RESPONSIBILITIES AND CAPABILITIES OF OWNER/OPERATORS IN THE DEVELOPMENT OF A NATIONAL INFRASTRUCTURE FOR NUCLEAR POWER

NG-T-3.1 (Rev. 1)

C-41 (May 13)

FOREWORD

One of the IAEA's statutory objectives is to "seek to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world". One way this objective is achieved is through the publication of a range of technical series. Two of these are the IAEA Nuclear Energy Series and the IAEA Safety Standards Series.

According to Article III, A.6, of the IAEA's Statute, safety standards establish "standards of safety for protection of health and minimization of danger to life and property." The safety standards include the Safety Fundamentals, Safety Requirements, and Safety Guides. These standards are written primarily in a regulatory style, and are binding on the IAEA for its own programmes. The principal users are Member State regulatory bodies and other national authorities.

The IAEA Nuclear Energy Series comprises reports designed to encourage and assist R&D on, and practical application of, nuclear energy for peaceful uses. This includes practical examples to be used by owners and operating organizations of utilities, implementing organizations, academia, and government officials in Member States, among others. This information is presented in guides, reports on technology status and advances, and best practices for peaceful uses of nuclear energy based on inputs from international experts. The IAEA Nuclear Energy Series complements the IAEA Safety Standards Series.

An appropriate infrastructure is essential for the safe, secure, peaceful and sustainable use of nuclear power. Member States introducing nuclear power face the challenge of building the necessary infrastructure for the first nuclear power plant. The IAEA supports these Member States through technical assistance, missions and workshops and with new and updated technical publications.

The IAEA publication Milestones in the Development of a National Infrastructure for Nuclear Power, NG-G-3.1 (Rev. 1), first issued in 2007 and updated in 2015, defines three milestones in the development of infrastructure and provides detailed guidance for 19 specific infrastructure issues ranging from a government's national position on nuclear power to the procurement of items and services for the first nuclear power plant (NPP). The guidance provided in that publication is referred to as "the Milestones approach".

The development of the infrastructure for a nuclear power programme includes the establishment of policies and strategies in areas such as human resource development, nuclear fuel cycle and waste management, industrial involvement, nuclear safety, etc. It also implies the establishment of a legal and regulatory framework that creates an environment enabling the project to be implemented in a transparent and effective manner. These elements of the infrastructure will impact the project and will guide the discussions of the future owner/operator with potential vendors. In this regard it is important that the future owner/operator, if already identified, participates in this process from the beginning.

As the programme evolves, it is necessary to conduct a feasibility study, evaluate different technologies and identify the preferred ones, prepare a financial plan and finally procure the nuclear power plant. These are responsibilities of the future owner/operator in Phase 2.

After the procurement of the nuclear power plant, the owner/operator will apply for the required licences, oversee construction and prepare for operation. These activities take place in Phase 3.

This report provides guidance on the establishment and development of the owner/operator so that it can discharge its responsibilities throughout the programme phases.

The IAEA wishes to acknowledge the assistance provided by the contributors listed at the end of the report. The IAEA officer responsible for this revision was B. Lepouzé of the Division of Nuclear Power.

CONTENTS

1. INTRODUCTION 1

1.1. BACKGROUND 1
1.2. OBJECTIVE 2
1.3. SCOPE 2
1.4. STRUCTURE 3
1.5. USERS 3

2. DESIRABLE ATTRIBUTES OF AN OWNER/OPERATOR 3

2.1. STRONG LEADERSHIP THAT LEADS TO AN APPROPRIATE ORGANIZATIONAL CULTURE 4
2.2. ABILITY TO MANAGE GROWTH AND CHANGE 5
2.3. EFFECTIVE INTERNAL AND EXTERNAL COMMUNICATION 5
2.4. TECHNICAL AND COMMERCIAL COMPETENCE 5

3. OWNER/OPERATOR ORGANIZATIONAL STRUCTURES 6

3.1. THE GOVERNMENTAL STRATEGY 6
3.2. IMPACT OF THE CONTRACTING APPROACH ON THE ORGANIZATIONAL STRUCTURE 6
3.2.1. Typical structure of the owner/operator in a turnkey project 6
3.2.2. Typical structure of the owner/operator in a split-package approach 8
3.2.3. The build-own-operate (BOO) approach 8
3.3. SEPARATE OWNER AND OPERATING ORGANIZATION 9

4. ROLE OF THE OWNER/OPERATOR IN THE NUCLEAR POWER PROGRAMME 9

4.1. ROLE OF THE OWNER/OPERATOR IN PHASE 2 9
4.2. ROLE OF THE OWNER/OPERATOR IN PHASE 3 12

5. MANAGING GROWTH AND CHANGE 16

5.1. ESTABLISHING THE OWNER/OPERATOR ORGANIZATION 16
5.2. EVOLUTION OF THE ORGANIZATION 16
5.3. ACQUIRING AND DEVELOPING THE REQUIRED COMPETENCIES 18
5.3.1. Recruitment 19
5.3.2. Training 20

6. INTERFACE WITH STAKEHOLDERS 21

6.1. INTERFACE WITH THE NATIONAL GOVERNMENT AND THE NEPIO 22
6.2. INTERFACE WITH THE REGULATORY BODY 22
6.3. INTERFACE WITH THE GRID OPERATOR 22
6.4. INTERFACE WITH THE VENDOR, MAIN CONTRACTOR AND SUBCONTRACTORS 23

6.5. INTERFACE WITH THE WASTE MANAGEMENT ORGANIZATION 23
6.6. INTERFACE WITH THE EMERGENCY PLANNING AND RESPONSE ORGANIZATIONS 23
6.7. INTERFACE WITH THE PUBLIC AND WITH NEIGHBOURING COUNTRIES 23
6.8. INTERFACE WITH INTERNATIONAL ORGANIZATIONS 24

REFERENCES 26

ABBREVIATIONS 31

CONTRIBUTORS TO DRAFTING AND REVIEW 33

1. INTRODUCTION

1.1. BACKGROUND

The introduction of nuclear power into a country is accompanied by the need to build the institutional, human and physical infrastructure that will support the nuclear power programme throughout its life cycle. A number of organizations will be involved in the programme, each with particular responsibilities and capabilities.

The IAEA Nuclear Energy Series Guide, Milestones in the Development of a National Infrastructure for Nuclear Power [1], describes the role of three key organizations:

— The government[1];
— The regulatory body; and
— The owner/operator of the nuclear power plant (NPP).

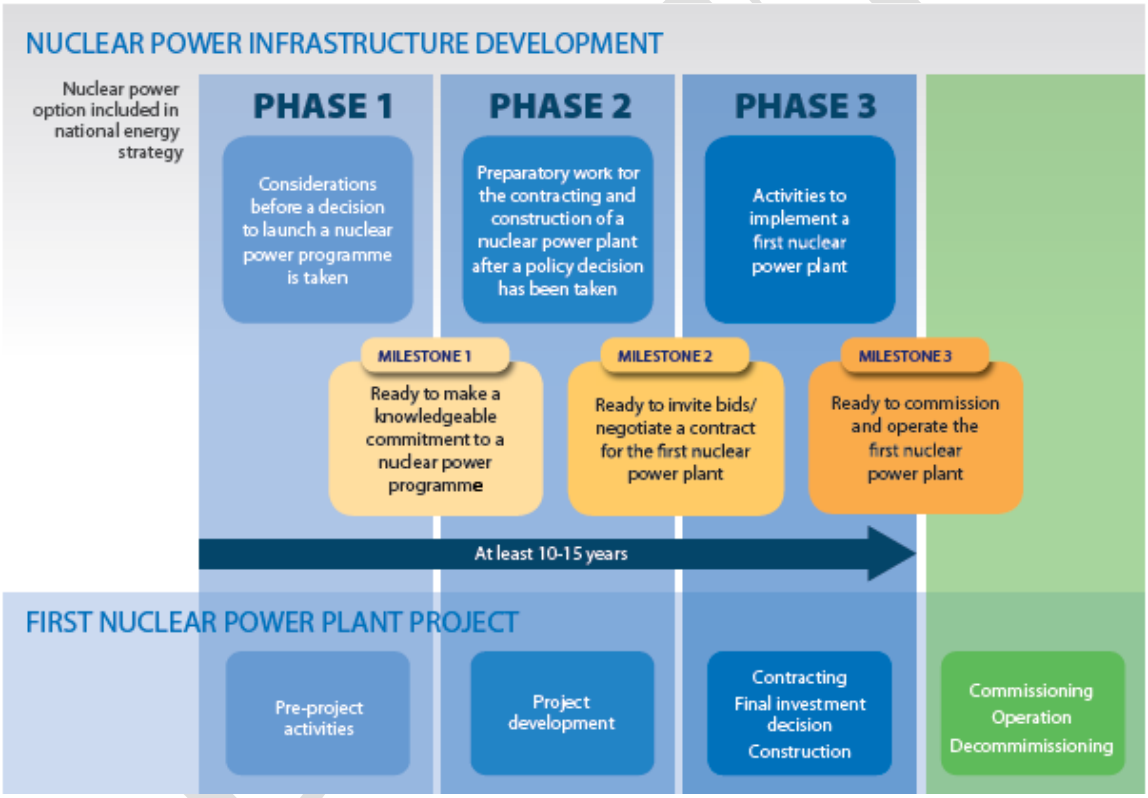

FIG. 1. Development of the infrastructure for a national nuclear power programme.

The IAEA's Milestones in the Development of a National Infrastructure for Nuclear Power [1], (hereafter referred to as the IAEA Milestones approach), has been widely adopted by countries embarking on a new nuclear power programme as well as by countries expanding their existing programmes after a long period without new constructions. The IAEA Milestones approach describes a set of infrastructure issues to be addressed during three distinct phases in

[1] The government mechanism responsible for coordinating the work of the organizations involved in nuclear power infrastructure development is referred to as the Nuclear Energy Programme Implementing Organization (NEPIO). Its responsibilities and functions are described in Reference [2]

the development of the infrastructure for a nuclear power programme, each punctuated by a milestone, as illustrated in Figure 1.

The three phases are:

— Phase 1: Considerations before a decision to launch a nuclear power programme is taken;
— Phase 2: Preparatory work for the contracting and construction of a nuclear power plant after a policy decision has been taken;
— Phase 3: Activities to implement the first nuclear power plant.

The three milestones are:

— Milestone 1 (at the end of Phase 1): Ready to make a knowledgeable commitment to a nuclear power programme;
— Milestone 2 (at the end of Phase 2): Ready to invite bids/negotiate a contract for the first nuclear power plant;
— Milestone 3 (at the end of Phase 3): Ready to commission and operate the first nuclear power plant.

Each key organization has a specific role to play, with responsibilities that change as the programme advances. The Nuclear Energy Programme Implementation Organization, or NEPIO, is responsible for the overall coordination of the programme and ensures the engagement of all important parties. The regulatory body is responsible to make independent regulatory decisions that are free from any undue influences, such as pressures associated with changing political circumstances or economic conditions. The owner/operator is responsible for selecting the technology, preparing and assessing the bid (if using competitive bidding), negotiating the contract(s) and managing the NPP project, including applying for the licences that are needed for construction and operation.

This report generally assumes that the same organization will own and operate the NPP, hence the use of the term “owner/operator”. The less frequent case where the owner and the operator are separate entities is discussed in Section 3.3.

Similarly, this report generally assumes the owner/operator will procure a plant through an engineering-procurement-construction (EPC) contract, also called a turnkey contract, though the impact of other contracting approaches is described in Section 3.2.

1.2. OBJECTIVE

This report is intended to provide practical guidance on the main activities to be undertaken by the owner/operator during Phases 2 and 3 of nuclear power infrastructure development. Member States can use this report to ensure that the responsibilities and capabilities of the owner/operator are understood by all nuclear power programme stakeholders and that the owner/operator develops effectively in line with the project schedule.

1.3. SCOPE

This report describes the responsibilities and capabilities of the owner/operator during Phases 2 and 3 of nuclear power infrastructure development and provides guidance on developing the required competences for the organization. It also discusses the management of the interfaces between the owner/operator and other stakeholders.

This report does not explicitly address Phase 1 as it is assumed that the owner/operator is designated early in Phase 2.

1.4. STRUCTURE

This publication contains six sections including this introduction:

— Section 2 lists the desirable attributes that an owner/operator should develop over the course of the programme;
— Section 3 describes typical organizational structures for an owner/operator organization following a variety of contracting approaches;
— Section 4 outlines the main responsibilities of the owner/operator in Phase 2 and 3;
— Section 5 describes the evolving nature of the owner/operator during the implementation of the programme and suggests some approaches to develop competence;
— Section 6 describes the interfaces that the owner/operator needs to manage with its main stakeholders.

1.5. USERS

This publication is intended to be used by decision makers, owner/operator executives and staff as well as other organizations involved in the nuclear power programme. It may also be useful to countries expanding their nuclear power programmes after long periods without new projects.

2. DESIRABLE ATTRIBUTES OF AN OWNER/OPERATOR

The owner/operator is expected to perform key activities during Phases 2 and 3 of nuclear power infrastructure development, some of which are presented in Figure 2:

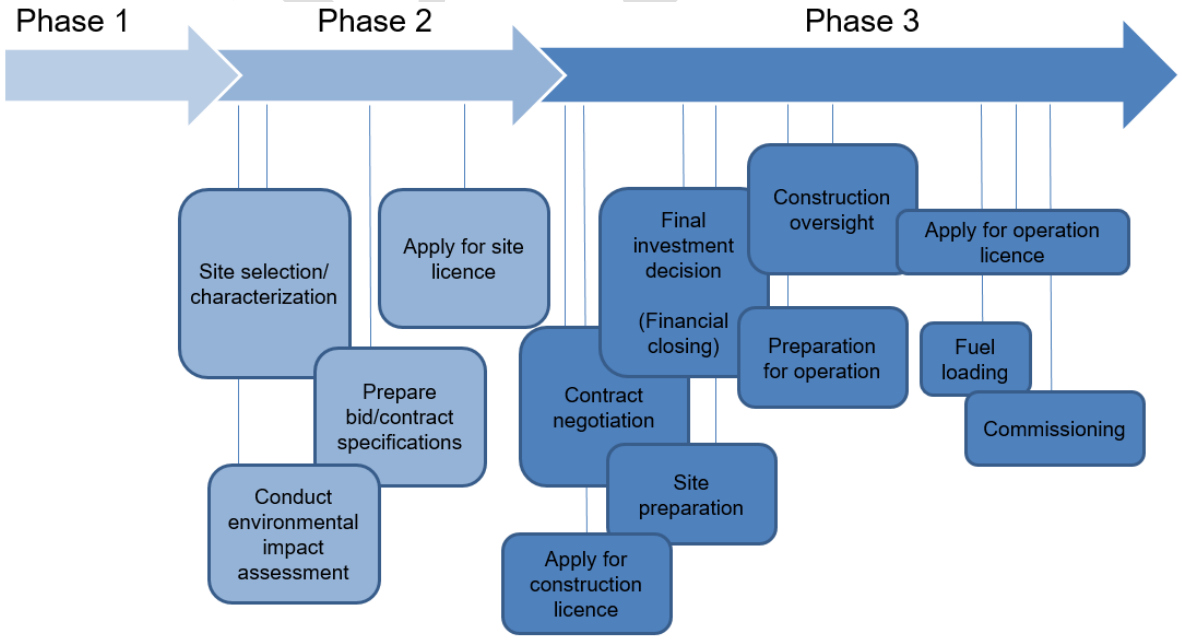

FIG. 2. Main milestones for an owner/operator in a nuclear power programme.

No activities are shown in Phase 1 since the Milestones approach assumes that the owner/operator is designated early in Phase 2. However, if prospective leaders of the owner/operator are identified in Phase 1, it is advisable that they participate in the development of the policies and strategies for the nuclear power programme, as these will have an impact on the owner/operator organization. These policies and strategies will also frame the discussions and negotiations with potential vendors and will influence the project activities and the licensing process in Phase 3.

In Phase 2, the focus of the owner/operator is on establishing and developing the organization itself and carrying out siting activities to support the preparation of documents necessary for the environmental impact assessment and the site licence application. Also during Phase 2, the owner/operator needs to develop its understanding of commercially available nuclear power technologies and establish technical specifications for the NPP to be included in the bid invitation or to guide negotiations with a preferred vendor.

In the beginning of Phase 3 the focus of the owner/operator is on contract negotiations and taking the final investment decision. Later in Phase 3, however, the focus will shift to preparing a construction licence application, overseeing construction activities, preparing an operating licence application and preparing for commissioning and plant operation.

A detailed list of the responsibilities of the owner/operator in Phases 2 and 3 are presented in Section 4 of this report.

As the owner/operator evolves from a project development organization in Phase 2 to a construction and commissioning organization in Phase 3, the needs both in terms of staffing and competencies will change. However, several common attributes are necessary to support the project throughout both phases.

2.1. STRONG LEADERSHIP THAT LEADS TO AN APPROPRIATE ORGANIZATIONAL CULTURE

Since the owner/operator has the primary responsibility for the safety and security of the NPP, it should develop an organizational culture that promotes the appropriate attitudes, values, standards, morals and norms of acceptable behaviour that are necessary in a nuclear facility.

Managers influence the organizational culture through their leadership and actions. Through their behaviour, managers demonstrate their commitment to nuclear safety and security. Their leadership should empower employees throughout the organization so that emerging problems can be identified and solved by employees internally at an early stage. Managers should encourage the reporting of potential safety or security concerns, near misses and incidents. The management should also provide responses to valid concerns without delay. More details can be found in Reference [3].

The IAEA Safety Principles (Principle 3 in Reference [4]) require that leadership in safety matters be demonstrated at the highest levels. Strong leadership is also important for effective and economic operation of the nuclear power plant.

The IAEA safety standards and guides recommend that an organization with responsibility for nuclear safety should establish and maintain a management system that fosters a strong safety culture. Reference [5] describes how this culture can be embedded in the management system of the organization due in large part to the leadership of top management.

In the same way, the Nuclear Security Fundamentals, IAEA Nuclear Security Series No. 20 [6], states that the prime responsibility for the security of nuclear material, other radioactive material, associated facilities, associated activities, sensitive information and sensitive information assets rests with the owner/operator. It also states that leadership in nuclear security matters should be demonstrated at the highest levels.

IAEA Nuclear Security Series No. 7 [7] on security culture mentions that an effective nuclear security culture can result in a significant increase in the effectiveness of the security

of radioactive material and associated facilities and transport. In a similar manner to safety culture, security culture refers to the personal dedication and accountability and understanding of all individuals engaged in any activity which has a bearing on the security of nuclear activities.

Finally, IAEA Services Series 21 [8] notes that the owner/operator should also establish procedures to carry out functions necessary to account for and control nuclear material and prepare reports for submission to the regulatory body.

2.2. ABILITY TO MANAGE GROWTH AND CHANGE

The owner/operator will start as a core group of decision makers, managers and experts brought together to start the first NPP project. As the project progresses, the owner/operator organization will grow in size, changing the group dynamics. This process is described in Section 5.

The management system developed for the organization should support the changes in size and scope. There will be a need to establish new processes or update existing ones as the organization's functions and responsibilities evolve.

An effective way to manage growth and change is to perform self-assessments at key stages in the project to ensure that the organization is ready for the next step. Self-assessments are designed to identify process weaknesses and obstacles to achieving performance objectives. Self-assessments require open communication and full involvement of the management of the organization. Independent assessments, carried out by independent audit teams internal or external to the organization, can effectively complement regular self-assessments. Guidance on self- and independent assessments is provided in Reference [3].

2.3. EFFECTIVE INTERNAL AND EXTERNAL COMMUNICATION

The owner/operator should establish clear lines and procedures for internal communication and reporting. Communications should be clear and concise, and the procedures should cover both the provision of correct and complete information and the receipt and dissemination of information.

The owner/operator will also need to communicate with a wide range of stakeholders connected with the implementation of the nuclear power programme, in particular with the vendor organization and the regulatory body. The necessary interfaces and communications with external organizations are discussed further in Section 06.

2.4. TECHNICAL AND COMMERCIAL COMPETENCE

It is important for the owner/operator to have the expertise needed to manage the NPP project and to make decisions in an informed manner. The technical expertise needed by the owner/operator will vary along the phases as the focus of the project will evolve from project development to contracting to construction and finally to operation.

It is likely that external support will be needed for some activities to be conducted by the owner/operator, mainly in the early phases of the project, as expertise may not be available in the country. This is particularly true for some specific activities involving areas such as nuclear safety and security, radiation protection, waste management, etc. Even without the full set of competencies available to perform these activities, the owner/operator should have sufficient knowledge to specify the work to be outsourced as well as to understand the results presented by the subcontractors. This level of knowledge is required to be a "knowledgeable customer" and this concept is presented in further detail in Section 5.3.

Competence in contracting and procurement will be equally important as the owner/operator will have to procure goods and services from the very beginning of the project and will have to ensure their quality while controlling costs. These contract management skills will be useful during the construction of the plant and later during operation.

3. OWNER/OPERATOR ORGANIZATIONAL STRUCTURES

3.1. THE GOVERNMENTAL STRATEGY

The IAEA's Building a National Position for a New Nuclear Power Programme [9] describes the "national position" as the outcome of a process that establishes the governmental strategy and commitment to develop, implement and maintain a safe, secure and sustainable nuclear power programme.

The governmental strategy defines the main objectives of the programme. It further identifies preferable options for the nuclear power programme, identifies potential infrastructure gaps and provides recommendations to address those gaps should the State decide to proceed.

The owner/operator and the regulatory body are the main implementers of the governmental strategy and their development and actions will be driven by the agreed strategy.

Elements of the governmental strategy that will impact the structure and actions of the owner/operator include:

— Size of the nuclear power programme;
— Timescale for the programme;
— Preferable reactor technologies to be considered;
— Contracting approach;
— Options for financing the project;
— Fuel cycle and waste management options;
— Considerations on human resource development;
— Considerations on national industrial involvement;
— Others.

3.2. IMPACT OF THE CONTRACTING APPROACH ON THE ORGANIZATIONAL STRUCTURE

Notwithstanding the governmental strategy, the number of technical staff that the owner/operator needs during Phases 2 and 3 depends on the contracting strategy selected for the construction of the nuclear power plant. Embarking and expanding countries have considered and adopted several contracting structures for NPP construction, and this section presents the three most common ones:

— Turnkey (EPC) approach;
— Split package approach;
— Build-own-operate (BOO) approach.

3.2.1. Typical structure of the owner/operator in a turnkey project

Under a turnkey approach, the owner/operator procures the NPP through a single contract that covers the entire plant construction. Most embarking countries are selecting this approach

for their first NPP. Figure 3 shows a typical structure in the case of an EPC contract where several organizations are involved in the purchase, construction and commissioning of an NPP:

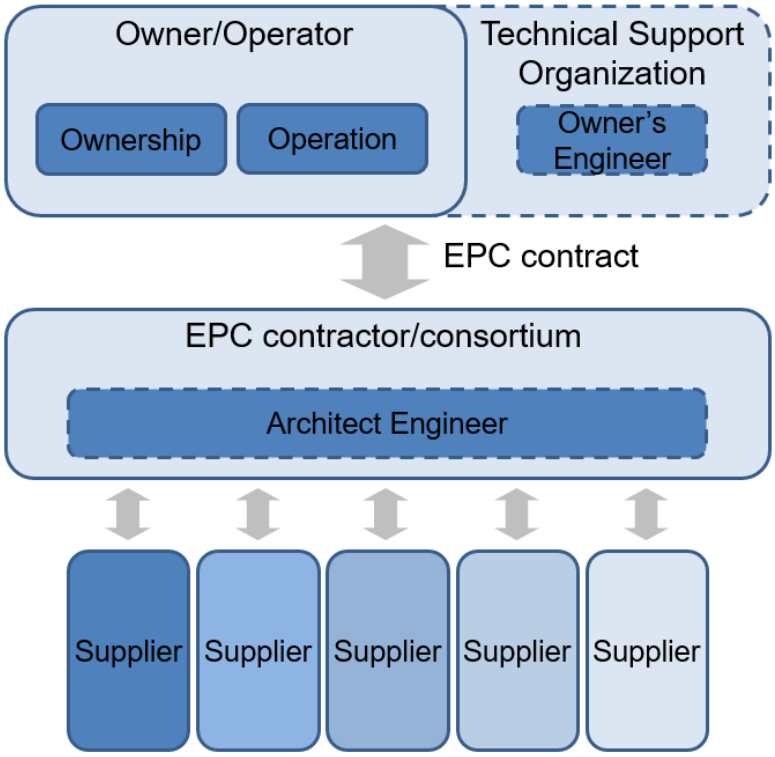

FIG. 3. Main organizations in the construction of a nuclear power plant in the case of an EPC contract.

In a turnkey contract the owner/operator is responsible to oversee the contract implementation signed with the vendor (EPC contractor). This activity requires expert knowledge in different areas and the owner/operator may need support from a Technical Support Organization (TSO) which will play the role of an owner's engineer.

When the procurement of a nuclear power plant is performed through a turnkey contract, the engineering and procurement of components and services, as well as the construction of the plant is under the responsibility of the EPC contractor. An EPC contractor is expected to have experience in design as well as in operation and its engineering functions include:

- Adapting the plant design to the requirements of the owner/operator and to the specific site conditions;
- Managing the procurement;
- Managing the construction;
- Managing the schedule and the interface between the various suppliers;
- Training the future owner/operator.

The team in the EPC contractor responsible for adapting the design, preparing the corresponding documentation and maintaining the plant configuration control during construction and commissioning is sometimes called an architect engineer.

In the case of an EPC contract, the management of the supply chain during the construction is under the responsibility of the EPC contractor and the owner/operator has to ensure that proper controls are applied.

3.2.2. Typical structure of the owner/operator in a split-package approach

Some expanding countries have adopted a split-package approach. In this approach, the procurement of the nuclear power plant is divided into several allotments and the owner/operator is responsible for the engineering, procurement, construction and management (EPCM) of the overall project. The main difference with a turnkey project is that the owner/operator manages rather than monitors the different contracts and their interfaces, including the supply chain, and plays the role of the architect engineer. Figure 4 shows a typical structure of a split package approach:

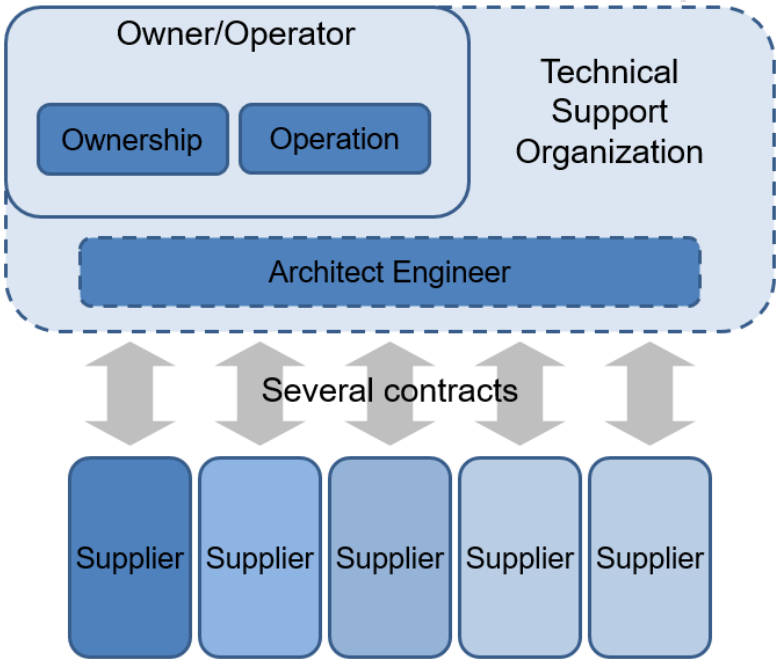

FIG. 4. Organizational structure in the case of a split package approach.

In this case, the owner/operator has to discharge the architect engineer functions and may need the support of a TSO for this purpose. This approach is appropriate for countries looking to build a fleet of NPPs of similar design or to achieve technological independence. This approach requires a higher level of competence and is more appropriate for an experienced owner/operator.

3.2.3. The build-own-operate (BOO) approach

In the less common BOO approach, the host government grants the developer the right to finance, build, own and operate a facility for which it will keep the associated revenues and bear the associated risks. The host government typically offers a power purchase agreement (PPA) for a certain period to give visibility on the return on investment to the project developer. A variant of BOO is Build-Own-Operate-Transfer (BOOT) where the assets are transferred to the host government or a designated entity after a defined period of time of operation.

As in the other schemes, the host government is responsible for the establishment of the national infrastructure for nuclear power. This includes the national commitment to the programme including stakeholder involvement, establishment of the legal and regulatory frameworks and development of the necessary policies and strategies for safety, security,

safeguards, emergency preparedness and response, spent fuel and nuclear waste management and decommissioning.

3.3. SEPARATE OWNER AND OPERATING ORGANIZATION

In the IAEA Milestones approach [1], as well as in other IAEA publications, there is no distinction between the owner of the assets and the operator of the NPP, as the common approach in operating countries is to have an organization that owns and operates the facility. However, there are cases among embarking countries where the owner and the operating organization are two different entities with distinct roles and responsibilities. These types of arrangements are usually being considered to allow the embarking country to gain from the expertise of an experienced nuclear operator by establishing a joint-venture while retaining the full ownership of the NPP.

While the owner organization will benefit from the revenue of electricity sales, it must provide the operator sufficient resources for the safe operation of the NPP as well as funding for decommissioning and radioactive waste management. It should also service any outstanding debt and distribute dividends to its shareholders.

The operator of the plant, which as the licensee bears the prime responsibility for safety and security, will prepare and discuss the budget with the owner to obtain the necessary financial support. It is therefore important that the relationship between the two entities be clearly defined in a contract. The owner will need to have a sufficient understanding of nuclear power and of the licence requirements of the operating organization to manage the contract.

4. ROLE OF THE OWNER/OPERATOR IN THE NUCLEAR POWER PROGRAMME

The owner/operator is the project developer in Phase 2. It owns the assets of the NPP and will eventually benefit from the income from the sale of the electricity generated.

In Phase 3 the owner/operator is responsible for submitting licence applications, overseeing construction and preparing for commissioning and future operation.

The owner/operator has the overall responsibility for safety and security as it evolves from a project developer to an operating organization. This process will be discussed in detail in Section 5.2.

4.1. ROLE OF THE OWNER/OPERATOR IN PHASE 2

Following the country's knowledgeable commitment to proceed with the development of the nuclear power programme, the owner/operator is designated. The owner/operator initiates the development of the organization and begins to develop the competencies necessary to support the activities to be conducted late in Phase 2 and in Phase 3.

Table 1 identifies the main activities to be conducted by the owner/operator in Phase 2, which are organized by infrastructure issues as in the Milestones approach. They are not in chronological order as several of them may be conducted in parallel depending on the resources available. References to other documents, that provide additional guidance to the reader on the scope of activities, are also identified:

TABLE 1. MAIN ACTIVITIES OF THE OWNER/OPERATOR IN PHASE 2

Issue	Activity	Reference for further detail
1. National position	Decide with the Government on the strategy for developing contract arrangements for the nuclear power plant (NPP).	NG-G-3.1, section 3.1.2 [1] NG-T-3.6 [2]
2. Nuclear safety	Participate in the global nuclear safety framework.	SSG-16, action 173 [10]
	Strengthen cooperation on safety related matters with States with advanced nuclear power programmes.	SSG-16, action 16 [10]
	Establish contact with organizations in other States and international organizations to seek advice on safety related matters.	
	Develop the expertise to prepare for the conduct or the review of safety assessments.	SSG-16, action 118 [10]
	Develop an in-depth understanding of the safety principles and safety requirements applicable in the design of a NPP.	SSG-16, action 173 [10]
3. Management	Define an organizational structure and recruit appropriate staff.	NG-G-3.1, section 3.3.2 [1]
	Establish a management system that promotes a strong safety culture.	NG-G-3.1, section 3.3.2 [1] SSG-16, actions 75, 76 and 77 [10] GSR Part 2 [5]
	Assess alternative technologies to determine which are most appropriate or preferred.	NG-G-3.1, section 3.3.2 [1] NP-T-1.10 [11]
	Establish bid invitation specifications (BIS) and evaluation criteria.	NG-G-3.1, section 3.3.2 [1] NG-T-3.9 [12]
	Build project management capabilities and a competent procurement team.	NG-G-3.1, section 3.3.2 [1]
	Establish working relationships with the regulatory body.	NG-G-3.1, section 3.3.2 [1]
	Institute procedures to ensure that knowledge critical to safe and secure operation will always be preserved.	NG-G-3.1, section 3.3.2 [1]
4. Funding and financing	Work with the Government to develop a funding plan for the establishment of the regulatory framework, the regulatory body, the Government stakeholder involvement programme, siting and environment protection activities that lie with the Government, emergency preparedness and response, education, training and research, required improvement to the national grid if any, incentives to promote localization, storage and disposal of radioactive waste including spent fuel, decommissioning.	NG-G-3.1, section 3.4.2 [1]
	Establish a financing plan for the NPP project along with a strategy to manage the financial risks.	NG-G-3.1, section 3.4.2 [1] NG-T-4.1 [13] NG-T-4.6 [14]
5. Legal framework	Understand the obligations in relation to the international legal instruments that are part of the legal framework of the country.	Handbook on nuclear law [15], [16]
	Understand the comprehensive nuclear law as well as the relevant legislation that has been amended accordingly.	Handbook on nuclear law [15], [16]
6. Safeguards	Develop awareness of the requirements of nuclear material accounting and control, in order to affect the necessary resources for this purpose, such as staffing, training and technical resources.	Nuclear material accounting handbook [17]
	Include in the BIS requirements on safeguards design features that would facilitate effective safeguards implementation.	NG-G-3.1, section 3.6.2 [1] NG-T-3.9 [12]
7. Regulatory framework	Develop with the regulatory body and, as needed, implement a protocol for communications about licensing and safety, security and safeguards issues.	NG-G-3.1, section 3.7.2 [1] SSG-16, action 32 Nuclear security series N° 19 [18]
8. Radiation protection	Develop plans for monitoring and protecting workers and the public.	NG-G-3.1, section 3.8.2 [1]
	Reflect radiation protection plans in the plant's design requirements.	NG-G-3.1, section 3.8.2 [1]

Issue	Activity	Reference for further detail
	Develop plans for recruitment and training of radiation protection staff and the procurement of radiation protection equipment and services.	NG-G-3.1, section 3.8.2 [1]
9. Electrical grid	Implement detailed studies to determine any expansion, upgrade or improvement necessary to accommodate the size, technology and site that are anticipated for the new NPP.	NG-G-3.1, section 3.9.2 [1] NG-T-3.8 [19]
10. Human resource development	Identify competences that will be needed in Phase 3 and beyond and establish plans to develop them. The plans should identify future organizational structures as well as staff requirements and include recruitment and training plans based on gap analyses.	NG-G-3.1, section 3.10.2 [1] NG-T-3.10, sections 3 and 4 [20]
	Build upon the efforts initiated during Phase 1 to assess the domestic and foreign capacity for training the people who will be needed.	NG-G-3.1, section 3.10.1 [1]
	Build upon the efforts initiated during Phase 1 to assess the domestic research capabilities that may need to be developed.	NG-G-3.1, section 3.10.1 [1]
	Determine the scope of the training system to be supplied by the vendor, assuring that the scope corresponds to the established strategy, and that those elements of the training system not included in that scope are understood and will be supplied through other mechanisms.	NG-G-2.1, Appendix 1 [21]
	Specify that systematic approach to training (SAT) based training will be required for both vendor-provided and operating organization-provided training for plant personnel.	NG-G-2.1, Appendix 1 [21]
	Plan for effective knowledge transfer and ensure that knowledge transfer provisions are incorporated into agreements and contracts associated with the nuclear power programme.	SSG-16, paragraph 3.12 [10]
11. Stakeholder involvement	Establish a stakeholder involvement programme.	NG-G-3.1, section 3.11.2 [1] NG-T-1.4 [22]
	Explain the basic technology being employed, its construction plans, its safety responsibilities and the impact on, and benefits for, the local community.	NG-G-3.1, section 3.11.2 [1] NG-T-1.4 [22]
	Establish public information centres as appropriate.	NG-G-3.1, section 3.11.2 [1] NG-T-1.4 [22]
12. Site and supporting facilities	Conduct site assessment to justify the acceptability of the preferred sites based on detailed investigations and site characterizations (derivation of the site related design basis).	SSG-35 [23] NG-G-3.1, section 3.12.2 [1]
	Use site assessment results to derive the site related design basis, and reflect it in the BIS for the NPP.	NG-G-3.1, section 3.12.2 [1] NG-T-3.9 [12] NG-T-3.7, sections 4 and 5 [24]
	Ensure the availability and integrity of the preferred site(s).	NG-G-3.1, section 3.12.2 [1]
	Identify necessary improvements and develop implementation plans for local infrastructure at the preferred site or sites, such as access, services and facilities.	NG-G-3.1, section 3.12.2 [1] NG-T-3.7 [24]
13. Environmental protection	Study the prospective impacts of NPP operation on people and the environment for its preferred candidate NPP sites and to ensure that it can comply with the country's environmental laws and regulations. For its preferred candidate site or sites, conduct environmental assessments according to the country's environmental laws and regulations.	NG-G-3.1, section 3.13.2 [1] NG-T-3.11 [25]
	Include, in the BIS, a comprehensive specification of the environmental site conditions, factors, characteristics and data for the site(s).	NG-G-3.1, section 3.13.2 [1] NG-T-3.9 [12]
14. Emergency planning	Work with the Government, the regulatory body and the relevant national and local institutions to specify responsibilities of each organization for emergency preparedness and response related to NPPs.	NG-G-3.1, section 3.14.2 [1] SSG-16, action 135 [10] GSR Part 7 [26] GS-G-2.1 [27]
	Start implementing new arrangements as identified in Phase 1 for strengthening the infrastructure for emergency preparedness and response.	SSG-16, actions 137, 138 and 139 [10] GSR Part 7 [26] GS-G-2.1 [27]

Issue	Activity	Reference for further detail
15. Nuclear security	Include, in the BIS, specifications related to nuclear security and especially the design of the physical protection of the NPP.	NG-T-3.9 [12]
	Plan programmes for the management of sensitive information, and for promotion of a nuclear security culture and trustworthiness of personnel.	NG-G-3.1, section 3.15.2 [1] Nuclear security series N° 19 [18] Nuclear security series N°7 [7]
	Assign roles and responsibilities for preparing for, detecting and responding to nuclear security events.	NG-G-3.1, section 3.15.2 [1] Nuclear security series N° 19 [18]
16. Nuclear fuel cycle	Work with the Government and the regulatory body to develop the national nuclear fuel cycle policy and strategy.	NG-G-3.1, section 3.16.2 [1] NW-T-1.24 [28]
	Develop BIS related to the nuclear fuel cycle.	NG-G-3.1, section 3.16.2 [1] NG-T-3.9 [12]
17. Radioactive waste management	Develop, for inclusion in the BIS, provisions for radioactive waste management, including minimizing radioactive waste volumes and toxicity, requirements for associated facilities and requirements for a decommissioning plan.	NG-G-3.1, section 3.16.2 [1] SSG-16, action 127 [10] NG-T-3.9 [12] NW-T-1.24 [28]
18. Industrial involvement	Identify which national or local suppliers can reliably supply commodities, components or services to the nuclear related or non-nuclear portions of the NPP.	NG-G-3.1, section 3.18.2 [1] NG-T-3.4 [29]
	Identify what upgrades in skills and capabilities are realistic in the time frame that would be required to support nuclear construction.	NG-G-3.1, section 3.18.2 [1]
	Determine localization criteria to be included in the BIS.	NG-G-3.1, section 3.18.2 [1] NG-T-3.9 [12]
	Encourage, with support of the Government, industrial organizations in the country to develop their capabilities with the objective of participating in the construction of NPPs and supporting their safe long term operation.	SSG-16, actions 63 and 64 [10]
19. Procurement	Establish a procurement capability for pre-project activities (e.g. environmental impact assessment, siting and consulting).	NG-G-3.1, section 3.19.2 [1]

4.2. ROLE OF THE OWNER/OPERATOR IN PHASE 3

In Phase 3 the owner/operator will evaluate the bids (if competitive bidding is used), negotiate the contract(s), and manage the NPP project. This will include applying for the required licences and overseeing the construction. Later in Phase 3, the owner/operator will prepare for commissioning and operation.

Table 3 identifies the main activities to be conducted by the owner/operator in Phase 3, which are organized by infrastructure issues as in the Milestones approach. They are not in chronological order as several of them may be conducted in parallel depending on the resources available. References to other documents, that provide additional guidance to the reader on the scope of activities, are also identified:

TABLE 2. MAIN RESPONSIBILITIES OF THE OWNER/OPERATOR IN PHASE 3

Issue	Activity	Reference for further detail
1. National position	Establish a mechanism to exchange information with other countries' operators through participation in the World Association of Nuclear Operators (WANO).	NG-G-3.1, section 3.3.3 [1] SSG-16 [10]
2. Nuclear safety	Continue to implement the national policy and strategy for safety.	SSG-16, action 9 [10]
	Implement a cooperation programme with the vendor and with other organizations operating NPPs of the same type as that selected, for the purposes of strengthening safety, reliability and sustainability.	SSG-16, action 18 [10]
	Obtain support from external support organizations or individual experts in performing or reviewing safety assessments, as necessary.	SSG-16, action 121 [10]
	Establish an internal entity, sometimes called the design authority that will maintain the knowledge of the safety design and its configuration management over the lifetime of the plant.	NG-G-3.1, section 3.2.3 [1]
3. Management	Invite bids, evaluate the bids received and select the winning bid(s) in accordance with the bid evaluation criteria (if competitive bidding is used).	NG-G-3.1, section 3.3.2 [1]
	Train staff and establish a project management organization that will emphasize quality management and be able to ensure that all contract requirements are fully met.	NG-G-3.1, section 3.3.2 [1]
	Prepare a licence application in compliance with the regulatory requirements.	NG-G-3.1, section 3.3.3 [1]
	Initiate and manage the contract, including appropriate auditing to verify compliance.	NG-G-3.1, section 3.3.3 [1]
	Complete construction and apply for a licence/authorization to operate the plant.	NG-G-3.1, section 3.3.3 [1]
	Develop a contract for a continuing nuclear fuel supply.	NG-G-3.1, section 3.3.3 [1]
	Establish mechanisms for turnover responsibility from the main supplier to the owner/operator.	NG-G-3.1, section 3.3.3 [1]
	Clearly specify the roles and responsibilities of external support organizations.	SSG-16, action 69 [10]
	Make appropriate arrangements to avoid conflicts of interest when obtaining external support.	SSG-16, action 70 [10]
	Oversee the activities performed by external support organizations and contractors, and assess the quality of the services provided.	SSG-16, action 71 [10]
	Ensure that senior management provide effective leadership and effective management for safety to ensure a sustainable high level of safety and a strong safety culture.	SSG-16, action 78 [10]
	Establish appropriate arrangements for management of safety related knowledge (including record management and report management) and knowledge transfer.	SSG-16, action 81 [10]
	Implement an integrated management system that promotes a strong safety culture.	SSG-16, actions 79 and 80 [10]
	Implement leadership and succession development programmes to develop future leaders with a strong emphasis on safety.	SSG-16, action 82 [10]
4. Funding and financing	Continue to work on the financing plan for the NPP project including a strategy for managing associated financial risks.	NG-G-3.1, section 3.4.2 [1] NG-4.1 [13]
	Implement an agreement on the financing arrangements for the first NPP project based on the contract and financing negotiations. This stage is often called the final investment decision.	NG-G-3.1, section 3.4.3 [1]
	Ensure that mechanisms are in place to meet the civil liability for nuclear damage in accordance with the nuclear legislation.	NG-T-4.2 [30]
6. Safeguards	Submit design information to the state authority with responsibility for safeguards implementation.	NG-G-3.1, section 3.6.3 [1]
	Support installation of IAEA equipment for containment and surveillance.	NG-G-3.1, section 3.6.3 [1]
	Implement all elements of the safeguards infrastructure at the facility prior to fuel arriving at the first NPP.	NG-G-3.1, section 3.6.3 [1] Service series 15 [17] Service series 21 [8]
7. Regulatory Framework	Maintain an effective working relationship and open communication with regulators.	NG-G-3.1, section 3.7.3 [1]

Issue	Activity	Reference for further detail
	Agree with regulators on the programme/schedule for licensing meetings, taking into account the important milestones of the first NPP construction schedule.	NG-G-3.1, section 3.7.3 [1]
	Submit the safety documentation required in the licensing process in a timely manner and be prepared to respond to enquiries from the regulatory body.	
	Require organizations in the supply chain to comply with national safety requirements.	
	Provide regulatory inspectors with unfettered access to the NPP and design information during inspections of construction and commissioning activities.	
8. Radiation protection	Install radiation monitoring equipment on the NPP site prior to initial fuel being on-site.	NG-G-3.1, section 3.8.3 [1]
	Implement radiation dosimetry requirements for all workers prior to initial fuel being on-site.	NG-G-3.1, section 3.8.3 [1]
	Develop and implement programmes to minimize radiation exposure during plant operation and maintenance prior to initial fuel being on-site.	NG-G-3.1, section 3.8.3 [1]
9. Electrical grid	Implement the grid upgrade plans developed during Phase 2.	NG-G-3.1, section 3.9.3 [1]
	Develop arrangements to ensure coordination of grid operations with NPP operations.	NG-G-3.1, section 3.9.3 [1] NG-T-3.8 [19]
	Verify the completion of all upgrades and enhancements to the grid and interconnections.	NG-G-3.1, section 3.9.3 [1]
	Install and test the redundant off-site power supplies to the NPP.	NG-G-3.1, section 3.9.3 [1]
10. Human resource development	Recruit, hire and develop the project management organization needed early in Phase 3 to initiate efforts to acquire the first NPP.	NG-G-3.1, section 3.10.3 [1] NG-G-2.1, appendix 1 [21]
	Recruit, hire and develop the human resources necessary to commission and operate the first NPP based on needs as defined in workforce plans.	NG-G-3.1, section 3.10.3 [1]
	Arrange with the supplier or other owner/operators for training of the operations and maintenance team on existing similar plants.	
	Specify that SAT based training will be required for both vendor-provided and operating organization-provided training for plant personnel.	NG-G-2.1, appendix 1 [21]
	Implement plans for knowledge transfer. Ensure that provisions for effective knowledge transfer are incorporated into the agreements and contracts associated with the nuclear power programme.	SSG-16, paragraph 3.12 [10]
	Develop and implement a SAT-based training and a qualification programme for plant personnel.	NG-G-2.1, appendix 1 [21]
	Qualify plant personnel for fuel loading and initial critical operation.	NG-T-2.2 [31]
	Acquire or have access to a full-scope plant specific simulator for training control room operators.	NG-G-3.1, section 3.10.3 [1]
	Develop and implement a systematic way of categorizing, disseminating and retaining knowledge, including training material, obtained through international cooperation and contracted commercial services.	NG-G-3.1, section 3.10.3 [1] NG-G-2.1, appendix 1 [21]
	Build upon the efforts of Phase 2 to develop the full range of scientific, technical, managerial and administrative disciplines that will be needed and to assess their availability within the country.	NG-G-3.1, section 3.10.3 [1]
	Build upon the efforts during Phase 2 to develop and implement specialized recruiting and training that will be needed in nuclear safety, nuclear security, safeguards, radiation protection, management systems and emergency preparedness and response.	NG-G-3.1, section 3.10.3 [1]
	Develop domestic research and technical support capabilities over time, to support the work of the nuclear specialists.	NG-G-3.1, section 3.10.3 [1]

Issue	Activity	Reference for further detail
11. Stakeholder involvement	Continue to implement and assess the stakeholder involvement plan in conjunction with the Government, the regulatory body and the relevant organizations in the programme. This includes: — Communicating routinely about construction progress and preparations for operation; — Communicating the operating organization's plans for routine communication, once the NPP is operational, to all stakeholders including local communities; — Communicating on the on-site and off-site emergency response plans; — Continuing to openly discuss issues and how they are being addressed.	NG-G-3.1, section 3.11.3 [1] NG-T-1.4 [22]
12. Site and supporting facilities	Confirm the site's suitability and the completion of all licensing and approval processes established by the nuclear regulatory body.	NG-G-3.1, section 3.12.3 [1]
13. Environmental protection	Complete all licensing and approval processes established by the nuclear regulatory body and the environmental regulatory body for the nuclear programme.	NG-G-3.1, section 3.13.3 [1]
	Implement an environmental monitoring programme including the establishment of baseline data.	NG-G-3.1, section 3.13.3 [1]
14. Emergency planning	Develop and implement an emergency preparedness programme and emergency plans and procedures for NPPs, and prepare the corresponding chapter of the safety analysis.	SSG-16, action 141 [10]
	Demonstrate emergency response capabilities by conducting appropriate exercises that include local authorities, and local communities.	SSG-16, action 145 [10]
15. Nuclear security	Develop and receive approval of the security plan.	NG-G-3.1, section 3.15.3 [1]
	Construct, test and accept the physical protection system.	NG-G-3.1, section 3.15.3 [1] Nuclear security series 10 [32] Nuclear security series 13 [33]
	Demonstrate the effectiveness of the system for protecting nuclear material and facilities, through inspections, verification and on-site exercises.	NG-G-3.1, section 3.15.3 [1]
	Implement the national response plan including arrangements with outside response forces to supplement on-site response, as well as training and exercises.	NG-G-3.1, section 3.15.3 [1] Nuclear security series 13 [33]
16. Nuclear fuel cycle	Develop plans to implement the interim storage strategy, including identifying a suitable location, transport capabilities and funding arrangements.	NG-G-3.1, section 3.16.3 [1] NW-T-1.24 [28]
17. Radioactive waste management	Put in operation enhanced or new facilities for the storage or disposal of low and intermediate level waste (LILW) to be prepared to receive radioactive waste from the NPP.	NG-G-3.1, section 3.17.3 [1] SSG-16, action 130 [10] NW-T-1.24 [28]
	Develop an initial decommissioning plan as part of the licensing of the first NPP units.	NG-G-3.1, section 3.17.3 [1] GSR Part 6 [34]
	Monitor international efforts and progress with regard to the disposal of radioactive waste.	SSG-16, action 132 [10]
18. Industrial involvement	Promote educational and industrial development for national participation in the nuclear programme.	NG-G-3.1, section 3.18.3 [1] NG-T-3.4 [29]
	Implement decisions made in the BIS about using national or foreign sources for commodities, components and services.	NG-G-3.1, section 3.18.2 [1]
	As the construction phase of the first NPP project nears completion, reassess the capability of national/local supply sources to support operation.	NG-G-3.1, section 3.18.3 [1]
19. Procurement	Establish a procurement organization with the programmes and skills necessary to conduct ongoing purchasing of equipment and services during Phase 3.	NG-G-3.1, section 3.19.3 [1] NP-T-3.21 [35]

5. MANAGING GROWTH AND CHANGE

5.1. ESTABLISHING THE OWNER/OPERATOR ORGANIZATION

The first step in establishing an owner/operator will be the appointment of a core group of competent managers and key specialists from which the organization can be built. At least some of these people should have participated in the Phase 1 work of the NEPIO. The organization can be newly established or developed as part of an existing power utility.

Some embarking countries have chosen the latter option, which has the advantage of benefiting from the existing physical, institutional and human infrastructure available in the power utility. Examples of such infrastructure are the quality assurance programme, document management system, procurement process, IT support, etc. In addition to that, several competencies available in the areas of finance, legal, project management, operations and maintenance can be useful for the future NPP project. This approach, however, may also lead to conflicts of priority between conventional projects and the nuclear power project and will require an understanding of the unique needs of a nuclear project by the upper management of the utility.

Other embarking countries have established a new owner/operator organization with staff from nuclear research organizations and/or atomic energy commissions, if they exist. In such cases the structure and management systems of the owner/operator organization need to be built from scratch. Also, the staff may not have the project management skills necessary for the development and implementation of a large scale commercial project.

In both cases, a key task for the core group of managers and specialists appointed to lead the project is the establishment of a programme to foster an organizational culture that recognizes the importance of safety, security and safeguards. This core group should instil this culture through its leadership in the organization as well as in its contractors.

5.2. EVOLUTION OF THE ORGANIZATION

It is important to recognize that the structure and staffing of the owner/operator is not static but evolves due to the needs in different phases, as presented in Figure 5.

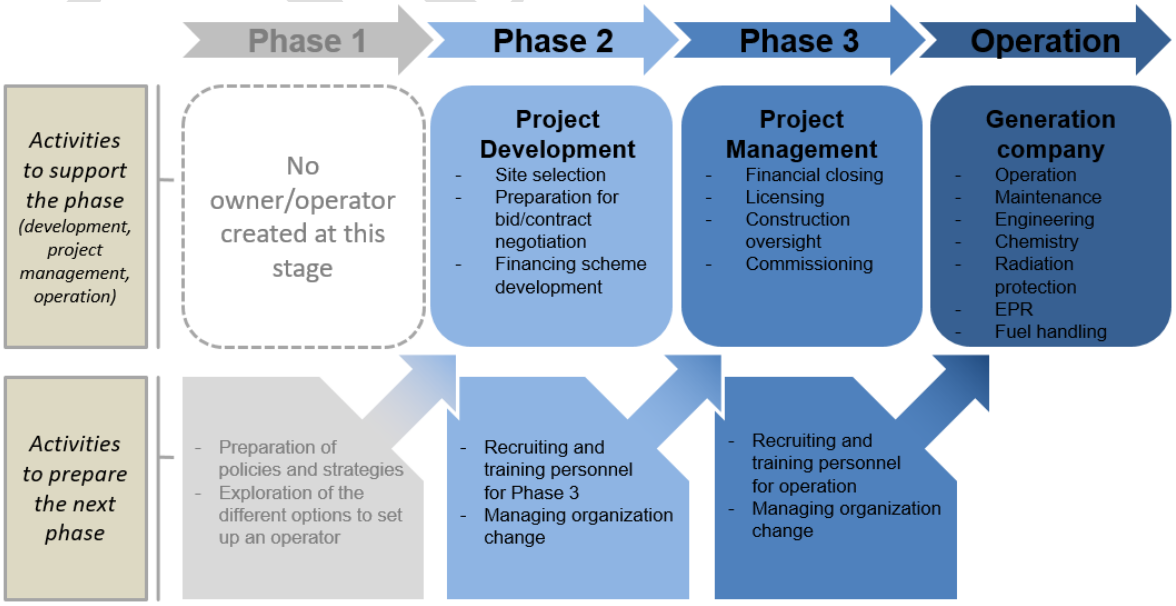

FIG. 5. The changing nature of activities of the Owner/Operator.

In Phase 1, while there is normally no owner/operator identified, the NEPIO will prepare the pre-feasibility studies, including drafting policies and strategies that will influence the activities of the owner/operator in Phase 2.

In Phase 2, the owner/operator functions as a project development organization. The structure of this organization will evolve rapidly as the number of staff increases. During this phase, the organization will develop the capability to specify technical requirements and negotiate with potential vendors and partners. At the same time, it needs to recruit and train the staff needed for Phase 3.

As the project moves into Phase 3, the owner/operator becomes a project management organization and addresses three significantly different issues, namely financing and contracting, managing construction oversight and preparing the licence application(s). At the same time, it needs to recruit and train the staff needed for commissioning and future operation.

Typical organizational charts for Phases 2 and 3 are presented in Figures 6 and 7.

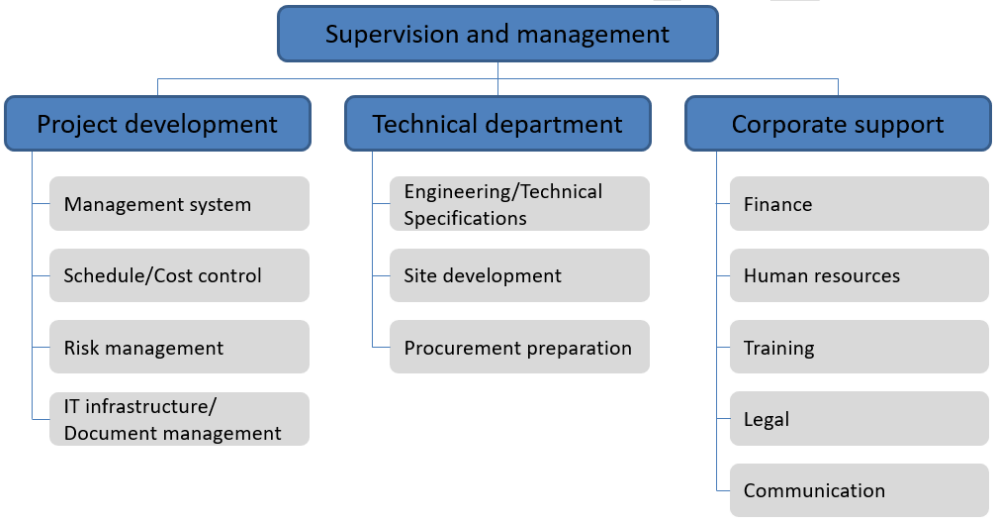

FIG. 6. Example of an organizational chart for Phase 2.

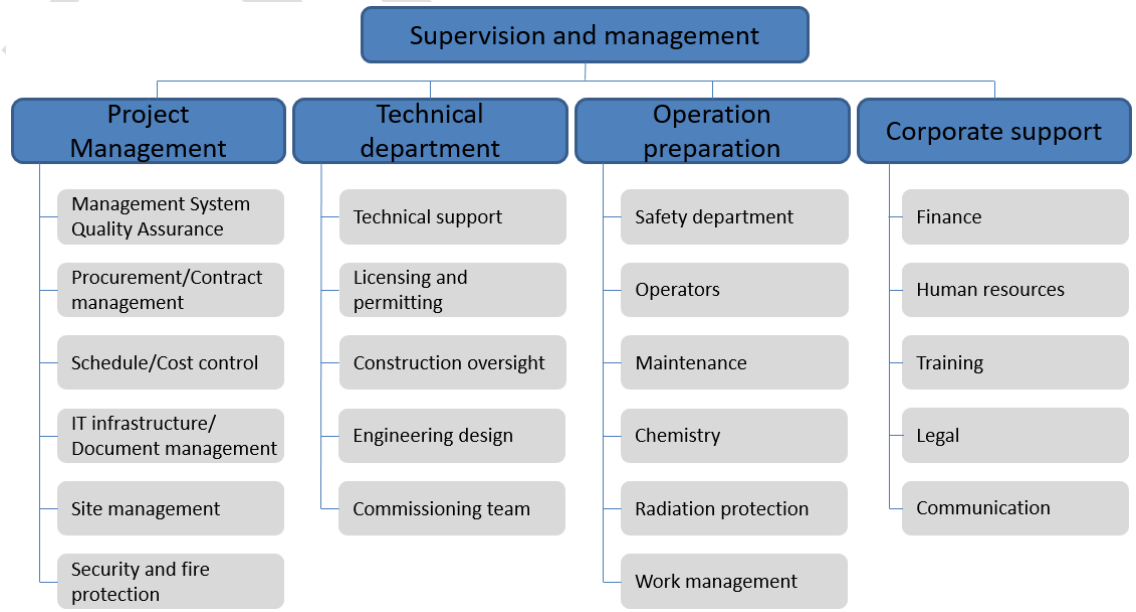

FIG. 7. Example of an organizational chart for Phase 3.

The following table gives an indication of the number of staff necessary for a two-unit project through an EPC contract. Once the reactor technology is known, the owner/operator should prepare a detailed human resource development plan, in consultation with the vendor, to support Phase 3.

TABLE 3. EXAMPLE OF THE AVERAGE NUMBER OF TECHNICAL STAFF IN OWNER/OPERATOR AT DIFFERENT STAGES FOR AN EPC CONTRACT: TWO 1000 MW UNITS

Division	During project development (Phase 2)	During construction (Phase 3)	During commissioning (at Milestone 3)	At operation	Comments
Engineering	20	80	80	70	Engineers during operation won't have the same profile as during construction (material and system engineers)
Planning and project control	20	20	50	50	Numbers assume operating staff will be responsible for outage management
Material control and management	10	40	20	-	
Construction Control	10	30	20	-	
Commissioning	0	50	170	-	Some staff (but not all) may join the maintenance team at operation
Maintenance	0	0	100	230	Includes I&C, mechanical, electrical and logistics
Technical support	5	15	100	100	Includes industrial safety, radiological protection, chemical, fire prevention
Management, human resources, training and procurement	15	125	60	100	Includes finance and contract control
Nuclear safety and quality management	20	20	30	30	
Security and physical protection	5	30	60	60	
Operators for both units	0	60	180	180	
Total	105	470	870	820	

(Note: The table is for staff in the owner/operator organization. The number of employees from the vendor or subcontractors who were involved in construction and commissioning is not included.)

While the numbers of personnel required for commissioning and operation are well known, much less data is available for the early phases of the project and the figures may vary greatly depending on the use of external support and/or the pace of the NPP project.

5.3. ACQUIRING AND DEVELOPING THE REQUIRED COMPETENCIES

One of the first activities to be performed by the owner/operator is an analysis of the competencies required to support the activities to be conducted in Phases 2 and 3. While many

of the owner/operator's activities require in-house competencies, it may be more appropriate for others to be outsourced.

The determination of which activities will be performed in-house and those that will be outsourced will have an impact on the organization's recruitment plan and its training programme. Figure 8 shows the typical decision making process and a number of factors needed to be considered:

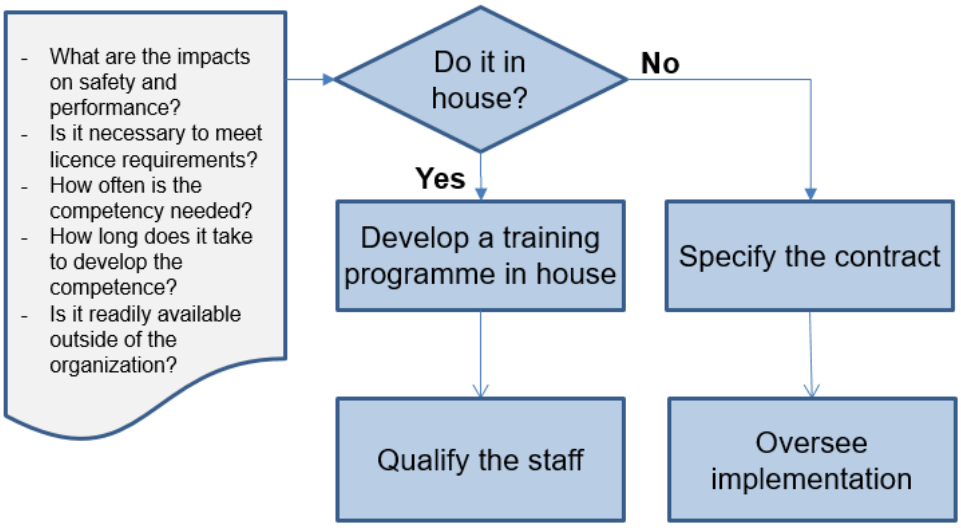

FIG. 8. Process to identify the competencies needed depending on whether an activity is outsourced or not.

To make effective use of outsourcing, the owner/operator still needs the competency to specify the work to be performed and to supervise its implementation. This capacity is known as being a knowledgeable customer. Several embarking countries that have outsourced activities also used this opportunity to develop their own competencies by including in the contract an element of training (e.g. shadowing, mentoring and on the job training).

If the decision is made to perform a given activity in-house, the development of the required competencies often necessitates early considerations related to recruitment and training, especially for those positions with long lead times. Typically, the approach to recruitment and training will follow a phased approach once the organization is formed.

5.3.1. Recruitment

Recruiting appropriate staff is central to the development of a successful organization. For activities that will be done in house, the staff overseeing the recruitment process together with the management of the organization should develop job profiles. The organization should consider existing human resource pipelines in the country to support the initial recruitment, as well as the continuous and dynamic cycle that will impact the overall recruitment process, as shown in Figure 9.

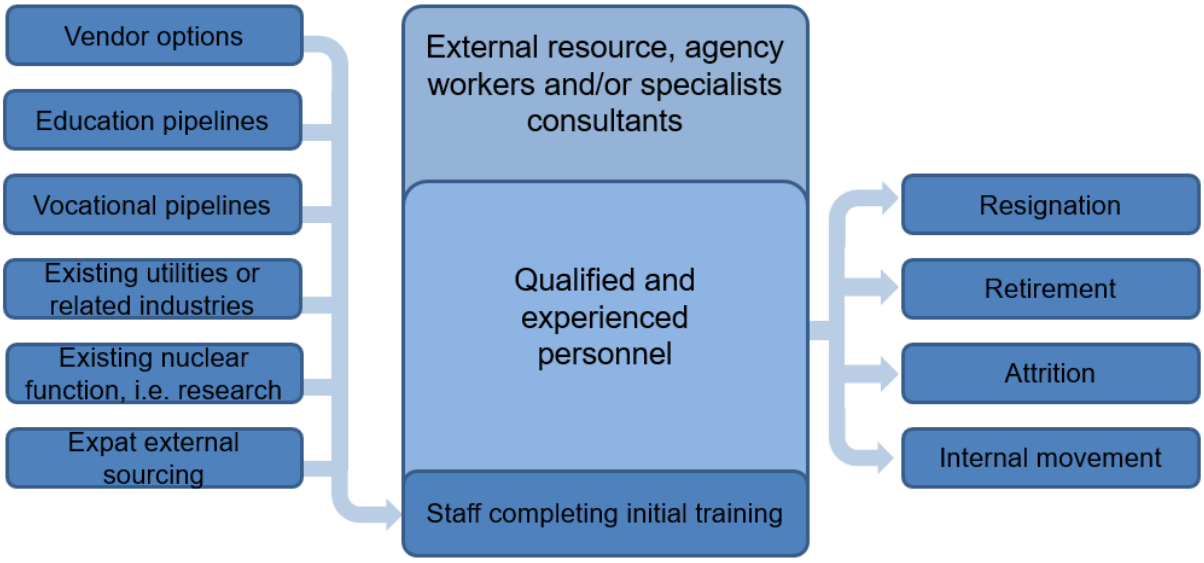

FIG. 9. Recruitment lifecycle activities.

In addition to reviewing the existing educational and vocational pipelines, the owner/operator should also consider other relevant industries, such as electrical utilities, as well as nuclear research organizations as potential recruitment options. All the individuals recruited, including experienced staff recruited externally, will require training, development and qualification before setting to work. Given that workforce planning is a dynamic process, the owner/operator's recruitment plan should also consider the potential loss of qualified staff through resignations, retirement, attrition and internal movement. The owner/operator will supplement its staff with an external resource, such as a TSO or consultants, for specific tasks. The recruitment plan will evolve as the organization moves from Phase 2 to Phase 3, and as new competencies are required.

The number of personnel recruited from the various sources will depend on the programme specifics, such as, the number of units to be constructed and the contractual arrangements with the vendor. In some cases, it may be necessary to conduct surveys of existing national education programmes and vocational training organizations to determine the national capability to meet the programme demands. Where a shortfall of capacity is identified it will be necessary for the owner/operator to put in place arrangements with the government to ensure sustainable educational and vocational pipelines are in place to support the long term demands of the nuclear power programme.

Options for recruitment and workforce planning considerations are further discussed in References [20] and [22].

5.3.2. Training

As with the recruitment process, the owner/operator needs to develop a training programme aligned with the overall nuclear power programme objectives. This programme will provide initial training to new staff as they are recruited and continuing training for existing staff. Therefore, the owner/operator needs to establish a training department in Phase 2 to conduct these activities as well as to support the development of future instructors.

In Phase 3, the majority of the plant specific training will be provided by the vendor through the EPC contract. However, this training is usually limited to maintenance and operation, and areas such as engineering, management, security etc. may require separate

training programmes. It is expected that a training centre at the site will be operational in Phase 3, which will play a role in training staff during construction.

The development of the training programme must take into account that some job positions require long lead times and possibly language training. It is important to recognize that for many job positions, actual experience at an operating nuclear power plant is required in addition to classroom training. This applies not only to control room operators but also to several specialist and managerial positions. Therefore, training plans should be developed for each job position in a systematic way.

The training model used throughout the nuclear industry is the Systematic Approach to Training (SAT) which includes the following steps:

— Analysis of the competencies needed for the job;
— Design of the training to convert the competencies into learning objectives;
— Development of the training material to achieve the learning objectives;
— Implementation of the training using the material developed;
— Evaluation of the training with a feedback for continual improvement.

This approach has become an industry standard and is even a regulatory requirement in some countries. Therefore, the owner/operator needs to ensure that all staff involved in development of the organization's training programme, including the vendor's training personnel, are competent in the use of an SAT based training programme.

6. INTERFACE WITH STAKEHOLDERS

All the organizations involved in the nuclear power programme will have stakeholders that must be engaged throughout the different phases. The owner/operator, in particular, has to engage with a large number of stakeholders, including the public. Figure 10 shows typical stakeholders in interface with the owner/operator:

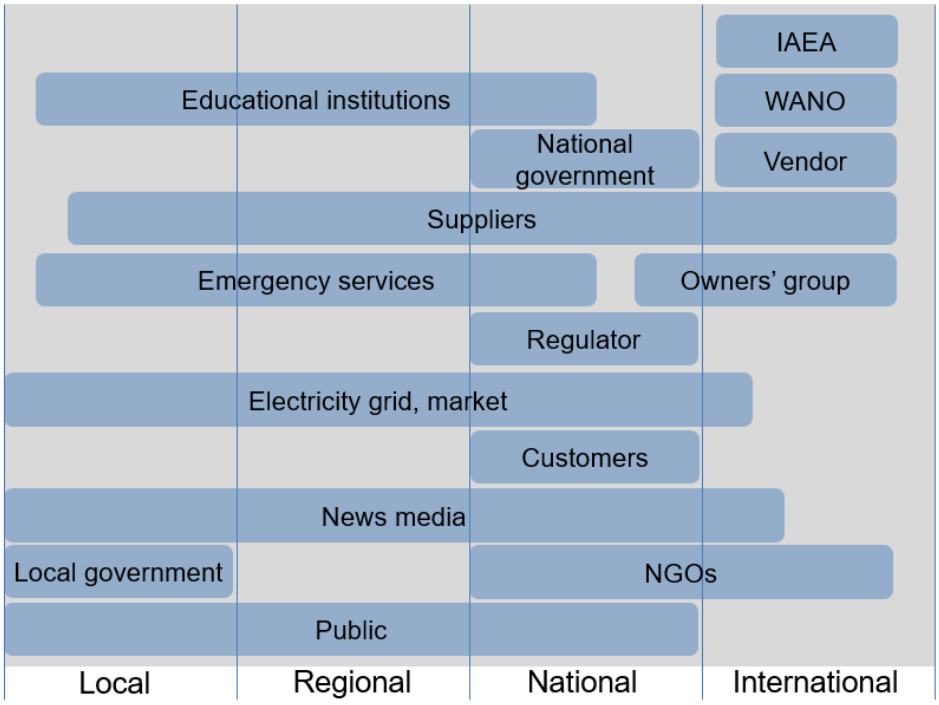

FIG. 10. Typical stakeholders in interface with the owner/operator.

Stakeholders for the owner/operator typically include national, regional and local authorities, regulatory bodies, the vendor, emergency response organizations, technical support organizations, grid operator, police, etc. One of the most important stakeholders is the public, especially the community living or working near the nuclear power plant site. Other stakeholders of interest may include the media, non-governmental organizations (NGOs), educational institutions, other nuclear power operators, international organizations and owners' groups.

In Phase 2, the owner/operator should establish a stakeholder involvement strategy and plan and initiate engagement with identified stakeholders. This strategy and plan may benefit from previous work performed at the national level in Phase 1 and should be coordinated through the NEPIO with the plans of the other key organizations. Guidance on the development of a stakeholder strategy and plan is provided in Reference [22].

6.1. INTERFACE WITH THE NATIONAL GOVERNMENT AND THE NEPIO

The NEPIO, which has the role of national coordination, will be a key stakeholder for the owner/operator in Phases 2 and 3 as the owner/operator is responsible for the implementation of the relevant policies developed by the NEPIO.

The owner/operator has to identify the activities for which it will need support from the government. In Phase 2, the owner/operator needs support from the government and the relevant ministries to establish the investment framework and the definition of the contracting strategy. The owner/operator also needs to work with the NEPIO to determine which enhancements are necessary in the educational system to ensure the availability of individuals with appropriate backgrounds. Industrial involvement policy, prepared by the NEPIO in Phase 1, also needs to be considered as the owner/operator is preparing for contract negotiation. Finally, international cooperation will also contribute to the development of the owner/operator, and this will require intergovernmental coordination led by the NEPIO.

6.2. INTERFACE WITH THE REGULATORY BODY

At every stage of the project, the owner/operator needs to interact with the regulatory bodies (for safety, security, safeguards and environmental protection) to ensure compliance with the legal and regulatory frameworks. Mechanisms should be established to support communication and information exchange between the organizations for this purpose. The owner/operator needs to provide the regulatory inspectors with unfettered access to the NPP, including design and operational information, to assess compliance with regulatory and licensing requirements.

Typical interactions include regular meetings, presentation of plans and progress reports, applications for licences and permits, submission of safety documentation for obtaining approvals, etc. The owner/operator may also receive formal letters requesting information or specific actions, or formal instructions from the regulator(s). The owner/operator may consider establishing a process to manage and respond to these requests in a timely manner.

6.3. INTERFACE WITH THE GRID OPERATOR

The owner/operator should also establish communication protocols with the grid operator in Phase 2 as it will need to provide information concerning the location, size and typical technical requirements of the nuclear power plant. The grid operator will first use this information to estimate the necessary upgrades to the grid that are required to provide electricity to the NPP construction site. Once the technology is chosen, there will be additional enhancements to ensure that the grid connections to the nuclear power plant are sufficient, and

can also provide the NPP with a reliable external electrical supply that is independent of the plant output.

In addition, the grid operator may require the nuclear power plant to have certain performance characteristics to ensure the proper operation and security of the electrical grid. The owner/operator will need to agree on such requirements and include them in the contract specifications for the NPP.

The owner/operator and the grid operator will also need to agree on the schedule for grid enhancements in order to complete them prior to commissioning the nuclear power plant.

By the end of Phase 3, the owner/operator will need to have arrangements in place for routine communication between the nuclear power plant and the grid operator, including for maintenance of the grid and planned outages of the NPP.

6.4. INTERFACE WITH THE VENDOR, MAIN CONTRACTOR AND SUBCONTRACTORS

The responsibilities of the organizations participating in the construction of the nuclear power plant will depend on the nature of the contracts used for procurement. In all contract arrangements, including turnkey contracts, the owner/operator retains the ultimate responsibility for the safety aspects of the project and for ensuring that the construction of the plant meets the necessary quality and safety standards. The owner/operator will need to ensure that the national safety requirements are understood and applied throughout the supply chain by the EPC contractor.

During the licensing process, the owner/operator will need technical support from the vendor. This support will continue after commissioning, as a long-term support is expected at the operational phase of the plant.

6.5. INTERFACE WITH THE WASTE MANAGEMENT ORGANIZATION

The nuclear power plant, when in operation, will generate waste and spent fuel for which the owner/operator is responsible. It will need to liaise with a waste management organization as defined by national laws and regulations. While this organization may not exist at the time of construction, the owner/operator should analyse the nature and volume of waste and spent fuel that will be generated during operation of the NPP.

The owner/operator and the waste management organization will have to implement the national waste policy that will be decided in Phase 2. Regular exchanges and communication will take place between the two organizations for this purpose.

6.6. INTERFACE WITH THE EMERGENCY PLANNING AND RESPONSE ORGANIZATIONS

The owner/operator is responsible for implementing on-site emergency plans and procedures. It will also need to establish interfaces with local and national emergency planning and response organizations (central government agencies, local government agencies, fire brigade, police, ambulance and hospital services, etc.) to ensure effective coordination. These interfaces should be formalized through emergency planning arrangements and routinely tested through local and national drills.

6.7. INTERFACE WITH THE PUBLIC AND WITH NEIGHBOURING COUNTRIES

Maintaining public support for the nuclear power plant project requires joint efforts from the NEPIO and the owner/operator. The government role lies more at national level to provide

the justification for the nuclear power programme with support from the owner/operator while the owner/operator has a major role in informing the public at a local level, in line with the national policy. The government and the regulatory body need to promote the roles and responsibilities of an independent regulator in the oversight of the nuclear power plant. The support of individuals living close to the proposed site of the nuclear power plant will be particularly important and should be consulted by the owner/operator in Phase 2.

The owner/operator may include the establishment of public information centres as part of its overall communication strategy. These centres may be located at the site as well as in larger metropolitan areas. Neighbouring countries also have an interest in the new nuclear power programme, however, their involvement will be facilitated by the government.

6.8. INTERFACE WITH INTERNATIONAL ORGANIZATIONS

The owner/operator is expected to participate in activities organized by international organizations such as the IAEA, the World Association of Nuclear Operators (WANO) and the relevant owners' group. This will provide the new owner/operator with a way of obtaining valuable information on the practical experience of other organizations in the construction and operation of nuclear power plants and the lessons learned.

REFERENCES

[1] INTERNATIONAL ATOMIC ENERGY AGENCY, Milestones in the Development of a National Infrastructure for Nuclear Power, IAEA Nuclear Energy Series No. NG-G-3.1 (Rev. 1), IAEA, Vienna (2015).

[2] INTERNATIONAL ATOMIC ENERGY AGENCY, Responsibilities and Capabilities of a Nuclear Energy Programme Implementing Organization, IAEA Nuclear Energy Series No. NG-T-3.6 (Rev. 1), IAEA Vienna (2017).

[3] INTERNATIONAL ATOMIC ENERGY AGENCY, Application of the Management System for Facilities and Activities, IAEA Safety Standard Series No. GS-G-3.1, IAEA, Vienna (2006).

[4] INTERNATIONAL ATOMIC ENERGY AGENCY, Fundamental Safety Principles, IAEA Safety Standard Series, No. SF-1, IAEA Vienna (2006).

[5] INTERNATIONAL ATOMIC ENERGY AGENCY, Leadership and Management for Safety, IAEA Safety Standard Series No GSR Part 2, IAEA, Vienna (2016).

[6] INTERNATIONAL ATOMIC ENERGY AGENCY, Objective and Essential Elements of a State's Nuclear Security Regime, IAEA Nuclear Security Series No. 20, IAEA, Vienna (2013).

[7] INTERNATIONAL ATOMIC ENERGY AGENCY, Nuclear Security Culture, IAEA Nuclear Security Series No. 7, IAEA Vienna (2008).

[8] INTERNATIONAL ATOMIC ENERGY AGENCY, Guidance for States Implementing Comprehensive Safeguards Agreements and Additional Protocols, IAEA Service Series No. 21, IAEA, Vienna (2012).

[9] INTERNATIONAL ATOMIC ENERGY AGENCY, Building a National Position for a New Nuclear Power Programme, IAEA Nuclear Energy Series No. NG-T-3.14, IAEA, Vienna (2016).

[10] INTERNATIONAL ATOMIC ENERGY AGENCY, Establishing the Safety Infrastructure for a Nuclear Power Programme, IAEA Safety Standards Series No. SSG-16, IAEA, Vienna (2011).

[11] INTERNATIONAL ATOMIC ENERGY AGENCY, Nuclear Reactor Technology Assessment for Near Term Deployment, IAEA Nuclear Energy Series No. NP-T-1.10, IAEA, Vienna (2013).

[12] INTERNATIONAL ATOMIC ENERGY AGENCY, Invitation and Evaluation of Bids for Nuclear Power Plants, IAEA Nuclear Energy Series No. NG-T-3.9, IAEA, Vienna (2011).

[13] INTERNATIONAL ATOMIC ENERGY AGENCY, Financing of New Nuclear Power Plants, IAEA Nuclear Energy Series No. NG-T-4.1, IAEA, Vienna (2008).

[14] INTERNATIONAL ATOMIC ENERGY AGENCY, Managing the Financial Risk Associated with the Financing of New Nuclear Power Plant Projects, IAEA Nuclear Energy Series No. NG-T-4.6, IAEA, Vienna (2017).

[15] STOIBER, C., BAER, A., PELZER, N., TONHAUSER, W., Handbook on Nuclear Law, IAEA, Vienna (2003).

[16] STOIBER, C., CHERF, A., TONHAUSER, W., DE LOURDES VEZ CARMONA, M., Handbook on Nuclear Law: Implementing Legislation, IAEA, Vienna (2010).

[17] INTERNATIONAL ATOMIC ENERGY AGENCY, Nuclear Material Accounting Handbook, IAEA Service Series No. 15, IAEA, Vienna (2008).

[18] INTERNATIONAL ATOMIC ENERGY AGENCY, Establishing the Nuclear Security Infrastructure for a Nuclear Power Programme, IAEA Nuclear Security Series No. 19, IAEA, Vienna (2013).

[19] INTERNATIONAL ATOMIC ENERGY AGENCY, Electric Grid Reliability and Interface with Nuclear Power Plants, IAEA Nuclear Energy Series No. NG-T-3.8, IAEA, Vienna (2012).

[20] INTERNATIONAL ATOMIC ENERGY AGENCY, Workforce Planning for New Nuclear Power Programmes, IAEA Nuclear Energy Series No. NG-T-3.10, IAEA, Vienna (2011).

[21] INTERNATIONAL ATOMIC ENERGY AGENCY, Managing Human Resources in the Field of Nuclear Energy, IAEA Nuclear Energy Series No. NG-G-2.1, IAEA, Vienna (2009).

[22] INTERNATIONAL ATOMIC ENERGY AGENCY, Stakeholder Involvement Throughout the Life Cycle of Nuclear Facilities, IAEA Nuclear Energy Series No. NG-T-1.4, IAEA, Vienna (2011).

[23] INTERNATIONAL ATOMIC ENERGY AGENCY, Site Survey and Site Selection for Nuclear Installations, IAEA Safety Standards Series No SSG-35, IAEA, Vienna (2015).

[24] INTERNATIONAL ATOMIC ENERGY AGENCY, Managing Siting Activities for Nuclear Power Plants, IAEA Nuclear Energy Series No. NG-T-3.7, IAEA, Vienna (2012).

[25] INTERNATIONAL ATOMIC ENERGY AGENCY, Managing Environmental Impact Assessment for Construction and Operation in New Nuclear Power Programmes, IAEA Nuclear Energy Series No. NG-T-3.11, IAEA, Vienna (2014).

[26] INTERNATIONAL ATOMIC ENERGY AGENCY, Preparedness and Response for a Nuclear or Radiological Emergency, IAEA Safety Standard Series No GSR Part 7, IAEA, Vienna (2015).

[27] INTERNATIONAL ATOMIC ENERGY AGENCY, Arrangements for Preparedness for a Nuclear or Radiological Emergency, IAEA Safety Standard Series No. GS-G-2.1, IAEA, Vienna (2007).

[28] INTERNATIONAL ATOMIC ENERGY AGENCY, Options for Management of Spent Fuel and Radioactive Waste for Countries Developing New Nuclear Power Programmes, IAEA Nuclear Energy Series No. NW-T-1.24, IAEA, Vienna (2013).

[29] INTERNATIONAL ATOMIC ENERGY AGENCY, Industrial Involvement to Support a National Nuclear Power Programme, IAEA Nuclear Energy Series No. NG-T-3.4, IAEA, Vienna (2016).

[30] INTERNATIONAL ATOMIC ENERGY AGENCY, Financing of New Nuclear Power Plants, IAEA Nuclear Energy Series No. NG-T-4.2, IAEA, Vienna (2008).

[31] INTERNATIONAL ATOMIC ENERGY AGENCY, Commissioning of Nuclear Power Plants: Training and Human Resource Considerations, IAEA Nuclear Energy Series No. NG-T-2.2, IAEA, Vienna (2008).

[32] INTERNATIONAL ATOMIC ENERGY AGENCY, Development, Use and Maintenance of the Design Basis Threat, IAEA Nuclear Security Series No. 10, IAEA, Vienna (2009).

[33] INTERNATIONAL ATOMIC ENERGY AGENCY, Nuclear Security Recommendations on Physical Protection of Nuclear Material and Nuclear Facilities (INFCIRC/225/Revision 5), IAEA Nuclear Security Series No. 13, IAEA, Vienna (2011).

[34] INTERNATIONAL ATOMIC ENERGY AGENCY, Decommissioning of Facilities, IAEA Safety Standard Series No GSR Part 6, IAEA, Vienna (2014).

[35] INTERNATIONAL ATOMIC ENERGY AGENCY, Procurement Engineering and Supply Chain Guidelines in Support of Operation and Maintenance of Nuclear Facilities, IAEA Nuclear Energy Series No. NP-T-3.21, IAEA, Vienna (2016).

[36] INTERNATIONAL NUCLEAR SAFETY ADVISORY GROUP, Safety Culture, INSAG-4, IAEA Vienna (1991).

[37] INTERNATIONAL ATOMIC ENERGY AGENCY, Management of Continual Improvement for Facilities and Activities: A Structured Approach, IAEA-TECDOC-1491, IAEA, Vienna (2006).

[38] INTERNATIONAL ATOMIC ENERGY AGENCY, Management of Procurement Activities in a Nuclear Installation, IAEA-TECDOC-919, IAEA, Vienna (1996).

[39] INTERNATIONAL ATOMIC ENERGY AGENCY, Technical support to nuclear power plants and programmes, IAEA Nuclear Energy Series No. NG-T-3.28, IAEA, Vienna (working document).

[40] INTERNATIONAL ATOMIC ENERGY AGENCY, Alternative Contracting and Ownership Approaches for New Nuclear Power Plants, TECDOC No. 1750, IAEA Vienna (2014).

[41] INTERNATIONAL ATOMIC ENERGY AGENCY, IAEA Safety Glossary Terminology Used in Nuclear Safety and Radiation Protection, STI/PU/1290, IAEA Vienna (2007).

[42] INTERNATIONAL ATOMIC ENERGY AGENCY, Project Management in Nuclear Power Plant Construction: Guidelines and Experience, IAEA Nuclear Energy Series No. NP-T-2.7, IAEA, Vienna (2012).

[43] INTERNATIONAL ATOMIC ENERFY AGENCY, Knowledge Management for Nuclear Industry Operating Organizations, TECDOC 1510, Vienna (2006).

[44] INTERNATIONAL ATOMIC ENERGY AGENCY, Recruitment, Qualification and Training of Personnel for Nuclear Power Plants, IAEA Safety Standard Series No NS-G-2.8, IAEA, Vienna (2002).

[45] INTERNATIONAL NUCLEAR SAFETY ADVISORY GROUP, Maintaining the Design Integrity of Nuclear Installations throughout their Operating Life, INSAG-19, Vienna (2003).

[46] INTERNATONAL ATOMIC ENERGY AGENCY, Authorization of nuclear power plant control room personnel: methods and practices with emphases on the use of simulators, IAEA-TECDOC-1502, IAEA, Vienna (2006).

[47] INTERNATIONAL ATOMIC ENERGY AGENCY, Competency Assessments for Nuclear Industry Personnel, STI/PUB/1236, IAEA, Vienna (2006).

[48] INTERNATIONAL ATOMIC ENERGY AGENCY, The Operating Organization for Nuclear Power Plants, IAEA Safety Standard Series No. NS-G-2.4, IAEA, Vienna (2002).

[49] INTERNATIONAL NUCLEAR SAFETY ADVISORY GROUP, Ensuring Robust National Nuclear Safety Systems – Institutional Strength in Depth, INSAG-27, Vienna (working document).

ABBREVIATIONS

BIS	Bid Invitation Specification
BOO	Build-Own-Operate
BOOT	Build-Own-Operate-Transfer
EPC	Engineering, Procurement and Construction (Contract)
EPCM	Engineering, Procurement and Construction Management
EPR	Emergency Preparedness and Response
FID	Final Investment Decision
IAEA	International Atomic Energy Organization
NEPIO	Nuclear Energy Programme Implementing Organization
NGO	Non-Governmental Organization
NPP	Nuclear Power Plant
PPA	Power Purchase Agreement
SAT	Systematic Approach to Training
TSO	Technical Support Organization
WANO	World Association of Nuclear Operators

CONTRIBUTORS TO DRAFTING AND REVIEW

Artisyuk, V.	Rosatom CI&CET, Russian Federation
Bastos, J.	International Atomic Energy Agency
Cho, J.R.	KHNP, Republic of Korea
Drury, D.	International Atomic Energy Agency
Dunlop, S.	International Atomic Energy Agency
Kovachev, M.	International Atomic Energy Agency
Gest, P.	Consultant, France
Kobetz, T.	International Atomic Energy Agency
Jeannin, B.	International Atomic Energy Agency
Lepouzé, B.	International Atomic Energy Agency
Letalon, J-J.	Électricité de France, France
Lindell, P.	Consultant, Sweden
Lindler, J.	EXCEL Services, United States of America
Martynenko, Y.	International Atomic Energy Agency
Molloy, B.	International Atomic Energy Agency
Mortin, S.	SM Consult ltd., United Kingdom
Pyy, P.	International Atomic Energy Agency
Reilly, F.	PwC LLC, United Kingdom
Shahkarami, A.	Exelon Generation, United States of America
Saraev, O.	Rosenergoatom, Russian Federation
Smirnov, I.	Akkuyu Project Company, Turkey
Stott, A.	International Atomic Energy Agency
Sun, S.	Huaneng Shandong Shidao Bay Nuclear Power, People's Republic of China
Tersigni, D.	Électricité de France, France
Toba, A.	JAIF International Cooperation Center, Japan
Troshchenko, Y.	International Atomic Energy Agency
Van Sickle, M.	International Atomic Energy Agency

Consultancy Meetings

Vienna, Austria:
16-18 June 2014, 17-19 September 2014, 13-15 April 2015, 8-10 September 2015, 4-6 April 2016

Technical Meetings

Atlanta, Georgia, USA, December 2016
Vienna, Austria, July 2018