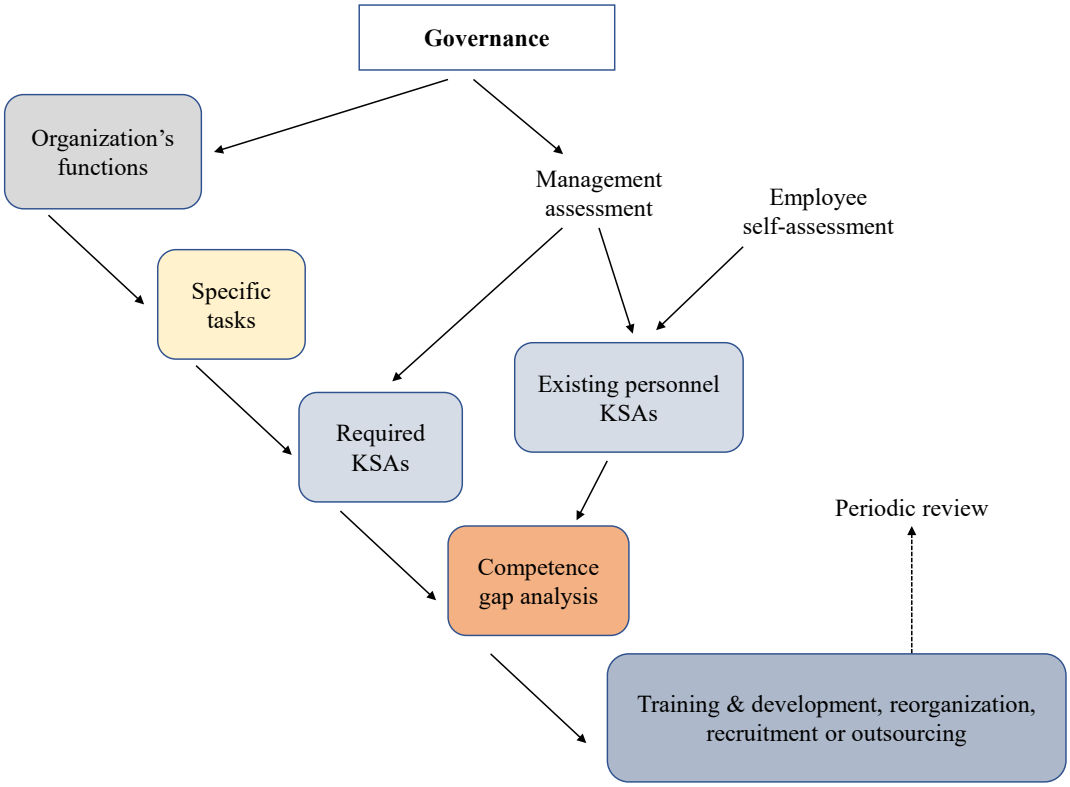

FIG. 6. Systematic approach to the analysis of competency gaps.

belonging to the function. This process requires the computation of workload in terms of the number of tasks that exist and the number of times a particular task needs to be performed. In addition to a profile of the current needs, a profile of the future needs and aspirations of an organization can be established. Such assessment of needs can also be developed as the outcome of an organization's governance process.

The next step of the hierarchical mapping process is to analyse the existing competencies of an individual or organizational subdivision in a similar manner and carry out gap analysis. A source of information predominantly used to estimate the existing competencies is employee performance reviews, as they examine an individual's competencies and discuss proposed development plans. The number of employees and the level and type of competencies that are needed to fill any gaps can be determined based on analysis. A critical competency possessed only by a single person can be considered to be a gap. A profile of competency gaps can be produced at any organizational level or for an entire organization. The gaps can be prioritized, taking into account their importance to the safety and regulatory functions.

4.3.2. Mapping organizational competencies based on the role and typical tasks

Mapping approaches suitable for different tasks are depicted in Fig. 7. If the tasks can be described beforehand and do not require much communication (Quadrant I in Fig. 7), then the existing regulatory requirements, processes and work descriptions are sufficient for mapping. A hierarchical mapping can start from the strategy and business goals of an organization. Subsequently, the mapping will lead to processes, group and individual roles and finally to the competency needs of these groups and individuals. It is essential for an organization to map the roles required for each process and to determine individual competencies for each role. This mapping approach mainly sees organizational competencies as the sum of the individual competencies, with a focus on human capital (see Refs [1, 13, 14] for a description).

If the tasks are routine but communication between the roles is essential (Quadrant II), the mapping can, in addition to the existing processes, include the need for communication between the teams and roles. This can

TASKS \ INTERACTION	INDEPENDENT Contribution from key individuals	INTERDEPENDENT Collective endeavour (collaboration between roles)
FOCUS ON FAMILIAR PROBLEMS	I. Existing processes, operational procedure, regulatory requirements. Tasks for the organization. Tasks for the groups. Roles to fill the tasks, description of roles. Knowledge loss risk management document includes a model that describes good approaches.	II. In addition: Analyse the communication needs (or input/output) between groups. Analyse the communication between the roles.
FOCUS ON NOVEL PROBLEMS	III. Competence areas based on tasks. Link between current individual and group level tasks. Identify success factors from past projects. Individuals who possess extra knowledge that enables exceptional performance of a process. Knowledge loss risk management document includes a model that can be used.	IV. In addition: Individuals act as nodal points or interpreters between processes of different expertise areas. Networks which enable efficient problem solving.

FIG. 7. Approaches to mapping.

consist of, for example, the input/output requirements of the processes and the coordination of work tasks or competencies needed for collaboration between roles and teams. This mapping approach focuses on human and formal structural capital.

When the typical tasks of an organization include solving novel problems (Quadrants III and IV), they cannot be completely described using existing processes. Therefore, the explicitly described processes do not provide a sufficient starting point for the mapping of organizational competencies. To maintain and develop competencies for this type of work, constant learning and acquisition of new knowledge is needed. In addition to the approaches already described, mapping that focuses on organizational learning and areas where competencies need to be developed is required. This approach starts by identifying the expertise areas where novel problems are most likely to occur. Next, current and past success factors and general problem solving approaches are identified. Lastly, organizational learning is addressed.

In organizations where tasks include novel problems, but the roles are mainly independent (Quadrant III), existing individual competencies can be the basis for some of the organization's core competencies. In this case, the mapping can also include the human capital of individual experts. Furthermore, mapping can address how individual competencies are connected to collective and core competencies, and whether particular individual competencies are critical enablers for the upper level competencies.

In organizations where tasks include novel problems and require collaboration (Quadrant IV) in addition to individual competencies, formal and informal networks are important parts of organizational competencies. In this case, mapping can address the enablers of effective problem solving in expert networks and learning processes. These networking enablers can be specialists with wide experience who can collaborate over different expertise areas and recognize where additional collaboration is required.

4.3.3. Competency loss risk assessment

Organizational competency loss risk assessment is an approach that can be implemented in any organization with a well defined process and human resources management structure. This approach shows the links between the business goals of an organization and its core processes, subprocesses, organizational competency needs and

available human resources. Based on the results of organizational competency loss risk assessment, managers can develop a strategic plan to address competency loss risk and take corrective actions.

As part of the risk assessment, nuclear organizations can create a competency matrix in accordance with available human resources. The matrix assesses the present personnel in an organization and its future competency gaps due to changes in organizational structure, personnel rotation, ageing and retirement, and detects options to address any possible knowledge loss issues (e.g. process improvements, reorganization or elimination of non-core activities). The matrix is based on the notion that one person can cover one organizational competency. In practice, however, key experts often possess knowledge, skills and experience that cover several organizational competencies. This gives nuclear organizations a reserve of competencies that are very important for successful performance. In creating the matrix, managers can consider all available employees, determine their competencies and determine which overlap. Such an approach will provide a reflection of the current situation; it can help to identify competency gaps in specific areas and inform what kind of human resources are needed, taking into account the new competency demands resulting from new projects or new tasks (e.g. expanding capacity, decommissioning, restart and major modifications). Corrective action at an early stage is a proactive response to future risks.

5. TECHNIQUES FOR ASSESSING ORGANIZATIONAL COMPETENCIES

The assessment of organizational competencies deploys various techniques. As part of competency management, an organization may need to assess its current competencies and identify the associated gaps using self-assessment and benchmarking.

5.1. SELF-ASSESSMENT

Self-assessment involves identifying the key factors and good practices relating to the topics explored in this publication. A maturity model can be designed based on the established best practices, as well as a simple scoring scale which considers current and future desired performance. Gap analysis is then used to identify strengths and weaknesses.

5.2. OPERATIONAL BENCHMARKING

Operational benchmarking directly compares human, structural and technical capital between similar organizations. The benchmarking process involves a detailed analysis of the human, organizational and technical areas and identifies good practices in each organization. It can be carried out within a single country if there are two or more organizations performing a similar function. If this is not possible (e.g. for a regulatory body), then international collaboration is necessary. It is outside the scope of this publication to provide the details of the benchmarking process (see Ref. [15] for a description of this technique).

5.3. AUDIT AND PEER REVIEW

Audit and peer review are similar to the benchmarking process but involve external experts familiar with the subject matter and capable of auditing the human, structural and technical capital areas. This can be external to the whole organization or the process can encompass internal organizational peer reviews and audits. As with quality assurance and other similar audits, experts recommend an approach using a pre-established checklist.

5.4. KEY PERFORMANCE INDICATORS

Key performance indicators can be used to measure directly human, structural and technical capital. Such a method will often yield information that can be used to assess performance and to guide future policies for improvement. Defining the right indicators is complex and context dependent; therefore, it is important that the selection and number of indicators are properly aligned with real issues that need to be measured and addressed.

5.5. STANDARD ORGANIZATIONAL PERFORMANCE MODELS

The European Foundation for Quality Management (EFQM) excellence model[1] provides a well established route for determining organizational performance. Many areas of the model, such as the effectiveness of organizational processes, relate directly to structural capital.

6. SUMMARY

Organizational competencies are the abilities of an organization to meet its objectives effectively and efficiently through the interaction of people having the appropriate explicit, implicit and tacit knowledge and skills, behaviours and culture, processes, procedures, systems and technology and organizational structure in its given environment. Organizational competencies can be described using an intellectual capital model, which is typically classified into three broad categories: human, structural and relational capital.

The management of organizational competencies constitutes processes used to identify and evaluate an organization's current strengths and weaknesses, to predict its future needs, and to identify and implement the required corrective and anticipative actions.

Intellectual capital exists at different levels in an organization in the form of strategic core competencies (or the organization's key success factors), collective competencies and individual competencies.

Mapping organizational competencies is a process that helps identify an organization's needs and its current stage in order to develop an action plan to align its competencies with its mission. This process also enables an organization to assess its competency and knowledge loss risk and to develop appropriate remedial actions.

Competency mapping can be performed at any organizational level, based on priority and importance. The selected mapping technique has to fit the purpose and the organization for which it is intended. Mapping organizational competencies can provide an organization with the information needed for effective competency management. As part of competency management, an organization may need to assess its current competencies and identify the associated gaps using self-assessment and benchmarking. Organizations can also manage their competencies as part of an overall organizational integrated management system.

Operating organizations and countries that are experiencing a change in the industry, with prospects for new nuclear power plants or plans to phase out existing programmes, need to realign their organizational competencies to meet future demands. For newcomers to nuclear power, organizational competencies need to be built according to the demands of nuclear technology.

The competencies of operating organizations in the nuclear sector vary considerably due to factors such as:

— The current status of the nuclear programme;
— Social, economic and infrastructure conditions;
— The size and structure of the organization, and the amount of nuclear business;
— The extent of the support base provided by vendors and technical support organizations;
— The current maturity of the organization;
— The number of competing organizations performing similar functions.

[1] See www.efqm.org for further information.

These processes and approaches help to develop organizational competencies in both mature countries with existing nuclear capability, and countries seeking to embark on a nuclear power programme. Competency mapping and methodologies for newcomer states are similar to those for legacy and operating states, but they may require a larger scope and depth with the necessary government support.

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Annex I

INTEGRATIVE COMPETENCY MODEL[1]

Competency models such as the integrative competency model (ICM) are fundamental tools for managing the available human capital more efficiently and effectively, and they provide the necessary information to forecast the management, technical and scientific needs of a competent workforce. Organizations establish a competency based management practice to assist in linking diverse categories and types of competency with the strategic objectives of an organization and its processes (see Fig. I–1).

I–1. DESIGN AND CHARACTERISTICS

The ICM more effectively manages a large variety of strategic, organizational and human capital issues, including:

— Alignment of competencies with an organization's trends, mission, vision, business lines, processes and corporate strategy;
— Support of the organizational transformation process;
— Strategic plans;
— Knowledge management;
— Human capital index;
— Human resource planning;

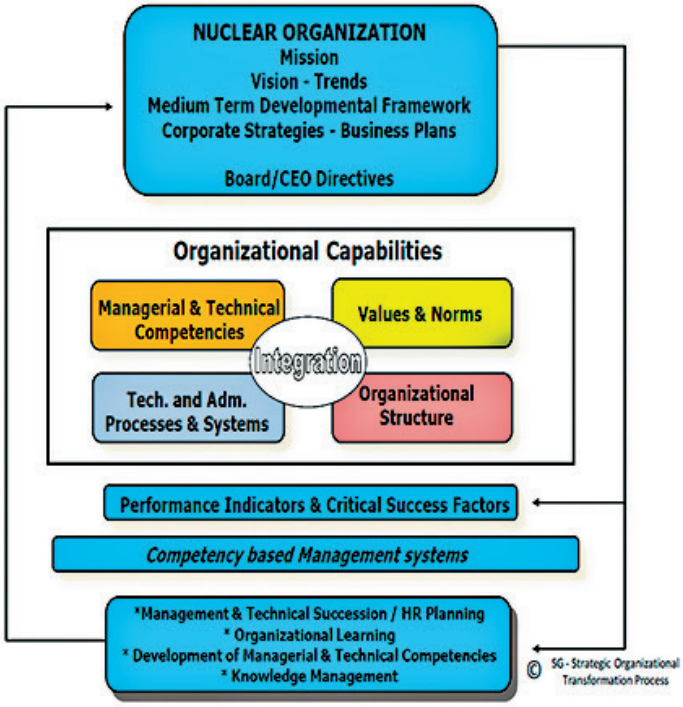

FIG. I–1. Strategic organizational transformation process (courtesy of S. Gardelliano).

[1] This annex is based on GARDELLIANO, S., Case Study: Mapping Organization Competencies — Competency Team Builders and the Integrative Competency Model, available at http://wiki-nkm.iaea.org/wiki/images/e/e2/Case-study-S-Gardelliano.pdf

— Succession management;
— Skills and knowledge obsolescence;
— Attrition programmes;
— Job families, post benchmarking and job descriptions;
— Recruitment, placement and transfers;
— Performance management;
— Team building;
— Learning needs analysis;
— Management development.

The ICM can be presented as a comprehensive and reliable organizational competency database, with the following characteristics:

— Simple, practical, flexible and easy to maintain;
— Designed in-house and specific to the organization;
— Inexpensive to design and implement;
— A developmental system implemented by an experienced internal professional or consultant.

Although the ICM is applied to the whole organization, it can first be used for a part of the organization, business line or process. In the model, a competency is defined as a set of skills, related knowledge and attributes that enable an employee to perform a task or activity within a function or job. A competency can be demonstrated and easily transferred to another job. Any essential competency in the ICM is defined by six to eight key behavioural indicators (KBIs), which describe the proficient application of the competency in question (see Fig. I–2). Behaviours can be observed and measured to drive the successful performance of the competency (e.g. KBI 1 — Team Leadership: Can build effective teams).

Figure I–2 groups competencies into three main categories: managerial, generic and technical/functional. The three levels of application for each competency are knowledgeable (K), proficient (P) and advanced (A). Each function or job usually requires 8–12 essential competencies.

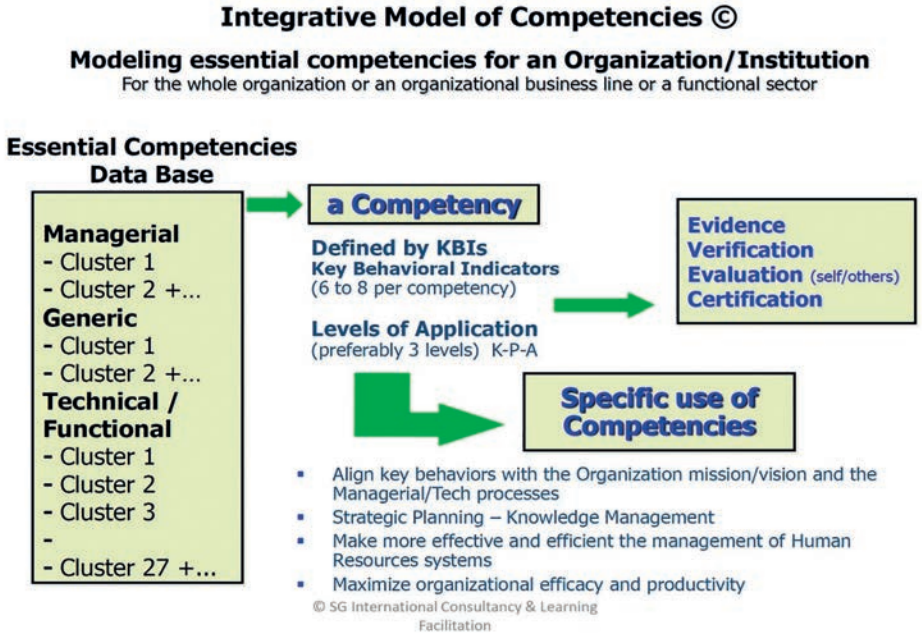

FIG. I–2. Database of essential competencies (courtesy of S. Gardelliano).

I–2. MAPPING PROCESS

Once designed, the ICM is subjected to a verification process by conducting simulations in specific applications, such as describing posts or job profiles, individual self-assessment, forecasting learning needs, recruitment, performance evaluations and forecasting competencies for new technology and processes. After suitable database software has been identified, the formal mapping process for the whole organization or for any priority area can be performed.

I–3. COMPETENCY TEAM BUILDERS

Competency team builders (CTBs) contribute substantively to the mapping process and make the ICM operational. They collect data, analyse them and propose a set of essential competencies, including key behavioural indicators. Normally, the CTB unit has at least two specialists and one manager of the subject area, as well as a responsible person from the competency management unit. A third specialist or someone from human resources can also be added. CTB units of five members have been found to be very effective. Before starting their work, CTBs are briefed on the ICM format and trained on team performance, preparing knowledge maps, interview and observation techniques and protocols, improving work process techniques, technical drafting and any other relevant areas.

I–4. LESSONS LEARNED

Before starting any mapping process, it is extremely important to determine a suitable competency framework (including software) that covers the whole organization. It can be expected that there will be a need for permanent updating and the expansion of the system over time. In the case of large corporate groups, the competency model should be compatible with one of the company members. Support from top management can reinforce the importance of utilizing the competency model as a developmental tool, and organizations interested in simulating scenarios of their human capital could find this simple and practical model helpful and effective.

Annex II

MAINTAINING ORGANIZATIONAL COMPETENCY: 'INTELLIGENT CUSTOMER' CAPABILITY AT MAGNOX, UNITED KINGDOM

Regulators in the United Kingdom require that nuclear licence holders maintain a 'nuclear baseline', which defines the roles and capabilities required to ensure safety and competency to act as a licensee. The nuclear baseline is agreed with the nuclear regulator, and an essential part is the intelligent customer capability. This capability ensures that licensees are able to engage contractors to perform safety related work packages and that they maintain an understanding, knowledge and ownership of contractors' work that could potentially affect nuclear safety, industrial safety, health and environment management. Key activities in maintaining intelligent customer capability include:

— Annual review of intelligent customer skills to ensure relevance;
— Appointment of staff to intelligent customer roles;
— Forecasts of the demand for intelligent customer capability;
— Maintenance of a minimum intelligent customer capability regardless of workload;
— Confirmation that staff in intelligent customer roles remain suitably qualified and experienced;
— Chief engineer approval prior to changes to intelligent customer appointments.

Specific skill areas that require intelligent customer capability (i.e. technically novel, complex or important to safety) are listed in a register, coordinated by the chief engineer and agreed with the regulatory authority. Most are technological, while others relate to policy and strategy, regulatory matters or processes. There is a requirement that at least one intelligent customer role is maintained in each skill area. Managers maintain the intelligent customer capability by encouraging the recruitment, training and development of employees with the necessary skills.

As the site moves through the phases of its life cycle (from construction to power generation, defuelling to decommissioning), the hazards inherent to the site will change, and thus the work packages required from contractors. The skill areas will then reflect the generally diminishing safety hazard but increasing environmental significance. The chief engineer reviews and revises the register to reflect such changes in the requirements.

For each skill, there is a defined set of criteria which indicates the suitable qualifications and experience of the person (SQEPness) and the competencies expected of the intelligent customer role. The knowledge is passed to successors to achieve similar competency levels. New staff in intelligent customer roles are typically trained both formally and through coaching and mentoring schemes, often sharing tasks with the incumbent until they are fully competent. Staff in intelligent customer roles also participate in communities to share knowledge both within and across different fields of expertise.[1]

[1] See http://wiki-nkm.iaea.org/wiki/images/d/db/Case-study-B-Radford.pdf for a flow chart on work package evaluations and the intelligent customer capabilities listed on the Magnox register.

Annex III

COMPETENCY MODEL OF RESEARCH ENGINEERS SPECIALIZING IN RESEARCH REACTORS (ROSATOM TECHNICAL ACADEMY)

The major challenge for newcomer countries in the first stage of the implementation of their national nuclear programmes is comprehensive development of nuclear infrastructure according to the IAEA Milestones Approach [III–1]. The level of development of certain infrastructure issues depends on the scale of the particular project, the type and capacity of the reactor, and the programme for its application (graded approach) [III–2]. For developing countries, the construction of centres for nuclear science and technology (CNSTs) based around research reactors opens up a wide range of opportunities for the use of radiation in industry, agriculture and medicine, and also promotes education and training.

The establishment of national nuclear infrastructure directly depends on one of the 19 infrastructure issues in the IAEA Milestones Approach — human resource development (see table 1 of Ref. [III–1]). It is a key factor for the safe and effective implementation of national nuclear programmes and also the availability of tools for managing organizational competencies as part of the knowledge management initiative. With this in mind, the Rosatom Technical Academy (previously the Rosatom Central Institute for Continuing Education and Training) has developed a competency model for research engineers specializing in research reactors.

III–1. METHODOLOGY JUSTIFICATION

To build a competency model for research engineers specializing in research reactors, the four quadrant model was used as a practical approach for a comprehensive description of both the basic competencies of the subject studied and its main and supplementary functions [III–3]. An analysis of three approaches to determine the level of competency was also carried out. Thus, the competency model is represented by the following:

— Basic competencies in compliance with the four quadrant model;
— Main and supplementary functions of research engineers specializing in research reactors;
— Qualification framework;
— Basic organizational framework of research engineers specializing in research reactors.

The competency model is to be used as a basic tool for the development of research personnel and management of organizational competencies for CNSTs based around research reactors and including systematic approaches to training [III–4], for which a training course for the managers and specialists was developed (see Fig. III–1).

III–1.1. Regulatory and research framework

Quadrant 1 comprises the following:

(1) Regulatory framework (Russian Federal laws): The ability to read, understand and organize activity in accordance with the federal laws in the nuclear field.
(2) Regulatory documents (Federal standards and rules, Rosatom standards and regulations): The ability to work in accordance with all levels of normative and technical standards to reach the objectives of the research.
(3) Licences: The ability to ensure compliance of performed research with licence requirements and licensing documents (application and licence action conditions), including personal licensing.
(4) Legal basis for research activities in the workplace: The ability to achieve research objectives in accordance with the local regulations, rules and procedures of the organization concerning the workplace.

1. Regulatory research framework 1.1. Regulatory framework (Russian Federal laws) 1.2. Regulatory documents (Federal standards and rules, Rosatom standards and regulations) 1.3. Licences 1.4. Legal basis for research activities in the workplace	2. Technical disciplines 2.1. Nuclear physics 2.2. Nuclear technology 2.3. Reactor material science 2.4. Mechanical engineering 2.5. Reactor coolant chemistry 2.6. Radiation safety 2.7. Nuclear fuel cycle 2.8. Measuring equipment 2.9. Thermal hydraulics 2.10. Information technology
3. Research practice 3.1. Research methods justification 3.2. Research programme development 3.3. Terms of reference development 3.4. Conducting research 3.5. Analysis of research results 3.6. Preparation of research reports	4. Personnel and behavioural competencies 4.1. Analytical thinking, problem solving and decision making 4.2. Planning and organization of work 4.3. Self-management 4.4. Safety culture 4.5. Project management 4.6. Team work 4.7. Mentoring 4.8. Knowledge management

FIG. III–1. Four quadrant competency model for a research engineer specializing in research reactors.

III–1.2. Technical disciplines

Quadrant 2 comprises the following:

(1) Nuclear physics: The understanding of the physical processes occurring in the reactor core and reflector.
(2) Nuclear technology: The application of knowledge about reactor design and typical research facilities.
(3) Reactor material science: The understanding of the radiation damage of materials applicable in the nuclear field.
(4) Mechanical engineering: The understanding of the corresponding material properties for optimal selection of the irradiation device material and for refuelling equipment, and ability to perform their strength calculations.
(5) Reactor coolant chemistry: The application of methods to obtain and maintain the required quality of the coolant, and the understanding of ionizing radiation processes on coolants.
(6) Radiation safety: The knowledge and understanding of possible radiation exposure to personnel, the population and the environment, as well as the use of methods of reducing radiation hazard.
(7) Nuclear fuel cycle: The understanding of the nuclear fuel production processes and the reprocessing of irradiated fuel.
(8) Measuring equipment: The understanding of the physical phenomena forming the basis of measurement, and the knowledge of modern measuring instruments.
(9) Thermal hydraulics: The ability to carry out thermal hydraulic calculations for experimental devices, including irradiation devices.
(10) Information technology: The ability to create, collect, manage, transfer and/or exchange information.

III–1.3. Research practice

Quadrant 3 comprises the following:

(1) Research methodology justification: The understanding of research processes and the knowledge of the main research methods as well as their practical application.

(2) Research programme development: The ability to programme and schedule development for scientific research included in the calendar of the CNST based around research reactors.
(3) Terms of reference development: The ability to set research purposes and objectives in order to perform research activity.
(4) Conducting research: The practical study of the subject using scientific methods to determine facts and properties.
(5) Analysis of research results: The ability to apply a comprehensive evaluation of the research results.
(6) Preparation of research reports: The ability to structure the information obtained during the research and to analyse data to transfer results to stakeholders.

III–1.4. Personnel and behavioural competencies

Quadrant 4 comprises the following:

(1) Analytical thinking, problem solving and decision making: The ability to perform a comprehensive analysis of a scientific task, to collect and analyse the necessary information and to develop a complex solution.
(2) Planning and organization of work: The ability to coordinate effectively for scientific research.
(3) Self-management: The ability to work independently, to have an opinion and to be flexible in research, especially in difficult and problematic situations.
(4) Safety culture: The ability to ensure safety as a priority and to take personal responsibility and maintain self-control in the performance of all work relating to safety.
(5) Project management: The ability to achieve coordinated implementation of a complicated task on time, within the scope of the work and on budget.
(6) Team work: The ability to perform joint work for a common goal.
(7) Mentoring: The ability to transfer knowledge from holder to successor.
(8) Knowledge management: The ability to collect, manage and transfer knowledge.

III–2. MAIN AREAS OF EXPERTISE

The main areas of expertise of research engineers specialized in research reactors are on the basis of the IAEA publications on research reactor applications [III–5, III–6] and Russian project experience:

(a) Fundamental research: Obtaining a scientific evidence base to facilitate the development of new technologies, especially the study of the fundamental properties of the neutron as one of the ‘core’ elementary particles and the use of the neutron as a tool for studying the properties of materials.
(b) Physics, engineering, irradiation technology and nuclear reactor safety: Obtaining the necessary initial nuclear physical characteristics of materials used in reactor construction and other nuclear technologies; and carrying out the necessary experiments to develop theories of reactor calculations and for subsequent verification of these theories using research reactors, including critical stands.
(c) Reactor materials science: Development of technologies for producing fuel, construction, absorption and other materials, and the study of their properties before and after radiation, as well as in endurance tests of the structural elements of future reactors (e.g. experimental fuel rods and sample fuel assemblies, absorbing rods of the control system and other equipment operating under the conditions of reactor radiation).
(d) Nuclear fuel cycle: The technology of nuclear fuel production, including defining the structure of the fuel composition, the choice of fuel element design and its working resource for the study and improvement of the nuclear fuel cycle and its technical and economic parameters, as well as the reduction of the radiation hazards of the nuclear fuel cycle.
(e) Materials transmutation: Irradiation of samples and target to produce materials with modified thermal, electrical and optical properties.
(f) Neutron activation analysis: Qualitative and quantitative definition of the substance structure, based on the measurement of the radiation energy and half-lives of radioactive isotopes produced in the test substance when irradiated with neutrons or other particles.

(g) Geochronology: A method of determining the age of rocks using isotopes.
(h) Neutron therapy: The therapeutic effect of the neutron field on affected organs in order to combat cancer.
(i) Neutron radiography: A non-destructive testing method, based on taking an X ray of the object with a collimated beam of neutrons and registering the shadow image of the object on the X ray film or other detectors.
(j) Radionuclide production: The production of isotopes.
(k) Education and training: The education and training of specialists in order to implement nuclear programmes.
(l) Agriculture and food industry: The uses of radiation for pest control, increasing productivity and improving shelf lives.

III–3. SUPPLEMENTARY FUNCTIONS

The supplementary functions of research engineers specializing in research reactors include:

— Analysis techniques and methods of selecting and processing of information;
— Professional marketing;
— Plans, programmes and research method development;
— Providing quality testing and certification of products and services;
— Organizational and technical support of research;
— Fundamental and applied research;
— Research results analysis and proposals for their implementation;
— Behavioural models of research object development.

III–4. COMPETENCY LEVEL

Table III–1 shows the result of comparative analysis of three approaches to determining the level of competency:

— The first approach was used by the IAEA to determine the level of competency of the regulatory body personnel, which categorizes competency levels as basic, medium and high (see Ref. [III–7]).
— The second approach is implemented in the Russian Federation to establish a professional standards system (qualification levels 2–8).
— The third approach (levels of scientific personnel positions) has traditionally been used in research organizations in the nuclear industry in the Russian Federation.

III–5. BASIC ORGANIZATIONAL FRAMEWORK

The basic organizational framework is a mapping of the functions of research engineers specializing in research reactors on a general organizational chart of a CNST based around research reactors. As shown in Fig. III–2, the functions of this role with respect to management are accountable to the deputy head of science of the CNST.

The types of laboratory will depend on the technical characteristics, availability of certain facilities, operating activity and staffing of the CNST. Examples include the following:

(a) A laboratory for ejected beam research to conduct fundamental research, neutron therapy, geochronological research, neutron activation analysis and neutron radiography;
(b) A laboratory for measuring systems, automation and information systems (e.g. development and installation of automated systems for research as well as the maintenance of a centralized database);
(c) A physical and technical laboratory to calculate neutron physical conditions of experimental sample irradiation, as well as performing control functions on core refuelling and monitoring nuclear hazardous operations at core refuelling;

TABLE III–1. COMPETENCY LEVELS OF RESEARCH ENGINEER SPECIALIZING IN RESEARCH REACTORS

Competency level	Qualification levels[a]	Indicators of skill levels[a]			Levels of scientific personnel positions	
		Powers and responsibility	Skills	Knowledge	Position	Required characteristics
Basic	2	Activity under guidance with elements of independence in performing familiar tasks Individual responsibility	Performing standard tasks Choosing action according to instructions Correcting actions according to the conditions of their implementation	The use of special knowledge	Junior researcher	Specialize in conducting studies on specific topics in accordance with the approved methods under the supervision of a responsible officer
Medium	3	Activity under guidance with elements of independence in performing typical practical tasks Planning of own activities based on the objectives set by the head Individual responsibility	Performing typical practical tasks Selecting the mode of action on the basis of knowledge and practical experience Correcting actions subject to the conditions of their implementation	The understanding of technological and methodological foundations for solving practical tasks The use of special knowledge	Research engineer	Experience in the profession of not less than five years Conduct research on specific topics in sections as a responsible officer
	4	Activity under guidance showing independence in performing practical tasks, requiring the analysis of a situation and its changes Planning of own activities and/or the activity of a group of workers according to objectives Responsibility for deciding on tasks and the results of activity of a group of workers	Performing typical practical tasks Selecting the mode of action based on knowledge and practical experience Current and final control, evaluation and correction of activities	The understanding of the scientific and technical and methodological foundations of solving practical tasks The use of special knowledge Independent work with information	Senior researcher	Experience in the profession of not less than ten years Performer of the most complex and demanding research Availability of scientific papers

TABLE III–1. COMPETENCY LEVELS OF RESEARCH ENGINEER SPECIALIZING IN RESEARCH REACTORS (cont.)

Competency level	Qualification levels[a]	Indicators of skill levels[a]			Levels of scientific personnel positions	
		Powers and responsibility	Skills	Knowledge	Position	Required characteristics
	5	Independent work on performing practical tasks, requiring independent analysis of a situation and its changes Participation in the decision management of tasks set within the division Responsibility for deciding on tasks and the results of the performance of the group of employees or division	Performing typical practical tasks with some elements of design Choosing ways to solve issues in changing (or different) working conditions Current and final control, evaluation and correction of activities	The use of professional, technological or methodological knowledge Independent search for information needed to perform professional tasks		Experience in the profession of not less than ten years Scientific management of a group of workers in the performance of independent tasks Availability of scientific papers
High	6	Independent activity, involves determining tasks of self and/or of subordinates to achieve objectives Ensuring interaction of employees and related divisions Responsibility for the results of work performance on the level of the division or organization	Development, implementation, monitoring, evaluation and correction of professional activities, technological and methodological solutions	The use of professional, technological or methodological knowledge Independent search, analysis and evaluation of professional information	Leading researcher	Scientific management of research on specific issues of science and technology or a responsible performer of certain tasks of scientific and technical programmes Development of scientific and technical solutions for the most complex problems and research methods Justification of new research directions PhD qualified Availability of major scientific papers

TABLE III–1. COMPETENCY LEVELS OF RESEARCH ENGINEER SPECIALIZING IN RESEARCH REACTORS (cont.)

Competency level	Qualification levels[a]	Indicators of skill levels[a]			Levels of scientific personnel positions	
		Powers and responsibility	Skills	Knowledge	Position	Required characteristics
	7	Definition of strategy, management processes and activities, including innovation, with decision making at the level of large organizations or divisions Responsibility for the results of the activity of large organizations or divisions	Meeting the challenges of development in the field of professional activities and/or organizations using a variety of methods and technologies, including innovative ones Development of new methods and technologies	Understanding of the methodological foundations of professional activity Creation of new knowledge applied in a particular field Determination of sources and searching for information needed for the development of the field of professional activities and/or organizations	Chief researcher	Scientific management of research on major scientific problems Participation in their conduct Formation of new research directions PhD qualified Scientific school Scientific authority in the relevant area of expertise Availability of major scientific papers
	8	Definition of strategy, management processes and activities, including innovation, with decision making at the level of large organizations Responsibility for the results of the activity of large organizations and/or industry	Solving problems of a research and design nature, related to increasing the efficiency of processes	Creating new knowledge of an interdisciplinary and cross-industry character Evaluation and selection of information needed for the development of the field of activity	Laboratory head	Scientific management of research problems provided in the thematic plan of the laboratory Organization of research on this topic Direct participation in the most important works PhD qualified Availability of scientific papers Experience of scientific and organizational work of not less than five years

[a] According to Ministry of Labour of the Russian Federation No. 148n from 12 April 2013, On the approval of skill levels for the development of draft occupational standards.

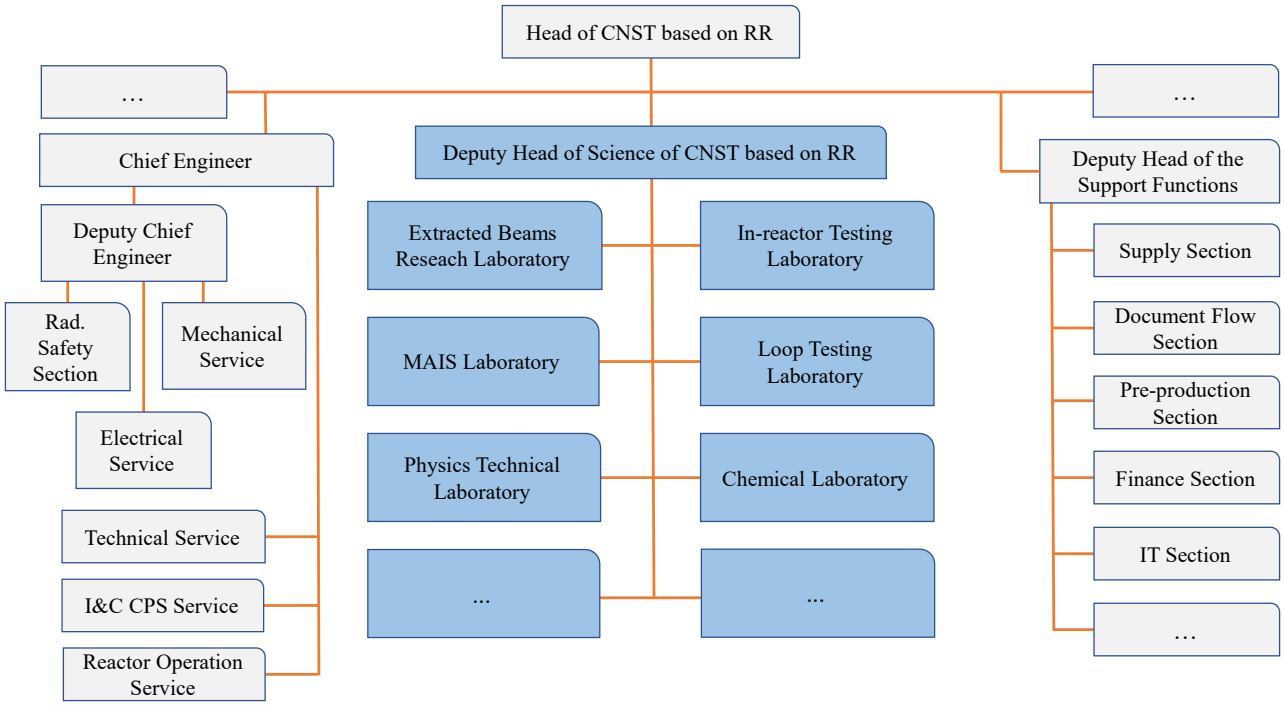

FIG. III–2. Basic organizational framework for research engineers specializing in research reactors.

(d) A chemical laboratory to study coolant chemical technology (i.e. preparation and maintenance of coolant quality parameters within the specified range, routine sampling and monitoring, and decontamination of equipment and work premises);
(e) An in-reactor testing laboratory to organize and perform ampoule tests of fuel rods and fuel assemblies;
(f) A loop testing laboratory for reactor testing and isotope production.

III–6. CONCLUSION

As a result of work on competency model development and taking into account the methodology for the systematic assessment of competency needs [III–7], a basic competency model for research engineers specializing in research reactors can be used as an effective tool for the management, planning and development of research personnel for CNST projects.

Figure III–3 presents the initial scheme for the development of research personnel for a CNST based on competency management. This approach provides a link between the functions of a research engineer and the normative basis for research engineer employment (the upper level of the scheme). The second level of the scheme establishes a link between the specific production tasks of research engineers and the requirements of the corresponding position. The third level of the scheme, outlined in the ‘competency management’ framework, is designed to ensure that the candidate for the position (or an employee of the CNST) are in compliance with the required (working) level of competencies, with appropriate evaluation and analysis. Programmes of higher professional education (HPE) and continuing professional education (CPE) can help to achieve the required working level of competencies.

For effective functioning of the system for the training and development of research engineers specializing in research reactors on the basis of the results, the following practical measures can then be implemented:

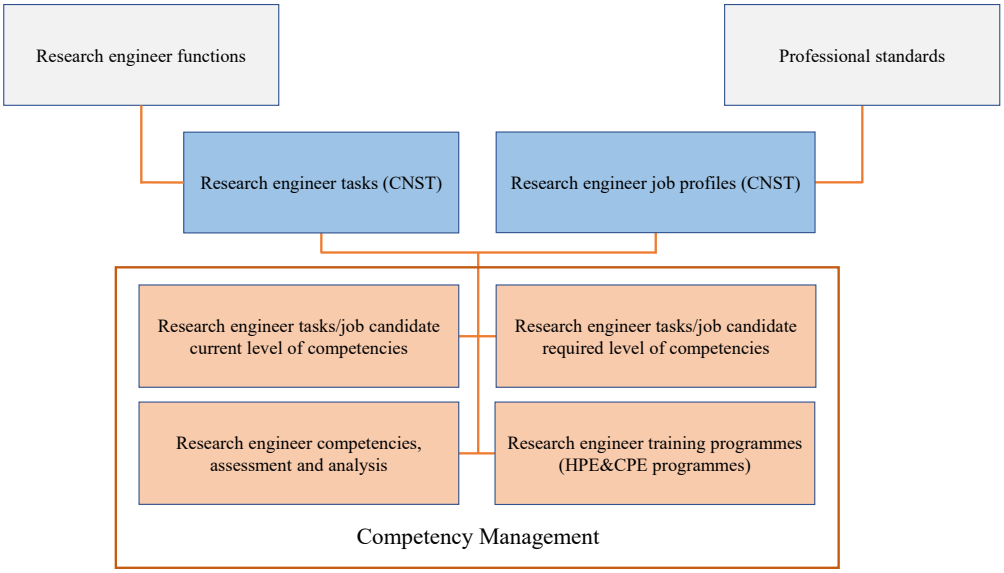

FIG. III–3. Basic scheme of human resources development based on competency management.

(a) Development of professional and training standards in the field of the competencies of research engineers specializing in research reactors as a regulatory framework for the synergy of professional activity and the system of professional training;
(b) Development of job profiles for the role for national CNSTs in accordance with the technical specifications of facilities and operational objectives;
(c) Development of HPE and CPE programmes in accordance with professional and educational standards;
(d) Development of evaluation forms for the compliance of research engineers with job profiles;
(e) Implementation of a regular evaluation system in the CNST human resource management system (e.g. perform assessments when recruiting to identify and analyse the current level of competency of the candidate for the position);
(f) Development and implementation of training for the role in universities;
(g) Development and implementation of CPE programmes for research engineers specializing in research reactors.

As a result of the implementation of such measures, countries that have embarked on the development of nuclear technologies can receive a comprehensive tool for planning, selecting, evaluating and developing research personnel for CNSTs. Based on the methodology for competency management, it is also possible to build an expanded system of personnel training to ensure adequate human resources for CNST projects.

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ABBREVIATIONS

CNST	centre for nuclear science and technology
CPE	continuing professional education
HPE	higher professional education
ICM	integrative competency model

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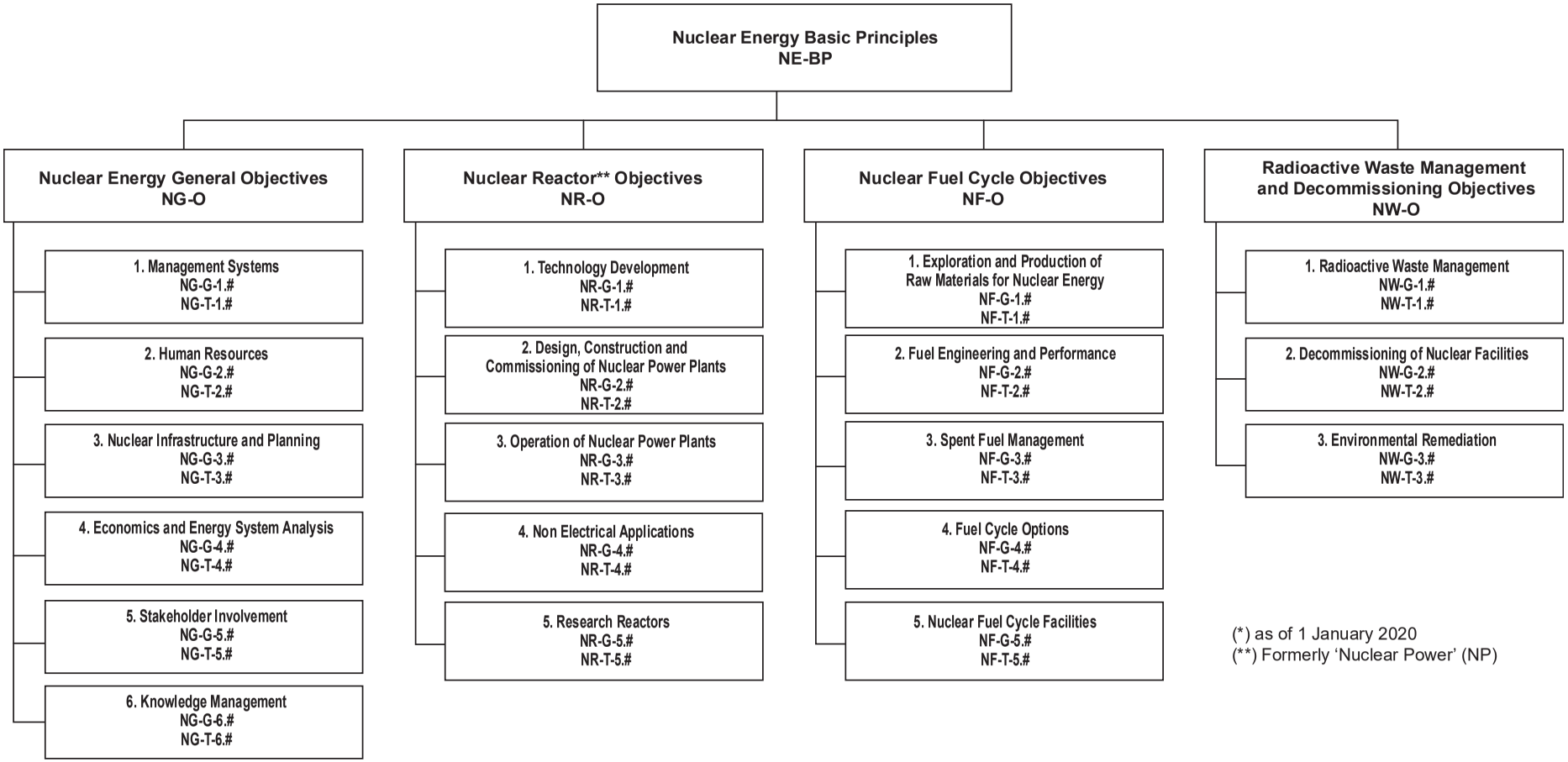

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