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Milestones in the Development of a National Infrastructure for Nuclear Power

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MILESTONES IN THE DEVELOPMENT OF A NATIONAL INFRASTRUCTURE FOR NUCLEAR POWER

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IAEA NUCLEAR ENERGY SERIES No. NG-G-3.1

MILESTONES IN THE DEVELOPMENT OF A NATIONAL INFRASTRUCTURE FOR NUCLEAR POWER

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FOREWORD

Energy is essential for development. Nearly every aspect of development — from reducing poverty and raising living standards to improving health care and industrial and agricultural productivity — requires reliable access to modern energy sources. In this context it is important to consider the global lack of access to electricity. Current forecasts suggest the world will see an increase in global energy consumption of over 50% by 2030, with 70% of this growth in demand expected to come from developing countries. Many IAEA Member States without nuclear power programmes have expressed interest to the Agency about the possibility of introducing nuclear power plants to meet their energy needs without increasing their reliance upon fossil fuels.

In order to introduce nuclear power plants there are a wide range of infrastructure issues that need to be considered. An overall description of the issues was presented by the IAEA in a brochure 'Considerations to Launch a Nuclear Power Programme', which was provided for information to its Board of Governors as GOV/INF/2007/2 in March 2007, and which was mainly targeted at policy makers. This publication expands the three phases of development outlined in the brochure and provides guidance on the timely preparation for a nuclear power programme through an easy to understand sequential development process. It provides a more detailed description for a technical audience of the complete range of infrastructure issues that need to be addressed and the expected level of achievement (or milestones) at the end of each phase.

This publication can be used by Member States to assess their own development status, and to enable them to prioritize the activities that they need to complete in order to prepare to order, license, construct and then safely operate a nuclear power plant. The guidance aims to help Member States to understand their commitments and obligations associated with the significant undertaking of a nuclear power programme. It also clarifies that the ownership of the responsibility for implementation of a nuclear power programme rests with the country and its organizations and cannot be subcontracted or avoided. The guidance may also be used to support self-assessment by a Member State already operating a nuclear power plant.

Other organizations such as donors, suppliers, nuclear energy agencies and utilities may also find an assessment based upon this publication useful. Such assessments could build confidence that the country has the ability to legislate, regulate, construct and safely and securely operate a nuclear power plant.

The IAEA officers responsible for this publication were R.I. Facer, J. Phillips and N. Pieroni of the Division of Nuclear Power, Department of Nuclear Energy.

EDITORIAL NOTE

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1. INTRODUCTION

1.1. BACKGROUND

A nuclear power programme is a major undertaking requiring careful planning, preparation and investment in time and human resources. While nuclear power is not alone in this respect, it is considered different because of the issues associated with the possession and handling of nuclear material.

The decision by a Member State to embark on a nuclear programme should be based upon a commitment to use nuclear power for peaceful purposes, in a safe and secure manner. This commitment requires the establishment of a sustainable national infrastructure that provides governmental, legal, regulatory, managerial, technological, human and industrial support for the nuclear programme throughout its life cycle. The demonstration of compliance with international legal instruments, internationally accepted nuclear safety standards, security guidelines and safeguards requirements is essential in establishing a responsible nuclear power programme.

The development and implementation of an appropriate infrastructure to support the successful introduction of nuclear power and its safe, secure, peaceful and efficient application is an issue of central concern, especially for countries that are considering and planning the first nuclear power plant. The infrastructure needed to support the implementation of a nuclear power plant covers a wide range, from the physical facilities and equipment associated with the delivery of the electricity, the transport of the material and supplies to the site, the site itself, and the facilities for handling the radioactive waste material, to the legal and regulatory framework within which all of the necessary activities are carried out, and the human and financial resources necessary to implement the required activities. In short, infrastructures, as used in this publication, include all activities and arrangements needed to set up and operate a nuclear programme.

Decision makers, advisers and senior managers in governmental organizations, utilities, industrial organizations and regulatory bodies in the countries adopting or expanding nuclear power programmes, or exporting supplies for these programmes, should ensure that the needed national infrastructure is available. This infrastructure is relevant whether the nuclear power programme is planned for the production of electricity, for seawater desalination or for any other peaceful purpose.

This publication was developed to facilitate the assessment of progress towards the development of infrastructure for a country that is considering the

introduction of nuclear power as part of its national energy strategy. The information presented in this publication is intended to relate the experience and good practices of countries with developed nuclear energy programmes and is not intended to impose standards for those contemplating the use of nuclear energy for the first time. Experience has shown that early attention to all the issues presented here can facilitate the efficient development of a successful national nuclear energy programme. Lack of appropriate attention to any of the issues may result in future difficulties that may significantly affect the successful introduction of nuclear power.

The development of a nuclear power programme entails attention to many complex and interrelated issues over a long duration. The introduction of a nuclear power programme involves a commitment of at least 100 years to maintain a sustainable national infrastructure throughout operation, decommissioning and waste disposal. Experience has shown that the time frame from the initial policy decision by the State to the operation of the first nuclear power plantmay well be 10–15 years. The time frame may be longer depending upon the resources devoted to the development process. For a country with little-developed technical base the implementation of the first nuclear power plant would, on average, take about 15 years. For a country with a strong technical base this could be reduced to ten years if the country initiates a significant and concerted effort to achieve implementation in a rapid manner. Even for countries with existing nuclear power programmes it may take about ten years to approve and construct a new nuclear power plant.

This publication assumes that a Member State contemplating the introduction of a nuclear power programme has stable political, economic and social environments. While political stability is necessary to attract the support of international institutions and vendors, such stability alone does not guarantee that a power plant vendor can be found who will agree to build a plant, or that financing will be found for the nuclear power plant.

Undertaking a nuclear programme is a major commitment requiring strict attention to nuclear safety and the control of nuclear material. This commitment is a responsibility to not only the citizens of the State developing such a programme, but also a responsibility to the international community.

The fundamental nuclear safety objective is to protect people and the environment from the harmful effects of ionizing radiation. A comprehensive safety framework needs to be developed that permeates all development activities. One option for the development of this framework is to use the information found in the IAEA publication ‘Fundamental Safety Principles’, which contains ten safety principles that represent the international consensus on the high level of safety required for the sustainable use nuclear power. The first principle establishes that the ultimate responsibility for safety must rest

with the operator. It is incumbent on the leadership and management of the Member State and the operator to develop awareness of safety issues and the encouragement and enforcement of a safety culture throughout the entire programme. It cannot be overemphasized that everyone involved in a nuclear power project carries a responsibility for safety.

In addition to nuclear safety, and no less significant, are the issues associated with the control of nuclear material, either to ensure the security of the material, or to ensure that all of the activities in a country can be demonstrated to ensure that there is no risk of proliferation of nuclear weapons and that all the materials are adequately accounted for and protected. This also requires the development of a culture, system and practices that ensure that all staff are aware of their responsibilities and the importance of their actions.

An interested Member State can benefit from this publication to judge: (1) its own progress and readiness to introduce nuclear power; and (2) the magnitude of the commitment necessary to ensure that it is fully prepared to achieve the peaceful use of nuclear power in a safe, secure and technically sound manner. Examples of assistance include, among others, the identification and implementation of the issues that need to be addressed within a basic nuclear power infrastructure framework, the sharing of nuclear power infrastructure between countries, and the establishment of milestones in infrastructure activities that should be reached by a country developing nuclear power.

1.2. OBJECTIVE

This publication provides a framework of milestones in the development of a national nuclear infrastructure, which allows the Member State to ensure sequentially at each milestone that it has:

(1) Comprehensively recognized and identified the national commitments and obligations associated with the introduction of nuclear power;
(2) Established and adequately prepared the entire national infrastructure needed to begin the construction of a nuclear power plant;,
(3) Established all the necessary competences and capabilities to be able to regulate and operate a nuclear power plant safely, securely and economically over its lifetime, and to be able to regulate and manage the ensuing radioactive waste.

1.3. SCOPE

The scope of this publication includes both the 'hard' (grid, facilities, etc.) and 'soft' (legal, regulatory, training, etc.) infrastructure needed for a nuclear power plant. Infrastructure needs are discussed from the time a Member State first considers a nuclear power plant, through the planning stage, bid preparation, construction, startup, and preparation for commissioning.

Operation, decommissioning, spent fuel and waste management are addressed by this publication to the degree necessary for planning purposes required prior to nuclear power plant commissioning. This publication takes the view that all the issues, including operation and decommissioning, as well as spent fuel and waste management, should be considered and the planning should be in progress by the time the bid request is issued. Having reached the point of readiness to commission a nuclear power plant, the Member State should have developed an understanding of the commitments required for a successful nuclear programme and be able to uphold those commitments throughout the programme life.

1.4. USERS

Decision makers, advisers and senior managers in the governmental organizations, utilities, industries, and regulatory bodies of a country interested in developing nuclear power may use this publication to identify the various sequential activities required to plan, purchase, build, and be prepared to operate and maintain a nuclear power plant.

International organizations may use this publication to help determine the degree of State progress in developing and implementing the infrastructure necessary for executing a nuclear power plant project, so that assistance can be provided in a meaningful and timely manner.

Other organizations, such as donors, suppliers, nuclear energy agencies, and operator organizations, may use this publication to provide confidence that the country has the infrastructure necessary to regulate, construct and safely operate a nuclear power plant or to identify areas for potential assistance.

1.5. STRUCTURE

This publication consists of two main sections in addition to this introduction. In Section 2, the three major infrastructure milestones for the development of a nuclear power programme are discussed. In Section 3, a total

of 19 important infrastructure issues, and the desired conditions to reach/achieve the milestones, are presented. The Appendix provides a summary of the issues in tabular form and an overview of the activities for all issues for each milestone.

1.6. USING THIS GUIDE

This publication should be used as guidance on how to assess the progress toward establishing a national nuclear programme, and to aid in planning the steps necessary to develop a national infrastructure. It is not a comprehensive guide on how to create the entire infrastructure needed for a nuclear power programme, but rather presents the elements of infrastructure that should exist at significant times in the development process. A wealth of information and guidance on each of the issues included in infrastructure development is available, for example from the IAEA publications listed in the Bibliography.

2. THE PROGRAMME TO DEVELOP INFRASTRUCTURE MILESTONES

2.1. INFRASTRUCTURE MILESTONES

In preparing the infrastructure to introduce nuclear power, there are several activities that need to be completed. These activities can be split into three progressive phases of development. The duration of these phases will depend upon the degree of commitment and resources applied in the Member State. A description of the conditions that would be expected to be achieved by the end of each phase is provided. The term ‘infrastructure milestone’ refers to the conditions necessary to demonstrate that the phase has been successfully completed. The ‘infrastructure milestone’ is thus a description of a set of conditions and does not necessarily have specific time based implications. It should be noted that decisions early in the process, such as turnkey purchase versus indigenous construction, can greatly influence the resources necessary to create the required infrastructure.

The development of infrastructure necessary to support a nuclear power programme would be expected to proceed through phases 1–3, leading to the achievement of the corresponding milestones, while at the same time many

other specific activities are progressing in order to ensure implementation of the first nuclear power plant project. The three programme phases of development 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 completion of the infrastructure conditions of each of these phases is marked by a specific milestone at which the progress and success of the development effort can be assessed and a decision made to move on to the next phase. These milestones are:

— Milestone 1: Ready to make a knowledgeable commitment to a nuclear programme;
— Milestone 2: Ready to invite bids for the first nuclear power plant;
— Milestone 3: Ready to commission and operate the first nuclear power plant.

A schematic representation of the phases and milestones is given in Fig. 1.

There are three major organizational entities typically involved in the development of a nuclear power programme: the government, the owner/operator of the nuclear power plant and the regulatory body. Each has a specific role to play, with responsibilities changing as the programme advances. In the discussion here, it is assumed that the government will form a group to study and initially promote the development of the programme. In this publication, this group is called the 'Nuclear Energy Programme Implementing Organization' (NEPIO). It should be noted that this designation is used here for illustrative purposes only[1]. The government may organize the activity in a manner most appropriate to its own customs and needs. Similarly, the owner/operator organization may be State owned, be part of a utility or be another

[1] In an earlier publication, Basic Infrastructure for a Nuclear Power Project, IAEA-TECDOC-1513), the designation "Nuclear Power Implementation Agency (NPIA)" was used with the same meaning as NEPIO. The scope of activities described in this publication may be organized in many different ways so long as all issues and activities are included.

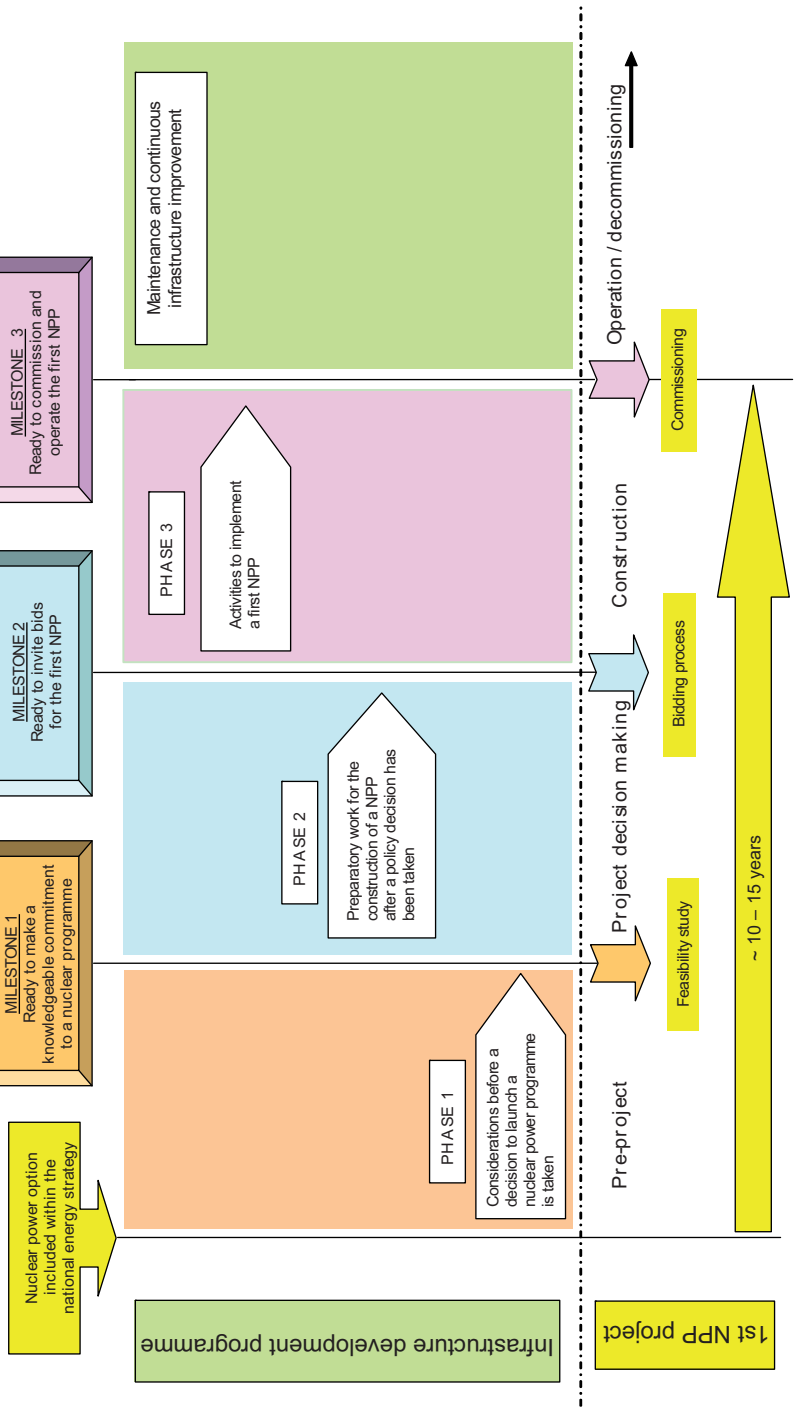

FIG. 1. Infrastructure development programme.

commercial entity. The regulatory body is effectively independent from the owner/operator and other government agencies responsible for developing the nuclear programme, but may exist within the government.

For each milestone, 19 issues that need to be considered are shown schematically in Table 1. The order of the issues does not indicate an importance or hierarchy. Each issue is important and requires careful consideration. Depending on the perspective, the different issues have different weights. For example, from a legal standpoint the legal framework is

TABLE 1. INFRASTRUCTURE ISSUES AND MILESTONES

Issues	Milestone 1	Milestone 2	Milestone 3
National position			
Nuclear safety			
Management			
Funding and financing	Conditions	Conditions	Conditions
Legislative framework			
Safeguards			
Regulatory framework			
Radiation protection			
Electrical grid			
Human resources development			
Stakeholder involvement			
Site and supporting facilities			
Environmental protection			
Emergency planning			
Security and physical protection			
Nuclear fuel cycle			
Radioactive waste			
Industrial involvement			
Procurement			

the most important issue. From a safety perspective the regulatory framework and nuclear safety predominate. From an economist's perspective, the decision making under the national framework and the funding and financing issues are likely to be the prime considerations. Similar comments could apply for safeguards or security, or the other areas. The difference in weight clearly depends upon the perspective of the reader. Different organizations will need to consider which of these issues relate to them and which, therefore, they should address with the highest priority. The three major organizations, i.e. government, owner/operator and regulatory body, need to ensure that there is awareness of all these issues.

2.2. MILESTONE 1: READY TO MAKE A KNOWLEDGEABLE COMMITMENT TO A NUCLEAR PROGRAMME

It is assumed that a country has assessed that it needs additional energy and has included nuclear power as a possible option to meet some of these needs. At this point in the political decision making process, it would begin the first phase of the programme, which would culminate in the attainment of milestone 1. At this time the country would be in a position to make an informed decision on whether it is appropriate to introduce a nuclear power programme.

If a Member State is contemplating the introduction of nuclear power as part of its energy supply portfolio, then it is essential that the State acquire a comprehensive understanding of the various obligations and commitments involved, and the national strategy to discharge them, before any decision on implementation is taken.

In addition, it is important for a Member State to have a clear understanding of its energy needs, the potential role, appropriateness and viability of nuclear power in its long term energy plan and in the context of its national and socioeconomic development. Included in these considerations would be the need to assess the possibility of installing a nuclear power plant on the national grid network, recognizing that it is usually accepted that no single electric power producing unit should account for more than 5–10% of the installed capacity of the regional electricity network to which it is connected, although notable exceptions do exist. Regional and international cooperation should also be taken into consideration.

A Member State considering a nuclear power programme would be expected to have an existing national infrastructure for radiation, waste and transport safety. This infrastructure would be expected to be in compliance with international standards, and would cover all current activities, practices

and facilities in that Member State. Making use of the existing infrastructure, together with the experience in developing and implementing such a national safety infrastructure, should greatly assist the Member State in building up the necessary infrastructure for a nuclear power programme.

The initial phase in the development of a nuclear power programme involves the considerations and planning before a firm decision to develop a nuclear power programme is taken. During this phase the responsible organizations are the government and the NEPIO. The NEPIO should develop for the Member State a complete understanding of the commitments associated with the use of nuclear power.

An effective management system and staff capabilities need to be developed to ensure that owner/operator obligations are properly carried out. Additionally, preliminary discussions with potential nuclear system vendors should be conducted to ascertain their interest in, and possible concerns or limitations for, participating in the development of a nuclear power programme and in the supply of a nuclear power plant.

2.3. MILESTONE 2: READY TO INVITE BIDS FOR THE FIRST NUCLEAR POWER PLANT

Following the policy decision to proceed with the development of a nuclear power programme, substantive work for achieving the necessary level of technical and institutional competence should be undertaken. This phase requires a significant and continuing commitment from the government. It is assumed that the duties of the NEPIO will be incorporated into the appropriate government agency, which will now act as the guiding organization for the country's programme.

During the second phase of the programme, the country will carry out the work required to prepare for the construction of a nuclear power plant. The regulatory body will need to be developed to a level at which it can fulfill all of its oversight duties. The necessary infrastructure should be developed to the point of complete readiness to request a bid or enter into a commercial contract. This publication assumes that the country may use the competitive bid process to purchase the first nuclear power plant; however, it is acknowledged that there are a number of different procurement processes for the acquisition of the first power plant.

The owner/operator (or utility) has a key role at this time, ensuring that it has developed the competence to manage a nuclear project, to achieve the level of organizational and operational culture necessary to meet regulatory

requirements, and the ability to demonstrate that it is an adequately informed and effective customer.

2.4. MILESTONE 3: READY TO COMMISSION AND OPERATE THE FIRST NUCLEAR POWER PLANT

The third phase in the development of nuclear power programme consists of all the activities necessary to implement the first nuclear power plant. Much of the work on infrastructure development is well advanced at this stage. The greatest capital expenditures will occur during this phase, necessitating close attention by all organizations. In the context of this publication, the commissioning process is assumed to start before fuel is delivered to the site.

Successful completion of this phase will bring the government to the point of having established a nuclear power programme that will bring the benefits of energy security and economic development envisioned in the initial policy decision. At the end of this phase the owner/operator will have developed from an organization capable of ordering a nuclear power plantto an organization capable of accepting the responsibility for commissioning and operating one. This will require significant development and training for all levels of staff, and the demonstration that the owner/operator can manage the project throughout its life.

While achieving the third milestone is a major accomplishment, it should be remembered that it is only the beginning of a lasting commitment to the safe, secure and effective application of nuclear power.

3. DESCRIPTION OF INFRASTRUCTURE ISSUES

There is a set of major issues, with each of these issues requiring specific actions during each phase. The substantial completion of these actions represents attainment of the conditions for achieving the associated milestone. A discussion of the conditions necessary to address each milestone is presented in this section. A summary of these conditions is presented in the Appendix. As mentioned earlier, the order of these issues does not imply importance or hierarchy. All issues are important and require appropriate attention.

3.1. NATIONAL POSITION

The government should adopt a clear statement of intent to develop a nuclear power programme and communicate that intent locally, nationally, regionally and internationally. The rationale for pursuing such a programme should flow from a national energy policy supporting the desired economic development goals of the country and considering the contribution that nuclear power will make to that policy. While nuclear power is generally employed for safe, clean and economical generation of electricity, its application for desalination or process heat may also be relevant.

Strong government support is vital to the successful implementation of a nuclear power programme, and the intention to develop such a programme should be announced at the most senior level of government. Government leadership and funding is necessary for the initial programme development and continued government support will be required throughout the life of the programme. Careful consideration should be given to the means of maintaining the long term political, economic and social stability required throughout the life of the nuclear power programme.

3.1.1. National position: Milestone 1— Ready to make a knowledgeable commitment to a nuclear programme

The introduction of nuclear power requires long term commitments, both nationally and internationally. A time frame of at least 100 years should be considered for a nuclear power programme, with a 10–15 year initial implementation period. It is therefore of utmost importance to fully understand the long term commitments required for a nuclear power programme before even considering a specific nuclear power plant project.

A full understanding of the commitments can be best achieved by forming a NEPIO. This organization should be charged with the task of producing a comprehensive study of the issues and conditions necessary for the successful implementation of nuclear power in the country. The organization should report to a high level in the government, such as the ministry of energy or industry, and should be given adequate time and funding to prepare a comprehensive report. The initial organization staffing may make liberal use of consulting expertise, but it is important for the leadership to remain with the government. An example of a possible structure is shown in Fig. 2.

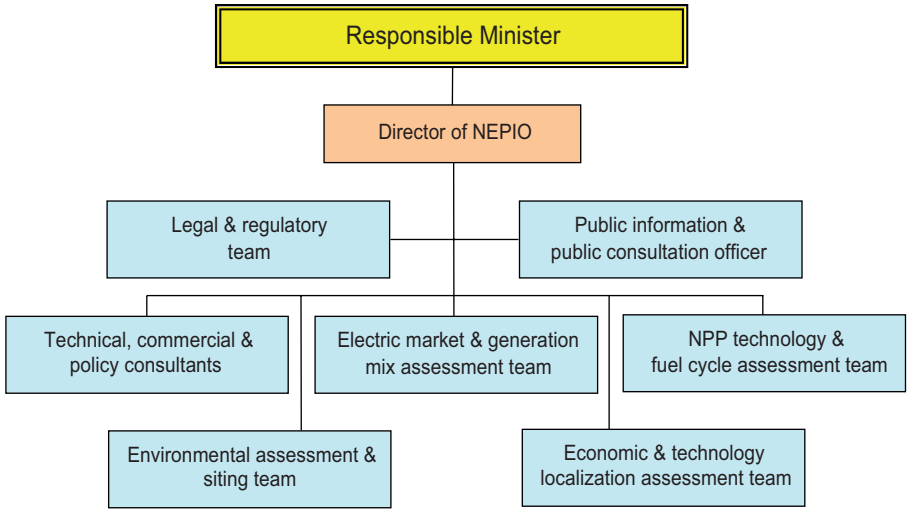

FIG. 2. Example of a NEPIO.

The key points which should be studied in order to understand the commitments include:

- The need to ensure the safety, security and non-proliferation of nuclear material;
- The need to join the appropriate international legal treaties and conventions;
- The need to develop a comprehensive legal framework covering all aspects of nuclear law,, which includes safety, security and nuclear liability and other legislative, regulatory and commercial aspects;
- The need to have an effective, independent, competent regulatory body;
- The appropriate role for, and the compatibility of, nuclear power in the nation's sustainable development strategy;
- The need to develop project management capabilities;
- The need to develop and maintain the national human resource capability within both the government and industrial sectors to successfully manage, operate, maintain and regulate nuclear facilities;
- The need to ensure the availability of financial resources for the construction of nuclear facilities and for the long term operation, regulation and decommissioning of those facilities;

— The need to provide policies, programmes and resources for decommissioning and the safe management of spent fuel and radioactive waste;
— The need to provide industrial capability for equipment and services support for the nuclear programme, either through international procurement or indigenous development;
— The importance of gaining and keeping the confidence of the nation and the international community by maintaining open, transparent and timely interaction and communication regarding all aspects and activities of the nuclear programme.

Demonstrating a recognition of the commitments inherent in undertaking a nuclear programme and a determination to fulfill those commitments forms the basis for a credible national position to develop a nuclear power programme.

3.1.2. National position: Milestone 2 — Ready to invite bids for the first nuclear power plant

The transition from the policy decision to develop a nuclear power programme to the declaration of readiness to implement that programme by initiating the first nuclear power plantproject requires continued support and involvement by the government. It is the responsibility of the government to implement the necessary legal framework. It is also incumbent upon the government to ensure that complete technical and institutional competence to embark on a nuclear power planthas been attained.

The fulfillment of these responsibilities may be best achieved by integrating the NEPIO as an official part of a government agency, such as the ministry of energy or industry, with the full authority to conduct the necessary activities. A significant investment is required to bring a nuclear programme to the point of readiness to initiate a nuclear project, but this investment is small compared with the investment required to build the first nuclear power plant, and is vital to its success. It is also important to consider that the necessary human resource requirements may vary considerably depending upon the decisions made during this phase. (i.e. a turnkey project versus indigenous construction and equipment supply.)

During this phase of development it is expected that the government will:

— Enact appropriate legislation and adopt the relevant international legal instruments;

— Establish a competent and effectively independent regulatory body (or expand the existing regulatory body) to license and regulate the design and operation of nuclear facilities and have adequate authority, staffing and financial resources;
— Establish and maintain an effective State system of accounting for and control of nuclear material (SSAC);
— Establish the financial and operational modalities for the ownership and operation of nuclear facilities, including government and/or private ownership and foreign ownership or operation;
— Establish a policy for the nuclear fuel cycle, including arrangements for secure sources of supply, safe and secure transportation and storage of new and spent nuclear fuel, and long term waste management;
— Establish the legal, organizational and financial arrangements for decommissioning and radioactive waste management liabilities;
— Establish and maintain stakeholder involvement regarding the nuclear power programme;
— Establish a policy for national and industrial participation in the nuclear programme and initiate programmes for the development of the human and physical resources required to implement the policy;
— Develop programmes for national safeguards for nuclear materials;
— Develop programmes for the security of nuclear materials and facilities;
— Develop programmes for radiation protection and emergency planning;
— Adopt international standards for environmental protection.

Accomplishing these conditions will provide a credible basis for requesting a bid for the first nuclear power plant.

3.1.3. National position: Milestone 3 — Ready to commission and operate the first nuclear power plant

To reach the point of readiness to commission and operate a nuclear power plant, the government should have established the basic infrastructure to license, regulate and safely operate the plant within the established laws and consistent with international commitments. Monitoring the development and ensuring the competence of the organizations and institutions responsible for the construction, operation and regulation of all associated activities is necessary. The government should accomplish this through the agency previously charged with the responsibility for nuclear programme implementation.

During the transition from issuing a bid request for the first nuclear power plant and the preparation for commissioning and operation, the government should:

— Ensure that all laws and legal instruments remain in place and the responsibility for their compliance cleary designated;
— Ensure that the regulatory body is fully funded, staffed with competent and trained personnel, and provided with the necesary facilities and resources, and has assumed its responsibilities and functions with full authority;
— Ensure that the regulatory body has confirmed the technical and management competence of the owner/operator;
— Ensure that stakeholder involvement remains an important priority;
— Ensure that the financing is sufficient to sustain the safe operation of the nuclear power plant and related facilities, and also ensure that mechanisms are available for compensation of nuclear damage;
— Ensure that a system for the funding of decommissioning and spent fuel and waste management is developed;
— Ensure that the programmes for human and physical resource development are proceeding to support the continued safe operation of all nuclear facilities;
— Ensure that an appropriate funding plan has been implemented for waste, long term spent fuel management and for the decommissioning of the nuclear power plant.

Having ensured the existence and competence of the basic national infrastructure, the country will be ready to commission and operate the first nuclear power plant.

3.2. NUCLEAR SAFETY

Nuclear safety requires the commitment by all elements of the national government, operating, regulatory, vendor and other organizations in the promotion and achievement of safety in the conduct of, preparing for and implementing a nuclear power programme. All of the issues in preparation of the infrastructure for nuclear power have some impact upon safety.

When embarking on a nuclear power programme, countries will become partners of a global nuclear safety regime dedicated to maintaining nuclear safety worldwide. Becoming a responsible partner provides benefits from participating in a network of international cooperation in nuclear safety. As

part of this cooperation, a necessary element is to jointly ensure that programmes are implemented that are consistent with the IAEA Fundamental Safety Principles and the other IAEA safety standards, or their equivalent.

Past experience has demonstrated that reliance on engineered safety systems is, by itself, insufficient to ensure nuclear safety. The important lesson is that safe and secure operations can only be ensured if there is an infrastructure in place to make sure that the specific requirements of nuclear power technology are recognized and that appropriate conditions are established to deal with them safely.

3.2.1. Nuclear safety: Milestone 1— Ready to make a knowledgeable commitment to a nuclear programme

An integral part of becoming ready to make a knowledgeable commitment to a nuclear power programme that is associated with the decision to pursue a nuclear power component of a Member State's energy mix is the recognition of the importance of safety. Safety is a necessary component of all activities associated with the design, manufacture, building and operation of a nuclear power facility.

Building a nuclear power plant requires the same strategic planning and analysis of economic, technological, environmental and social implications as any other large scale investment. However, building the first plant implies a long term commitment which poses specific requirements for a national nuclear power infrastructure and for participation in the international network on nuclear safety. New nuclear countries need to take early actions to fulfill their responsibilities for nuclear safety.

Therefore, a decision to proceed with a nuclear programme should be based on an extensive national advisory and consultative process to seek expert views and consult the general population, as well as the views of the agencies, organizations and individuals representing various interest groups. To this end, the establishment of a stakeholder involvement programme, even if one is not required by law, is advocated. The establishment of a dialogue among all stakeholders should be seen as an essential part of any complete nuclear programme. The dialogue should be supported by the efforts of authorities and institutions to increase public knowledge of nuclear safety issues (see Section 3.11 on stakeholder involvement in this publication).

At this initial stage of the programme, the focus should be on: recognition of the need for consideration of the IAEA Fundamental Safety Principles; the ultimate responsibility of the operator; an effective legal and governmental framework for safety, including an independent regulatory body; establishment of effective leadership and management for safety; decommissioning and long

term management of radioactive waste; efforts to prevent and mitigate accidents; and arrangements for emergency preparedness and response.

In addition, the need to participate in the global nuclear safety regime will include planning to subscribe to intergovernmental instruments on safety (e.g. legally binding conventions and non-legally binding codes of conduct), and participating in various efforts to share knowledge and experience through information networks and through participation in regional and international organizations. Early membership as a Contracting Party of the Convention on Nuclear Safety and active participation in the peer review process will demonstrate commitment to the global nuclear safety regime.

While the legislative and regulatory regimes are of utmost importance for a successful nuclear programme, they alone will not provide the highest level of safety. Experience has shown that the development of a safety culture within all organizations involved in the nuclear programme will not only elevate the level of safety achieved, but will also result in a more efficient and credible programme. Recognizing the need to establish a safety culture requires that all individuals involved in the programme accept a personal responsibility for safety and perform all their activities with this thought in mind; this is a key activity that needs to be demonstrated in order to achieve milestone 1.

3.2.2. Nuclear safety: Milestone 2: Ready to invite bids for the first nuclear power plant

Even recognizing that the ultimate responsibility for safety rests with the operator, all efforts should be taken to ensure that an adequate level of safety consciousness and the acceptance of personal responsibility for safety are achieved by all participants in the nuclear project. This includes government representatives, vendors, operators, regulators and other stakeholders.

Once the decision to embark on a nuclear power plant project is made, the usual implementation process for large scale investment projects will be initiated. A first nuclear power plant of a country will most likely be supplied by a foreign vendor. The vendor country should have a continuing commitment to the buyer country for nuclear safety. However, the decision making process for a nuclear power plant is, in comparison to non-nuclear projects, complicated by a number of additional nuclear safety considerations specific to its construction.

The framework of infrastructure development identified in other parts of this guide provides an additional basis for achieving an acceptable level of safety. In addition to the technical issues, it needs to be demonstrated that the attitude throughout the industry recognizes the importance of safety and the activities necessary to achieve this.

At the outset, a long term nuclear policy should be considered which addresses nuclear capacity planning, decommissioning and waste management strategies as mentioned elsewhere in this publication. The nuclear policy should also consider the level of planned national participation by industry and the impact of the required human resources over the lifetime of the programme.

A properly established legal and regulatory framework is needed for the regulation of nuclear facilities and for the assignment of responsibilities. The government is responsible for establishing a licensing system and for the implementation of an independent, competent and effective regulatory body with sufficient knowledge to evaluate advice and submissions and to make safety decisions.

Regulations which may have an impact on the choice of technology should be established early in the process. The use of proven and licensed technology can provide the possibility for regulators in the importing country to make use of the experience of the regulator from the exporting country. Establishing a liability regime is essential in clarifying the responsibilities of all parties. It is suggested that a continuing relationship with the nuclear power plant supplier and architect, under appropriate liability arrangements, be included in the bid specification.

3.2.3. Nuclear safety: Milestone 3 — Ready to commission and operate the first nuclear power plant

A suite of elements should be in place to address, in a proactive manner, safety. A safety culture should be adopted by the constructor, the engineer and the operator, as well as the regulatory body. The IAEA Safety Fundamentals and Safety Standards can provide the reference for ensuring that good international safety practices are in place to assist in the successful completion of the project. The regulatory body should be sufficiently prepared at this time and have the authority to determine whether an adequate appreciation of safety is present and to take appropriate measures.

Specific to a project to build a nuclear power plant is the recognition that safety issues are intrinsic to every aspect of the project. In parallel to establishing a project management plan, an effective system of safety regulation and supervision has to be put in place for the licensing process of the nuclear power plant to include site selection and evaluation, construction, commissioning, commercial operation, decommissioning and management of spent fuel and radioactive waste.

The following points highlight some of the issues, drawn from the experience of other countries, which are of particular safety importance in constructing the first nuclear power plant in a country:

— *Operator skills and attitudes.* The operator of the nuclear power plant has the first and primary responsibility to ensure safety;
— *Management system.* A management system for nuclear facilities and activities needs to be installed that deals in a coherent manner with safety, health, environmental, security, quality and economic requirements throughout the lifetime of the facilities and for the entire duration of activities in normal, transient and emergency situations.
— *Safety culture.* Should be assessed and maintained over the life of the plant.
— *Legal framework.* Although primary reliance is placed on the operator to ensure safety, a legal structure as a foundation is needed.
— *Regulatory independence, competence and authority.* Just as the operator needs to have experienced staff, there is a need for sophisticated, competent and knowledgeable regulatory staff with appropriate access and support.
— *Technical competence.* A common theme of several of these elements is the need for staff with the skills to undertake the operation, regulation and maintenance of the entire nuclear programme in a sustainable manner.
— *Financial stability.* Recent studies have shown that nuclear power is and will be cost competitive with other generation technologies, particularly with the advent of constraints on carbon emissions. To sustain safety, adequate financial support throughout and beyond the operating life of the plant is necessary.
— *Emergency preparedness.* Every country that places reliance on nuclear power needs not only take the steps to ensure safe operation, but also to prepare for the possibility that its efforts might fail and that a nuclear emergency could arise.
— *International connectivity.* Interfaces with support capabilities around the globe should are important.

These issues are treated in more detail in various parts of this publication.

3.3. MANAGEMENT

The roles and responsibilities of management will change over time as the process of assessing and implementing a national nuclear programme progresses from study to implementation to operation. The management of a nuclear programme is a demanding undertaking. A highly competent management is vital to the success at all stages of development. The following discussion addresses the characteristics and activities of management at each milestone in the development process.

3.3.1. Management: Milestone 1 — Ready to make a knowledgeable commitment to a nuclear programme

During the early phases of the process, the NEPIO is established to manage and conduct a detailed study of the required activities to facilitate a decision to proceed with the implementation of a national nuclear power programme. The organization has a reporting relationship, preferably to a cabinet level, which provides the credibility necessary to command respect internally and internationally. Adequate staffing and funding have been provided to carry the detailed study through to completion. The members of the organization need to possess the expertise necessary to address all relevant issues. Gaps in the necessary expertise can be filled by consultants. However, the leadership of the organization and the responsibility for the study remains with individuals of national origin. A charter has been given to the organization to explore the complete range of issues associated with the development of a national nuclear power programme, including:

— Energy strategy and the compatibility of nuclear power with those needs;
— Stakeholder involvement;
— Availability of nuclear technologies, and their suitability for domestic application;
— Suitable site locations for nuclear facilities;
— Availability of long term financial resources, both public and private;
— Ownership options and operational responsibilities;
— Security and safeguards requirements;
— Spent fuel and radioactive waste management and disposal;
— Legal framework necessary to enable and support a nuclear programme;
— Regulatory framework necessary for the control of nuclear facilities and activities;
— Availability of, and need for, human resources;

— Availability and needs of supporting industry;
— Other such issues as the State may consider necessary to its situation.

Exploring these issues will result in the initial development of management expertise and generate an understanding of the scope and depth of management needed to pursue full implementation of a nuclear power programme.

3.3.2. Management: Milestone 2 — Ready to invite bids for the first nuclear power plant

On the behalf of the government the NEPIO should ensure: implementation of the national laws; establishment, staffing and funding of the regulatory body; and promotion of the continued government and public support of the programme, including plans and actions for related infrastructure enhancement.

The owner/operator organization should be designated and assume responsibility for the development and implementation of the first nuclear power plant. The owner/operator organization functions independent of the political and regulatory establishments. The resources and expertise of each organization should be adjusted accordingly.

The government should:

— Designate the owner/operator organization that will assume the responsibility of preparing a nuclear power plant order, construction and operation;
— Work with the legislative body to enact the appropriate laws to facilitate the development of a safe and peaceful nuclear power programme, and its control;
— Expand or establish an effectively independent regulatory body;
— Establish an effective SSAC;
— Establish policies for the organization of spent fuel and waste management;
— Establish a plan for human and physical resource development consistent with the policy for national participation in the manufacturing, construction, operation and support of a nuclear facility;
— Continue a public education and consultation programme.

The independent regulatory body should:

— Increase staff as appropriate to develop a regulatory structure;
— Establish a formal management system and begin formal staff training to create a safety and quality culture responsible for the licensing and oversight of nuclear facilites;
— Develop regulations to implement the laws for site and plant licensing and oversight of nuclear facilities;
— Review and approve site suitability determinations made by the NEPIO or owner/operator;
— Communicate the independent role of the regulator to internal and external stakeholders.

The owner/operator organization should:

— Increase its staffing as appropriate to begin preparation for bid specification development and evaluation;
— Establish a formal management system and begin formal staff training to create a safety and quality culture accepting full responsibility for the safe operation and maintenance of the nuclear facilities;
— Implement the nuclear safeguards regulations;
— Establish a nuclear security programme;
— Characterize the preferred sites through surveys and environmental assessments;
— Determine the appropriate or preferred nuclear technologies for implementation;
— Select a nuclear power plant site or sites for which environmental assessments, licensing applications, and bid invitations are prepared;
— Continue a vigorous public information and consultation programme, especially with respect to the chosen sites;
— Develop bid evaluation criteria;
— Develop a contracting strategy;
— Develop a fuel supply strategy and establish a fuel supply plan consistent with the contracting strategy;
— Establish a spent fuel and radioactive waste management;
— Develop a financing strategy and begin implementing a financial plan consistent with the contracting strategy;
— Establish a working relationship with the regulatory body and international and professional organizations;
— Establish a trained staff and trained project management organization with emphasis on quality management.

Establishing the above conditions will enable the government and the owner/operator to proceed to request a bid for the first nuclear power plant.

3.3.3. Management: Milestone 3 — Ready to commission and operate the first nuclear power plant

The government will continue to promote government and public support for the nuclear programme and pursue human resource development for the long term viability of the programme.

The government should:

- Continue to promote educational and industrial development for national participation in the nuclear programme;
- Continue to communicate the importance of the nuclear programme to the public;
- Lead the national planning for waste disposal and decommissioning.

The independent regulatory body should:

- Continue staff development;
- Conduct environmental and safety reviews of the proposed nuclear power plant;
- Develop an operational oversight plan;
- Continue to interact with inernal and external stakeholders in a transparent manner so that the independence of the regulator is evident.

The owner/operator will proceed with the task of constructing, licensing and preparing to commission and operate the nuclear power plant.

The owner/operator should:

- Formally evaluate all bids and select the winning bid in accordance with the bid evaluation criteria;
- Negotiate the contract with a scope of supply consistent with the contracting strategy;
- Sign the contract for a first nuclear power plant;
- Obtain financing consistent with the financing strategy and the contract;
- Establish a licensing strategy to support site and plant licensing;
- Prepare a licence application in conformity with the regulatory requirements;
- Complete construction and obtain a licence for the nuclear power plant;

— Obtain staff, train them and obtain a licence or certification of competent operation, for the maintenance and support organizations;
— Contract for a continuing fuel supply;
— Establish provisions for any needed external operational, training, engineering and maintenance support;
— Obtain public support for the operation of a nuclear power plant.

The owner/operator is capable of assuming full responsibility for the safe and efficient operation of all nuclear facilities in accordance with internationally accepted norms and standards.

3.4. FUNDING AND FINANCING

The funding and financing requirements for a nuclear power programme overall, and a nuclear power plant specifically, are very large[2]. The initial funding for infrastructure development will likely need to come from government sources. Initial activities to understand the commitments involved in creating a nuclear programme and to begin development of the human expertise to manage and regulate nuclear facilities will be of prime importance to subsequent efforts to obtain financing for a nuclear power plant. Developing the confidence of the financial community requires the stable and continuing determination to competently manage the construction, licensing and safe operation of a nuclear power plant and associated facilities.

Financing for the first nuclear power plant can be pursued in a number of ways. Total financing and ownership by the government is an option if the nation's overall economic situation provides the revenue that can be dedicated for this purpose. This approach is probably not feasible for some countries. Export financing is the most likely vehicle for a nuclear power project. However, export financing will still only cover a part of the overall investment. Local or foreign commercial financing will be needed for the balance of capital cost and the covering of interest during construction. A more likely approach is obtaining private financing backed by specific government guarantees. Completely private funding by a consortium of partners seeking a return on

[2] In general, the term 'funding' refers to items that are the fiscal responsibility of a government in establishing a nuclear power programme, e.g. ensuring the necessary resources for regulation. The term 'financing' refer to items that are the fiscal responsibility of the owner/operator (whether it is the government or a private utility).

their investment through guaranteed sales of the energy from the nuclear power plant may be possible.

Credit worthiness is the first order of consideration for obtaining any project financing. Economic policy, debt management and legal risk sharing mechanisms are all important in this regard.

3.4.1. Funding and financing: Milestone 1 — Ready to make a knowledgeable commitment to a nuclear programme

As a minimum, the NEPIO should be funded to fully develop an understanding of the commitments required for the introduction of nuclear power. Of equal importance is the early funding for drafting and promulgating the necessary legislation and the expansion of an existing, or the establishment of a new regulatory body with the necessary resources to ensure competence. An understanding of the subsequent needs to fund waste disposal and decommissioning is also necessary. Establishing these conditions should demonstrate the seriousness of the nation's intentions and will likely be a prerequisite for beginning to explore financing options for a nuclear power plant.

To support a viable financial plan for nuclear power, the studies performed by the NEPIO should include the need to develop strategies for:

- Funding the efforts to create the basic infrastructure necessary to prepare for the introduction of nuclear power;
- Developing and maintaining a reasonable level of stakeholder involvement;
- Funding the creation or, hiring of, expertise to develop the necessary legislative framework;
- Funding the expansion, or creation, of a competent regulatory body, and its operation;
- Creating the expertise for competent project management for nuclear facility construction;
- Financing the creation of competent operating staff to safely manage, operate and maintain nuclear facilities;
- Financing security and safeguards arrangements for the protection of nuclear facilities and materials;
- Long term financing to ensure safe and secure handling of spent fuel, radioactive waste, plant decommissioning, and the options for disposal;
- Realistically financing a nuclear power project, given the overall national economic and social policies and conditions.

The development of strategies for the funding and financing of all elements of a national nuclear power programme will demonstrate recognition of the commitments.

3.4.2. Funding and financing: Milestone 2 — Ready to invite bids for the first nuclear power plant

Obtaining financing for a first nuclear power plant is a complex undertaking, and developing a successful plan to obtain such financing will require significant expertise.

Controlling the cost of financing will require attention to many issues. The sources of financing seek opportunities to earn a fair rate of return on their investment with confidence in their capital recovery over a reasonable period of time. These requirements apply whether the financing is public or private, but public financing may have a higher risk tolerance than private financing. However, common to both approaches is the control of risk.

Nuclear power carries some unique and significant financial risks. The occurrence of a nuclear incident causing loss or permanent shutdown of the facility and substantial damage liability bring the risk of a complete loss of investment. Construction delays, regulatory delays and delays from public intervention bring the risk of significantly increased cost, resulting in a decreased return on investment and uncertainty of timely capital recovery.

A successful financial plan should consider the nation's susceptibility to these risks and factors to minimize them. The political and economic stability of the nation, the degree of socio-political involvement, the prospects of continued economic development, the protection to foreign investment, the promulgation of legislation favorable to nuclear power, the existence of a competent regulatory body and the capability to manage large capital construction projects are all issues of interest and importance to financial institutions.

A sound financial plan is also necessary to attract vendor interest in bidding on the first nuclear power plant.

Many of the strategies for funding and financing developed in the process of becoming ready to make a knowledgeable commitment to a nuclear programme should have evolved into firm actions and plans as follows:

— A strong public and government policy in support of nuclear power;
— An established credit worthiness;
— A reasonable degree of stakeholder involvement;

— A complete legislative framework supportive of the peaceful use of nuclear power and of any financial guarantees necessary to support specific financial approaches;
— A competent regulatory framework with funding sources to fulfil its responsibilities and maintain its existence;
— Fully funded security and safeguards programmes;
— Plans in place to fully finance long term waste management and decommissioning;
— Financial plans implemented, resulting in a stable source of financing for a first nuclear power plant;
— A structure for the electricity rates and tariffs that are sufficient to ensure a return on capital investment.

Having identified and obtained a reliable source of financing and having funded the activities of the national infrastructure will satisfy the principal financial aspects required to support the request for bid for the first nuclear power plant.

3.4.3. Funding and financing: Milestone 3 — Ready to commission and operate the first nuclear power plant

After the necessary financial and funding mechanisms have been successfully implemented to complete the construction of the first nuclear power plant, the remaining financial obligations prior to operation are:

— Electricity rates and tariffs are sufficient to ensure a return on capital investment;
— Mechanisms are implemented to provide funding for decommissioning, long term spent fuel and waste management and disposal.

Financing the construction of the first nuclear power plant and providing for the funding of long term obligations satisfies the financial requirements necessary to be ready to commission and operate the first nuclear power plant.

3.5. LEGISLATIVE FRAMEWORK

The legal framework establishes the duties and responsibilities of the various organizations necessary for a successful nuclear power programme. It includes both the legislative framework and the regulatory framework.

TABLE 2. RELEVANT INTERNATIONAL INSTRUMENTS

- Comprehensive Safeguards Agreement (INFCIRC/153 Corr.)
- Additional Protocol pursuant to INFCIRC/540 (Corr.)
- Convention on Early Notification of a Nuclear Accident (INFCIRC/335)
- Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency (INFCIRC/336)
- Convention on Nuclear Safety (INFCIRC/449)
- Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (the 'Joint Convention'), reproduced in document INFCIRC/546
- Convention on the Physical Protection of Nuclear Material (INFCIR/274) and Amendment
- Vienna Convention on Civil Liability for Nuclear Damage (INFCIRC/500)
- Joint Protocol Relating to the Application of the Vienna Convention and the Paris Convention, reproduced in document INFCIRC/402
- Protocol to Amend the 1963 Vienna Convention on Civil Liability for Nuclear Damage
- Convention on Supplementary Compensation for Nuclear Damage
- Revised Supplementary Agreement concerning the provision of Technical Assistance by the IAEA

Because of the importance of each of these components, these frameworks have been treated in separate parts of this guide.

Nuclear power programmes cannot be operated in isolation. Legislation should therefore implement, or authorize implementation of, any international instruments to which the government is a party. Table 2 lists the key international instruments that should be considered. National legislation should cover, in a comprehensive manner, all aspects of nuclear law, i.e. nuclear safety, security, safeguards and liability for nuclear damage.

While the legislation may address both the enabling and regulatory aspects of nuclear power, general experience suggests that safety and credibility are best served by institutionally separating the two functions. Therefore, the legislation should provide for an effective separation between the functions of the regulatory body, and those of any other body or organization concerned with the promotion or utilization of nuclear energy

As stated in Section 2.2, any Member State considering embarking on a programme of nuclear power should have in place a national infrastructure for radiation, waste and transport safety that is in compliance with international standards and covers all current activities, practices and facilities in that Member State. In overseeing the development of the necessary legislative

framework for a nuclear power programme, NEPIO should make use of the experience and knowledge gained in developing and implementing the existing national safety infrastructure.

Nuclear law is a specialized field. Professional input from experts is highly desirable to completely understand and correctly formulate the appropriate legislation. However, the legislation should be consistent with national legal and political traditions, institutions, economic circumstances, level of technological development and cultural values. The legislation needs to be in place early in the development effort for a nuclear programme.

3.5.1. Legislative framework: Milestone 1 — Ready to make a knowledgeable commitment to a nuclear programme

A fundamental understanding of the requirements for a legislative framework should be developed by the government and NEPIO, and be discussed with the appropriate government institutions and agencies. Clearly the knowledge and experience of the regulatory body for the control of radiation sources is a valuable resource in this respect. Also, the existing legislative framework for radiation, waste and transport safety needs to be taken into account.

The basic elements to recognize what will have to be accomplished include:

- Legislation dealing with the national energy policy, economic and commercial considerations, with a clear designation of responsible institutions or bodies, including their relationships with nuclear power;
- Legislation dealing with establishing effectively independent regulatory authorities, a system of licensing, inspection and enforcement and including all subject areas of nuclear law, i.e. radiation protection, radioactive material and radiation sources, the safety of nuclear installations, emergency preparednes and response, mining and milling, transport, radioactive waste and spent fuel, nuclear liability and coverage, safeguards, export and import controls, and physical protection.
- Legislation on foreign investment, including the roles of foreign entities, vendors and suppliers, and intellectual property rights;
- Legislation dealing with the roles of national government, local government, stakeholders and the public;
- Legislation dealing with fuel cycle issues in general and the ownership of nuclear material;
- Provision for the development of human resources to ensure the continued integrity of the nuclear programme;
- The commitment to use nuclear power for peaceful purposes.

3.5.2. Legislative framework: Milestone 2 — Ready to invite bids for the first nuclear power plant

All legislation dealing with the nuclear power programme, including the financial aspects, needs to have been developed, promulgated and in force prior to proceeding with a request for bid for the first power plant.

Appropriate national legislation required to be enacted pursuant to the relevant non-proliferation undertakings of the State should be in place. The responsibility for safety, security and safeguards has been clearly established.

Legislation has been enacted that specifies the allowed ownership of nuclear facilities and nuclear materials. The legislation establishes clear responsibilities and liabilities for the operation of nuclear facilities and the handling and safeguarding of nuclear material.

Legislation has been adopted that establishes an effectively independent regulatory body with full authority to implement the functions assigned to it by the enabling legislation. Budget appropriations are made to support the establishment and staffing of the regulatory body. .

The laws protecting foreign investment and intellectual property have been supplemented if necessary to support industrial contracting. If appropriate for the financing strategy, legislation providing funding or guarantees is adopted. Also, funding of appropriate human and physical facilities development is established.

3.5.3. Legislative framework: Milestone 3 — Ready to commission and operate the first nuclear power plant

Comprehensive legislative oversight in the country is established. Appropriate funding or guarantees remains in place. The funding of appropriate human and physical facilities development and legislative support continues, as necessary. The legislative framework should be maintained and amended as necessary during the life of the nuclear power programme.

3.6. SAFEGUARDS

Reference is made to international treaties and agreements, such as the Treaty on the Non-Proliferation of Nuclear Weapons (NPT), wherein States Party to the NPT undertake to accept safeguards. These safeguards would be set forth in an agreement to be negotiated and concluded with the IAEA for the exclusive purpose of verification of the fulfillment of obligations assumed

under such treaties with a view to preventing the diversion of nuclear energy from peaceful uses to nuclear weapons or other nuclear explosive devices.

In this regard, a government contemplating a nuclear power programme should have a clear understanding of, and commitment to, its international non-proliferation obligations as well as of its safeguards agreement with the IAEA. This knowledge will provide an understanding of the safeguards commitments inherent in the use of nuclear power, and give support to the State's implementation of an effective strategy for meeting its safeguards obligations.

3.6.1. Safeguards: Milestone 1 — Ready to make a knowledgeable commitment to a nuclear programme

Non-nuclear weapon States that are party to the NPT should have a comprehensive safeguards agreement (CSA) conforming to INFCIRC/153 (Corrected), which is in force with the IAEA. Many States with a CSA have also concluded an additional protocol (AP) on the basis of INFCIR/540 (Corrected), providing for the implementation of the IAEA's strengthened safeguards system. Many States that do not have any nuclear facilities have concluded a small quantities protocol (SQP), which has the effect of holding in abeyance many of the detailed provisions of the CSA. The CSA together with the AP contain specific obligations undertaken by the State to accept safeguards, and the necessary rights and tools for the IAEA to implement safeguards in order to provide a credible assurance that the State complies with its obligations under the NPT for the exclusively peaceful use of nuclear energy. The implementation of safeguards is applied as appropriate to the nuclear material and activities within the State or anywhere under the control or jurisdiction of the State.

In order to exercise the required State control and to facilitate cooperation with the IAEA in implementing the provisions of CSAs and APs, the State should establish and maintain an adequate SSAC. This is an obligation under the CSA independent of the amount of nuclear material or the extent of nuclear applications in the State. The establishment of an SSAC serves a useful purpose; that is, to ensure the effective implementation of the safeguards that are applied. In this respect, the recognition of the need to implement the following factors are considered of primary importance when establishing safeguards in any State:

— Cooperation between the State, facility operator and IAEA in safeguards implementation;
— Adequacy of the SSAC in relation to IAEA requirements for accounting for and control of nuclear material;

— Capability of the IAEA to independently verify the completeness and correctness of the State's declaration, which has been reported in accordance with its safeguards agreement.

3.6.2. Safeguards: Milestone 2 — Ready to invite bids for the first nuclear power plant

In the preliminary stages of the development of a nuclear programme, the SSAC would not necessarily involve a large number of staff, possibly one or two individuals, whose primary objective would be to make provision of information available to the IAEA and implement those safeguards relevant activities to be performed in accordance with the applicable safeguards agreement(s). Such an activity would, for example, include early provision of design information to the IAEA once a decision to construct a nuclear power plant has been made by the government.

As the development of nuclear programme planning proceeds, the SSAC's organizational and functional responsibility should be adjusted by the State in the manner deemed appropriate in order that the State can continue to fulfill its safeguards obligations in an effective manner. Additionally, the terms of all international and/or regional instruments to which the government has adhered, or intends to adhere, should be examined to ensure that its national legislation is consistent with the obligations arising out of those instruments.

A State should provide early information to the IAEA on its plans related to the nuclear fuel cycle, research efforts, locations where nuclear material may be used, and the export and import of materials and items subject to the relevant safeguards instruments. Guidelines and training have been developed by the IAEA, which are available to assist the State in these matters.

Depending on the policy decisions made by the State in support of developing a nuclear power infrastructure and the nature of the State's existing legislation, rules and regulations, the State may need to prepare relevant safeguards specific legislation, rules, regulations and procedures. For example, as the country plans to develop/utilize nuclear materials and nuclear technology, import–export controls may need to be adjusted or established, and effectively implemented in accordance with the State's national laws/regulations. In this respect, organizations and programmes for the effective implementation and enforcement of such legislation should be planned, and assurance of this status necessary prior to requesting a bid for the first nuclear power plant.

3.6.3. Safeguards: Milestone 3 — Ready to commission and operate the first nuclear power plant

Safeguards measures are typically applied to all nuclear material, and as appropriate to nuclear relevant activities and facilities, under the control or jurisdiction of the State. Prior to achieving milestone 3, national legislation and regulation on safeguards should clearly identify the nuclear activities, installations, facilities, locations and material to which safeguards will be applied. All other elements of the safeguards infrastructure, including the SSAC and facility operator staff being trained and appropriately equipped, should be in place and a process for effectively maintaining them, prior to the receipt of the initial fuel for the first nuclear power plant.

3.7. REGULATORY FRAMEWORK

Crucial to the long term success of a national nuclear power programme is the existence of an independent and competent nuclear regulatory body. The confidence of the public and the international community depends on an effective regulatory body. The essential need for a competent and effective regulatory body should be understood and given high priority by the NEPIO, in close consultation with the existing regulatory body for the control of radiation sources. The development of competent human and physical resources for the expanded, or new, regulatory body is as important as it is for the owner/operator organization. The technical training, knowledge and capabilities of the regulator should be adequate for competent interaction with the owner/operator, supplier organizations and consultants.

Experience has shown that safety and credibility are best served by a complete separation of the regulatory body from the promotional and implementing organizations and the political process. While not all governments have begun their nuclear programmes with this provision, virtually all are adopting this approach.

Member States embarking on a nuclear power programme should consider the efficiencies of building on the national infrastructure already in place for radiation, waste and transport safety. Expanding the existing regulatory body to take on the role as regulator for a nuclear power plant would seem to offer significant advantages in terms of utilizing resources (facilities and human) that are likely to be limited in many Member States.

The body of regulation to fully support a nuclear programme is extensive. Some governments have begun the process by adopting the regulations of the governments supplying the first nuclear power plant. This is an acceptable

approach, provided it is consistent with the established laws. However, over time and as the staffing and experience of the regulatory body increases, it is desirable to adapt that regulation to local and cultural conditions.

The following discussion addresses the conditions of the regulatory framework at each milestone in the development process.

3.7.1. Regulatory framework: Milestone 1 — Ready to make a knowledgeable commitment to a nuclear programme

The fundamental elements of a regulatory framework include:

- Designation of an effectively independent regulatory body, with clear authority and adequate human and financial resources;
- Assignment of core regulatory functions for the development of regulations, for licensing, review and assessment, inspection, enforcement and public information;
- Authority to obtain technical support as needed;
- Clear definition of the relationship of the regulatory body to other organizations;
- Establishment of the rights and responsibilities of licensees;
- Authority to implement international obligations, including IAEA safeguards;
- Authority to engage in international cooperation;
- Provisions to protect proprietary, confidential and security information;
- Provisions for stakeholder and public information and interactions;
- Compatibility with the existing regulatory framework for radiation, waste and transport safety.

3.7.2. Regulatory framework: Milestone 2 — Ready to invite bids for the first nuclear power plant

The legislation developed under the legislative framework will establish the appropriate effectively independent regulatory body and scopes of authority. After the legal requirements are in place the regulatory body is fully established and empowered in accordance with the enabling legislation. Mechanisms have been established for open communications with the owner/operator organization. Such mechanisms are transparent so that the independence of the regulatory body is evident. The focus remains on the competent consideration of safety issues. The entire licensing process should be developed and publicized so it is clear to all stakeholders. The regulatory

criteria for acceptance and approval of the nuclear power plant design should be determined prior to issuance of power plant bid.

At this stage of development, the important priority issues for regulatory attention are:

— Overall organization, staffing and training;
— Safeguards;
— Security;
— Nuclear and radioactive materials transportation, handling and storage;
— Radiation protection;
— Formal licensing process;
— Regulations, codes and standards for siting, design, construction, and operation necessary for licensing a nuclear power plant, including the management system;
— Emergency preparedness requirements (site, off-site, national);
— Establishment of international relationships with other regulatory bodies;
— Waste management, including disposal considerations.

Appropriate regulations, codes and standards have been developed or amended and issued for:

— The import/export, transshipment, transportation, storage and handling of nuclear and radioactive material;
— Radiation protection;
— Site environmental assessment and licensing;
— Nuclear plant siting, design, construction and commissioning;
— Security and safeguards;
— Waste management;
— Emergency planning.

Competent staff is in place to:

— Perform licensing of sites;
— Review, assess and license nuclear plant designs;
— Develop programmes for the inspection and oversight of nuclear construction;
— Develop requirements for operator training and certification;
— Prepare for operational inspection and oversight.

The regulatory body is in place with plans to augment the staff as necessary to perform its functions during the various phases of plant licensing, construction, commissioning and operation.

3.7.3. Regulatory framework: Milestone 3 — Ready to commission and operate the first nuclear power plant

All regulations, codes and standards for nuclear plant construction are in place and staffing is sufficient for the efficient and effective review and licensing of a nuclear facility. Regulatory requirements for plant operator training and certification have been developed. The regulatory body has confirmed that the licensee has demonstrated compliance with the relevant regulatory requirements.

Prior to plant commissioning the regulatory body remains competent in all aspects of nuclear licensing and oversight. Plans to maintain competent staff and develop future staff are in place. Open communications with the government, the operator and the public is being maintained. International and professional interfaces are being maintained.

Prior to criticality and operational testing the regulatory body have issued the licenses and permits required to operate a nuclear facility. The staff is in place and fully competent to review and oversee the operation and maintenance of the plant in accordance with formally established programmes.

A competent, independent regulatory body is in place to inspect the activities of all nuclear facilities and ensure compliance with license conditions and other regulatory requirements throughout the life of the facility.

3.8. RADIATION PROTECTION

Laws, regulations and monitoring programmes are necessary to ensure worker, public and environmental protection under all circumstances. Most countries have some provisions for radiation protection because medical, industrial and research applications of ionizing radiation are applied throughout the world. A Member State considering nuclear power would be expected to have in place a national infrastructure for radiation, waste and transport safety that is in compliance with international standards and covers all current activities, practices and facilities in that Member State. While the radiation protection aspects of a nuclear power programme require special consideration, the existing infrastructure should continue to form the basis for radiation protection. Appropriate expansion to cater for the special needs of a nuclear power programme would then take place.

3.8.1. Radiation protection: Milestone 1 — Ready to make a knowledgeable commitment to a nuclear programme

The NEPIO should develop an understanding of the additional hazards presented by nuclear power plant operation over and above those posed by medical, industrial and research applications of ionizing radiation. The Basic Safety Standards and other IAEA safety standards provide guidance for operators and regulators to establish radiation protection requirements and practices. The IAEA safety standards consider the guidelines produced by the International Commission on Radiological Protection and the scientific knowledge on consequences of radiation exposure presented in the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR).

The realization of the radiation hazards posed by nuclear power plant operation and nuclear material transportation and storage, as well as waste management, and the need to enhance national laws and programmes provides recognition of the commitments required in this area.

3.8.2. Radiation protection: Milestone 2 — Ready to invite bids for the first nuclear power plant

Although the radiation hazards associated with nuclear power plant operation will not be present for some time, preliminary actions to prepare adequate protection programmes should be taken:

— Reviewing existing laws governing radiation protection and ensuring that legislation needed for enhancement has been promulgated;
— Development of specific regulations by the regulatory body;
— Planning by the owner/operator for programmes for worker, public and environmental monitoring and protection;
— Identification of specific challenges for environmental monitoring at the chosen site, and development of plans to resolve them;
— Characterization and measurement of background sources of radiation at the site.

3.8.3. Radiation protection: Milestone 3 — Ready to commission and operate the first nuclear power plant

It is necessary to have all radiation monitoring and protection programmes implemented prior to the time radioactive material first arrives on site. Therefore, by the time of initial fuel delivery, the conditions necessary include:

— Radiation monitoring equipment in place and operational both on and off-site;
— Fully implemented site environmental monitoring programme;
— Functioning off-site radiation monitoring programmes;
— Radiation dosimetry requirements in place for all workers;
— Development of programmes to optimize radiation exposure during plant operation and maintenance;
— Waste management capabilities in place.

3.9. ELECTRICAL GRID

Fundamental to the decision to employ nuclear power as part of a national energy strategy is the size and configuration of the national electrical grid. A generally accepted principle is that a single power plant should represent no more than 5–10% of the total installed capacity. Although exceptions do exist, this is important for a nuclear power plant for two reasons. First, nuclear power plants are most efficiently run as base load generation and the dispatching of their full capacity should be possible. Second, grid reliability is an important consideration in nuclear safety, requiring a reliable supply of electricity independent of plant output. A reliable grid is necessary even if the application of the nuclear plant is for desalination or process heat since off-site power is important for safe operation. Therefore, an early consideration in the decision to implement a nuclear power programme is an assessment of the current and future planned state of the national electrical grid.

3.9.1. Electrical grid: Milestone 1 — Ready to make a knowledgeable commitment to a nuclear programme

The study conducted by the NEPIO looks at the appropriate role for and the compatibility of nuclear power in the nation's sustainable development strategy. One of the key elements for consideration is the electrical grid requirements to support deployment of a nuclear power plant.

Key issues for consideration are:

— The existing grid and generating capacity in relation to the available nuclear power plant technology;
— The anticipated future growth of grid capacity;
— The historical stability and reliability of the electrical grid;
— The potential for local or regional interconnections to improve grid characteristics.

Consideration of the issues for grid size, structure and reliability provides recognition of the conditions of the electrical grid for the deployment of a nuclear power plant

3.9.2. Electrical grid: Milestone 2 — Ready to invite bids for the first nuclear power plant

The NEPIO identified the requirements for grid compatibility for a nuclear power plant deployment. The electric utility, in conjunction with the plant owner/operator (if different) should undertake the detailed studies to determine the necessary expansion, upgrade or improvement necessary to accommodate a plant of the anticipated size and technology built at the chosen site.

The electric utility should have in place:

- Plans for grid enhancement and/or expansion compatible with the expected increased generating capacity;
- Plans to increase or strengthen regional interconnects to achieve acceptable grid reliability;
- Plans to provide redundant, reliable sources of off-site power for the nuclear power plant;
- Funding and schedules compatible with the construction and commissioning of a planned nuclear power plant.

The existence of plans, funding and schedules for grid enhancement compatible with the construction and commissioning of the planned plant provides a reasonable basis to conclude that the grid will be ready to accommodate such a plant.

3.9.3. Electrical grid: Milestone 3 — Ready to commission and operate the first nuclear power plant

The execution of the plans adopted above should create the necessary conditions to successfully commission and operate a nuclear power plant. The electric utility, in conjunction with the owner/operator (if different) should:

- Ensure coordination of grid operations(central grid operations) with power plant operations;
- Verify the completion of all upgrades and enhancements to the grid and interconnections;
- Test the reliability of the grid system;

— Install and test the redundant off-site power supplies to the nuclear power plant.

Establishing these conditions will demonstrate the readiness of the grid to support the commissioning and operation of a nuclear power plant.

3.10. HUMAN RESOURCE DEVELOPMENT

The knowledge and skills necessary to purchase, properly construct, licence, operate, maintain and comply with regulations of a nuclear power plant are spread across most scientific and engineering disciplines. While much of the knowledge and skills necessary for plant construction are the same as for any large facility, there are specific considerations for nuclear construction. Additional knowledge and appreciation of the increased attention to detail to ensure operational safety, security and radiation protection are vital and require a heightened attention to the quality of major systems and equipment. Specific expertise in nuclear physics and nuclear materials science for reactor operation and fuel cycle management is crucial. Operation and maintenance require this same special attention and differentiate nuclear power plant operation from conventional power plants. Along with the technical skills a strong commitment to a safety culture which instills a personal responsibility for the safety of all individuals involved in the programme is necessary.

Human resource development needs vary widely, depending upon the national decision to fill the needs through indigenous development or purchase the capabilities through a turn key project. Even if a turn key project is the preferred approach, consideration of developing indigenous capabilities should be considered for the long term. The development of such indigenous capabilities will require significant attention to education and training.

In addition to fundamental scientific and technical education, nuclear workers typically require several years of specialized training in safety, security and radiation protection, and in the design and operation of the specific technology chosen for deployment. The specialized training, and even the fundamental education to some extent, can be obtained from the vendors and suppliers of the nuclear system and its systems and components. However, it is desirable for a nation to develop its own educational and training capabilities to better assure the long term availability of the crucial human resource and to provide opportunities for its citizens. While the development of human resources requires investment, this investment brings overall benefit to the economic development of the nation.

3.10.1. Human resource development: Milestone 1 — Ready to make a knowledgeable commitment to a nuclear programme

An important element of the responsibilities of the NEPIO is to identify the knowledge and skills needed to develop and sustain a safe, secure and efficient nuclear power programme. Whether the knowledge and skills are to be purchased or developed, they should fully exist. A plan to develop and maintain a human resource base possessing the knowledge and skills should be developed in conjunction with all parties to be involved in the nuclear power programme. The practicality of this plan should be part of the initial information used in making the decision to proceed with the development of nuclear power. Even if much of the initial knowledge and skills are to be provided by foreign sources of manpower, long term knowledge and skills to manage and oversee the project should be developed and kept within the nation.

Important areas for consideration by the NEPIO include:

- Evaluating the attitudes and organizational culture prevailing in the national industries and management, their suitability for the nuclear environment, and practicality of instilling a safety culture in the required period of time;
- Recognition of the full range of scientific and technical disciplines needed for a fully functioning nuclear power programme;
- Assessment of the availability of those disciplines within the nation;
- Assessment of the educational capabilities within the nation or from foreign sources to produce individuals for those disciplines;
- Identification of the specialized training needed for even experienced personnel in nuclear safety, security, safeguards, radiation protection and management system;
- Assessment of the availability of specialized training from either foreign or domestic sources;
- Development of firm plans to obtain, either by purchasing or developing, the resources necessary for the initial start of the nuclear programme;
- Development of firm plans to obtain the flow of human resources over the life of the nuclear programme.

Recognition of all necessary prerequisites for the competence — including knowledge, skills and attitudes — of personnel involved in the nuclear programme is essential. In particular, the full range of scientific and technical disciplines and specialized training needed for for a nuclear power programme should be identified, reflecting the choices made about the

programme and the degree of localization of technology and firm plans to obtain and sustain those resources.

3.10.2. Human resource development: Milestone 2 — Ready to invite bids for the first nuclear power plant

To be prepared to issue a bid request for the first nuclear power plant, the majority of the total human resources will need to be in place. Staff need to be in place with a basic knowledge of the specific technologies chosen to prepare the bid specification and evaluation criteria. Staff should be available to evaluate and select a winning candidate from a technical, management, business and economic perspective. Of fundamental importance is the existence of a well qualified regulatory personnel developing the regulations, codes and standards by which the plant will be licensed nationally. While licensed operators and maintenance technicians need not be in place, some knowledge of operational and maintenance requirements need to exist within the team. Initial education and training for the remaining resources to fully support plant operation should begin at this time.

Specific human resource needs at this time may include, depending on the acquisition strategy:

— Business and technical expertise to develop technical and scientific expertise for site qualification and preparation of the construction permit request;
— Political and social expertise for public communication;
— Technical and regulatory expertise to develop and implement regulations, codes and standards for plant licensing, site approval, operator licensing, radiation protection, safeguards, physical protection, emergency planning, waste management and decommissioning;
— Business and technical expertise for fuel cycle procurement and management;
— Expertise to conduct training programmes for construction project management and the management system;
— Expertise to conduct training programmes for operation and maintenance personnel for system turnover and eventual operator licensing;
— Plans to fully staff and train the regulatory body for operational oversight;
— Plans to fully staff and train operating, maintenance and support organizations;

— Plans to develop future expertise in all relevant areas, including any needed enhancements to the national educational institutions.

3.10.3. Human resource development: Milestone 3 — Ready to commission and operate the first nuclear power plant

Virtually all of the human resources should be in place to be ready to commission and operate the first nuclear power plant. Educational and training programmes to develop a continuing flow of qualified people to all areas of the programme should be well under way.

Specific human resource requirements at this time include:

— A fully staffed nuclear power plant operation, maintenance and technical support organization;
— A fully staffed regulatory body with specific expertise in operating plant oversight;
— Succession and personnel development planning to sustain the competence of all areas of the national nuclear programme;
— Enhanced educational opportunities for nuclear science and technology;
— Enhanced training programmes for the development of operator and technicians.

3.11. STAKEHOLDER INVOLVEMENT

Strong, continuing government support is necessary through all phases of a nuclear programme. Government support can only be sustained through a positive political atmosphere. A positive, stable political atmosphere requires a reasonable degree of general stakeholder involvement.

Stakeholders are defined in this guide as those who have a specific interest in a given issue or decision. The group includes the general public. There are normally two types of stakeholders: internal, and external. Internal stakeholders are those involved in the decision making processes, while external stakeholders may be affected by the potential outcome of the project. The involvement of both stakeholder groups can be essential to achieving project goals and objectives and can contribute substantially to safety.

General public involvement is best achieved through an open and honest dialogue between proponents of the nuclear programme (e.g. government, utilities and the owner/operator) and other stakeholders. The principal and most influential stakeholders are the societal opinion leaders, e.g. national and local government officials, heads of business and industry, the media and

leaders of non-governmental organizations. However, all concerned citizens should be provided with relevant information and have opportunities to participate in the dialogue.

Since nuclear power has the potential for causing concern across national boundaries, a dialogue with neighbouring countries should also be undertaken.

While open information programmes are important, in the final analysis sustained, successful socio-political involvement will depend on the competence and credibility of the organizations and individuals responsible for the nuclear programme. Competence of the regulatory body and the owner/operator is vital to maintain public confidence.

3.11.1. Stakeholder involvement: Milestone 1 — Ready to make a knowledgeable commitment to a nuclear programme

One of the commitments to be understood by the government as it contemplates a nuclear power programme is the importance of gaining and keeping the confidence of the nation and the international community by maintaining open and timely interaction and communication regarding all aspects and activities of the programme.

The government and the NEPIO should begin to address this commitment from the very beginning. Expert consultants in the areas of public communication and education may be employed to assist the efforts. However, national leaders are in the best position to understand and relate to the social and cultural norms of their society and should provide the necessary guidance.

The appropriate conditions at this phase are to plan to:

— Conduct surveys or public opinion polls to determine the degree of knowledge and receptiveness to the local use of nuclear power;
— Develop pubic information tools that respond to the surveys and clearly explain the reasons for the government interest in and the societal benefit to resulting from the use of nuclear power;
— Develop and implement a plan of interaction with opinion leaders and other stakeholders, including neighbouring countries;
— Train and have available senior spokespersons to interact with stakeholders in response to any request.

These initial conditions should build a strong public information and education programme that should help to gain and keep the confidence of the national and international communities.

3.11.2. Stakeholder involvement: Milestone 2 — Ready to invite bids for the first nuclear power plant

While the government and the NEPIO begins the process for gaining and maintaining socio-political involvement, other organizations should join the effort as they are created. The regulatory body and the owner/operator organizations should develop public information and education programmes and engage in public dialogue as they form and begin to exercise their responsibilities. Effective public communication is a skilled discipline and those involved should receive professional training.

The appropriate conditions to be established for each organization are:

— The government should continue to communicate the reasons for and expected benefits of the introduction of nuclear power and remain responsive to expressions of concern as the implementation moves forward;
— The regulatory body should explain its independent role in licensing and inspecting all nuclear activities to ensure compliance with safety regulations and standards;
— The regulatory body should decide upon and communicate the formal process for public participation in the licensing process and should declare its openness to public participation;
— The owner/operator should explain the basic technology being employed and the plans for construction activities;
— All organizations should openly discuss problems and difficulties encountered and the plans to successfully resolve them;
— All organizations should communicate with one another in a transparent and professional manner demonstrating understanding and respect for their respective roles.

The participation of all organizations in an open, effective public communications programme should maintain the socio-political involvement required to demonstrate the readiness for requesting a bid for the first nuclear power plant.

3.11.3. Stakeholder involvement: Milestone 3 — Ready to commission and operate the first nuclear power plant

By the start of construction of the nuclear power plant, each of the organizations involved should have established reasonable credibility with the

stakeholders and the public. The communication efforts should continue throughout the construction and preparation for operation.

The appropriate conditions to be established for each organization are:

— The government should continue to explain its rationale for introducing nuclear power, addressing the balance of benefits and costs/risks considered for the safe, secure and peaceful application of nuclear power;
— The regulator should continue to communicate the progress of the licensing process and the planned operational inspection programme;
— The regulator should provide opportunities for appropriate public involvement in the licensing and inspection process in strict compliance with the formal process adopted and previously explained;
— The owner/operator should routinely communicate the progress of the construction programme and the preparations for operation;
— All organizations should continue to openly discuss problems and difficulties encountered and their resolutions;
— All organizations should continue to interact with one another in a transparent and professional manner.

Continued pursuit of an open public communications effort should maintain the socio-political involvement supportive of commissioning and operating the nuclear power plant.

3.12. SITE AND SUPPORTING FACILITIES

Site selection and evaluation are a crucial part of establishing a nuclear power programme and can be significantly affected by costs and public acceptance. Site surveys are necessary to determine the availability and suitability of potential sites. General surveys should initially categorize and rank potential sites in order of merit by a set of criteria reflective of national and cultural considerations. As nuclear programme development proceeds, the sites should be narrowed to those most favorable and the final site selected for characterization for the bid specification. The selected site should be secured at an early time to ensure its availability and integrity.

In addition to the nuclear power plant, the sites for other facilities, such as interim spent fuel storage or other fuel cycle and waste processing facilities, should be studied with the same care and attention. Transportation options between facilities are also important to consider. Physical infrastructure to house and support workers, to provide ready access for equipment delivery, to

accommodate water and electricity needs and to minimize the impact on local communities should be carefully reviewed for all nuclear related sites.

The important elements of site study and characterization include:

— Ease of integration into the electric system;
— Geology and tectonic;
— Seismology;
— Heat removal capability;
— Hydrology;
— Demography;
— Meteorology;
— Nuclear safety and radiation protection aspects;
— Environmental effects;
— Risks from man-made events;
— Availability of local infrastructure;
— Ease of access;
— Legal aspects;
— Public interaction;
— Vulnerability to malicious acts.

3.12.1. Site and supporting facilities: Milestone 1 — Ready to make a knowledgeable commitment to a nuclear programme

The NEPIO should conduct general surveys largely on the basis of existing data and information about each of the above elements should be considered, at least to a preliminary degree. Sites identified should be ranked in order of merit. Site surveys may be subdivided into three distinct phases:

— Regional analysis and identification of potential sites;
— Screening of potential sites and selection of candidate sites;
— Comparison of candidate sites.

The general knowledge of available sites and their relative merit should serve to provide recognition of the commitments with respect to siting nuclear facilities. The IAEA safety standards provide one way to establish requirements and guides for site evaluation.

3.12.2. Site and supporting facilities: Milestone 2 — Ready to invite bids for the first nuclear power plant

A much more detailed site characterization is completed for one or more sites that meet the national criteria for nuclear facility application. The important elements listed above should be treated in detail.

The important steps that should have been taken at this time include:

- One or more suitable sites have been carefully characterized and selected;
- The site(s) have been secured to ensure their availability and integrity;
- Local legal, political and public acceptance issues have been identified and resolutions implemented or planned;
- Appropriate site(s) characteristics have been included in the bid specification;
- Necessary improvements or upgrades to local infrastructure such as site(s) access, services and facilities have been identified and planned;
- Environmental monitoring should be initiated to establish the baseline situation.

The completion of site characterization, the assurance of availability, and the provisions for local infrastructure improvements provide the suitable site(s) for the bid for the first nuclear power plant.

3.12.3. Site and supporting facilities: Milestone 3 — Ready to commission and operate the first nuclear power plant

By the time the first fuel arrives on the selected site:

- All site services will be in place and be functional;
- All site security will be in place;
- All site environmental monitoring will be under way;
- Emergency planning provisions are fully in place, including protocols with local and national government, including appropriate international arrangements;
- Routine communication with local authorities and the public is taking place.

3.13. ENVIRONMENTAL PROTECTION

Environmental protection should receive careful attention as a nuclear programme is contemplated. A specific consideration with nuclear power production is the release of gaseous and liquid radioactive effluents during normal plant operation. Large releases of radiation are low probability events which are more appropriately treated through the nuclear safety programme. Land use, water use and quality and other more conventional environmental impacts should also be considered. The overall impact will vary depending on the facilities needed as determined by the fuel cycle strategy adopted. The impact of other facilities related to the nuclear power plant should be considered as well.

3.13.1. Environmental protection: Milestone 1 — Ready to make a knowledgeable commitment to a nuclear programme

The unique environmental issues associated with nuclear power should be analysed by the NEPIO. The construction and operation of nuclear facilities should receive the same scrutiny and compliance with the national environmental laws and regulations as any other energy source or industrial facility. The potential environmental impacts and improvements should be communicated as part of the overall nuclear development programme.

The following issues should be considered:

- Land use, water use and environmental effects of low level radioactive effluents from normal operation and maintenance represent the major environmental issues for nuclear power facilities;
- Existing environmental laws and regulations may need to be reviewed and enhanced to cover nuclear facility construction and operation;
- The responsibilities of the regulatory body and other environmental agencies should be clearly defined;
- Formal environmental studies and reports should be conducted early, beginning with site categorization and selection.

Attention to these issues will demonstrate recognition of the commitments associated with this milestone.

3.13.2. Environmental protection: Milestone 2 — Ready to invite bids for the first nuclear power plant

Environmental studies should be performed for the potential or selected site for nuclear facilities to ensure that environmental laws and regulations can be met and particular environmental sensitivities identified. Particular environmental sensitivities should be addressed in the bid specification where unique plant design provisions or construction techniques are necessary to address those sensitivities.

Issues for consideration include:

- Pathways for effluent transport and concentration in the surrounding environment;
- Predominant plant and animal life and their particular sensitivities;
- Local population demographics and trends;
- Predominant land use;
- Water use and the possible need for cooling towers;
- Impacts of construction activities on the local environment.

Early knowledge of the environmental characteristics of the intended sites and the identification of design or construction provisions to address them satisfy the conditions for this milestone.

3.13.3. Environmental protection: Milestone 3 — Ready to commission and operate the first nuclear power plant

Assurance that the environmental laws and regulations will be complied with should have been accomplished as part of the licensing process for the site and the nuclear power plant. Programmes for monitoring and assessment should be fully implemented.

Conditions that should have been established or are under way include:

- Identification of specific environmental requirements and their inclusion in the licensing conditions for facility operation;
- Complete characterization of the site and its surroundings to create a baseline condition;
- Development and full implementation of environmental monitoring programmes in accordance with international standards.

3.14. EMERGENCY PLANNING

Nuclear plants are designed and operated with full attention to safety. Safety system design minimizes the probability of radiation release from the plant. However, the probability is not zero and accidents have happened. The two most serious accidents, Three Mile Island and Chernobyl, demonstrated that emergency planning for the protection of plant personnel, emergency workers and the public beyond the site boundary is a necessary element of overall plant safety and provides an additional level of defence in depth.

3.14.1. Emergency planning: Milestone 1 — Ready to make a knowledgeable commitment to a nuclear programme

In studying the requirements for a nuclear power programme, the NEPIO should develop an appreciation of the need for emergency planning. While emergency planning requirements are set by the regulatory body, in accordance with national law, and implementation is the responsibility of the owner/operator, it is necessary to involve local and national government. Emergency sheltering or public evacuation may be recommended by the owner/operator, but the authority to order them remains with local governmental authority. The provisions made for public protection by emergency planning should be communicated as part of the public information effort.

An appreciation of the importance of emergency planning and the agreement on allocation of roles of the owner/operator and governmental authority as well as consideration for future membership to the conventions on early notification of a nuclear accident and on assistance in the case of a nuclear accident or radiological emergency demonstrate recognition of the commitments for emergency planning.

3.14.2. Emergency planning: Milestone 2 — Ready to invite bids for the first nuclear power plant

While all implementation details do not need to be in place, the detailed approach to emergency planning begins when deciding on site selection. Emergency preparedness plans should consider both the nuclear power plant and the surrounding community. Issues of importance at this time include:

— Basic regulations requiring emergency planning have been developed;
— Threat assessments have been performed;
— Plans for emergency response and concept of operations have been formulated;

— Procedures for protecting emergency workers have been formulated;
— Demographic characteristics of the selected site or sites have been studied as part of the site evaluation and licensing;
— Procedures for provisions for public notification, information and instructions have been included as part of site preparation;
— Approaches for sheltering and public evacuation have been considered and any impediments identified;
— Procedures for medical response have been formulated;
— Procedures for immediate and long term environmental protection have been formulated;
— Procedures to deal with non-radiological consequences have been considered;
— Necessary agreements for local and national authority participation have been identified and preliminary discussions held.

Establishing the conditions to prepare for the effective implementation of emergency planning will provide confidence in the plans at the time of plant operation.

3.14.3. Emergency planning: Milestone 3 — Ready to commission and operate the first nuclear power plant

By the time the first nuclear fuel arrives on site, all preparations for emergency planning should be completed and tested. The necessary conditions to be established include:

— All plans have been finalized into firm programmes and procedures and have been implemented;
— The regulatory body has reviewed and approved the emergency plans;
— Protocols and procedures between the owner/operator, local and national authorities and the regulatory body have been developed and are in place;
— Emergency notification systems are in place and thoroughly tested;
— Impediments to sheltering and evacuation have been removed;
— Emergency drills and exercises have been run — with the participation of local and national organizations and demonstrations given to the regulatory authority — to test and to ensure the effectiveness of the emergency arrangements.

3.15. SECURITY AND PHYSICAL PROTECTION

Security and physical protection are intended to prevent malicious acts by inside or outside adversaries that might endanger the public or the environment. Programmes for security and physical protection for the nuclear power plant and other facilities, nuclear material, fuel, and radioactive waste transportation, and storage need to be provided at all times. Nuclear security requires the concerted effort and commitment of all organizations involved in planning, designing, constructing and operating a nuclear power plant. To be effective, it is critical that these organizations acknowledge the importance of nuclear security and embrace a nuclear security culture. Guidance on nuclear security is available in the IAEA Nuclear Security Series.

Laws providing authorities for nuclear security and criminal penalties for infractions are necessary. An on-site security staff is needed as a first level of prevention. Agreements with local and national authorities augment the on-site staff and provide a second level of prevention. Programmes for careful staff selection and qualification for access to nuclear facilities or material help to ensure the absence of internal threats or collaboration with external threat entities. Security plans and procedures should be carefully coordinated with nuclear safety requirements so that conflicts do not result in an increased risk to the public.

3.15.1. Security and physical protection: Milestone 1 — Ready to make a knowledgeable commitment to a nuclear programme

In making a commitment to pursue nuclear energy, it is important that a commitment be made to strive to prevent any malicious acts that will endanger the public, and simultaneously impact the international nuclear community. Therefore, a commitment to pursuing a strong security culture should be established prior to making a commitment to pursue a nuclear programme.

Acknowledgement of the requirements for security and physical protection and the identification of necessary legislation provide recognition of the commitments.

3.15.2. Security and physical protection: Milestone 2 — Ready to invite bids for the first nuclear power plant

At the time of requesting a bid for the first nuclear power plant, the following conditions should have been established:

— Laws providing appropriate authorities for security and physical protection have been promulgated;
— Security requirements and desirable features for the site, layout and design of the nuclear power plant have been formulated;
— Protocols and programmes for local and national law enforcement assistance have been established;
— Programmes for the definition of sensitive information, protection requirements and associated penalties have been put in place;
— Laws providing for penalties for malicious acts, illegal possession and trafficking on nuclear materials, as described in international instruments, have been promulgated;
— Programmes for the careful selection and qualification of nuclear programme staff with access to facilities or sensitive information are in place and are being implemented;
— A programme to develop a design basis threat (DBT) has been established;
— The term 'unacceptable consequences' has been defined at the State level, which provides the basis against which physical protection systems will be developed;
— Ensure that a security culture recognizing the importance of nuclear material exists.

3.15.3. Security and physical protection: Milestone 3 — Ready to commission and operate the first nuclear power plant

At the time of commissioning the first nuclear power plant, the following conditions should be established:

— Definition of targets on-site that will result in unacceptable consequences;
— Approval by the State of a DBT;
— Design of a physical protection system to protect targets from DBT;
— Construction, testing and acceptance of physical protection system by the operator;
— Acceptance of the operator security plan by the country;
— Training of guards and operators;
— Training and equipment of appropriate personnel to prevent the illicit trafficking of nuclear material;
— Development of physical protection for the transportation and storage of nuclear material and waste;

— Development of agreements of responsibility with outside response forces to supplement on-site staff;
— Coordination of nuclear security and nuclear safety plans for response to emergency situations of malicious origin;
— Exercises of the physical protection system, as well as coordination with outside response forces and with safety response forces.

3.16. NUCLEAR FUEL CYCLE

A thorough consideration of the fuel management strategy is essential from the earliest planning stages. This will influence the selection of a specific nuclear technology.

The fuel cycle is usually thought of as two components: the front end, or those activities prior to consuming the fuel in a nuclear power plant, and the back end, or those activities after the fuel is removed from the reactor. The front end consists of numerous industrial activities: mining, milling, chemical conversion, enrichment and fabrication. For certain technologies, heavy water production and use may substitute for enrichment. The back end consists of: spent fuel storage, transportation and ultimate disposal of spent fuel or reprocessing and disposal of high level radioactive waste.

Enrichment and reprocessing involves technologies that are sensitive from the point of view of proliferation. Implementing IAEA safeguards, as explained in the relevant bibliography, is an important component in addressing this concern.

The international nuclear market has expanded to the point that all front end services may be confidently purchased, which reduces the needs to develop a national fuel cycle infrastructure. International initiatives are being proposed which should provide further assurance of fuel supply at competitive pricing. The back end functions are generally provided nationally, with on-site and interim storage being the responsibility of the owner/operator and the ultimate disposal being the responsibility of the government. Technologies for spent fuel storage are mature, with multiple vendors available to respond to specific needs.

3.16.1. Nuclear fuel cycle: Milestone 1 — Ready to make a knowledgeable commitment to a nuclear programme

In considering a nuclear power programme, the NEPIO should develop a broad knowledge of the steps in the nuclear fuel cycle and determine the approaches that may be feasible for the country. The level of investment and

the human resource needs will vary considerably with the options chosen. For most countries, the development of a completely indigenous nuclear fuel cycle concurrent with the first nuclear power plant would be a daunting task and would not likely yield economic benefits. However, a country with abundant uranium deposits may decide to embark on mining and milling operations while purchasing conversion, enrichment and fabrication services.

Depending upon the degree of concern for energy security, the amount of inventory of fresh fuel is another issue worthy of attention.

With regard to the back end, the need to provide on-site spent fuel storage for at least two to three years of cooling time is necessary irrespective of the future plans for the fuel. Additionally, it is highly likely that interim spent fuel storage, whether on-site or at an independent site, will be needed for several decades. The issue of ultimate disposal will be discussed in the following section.

As the decision to employ nuclear power is considered, the following information should be available:

— Knowledge of the individual steps in the nuclear fuel cycle;
— Knowledge of the sources of supplies and services for each step;
— National natural resources and capabilities with respect to each step;
— Feasible policy options for a national fuel cycle strategy;
— Impact on personnel requirements of various reactor acquisition and fuel cycle strategies.

Armed with the knowledge and feasible approaches to the nuclear fuel cycle, the country has recognition of the associated commitments involved with the development of a nuclear power programme.

3.16.2. Nuclear fuel cycle: Milestone 2 — Ready to invite bids for the first nuclear power plant

Since the fuel cycle strategy is an important element in the bidding and contracting for a nuclear power plant, the policy decisions on the fuel cycle strategy should have been made at this point in time. Some variations in the strategy may be necessary depending on the specific technology options which will be considered, e.g. heavy water versus light water technology.

The following decisions should have been made at the time to issue the bid for the first nuclear power plant:

— Arrangement for purchasing the first reactor core;
— The number of reload cores to be contracted with the first nuclear power plant;

— The specific fuel cycle services that will be either purchased or developed indigenously concurrent with the nuclear programme development;
— The long term strategy with respect to purchasing or developing fuel cycle capabilities;
— The long term strategy with respect to reprocessing;
— The capacity of on-site spent fuel storage to be contracted along with the first nuclear power plant,
— The strategy for interim spent fuel storage.

3.16.3. Nuclear fuel cycle: Milestone 3 — Ready to commission and operate the first nuclear power plant

As part of the construction of the nuclear power plant, the initial core will have been delivered to the site. Provisions for reloads in accordance with national strategy will have been contractually committed. On site spent fuel storage will have been constructed as part of the nuclear power plant. Ultimate waste disposal strategy will be discussed in the following section.

The additional requirements at this time are as follows:

— Plans to implement the interim storage strategy are in place;
— The location of interim spent fuel storage facilities have been identified;
— The schedule and budget for interim spent fuel storage is consistent with the on-site storage capabilities.

3.17. RADIOACTIVE WASTE

The handling and disposal of radioactive waste is an essential issue associated with the application of nuclear power. Radioactive waste needs to be managed in such a way as to avoid imposing an undue burden on future generations; that is, the generations that produce the waste have to seek and apply safe, practicable and environmentally acceptable solutions for its long term management In certain circumstances, safe and efficient management of spent fuel and radioactive waste might be fostered through agreement among countries to use facilities in one of them for the benefit of the others. Radioactive waste is generally treated on the basis of three levels: low, intermediate and high. Capabilities for low and intermediate level waste (LILW) management exist in many countries in conjunction with medical, industrial and research applications, within the framework of the national infrastructure for radiation, transport and waste safety. Some countries have also developed disposal capacity for these wastes. The capability for high level

waste (HLW) disposal is being pursued by all countries employing nuclear power generation.

The additional volume and the different spectrum of radioactive isotopes associated with nuclear power need to be understood with respect to existing low and intermediate level disposal capabilities. Programmes and technology for LILW minimization and processing have been developed and successfully implemented in many countries.

Although concepts exist for the ultimate disposal of spent fuel or HLW, no disposal facility has yet been implemented. The demonstrated capability to store spent fuel safely for decades, however, provides time for the development of final disposal strategies for spent fuel or HLW. Nevertheless, these strategies fshould be considered early in the programme development because waste disposal is a subject of concern to the general public.

The prominent strategies being pursued at this time are disposal in geological formations of either spent nuclear fuel and/or the HLW remaining after the reprocessing of spent fuel. Research is under way to minimize the volume and toxicity of HLW through various processes such as nuclear transmutation.

3.17.1. Radioactive waste: Milestone 1 — Ready to make a knowledgeable commitment to a nuclear programme

A clear recognition of the additional responsibilities for radioactive waste from a nuclear power programme is needed within the NEPIO. The need to be able to communicate how to safely and securely deal with the radioactive waste should be recognized.

The major considerations include:

- Knowledge of the current national capabilities, regulatory framework and experience with radioactive waste handling, storage, and disposal;
- Knowledge of the additional volume and isotopic content of LILW from nuclear power facilities;
- Knowledge of the existing options for long term spent fuel storage;
- Knowledge of the options and research pursued internationally for the ultimate disposal of spent fuel or HLW;
- Organization and financing for spent fuel and radioactive waste management.

Knowledge of the current capabilities for waste disposal, the increased burdens to be realized from nuclear power facility operation and the options for eventual ultimate disposal of HLW demonstrate a recognition of the related

commitments associated with nuclear power. In addition, becoming a contracting party to the Joint Convention will provide the means for mutual learning in the global scientific community.

3.17.2. Radioactive waste: Milestone 2 — Ready to invite bids for the first nuclear power plant

The additional burdens of radioactive waste disposal from operation of a nuclear power plant will not be realized for several years. Early considerations for radioactive waste include:

- Revising the laws and regulations associated with LILW disposal;
- Developing provisions for waste volume and toxicity minimization as part of the bid specification;
- Planning to enhance the waste disposal programmes and facilities to be prepared to accommodate the operation of the first nuclear power plant, including provisions for on-site storage;
- Assigning responsibility to continue to follow international efforts and progress on high level waste disposal.

Preparations for the handling of the additional burdens of radioactive waste from nuclear power generation, and continuing to consider policy for ultimate HLW disposal demonstrate achievement of this milestone.

3.17.3. Radioactive waste: Milestone 3 — Ready to commission and operate the first nuclear power plant

Low and intermediate radioactive waste will be generated as soon as the initial reactor core is delivered to the nuclear power plant site. High level waste will be generated as soon as the plant begins operation, but this HLW will be contained within the spent nuclear fuel, which will remain on-site for some time.

The necessary conditions at this time are:

- Existing, enhanced or new facilities for the storage or disposal of LILW are fully operational and are prepared to receive waste from the nuclear power plant;
- The responsible organization and funding system has been established;
- The responsible organizations continue to follow international efforts and progress toward ultimate HLW disposal, and revise national policy as appropriate.

3.18. INDUSTRIAL INVOLVEMENT

Many commodities, components and services are required to construct and support the operation of a nuclear facility. Spare parts, consumable supplies, instrument repair and calibration services are among the many support needs. These supporting activities can be a source of jobs and economic growth for the country and the local region. However, supplying equipment and services to support a nuclear facility requires industrial organizations that can comply with the codes and standards and operate under rigorous quality programmes. In the early stages of nuclear programme development, the nation should adopt a policy of intent with respect to developing or enhancing industrial capabilities. This policy should evolve into firm plans to develop the facilities, programmes and skills to realize the desired level of involvement.

3.18.1. Industrial involvement: Milestone 1 — Ready to make a knowledgeable commitment to a nuclear programme

Initial considerations by the NEPIO should include the opportunity for national and local industrial involvement and support of the nuclear power programme. However, full realization of the qualifications necessary to provide nuclear equipment and services is vital to successful industrial participation. Of primary importance is the strict application of quality standards for nuclear equipment and services that are much more stringent than for other industrial operations. A supplier of a nuclear power plant, whether or not on a turn key basis, would need assurance of the existence of industrial capabilities that are adequate to support the mode of acquisition before agreeing to yield any scope of participation to domestic industry.

In its study of nuclear programme development, the NEPIO should include:

— Assessments of national and local industrial capabilities;
— Assessment of the interest of business and industrial leaders in participating in the nuclear programme considering the special requirements that are necessary;
— Consideration of the ability to obtain the necessary investment for intended upgrading of industrial facilities and programmes;
— Develop short term and long term policies to encourage the level of participation that is practical and desired.

A consideration of national policy with respect to national and local industrial involvement, coupled with an awareness of the demanding requirements for

nuclear programme support, should create a clear recognition of the commitments.

3.18.2. Industrial involvement: Milestone 2 — Ready to invite bids for the first nuclear power plant

A realistic assessment of the national and local capabilities to supply commodities, components and services for nuclear facility construction should be done by the part of the owner/operator organization responsible for creating the bid specification and acceptance criteria. No matter what the desires and policy for national industrial participation may be, the ability to meet schedule and quality requirements will be crucial to the successful construction of a nuclear facility on time and within budget. Construction and quality delays will greatly increase the cost of a project and negatively affect the confidence of the regulatory body and the public. Planned domestic industry involvement should be called out in the bid specification and will have to be negotiated with the nuclear power plant supplier. However, opportunities may still exist for local industry involvement in the non-nuclear safety related areas of the project. Some power cycle portions of the facility or some supporting buildings and structures can be constructed to typical commercial standards. Plans and programmes by government or industry can also be put in place for transition to national and local suppliers in the future as their capabilities develop.

At this stage the owner/operator should consider:

- Which national or local suppliers can reliably supply commodities, components or services to the nuclear related or non-nuclear portions of the facility to be constructed;
- What upgrades in skills and capabilities are realistic in a time frame to support nuclear construction;
- Firm decisions on national or foreign sources of supply for commodities, components and services for the first nuclear power plant;
- Bid specification clarity in accordance with those decisions.

With a clear recognition of the appropriate sources of supply to ensure a successful and timely construction programme, this milestone is completed.

3.18.3. Industrial involvement: Milestone 3 — Ready to commission and operate the first nuclear power plant

As the construction phase of the nuclear power programme nears completion, a reassessment of the sources of supply to support operation can

be undertaken. If the national and local industrial structure has progressed sufficiently, the supply of spare parts, consumable supplies, maintenance services and calibration services can be allocated accordingly. However, the same supplier qualification necessary for facility construction by the owner/operator is also needed for operational support.

3.19. PROCUREMENT

Procurement of equipment and services for a nuclear facility is a complex function requiring special quality and environmental qualification stipulations. Much of the equipment associated with a nuclear power plant can be provided by the plant supplier if the nation and the owner/operator so desire. The design and quality standards should be included in the bid specification. If the nation desires the owner/operator to purchase some of the nuclear safety related equipment from national or local suppliers or other international suppliers, the owner/operator needs to specify the quality requirements and verify that the supplier meets those requirements.

3.19.1. Procurement: Milestone 1 — Ready to make a knowledgeable commitment to a nuclear programme

The national position with respect to procurement is closely related to the decision on national or local industry involvement. The NEPIO should be aware of the unique requirements associated with purchasing equipment and services for nuclear facilities.

The NEPIO should:

- Recognize the need for a procurement policy consistent with the industrial participation policy;
- Consider a strategy to ensure that the necessary expertise is developed in a timely manner.

Consistent policies taken with full knowledge of the special requirements for nuclear procurement demonstrates recognition of the commitments.

3.19.2. Procurement: Milestone 2 — Ready to invite bids for the first nuclear power plant

The owner/operator should establish a procurement programme consistent with the national policy for industrial participation and procurement.

The owner/operator should:

- Develop programmes and procedures that meet the established requirements;
- Develop formal procurement specifications and approved vendor lists.

When the owner/operator is fully prepared to carry out the functions of nuclear procurement, the milestone is completed.

3.19.3. Procurement: Milestone 3 — Ready to commission and operate the first nuclear power plant

In preparing for nuclear power plant operation and maintenance, it is likely that the owner/operator will establish its own procurement organization with the programmes and skills necessary to conduct nuclear related purchasing of equipment and services.

Appendix

SUMMARY OF CONDITIONS TO ACHIEVE THE MILESTONES

Infrastructure issue	Milestone 1 — Ready to make a knowledgeable commitment to a nuclear programme	Milestone 2 — Ready to invite bids for the first nuclear power plant	Milestone 3 — Ready to commission and operate the first nuclear power plant
3.1 National position	• NEPIO established and staffed • Safety, security and non-proliferation needs recognized • Appropriate international legal instruments identified • Comprehensive legal framework identified • Establishment of effectively independent regulatory body recognized • Nuclear power included in nation's development strategy • Needs of project management identified • Human resources needs surveyed • Financial resources evaluated • Arrangements for handling and storage of radioactive waste identified • Supply of national and international components and services assessed • Transparent communication and interaction regarding the nuclear programme established	• National legislation enacted • International legal instruments adopted • Regulatory body established • An effective SSAC established • Financial and operational modalities established • Policy for nuclear fuel cycle established • Legal and financial arrangements for decommissioning established • Socio-political involvement established • Stakeholder involvement established and maintained • Policy for national industrial participation established • Human resources development programme started • Safeguards programme provided • Security programme provided • Radiation protection and emergency plans established • International standards for environmental protection adopted • Commitments and obligations of owner/ operator organizations established	• Implementation of national laws and regulations ensured • Regulatory body funds and staff assured • Technical and managerial owner's competence verified by regulatory body • Acceptable level of socio-political involvement maintained • Sufficient financing availability ensured • Human and physical resources ensured • Appropriate funding plan for waste, long term spent fuel management and decommissioning implemented and ensured

Infrastructure issue	Milestone 1 — Ready to make a knowledgeable commitment to a nuclear programme	Milestone 2 — Ready to invite bids for the first nuclear power plant	Milestone 3 — Ready to commission and operate the first nuclear power plant
3.2 Nuclear safety	Recognize the need for : • Relevance of nuclear safety • Long term commitment for the first nuclear power plant • Cooperation in international partnerships • Need of intergovernmental instruments on safety • Support through international cooperation • Independent regulatory body	• Safety responsibilities by all stake-holders recognized • Legal and governmental framework consistent with Fundamental Safety Principles implemented • Safety culture evaluated • Regulatory body able to evaluate the safety submission	• Safety culture adopted by the constructor, engineer, operator and regulatory body organisations • Regulatory body prepared to determine whether an adequate appre-ciation for safety is present and with the authority to act independently • Programs to maintain technical skills and management attitude to assure strong safety culture are in place
3.3 Management	• Energy strategy and nuclear power compatibility analysed • Stakeholder involvement evaluated • Available nuclear technologies identified • Availability of long term financial resources analysed • Ownership options and operational responsibilities considered • Security and safeguards requirements analysed • Spent fuel and radioactive waste inter-mediate and final handling needs recognized • Legal nuclear framework analysed • Regulatory framework analysed • Human resources needs assessed • National industry participation assessed • Unique Member State conditions evaluated	• Owner/operator organization designated • Public education and consultation programme continued • Adequate staff to prepare for and analyse bids available • Management system established • Staff training started • Safeguards regulations implemented • Preferred sites characterized • Site or sites for bid invitation selected • Preferred nuclear technologies determined • Bid evaluation criteria determined • Contracting strategy established • Fuel cycle strategy developed • Spent fuel and radioactive waste management strategy established • Financing strategy and financial plan developed • Working relationship with regulatory body, international and professional organizations established • Project management organization implemented.	• Promotion of education and national industry participation continued • Public communication continued • National planning for waste disposal and decommissioning conducted • Bids evaluated and winning bid selected • Contract negotiated • Contract for first nuclear power plant signed • Financing obtained • Plant site and construction licensing obtained • Operation staff trained and licensed • Continuing fuel supply contracted • External operational, training, engineering and maintenance support established • Public support for nuclear power plant operation obtained

Infrastructure issue	Milestone 1 — Ready to make a knowledgeable commitment to a nuclear programme	Milestone 2 — Ready to invite bids for the first nuclear power plant	Milestone 3 — Ready to commission and operate the first nuclear power plant
3.4 Funding and financing	Strategies established for funding and financing: • Initial infrastructure • Socio-political acceptance • Creation or hiring expertise • Creation and continuation of a competent regulatory body • Creation of expertise for competent project management • Creation of competent operating staff • Security and safeguards arrangements • Long term handling radioactive waste and plant decommissioning • Nuclear power plant project within overall national conditions	• Strong public and governmental policy supported • Creditworthiness established • Reasonable degree of socio-political acceptance obtained • Complete legislative framework • Means of financing identified	• Financial and funding mechanisms implemented • Mechanisms implemented to provide the funding for long term spent fuel handling and final disposal, waste management, and decommissioning
3.5 Legislative framework	• All the basic elements for the legislative framework identified by NEPIO and discussed with the other involved organizations • Determination to develop and promulgate required laws indicated by government	• All legislation dealing with the nuclear power programme developed, promulgated and in force • National legislation pursuant to NPT treaties and appropriate international legal instruments in place • Responsibilities for safety, security and safeguards established • Legislation for ownership of nuclear facilities and materials enacted • Legislation for independent regulatory body adopted • Laws protecting intellectual property, foreign investments, funding and guarantees adopted • Funding of human and physical facilities development established • Necessary financial legislation in place	• Comprehensive legislative oversight established • Funding/guarantees remain in place • Funding of human/physical development continues • Legislation maintained and amended as necessary

Infrastructure issue	Milestone 1 — Ready to make a knowledgeable commitment to a nuclear programme	Milestone 2 — Ready to invite bids for the first nuclear power plant	Milestone 3 — Ready to commission and operate the first nuclear power plant
3.6 Safeguards	• Obligations under NPT and non-proliferation treaties, including establishment of SSAC, recognized • Implementation and enforcement of safeguards legislation planned	• Terms of international safeguards agreement in place • SSAC established and operational • Early safeguards relevant information provided to IAEA • Specific legislation and relevant safeguards procedures are in place	• All safeguards measures and an effective SSAC in place before receipt of initial fuel loading • Information regarding fuel cycle and all relevant nuclear material subject to safeguards instruments provided to IAEA
3.7 Regulatory Framework	• Clear recognition of the need for a regulatory framework identified	• Legislation to establish the effectively independent nuclear regulatory body developed • Nuclear regulatory body established • Entire licensing process developed • Regulatory criteria for acceptance and approval of design determined • Mechanisms for open communications with owner/operator established • Appropriate regulations, codes and standards developed • Competent regulatory staff is in place • Consultant and expert services planned and available	• All regulatory regulation is in place • Sufficient regulatory staffing is in place • Licenses and permits prior to criticality and operation issued • Plant operators certified • Inspection and enforcement activities in place • Competence of regulatory body staff maintained • Open communications with government, operator and the public maintained • International and professional interfaces maintained
3.8 Radiation Protection	• Recognition of hazards presented by nuclear power plant operation, developed by NEPIO and the need to enhance national laws and expand their safety infrastructures. • Radiation protection requirements and practices equivalent to those provided by the IAEA's Basic Safety Standards and safety standards considered.	• Preliminary actions to prepare adequate radiation protection programmes taken • Existing laws governing radiation protection reviewed and enhanced. • Specific regulations developed by the regulatory body • Background radiation sources characterized and measured	• All necessary radiation monitoring and protection programmes to optimize the radiation exposure of the public and workers in place • Waste management capabilities in place.

Infrastructure issue	Milestone 1 — Ready to make a knowledgeable commitment to a nuclear programme	Milestone 2 — Ready to invite bids for the first nuclear power plant	Milestone 3 — Ready to commission and operate the first nuclear power plant
3.9 Electrical grid	• Study of compatibility of nuclear power in the nation's development strategy conducted by NEPIO • Electrical grid requirements considered	• Detailed studies to determine grid expansion, upgrade or improvement undertaken • Plans, funding and schedule for grid enhancement exist	• Plans for grid enhancement executed • Grid ready to support commissioning and operation of a nuclear power plant
3.10 Human resources development	• Knowledge and skills needed to support a nuclear programme identified by NEPIO • Plan to develop and maintain the human resource base developed	• Sufficient human resources to issue bid request are in place • Initial education and training for remaining human resources for plant operation started and financial resources committed	• All human resources to commission and operate the first nuclear power plant are in place • Education and training programmes for continuing flow of qualified people are underway
3.11 Stakeholder involvement	• Open and timely interaction and communication regarding the nuclear programme addressed from the beginning • Strong public information and education programme initiated by government and NEPIO	• Public information and education programme developed by all involved organizations	• Reasonably credibility with stake-holders and public established • Communication efforts through construction and preparation for operation continued • Socio-political involvement maintained
3.12 Site and supporting facilities	• General survey of potential sites, conducted by NEPIO • Possible sites identified	• Detailed site characterization performed • Suitable sites for bid selected	• All site services and provisions in place and functional
3.13 Environmental protection	• Unique environmental issues analysed by NEPIO • Environmental impacts and improve-ments communicated	• Environmental studies for selected sites performed • Particular environmental sensitivities included in bid specifications	• Compliance with environmental laws and regulations assured • Programmes for monitoring and assessment fully implemented in compliance with international standards

Infrastructure issue	Milestone 1 — Ready to make a knowledgeable commitment to a nuclear programme	Milestone 2 — Ready to invite bids for the first nuclear power plant	Milestone 3 — Ready to commission and operate the first nuclear power plant
3.14 Emergency planning	• Appreciation of the need for emergency planning developed by NEPIO • Communication with and involvement of local and national government taken into account	• Detailed approach to emergency planning started	• Preparation for emergency planning completed and tested
3.15 Security and physical protection	• Requirements for security and physical protection acknowledged • Necessary legislation identified	• Legislation promulgated • DBT defined • Security requirements defined • Sensitive information defined • Physical protection by trained on-site security staff provided • Local and national law enforcement assistance established • Programmes for selection/qualification of staff accessing to facilities or sensitive information are in place	• All security conditions established and implemented
3.16 Nuclear fuel cycle	• Knowledge of nuclear fuel cycle steps and approaches, developed by NEPIO • Need for site spent fuel storage recognized • Interim spent fuel storage considered	• Fuel cycle strategy decided	• Provisions for reloads contractually committed • On site spent fuel storage constructed
3.17 Radioactive waste	• The burdens of radioactive waste from nuclear power plants recognized by NEPIO • Current capabilities for waste disposal reviewed • Options for ultimate disposal of high level radioactive waste recognized	• Handling the burdens of radioactive waste considered • Policy for ultimate high level waste disposal in preparation	• Facilities for the storage or disposal of low and intermediate level radioactive waste fully operational

Infrastructure issue	Milestone 1 — Ready to make a knowledgeable commitment to a nuclear programme	Milestone 2 — Ready to invite bids for the first nuclear power plant	Milestone 3 — Ready to commission and operate the first nuclear power plant
3.18 Industrial involvement	• National policy with respect to national and local industrial involvement considered • Strict application of quality programmes for nuclear equipment and services recognized	• Realistic assessment carried out of the national and local capabilities • Ability to meet schedule and quality requirements analysed • Plans and programmes to transition to national and local suppliers in place	• Reassessment of sources of national supply to support operation undertaken • Supplier qualification requirements similar as for the construction stage established
3.19 Procurement	• Unique requirements associated with purchasing nuclear equipment and services recognized by NEPIO • Consistent policies for nuclear procurement taken	• Procurement programme consistent with national policy for industrial participation established • Owner/operator fully prepared to carry out nuclear procurement	• Owner/operator procurement organization established

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In order to introduce a nuclear power programme, a country has to consider a wide range of infrastructure issues. This guide provides guidance on the preparations needed to implement a nuclear power programme through an easy to understand, sequential development process. It provides a detailed description for a technical audience of the complete range of infrastructure issues that need to be addressed and the expected level of achievement (or milestones) at the end of each phase. This publication can be used by States to assess their own development status, and to prioritize the activities that they need to complete in order to order, license, construct and safely operate a nuclear power plant. This guide also aims to help Member States understand their commitments and obligations associated with the significant undertaking of a nuclear power programme.

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