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Initiating Nuclear Power Programmes: Responsibilities and Capabilities of Owners and Operators

IAEA
International Atomic Energy Agency

INITIATING NUCLEAR POWER PROGRAMMES: RESPONSIBILITIES AND CAPABILITIES OF OWNERS AND OPERATORS

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FOREWORD

There is an increasing interest in developing nuclear power due to growing energy needs, limitations on natural resources and concern for the environment. However, the introduction and development of nuclear power is a major undertaking. This requires building the necessary national infrastructure to construct and operate nuclear power plants in a safe, secure and technically sound manner. Many IAEA Member States that do not yet have nuclear power programmes have expressed their interest to the IAEA about the possibility of introducing nuclear power plants to help meet their energy needs.

To assist these Member States, the IAEA is preparing a series of guides and reports. An overall description of the issues was presented by the IAEA in a brochure entitled Considerations to Launch a Nuclear Power Programme (GOV/INF/2007/2), which was targeted mainly at policy makers. A subsequent IAEA Nuclear Energy Series publication, Milestones in the Development of a National Infrastructure for Nuclear Power (NG-G-3.1), describes 19 infrastructure issues that should be addressed through the three phases of development outlined in the brochure, Considerations to Launch a Nuclear Power Programme. The IAEA is preparing a number of guides addressing these issues.

Once a firm decision has been made by a government to proceed with the development of a nuclear programme, a number of organizations must be developed. A key organization for the successful construction and operation of the first nuclear power plant is the owner/operator, who provides ownership and management of the project. The owner/operator must clearly understand what must be done and how it has to act, who are partners and supporters and the corresponding interactions that have to be established. The owner or operator may be state owned or a private company. It may be an existing utility, or a specially established project organization. Its responsibilities include bidding, construction, licensing, commissioning, operation, maintenance, life management and final decommissioning. It will have the ultimate responsibility to meet the safety, security and safeguards requirements at national and international levels.

This report provides practical guidance on the main activities, responsibilities and desirable attributes of the designated owner/operator in a country initiating a nuclear power programme. It also describes the interfaces that the owner/operator will need with other organizations involved in the nuclear power programme. This publication can be used by Member States to build their owner/operator organization for the first nuclear power plant. It may also be of interest to others who are initiating the restart of a dormant nuclear power programme.

The IAEA officer responsible for this publication was X. Li of the Division of Nuclear Power.

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1. INTRODUCTION

1.1. BACKGROUND

The introduction of nuclear energy into a country is accompanied by the need to build the institutional, human and physical conditions to construct and operate a nuclear power plant in order to comply with the obligations for the peaceful uses of nuclear energy with regard to safety, security and safeguards. A number of organizations will be involved, each with particular responsibilities and capabilities.

The IAEA has issued a number of publications to advise countries introducing nuclear power, including recent publications such as Considerations to Launch a Nuclear Power Programme [1], the IAEA Nuclear Energy Series Guide, Milestones in the Development of a National Infrastructure for Nuclear Power [2], Evaluation of the Status of National Nuclear Infrastructure Development [3], the International Safety Group (INSAG) report Infrastructure for Nuclear Safety [4] and technical documents on Basic Infrastructure for a Nuclear Power Project [5] and on Managing the First Nuclear Power Plant Project [6]. The programme and activities of the IAEA in this regard are directed towards building the capabilities of organizations that will be responsible for implementation of nuclear programmes in Member States. In particular, Ref. [2] describes the phases of a nuclear programme and a set of infrastructure issues to be addressed.

In Ref. [2], the distinction is made between a nuclear power programme and a nuclear power plant project. A nuclear power plant project refers to the construction, commissioning and operation of a nuclear power plant. But before a nuclear power plant project can proceed in a country that does not have nuclear power, a nuclear power programme must establish the infrastructure that will support the nuclear power plant project during its planning, licensing, construction, commissioning, operation, fuel and waste management, and decommissioning.

Reference [2] describes three distinct phases in the development of the infrastructure for a nuclear power programme, each punctuated by a milestone, as illustrated in Fig. 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 construction of a nuclear power plant after a policy decision has been taken;
— Phase 3: Activities to implement a 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 programme;
— Milestone 2: (at the end of Phase 2). Ready to invite bids for the first nuclear power plant;
— Milestone 3: (at the end of Phase 3). Ready to commission and operate the first nuclear power plant.

1.2. OBJECTIVE

This publication provides practical guidance on the main activities, responsibilities and desirable attributes of the designated owner/operator of the first nuclear power plant in a country, the experiences from Member States in building an owner/operator organization and the interfaces of the owner/operator with the main stakeholders in the nuclear power plant project.

1.3. SCOPE

This report describes the main activities and responsibilities of the owner/operator, during Phases 2 and 3 and the desirable attributes that the owner/operator should develop in order to be a successful operator of the first nuclear power plant in the long term. It also provides some experience from Member States in building

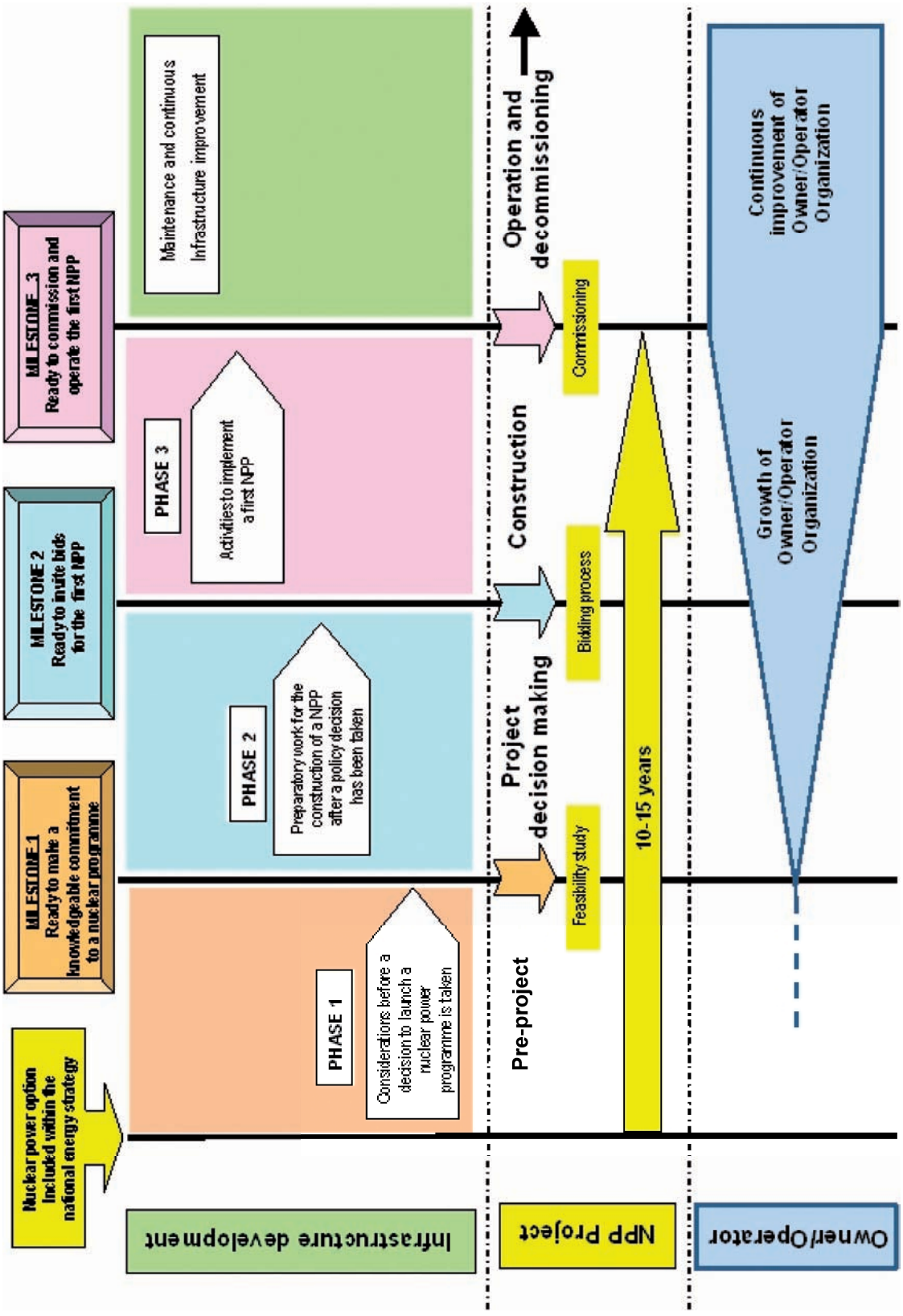

FIG. 1. Three distinct phases in the development of the infrastructure for a nuclear power programme.
(Note: This figure shows the growth of the owner/operator organization alone and does not include the growth of other organizations involved in the nuclear power plant project, such as the large number of people recruited for construction activities during Phase 3.)

owner/operator organizations and identifies the interfaces of the owner/operator with the main stakeholders. It does not provide guidance beyond Milestone 3 for commissioning and operation.

This publication assumes that a nuclear energy programme implementing organization (NEPIO) has been set up and that the first nuclear power plant in the country will be based on a design from an experienced vendor organization.

1.4. USERS

This report is intended to be used by decision makers, managers and advisers in the owner/operator and other organizations involved in the implementation of a nuclear power project for the first time in a country. It may also be useful to countries restarting a dormant nuclear power programme.

1.5. STRUCTURE

This publication consists of five sections including this introduction. Section 2 summarizes the main activities and responsibilities of the owner/operator in the three phases in the implementation of the nuclear power programme. Section 3 outlines the desirable attributes of the owner/operator organization. Section 4 describes some experience from Member States in building the owner/operator organization. Section 5 lists the other organizations interfacing with the owner/operator and describes the interfaces that the owner/operator will need to establish with the main stakeholders. An appendix provides some examples of the contract structures that may be used in the construction of the nuclear power plant.

2. MAIN ACTIVITIES AND RESPONSIBILITIES OF THE OWNER/OPERATOR

The nuclear power plant owner/operator should become a legal entity that can be licensed in accordance with the national legislation and nuclear regulations to operate a nuclear power plant. The licensed organization carries the ultimate responsibility for nuclear safety during the life of the plant and the responsibilities cannot be delegated (Principle 1 of the Fundamental Safety Principles [7]).

This section explains the key terms of the NEPIO and owner/operator. It also describes the main activities during the three Phases and identifies the specific responsibilities of the owner/operator against each of the 19 issues identified in Ref. [2] during the three phases.

2.1. KEY TERMS

NEPIO

Reference [2] assumes that an organization will be formed by the government to study and initially promote the development of the nuclear power programme and lead the way to achieving Milestones 1 and 2. In this guide, this organization is called the NEPIO.[1] The name of the organization is not important, but its functions, leadership and coordination are vital to the ultimate success of a nuclear power programme. If the decision is made to proceed with a nuclear power programme, specific areas of responsibility are likely to

[1] In Ref. [5], such an organization is called the nuclear power implementation agency (NPIA).

migrate from the NEPIO to other organizations, such as the regulatory body and the owner/operator organization. The NEPIO may continue to play a role in the coordination of various organizations involved in the implementation of the programme through Phases 2 and 3. Further guidance on the role of the NEPIO is provided in Ref. [8].

Owner/operator

After a policy decision has been taken to launch a nuclear power programme and commence the preparatory work for the construction of the first nuclear power plant, an appropriate organization must be charged with the responsibility to implement the first nuclear power plant project. This organization will also have the ultimate responsibility for the safety of the nuclear power plant. Its responsibilities will include bidding, construction, licensing, commissioning, operation, maintenance, life management and final decommissioning. This organization may be state-owned, or a private company. It may be an existing utility, or a specially established project organization. In Ref. [2], this organization is called the 'owner/operator', which is used in this report for reasons of consistency.

It is recognized that in some countries, the owner/operator may not be a single organization. The organization that is the legal owner of the nuclear power plant may not be the same organization as the operator. The division of responsibilities between the owner and the operator will depend on the particular arrangements in the country and may be dictated by the government. However, it is made clear in the IAEA's publications, such as the IAEA Safety Glossary [9], that the 'operating organization' or 'operator' is ultimately responsible for the safety of the nuclear power plant. The owner of the nuclear power plant would be the organization recognized by law as having the ultimate right to use the nuclear power plant and receive the profits from its operation. It may be responsible for financing, but most other activities would be delegated to the operating organization.

In the remainder of this report, it is assumed that the owner and operator is a single organization, the 'owner/operator'.

2.2. PHASE 1: PRE-PROJECT

The main activities during this phase are concerned with gaining a good understanding of the national and international obligations and commitments associated with a nuclear power programme, and to prepare for a knowledgeable government decision at Milestone 1. These activities will typically be under the management of the NEPIO.

If the organization that is to be designated as the owner/operator already exists, it is likely to be represented in the NEPIO during Phase 1. However, the main activities of the owner/operator are likely to start after Milestone 1 is reached, and a formal decision is made to proceed with developing the first nuclear power plant project.

In this phase, the owner/operator has no direct responsibilities in the activities performed and managed by the NEPIO.

2.3. PHASE 2: PROJECT DECISION MAKING

After the policy decision has been taken to proceed with the development of a nuclear power programme, work must be started to establish or develop an owner/operator organization and an independent regulatory body. By the time of reaching Milestone 2, many issues will have become the responsibility of the owner/operator.

During Phase 2, the designated owner/operator will develop the capability to manage a nuclear power plant project, to achieve the level of organization and safety culture necessary to meet the regulatory requirements, and to demonstrate that it is an adequately informed and effective customer. It must also build relationships with key stakeholders.

At the end of Phase 2, the owner/operator will have developed into an organization capable of providing relevant technical inputs for the choice of the appropriate nuclear technology for the country, and selecting the contractual approach for the construction of the first nuclear power plant. By Milestone 2, the owner/operator will have prepared a bid invitation specification (BIS). (Guidance on preparing the BIS is provided in Refs [6, 10].) The owner/operator will also have developed the capability to assess bids, review vendor qualifications and place contracts. To achieve this, a significant recruitment, development and training of staff at all levels will be required.

Table 1 summarizes the typical owner/operator responsibilities in Phase 2, taking into account its activities described above.

TABLE 1. TYPICAL OWNER/OPERATOR RESPONSIBILITIES IN PHASE 2

Issue	Owner/operator responsibilities
National position	— Create the owner/operator organization following the government decision.
Nuclear safety	— Establish an appropriate internal system to identify its safety responsibilities based on the legislation in force. — Initiate the necessary actions to establish and continuously improve safety culture across its organization. — Ensure that an understanding of nuclear safety requirements is developed in the whole supply chain. — Together with the regulatory body, adhere to international legal instruments such as: • The Convention on Nuclear Safety [11]; • The Convention on Early Notification of a Nuclear Accident [12]; • The Convention on Physical Protection of Nuclear Materials and its Amendment [13]; • The Vienna Convention on Civil Liability for Nuclear Damage [14, 15]; • The Convention on Assistance in Case of a Nuclear Accident and Radiological Emergency [16].
Management	— Establish a management system including the organizational chart of the owner/operator, which is adequate to the main tasks of this phase, which are to prepare the BIS and to build a safety culture. — Ensure that the factors important for the development of a strong safety culture are considered throughout this phase. — Define the areas of competence to be established in its organization. — Implement a programme of staff recruitment and training. — Select the preferred nuclear power plant sites for the BIS. — Determine the preferred nuclear technology (reactor and fuel type). — Determine the fuel cycle and fuel procurement strategy. — Determine the strategy for spent fuel and radioactive waste. — Establish the preferred contractual approach (turnkey, split package, etc.). — Develop the financial strategy and financial plan. — Prepare the BIS, including the bid evaluation criteria [10]. — Establish efficient and effective working relationships with the regulatory bodies and similar relationships with international and professional organizations. — Start to build a project management organization to manage the construction of the first nuclear power plant.
Funding and financing	— Develop the financing strategy and financial plan. (For further information, see Refs. [17, 18].) — Arrange the financing for the project in consultation with the government authorities and foreign and local sources of finance.
Legislative framework	— Establish the necessary interfaces with the government, regulatory bodies and national agencies. — Understand the licensing process and the associated safety documentation.

TABLE 1. TYPICAL OWNER/OPERATOR RESPONSIBILITIES IN PHASE 2 (cont.)

Issue	Owner/operator responsibilities
Safeguards	— Consider a safeguards by design approach [19]. — Start to establish procedures and train its staff to meet safeguards requirements, and demonstrate to the government authorities that it has done so. — Submit the necessary preliminary design information related to safeguards to the IAEA through the national regulator, according to the provisions set forth in the safeguards agreements [20, 21]. — Consult with operators of the same type of facilities on technical features for implementing safeguards (e.g. installation of containment and surveillance devices, cabling, penetration of containment, etc.). In safeguards terminology, the national regulator is the State Authority for State systems of accounting for and control of nuclear material (SSAC). Guidance on physical protection and safeguards is provided in [22–24].
Regulatory framework	— Set up an effective working relationship with the regulators with open communication. — Ensure that other organizations that may be supplying goods or services to the nuclear power plant understand the national safety requirements. — Understand the safety regulations relevant to the bid process and be able to translate them into the bid specification.
Radiation protection	— Start to prepare a programme for radiation monitoring and radiation protection of the workforce, public and the environment. — Perform the characterization of background sources of radiation at planned nuclear power plant sites in accordance with the regulations.
Electrical grid	— Provide information on the proposed nuclear power plant to the grid operator so that it can determine the necessary grid enhancements and design them. — Ensure that the proposed grid design provides a sufficiently reliable grid connection and an adequate external electrical supply to the nuclear power plant for reactor trip and shutdown conditions. — Ensure that the possible schedule for grid enhancements is compatible with the likely schedule for construction of the nuclear power plant. — Include grid characteristics and requirements in the BIS.
Human resource development	— Recruit and train the staff needed for Phase 2 responsibilities [25]. — Develop plans to recruit and train staff for Phase 3. — Request the government to develop any needed enhancements to the country's educational and research institutions, and provide financial support if needed.
Stakeholder involvement	— Prepare and implement the strategy for dealing with the public. — Recruit experts in the areas of public communication and education, and train its own staff in these areas. — Explain the basic technology being employed and the plans for the construction schedule. — Openly discuss potential problems and difficulties as well as the plans to resolve them. — Communicate transparently and professionally with other organizations participating in the nuclear power programme. — Demonstrate that it is a competent and credible organization that deserves the confidence of the public. — Agree with local authorities near the nuclear power plant site on the financial and technical support for social infrastructure development. — Open a public information centre near the nuclear power plant site and other places.

TABLE 1. TYPICAL OWNER/OPERATOR RESPONSIBILITIES IN PHASE 2 (cont.)

Issue	Owner/operator responsibilities
Site and supporting facilities	— Carry out the detailed site investigations of possible sites for the nuclear power plant and recommend the preferred site or sites. — Secure the availability of the chosen site or sites. — Identify local legal, political and public acceptance issues for the chosen site and plan on resolving them. — Include the characteristics of the site in the BIS. — Identify and plan any necessary improvements or upgrades to site characteristics and local infrastructure, such as improved road access and mains water supply. The candidate sites to be investigated may have been nominated or recommended by the government following an initial investigation in Phase 1. Guidance on some aspects of the site study is provided in Refs [6, 26].
Environmental protection	— Ensure that the necessary environmental impact assessment studies for the candidate sites are carried out. — Submit the environmental impact assessment and the application for environmental clearance to the environmental regulator. — Include any special environmental features of the site in the BIS.
Emergency planning	— Identify the local and national organizations that will take part in emergency planning. — Start to prepare the emergency plans and procedures. (Further information is provided in Refs [27, 28]).
Security and physical protection	— Establish an interface with the responsible national agency (security regulator). — Provide the inputs and expertise necessary to allow the security regulators and the concerned government authorities to define the design basis threats (DBTs). — Include security requirements in the BIS. — Define the physical protection features of the nuclear power plant site. — Introduce arrangements for security classification of the nuclear power plant data. — Develop a programme for the selection and training of security staff.
Nuclear fuel cycle	— Provide technical information to the government for nuclear fuel strategy. — Reach agreement with the government for nuclear fuel strategy including fuel procurement and management of spent nuclear fuel particularly with regard to the national non-proliferation commitment [20, 21, 29]. (The strategy for spent nuclear fuel includes whether or not to reprocess the fuel and the arrangements for storage and disposal of spent fuel and/or high level waste.) — Introduce specifications related to nuclear fuel in the BIS to define what should be procured separately. — Submit through the national regulator to the IAEA the necessary safeguards-related information according to provisions set forth in the safeguards agreements [20, 21].
Radioactive waste	— Participate in the establishment of a radioactive waste management organization if no national agency exists. — Establish an interface with the radioactive waste management organization. — Provide technical information to the waste management organization to allow the policy for waste disposal to be established. — Ensure that relevant procedures are created for implementing safeguards, should the waste contain nuclear material. — Include specifications for minimization, handling, treatment, conditioning and storage of radioactive waste in the BIS.
Industrial involvement	— Carry out a realistic assessment of potential local suppliers of goods and services. — Analyse the ability of local suppliers to meet the schedule and quality requirements and provide input to the government. — Reach an agreement with government for participation by local suppliers. — Define local supplier participation in the BIS including technology transfer requirements.
Procurement	— Start to develop procurement management procedures and a quality assurance programme, including the establishment of approved vendor lists [30, 31]. — Start to establish the procurement team/department. — Include specific requirements for goods and services procurement,in the BIS in accordance with local legislation.

2.4. PHASE 3: CONSTRUCTION

During this phase, the owner/operator will need to carry out all the activities necessary to manage and supervise the construction of the first nuclear power plant and prepare its commissioning. The owner/operator will need to grow to be an organization able to operate and maintain the nuclear power plant. The main activities of the owner/operator during this phase will typically include:

— Inviting and evaluating bids.
— Liaising with the regulatory bodies
— Placing contracts for the supply and construction of the nuclear power plant.
— Preparing all required documentation to obtain the necessary licences in accordance with the national regulations.
— Managing and supervising the construction of the first nuclear power plant in accordance with design bases, regulatory requirements and contractual provision.
— Recruiting and training operating personnel, and arranging for them to be licensed where required.
— Developing its organization and management system to be suitable for an operating nuclear power plant.

During the construction of the nuclear power plant in Phase 3, the number of personnel involved in the nuclear power plant project will reach a maximum due to the large number of personnel taking part in construction activities. Normally, most construction workers are employed by the subcontractors of the vendor or main contractor and are not employees of the owner/operator organization. Hence, the number of employees in the owner/operator organization will not necessarily be at a maximum during Phase 3. The growth of the owner/operator is shown schematically in Fig. 1.

Guidance on the responsibilities of the owner/operator of the first nuclear power plant in a country, related to the construction of a nuclear power plant in Phase 3, is provided in Refs. [6, 32].

Table 2 summarizes the typical owner/operator responsibilities in Phase 3 taking into account its activities described above.

TABLE 2. TYPICAL OWNER/OPERATOR RESPONSIBILITIES IN PHASE 3

Issue	Owner/operator responsibilities
National position	No direct responsibilities.
Nuclear safety	— Ensure the continuation of management commitment to foster the development of a strong safety culture. — Build and maintain technical knowledge and skills for the safe operation and maintenance of the nuclear power plant. — Ensure that the other involved organizations (construction, engineering and any others that are external to the owner/operator) understand and apply the national safety requirements and develop a strong safety culture. — Ensure participation in the activities related to the international legal instruments.
Management	— Issue the BIS to the bidders including an identified site or sites. — Evaluate the bids and choose the preferred bidder or bidders. — Negotiate the contracts with a scope of supply consistent with the procurement strategy. — Sign the contracts for the first nuclear power plant. — Prepare technical documentation for the licensing application, with contributions from the vendor or main contractor. This should include a preliminary decommissioning plan. — Submit the applications to the regulatory body for a site permit and a construction licence. — Make suitable contractual arrangements with fuel and fuel service suppliers. — Establish a team or department for public communication and information. — Implement a management system and perform audits in order to ensure that all participants in the first nuclear power plant project, including subcontractors, meet the specific requirements (nuclear standards and codes, technical specification, etc.). — Train the operating personnel and arrange for them to be licensed if necessary.

TABLE 2. TYPICAL OWNER/OPERATOR RESPONSIBILITIES IN PHASE 3 (cont.)

Issue	Owner/operator responsibilities
Funding and financing	— Determine the nuclear power plant project budget based on the agreed contract and owner/operator participation. — Determine the required cash flow according to the nuclear power plant project schedule and contractual provisions (payment milestones). — Implement the financial plan, based on the agreed contracts (loans, state funding, other financial mechanisms). — Follow the mechanism for provision of the funding for the long term management of spent fuel and radioactive waste and for decommissioning.
Legislative framework	— Maintain the established interfaces with the government and different regulatory bodies, international (e.g. the IAEA) and national agencies in order to understand the legislation and comply with it.
Safeguards	— Train its staff to meet safeguards requirements and to demonstrate that it has done so to the government authorities. — Implement all safeguards measures and have the nuclear power plant safeguards system approved by the national regulatory body before receipt of the first nuclear fuel on the nuclear power plant site. — Provide to the national regulatory body or government the information on nuclear material subject to safeguard instruments to be supplied to the IAEA in accordance with international conventions.
Regulatory framework	— Maintain an effective working relationship and open communication with regulators. — Agree with regulators on the programme/schedule for licensing meetings, taking into account the important milestones of the first nuclear power plant construction schedule. — 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.
Radiation protection	— Implement all necessary radiation and environmental monitoring and protection programmes before the first nuclear fuel load is transferred to the nuclear power plant site. — Ensure all necessary services to implement the radiation protection programme using external subcontractors (for calibration services, laboratory analysis, etc.) where appropriate. — Develop the team/department and capabilities for safe implementation of radioactive waste management activities, before the first criticality.
Electrical grid	— Agree with the grid operator on the schedule for grid upgrade projects to meet the nuclear power plant construction schedule. — Liaise with the grid operator during construction of grid upgrades and verify when they are complete. — Establish with the grid operator all necessary agreements for future operation (e.g. electrical supply during construction, licence for connection to the grid of the first nuclear power plant, etc.). — Establish and agree on procedures for the coordination of grid operations with nuclear power plant operations.
Human resource development	— Develop a strategy for human resources for nuclear power plant operation, taking into account resources provided under the contract with the vendor and the availability of other service providers. — Recruit and train staff needed for nuclear power plant operation, maintenance and technical support, taking into account the training provided under the contract with the vendor. — Ensure that an adequate number of trained and certified staff/operators are available by the first fuel load. — Develop plans for the continuing recruitment, and training of staff, and personnel development for the lifetime operation of the nuclear power plant.

TABLE 2. TYPICAL OWNER/OPERATOR RESPONSIBILITIES IN PHASE 3 (cont.)

Issue	Owner/operator responsibilities
Stakeholder involvement	— Explain the technology being deployed in the nuclear power plant and the plans for construction activities. — Routinely communicate progress during the construction phase and make preparations for operation. — Openly discuss problems and difficulties encountered, and how to resolve them. — Continually demonstrate that the owner/operator is a competent, transparent and credible organization that deserves the confidence of the public.
Site and supporting facilities	— Ensure that all site services (cooling water, electrical supply, offices, transport, lodging, communications, roads, heating, etc.) are available and functioning when needed for construction or commissioning. — Ensure that site security arrangements, environmental monitoring and emergency planning arrangements are functioning correctly before the first fuel load arrives on site at the nuclear power plant.
Environmental protection	— Complete the characterization of the site and its surroundings. — Establish systems for monitoring and assessing all environmental releases from the nuclear power plant in accordance with national laws and international standards, and implement all features before the first fuel load. — Agree with the environmental regulator on the arrangements for independent measurements of environmental releases from nuclear power plant, if necessary. — Agree with the environmental regulator on how information on releases from the nuclear power plant will be reported or published.
Emergency planning	— Finalize the emergency plan and put it into effect. (Further information is provided in Refs. [27, 28]). — Establish protocols and procedures for the interfaces with organizations involved in the emergency plan (police ambulances, transportation, local and national government organizations, etc.). — Arrange for systematic training of staff in the emergency service organizations so that they understand the special issues that can affect nuclear sites. — Perform emergency exercises at intervals jointly agreed by all the parties involved to ensure that the arrangements are fully effective before the first fuel load arrives at the nuclear power plant site.
Security and physical protection	— Set up selection and qualification programme of the security staff. — Ensure that security and physical protection systems and procedures are in place before the first fuel load on the nuclear power plant site and obtain approval from competent authorities. — Ensure that sufficient trained security staff are available. — Interface with national and local government bodies for security measures.
Nuclear fuel cycle	— Place contract(s) for the first fuel load.[a] — Make contractual arrangements for future fuel reloads. — Ensure that adequate storage capacity is constructed at the nuclear power plant site for interim storage of spent fuel. — Ensure that the costs for long term storage and management of spent fuel are included in the operating costs and funded in accordance with the legislation. — Submit through the national regulator to the IAEA the necessary safeguards-related information according to provisions set forth in the safeguards agreement [20, 21].
Radioactive waste	— Ensure that a fully operational facility for treatment, conditioning and storage of radioactive waste is available at the nuclear power plant site by the first criticality. — Ensure that the facility is able to produce a waste form that would be acceptable to the waste management organization. — Ensure that the costs for radioactive waste management and disposal are included in the operating costs and funded in accordance with the legislation. — Ensure that relevant procedures have been created for implementing safeguards should the waste contain nuclear material.

TABLE 2. TYPICAL OWNER/OPERATOR RESPONSIBILITIES IN PHASE 3 (cont.)

Issue	Owner/operator responsibilities
Industrial involvement	— Reassess potential local suppliers of goods and services during the contract negotiations based on the specific vendor technical requirements. — Specify in the contracts the final arrangements for local supply of goods and services for the construction period. — Establish local supplier qualification requirements. — Place the contracts for the procurement of the local supply in accordance with the nuclear power plant schedule, if necessary. — Supervise the fabrication of the goods by local suppliers in accordance with specific requirements, if necessary.
Procurement	— Establish a procurement programme that is consistent with national policy on industrial participation. — Develop the capabilities to carry out procurement of full facilities, equipment and components for the nuclear power plant. — Establish a suitable procurement organization that may be based at the nuclear power plant site or centrally in order to provide the spares, consumables and services for future operation and maintenance of the nuclear power plant [30, 31].

[a] This could be one contract for complete fuel assemblies or separate contracts for uranium, conversion, enrichment and manufacturing.

2.5. AFTER MILESTONE 3: COMMISSIONING AND OPERATION

Beyond Milestone 3, when the construction of the nuclear power plant is completed and the nuclear power plant is commissioned, the owner/operator will be responsible for the long term operation, maintenance, plant life management and decommissioning. The IAEA has published numerous requirements and guides on the commissioning and following phases of a nuclear power plant lifetime. These documents are based on the experience of Member States and the present state of nuclear technology. Documents relevant to the owner/operator include Refs [33–38].

3. DESIRABLE ATTRIBUTES FOR THE OWNER/OPERATOR

This section summarizes some desirable attributes of an owner/operator organization. These characteristics are particularly important when the nuclear power plant is in operation, but the owner/operator will need to start developing these attributes as early as possible. The desirable attributes are described in more detail in various IAEA publications.

3.1. HAVING A STRONG SAFETY, SECURITY, SAFEGUARDS CULTURE

Since the owner/operator has the ultimate responsibility for the safety and security of its nuclear power plant, it should develop a strong safety, security safeguards culture in its organization. INSAG defines safety culture as "that assembly of characteristics and attitudes in organizations and individuals, which establishes that, as an overriding priority, nuclear plant safety issues receive the attention warranted by their significance" [39]. Security culture is defined in a similar way [40]. Safety culture comprises the values, standards, morals and norms of acceptable behaviour. These are aimed at maintaining a self-disciplined approach to the enhancement of safety beyond legislative and regulatory requirements. Therefore, a safety culture has to be inherent in the

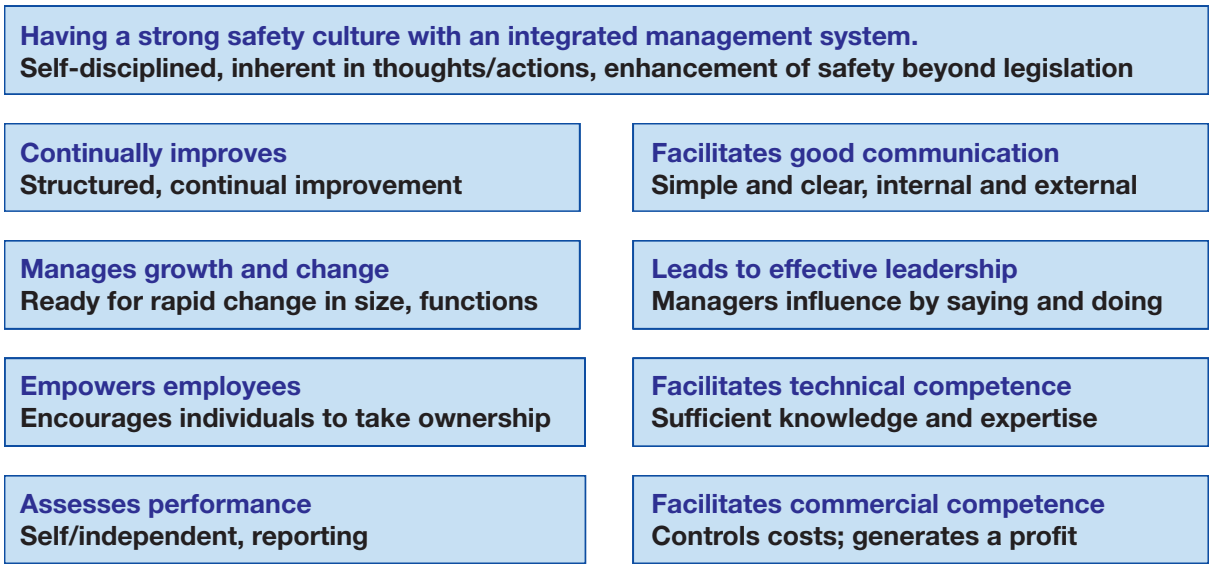

FIG. 2. Summary of the desirable attributes for the owner/operator.

thoughts and actions of all the individuals at every level in an organization. The same approach should be followed for security and safeguards. The leadership provided by top management is crucial to the development of the culture. For further guidance, see Refs [19, 33, 39–42].

The IAEA safety standards and guides recommend that an organization with responsibility for nuclear safety should establish and maintain an integrated management system that should foster a strong safety culture. It must also ensure that any legal requirements and formally agreed stakeholder requirements are met, in addition to customer and product requirements. It should combine the management system areas such as safety, health, environmental, security, quality, economic and commercial elements and social responsibility, by establishing a process-based management system (Fig. 2). For further guidance on management systems, see Refs. [43–45].

3.2. STRIVING FOR CONTINUAL PROCESS IMPROVEMENT

The goal of the owner/operator is to operate the nuclear power plant effectively and to meet safety, security and safeguards requirements. A system for continuous improvement of all the processes used by the organization will contribute greatly to the goal. The organization first has to document and define its processes and then use the information from managing those processes to identify and prioritize improvement initiatives. A structured methodology to identify and implement improvements can be used to reduce cost and enhance safety at the same time.

The following principles are essential to the effective introduction of structured continual improvement [46]:

— Long term commitment from senior management in the entire organization;
— The implementation in the organization of a process management approach, such as that advocated by IAEA safety standards [43–45];
— The alignment of the processes with the objectives of the organization through the organization's business plan;
— The use of the process information as an input to managing the organization;
— The employment of the information derived from the process performance to identify and prioritize the processes that require improvement;
— The active participation of all staff of the organization in using its processes to contribute to continual process improvement.

3.3. ABILITY TO MANAGE GROWTH AND CHANGE

The owner/operator will probably start as a core group of decision makers, managers and experts with expertise in different fields brought together to start the first nuclear power plant project. As the project progresses through the milestones, the owner/operator organization necessarily has to grow larger in size and complexity, changing the group dynamics. This growth during Phases 2 and 3 is illustrated in Figure 1. The owner/operator organization should plan for this rapid change in its size as well as in its functions, responsibilities, organization and management techniques. The growth and change must be achieved in a way that promotes the development of a strong safety, security and safeguards culture in the organization.

3.4. EMPOWERING EMPLOYEES THROUGHOUT THE ORGANIZATION

The management system in the organization should provide the means to empower the individuals in the organization to perform their assigned tasks [44]. The act of empowering individuals and making them accountable for their work should encourage them to take ownership of their work and to seek to improve their performance.

Employees within the organization may be able to foresee emerging problems and solve them at an early stage. If employees are not empowered to do so, then emerging issues may be ignored until they become unmanageable. Empowered individuals and teams reverse this trend, and can recognize and deal with emerging issues before they become problems. Managers and supervisors should encourage and welcome the reporting by individuals throughout the organization of potential safety, security or safeguards concerns, incidents, near misses and accident precursors. They should also respond to valid concerns promptly and in a positive manner.

The key to successful project leadership is to empower all team members. Once the feeling of empowerment spreads throughout the organization, every employee will begin to take action to eliminate problem areas at a very early stage. Successful leaders are able to motivate and empower others in this way. When all the employees feel empowered, they take much more initiative and show more persistence.

3.5. SELF AND INDEPENDENT ASSESSMENT OF PERFORMANCE

Self-assessment is essentially a critical comparison of activities and results against a predetermined set of performance expectations such as goals, targets and objectives. Self-assessment has been identified as an important mechanism that organizations can use to improve their performance. Its purpose is to promote improved performance through the direct involvement of personnel in the critical examination and improvement of their own work activities and work results. It is designed to ensure that line management continually monitors performance and takes timely corrective actions to improve it. At lower levels of the organization, potential weaknesses can be detected and often resolved well before they develop into major problems. Self-assessments are also designed to identify and overcome process weaknesses and obstacles to the achievement of performance objectives. As a result, the allocation of resources can be prioritized.

Successful self-assessment requires open and active reporting within the organization of events and near misses. An organization will not be able to learn from its mistakes if they are not reported.

Self-assessment can be reinforced by independent assessment, which can be carried out by independent audit teams within the organization or by bodies that are external to the organization. Such independent external assessment can be carried out by teams from the IAEA, e.g. the Integrated Nuclear Infrastructure Review Mission (INIR), the Operational Safety Assessment Review Team (OSART), the International SSAC Advisory Service (ISSAS), the International Physical Protection Advisory Service (IPPAS) and the Safety Culture Assessment Review Team (SCART) for operating organizations. The World Association of Nuclear Operators (WANO) also arranges peer review visits to member organizations to carry out independent assessments. A successful owner/operator welcomes and makes use of such external assessments. The owner/operator can also arrange for groups of its staff to visit owner/operators in other countries in order to exchange experience. Some guidance on self- and independent assessment is provided in References [44, 47–49].

3.6. HAVING GOOD COMMUNICATIONS – INTERNAL AND EXTERNAL

The owner/operator organization should establish simple and clear lines of communication and reporting within the company. Communications should be clear and concise, and the communication process should cover both the provision and the receipt of correct information. In all communications, the sender has the responsibility to ensure that the information is fully and correctly understood.

The owner/operator organization will also need to establish clear communications with the wide range of stakeholders connected with the implementation of the programme. Good communication will ensure that all the persons and organizations correctly understand the sent message. They will more likely respond favourably to the message if it seems reasonable and fair to both the receiver and the sender. The mode of communication is as important as the contents of the message; the message should be easy to understand and take into account the receivers' attitudes and feelings.

The owner/operator must establish very effective communication with the regulatory bodies and must also ensure that the national safety regulations are communicated effectively throughout the supply chain.

The necessary interfaces and communications with external organizations are discussed further in Section 5.

3.7. EFFECTIVE LEADERSHIP

There is a strong link between the leadership of the organization, its management system and its safety culture and ethics. IAEA Safety Principles (Principle 3 in [50]) require that leadership in safety matters must be demonstrated at the highest levels. Strong leadership is also important for effective and economic operation of the nuclear power plant.

Top managers and leaders influence the culture and ethics of the organization by what they say, but even more importantly by what they do. Good leaders have a major influence on the safety culture in the organization. They do this by always adopting a conservative risk-based approach to decision making and demonstrating that they always place a high value on safety, security and safeguards. They communicate in an open and responsible manner with regulators, employees and all other stakeholders, and maintain a blame-free reporting culture that encourages full reporting of unsafe or unethical practices, incidents and near misses. They promote continual improvement of the organization. All these activities can also improve the effective and economic operation of the nuclear power plant.

3.8. TECHNICAL COMPETENCE

Since the owner/operator carries the ultimate responsibility for safe and secure operation of the nuclear power plant, it needs to have sufficient technical expertise within its organization to fully understand all the issues that affect the safe and effective operation of its plant. The owner/operator is likely to initially need significant technical support from the plant design or vendor organizations, but should recruit and train sufficient specialist staff to ensure that it has the necessary knowledge and capability within its own organization to be able to take full responsibility for operation and safety.

3.9. COMMERCIAL COMPETENCE

If the nuclear power plant project is to be successful, then it must be economic and the owner/operator must exercise the normal commercial disciplines of successful private companies in order to control costs and generate a profit. But it is important that the commercial discipline is not allowed to conflict with the overriding priority given to safety, security and safeguards; the use of an integrated management system as described above will help in this regard.

Procurement of goods and services is a key commercial activity throughout the life of the nuclear power plant. From the very beginning of the project, the owner/operator should set up strong procurement and quality

management organizations able to deal with the quality management systems of the various stakeholders. Guidance on this is provided in References [30, 31].. Consideration should also be given to developing integrated logistic support (ILS) [51].

There is no conflict between safety, security or safeguards and commercial success. A successful nuclear power plant will need to be a reliable one, which requires the plant to be well-managed and well-maintained; a well-managed and well-maintained plant will be a safe, secure and commercially successful one.

4. OWNER/OPERATOR ORGANIZATIONAL AND CONTRACT STRUCTURE

4.1. OWNER/OPERATOR ORGANIZATIONAL CHART

Figure 3 shows an example of the organizational chart of the owner/operator during Phases 2 and 3 in China, where the owner/operator was managing and supervising the construction of two units each of 1000 MW capacity.

4.2. CONTRACT STRUCTURES

The number of technical professionals that the owner/operator needs during Phases 2 and 3 will depend on the contract structure chosen for the construction of the nuclear power plant. The contract structure could be a 'super turnkey', where a single contract covers the entire plant construction, or a 'normal turnkey', where a single contract covers most plant construction, but the owner/operator manages the civil and infrastructure

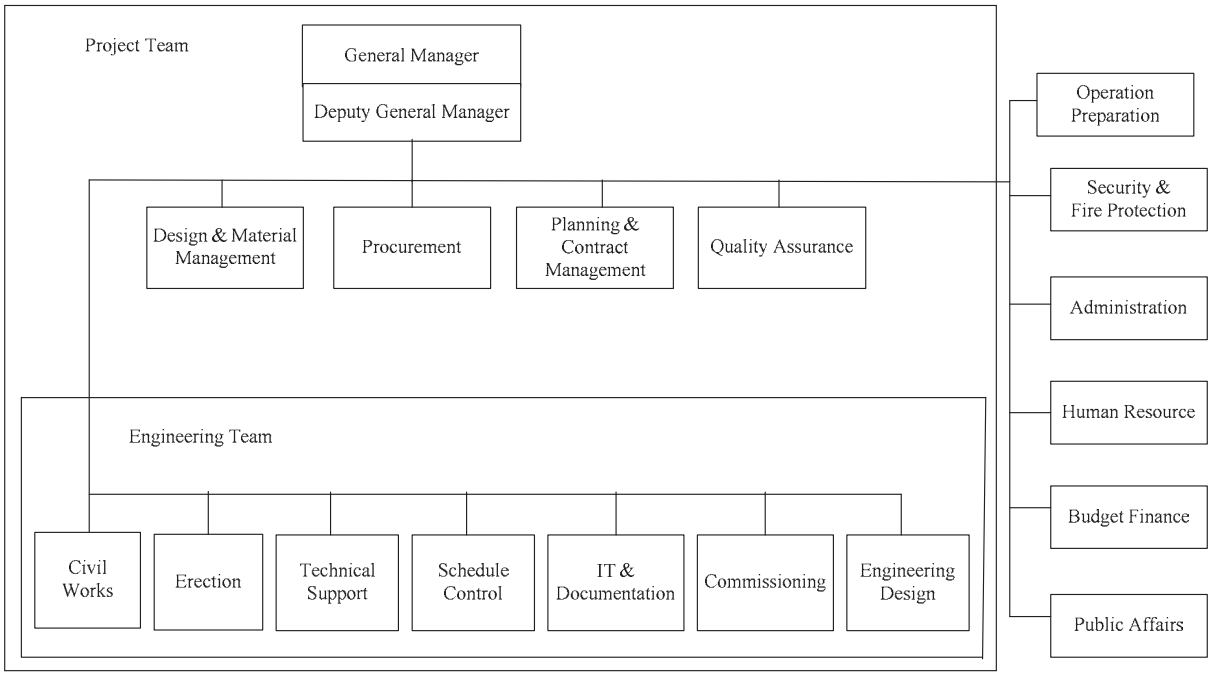

FIG. 3. Example of an organizational chart of the owner/operator.

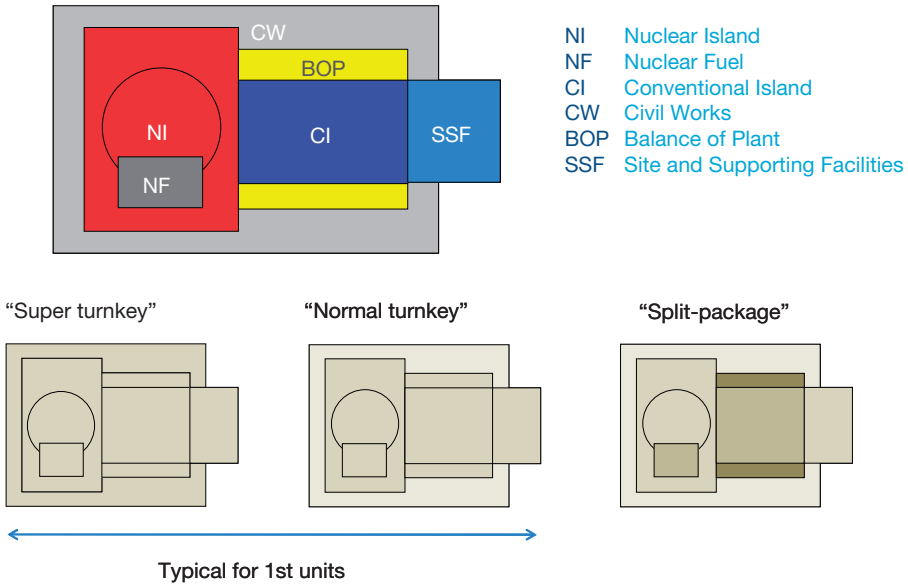

FIG. 4. Typical contract structures for nuclear power plant construction.

works. Alternatively, the contract could be a ‘split package’ or ‘multi-contract’ approach, where the owner/operator or his architect engineer places a number of contracts for separate packages of work [6, 32]. Some possible contract structures are illustrated in Figure 4. For the first unit, the super turnkey or normal turnkey is typically chosen because the owner/operator has to manage fewer project interfaces than in the multi-package approach. The owner/operator retains the overall responsibility for the success of the project no matter which contract structure is chosen.

The appendix shows examples of detailed contractual organizational charts for the above-mentioned three different contract structures.

4.3. HUMAN RESOURCES

The owner/operator organization will need to grow in size during Phases 2 and 3, and recruit technical professional in a range of disciplines

Table 3 gives an example of the number of technical professionals that were needed in an owner/operator in Romania, where the owner/operator was managing and supervising the construction of two units each of 700 MW capacity, using a normal turnkey contract for the first unit and being involved in the second unit with more responsibilities. The number of technical staff required for the first unit included the responsibility for knowledge transfer by on-the-job training in order to increase local participation to the second unit.

Table 4 provides an example of the number of technical professionals that were needed in an owner/operator in China, where the owner/operator was managing and supervising the construction of two units each of 1000 MW capacity using a split package contract structure.

TABLE 3. EXAMPLE OF THE NUMBER OF TECHNICAL STAFF IN OWNER/OPERATOR AT DIFFERENT STAGES FOR A NORMAL TURNKEY CONTRACT: TWO UNITS, 700 MW EACH

Division	During preparation (Phase 2)		During construction (Phase 3)		During commissioning (at Milestone 3)	
	Average	Maximum	Average	Maximum	Average	Maximum
Engineering	30	80	80	120	30	50
Planning and project control	10	20	10	20	10	20
Procurement	10	20	30	80	10	20
Material control and management	5	10	20	70	10	20
Construction Control and supervision	10	20	60	80	10	30
Commissioning	0	0	50	100	150	200
Finance and contracts control	10	20	20	30	10	20
Quality management	5	10	10	20	5	10
Industrial safety	1	2	2	5	1	2
Fire protection	1	2	5	10	1	2
Nuclear safety, licensing and compliance	5	10	10	20	10	20
Human resources	2	3	2	5	2	3
Training	2	5	5	10	15	20
Security and physical protection	1	5	10	30	30	40
Operators per unit	0	0	0	0	50	80
Total	92	207	314	600	344	537

(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.)

TABLE 4. EXAMPLE OF THE NUMBER OF TECHNICAL STAFF IN OWNER/OPERATOR AT DIFFERENT STAGES IN A SPLIT PACKAGE CONTRACT: TWO UNITS, 1000 MW EACH

Division	During preparation (Phase 2)		During construction (Phase 3)		During commissioning (at Milestone 3)	
	Average	Maximum	Average	Maximum	Average	Maximum
Engineering	40	90	60	100	30	60
Planning and project control	8	15	10	20	10	20
Procurement	20	30	30	80	30	50
Material management	1	5	5	10	5	10
Construction	10	30	45	60	40	50
Commissioning	0	0	30	50	150	300
Finance	10	15	10	15	10	15
Contracts control	10	15	15	25	10	20

TABLE 4. EXAMPLE OF THE NUMBER OF TECHNICAL STAFF IN OWNER/OPERATOR AT DIFFERENT STAGES IN A SPLIT PACKAGE CONTRACT: TWO UNITS, 1000 MW EACH (cont.)

Division	During preparation (Phase 2)		During construction (Phase 3)		During commissioning (at Milestone 3)	
	Average	Maximum	Average	Maximum	Average	Maximum
Quality management	2	5	8	12	10	15
Industrial safety	1	2	5	8	5	8
Licensing	2	5	3	5	3	5
Nuclear safety	1	1	2	2	3	5
Human resources	2	3	3	5	3	5
Training	1	2	3	5	5	10
Safety protection	1	3	3	5	3	5
Fire protection	1	2	3	5	3	5
Operators per unit	0	0	0	0	50	80
Total	110	223	235	407	367	663

(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.)

5. INTERFACES WITH STAKEHOLDERS

5.1. MAIN STAKEHOLDERS

A number of organizations will be involved in implementing the first nuclear power plant. Each organization may have its own responsibilities for a limited group of activities, but all of them should share a common goal — the safe, secure and cost effective performance of the nuclear power plant. The owner/operator has the lead role in coordinating between the main partners, which is of great importance to the success of the nuclear power plant;

The term ‘stakeholder’ in this section refers to a person, group of people, or an organization or institution with a direct interest, involvement or investment in the activities concerned [2]. They may also be called ‘interested parties’ or ‘concerned parties’ [8]. Internal stakeholders are those involved in the decision-making process or directly involved in the implementation of the nuclear power plant project. The main internal stakeholders may also be called partners in the project. External stakeholders are those without direct involvement in the implementation of the nuclear power plant project but with a direct interest in the outcomes and impact of the project.

The stakeholders can be local or regional organizations or national or international bodies. The relationship of the owner/operator with the stakeholder can also vary from unofficial and informal to official and formal, as shown in Figure 5.

In addition to the owner/operator, depending on the internal organization of each country, the internal stakeholders typically include:

The public authorities:

— The national government and legal authorities;
— The NEPIO;
— Energy/Electricity Ministries;

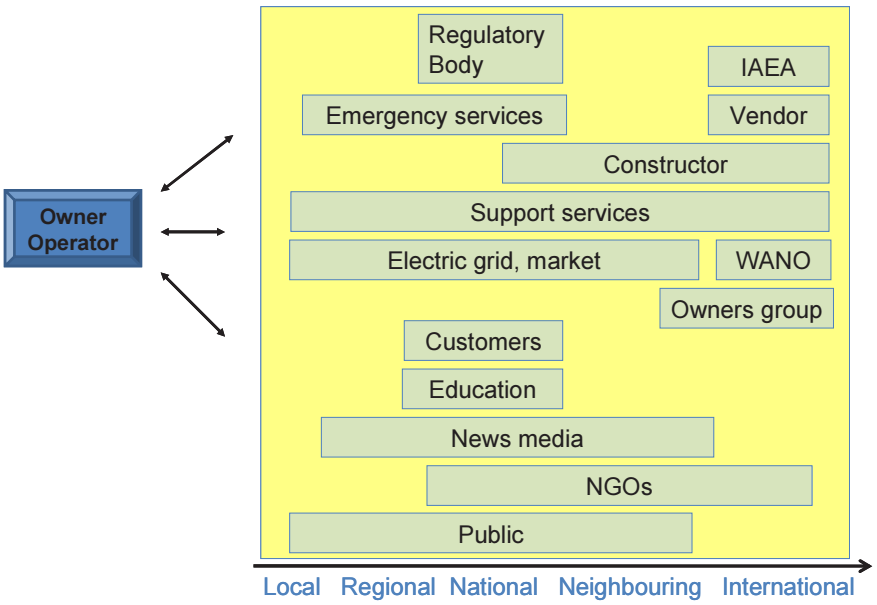

FIG. 5. The different kinds of stakeholders.

— Ministry of Industry
— Ministry of Finance;
— Customs authorities;
— Local authorities at the nuclear power plant sites.

Regulators:

— Nuclear safety regulator;
— Nuclear security regulator;
— The safeguards regulator (SSAC);
— The industrial health and safety regulator;
— The environmental regulator;
— The electricity market or tariff regulators;
— The financial regulator.

Organizations involved in the construction of the nuclear power plant:

— Nuclear power plant vendor;
— Architecture–engineer organizations;
— Design organizations;
— Main contractors;
— Subcontractors.

Organizations involved in emergency arrangements for the nuclear site:

— National government bodies;
— Local government authorities;
— The fire brigade;
— The police;
— Ambulance service and local hospitals;
— Other emergency services.

Organizations that provide services or support to the nuclear power plant:

— Nuclear fuel suppliers;
— Waste management organizations;
— Technical services support organizations;
— Consultants;
— Research and development organizations;
— Local suppliers of goods and services;
— Financial organizations;
— Various industry associations.

Organizations related to the operation of the national electricity system;

— Electrical grid operator;
— Electricity market organization.

The external stakeholders typically include:

— Neighbouring countries;
— The general public in the country;
— People living or working near the nuclear power plant site;
— Electricity customers;
— The owners or operators of other power plants in the country;
— Universities and other educational institutions;
— Standards organizations;
— Non-governmental organizations (NGOs);
— News media.

International organizations include:

— IAEA;
— World Association of Nuclear Operators;
— Owners' groups for different types of reactors.

The typical responsibilities of some of the main stakeholders and the interfaces that the owner/operator will have with them are summarized below.

5.2. MANAGING INTERFACES WITH STAKEHOLDERS

Interfaces between organizations occur when there is some kind of formal or informal interaction. These interfaces typically involve the use of some object – real or virtual – that is exchanged between the different stakeholders. These objects have been referred to in past management literature as 'boundary objects'. They can be physical objects, such as letters, documents and drawings or virtual objects, such as e-mail or an electronic file, or information exchanged at meetings

The objective of managing interfaces is to ensure that the object transferred between the organizations communicates the intended information correctly. Where appropriate, particularly where safety, security or safeguards could be affected, a formal 'interface agreement' or memorandum of understanding should be developed between organizations in order to define the working arrangements, responsibilities and accountabilities.

5.2.1. The national government and the NEPIO

— General

After establishing the owner/operator, the government usually interfaces with the owner/operator in enacting appropriate legislation and in developing the necessary infrastructure for the nuclear programme, including the legal, industrial and financial framework, and in developing the necessary human resources and the R&D facilities to provide manpower to this high technology endeavour. The owner/operator will have to interface directly with a number of different government departments and organizations or with the NEPIO.

— Establishing the legal framework

The government is primarily responsible for implementing the legal and governmental framework necessary for the introduction of nuclear power, to enact legislation, to establish and empower the necessary regulatory organizations and to establish their responsibilities under the national laws.

— Establishing a regulatory body

The government is responsible for setting up an independent regulatory body to regulate nuclear safety, security and safeguards. The regulatory body must have sufficient authority to undertake the development of codes of practice, rules and regulations regarding the functioning of nuclear installations in the country. The regulatory body should also be vested with the authority to carry out inspections and to enforce of the regulations.

— Implementation of IAEA safeguards

The government is primarily responsible for enacting legislation and ensuring that the necessary procedures to implement IAEA safeguards are in place. The government is required to ensure that the owner/operator continues to comply with all the legal and procedural requirements related to safeguards and submits the required information in a timely manner to the government and to the IAEA.

— Maintaining public support for the nuclear power plant project

Maintaining public support for the nuclear power plant project is the joint responsibility of the government and the owner/operator. It is primarily the responsibility of the government to ensure the acceptance and support of neighbouring countries.

— Nuclear fuel cycle policy

It is primarily the responsibility of the government to decide/agree on the fuel cycle policy, with major inputs from the owner/operator and the regulatory authorities.

— Policy on management and disposal of radioactive waste

A primary responsibility of the government is developing the national policies for waste disposal and eventual decommissioning of the nuclear power plant, including its financing. The owner/operator is responsible for providing major inputs to the government, and expects it to interface smoothly in the development of policies on matters affecting it.

The government has the responsibility to verify and confirm that appropriate funding mechanisms have been implemented, including funding for long term fuel handling and disposal, waste management and decommissioning.

— Financial policy

The means of financing would ultimately be decided by the government authorities. The government has a major interface with the owner/operator to obtain major inputs for developing the financing plan.

— Policy on industry participation

The government has the responsibility to develop the policy on national industrial participation in the nuclear power programme of the country.

The government will generally expect the owner/operator to develop long term plans and programmes for gradually increasing the level of national/local participation in the nuclear power plant projects to meet the national objectives. The contractual agreements with nuclear power plant suppliers and their subcontractors are expected to incorporate some clauses to obtain their commitment to transfer the technology to local entities gradually, without jeopardizing their proprietary rights.

5.2.2. Regulatory body

In some Member States, a single regulatory body will deal with nuclear safety, security and safeguards. In others, nuclear safety, nuclear security and safeguards may have separate regulators. In either case, the owner/operator has a major interface with the regulator(s).

The regulatory body is responsible for expanding the infrastructure to have in place appropriate regulations, regulatory codes and standards related to the construction and operation of nuclear power plants, for the transport, storage and handling of nuclear and radioactive material, and for radiation protection. These should be in compliance with international standards and national nuclear safety regulations.

It is a joint responsibility of the owner/operator and the regulator(s) to set up suitable mechanisms to keep the communications between them transparent and timely. The expectation of the owner/operator is that a stable regulatory regime would be established. The expectation of the regulators is that the owner/operator will communicate openly and honestly, and be committed to meeting the regulator's expectations.

At every stage of the project, the owner/operator and the regulator(s) need to interact with each other for the successful completion of the project and subsequent operation of the nuclear power plant.

The exchanges between the parties can be both formal and informal. Informal communications may consist of routine communications, presentation of plans and progress reports, etc. Formal communications from the owner/operator to the regulator(s) can include applications for licences and permits, submission of safety documentation for obtaining approvals, etc.. Formal communications from the regulator(s) to the owner/operator can include the issue of licence instruments or other permits or formal letters requesting information or specific actions, or giving formal instructions. Meetings between the regulator(s) and the owner/operator can also be formal or informal.

5.2.3. Environmental regulator

Most countries have some arrangements for environmental protection, including provisions for radiation protection, because medical, industrial and research applications of ionizing radiation are applied throughout the world. However, the infrastructure for environmental regulation may need to be enhanced to allow for the additional environmental impact of nuclear power plants. It is the joint responsibility of the owner/operator and the environmental regulator to set up suitable mechanisms to keep the communications between them transparent and timely. As concerns the nuclear and security regulators, the exchanges between the two parties can be both informal and formal.

5.2.4. Electricity grid operator

The primary responsibility of the organization that owns and operates the electricity grid is to maintain a safe and secure electrical grid system that provides reliable electrical supplies to electricity consumers. It may have legal obligations concerning the operation of the system, which may be monitored by an energy regulator

or the energy ministry of the country. The connection of a nuclear power plant to the grid will add additional responsibilities.

The owner/operator should establish good communications with the grid operator at an early stage. It is likely to be the responsibility of the grid operator during Phase 2 to determine the necessary additions or upgrades to the grid that would be required to provide electrical supplies to the nuclear power plant site during construction and to accommodate the nuclear power plant during its operation. The extent of upgrades of the grid will depend on the location, size and technical characteristics of the nuclear power plant and the owner/operator will need to provide this information to the grid operator. There may need to be additional enhancements to ensure that the grid connections to the nuclear power plant are sufficiently reliable, and can provide the nuclear power plant with an external electrical supply that is independent of the plant output. The cost and practicality of the grid upgrades will be one input in the choice of the most suitable site for the nuclear power plant.

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 BIS.

The owner/operator and the grid operator will also need to agree on the schedule for grid enhancements, which will be carried out during Phase 3 in order to be completed in time for commissioning the nuclear power plant.

The nature of funding for grid upgrades will be determined by the market arrangements in the country. The responsibility for arranging the funding may be with the government, the market regulator or the financial regulator.

By the end of Phase 3, the owner/operator will need to agree the arrangements for routine communication between the nuclear power plant and the grid operator that will be used during nuclear power plant operation.

5.2.5. 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 to procure the nuclear power plant, and should be defined in the contracts. Some typical contract structures have been described in Section 4.

The nuclear power plant vendor would normally be responsible for providing the owner/operator with plant design and performance information, safety studies and other information that the owner/operator needs to satisfy the nuclear regulator that the design can be licensed in the country. Security (e.g. physical protection) and safeguards (the concept of safeguards by design) must be considered at the earliest stage of the project.

For a turnkey contract, the main contractor who oversees the construction of the nuclear power plant would have total responsibility for construction, from site preparation through to commissioning of the nuclear power plant with the owner/operator, and final handover to the owner/operator after satisfactory demonstration of its operation at rated capacity. The main contractor would be responsible for ensuring that all aspects of the construction comply with the necessary quality standards and regulations, and for providing quality assurance records and other information that the owner/operator will need to demonstrate regulatory compliance.

However, for all contract structures, 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 throughout the supply chain.

5.2.6. Waste management organization

The duties of the waste management organization will be defined by the national laws and regulations dealing with management of spent fuel and disposal of radioactive waste. It will be the responsibility of the waste management organization to develop the facilities for receiving radioactive wastes and spent fuel from the nuclear power plant, and its long term management or disposal. The waste management organization will also be responsible for specifying the form in which it will accept the waste.

The owner/operator will be responsible for providing the waste management organization with information on the nature and quantity of wastes and spent fuel that will be produced. It will also be responsible

for ensuring that the facilities at the nuclear power plant for dealing with waste are able to sort and package it into a form that is acceptable to the waste management organization for long term storage or disposal.

5.2.7. Emergency planning and response organizations

The emergency planning and response organizations (central government agencies, local government agencies, fire brigade, police, ambulance and hospital services, etc.) have a responsibility to cooperate with the owner/operator to set up an emergency planning arrangements for the nuclear power plant.

They are also responsible for participating in emergency exercises to test emergency preparedness. The frequency of such exercises needs to be agreed by all the parties involved.

The owner/operator will need to establish good communications with all the emergency planning and response organizations, in order to plan and practice the emergency planning arrangements.

5.2.8. The public

The general public in the country do not have any direct responsibilities in the nuclear power plant project, but the support of the public, particularly those living near nuclear facilities, is important to a successful nuclear power plant project. An open and honest public communications programme is recommended to address the concerns of all citizens. Particular attention should be paid to opinion formers and opinion leaders such as the news media, heads of business and industry, leaders of NGOs and local officials.

5.2.9. International organizations

The owner/operator is likely to be able to join international organizations such as WANO and the relevant owners' group once the nuclear power plant design has been chosen and construction started. The membership of such organizations is optional for the owner/operator, but is recommended as a means of providing the new owner/operator with a way of obtaining valuable information on the practical experience of other organizations operating nuclear power plants, the lessons learned from events, ways to improve a safety, security and safeguards culture, etc. Such organizations can provide training, peer review visits and feedback on operational experience. In each case, the interface is directly between the owner/operator and the international organization. The IAEA can also provide technical support or independent assessment as described in Section 3.5. The formal interface with the IAEA is via the government of the Member State.

Appendix

EXAMPLES OF CONTRACTUAL ORGANIZATIONAL CHARTS

A.1. CONTRACTUAL CHART FOR A SUPER TURNKEY CONTRACT

Figure A.1. shows a typical organizational chart for a 'super turnkey' contract, also known as the engineering, procurement and construction (EPC) contract.

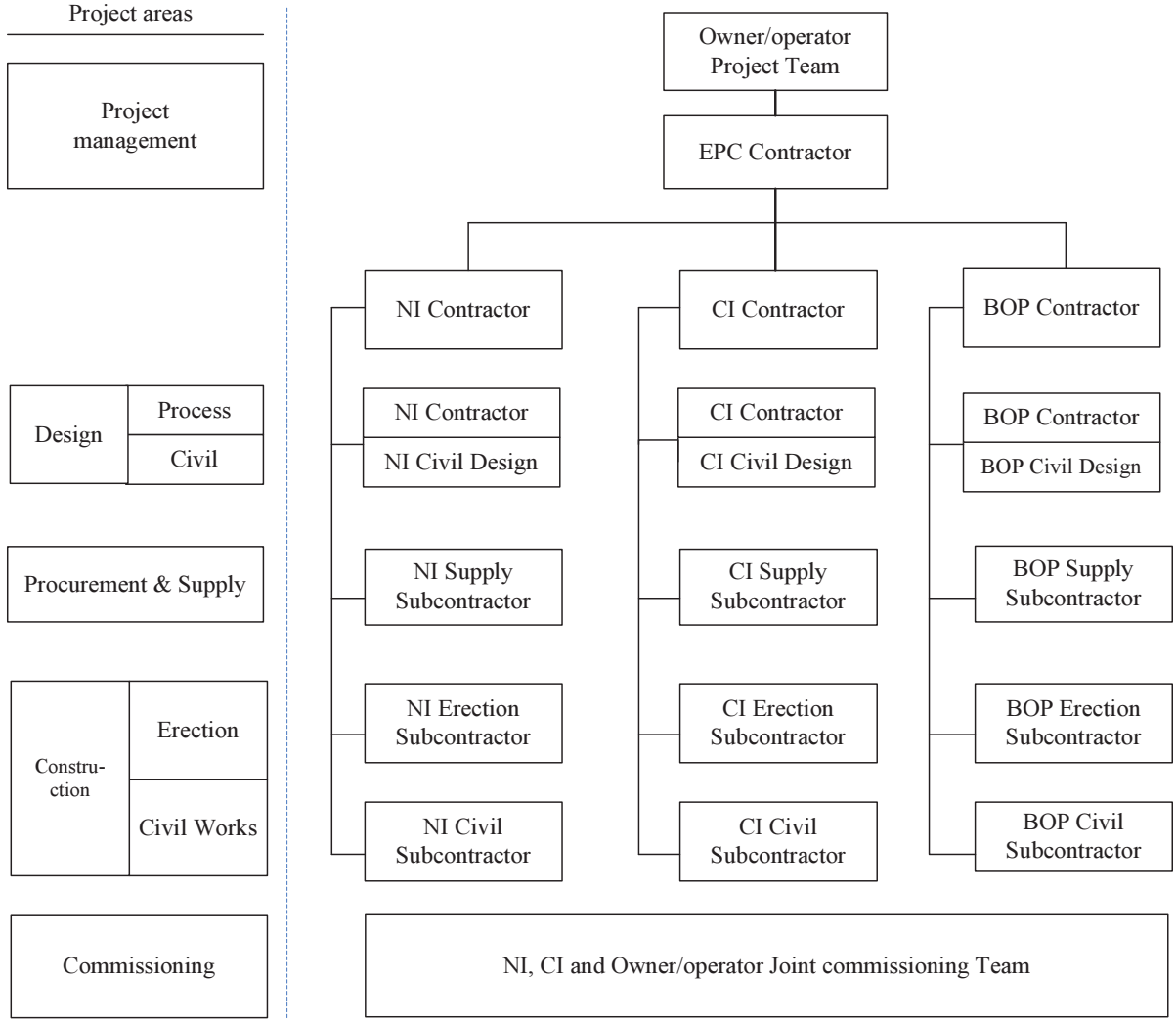

FIG. A.1. Super turnkey contract — Example of an organizational chart.

A.2. CONTRACTUAL CHART FOR A NORMAL TURNKEY CONTRACT

Figure A.2. shows a typical contractual chart for a normal turnkey contract, where the owner/operator takes the responsibility for civil works and erection.

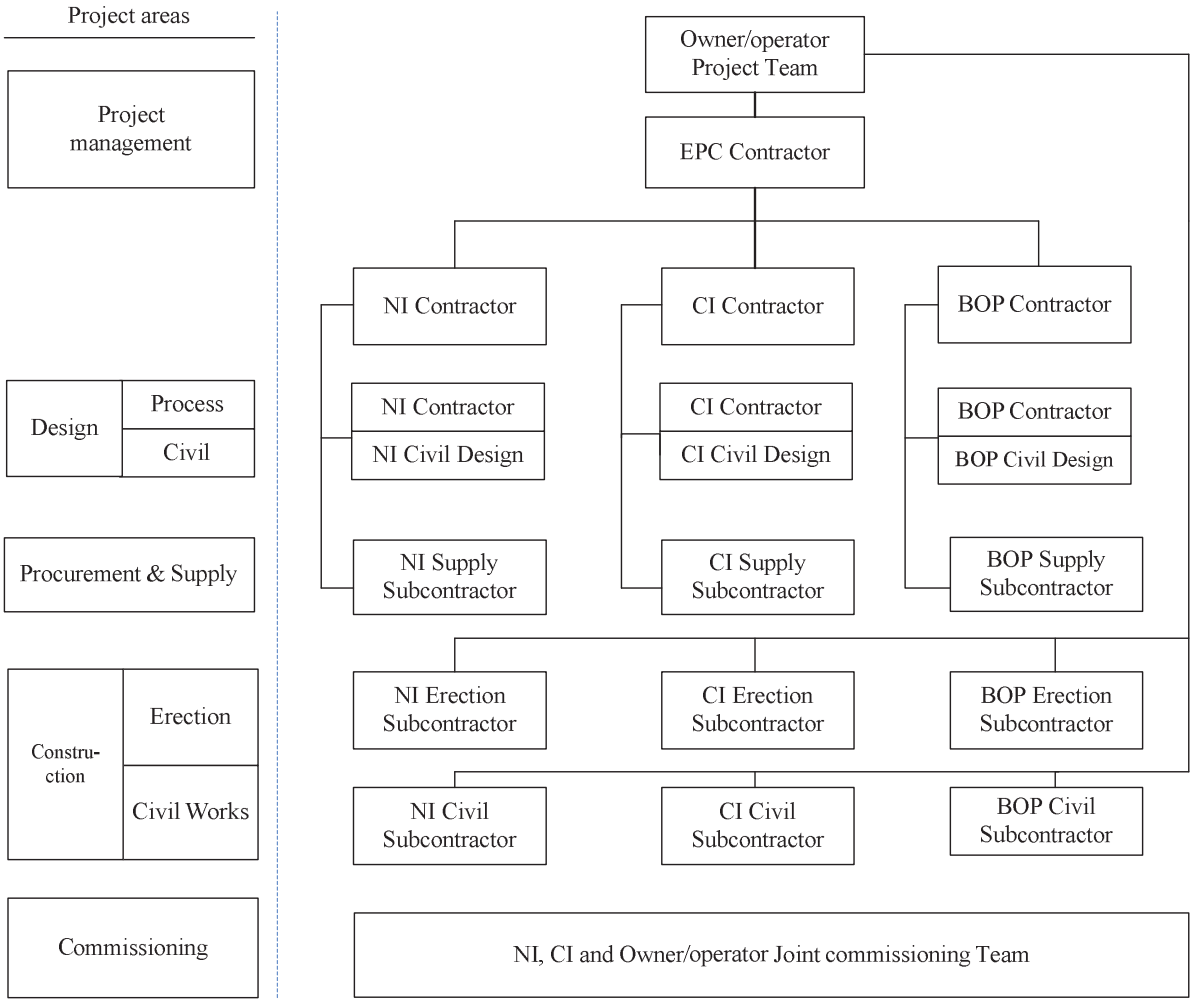

FIG. A.2. Normal turnkey contract — Example of a contractual organizational chart.

A.3. CONTRACTUAL CHART FOR A SPLIT PACKAGE CONTRACT

Figure A.3. shows a typical contractual chart for a split package contract, where the owner/operator places a number of contracts for separate packages of work, and uses a project management company assist the management of the contracts.

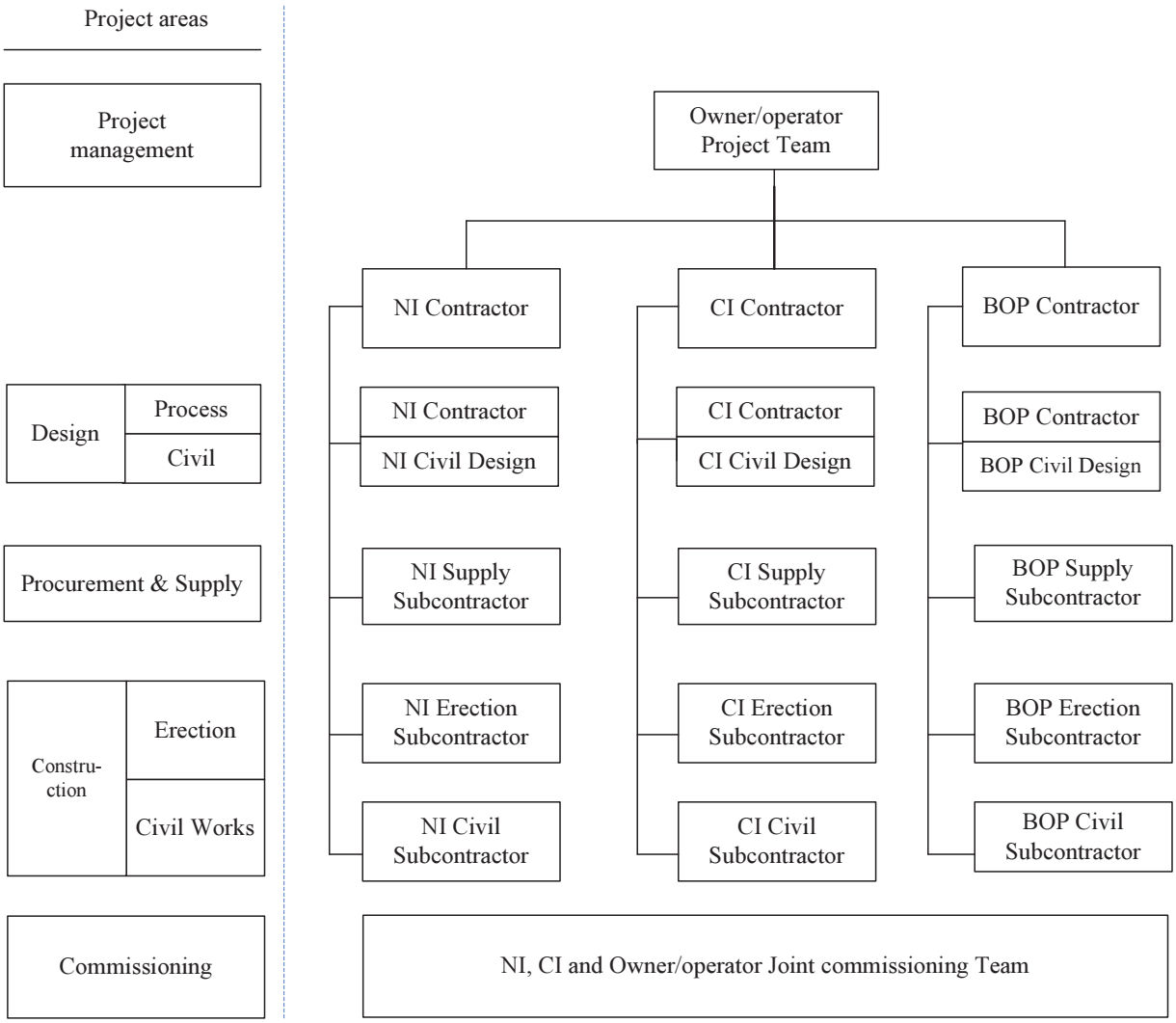

Fig. A.3. Split package contract: Example of a contractual organizational chart.

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ACRONYMS AND ABBREVIATIONS

BIS	Bid invitation specification
EPC	Engineering, procurement and construction (contract)
ILS	Integrated logistic system
INIR	International Nuclear Infrastructure Review mission
INSAG	International Nuclear Safety Group
IPPAS	International Physical Protection Advisory Service
ISSAS	International SSAC advisory service
NPIA	Nuclear power implementation agency
OSART	Operational Safety Assessment Review Team
QMS	Quality management system
SCART	Safety Culture Assessment Review Team
SSAC	State system of accounting for and control of nuclear material
TSO	Technical services/support organization
WANO	World Association of Nuclear Operators

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