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Invitation and Evaluation of Bids for Nuclear Power Plants

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IAEA NUCLEAR ENERGY SERIES PUBLICATIONS

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INVITATION AND EVALUATION OF BIDS FOR NUCLEAR POWER PLANTS

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INVITATION AND EVALUATION OF BIDS FOR NUCLEAR POWER PLANTS

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FOREWORD

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

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

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

The introduction and expansion of nuclear power opens new challenges to Member States — developing bid invitation specifications, evaluating bids and contracting with the successful bidder (contractor). These topics were subject of a number of IAEA publications that were issued at a time when the conditions in the nuclear and power generation industries were quite different from current conditions. Feedback from Member States and IAEA missions has indicated that an integrated and updated guidance report is needed in this area.

This report focuses on bid invitation, bid evaluation and contracting taking into account recent information on the bidding process experienced by Member States.

This report emphasizes the integrity and interdependence of various activities related to the bid invitation, technical and economic evaluation and contracting. It also updates information existing IAEA publications in order to better reflect developments in the nuclear and energy industry, and presents a more compact and user friendly guidebook integrating existing IAEA reports on the subject.

This report provides the information necessary to organize and guide activities related to the invitation, the technical and economic evaluation of bids, and contracting as an integrated process. Further, this publication indicates how and to what degree the activities preceding the preparation of the bid invitation specification, the evaluation of bids and contracting could influence the process.

The IAEA expresses its appreciation to all who participated in the meetings and discussions during the preparation of this report. The IAEA is particularly grateful to A. Rastas (Finland) and N. Perovic (Switzerland) for their collaboration and assistance in preparing this report.

The IAEA officer responsible for this report was Xiaoping Li of the Division of Nuclear Power.

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SUMMARY

The development of a nuclear programme is a major undertaking requiring attention to many complex and interrelated tasks over a long duration. One of them is the bidding process, which includes the development of bid invitations specifications, the evaluation of bids and the contracting with the successful bidder (contractor). The necessary infrastructure should be developed to the point of readiness for a bidding process to acquire a nuclear power plant (NPP). Therefore, the preparatory phase preceding the bidding process includes numerous activities, such as but not limited to, energy system planning, siting and feasibility studies, environmental impact assessment, development of nuclear related legislation, financing, organization of the regulatory authority, etc.

In addition, when starting the bidding process, the owner of a nuclear power plant should have adequate human resources with basic technical and economic knowledge in order to evaluate the bids and conduct contract negotiations. It is generally advisable for the owner to obtain assistance from well-qualified consultants who have the experience and specialized knowledge with the bidding process that may be lacking in the owner's organization.

Besides the organization, it is necessary to set up an overall time schedule for the bidding process that, depending on the quality of preparations, could typically require 20–40 months.

The ultimate objective of the bidding process is to conclude with the successful bidder a contract that enables construction and commission of an NPP that meets owner's needs in an optimum way. The bidding process can be divided in the following main phases:

— Preparation of the bid invitation specifications (BIS);
— Preparation of bids;
— Evaluation of bids;
— Contract negotiations and signature.

The main purpose of the BIS is to clearly present the:

— Owner's requirements — technical, commercial and financial — expectations and plans;
— Conditions and circumstances under which the contractor will have to perform its responsibilities;
— Form and content of bids;
— Criteria on which the bids will be evaluated.

During the bid evaluation process, all aspects of the technical, economic, financial and contractual approaches must be considered. The technical evaluation of the bids mainly verifies the compliance with and the properties of:

— Scope of supply and services;
— Technical design features;
— Project implementation;
— Warranties;
— National participation and technology transfer;
— Nuclear fuel;
— Options and alternatives.

The objective of the economic evaluation of bids is the ranking of bids according to costs. The different types of costs which will be incurred during plant construction; lifetime and decommissioning may be classified as follows:

— Total capital investment costs (TCIC);
— Nuclear fuel cycle costs;
— Operation and maintenance (O&M) costs.

Various methods of cost assessment and comparison are used to evaluate the economic order of bids. An IAEA software package (BIDEVAL-3) enables a full-scale economic evaluation, including all required elements

and parameters, and results are used in the Levelized Discounted Energy Generation Cost (LDEGC) as the criterion for ranking. A more simplified economic evaluation approach can also be applied if there are no major differences in the technical aspects and economic parameters of the bids.

A typical bid evaluation process would follow the following steps:

— Preliminary bid evaluation;
— Preparation of preliminary bid evaluation report;
— Deciding on the short list of bidders, if feasible;
— Detailed bid evaluation;
— Preparation of final evaluation report.

The main objectives of the contract negotiations are to:

— Meaningfully minimize the deviations of the bids from the BIS requirements;
— Provide the ultimate basis for the selection of the contractor;
— Complete the contract structure, format and content that will best serve the execution phase of the project as well as the plant operation.

The main activities and documents of a bidding process are shown schematically in Fig. 1.

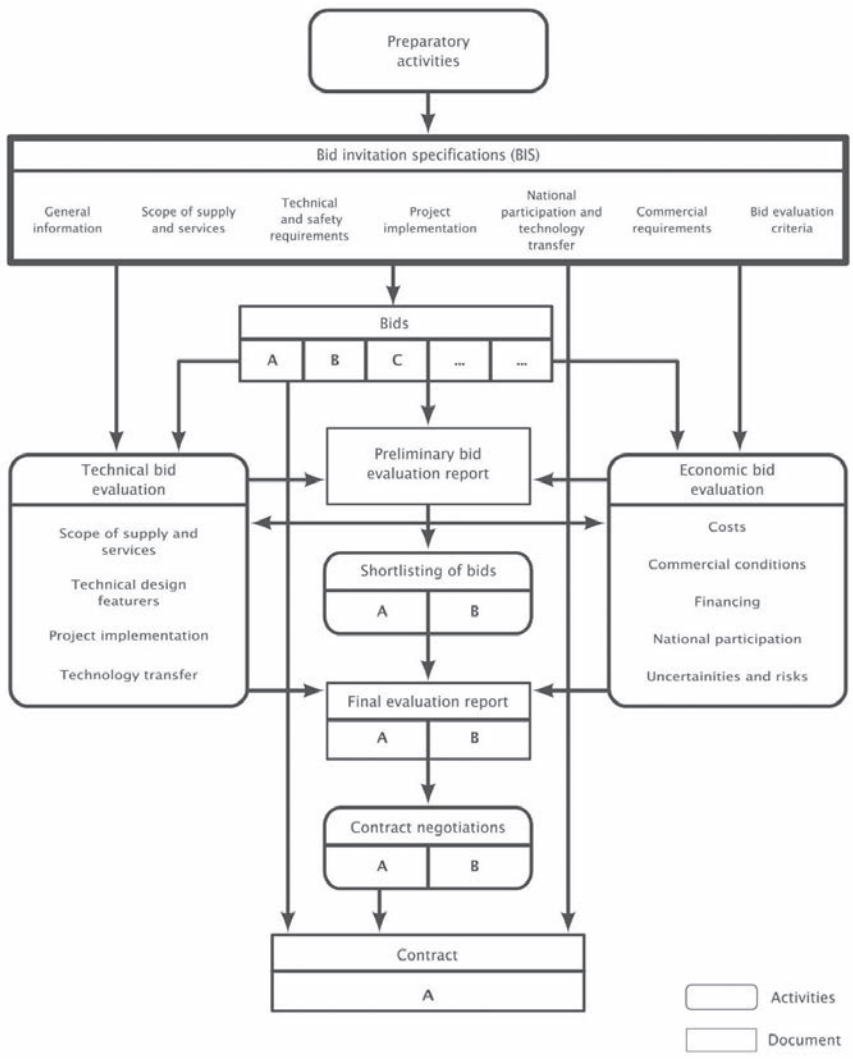

FIG. 1. Overall scheme of a bidding process in case of bids A, B, C.

1. INTRODUCTION

1.1. BACKGROUND

The decision to acquire a nuclear power plant (NPP) — whether it is the first plant or a subsequent NPP unit in a country — is based on the results of previously performed activities, such as energy system planning, siting studies, feasibility studies and other studies related to infrastructure development. In these activities, the justification of acquiring the plant and the principal characteristics of the project are investigated and the results constitute the background of the project.

At the end of the preparatory activities the owner/operator (in this publication the "owner") starts a bidding process. It is also possible that the owner has pre-selected a contractor and decides to proceed with direct negotiations. The first stage of the bidding process is the preparation of bid invitation specifications (BIS). The next steps are the evaluation of the bids provided by the bidders and the contracting with the successful bidder (contractor).

The IAEA has addressed the bidding process in the publications Bid Invitation Specifications for Nuclear Power Plants (IAEA-TRS-275, 1987) [1], Technical Evaluation of Bids for Nuclear Power Plants (IAEA-TRS-204, 1981) [2] and Economic Evaluation of Bids for Nuclear Power Plants, 1999 Edition (IAEA-TRS-396, 2000) [3]. The feedback from Member States and IAEA mission experts has indicated that an integrated and updated guidance report is needed to support activities in this area.

On the basis of the above mentioned publications, the accumulated experience from IAEA expert missions and others, it was decided to merge earlier publications into a single publication on the bid invitation, the bid evaluation and the contracting taking into account the recent information of NPP bidding process experienced by Member States.

Regarding the initial stages of a nuclear programme, the IAEA has recently published a number of guidance reports. The following publications have been taken into account in the preparation of this publication:

— Milestones in the Development of a National Infrastructure for Nuclear Power [4];
— Initiating Nuclear Power Programmes — Responsibilities and Capabilities of Owners and Operators [5];
— Considerations to Launch a Nuclear Power Programme [6];
— Responsibilities and Capabilities of Nuclear Energy Implementing Organizations (NEPIO) [7];
— Managing the First Nuclear Power Plant Project [8];
— Evaluation of the Status of National Nuclear Infrastructure Development [9];
— Common User Considerations by Developing Countries for Future Nuclear Energy Systems [10].

1.2. OBJECTIVE

The objective of this publication is to provide integrated and updated practical guidance on the issues that have to be addressed in the documents related to the bidding process, and how to perform the bid invitation, the bid evaluation and the contracting.

1.3. SCOPE

The scope of this publication covers the bidding process from the preparation of the BIS until the selection of the NPP design and the signature of the contract with the contractor. However the approach described in this publication can be used in other complex nuclear power related projects.

This publication is mainly directed to the turnkey contractual approach but it may also be useful in other kinds of contractual approaches.

This publication assumes that bids are submitted as closed proposals and negotiated between the owner and each bidder separately. The publication can be utilized with adaptations also in other kind of bidding approaches such as in the negotiated contract approach (when the contractor has been selected in advance).

This publication assumes that the necessary preparatory activities (see Section 2.1) have been completed before entering into the bidding process.

1.4. USERS

This publication is directed mainly to senior managers and professionals of prospective owner organizations in countries embarking on their first nuclear power project. This publication may also be useful to experienced owner organizations that wish to acquire follow-up NPP units, especially if much time has elapsed since a previous NPP project.

1.5. STRUCTURE

This publication consists of seven sections along with this introduction.
Section 2 describes some practical elements related to the bidding process.
Section 3 describes the preparation of the BIS.
Section 4 provides an overview of the bid evaluation process including the preparation, organization and implementation of the bid evaluation.
Section 5 provides the detailed information on the technical evaluation of the bids.
Section 6 provides the detailed information on the economic evaluation of the bids.
Section 7 describes the process of the contract negotiation.

1.6. USING THIS PUBLICATION

This publication can be used as general guidance on how to invite and evaluate bids and to enter into the delivery contract for NPPs. It is not a comprehensive guide on all the details but presents rather the key elements that should exist in the bidding process. More detailed information and guidance on some specific issues are available, for example, in the IAEA publications referenced in this publication. The situation will differ from country to country. Therefore, national specific conditions should be taken into account when organizing and structuring the bidding process. The IAEA does not take responsibility for the completeness of the examples, lists and references given in this publication.

2. GENERAL PRINCIPLES OF THE BIDDING PROCESS

2.1. PRECONDITIONS

The development of a nuclear programme is a major undertaking requiring attention to many complex and interrelated issues over a long duration. The necessary infrastructure should be developed to the point of complete readiness to invite bids as described in the IAEA Milestone publication [4], and Evaluation Methodology publication [9]. It is advisable to request an INIR mission [31] to review the status of the infrastructure before launching the bidding process.

The following subjects should have been settled or at least plans for settlement should exist before entering into the bidding process:

— Size or size range of the NPP;
— Feasible NPP designs;
— General technical requirements;
— Experience of potential contractors;
— Overall project schedule;
— Site characteristics;
— Adequate legal framework governing nuclear activities;
— Environmental impact;
— Radiation protection;
— Regulatory requirements and licensing procedure;
— Grid characteristics;
— Contractual approach and project management;
— Level of national participation;
— Nuclear fuel supply options;
— Nuclear waste management/disposal;
— Security and physical protection;
— Safeguards;
— Economics;
— Financing options;
— Owner's scope of supply;
— Organization of the owner;
— Emergency planning.

The above elements can be addressed in a feasibility study and/or technology assessment, preceding the bidding process.

The structure of the BIS and the methodology of technical and economic bid evaluations are based upon the assumption that the above elements have been considered and defined. The completeness of the above elements has a direct impact on the duration and quality of the whole bidding process.

2.2. BIDDING PROCESS

The ultimate objective of the bidding process is to sign with the successful bidder (contractor) a contract that enables the licensing, construction, commissioning, operation and decommissioning of a NPP in an acceptable way for the owner.

The bidding process can be divided into the following main phases:

— Preparation of the BIS (by owner);
— Preparation of bids (by bidders);
— Evaluation of bids (by owner);
— Contract negotiations (by owner and selected bidders - at least two);
— Signature of the contract (by owner and the successful bidder; i.e. the contractor).

The bidding process phases are shown schematically in Fig. 2. When making preparations for each phase, it is advisable to take into account the subsequent phases in order to assure smooth continuity and progress during the bidding process.

2.3. ORGANIZATION AND RESPONSIBILITIES

The owner is directly responsible for conducting the bidding process. Therefore, the owner of the future NPP should be designated in good time before entering the bidding process.

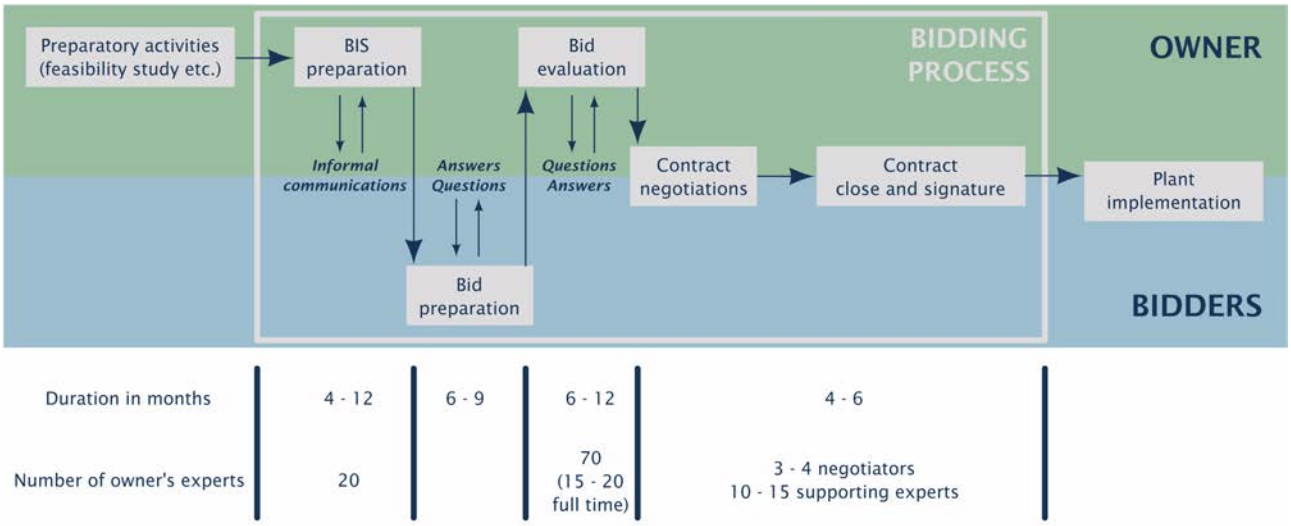

FIG. 2. Phases, durations and human resource needs of the bidding process for an NPP.

When starting the bidding process, the owner should have adequate human resources with basic knowledge to prepare the BIS, to evaluate the bids and to negotiate the contract from a technical, economic and legal perspective. Specific human resource needs may include:

— Technical expertise to develop specifications for an NPP and to evaluate the bids;
— Project and management system expertise to manage the bidding process and to develop specifications and to evaluate the bids regarding those areas;
— Detailed knowledge of the infrastructure in the country and at the site as well as the regulatory environment;
— Legal and business expertise for BIS preparation, bid evaluation, contract negotiations and fuel procurement;
— Financing expertise to negotiate with financing organizations and to develop financing plans;
— Expertise in stakeholder communication and public information.

Typical numbers of persons needed during the various phases of the bidding process are indicated in Fig. 2. The structure of the organization team may vary through the phases of the bidding process. However, it is advisable that the same key persons continue through the entire process. The knowledge and experiences acquired during initial phases are very useful in the subsequent phases of the bidding process.

It is generally advisable for the owner to obtain assistance from well-qualified consultants who have the experience with bidding processes and specialized knowledge that may be lacking in the owner's organization. Consultants should, however, always have only an advisory function.

The owner's responsibility area includes also necessary contacts with all related stakeholders prior to and during the bidding process. Further information on stakeholders is presented in reference [7]. The communication with stakeholders has a two-way benefit:

— The owner receives information and guidance that it needs in preparing the BIS, evaluating bids and negotiating contract;
— The stakeholder is better prepared for measures that it may put into action in the later phases of the project.

2.4. SCHEDULE

It is necessary to set up an overall time schedule for the bidding process and subsequent phases until the commercial operation of the NPP. Figure 2 includes an example of the typical durations for the phases of the bidding process. The total time needed for the bidding process is typically 20–40 months. The durations may vary considerably depending on the quality and amount of work done before entering into the bidding process.

The schedule should have milestones showing in which situations important decisions have to be taken and activities which have to be concluded before decisions can be taken. It should thus show the interrelationship of actions.

Making such a time schedule may be a challenge at the beginning of the bidding process, since deadlines and delays often will be imposed from the outside and will require both flexibility and ingenuity in the planning of work. It is nonetheless necessary for the owner to maintain a total and up to date overview of on-going and future activities with deadlines for their conclusion.

2.5. PREQUALIFICATION

To ensure that the potential bidders have suitable plant designs available and the necessary competence and experience to successfully complete a contract, the potential bidders may be requested to pass a prequalification process. Depending on the legislation, this process can be carried out as part of the bidding process or during the technology assessment if carried out before the bidding process. The prequalification process should include demonstration of the potential bidders' financial capability and technical competence, available resources and the provision of relevant references from comparable projects.

For this purpose, a request for information document for prequalification to solicit the required data could be developed and sent to the potential vendors. An example of contents of the request for information document is presented in Appendix I. After the prequalification of the vendors is completed, the BIS should be distributed to the vendors who passed the pre-qualification stage.

2.6. CONTRACTUAL APPROACH

The bidding process can vary significantly, depending on the contractual approach selected for the project. For this reason, the contractual approach for the project implementation should be defined in the BIS.

The following main types of contractual approaches have been applied to NPP projects:

— Turnkey contract: a single contractor or a consortium of contractors takes the technical responsibility for the whole NPP project;
— Split-package: the overall responsibility is divided between a relatively small number of contractors, each building a large section of the work;
— Multi-contract: the owner or its architect-engineer assumes overall responsibility for engineering and managing the NPP project, issuing a large number of contracts.

The selection of the type of contractual approach is one of the basic decisions to be taken concerning the realization of the NPP. It should, therefore, receive great attention and be based on a careful analysis of all aspects of the feasibility study and/or technology assessment, as well as other factors such as the owner's experience.

A turnkey contract approach is often used for the first NPP project in the country and also on subsequent projects when the country and owner have no long term plans for a comprehensive localization of the nuclear technology. In a turnkey approach, the responsibility for design and construction is delegated to a main contractor, who therefore assumes and requires extensive project management and project engineering resources. The owner project group will represent the interests of the owner throughout the implementation stage. The main functions of owner project management and contractor project management throughout the plant construction stage are described in IAEA publication [8].

2.7. CONTACTS WITH BIDDERS

It is a good practice for the owner to have dialogue with the potential bidders before the bidding process starts. A good forum for such dialogue could be a feasibility study/technology assessment conducted by the owner in cooperation with the potential bidders. The purpose of this dialogue is to help the owner better understand the

properties of the available NPP designs and the characteristics of the vendor market. In parallel, the bidders will obtain a good understanding of the owner's wishes and requirements before the final BIS is issued.

The owner should arrange contacts with bidders during the bidding process in a structured and controlled way. It is recommended that contact persons are nominated by the owner and each bidder. The owner should arrange regular meetings with each bidder in order to follow the bid preparation and to coordinate the bid evaluation process, as well as separate technical meetings if the need arises.

The bidders should also be treated by the owner in a fair and equal manner. Confidentiality must be respected. All communications between the owner and the bidders should be recorded and filed.

2.8. CONFIDENTIALITY

A NPP is a huge investment with a notable commercial value. Therefore, confidentiality aspects should deserve special attention during the bidding process. It is a common practice to require a confidentiality undertaking in written form from each person participating in the bidding process. Clear confidentiality rules have to be established and communicated.

2.9. IAEA ACCOUNT SYSTEM AND BIDEVAL-3

The IAEA has developed a comprehensive account system that can be utilized in the bidding process. The account system is capable of addressing a spectrum of capital costs, fuel cycle costs and O&M costs, from a complete NPP down to individual systems or components. Since the accounting system has a high degree of flexibility, it can be used with all types of reactors, single or dual purpose power plants, and various contractual approaches.

The IAEA computer program package for economic bid evaluation (BIDEVAL-3) is a set of computer programs designed to assist the owner in the economic evaluation of bids for nuclear power plants.

3. BID INVITATION SPECIFICATIONS

3.1. OBJECTIVES OF THE BIS

The primary objective of the BIS is to provide information to the bidders (the prospective contractors) on the following topics:

— Background and arrangement of the bidding process;
— The owner's technical and commercial requirements;
— The conditions and circumstances under which the contractor will have to perform the tasks;
— The expected structure and contents of the bids;
— The criteria on which the bids will be evaluated.

It is in the interest of the owner to provide complete and precise information in the BIS since this will facilitate the preparation and subsequent evaluation of the bids. It is also in the interest of the owner to promote competition and to encourage each bidder to prepare and present the bid meeting the owner's needs in the best possible way. This means that the owner should provide comprehensive information on all aspects which may affect the project and the owner should clearly express the requirements, conditions and wishes or expectations. On the other hand, the owner should refrain from being too restrictive in the demands and from making the content of the BIS too extensive by including detailed technical descriptions or basic information which is common knowledge.

It is recommended to also prepare the BIS in the negotiated contract approach because it would form a good basis for the contract negotiations and finalization of the contract.

3.2. BASIS

The basis of the BIS consists of:

— Relevant laws, acts, decrees, regulations, guidelines and resolutions applicable in the country;
— Relevant codes, standards, licensing and permiting procedures issued by the national authorities;
— Relevant codes, standards, licensing and permiting procedures adopted by the international organizations such as the IAEA;
— Results of preparatory activities carried out in the nuclear programme (e.g. site studies, feasibility studies, technology assessments, financing studies etc.).

If the owner has decided on a light water reactor, there are compilations of utility requirements, like the European Utility Requirements (EUR) [11] and the Utility Requirements Document (URD) [12] which could be used as one of the inputs for preparation of technical and safety requirements. Considerations presented in IAEA publication [10] could be used also as a reference in preparation of some general requirements.

3.3. STRUCTURE

There are many ways of structuring the contents of the BIS so that it has a logical sequence. As long as the BIS is complete, precise, clear, consistent and comprehensive, any reasonable internal structure and sequence can be used. In this publication, the approach adopted and presented is to divide the contents of the BIS into the principal subject matters, issues or systems to be considered. It is advisable to write the BIS text in the way that it can be utilized as is or with minor modifications as the future contract text.

The owner should establish an organizational unit (BIS team) which is in charge of the preparation of the BIS, and should select competent persons for this team. The authorities and responsibilities as well as the lines of communication should be well defined. The BIS team should have direct access to the highest decision maker within the owner's overall organization. The BIS team should also have easy access to outside expertise for assistance and advice in a wide range of special topics. The internal structure of the BIS team can be simple; there should be a project manager, an assistant project manager and about 20 competent professionals covering all disciplines (such as legal, commercial, financial, human resources, mechanical, electrical, nuclear, civil engineering) needed for the BIS preparation.

The overall effort required for preparing the BIS for an NPP under a simple project structure, such as a turnkey contract approach, is in the order of 15–20 professional person-years (including the BIS team and outside assistance) and the time needed is about 4–12 months. For a more complex project structure, such as a split package contract approach, the overall effort and time needed may be somewhat higher.

3.4. INFORMATION ON THE BIDDING PROCESS TO THE BIDDERS

3.4.1. Invitation letter

The invitation letter should state the intention of the owner to proceed with the project and it should indicate briefly the main characteristics of the project (power range, reactor type(s), scope of supply, project structure) the site of the plant and the proposed plant implementation schedule, as well as the general approach adopted for the bidding and contracting process. The invitation letter should also contain a brief summary of the main points of the BIS, with special emphasis on those parts which are of particular importance for the project.

In the invitation letter, the owner should request the bidders to send a written reply within an appropriate time (usually a few weeks) regarding the formal notification of their intent to bid.

3.4.2. Administrative instructions to the bidders

The administrative instructions to the bidders should contain all organizational and administrative rules and procedures for the bidding process and for the submission of the bid documents. At a minimum, information and instructions on the following points should be included:

— Owner's legal address and representatives;
— List of the BIS documents;
— Process for modifications to the BIS by the owner;
— Requests for clarifications by the bidders;
— Bid submission date and place;
— Rights of property of the bid documents;
— Contents and submission of the bid documents;
— Confidentiality;
— Bid validity;
— Bid commitment guarantee;
— Owner's commitments/obligation to the bidders.

The above items are discussed in more detail in Appendix II.

All bids should be structured in the same way since this will facilitate the bid evaluation. The owner should provide a general outline of the structure of the bids. An example of a table of contents for bids is provided in Appendix III.

3.4.3. Bid evaluation criteria

The purpose of enclosing in the BIS the bid evaluation criteria to be applied by the owner is to make clear to the bidders the items on which particular emphasis will be placed.

According to the conditions prevailing in the owner's country and the general approach established for the project, the evaluation criteria may cover the following items:

— Compliance of the bid with the contents and requirements of the BIS;
— Compliance with the terms and conditions of the draft contract;
— Implementation of nuclear safety, security and safeguards;
— Completeness of the scope of supply and services;
— Experience, reputation, organization, facilities, services and financial resources of the bidder;
— Project structure, project organization and implementation plan of the bidder;
— Technical characteristics of the plant, status and provenness of design, standardization, constructability, operability, safeguardabilty, and maintainability of the plant;
— Project schedule;
— Management system practices, procedures and measures;
— Assurance of supply of the plant and spare parts, including heavy water, if applicable;
— Warranties;
— Assurance of fuel supply and fuel cycle services;
— Assurance of nuclear safety, licensability, environmental effects, and waste management;
— National participation and technology transfer;
— Training programmes;
— Extent of follow-up services of the bidder during the plant operation;
— Prices, price adjustments, foreign and local currency requirements;
— Financing conditions;
— Electricity generation costs (levelized discounted electricity generation costs) or any other economic criteria decided by the owner.

In addition, the owner should identify the basis upon which the owner is entitled to eliminate a bid from the evaluation process.

The above items provide the general framework for the bid evaluation. The order in which the criteria are listed above should not be interpreted as an order of priorities. The owner may select and emphasize some of the above items or the owner may define and choose others.

3.5. GENERAL INFORMATION ON THE BID AND THE BIDDER

The BIS should specify general information that bidders are required to provide on the bid and the bidder. This information typically includes:

— Summary of the bid;
— Summary of technical description, scope of supply and services, and project implemetation;
— Legal and commercial documentation;
— Financial status of the bidder;
— Industrial safety records;
— Relevant experience of the bidder;
— Reference plant(s) and reference technologies;
— List of main potential subcontractors;
— Deviations and exceptions.

The above items are further discussed in Appendix IV.

3.6. GENERAL INFORMATION ON THE PROJECT

The owner should provide in the BIS general project information that the bidder needs when preparing the bid. The items to be dealt with include:

— Project description;
— Site information;
— Electric grid;
— National industrial capacity;
— Legislative framework;
— Applicable codes and standards.

The above items are discussed in more detail in the following subsections.

3.6.1. Project description

The owner should provide an overall description of the project including information about general plant characteristics (such as reactor type, electrical output, operating mode) and project implementation (such as contractual approach, timing of the project, national participation). It would be useful to provide, as complementary information, the bidders with the relevant parts of any feasibility study and/or technology assessment conducted before the bidding process.

The project description should also provide information about the nuclear power programme in the country and indicate how the project fits into the programme.

3.6.2. Site information

Before the preparation of the BIS, the owner should have selected a qualified site for the plant and performed an in-depth site investigation. The owner should include in the BIS all site information relevant to the bids.

Furthermore, the owner should offer the bidders free access to all detailed site studies and collected site data. Site information and data should cover at least the following areas:

— Geography and topography;
— Geology, soil mechanics and seismology;
— Hydrology;
— Oceanography (coastal side);
— Meteorology;
— Demography, traffic routes, agricultural and industrial use of land, access to the site;
— Potential natural hazards such as seismic hazards, volcanic hazards, tornados, tropical cyclones, lightning, floods, tsunamis, etc.;
— Potential external human induced events such as aircraft crashes, release of hazardous fluids, explosions, etc.;
— Particular environmental sensitivities.

More detailed instructions on relevant site information can be found in IAEA publications [13, 18].

A tentative plot plan for the plant may be enclosed in order to give the bidders an idea of the possible positioning and/or layout at the given site. It should be also indicated if the construction of additional units at the site is desired in the future.

It is good practice to offer the bidders free access to the site so that they can make their own studies if they consider it necessary for complementing the information given in the BIS. The owner should establish a procedure for the resolution of questions regarding the interpretation of the site data.

3.6.3. Electric grid

The technical characteristics of nuclear power plants such as startup, load change and load follow capabilities, effects of power cycling on components and fuel elements, and ability to withstand externally induced disturbances, are closely related to the integration of the plant in the electric grid system. Therefore, the owner should provide the bidders with detailed information on the electric grid system to which the plant is to be connected.

Further information on grid related aspects can be found in IAEA publications [19, 20].

3.6.4. National industrial capacity

The general purpose of the information on industrial capacity is to give the bidders a picture of the prevailing conditions of the country in which the project will be implemented. The information on local resources should cover industrial capacities, in particular. Lists and general descriptions of major technical support organizations, engineering firms, construction and erection companies, and mechanical, electrical and electronics industries existing in the country should be included.

3.6.5. Legal framework

It is the responsibility of the bidder to determine and to take into account the laws, acts, decrees, regulations and resolutions valid in the owner's country. However, the owner should include in the BIS a non-exhaustive list of the relevant legislation. Such legislation usually includes:

— 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 independent regulatory authorities; a system of licensing, inspection and enforcement, including all subject areas of nuclear law, i.e. radiation protection, radioactive material and radiation sources, the safety of nuclear installations, emergency preparedness and response, transport, radioactive waste and spent fuel, nuclear liability and coverage, security, safeguards, export and import controls, and physical protection;
— Legislation on foreign investment, including the roles of foreign entities, vendors and contractors, 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;
— The commitment to use nuclear power for peaceful purposes;
— National insurance legislation;
— International conventions and codes accepted by the owner's country;
— Other relevant legislation and legislation being developed.

3.6.6. Applicable codes and standards

Safety related and non-safety-related codes, standards, regulations and guides play key roles in ensuring the safety and good performance of nuclear power plants.

In this section of the BIS, the owner should give clear indications as to which codes and standards he requires or is willing to accept for the design and construction of the plant. In principle, there should be consistency in the codes and standards to be used. Mixing of codes and standards of different origin should be avoided.

The approach regarding safety related codes and standards is covered in Section 3.8.2.

3.7. GENERAL TECHNICAL REQUIREMENTS

In this section of the BIS the owner should specify technical requirements for the plant. The owner should also explain the intentions regarding the operation and maintenance of the plant. The items to be dealt with include:

— Main design characteristics;
— Safety and licensing;
— Operability and maintenability;
— Waste management and decommissioning;
— Security and physical protection;
— Emergency preparedness;
— Safeguards.

The above items are discussed in more detail in the following subsections.

3.7.1. Main design characteristics

In this section of the BIS the owner should provide the plant's main specifications and criteria for design purposes, such as:

— Number of NPP units requested and/or planned;
— Net electrical output each unit;
— Integration of the plant into the electricity grid, cooling and raw water supplies, communication links and road system;
— Reactor type(s);
— Design lifetime;
— Length of fuel cycle (for off-load refuelled reactors);
— Potential to use MOX fuel;
— Spent fuel storage capacity at the plant;
— Waste storage capacity at the plant;
— Environmental protection.

3.7.2. Safety and licensing

The purpose of this section of the BIS is to address in detail the nuclear safety and licensing requirements for the plant. These requirements are the result of the general legislation in force in the owner's country, as well as of

the regulations, rules, guides and procedures established by the nuclear and other regulatory authorities of the country.

The owner should provide in this section information on all national laws, decrees, rules, codes and standards related to nuclear safety which are applicable to the nuclear plant including measures regarding severe accidents. The owner should assist the bidder to have a clear understanding of all the international instruments to which the country is party. It is noteworthy that any country wishing to enter into an agreement with the IAEA for its assistance in connection with the implementation of a NPP will be required to follow those parts of the IAEA safety standards that pertain to the activities to be covered by the agreement. Design related requirements are given in IAEA safety standard [24].

Furthermore, the owner should give a detailed description of the licensing procedure (including the schedule) to be followed, indicating the different steps and the kind and number of documents to be submitted. The owner should point out clearly the expected participation of the contractor (the successful bidder) in the preparation of the relevant documents and the required assistance of the contractor during the licensing process.

The regulatory authority of the owner's country may not yet have developed a complete set of requirements and guidelines for the licensing of a NPP. In this case, the owner should indicate the policy to be applied for the licensing of the plant. At the very least, a hierarchy of safety requirements should be given, for example:

— National regulatory requirements;
— IAEA safety standards;
— Regulatory requirements of the country of origin;
— Regulatory requirements of other countries.

It is of great importance for the owner to fix the date of validity for the applicable safety regulations (reference date), since additional costs related to a modification of the safety conditions for the project after this date, usually, will be borne by the owner. Normally, the date of bid submission is taken as the reference date.

In addition to the regulatory requirements, the owner can have its own safety requirements that may go beyond the regulatory requirements. Those can be based, for instance, on the utility requirements publications [11, 12].

The bidders should be required to provide information regarding compliance of their bids with the safety requirements specified above in this section.

Furthermore, the bidders should be requested to provide detailed information on some general safety related topics with respect to their plants such as:

— Passive safety features;
— Redundancy, physical separation and diversification of safety systems;
— Protection against natural hazards, such as seismic hazards, volcanic hazards, tornados, tropical cyclones, lightning, floods, tsunamis, etc.;
— Protection against human-induced events, such as aircraft crashes, release of hazardous fluids and gases, electromagnetic interfaces, sabotage, etc.;
— Protection against severe accidents;
— Radiation protection and releases of radioactive materials.

All licensing requirements valid in the bidder's country, as well as ongoing modifications of codes and standards and licensing requirements which are known at the reference date, should be included in the bids as far as applicable to the specific technology the bidders are offering for the project.

The owner should also request the bidders to commit themselves to provide information on any ongoing modifications of the licensing requirements in their country during project execution at regular intervals.

3.7.3. Operability and maintainability

In this section of the BIS, the owner should provide details regarding the operational modes of the plant (base load and/or load following) including expected startups, load variations and external disturbances during the plant

life. If a load following capability is taken into consideration, the expected load change characteristics should also be indicated.

If the owner requires the achievement of certain specific operational characteristics for the plant, these should be clearly stated, giving also the related technical requirements. Such specific operational characteristics may refer to the following items:

— Target operational performance (availability, occupational exposure, etc.);
— Startup capabilities from hot and cold conditions;
— Shutdown capability;
— Power set-back capabilities and part load operation;
— Step and ramp load changes at different power levels;
— Ability to withstand a full load rejection without the reactor trip;
— Ability to withstand a turbine trip without the the reactor trip;
— Limits for frequency and voltage changes;
— Minimum accepted power load for continuous operation;
— Capability of the plant to operate in isolation from the grid;
— Operational cycles and transients.

Further information on these subjects can be found in IAEA publication [19].

Regarding the subject of plant maintenance, the owner should provide in this section a description of its general approach, procedures and practices for maintaining the existing electric power plants, if any (centralized services, organization, personnel, spare parts, scheduling, on-site and off-site facilities). Further guidance on these subjects can be found in IAEA publication [22].

According to the above specifications, the bidders should be requested to provide information on the technical conditions for the operation and maintenance of the plant. This information should demonstrate coverage of the basic requirements for operation and maintenance as well as the operational characteristics of the offered plant design.

The bidders should be requested to indicate the number of persons needed for operation, maintenance, refueling and in-service inspection. An estimate for the annual radiation exposure of personnel should also be provided.

The bidders should be requested to include in the bid information regarding operating procedures applicable to the proposed plant, in particular for:

— Steady state power operation and operational limits;
— Load changes and load rejection;
— Startup and part-load operations;
— Shutdown operation;
— Emergency situations including severe accidents.

The bidders should be requested to inform the owner of already established information- exchange systems of owners of similar plants, describing the scope of activities of each group and the possible advantages in joining such groups.

3.7.4. Waste management and decommissioning

The owner should request the bidders to provide information on waste handling, in particular on:

— Generation of gaseous, liquid and solid wastes;
— Processing (treatment and conditioning) of wastes;
— Storage of wastes.

Decommissioning of the NPP should be considered during the design phase of the NPP. The owner should request the bidder to provide a description of measures undertaken to simplify decommissioning, minimizing decommissioning waste and radiation exposure of workers.

Further information on these subjects can be found in IAEA publication [30].

3.7.5. Security and physical protection

Adequate physical protection of the plant and of any nuclear material is a combined owner and national responsibility. Design related requirements on physical protection should be included in the BIS. Those requirements should be based on a design basis threat. Further information on the topic can be found in IAEA publication [26].

The bidders should be instructed on any restrictions on handling items related to physical protection. These materials are normally handled separately from other parts of the BIS, bid and contract documentation. This information should be circulated or reviewed on a 'need to know basis' only.

The BIS should also define requirements of the security arrangements during the construction and commissioning of the NPP, including the transfer of responsibilities for security and physical protection.

3.7.6. Emergency preparedness

The owner is normally responsible for emergency preparedness in the plant area. For that purpose, requirements for adequate tools, instruments, equipment, communication systems, facilities (e.g. on-site emergency control center, laboratories) should be presented in the BIS. Further information on these arrangements can be found in IAEA publications [27, 28].

3.7.7. Safeguards

Safeguards agreements are negotiated at the governmental level; however the owner becomes involved in the implementation of the agreements and the relevant national legislation.

In order to provide cost effective proliferation resistance, its intrinsic features and extrinsic measures should be implemented throughout the full life cycle of the plant and be optimized by design and engineering:

— Intrinsic features:
  • Technology (e.g. nuclear material property, processes, etc.);
  • Technical design (e.g. core with small reactivity margins), including those that facilitate the extrinsic measures;
— Extrinsic measures:
  • State's commitments and obligations (e.g. IAEA safeguards, NP and Nuclear Weapons Free Zone related treaties and agreements)

Possible owner requirements on the NPP design may include:

— The attractiveness of nuclear material and nuclear technology in the NPP for a nuclear weapons programme should be low;
— The diversion of nuclear material should be reasonably difficult and detectable;
— NPP design should incorporate multiple proliferation resistance features and measures;
— The combination of intrinsic features and extrinsic measures, compatible with other design considerations, should be optimized in the design/engineering phase to provide cost-efficient proliferation resistance.

The owner should include in the BIS requirements for such design features which make physical safeguard measures possible. Further information on these subjects can be found in IAEA publication [25].

3.8. STRUCTURES SYSTEMS AND COMPONENTS

In this section of the BIS, the owner should request the bidders to provide a complete and detailed description of systems, structures and components (SSC).

3.8.1. Nuclear island

The owner should request the bidders to include all information on the functional and physical characteristics of structures, systems and components, the design basis, safety considerations, operational functions and incidental behaviours. For example, the information should include the following items:

— Functional description of systems and components;
— Description of design features;
— Flow diagrams;
— Process diagrams;
— Performance data sheets;
— Arrangement drawings;
— Component outline drawings;
— Containment penetrations drawings (electrical and mechanical);
— Component lists;
— Thermodynamic and thermohydraulic data;
— System and component design data;
— Operational and test procedures;
— Part load diagrams;
— Startup and shutdown diagrams;
— Transient diagrams.

3.8.2. Conventional island

The owner should request from the bidders corresponding information with respect to the conventional island as in the case of the nuclear island. Additionally, specific information for the turbine and generator, as listed below, should be requested:

— Heat balance diagrams for different power outputs;
— Startup and shutdown diagrams and procedures for turbine and generator;
— Transient diagrams and limit curves;
— Turbine heat rate curve versus generator output;
— Correction curves for turbine heat rate and generator power output;
— Diagrams for the turbine-generator set: reactive capability curve, saturation curves, short-circuit decrement curve, load time curve;
— Drawings for turbine and generator (layout, cross-sections, laydown areas for maintenance).

3.8.3. Balance of plant

The bidders should be requested to provide in this section of the bid the technical description of the balance of plant (BOP). Typical items of the BOP (outside the nuclear and conventional islands) are listed below:

— Protection and fire fighting systems;
— Fencing, access and egress controls;
— Storage facilities;
— Water supply system;
— Ventilation and air-conditioning systems;

— Air and gas systems;
— Auxiliary steam systems;
— Laboratories, workshops and laundries;
— Drainage system;
— Intake/discharge cooling water systems;
— Waste management system;
— Warehouse management.

3.8.4. Electrical systems

Regarding the electrical systems of the plant, the owner should request the bidders to provide information on the following items:

— Cabling principles;
— Plant system single line diagram;
— Diagrams of main circuit;
— Diagrams of internal circuit;
— Diagrams of measuring points;
— Drawings of cables and wiring;
— List of motors and condensers for normal and emergency power supply;
— Equipment lists;
— Equipment catalogues;
— Specifications for transformers and switchyard;
— Layout drawing for electrical components;
— Functional specifications;
— Test procedures.

3.8.5. Instrumentation and control (I&C) systems

Regarding the instrumentation and control of the plant, the owner should request the bidders to provide information on the following items:

— Drawings of control room(s) layout;
— Drawings of typical panels and instrument racks;
— Diagrams of measuring points;
— Drawings of cables and wiring;
— Equipment lists;
— Equipment catalogues;
— Diagrams of protection and control devices;
— Functional diagrams for I&C systems;
— Design sheets for I&C systems;
— Diagrams for reactor protection systems;
— List of alarm limit values;
— List of trip signals;
— Logic and analog diagrams;
— Flow diagrams for I&C systems;
— Platforms of digital I&C systems;
— Principles for preventing common cause failures;
— Functional specifications;
— Test procedures.

3.8.6. Civil structures

The owner should request the bidders to provide technical information regarding all civil structures to be constructed for the plant. This information should include the following items:

— Drawings of civil and structural layout;
— Formwork;
— Prestressing and/or reinforcements;
— Anchors and foundations;
— Steel structures;
— Embedded parts;
— Landscaping and architectural schemes;
— Underground utilities.

3.9. SCOPE OF SUPPLY AND SERVICES

In this section of the BIS the owner should request the bidders to provide a complete and detailed description of the scope of supply and services.

3.9.1. Completeness clause

Under the turnkey contract approach, the bidder is expected to supply all structures, systems and components, materials and services which are necessary for the complete plant. This responsibility is generally underlined with the so-called ‘completeness clause’ requiring that the contractor deliver everything that is not specifically identified as owner’s scope of supply and services, and is necessary for licensing, construction, commissioning and operation of the plant in accordance with the requirements of the BIS. However, the ‘completeness clause’ should preferably not be used as a substitute for detailed and precise specification of the contractor’s scope of supply and services.

3.9.2. Owner’s scope of supply and services

The owner’s scope of supply and services should be specified precisely in the BIS. The owner may supply the following:

— Site data and information;
— Development of the site (cleaning, levelling, draining, fencing);
— Access to the site (road, rail, harbour facilities);
— Improvement of roads for transport of heavy components;
— Connection of the site to the electric grid;
— Delivery of electricity during construction and commissioning;
— Switchyard;
— Communications (telephone, data connections);
— Drinking water and process water;
— Site offices and furniture;
— Accommodation for construction workers;
— Public information centre;
— Training centre;
— Storage facilities for construction materials;
— Site workshops;
— Environmental control system (radiological monitoring);
— Administration buildings and installations;
— Canteen;
— Sanitary services;

— Fire fighting installations and equipment (outside the buildings);
— Garages;
— Transport services;
— Site security installations and services;
— Medical services;
— Recreational installations and services;
— Assistance for obtaining local permits;
— Customs clearances and customs clearance zones on site;
— In-service inspection.

Each item of the owner's scope will result in an interface with the contractor's performance of its scope, as well as could potentially impact the project schedule. For this reason, the owner is advised to accept only those scope items which it could realistically deliver on time and in required quality. Further when deciding on its scope, the owner should also look ahead to the plant operation phase.

3.9.3. Bidders' scope of supply and services

In spite of the completeness clause, the owner should request the bidders to describe their scope of supply and services in the form of a detailed and uniform scope list. The bidders may be asked to arrange the information contained in the scope list in the sequence indicated in the IAEA Account System.

In addition, the bidders should be requested to present in the scope list, for each item, the responsible organization (contractor or owner) for various activities of the entire supply process, such as:

— Basic design;
— Detailed design;
— Engineering review;
— Manufacture or supply;
— Transport;
— Erection;
— Commissioning and turnover to operation organization;
— Licensing documentation.

In the case of heavy water reactors, the owner should indicate whether it intends to retain the supply of heavy water in the owner's scope or whether the owner wishes this item to be included in the bidder's scope.

The owner should also indicate in this section of the BIS any desired alternatives and options for items of the scope of supply and services.

The wishes of the owner regarding auxiliary or additional supplies and services which are not directly related to the plant, hence are not included in the concept of the 'completeness clause', should be clearly stated and defined in detail.

3.9.4. Nuclear fuel cycle supplies and services

The nuclear fuel cycle supplies and services may be offered either as part of the bid for the NPP, or separately. In case of separate contracts on fuel cycle supplies and services, the interfaces between these contracts and the plant contract have to be carefully evaluated and contractually well defined. A benefit to having a separate fuel contract is that this contract can be used as a model for corresponding contracts for fuel reloads during the plant operation phase.

The owner should clearly state its intentions regarding the handling of fuel cycle activities. In particular, owner should indicate which supplies and services related to the fuel cycle are included in owner's scope of supply and services, and which part should be offered by the bidders. The following supplies and services belong to the fuel cycle:

— Supply of yellow cake;
— Conversion to UO_2 or UF_6;
— Enrichment services (if applicable);
— Manufacture of fuel elements (first core and reloads) and core components;
— Handling and storage of new fuel assemblies;
— In-core fuel management;
— Fuel licensing services;
— Plans and procedures for refueling;
— Spent fuel management including storage, transport and direct disposal or, reprocessing and waste disposal.

It is usual that the manufacture of fuel for the first core and the first couple of reloads will be done by the plant contractor.

The owner may wish to obtain offers for manufacture of later reloads through competitive bids from other fuel manufacturers. Therefore the owner may request the bidders to express in the bids their commitment to deliver within their scope of supply and services all relevant data and information including physical, thermo-hydraulic, thermodynamic and mechanical data as well as calculations for reload batch planning (short term and long term).

The fuel management and licensing by the owner also requires qualified calculation software which may be part of the scope of supply and services of the bidder.

3.9.5. Scope of spare parts and consumables

The owner usually requests the bidders to include local or international provision of consumables for the plant as well as an adequate stock and future coverage of spare parts. The coverage periods should be oriented to the warranty periods for the different systems and components and on the competitive market situation for services and parts.

3.9.6. Alternatives and options

The owner usually requests the bidders to include in their bids detailed information on alternatives and options. This information should enable the owner to evaluate each alternative and option according to its own merits. The bidders should also be allowed to propose technical alternatives and options not specifically requested by the owner. In this case the bidders should provide justifications for their proposals and detailed information on the implications of each alternative and option offered. However, these proposals can be considered as options or alternatives only after the bidders have accepted the original requirement of the owner. If not, these alternatives or options could be considered deviations from owner's requirements.

3.10. PROJECT IMPLEMENTATION

In this section of the BIS, the owner should request the bidders to provide a complete and detailed description of project implementation.

3.10.1. Project structure

The owner should request the bidders to present the project structure including their project organization and project implementation plans. The project structure should identify whether the bidder is a single company or a consortium. In the case of a consortium, the consortium members have to be identified and their roles and responsibilities within the consortium should be described from the management, commercial and legal points of view.

The information about the project organization should include the following items:

— Distribution of responsibilities within the bidder's organization;
— Background and experience of the prospective top management staff for the project;

— Organizational charts of the project, including the main linkages between headquarters and the site office, the number of people and the duties of the responsible persons;
— Organizational charts of the site personnel.

If the owner has any specific requirements or expectations related to project structure and implementation, it should be stated clearly in the BIS. In some cases, the owner might not allow a consortium to be a contractor or will request a specific legal profile of the consortium.

The owner should request the bidders to provide their approach to project management , and the list of tools, software and procedures that they utilize to manage projects, as well as the consortium participants, if applicable, and the subcontractors and suppliers that they typically use. The owner should also request the bidders to designate a corporate manager who would deal with problems arising during project execution, in case they are beyond the authority and responsibilities of the project management.

3.10.2. Project schedule

The owner should request the bidders to provide a schedule of the project activities and events. In order to enable the bidders to better build up the schedule, the owner should provide the status of infrastructure development and the status of other preparatory activities at the time of issuance of the BIS.

The schedule should include all activities of the bidders which the bidders have to perform to meet their responsibilities regarding the scope of supply and services, as well as all other requirements of the BIS. The schedule should enable the owner to assess the feasibility and logic of the schedule. Based upon experience, this assessment eventually requires several thousand activities to be included in the schedule for the overall project scope. The owner should also request a list of milestones in the form of a milestone project schedule, as well as a schedule of the services offered, and a schedule for the submission of equipment and component documentation as well as licensing documentation.

The schedule should account for the duration of the handling of applications for various permits and licenses described in the licensing requirements and procedure. The period for review and approval of licensing documentation in accordance with national regulatory requirements should be included in the schedule.

The schedule provided by the bidders should include the interface dates with the activities in the owner's scope of supply and services.

Furthermore, the bidders should provide an overall time management programme (e.g. personnel power loading or work force planning) and a description of the methods they will apply for the control and updating of the schedules during construction, including a proposal for regular reporting to the owner.

3.10.3. Construction and commissioning

The owner should request the bidders to include in their bids a description of their plans for construction and erection of the plant. This description typically covers at least the following items:

— Interface management throughout the whole supply chain;
— Expediting engineering and component deliveries;
— Excavation;
— Site infrastructure during construction and erection;
— Storing and conservation of components;
— Sequence plans for construction;
— Construction methods to be applied (modularization etc.);
— Concrete production and testing;
— Personnel breakdown for activities at the site.

It is also of particular importance to request information on the technical conditions and procedures proposed for commissioning, including programmes for each step and relevant related documentation. This information should cover the following:

— System and component testing;
— Core loading;
— Cold and hot tests;
— Initial criticality;
— Low power tests;
— Startup and power tests;
— Trial operation and acceptance of the plant.

The owner should also request the bidders to commit themselves to providing monthly reports covering the progress of the project (procurement, manufacture, transport, testing, etc.).

3.10.4. Documentation and configuration management

The owner should request the bidders to provide a comprehensive list of all technical documentation which they will submit during project execution. The main types of documents should be briefly defined by the owner in order to ensure consistency in evaluation and in interpretation.

The owner should clearly state the owner's requirements for configuration management systems. The owner should request the bidders to provide information with regard to the configuration management system in use.

Further detailed information on this subject area is provided in IAEA publications [7, 23].

3.10.5. Management system

The owner should request the bidders to submit management/quality system documentation necessary for review and evaluation of their capabilities to meet the quality requirements. A preference may be given to an integrated management system that integrates safety, health, environmental, security, quality and economic elements in accordance with IAEA publication [21].

3.10.6. Risk management

The owner should request the bidders to provide a risk management programme and a preliminary project risk analysis. This preliminary analysis should cover technical, commercial and project implementation risks. The required risk management programme should include the following steps:

— Identify risks that could have a potential impact on the project;
— Evaluate risks in qualitative (to define main risks which require further analysis) and quantitative terms;
— Set out strategic actions to mitigate risks;
— Process to monitor and control the identified risk and contingencies during project implementation.

3.11. NATIONAL PARTICIPATION

The owner should indicate its requirements or expectations with regard to national participation and technology transfer. It is recommended that the owner include a breakdown (national participation list) of all locally available materials, services, systems, equipment and components which the owner believes can be used, performed or produced locally.

The owner should clearly state the goals of the project as they relate to technology transfer. The owner should also specify owner's plans for the implementation of technology transfer including the kind of arrangements the owner intends to use and the scope for each case (joint ventures, cooperative arrangements, technical assistance, licenses and know-how transfer agreements involving training of personnel, participation in the tasks, and provision of information and experts). The owner should request the bidders to provide information on the ways and means of ensuring compliance with the owner's requirements.

The volume and structure of national participation and technology transfer to be defined in BIS depends primarily on:

— Size of the nuclear programme in the country;
— Technical and economic status of national industry;
— Owner's business plans;
— Non-proliferation considerations.

The owner should request bidders to submit information on materials, structures, systems, components, and services which the bidder could provide locally and a list of possible local subcontractors. The bidders should identify the legal and commercial arrangements that could define the relationship with major national companies, for national participation as well as for technology transfer purposes.

Information needed has to be collected by the bidders (with owner's support) on a case by case basis, so that they can make a detailed proposal for national participation and technology transfer programme in their bids.

3.12. TRAINING

The scope of supply and services of the bidder normally includes training of the owner's operation and maintenance personnel. The owner should provide the organizational plan and structure that the owner intends to adopt for plant operation and maintenance as well as the different functions of the personnel.

The owner should request the bidders to submit complete information on the training programme, the training process and the training facilities. The bidders' proposals for training should include information on the following points:

— Overall programme of training courses and on the job training for the owner's personnel, including the contents, duration and grade of the training courses and on the job training; training time schedules and training locations;
— Training material, including training courses descriptions, training documents and aids (models, videos, equipments, etc.) and recommended training settings;
— Recommended personnel qualification requirements and examination procedures;
— Simulator services or, if required by the owner, the training facilities (i.e. full-scope training simulator) and simulator training programmes.

The bidders should also provide a plan for the organizational setup required to meet the objectives of the training programme, and a recruitment plan giving the number of persons to be employed, their qualifications and the dates when they will be needed.

3.13. COMMERCIAL REQUIREMENTS

3.13.1. Draft contract: Terms and conditions

There will usually be several contracts for a nuclear power project. Even with a turnkey approach, in addition to the main contract for the supply of the plant, there will be contracts for the owner's scope of supply and probably for at least some parts of the fuel cycle, and for financing. With a split package approach, a separate contract is needed for each package.

The owner should include in the BIS the draft of the main contract containing the contractual terms and conditions. The draft contract must be clear and precise; it should protect the owner's interests, but it should also be equitable and acceptable to the contractor. A balanced risk distribution is beneficial for project success. It is recommended that the risk is assigned to the party that can better control and manage it, because of its resources and specific experience. Having a properly balanced draft contract will enhance the responsiveness of the bidders. If however, a bidder does not agree with some of the terms and conditions proposed by the owner, the bidder must state this and give a list of deviating points in its bid. It should be clearly stated in the BIS that the bidder accepts all those terms and conditions of the draft contract which are not commented by the bidder in the bid.

The draft contract as well as the comments of the bidder forms the basis for the contract negotiations with the selected bidder(s). The result of these negotiations is the final contract, which governs the relationship between owner and contractor over the whole period of project execution.

The draft contract should deal with all administrative, organizational, legal, commercial, technical, economic and financial matters which are of importance to the project and which need to be settled for the final contract. The draft contract should be prepared with extreme care by specialists in the field, including industrial lawyers experienced in international contracting in the owner's country.

Further, if the owner wishes to incorporate one or more parts of the BIS into the contract, this should be clearly stipulated in the draft of the contract.

3.13.2. Commercial conditions

The owner should provide to the bidders the form in which the information on prices, terms of payment and financing conditions shall be provided. This information should be in sufficient detail so that the owner can perform the economic bid evaluation and then make the commercial contractual arrangements with the selected contractor.

Prices, price breakdown, price adjustment and currency

Depending on the contractual approach, the owner may request the bid prices in a unified format such as the IAEA Account System. However, the price breakdown in accordance with the IAEA Account System may not fit the owner's requirements for scope of supply and services, national participation or technology transfer. In this case the owner should tailor the accounts appropriately.

The prices quoted by the bidders for the scope of supply and services offered, referred to as base bid prices, should be in line with the requirements of the owner. These requirements can represent a combination of:

— Fixed or firm prices at the date of bid submission and should be applicable during the validity period. The bidders should clearly indicate in their bids which prices are fixed or firm;
— Provisional or estimated prices for bidders' scope of supply and services that cannot be properly defined at the time of bidding.

A fixed price is binding on the bidder if it is accepted during the validity period of the bids and it is not subject to adjustment as a result of escalation. A firm price is binding on the bidder if it is accepted during the validity period of the bids and it is subject to adjustment as a result of escalation. The price adjustment formula and the related coefficients may be provided by the bidders.

A provisional or estimated price does not fully commit the bidder with respect to the price unless it is defined as a guaranteed maximum. A provisional or estimated price may be based on firm or fixed unit prices (for work, materials, etc.) and estimations on needed quantities. The owner might benefit from such pricing structure in those situations where fixed and firm prices are difficult to predict, such as for complex inland transportation of heavy components.

The foreign portion of the base prices should be quoted in the currency (currencies) in which the bidder expects to be paid. The owner may request the bidder to quote the prices for domestically furnished components and services in the local currency.

Terms and schedule of payments

In the BIS the owner should state its wishes regarding the payment schedule and procedure.

The schedule of payments should be linked with certain milestones in connection with the progress of the project. The milestones and related conditions or events triggering the payments and the size of the payments should be precisely defined. Typically, the number of payments may vary between 10–20 and the number of triggering conditions or events for each payment may vary from 3–6.

3.13.3. Warranties

In the draft contract, the owner should set out its approach and requirements for warranties. The owner should request the bidders to offer warranties in line with these requirements.

For each of the warranties the following points should be specified:

— Subject of the warranty;
— Procedures for determining compliance and mitigation;
— Consequences of non-compliance (repair, replacement or monetary penalties);
— Criteria for the application (amounts and limits of monetary penalties or damage compensation);
— Conditions of the warranties — owner's tasks and responsibilities (operation of the plant, etc.).

Usual warranties should cover the following items:

— Design, materials and workmanship quality;
— Performance and physical parameters (net output, heat rate, steam conditions, operating characteristics, fuel integrity and burnup, etc.);
— Delivery time for the plant or for packages of software and hardware;
— Heavy water losses (if applicable);
— Title warranty.

The owner may request, or the bidders may offer, additional warranties for a wide range of subjects or plant characteristics, such as extended period warranties for special structures, systems and components, software warranty, specific fuel warranties. Some owners may request also an availability warranty for the first operational years of the plant.

3.13.4. Insurance

The draft contract should include the expectations and requirements of the owner related to the insurance coverage. The owner should make clear what insurance coverage is needed for the nuclear power plant and its related activities.

Generally, the insurances are relevant to Nuclear Third Party Liability Insurance, Nuclear Material Damage Insurance, Nuclear Transportation Insurance, Workers' Compensation, Employer's Liability, Commercial General Liability, etc.

3.13.5. Financing

Financing requirements or expectations, if any, should be also specified in the BIS. They may cover amount of financing requested and preference in terms of currency, interest rates (fixed or floating rates), and types of security.

The owner should also provide information on the portions of the different financing packages in the total financing.

The bidders should be requested to propose financing instruments or approaches indicating the institute or the group (consortium) of banks and other financial institutions participating in financing. Export credit financing, multi-country financing, co-financing and suppliers' credits are approaches which bidders may propose.

Information about the financing to be provided should include the following items:

— Source of financing;
— Amount and currency;
— Interest rate;
— Repayment period;
— Grace period;
— Fees and commissions;

— Downpayment;
— Schedule of payments.

The role of bidders ends with providing an outline of financing proposal supported by a commitment letter from the financing institution. The final negotiations and formal agreements are always between the owner and the financing institution.

Appropriate financial provision shall be made for:

— Decommissioning of facilities;
— Management of radioactive waste, including its storage and disposal;
— Management of spent fuel.

Further detailed information on this subject area is provided in IAEA publication [32].

4. BID EVALUATION PROCESS

The evaluation of bids is an extensive task, generally taking not less than six months to complete. During the bid evaluation process, technical, economic, financial and contractual aspects of the bids should all be considered.

The evaluation of the bids can be organized in different ways. It is often divided into two parts: technical evaluation and economic evaluation. These two parts, however, are very closely linked together. This publication deals with the evaluation of bids as a single process that consists of several parallel and sequential activities. Section 4 deals with the general outline of the bid evaluation process. The technical evaluation and the economic evaluation are discussed in Sections 5 and 6, respectively.

4.1. REFERENCE DOCUMENTS FOR BID EVALUATION

The main reference documents that should be reviewed and considered in the bid evaluation are:

— BIS prepared by the owner;
— Bid documents prepared and submitted by the bidders;
— Relevant parts of the Safety Analysis Report (SAR) of a reference plant or technologies (if available);
— Results of preparatory activities carried out in the nuclear power programme (such as feasibility study, technology assessment etc.);
— Applicable national and international legislation, requirements, regulations, agreements, including nuclear security and safegurards, etc.

In reviewing and considering the above referenced publications, one has to distinguish between the natures of the various types of information available. Whereas the BIS and the bid documents in most cases contain binding information which will later become part of the contract, other information serves merely as background information unless it will also become part of the contract. A great help in evaluating bids is the possibility to refer to similar projects already under construction or in operation.

4.2. PREPARATION AND ORGANIZATION

Bid evaluation has to be planned as part of the overall project schedule. Before bid evaluation commences, there is work required to prepare and organize the bid evaluation, such as:

— Defining evaluation approach and related methods;
— Establishing a time schedule for the evaluation period;
— Drawing up evaluation forms;
— Establishing organization and staffing;
— Appointing consultants (if applicable);
— Arranging facilities for evaluation;
— Compilation of a bid evaluation manual.

It is important for the preparations and organization of the bid evaluation that sufficient time is available and that one can start with the evaluation as soon as the bids have been received.

The time required for this preparation depends on the experience available but is several months. It is advisable to complete the preparations described in this section during the time that the bidders prepare their bids.

The above items are discussed in more detail in the following subsections.

4.2.1. Approach of bid evaluation

There are three types of evaluation approaches that are generally applied for bid evaluations:

— Single evaluation approach;
— Two-stage evaluation approach;
— Multi-evaluation approach.

These approaches are illustrated in Fig. 3.

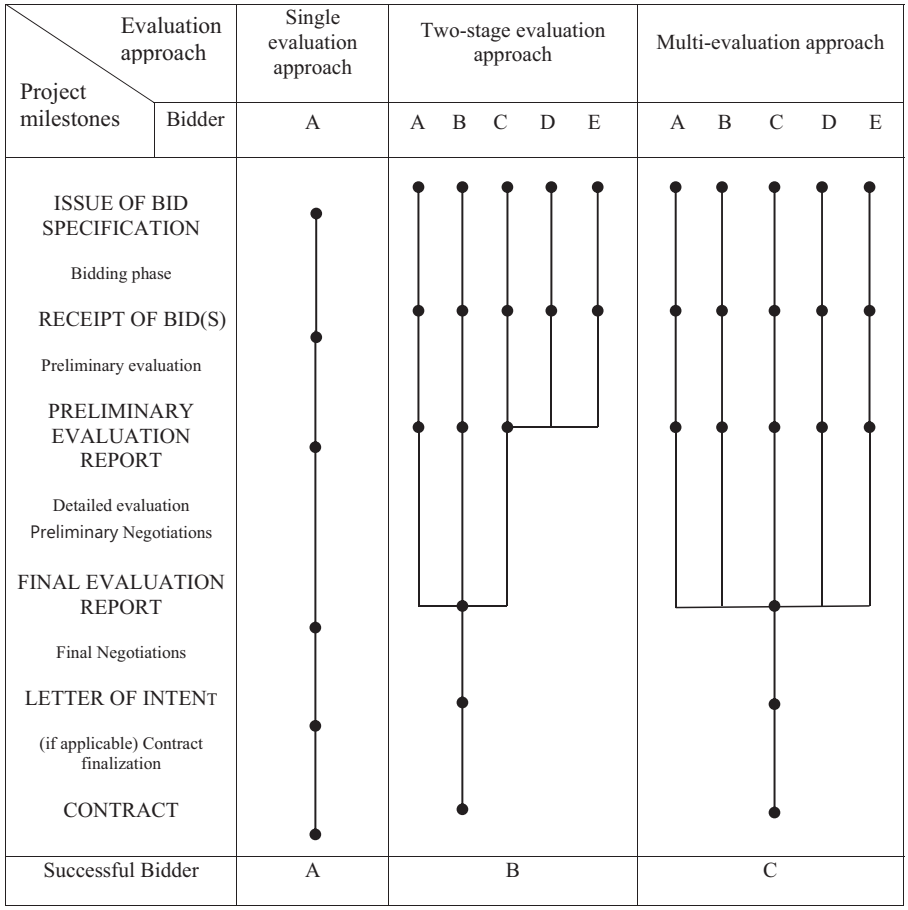

FIG. 3. Approach of bid evaluation.

These three evaluation approaches differ mainly in the number of bids which are evaluated in detail. The single evaluation approach is applied in the case of a negotiated contract approach with one particular bidder who, for technical, financial and/or political reasons, has been selected as the potential contractor for the plant. In the two-stage evaluation approach, after a preliminary evaluation, a short list of two to three bids is made. The shortlisted bids are then evaluated in more detail. A multi-evaluation approach means that all bids which have been received are evaluated to the same extent.

The recommended approach is to apply, if possible, a two-stage evaluation approach and to limit the detailed evaluation and negotiations to two, or at the most, three bids.

4.2.2. Scheduling of the bid evaluation

The time required for the bid evaluation, i.e. the time from receipt of the bids up to the submission of a final evaluation report, typically will take about 6–12 months for a turnkey bid, with another 4–6 months needed for contracting. This is, in particular, valid in cases in which a two-stage evaluation approach is applied. However, if the project is based on a complex business and financing model, the time required for bid evaluation may be longer.

4.2.3. Organization and staffing

The composition of the evaluation team should be a mixture of engineers, economists, human relations specialists and lawyers, with the persons at the management and intermediate level having sufficient experience on similar large scale industrial projects.

The evaluation team should normally consist of a number of working groups, each responsible for a part of the bid evaluation. The responsibilities of each working group should be well defined including the interfaces and interrelationships between the working groups. An evaluation committee is needed to coordinate and judge the work carried out by the corresponding working groups.

The composition and size of the working groups should be adapted to the disciplines and work load, which mainly depends on the number of bids received and the scope of supply and services set out in the BIS.

The number of personnel involved in a bid evaluation depends on time available for carrying out the evaluation, number of bids and scope of the bids, but also on the experience of the personnel available and the depth to which this evaluation is carried out. The total number of personnel required is typically around 70 people. Fifteen to 20 persons would be fully devoted to this work during the entire bid evaluation period; 30–40 persons would be required 50 to 70% of the time, whereas the rest would be involved less than 30% of the time.

The evaluation team should be thoroughly trained on the evaluation process before the evaluation starts. Participation in the preparation of the evaluation manual is one recommended way to give training for the members of the evaluation team.

4.2.4. Use of consultants

The use of consultants is generally recommended for bid evaluation, even in cases where nuclear experience is available within the owner's organization. Generally the number of bid evaluations and negotiations with bidders carried out by the owner for projects of such complexity and size is limited. In order to counterbalance the ability and experience of the bidders, it is advisable to call upon experienced consultants who know the market situation, as well as have been involved in a sufficient number of other evaluations of similar type.

The basic requirements for a consultant appointed for bid evaluation purposes are the following:

— Significant experience on different plant types and bidders;
— Good knowledge of safety regulations and philosophies followed in different countries;
— Good knowledge of the latest international applicable technical requirements and good practices;
— Good knowledge and experience in project structuring, organization and management;
— Good knowledge in organization and implementation of contract negotiations.

4.2.5. Facilities for evaluation

Facilities for the bid evaluation should be arranged in accordance with the following criteria:

— Each person belonging to the evaluation team should have access to all documentation that the person needs for the purpose of the evaluation;
— Only authorized persons can have an access to bid documentation and the reports produced during the bid evaluation.

It is advisable that the bid evaluation team works in dedicated rooms with access restricted to authorized persons. All bid related documentation should be kept securely in these rooms. There should also be a dedicated computer system (with its own server) separated from other computer systems of the owner. All electronic data transfer channels between the owner and bidders should be encrypted.

4.2.6. Bid evaluation manual

The bid evaluation process is best summarized in a manual which informs each person involved in the evaluation the basic responsibilities and necessary background information, in order for the work to be done in a thorough and expeditious manner.

The manual should cover overall bid evaluation, including: technical, economic, commercial, contractual and organizational matters. It is necessary that the evaluation manual be developed together with all key personnel involved in the bid evaluation.

The bid evaluation manual should typically include the following information:

— A list of the bidders that have been inivited to bid and a short description of the scope requested in the BIS;
— A description of the evaluation approach and related method which will be applied
— Evaluation criteria;
— The organizational set-up, the division of work and basic responsibilities for carrying out the evaluation;
— The overall schedule for the evaluation with an indication of the time at which various reports, questionnaires, etc. need to be ready;
— A list and brief description of the documents which form the basis for carrying out the evaluation;
— The bid evaluation forms which will be applied for the evaluation;
— Confidentiality and information security requirements;
— Principles for communications with the bidders;
— Management system requirements for the bid evaluation;
— Reporting requirements.

The evaluation manual is the main tool instructing the people carrying out the bid evaluation. As the number of bid evaluations carried out by most organizations is rather limited and the work itself is never routine, it is necessary that sufficient attention is paid to informing and instructing the people involved.

4.3. IMPLEMENTATION OF THE BID EVALUATION

The bid evaluation process, as shown in Fig. 4, starts with the receipt of the bids and ends with the issuance of the final evaluation report. The most important activities during the bid evaluation phase are the following:

— Receipt and opening of the bids;
— Preliminary bid evaluation, inlcuding:
  • Preparation of first questionnaires to be filled out by the bidders;
  • Analysis of bidders' answers to the questionnaires;
— Preparation of preliminary bid evaluation report;

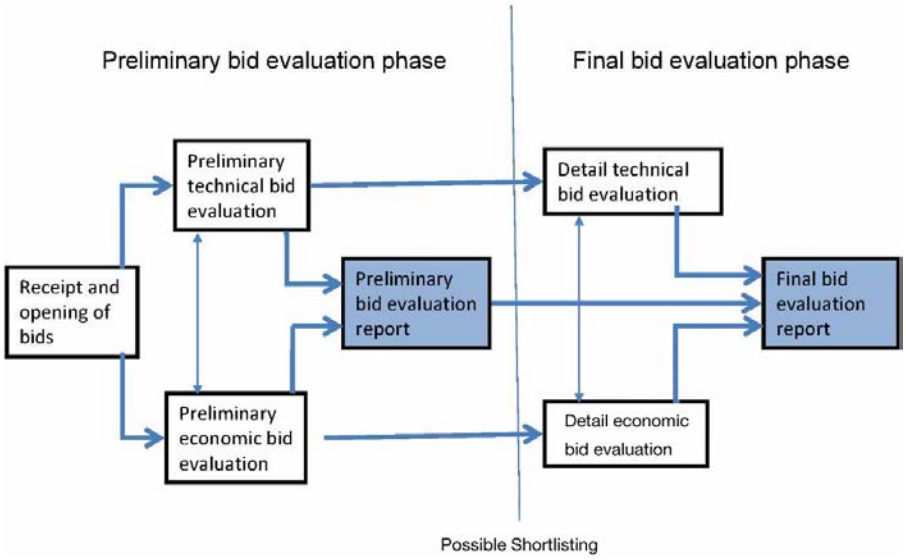

FIG. 4. Overall diagram of the bid evaluation.

— Creation of the short-list of the bidders, if forseen in the bidding process;
— Detailed bid evaluation including:
  • Preparation of additional questionnaires;
  • Meeting with bidders for clarifications and negotiations related to questionnaires;
— Preparation of final evaluation report.

The above activities are discussed in more detail in the following subsections.

4.3.1. Receipt and opening of bids

The bids should be submitted by the bidders in accordance with the instructions given in the BIS. All bid documents received should be labeled by set and volume so they can be clearly identified.

The sets of bid documents are then distributed to the key persons involved in the evaluation. All persons who receive a set should sign for receipt and be held responsible for these bid documents. It is recommended to keep at least one or two sets of bid documents in reserve and undistributed for verification, document control or reference purposes.

It is usual that bid prices, payment conditions and other important commercial conditions are submitted under a separate sealed cover. Unless it is a custom or requirement to open these in public, this part of the bid can be opened at the later stage of the evaluation. Even then, the number of persons having access to this information should be kept limited.

4.3.2. Preliminary bid evaluation phase

The aim of the preliminary bid evaluation phase is to review and confirm if the bids are compliant with the BIS requirements. This could lead to rejection of one or more bids due to non-compliance with important BIS requirements. Criteria for elimination of bids are normally outlined in the BIS. The decision for rejection of bids should be documented in a written report.

A further aim of the preliminary bid evaluation is to review the completeness of the information submitted in the bids, to check the scope of supply and services and to evaluate the main design features of the plant offered and evaluate the main economic, commercial and financial aspects of the bids.

If the evaluation approach selected is the two-stage approach, then the results of the preliminary evaluation phase must be much more conclusive, as the number of bids which are considered for further evaluation could be reduced to the two or three most viable bids. As an effective approach, the preliminary bid evaluation should be carried out by the senior personnel of the evaluation team, whereas the other persons of the team use their time to

get acquainted with the bid and give support as required. The number of key persons involved is generally six to eight senior professionals who cover all main aspects of the bid. In case specialized expertise is required, experts in the field are asked to give their opinion on specific aspects. This preliminary evaluation permits the senior personnel to also guide and supervise the detailed evaluation in a more effective manner. As they conduct this preliminary evaluation they will become quite familiar with the content of the bids, the scope of supply and services, as well as design features offered.

4.3.3. Preliminary bid evaluation report

The results of the preliminary bid evaluation phase should be laid down in a preliminary bid evaluation report. In the two-stage evaluation approach, it should serve as a basis for selection of the most suitable bids for the detailed evaluation in the next phase (short listing). The preliminary bid evaluation report should contain the following information:

— Basis, objectives and scope of the report;
— Background information on bidders;
— Preliminary assessment of the bid compliance with the BIS requirements (technical requirements, scope of supply and services, commercial requirements, etc.);
— Preliminary technical evaluation summary of the bids;
— Preliminary economic evaluation summary of the bids;
— Deviations, if any, from the information obtained earlier in connection with preparatory activities;
— Conclusions and recommendations.

4.3.4. Detailed bid evaluation phase

After the preliminary bid evaluation has been completed, the next phase in the bid evaluation process is to perform the detailed bid evaluation (and if applicable, only with the short listed bidders). The detailed bid evaluation is based on a detailed technical evaluation and a detailed economic evaluation and may include the following steps:

— Preparation of final questionnaires to be sent to the bidders;
— Assessment of the replies provided by the bidders to questionnaires;
— Meeting with bidders for clarification based on answers to questionnaires;
— Meeting with bidders concerning adjustments in scope of supply and services, options and commercial conditions (primarily with respect to prices) and deviations from the draft contract. (Note: this might not be permitted according to the legislation in some countries);
— Completing the final bid evaluation report;
— Defining the strategy and programme for the contracting phase.

4.3.5. Final bid evaluation report

The final bid evaluation report should give an all-inclusive picture of the evaluation work and list all documents issued by or on behalf of the owner during the bid evaluation. References should also be made to other documents which are only partly related to the bid evaluation work, such as site reports and reference plant design reports, in order to show what background documentation has been available.

The final evaluation report should cover a comparison of the main plant characteristics and parameters, summarizing the most important positive and negative features for the main aspects of the bids, especially emphasizing the problem areas related to the bids. Finally, recommendations on the selection of a bidder should be given, together with points which still need to be verified or improved during the negotiations and points which need a close follow-up during the construction and commissioning of the plant.

The final evaluation report can be made available depending on the scope, method and approach of the evaluation within 6–12 months after the receipt of turnkey bids. Negotiations with the preferred bidders, particularly if it is based upon competitive dialog, can start in parallel with the preparation of the final evaluation

report, upon receipt of answers to the questionnaires. The results of these negotiations should be taken into account at the preparation of the final evaluation report.

4.3.6. Review of bidders

It is recommended, and sometimes required, to review the bidders as part of the bid evaluation process. The purpose of this review is to clarify or verify the solutions for issues (or concerns) that have been identified by the owner during the bid evaluation. These issues can be of various natures such as:

— Design activities;
— Research and development activities;
— Manufacturing capacities;
— Management system;
— Supply chain (number and quality of subcontractors);
— Human resources;
— Financial standing;
— After-sales services;
— Longevity expectations;
— Lessons learned from previous projects (schedule and cost control, etc).

If such issues cannot be resolved through the question/answer process, the owner should request a visit to the bidder or his major subcontractor in order to obtain a clear understanding of the issue through a review/audit process. The agenda for such visits should be very specific and the visits should be limited to the resolution of one or a few issues only.

For some of the issues, direct communication with the operators of similar plants is also recommended.

5. TECHNICAL BID EVALUATION

The technical bid evaluation should be started immediately after the receipt and opening of the bids and continued until the issuance of the final bid evaluation report. It should cover the following items:

— Scope of supply and services;
— Technical design features;
— Project implementation;
— Warranties;
— National participation and technology transfer;
— Nuclear fuel;
— Alternatives and options.

The above items are discussed in more detail in the following sections.

5.1. SCOPE OF SUPPLY AND SERVICES

The evaluation of the scope of supply and services can be carried out according to the evaluation logic shown in Fig. 5.

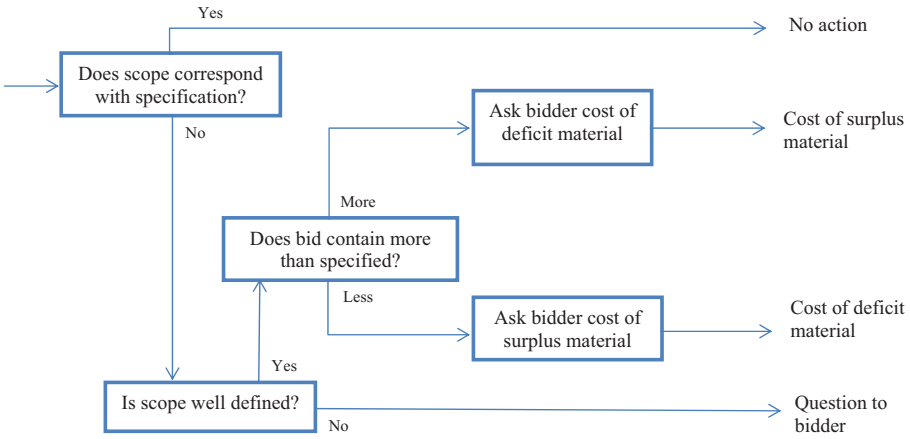

FIG. 5. Evaluation logic for scope of supply and services.

This logic should be applied systematically to each structure, system, component, and service. The evaluation should be carried out by making comparisons with the BIS. If the scope is not well defined or understood, one should question the bidder.

For the limits of scope, one should be careful to have an exact definition of these limits and physical interfaces. For example, it is not enough to say that the limit of supply for piping is 1 m outside the building. One should also specify who is responsible for providing the material for the connection (flanges and bolts), for making the connection and for testing the connection.

In addition to the evaluation of the scope of supply related to structures, systems and components, special attention should be paid to the following 'soft' items that may be dealt with in a limited way in scope lists contained in the bid:

— Supplies and services during construction and commissioning:
  - Testing of components and systems including required tools;
  - Pre-operational testing and commissioning;
  - Management system;
  - Licensing assistance;
  - Transferring of know-how, provision of drawings, descriptions, procedures, calculations, analysis, and other documentation required for supervising design and construction of the plant, for licensing, and for designing and ordering structures, systems and components belonging to owner's scope of supply and services;
  - Training;
  - Computer programs and other software tools needed during construction and commissioning period;
  - Non-permanent supplies and services which are necessary for the work on the site required for the operation and maintenance of the plant;
  - Packing, transport and insurance of equipment;
  - Spare parts, consumables and special tools;
— Operation and maintenance manuals, inservice inspection programme, plant and systems surveilance programme, plant design basis documentation, IT tools and databases needed during the operation phase of the plant (for in-core fuel management, plant modifications and other activities);
— Spare parts, consumables and special tools for operation and maintenance;
— Supporting services during operation.

5.2. TECHNICAL DESIGN FEATURES

5.2.1. Evaluation levels of technical design features

In general terms, the evaluation of the technical design features should be carried out on three levels:

1st level: Overall technical design evaluation of the plant.

2nd level: Specific technical design evaluation for systems and main components such as

reactor coolant system, feed water system, emergency core cooling systems, containment, reactor pressure vessel, steam generators, steam turbine and electrical generator.

3rd level: General technical design evaluation of mechanical and electrical components such as pumps, motors, valves, heat exchangers.

A possible timing of the evaluations on three levels is indicated in Fig. 6.

1st evaluation level of technical design features

The evaluation of the overall technical design covers items which are of importance for the performance and safety, security and safeguards of the plant, for example:

— Proven technology;
— Standardization;
— Simplification;
— Safety and licensability;
— Plant lifetime;
— Availability;
— Operability and manoeuvrability;
— Inspectability and maintainability;
— Refuelling schedules;
— Waste management and decommissioning;
— Security and physical protection;
— Emergency preparedness;
— Safeguards.

The above items are discussed in more detail in Appendix V.

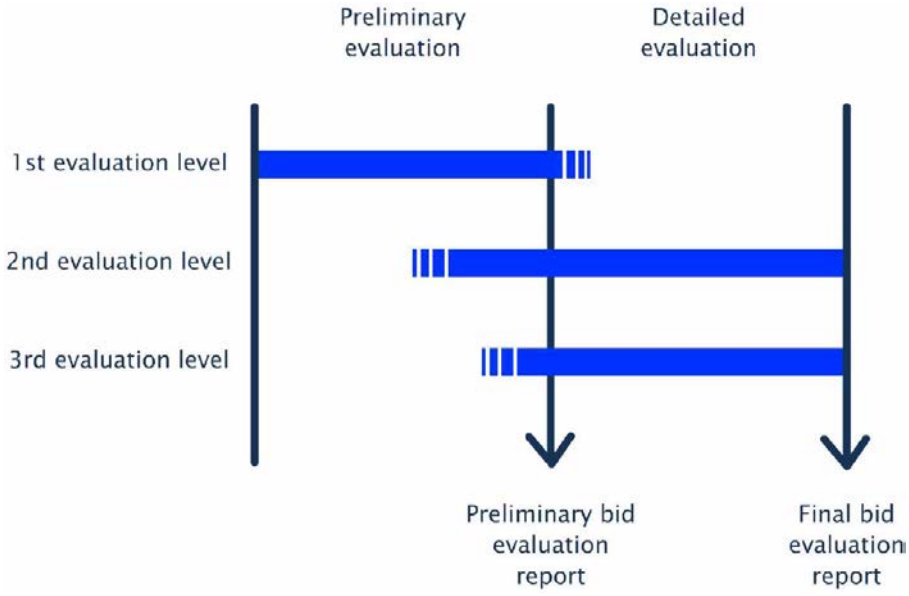

FIG. 6. Example of timing for the evaluation of technical design features.

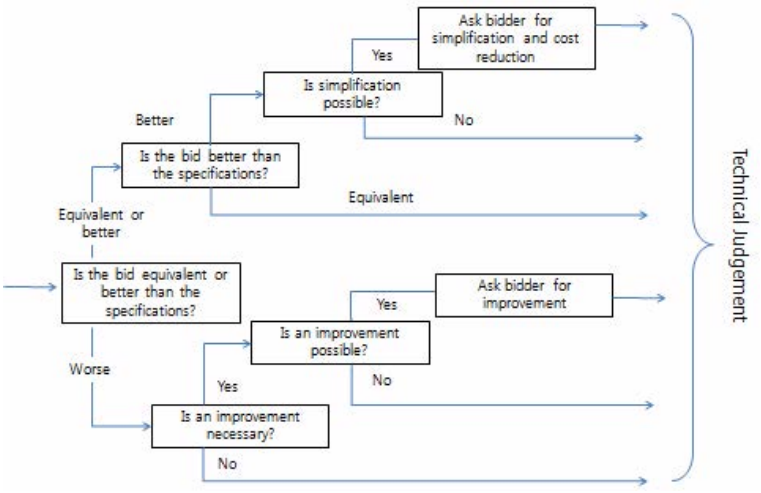

FIG. 7. Evaluation logic for technical design features.

2nd evaluation level of technical design features

For the evaluation of specific design features of structures, systems and components the plant is normally divided into the following parts:

— Nuclear island;
— Conventional island;
— Electrical systems and component;
— Instrumentation and control (I&C) systems;
— Balance of plant (BOP);
— Civil works and structures;
— Plant simulator.

3rd evaluation level of technical design features

The third evaluation level of technical design features is concerned with the general quality of the bulk of components supplied for the plant. It involves a general technical evaluation of the equipment offered, such as:

— Mechanical equipment, including pumps, heat exchangers, tanks and vessels, piping, valves, supports, insulation;
— Electrical equipment, including motors, switches, electrical cables, consoles, panels, racks, cubicles;
— I&C equipment and platforms for digital I&C systems;
— Architectural finish, including type of walls and roofs, doors and windows; wall, floor and ceiling finish, painting, external finish and other building services (lighting, heating, elevators).

5.2.2. Technical evaluation methods

The evaluation of the technical design features of a bid can be carried out according to the evaluation logic shown in Fig. 7.

This logic can be applied systematically to the following evaluation criteria which are considered in the evaluation of structures, systems, components and other general technical aspects of the bid:

— Reliability;
— Function and performance;
— Safety;

— Operation and maintenance;
— Materials.

Before starting the technical evaluation, the scope of the evaluation should be divided into a number of items which will be evaluated on the basis of the above evaluation criteria. The selection of these items should be made on the basis of the importance of these items to the overall performance of the plant. The items to be evaluated can be structures, systems and components, and technical aspects such as safety, licensability, operability and maintainability. For the latter aspects, other evaluation criteria have to be applied whenever the above criteria are not applicable.

The technical evaluation can be made either qualitatively or quantitatively.

The aim of qualitative evaluation is mainly to determine the technical acceptability of a bid and to bring out the positive and negative features of a design. Each structure, system,component or technical aspect which is felt important to be evaluated is examined against the requirements of the specifications according to the evaluation logic shown in Fig. 7.

Quantitative evaluation is carried out in the same way as the qualitative evaluation, with the only exception being that one quantifies the positive and negative features of a design in order to come to a clear technical ranking of the bids. The quantification can be either made in monetary or other numerical values. This evaluation method is required if one would also like to determine, besides the technical acceptability of the bids, the best technical bid and how much better one bid is compared to another.

5.3. PROJECT IMPLEMENTATION

Experience shows that problems during the design and construction phases can have a major impact on the overall plant economics (delays and cost overruns). For this reason, the bid evaluation should cover to the project implementation scenarios suggested by the bidders.

The evaluation of the project implementation should cover at least the following items:

— Project structure and organization;
— Project schedule;
— Construction and commissioning;
— Documentation and configuration management;
— Management system;
— Risk management.

The above items are discussed in more detail in Appendix VI.

5.4. WARRANTIES

The technical bid evaluation should also include the technical aspects of the proposed warranties including:

— Scope of the warranties;
— Duration of the warranties;
— Response time to warranty claims;
— Conditions for implementation of remedies.

The owner should verify that the scope and duration of warranties must be equal or better than required in the BIS. The scope should cover the quality, properties and performance of the plant and fuel. The duration for the plant warranties should not be less than two years after start of the commercial operation. The warranty durations of some structures, systems and components may deviate from the overall warranty duration of the plant (are longer).

Some bidders might require a complicated process before responding to warranty claims. Some others might require the owner’s assistance during mitigation (special tools, free access to the place of work, removal of

damaged equipment, decontamination, etc.). These differences are also an important input to the economic evaluation because they represent a cost risk for the owner. One way to eliminate such requirements on the part of contractor is to impose damage compensation on the contractor for plant downtime — i.e. cost consequences due to warranty claim and its mitigation in the contract.

5.5. NATIONAL PARTICIPATION AND TECHNOLOGY TRANSFER

The evaluation team should evaluate the disadvantages and advantages of offered national participation and technology transfer, only as they relate to the project and the national nuclear power programme. The potential direct and indirect advantages for the broader national economy may be assessed by some of the stakeholders, but is not part of the mandate of the evaluation team.

The technical assessment of national participation and technology transfer should include items such as:

— Technical feasibility of any offered national participation and technology transfer;
— Potential quality and schedule impact of the offered national participation on the project implementation;
— Potential advantages of the offered technology transfer for plant operation and maintenance;
— Differences in scope of offered national participation and technology transfer.

5.6. NUCLEAR FUEL

For the technical evaluation of the fuel and fuel cycle, the same evaluation criteria can be applied as for the structures, systems and components of the plant, namely:

Evaluation criteria	***Special features***
Reliability:	Fuel integrity
Function and performance:	Burnup, heat flux, linear power and other performance features
Safety:	Safety margins and possible release of radioactive materials from the fuel
Operation and maintenance:	Operational flexibility, refuelling schedules,possibilities of repair and insertion of third-party fuel
Materials:	Use and behaviour of cladding materials and other materials (spacers, upper and lower supports, fuel boxes, etc.).

Operational flexibility with the nuclear fuel is an important aspect of the fuel evaluation. This flexibility should correspond to the flexibility of the plant and to the needs of the owner. The speed and frequency with which power changes are required needs to be carefully evaluated against the fuel safety criteria. The operational flexibility as regards startup and load changes at the end of each fuel cycle needs to be evaluated as well.

The evaluation of the nuclear fuel not only covers fuel design, but also reactor core design including safeguards related issues like enrichment.

5.7. ALTERNATIVES AND OPTIONS

The selection of the required alternatives and/or options should be made in the technical bid evaluation. Offered options that are desirable, but not an absolute necessity, may also be selected in the technical bid evaluation. If these options are not offered by every bidder, the bidders not offering the option should be given the opportunity to do so. If this is not done, unnecessary options arbitrarily included in the evaluations could adversely displace the bid order in the final evaluation ranking, thereby raising litigious issues regarding fairness. In any event, all of the alternatives and options selected in the technical bid evaluation should be included in the entire assessment process.

The costs of any selected alternatives and/or options should be taken into account in the economic bid evaluation.

6. ECONOMIC BID EVALUATION

6.1. INTRODUCTION

The objectives of an economic evaluation of bids are the ranking of plant alternatives according to costs and evaluating the resulting cost differences. A data flow diagram of the economic bid evaluation process is presented in Fig. 8.

The economic bid evaluation is based on the following data and information:

— Bid prices;
— Results of the technical bid evaluation and corresponding interfaces;
— Commercial and contractual terms and conditions;
— Economic parameters;
— Financing terms and conditions;
— National participation and technology transfer;
— Owner's costs;
— Bids for initial fuel and some reloads;

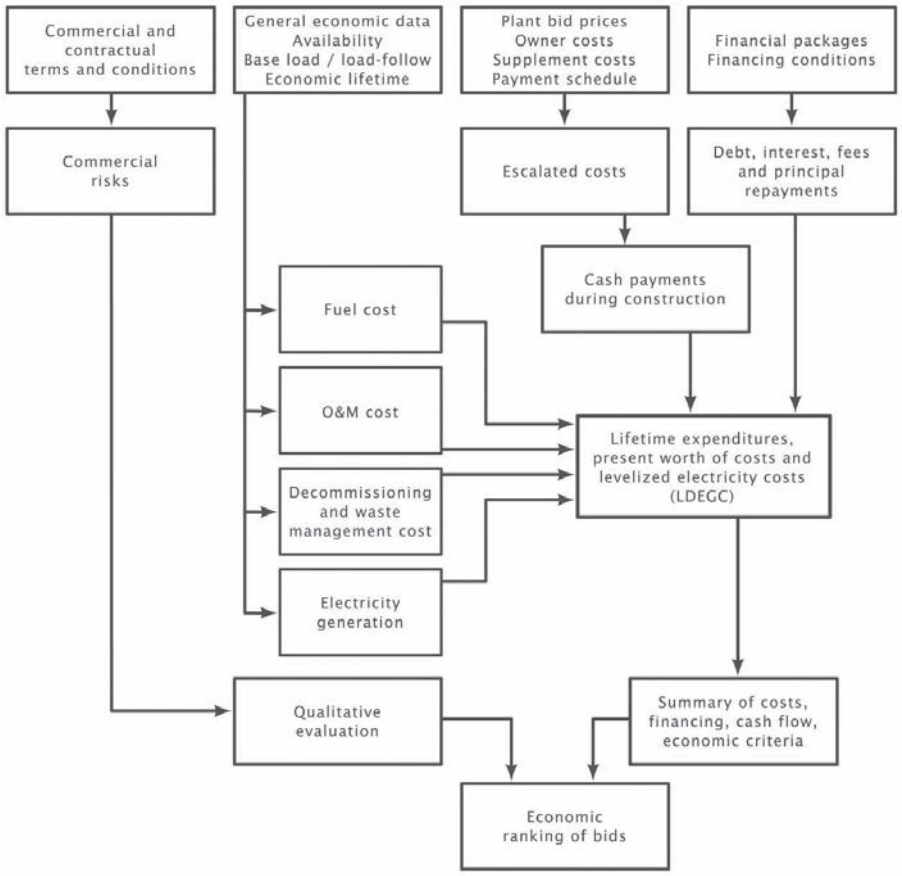

FIG. 8. Data flow diagram of the economic bid evaluation process.

— Options for further reloads;
— Operation and maintenance cost estimates;
— Back end cost estimates (spent fuel management).

The IAEA Account System could be applied for the economic bid evaluation. The level and completeness of cost detail available for inclusion in the IAEA Account System at any point in the bid evaluation process will depend on the type of contract being requested and the stage of contract negotiation.

The different types of cost which will be incurred during plant construction and during the economic life of the plant may be classified as follows:

— Total capital investments costs (TCIC);
— Nuclear fuel cycle costs;
— Operation and maintenance (O&M) costs.

These costs, together with the economic parameters, form the group of data and basic elements necessary for applying the Levelized Discounted Electricity Generation Cost (LDEGC) evaluation methods presented in this publication.

Various methods of cost comparison are used to evaluate the economic order of competing bids. The methods provided in this publication and the related IAEA software (BIDEVAL-3) enables a full-scale economic evaluation including all required elements and parameters and resulting with LDEGC as the criterion for ranking. However, if there are no major differences in offered technology, technical properties, financing, commercial elements, proposal for national participation; etc. a simpler economic evaluation approach can be used. Further information on the simpler economic evaluation approach is provided in Appendix VII.

6.2. COST CATEGORIES

6.2.1. Total capital investment costs (TCIC)

The investment costs for a complete NPP, or parts of it, include the costs of engineering, construction, commissioning and the trial test run up to commercial operation. The ‘base costs’ include costs associated with the equipment, structures, installation and materials (direct costs), as well as the engineering, construction and management services (indirect costs). In addition to the base costs there are also supplementary costs, financial costs and owner’s costs. Supplementary costs include spare parts, contingencies and insurance. Financial costs include escalation, interest during construction (IDC) and fees. Owner’s costs include the owner’s capital investment and services costs.

The overnight costs consist of the base costs, the supplementary costs and the owner’s capital investment and service costs.

The total capital investment costs (TCIC) are the costs of building the NPP and bringing it to commercial operation. The breakdown is shown as follows:

$$\text{Base cost} = \left\{ \begin{array}{c} \text{Direct cost (Account nos 21–29)} \\ + \\ \text{Indirect cost (Account nos 30–41)} \end{array} \right\}$$

$$\text{Overnight costs} = \text{Base cost} + \left\{ \begin{array}{c} \text{Supplementary costs (Account nos 50–54)} \\ + \\ \textit{Owner}\text{'s } \textit{capital investment} \text{ and services costs (Account no. 70)} \end{array} \right\}$$

$$\text{Total capital investment costs} = \text{Fore costs} + \left\{ \begin{array}{c} \text{Escalation costs (Account nos 60, 71)} \\ + \\ \textit{Interest} \text{ during construction and fees (Account nos 61, 62, 72)} \end{array} \right\}$$

Account numbers in parenthesis refer to the IAEA Account System.

6.2.2. Nuclear fuel cycle costs

The nuclear fuel cycle costs include the costs of uranium supply, conversion and enrichment; fuel fabrication; transport; spent fuel intermediate storage and final disposal of the spent fuel (for the direct disposal option). For the reprocessing option, the costs also include those for chemical reprocessing associated with waste management, along with storage and final disposal of high level radioactive waste, as well as any credits realized through the sale and use of uranium, plutonium, heavy water and other materials.

6.2.3. Operation and maintenance (O&M) costs

The operation and maintenance (O&M) costs include all non-fuel costs, such as costs of plant staffing, consumable operating materials (wear parts) and equipment, repair and interim replacements, purchased services and nuclear insurance. They also include taxes and fees, decommissioning allowances, waste management costs and miscellaneous costs. In addition, the costs of general and administrative support functions and the cost of providing working capital for plant O&M are included. Other O&M costs have to be calculated separately by the owner. The O&M costs are specific to every nuclear reactor and should be included in the overall bid evaluation.

6.3. CRITERIA FOR ECONOMIC RANKING

Both qualitative and quantitative criteria are used for the economic ranking of bids. As a rule, as much as possible of the economic evaluation should be performed in quantitative terms; i.e. monetary value. A number of criteria, representing a variety of objectives, could be used for ranking the bids. When several criteria are used, conflicts over the ranking of bids could arise. This situation can be avoided by using a predetermined hierarchy of importance and applying corresponding weighting factors to the criteria.

6.3.1. Qualitative criteria

A qualitative evaluation is necessary for those cases in which the data provided in a bid or the consequences to the owner cannot be readily quantified. This may be the case for some risks and benefits to the owner or to the country. For example, the data for technology transfer may be evaluated in qualitative terms. Many points, such as contractual aspects and licensing procedures can only be considered in a qualitative manner.

Techniques exist for comparing alternative choices on a relative basis. These techniques allow for the incorporation of judgement and personal values in a logical and structured method. A widely applied technique is to convert qualitative judgements into numerical values.

6.3.2. Quantitative criteria

The most common criteria on which to base investment decisions may be classified into two main groups:

— Criteria which consider the expenses without taking into account the time of their occurrence (which constitutes their main disadvantage) and which are based on:
  - Annual cost calculation;
  - Total net cash flow per monetary unit disbursed — Average annual net cash flow per monetary unit disbursed — Pay back or capital recovery time;

— Criteria which do consider the time associated with the expenses, using the discounting procedure to equalize the amounts of money at different moments of time, and which are based on:
  • Present worth values;
  • Internal rate of return.

A major difficulty in the economic evaluation of a project over a long plant life is that the future values of relevant economic parameters are not known. They must either be estimated, or a method must be chosen which does not require estimation. A key parameter is the electricity price in future years, which is required in order to calculate the flow of future revenue for each alternative.

Of the criteria indicated, only two of the present worth based criteria; i.e. the minimum present worth of total plant costs and the LDEGC, do not require this flow for their correct application. The criterion based on the minimum present worth of total plant costs is the simplest of all of the criteria mentioned. However, it does not take into account the possible variations in energy production for the different bids. Therefore, the method suggested in this publication is that by which the LDEGC are obtained.

6.4. ECONOMIC EVALUATION METHODOLOGY

6.4.1. LDEGC

The suggested 'yardstick' to use for the economic ranking of bids is the LDEGC. The term LDEGC is defined as the rate for each unit of electrical energy which must be charged in order to recover exactly the total plant lifetime costs, taking into account the time value of money. The total plant lifetime costs include capital investment costs, fuel cycle costs and O&M costs.

In other words, the sum of present worth of lifetime electricity revenues will equal the sum of the present worth of lifetime costs when each kilowatt-hour (kW·h) is sold at LDEGC monetary units. The bid which offers the minimum value for LDEGC is economically preferable.

This definition of LDEGC may appear at the same time to be rather simple and rather abstract. Its application, however, presupposes extensive calculations for determining the distribution of costs over time and the schedule of future energy production.

The IAEA computer program package for economic bid evaluation, BIDEVAL-3, is a set of computer programs designed to assist the user in the economic evaluation of bids for NPPs. The program follows the recommended method of determining the present value of all costs for capital investment, nuclear fuel, and operation and maintenance in order to obtain the LDEGC.

The program operates in a user friendly, interactive mode. Sensitivity analysis used for assessment of risks resulting from chosen values of key economic parameters can be carried out quickly with the computing and graphics capabilities of BIDEVAL-3.

6.4.2. Evaluation in constant or current money

The analyst has the choice of making an economic analysis in current money by including the effect of inflation, or in constant money by disregarding the effect of inflation. Current money means money as spent or earned. Future payments in current money are calculated using nominal escalation (or inflation) and nominal interest rates. Constant money means money of constant value; i.e. as if no general inflation existed. Future payments in constant money are calculated using real escalation and real interest rates.

The major drawback of a constant monetary analysis is that it is cumbersome to perform when loans are included in the economic study, since the terms of loans are always expressed in current monetary value. Repayment must be made in current monetary units and hence such units must be used in the financial analyses and the economic bid evaluation. Another drawback is that the actual future expenses (which will include inflation) are not reflected.

In general, bid evaluations and other engineering economic analyses are made in current money because, in a society of changing monetary values, this option affords more insight into the future effects on utility customers. On the other hand, the constant money analysis does offer a view of changing cost patterns without the inflation effect

and therefore may be appropriate in some cases. Working in constant money has the advantage of making the analysis essentially independent of the inflation rate. Cost trends due to real price escalation are clearly visible. Constant money analyses referenced to a nearby point in time result in costs presented in money that has a purchasing power close to current experience; value judgements are thus easier to make.

6.5. ECONOMIC PARAMETERS

Relevant economic parameters for the economic bid evaluation include:

— Inflation, escalation, discount and interest rates;
— Economic life;
— Reference date of prices (often the bid reference date);
— Date to which discounting will be performed (start of commercial operation of the plant or bid reference date);
— Exchange rates of currencies (reference currency versus foreign currencies).

Their use for the economic evaluation is explained in the following subsections.

6.5.1. Escalation and inflation rates

Inflation is measured by the change in the prices of a basket of goods and services over time, generally performed at a national level. Escalation is measured by the change in the prices of specific commodities; e.g. steel, cement, construction labour.

The increase in the costs and in the offered bid prices which will occur during the construction period have to be estimated and considered by the owner of the NPP. This increase must be taken into account when the total financing requirements for the project are established. The prices offered in the bids are usually subject to escalation. This is taken into account by using a price adjustment formula.

The capital investment costs, or their constituent parts, may be subject to escalation. This is a function of the labour and material cost indices in the supplier(s)' countries and/or in the buyer's country, depending on the origin of the supply. The economic bid evaluation should be based on estimates of the future values of these cost indices, which may be obtained from official sources.

In order to forecast the evolution of the labour and material cost indices, an in-depth analysis of historical trends and forecasting techniques should be part of the sensitivity analysis.

The offers from the various bidders often present different concepts related to:

— The weight of materials and labour in the price adjustments formulas;
— The determination of another price basis within the loan period;
— Monetary fluctuations.

These particular aspects and concepts make it necessary to analyse and carefully evaluate these factors with respect to their influence on the energy generation costs.

6.5.2. Discount rate

The discount rate is an economic parameter similar to a rate of interest. It reflects the time value of money that is used to convert benefits and costs occurring at different times to equivalent values at a common date (present value analysis). For economic bid evaluation purposes, this parameter is needed in order to discount all costs and benefits to a common reference date, which is usually the bid reference date. This reference date may also be the effective date of contract signing or a date fixed in the BIS.

The discount rate may be set by government policy or may be derived from a consideration of capital markets. In determining the appropriate discount rate in a current money analysis, care must be exercised when including the effect of inflation. It is possible that high inflation rates may influence the value of the real discount rate, since this value is based on a certain level of investment risk and high inflation rates may change the level of risk.

6.5.3. Interest during construction (IDC)

The IDC reflects the financial costs associated with the use of capital during plant construction. Money borrowed or committed for project implementation must be paid back or recovered with interest. Hence, IDC is the accumulated money disbursed by a utility to pay off interest on the capital invested in the plant during construction.

The interest rate is set by the terms of the loan. The nominal interest rate should be stated in the loan agreement. As money is committed to a project, interest is calculated from the cash flow for the project. The cash flow, together with the effective nominal interest rate should be investigated in detail during the bid evaluation process.

On the basis of the construction schedule presented by each bidder, the monthly, quarterly or other periodic disbursements are evaluated in terms of interest and commitment fees for the total loan or a fraction of it. The construction schedule normally reflects the requirements of the BIS.

6.5.4. Economic life

The design life of a structure, system or component is the time period for which it is designed to be operable within sufficient safety margins. The non-replaceable systems, structures and components of modern NPPs are designed normally for 60 or more years, which is also taken as the design life of the plant.

The economic life is defined as the time period extending up to the point at which the plant should be shut down because of its excessive costs or reduced profits. The economic life of an NPP is usually assumed to be shorter than the design life. One reason for this is that after a number of years, the cost of continued operation may rise substantially. The economic life is usually assumed to be from 25–40 years for evaluation purposes, although this range is somewhat arbitrary.

6.5.5. Currency exchange rates

Costs for a NPP project will arise in different currencies, but for comparing the final results, all costs should be expressed in one monetary unit. From the viewpoint of the national economy, expenditures in the local currency are generally preferable to expenditures in foreign currencies. The most important reasons for this preference are the related beneficial impacts on local industry development, employment, trade balance and recycling of local taxes.

Currency exchange rates are used to convert the import currencies in the bids to one currency at the reference date. Loans, such as export credit loans, are generally offered by bidders and/or banks and have to be integrated into the economic evaluation. Loans are expressed in specific currencies and must be evaluated in these currencies. This implies that, in the process of economic evaluation, conversion of all bids into a single currency cannot be done before a schedule of all expenses (including the construction period and the payback period) has been computed for each bid.

A major difficulty in the conversion of future costs in several currencies into the reference currency is that the future exchange rates are not known. One way to overcome this difficulty is to calculate the present worth in each currency separately, using the same reference date and the same real discount rate. The present worth is then converted into the reference currency, using the exchange rates valid at the reference date.

The bid reference date can be used as a basis for the exchange rate conversion coefficients. The values of the exchange rates should be obtained from official national banks, official publications, or other authoritative sources.

Since the economic evaluation will be carried out in current monetary terms, nominal discount rates will be used for calculating the present worth in the different currencies. These nominal discount rates should be based on the same real discount rate (set by the owner and common to all currencies) and on the projected inflation rates of the currencies.

6.6. EVALUATION OF FINANCING PROPOSALS

The evaluation of the financing proposals involves both a qualitative and a quantitative analysis. For the quantitative analysis, an analytical methodology should be developed with the assistance of a competent financial adviser. Important aspects of the qualitative and quantitative analyses are discussed in the following sections.

6.6.1. Qualitative analysis

The qualitative analysis considers such items as the firmness and completeness of the financial offers, the security structure, the ability of the bidder's banker to give assurance for the financing, and the attractiveness of the financing terms and conditions. The following items have to be considered:

— The qualitative analysis should begin with a review of each financing offer and should determine the degree to which it complies with the financing specifications of the BIS;
— It should be checked that the availability or drawdown periods of the loans match the payment schedule based on the construction sequence of the plant;
— If the repayment of the loan starts before commercial operation, refinancing may be necessary. The consequences have to be analysed by the owner and negotiated with the bidder, with regard to improvements or changes to the financing proposal.

6.6.2. Quantitative analysis

Various explicit and implicit financing fees and taxes have significant impact on the total amount of financing, as do the repayment period, the type of interest (fixed, floating or a combination of both) and the rate, and the method of compounding. These cost elements together lead to a considerable increase in the amount to be financed. Of further interest are the different currencies, their respective national inflation rates, the cross exchange rates between currencies and their resultant impact on the economic viability of the project.

Although the influence of financial offers is quantitatively taken into account in the computation of the LDGEC, detailed analyses of the financing proposals using internationally accepted methodologies are recommended.

6.7. ECONOMIC EVALUATION OF NATIONAL PARTICIPATION AND TECHNOLOGY TRANSFER

The assessment of the economic impact of national participation and technology transfer is a wide and difficult undertaking because they affect other industries and national economy. The economic bid evaluation should concentrate on those aspects which directly affect the nuclear power programme. The potential benefits to the national economy should not be quantified as part of the evaluation of the bids.

The economic bid evaluation should assess the short term and long term implications of national participation and technology transfer. Among the short term benefits, national participation and transfer of the technology for design and construction of the NPP can be quantified by calculating the economic benefits or disadvantages to the TCIC. The long term benefits of technology transfer can be expressed through its impact on the O&M costs and the fuel cycle costs.

The technical and economic evaluation teams should work together to perform quantitative and qualitative analyses on national participation and technology transfer.

6.8. UNCERTAINTIES AND RISKS

Uncertainties and risks can tangibly impact the economics of a project. Therefore, these aspects of the bids must be taken into account and carefully assessed in the economic bid evaluation. The main uncertainties and risks to be considered are connected with:

— Plant design weaknesses;
— Problems in project implementation (schedule and quality);
— Licensing problems;
— Lack of materials;
— Lack of qualified manufacturing capacity;
— Financing problems;
— Contractual uncertainties;
— Long term commitment of the bidder to nuclear energy.

The uncertainties should be assessed in regards to their impact on the time schedule, extra costs and extra financing. These uncertainties can be quantitatively evaluated and added to the plant costs in the form of contingencies. However, it will not be always possible to quantitatively present the consequences, all uncertainties and risks. In such cases the qualitative assessment should be applied.

7. CONTRACTING

7.1. INTRODUCTION

Contract negotiation is the final activity of the bidding process. The purpose of this section is to outline the contract negotiation process, its requirements and organization, so that the contract negotiation is the logical and productive conclusion of the bidding process and generates a contract that will serve the project execution phase.

Any negotiation is a complex and very difficult process, and its dynamics generate so many combinations of an already large number of criteria and elements that it is impossible to provide suggestions and solutions for every situation/scenario.

7.2. OBJECTIVES

The objectives of the contract negotiation are:

— To meaningfully minimize the deviations of the bids from the BIS requirements, both in the fields of technical and economic, and to make balanced compromises without interfering with the final goal of the project;
— To provide the ultimate basis for the selection of the contractor;
— To complete the contract structure, format and content that will best serve the execution phase of the project, as well as the plant operation, as applicable.

The negotiation process includes a detailed evaluation and analysis of the technical, project management and implementation, and commercial deviations that resulted from the bid evaluation process. This evaluation and analysis is the basis for defining the final contract negotiations strategy and tactics on the part of the owner.

7.3. BASIS

The contract negotiation is a continuation of the owner's strategy and priorities that should have been clearly presented in the BIS. If the strategy and priorities were well tuned to the owner's business and political environment, and in line with the characteristics of the vendors' market, it can reasonably be expected that the bidders will respond with bids compliant to the BIS. Further, if the bid evaluation criteria and process were consistent with this strategy and those priorities as specified in the BIS, the contract negotiations should have a sound basis for concluding the bidding process with a balanced and acceptable contract document.

The contract negotiation basis is established in the following sequences:

— It is first defined in the BIS;
— It is then refined during the bid evaluation process;
— It is then fine tuned during the final negotiations.

The sequential nature of the process ensures that the overall quality of the previous phases and their outcomes have a crucial impact on the quality and results of contract negotiation.

In addition to the subject of the contract negotiation the organization of contract negotiations should also follow the previous phases of the bidding process. In practical terms, this means that contract negotiations will take place in parallel with not less than two shortlisted contractors (competitive dialog).

However, maintaining the competitive environment by negotiating through to the end with two bidders should be carefully planned and implemented. The goal of the process should not be to end up with two equal contracts. Therefore, the owner should identify which deviations from the draft contract in the BIS should be negotiated with one bidder, and which deviations should be discussed with another bidder. The owner should also clearly identify the acceptable deviations for both bidders.

7.4. IMPLEMENTATION

Contract negotiation implementation includes the following items:

— Review of applicable legislative requirements;
— Review of the bid evaluation results and recommendations, and elaboration of alternatives;
— Possible modifications to owner's project strategy and priorities resulting from the evaluation process;
— Review, and if necessary update, of the target contract structure (list of articles and appendices and identification of their purpose);
— Best practices and lessons learned including contracting cases as well as management of disputes;
— Negotiation organization;
— Negotiation schedule;
— Negotiation manual.

7.4.1. Legislative requirements

During negotiations, it is very important to know if the potential contractors have a complete and good understanding of the applicable legislation framework, particularly as it relates to the various licensing requirements.

7.4.2. Bid evaluation and alternatives

The owner should define from the very beginning its priorities from the list of evaluation criteria and have them in mind during the contract negotiations. However, imposing its own positions on each and every topic is a wrong priority and at the end of the day may lead to adverse compromises. Therefore, the bid evaluation process is an important source for contract negotiation planning and strategy.

The consistency and distribution of deviations should be analyzed first. The deviations that are consistent in the bids of all bidders indicate the need to re-think the original requirement. On the contrary, inconsistent distribution of deviations provides a possibility to reinforce the owner's original requirement. Analysis of bid evaluation in general, and deviations specifically, often provides the possibility for the owner to adjust its original requirements and priorities to its own benefit.

This phase also includes considerations of whether the bid evaluation process resulted in a feasible or beneficial alternative to the original contracting approach. Further, the evaluation provides the owner with its first real cost and schedule information. Both of these could have an impact on the original approach to the project, its pricing structure and risk distribution. The competitive dialog is a very productive method providing flexibility for

introducing approaches and concepts that differ from the original requirements of the BIS. Therefore, it is recommended for the owner to make use of this for its own benefits. It is also recommended that the owner update its project risk assessment based upon actual data from the evaluation before starting contract negotiations.

7.4.3. Negotiation organization

The owner should have three teams working in parallel during the negotiations:

— The competitive dialog team elaborating the open or disputed contract articles and representing the leading team of the whole process;
— The financial team dealing with the financing aspects;
— The technical team working on the finalization of annexes, appendices/exhibits and on elaboration and completion of certain project manual procedures.

A negotiation procedure and schedule should be agreed upon between the owner and the bidders. The procedure should focus on resolution of disputes in order to avoid long and unproductive discussions on individual topics.

A large negotiation team for the competitive dialog could be unproductive. A negotiating team for the crucial deviations and pending issues should include around 3–4 persons. More members in such activities may not be effective in resolving problems. Project managers of the parties involved should be the leaders of the team. Depending on the scope of discussion for a given session, needed experts will be invited to provide explanations and elaborations, as required. For this support function, between 10–15 persons might be required.

It is important that the parties have a clear understanding of their respective limits of authority. The owner must not permit the negotiations to turn into consultations because the real decision makers are not in attendance at the negotiations. As an exception, and only on predefined topics, the disagreements and disputes or final conclusions can be brought to the attention of higher management.

The programmes of the individual teams should be synchronized because there is a strong interdependence among them.

7.4.4. Negotiation schedule

The owner should allow sufficient time for the negotiation process. Generally it will take around 4–6 months to negotiate a turnkey contract. A split package contract approach could require somewhat more time, because of the need to integrate the contracts schedules and other interfaces.

It is very important that the owner manages the negotiation process and prevents any undue delays and tactical extensions. The competitive dialog is a very useful tool to put pressure on the bidders, not only with respect to the schedule but also with respect to the provisions and structure of the contract.

Under the assumption that the quality of bids was good and that the bid evaluation process was also good and generated a limited number of deviations, it is reasonable to assume that contract negotiations based upon a competitive dialogue will require up to four months.

However, there is often substantial time needed between the agreement on the contract and its execution. Final reviews, translations, provision of bank guarantees and other attachments required for contract validity can take several months. In order to use this time productively, the owner should consider issuing a letter of intent to the selected bidder. The purpose of such a document is for the bidder to start working on the project prior to the formal contract being executed.

7.4.5. Negotiations manual

Prior to the start of contract negotiations the owner should develop a negotiations manual. The manual should give guidance for contract negotiations and include items, such as:

— Negotiation schedule and timetable for each bidder;
— Negotiation organization on part of the owner;

— Principles of competitive dialogue;
— Limits of authority of owner's team;
— Inventory of contract articles, annexes and procedures that require negotiations;
— Elements of the above inventory that should be addressed to upper management for resolution;
— Inventory of annexes and procedures that require completion;
— Method for resolution of open items or disputes;
— Principles of confidentiality and related procedure;
— Documentation of the negotiations.

Having a manual is an important tool for the negotiations. However, one must keep in mind that the negotiations are not predictable, and it is not unusual for the negotiations to deviate from the original programme. The expertise and experience of the negotiation team is and remains the prevailing requirement for success.

7.4.6. Good practices

From a practical point of view based upon specific nuclear projects, contracting experience that can be of use for the project contract negotiation can be summarized as follows:

— The draft contract provided by the owner in the BIS should represent a formal framework for the negotiations;
— A competitive environment is crucial for negotiations. Contract negotiations should be carried out through the end with two bidders;
— A competitive dialogue with shortlisted bidders can be an informative process between the owner and the bidder. As such, it might generate good and acceptable alternative solutions for the project that deviates from the original, owner-established requirements in the BIS. The owner should be open to alternative solutions resulting from either evaluation of the bids or negotiation with the bidders, and have a team prepared to analyze their impact on the project;
— Risks should be assigned to the party that is in the best position to manage them. Downloading all risks and responsibilities onto the contractor is often very costly, without any comparable benefits to the project or the owner;
— There is a substantial list of contract appendices and project procedures that should be mutually agreed upon and completed at contract execution date;
— The negotiation with the national investment institutions or banks on the financing proposal for the project could be simultaneously organized during the main contract negotiation for the project;
— There must always be decision makers from both parties at the negotiation table;
— Contracts should be drafted that are well balanced and written in a professional manner.

Appendix I

EXAMPLE OF REQUEST FOR INFORMATION(RFI)

Purpose of RFI document

Obtain information from NPP vendors to:

— Perform an overall evaluation of available NPP technologies;
— Get familiar and evaluate the plant design features;
— Evaluate the licensability of the plant design in a specific country;
— Evaluate the feasibility of construction at a predetermined site(s);
— Review the plant operation and maintenance features;
— Carry on a preliminary economic and financial analysis of the NPP construction project (budgetary estimate and business case);
— Help to set the basis for the contracting model;
— Form basis for the possible prequalification of potential bidders.

RFI document structure

Letter of Invitation:

(1) Introduction and purpose;
(2) General project information;
(3) Guidelines to vendors to submit the information;
(4) Scope of supply;
(5) Design requirements;
(6) Licensing and safety;
(7) Construction;
(8) Plant operation and maintenance;
(9) Quality assurance;
(10) Project organization;
(11) Commercial aspects, budgetary estimate and financing.

Vendor information package structure and contents

— Part I: Vendor information and references;
— Part II: Technical information;
— Part III: Commercial information.

Part I: Vendor information and references

— Vendor identification;
— Vendor qualification and experience in similar projects;
— List of references;
— Vendor organization;
— Vendor business status and financial information

Part II: Technical Information

(1) Plant description;
— Vendor standard plant description, if available;
— Plot plan;

— Building general arrangement drawings.

(2) Plant performance;

(3) Design;
— Overall design features;
— Proven design;
— Design life;
— Reactor coolant system and reactor non-safety aux. systems;
— Reactor systems;
— Engineered safety systems and containment;
— Fuel handling and storage, refuelling;
— Radioactive waste treatment;
— Plant cooling water systems;
— Plant auxiliary systems;
— Turbine-generator and steam water cycle systems;
— Electrical systems;
— I&C;
— Civil and structural design.

(4) Licensing, safety and physical security;
— Codes and standards;
— Availability of a standard plant design;
— Licensing status of vendor's standard plant design (e.g. design certification);
— Licensing basis and compliance with regulatory requirements;
— Licensing documentation;
— Classification criteria (structures, systems and components);
— Safety philosophy;
— Design basis accident;
— Severe accidents;
— Physical segregation and redundancy criteria;
— N+l or N+2 criteria for safety systems;
— Aircraft crash;
— Physical security.

(5) Construction and erection;
— Construction methods and sequence;
— Shop prefabricated modules;
— Construction modules;
— Proposed project schedule;
— Plant testing and commissioning.

(6) Plant testing and commissioning;
— Shop functional tests of major components;
— Preoperational testing of systems and components;
— Plant commissioning.

(7) Operation and maintenance;
— Plant operation modes;
— Load following capability. Load variation. Load rejection;
— Maintenance provisions;
— Plant staffing and organization chart.

(8) Quality assurance;
— Vendor's management system.

(9) Project organization proposed by vendor.

Part III: Commercial aspects, budgetary estimate and financing

(1) Vendor's position on contract model;
(2) Vendor alone or in consortium (if/when bids will be requested);
(3) Budgetary price and price breakdown;
(4) Vendor's position to a possible financing request;
(5) Main commercial conditions by vendor;
(6) Personnel training programme;
(7) Local participation;
(8) Technology transfer.

Appendix II

ADMINISTRATIVE INSTRUCTIONS TO THE BIDDER

The owner should provide the following information and instructions, at a minimum to the bidders:

(a) Owner's legal address and representatives

The full address of the owner should be given as well as the name(s) of the person(s) empowered to represent the owner regarding all purposes and aspects of the bidding process and to whom all communications of the bidders are to be directed.

(b) List of the BIS documents

To provide a quick overview of the contents of the BIS, it is convenient to include in this section a complete list of all documents constituting the BIS (including numbers of pages) and a short explanation of their purpose.

(c) Process for modifications to the BIS by the owner

To ensure a smooth bidding process, modifications to the BIS should not be made after they have been sent to the bidders. However, if omissions or discrepancies are discovered at a later date, modifications to the BIS may have to be made by the owner. In the administrative instructions, the procedure of dealing with such modifications should be indicated. Usually, a written communication is sent simultaneously to all bidders, notifying them of the changes made. This notification by the owner then becomes part of the BIS. The bidders are requested to send an acknowledgement of receipt to the owner. An identification or numbering system should be used in order to keep track of all modifications.

(d) Requests for clarifications by the bidders

The bidders have the right to request clarifications from the owner if they find discrepancies in the BIS or are in doubt about the meaning of any part of the BIS. It is general practice to consider only written requests for clarification and to answer these requests also in writing, with copies being sent to all bidders. Such clarifications may lead to modifications to the BIS. Regular or ad hoc open meetings with all bidders may be useful to complement the written communications.

(e) Bid submission date and place

The closing date for submission of the bids and the address to which they have to be sent should be given. It should be stated that bids submitted at a later date will not be accepted. If the BIS is well prepared and precise, a period of 6–9 months could be enough for bid preparation. The technical bid and the commercial bid may be presented separately, but in principle they should be submitted at the same date.

(f) Rights of property of the bid documents

The owner should state in the BIS whether or not it will return the bid documents to the bidders. The owner should also state how and under what conditions the confidentiality of this information will be maintained in the event the owner does not return the bid document to the bidders.

(g) Contents and submisson of the bid documents

Clear instructions regarding the submission of bids should be given. These instructions should include the following points: number of copies (typically 6–10), format, organization, structuring and labeling, language(s), engineering system of units to be used, and presentation of supplementary information (information which was not

specifically requested in the BIS but which the bidder may wish to submit). It is recommended to also request the bids in electronic format (both in editable and non-editable versions).

The owner should instruct the bidders how to submit the bid documents (e.g. the commercial bid could be submitted in a common package with technical proposal or in separate, closed and sealed envelope marked price proposal).

All bids should be structured in the same way since this will facilitate the bid evaluation process. The owner should provide a general outline of the structure of the bids. An example is provided in Appendix III of the main report.

(h) Confidentiality

Regarding the confidentiality of the documents, the owner should request the bidders not to disclose the contents of the BIS to any third party, except if it is necessary for bid preparation. At the same time the owner should assure the bidders of the confidential treatment of the bids by executing non-disclosure agreements with each of the bidders.

(i) Bid validity

The owner shall identify the bid validity date and the rules for the potential extension of the validity date.

(j) Bid commitment guarantee

To guarantee the bidder's commitment, the owner usually requests from the bidders bid commitment guarantees that can be provided by a bank or a financial institution. In the two-stage evaluation approach, bid commitment guaranties may be asked only from the shortlisted bidders. The bid commitment guarantees would be returned after the bidding process.

(k) Owner's commitments/obligation to the bidders

The owner should represent his intention to carry out the selection process in accordance with internationally accepted rules and standards. The owner must assure the bidders that the owner shall treat all of the bidders in a fair and equal manner. Further, its commitment to the project should be also clearly established. Both aspects serve the purpose of convincing the bidders that their efforts and investment in the bidding process would be justified.

Appendix III

EXAMPLE OF TABLE OF CONTENTS FOR BIDS

The information given in the bids should be arranged and presented in volumes. These should preferably be numbered and the same kind of information should be provided in the same volumes in all bids. The volumes should be kept separate and should be submitted in a certain sequence, as indicated below.

Vol.0: Executive summary

— Summary of the bid;
— Summary of technical description, scope of supply and services and project implementation.

Vol.1: General information

— Legal and commercial documentation;
— Financial status of the bidder;
— Safety record;
— Relevant experience of the bidders;
— Reference plant(s) and technologies;
— List of main potential subcontractors;
— Deviations and exceptions.

Vol.2: General technical aspects

— General design characteristics;
— Safety and licensing;
— Operation and maintenance;
— Waste handling and decommissioning;
— Safequards;
— Security and physical protection;
— Emergency preparedness.

Vol.3: Technical description of nuclear island
Vol.4: Technical description of nuclear fuel and fuel cycle
Vol.5: Technical description of turbine-generator plant systems
Vol.6: Technical description of balance of plant
Vol.7: Technical description of electrical systems
Vol.8: Technical description of instrumentation and control systems
Vol.9: Technical description of civil works and structures
Vol.10: Spare and wear parts, consumables and special tools
Vol.11: Scope of supply and services
Vol.12: Alternatives and options
Vol.13: Project implementation

— Project structure and organization;
— Project schedule;
— Construction and commissioning;
— Documents and configuration management;
— Management system;
— Risk management.

Vol.14: Training
Vol.15: National participation and technology transfer

Vol.16: Warranties
Vol.17: Commercial conditions and financing
Vol.18: Comments on draft contract: Terms and conditions

— Changes and additional work;
— Risks and transfer of title;
— Licensing and licensability;
— Take-over;
— Liability;
— Insurances;
— Force majeure;
— Termination and suspension of the contract;
— Propriatary information;
— Applicable law;
— Arbitration.

Appendix IV

GENERAL INFORMATION ON THE BID AND BIDDERS

The BIS should specify general information that bidders are required to provide on the bid and the bidder. This information typically includes:

— Summary of the bid;
— Summary of technical description, scope of supply and services and project implementation;
— Legal and commercial documentation;
— Financial status of the bidder;
— Safety records;
— Relevant experience of the bidder;
— Reference plant(s) and reference technologies;
— List of main potential subcontractors;
— Deviations and exeptions.

Above items are discussed in the following subsections.

IV.1. SUMMARY OF THE BID

For the convenience of the owner, the bidders should be requested to provide a summary of their bids. The summary by the bidders should include the organization of the bid, the division into parts or volumes, and a brief overview of the content of each part.

An explanation of the plant identification system used in the bid, including coding, classification, symbols and abbreviations, should also be requested in this section of the BIS.

IV.2. SUMMARY OF TECHNICAL DESCRIPTION, SCOPE OF SUPPLY AND SERVICES AND PROJECT IMPLEMENTATION

The owner should request the bidders to include in this section of their bids a summary of the offered plant and its implementation, since this will facilitate the first comparison of bids. The information provided by the bidders in this summary should refer only to the main items of their proposal, since detailed and comprehensive information on these points will be given in other parts of the bid. This summary should consist of three main parts: (1) a technical description of the plant, including the basic concept, the main data and the site plan; (2) the scope of supply and services; and (3) the project implementation.

IV.3. LEGAL AND COMMERCIAL DOCUMENTATION

The owner should request the bidders to provide complete documentation which proves their legal and financial capability to contract and execute the work in the owner’s country according to the laws in force. The bidders should also provide certified copies and translations, if applicable, of the statute of their companies, association of companies or consortium, as well as of the authorization of the corresponding relevant statutory organs board(s) of directors for the submission of the bid.

If the bidder is an association of companies or a consortium (if this is acceptable by the owner), the bidder should also state whether the association is a permanent one or whether it has been established for the purpose of the project, giving clear indications of the responsibilities of each company.

The owner could request the bidders to designate authorized representatives, including a local representative, and the establishment of an address in the owner’s country.

IV.4. FINANCIAL STATUS OF THE BIDDER

The financial status of a bidder is of prime importance to the future owner of the plant, because a long term business relationship for a large capital expenditure is at stake. The bidder should be requested to submit documentation of its last three annual reports and balances. In addition ratings from at least two rating organizations should be supplied.

IV.5. SAFETY RECORDS

Since safety is a particularly important requirement for nuclear power plants and safety often goes together with reliability, the owners should request the bidders to provide evidence (preferably independent assessments) on their industrial safety performance during manufacturing and construction as well as on the nuclear safety records of their finished products (plants).

IV.6. RELEVANT EXPERIENCE OF THE BIDDERS

In order to obtain proof of the expertise of the bidders in the techniques they offer, the owner should request them to include in their bids a complete list and an adequate description of the plants, works and projects constructed or managed by them, or in which they took part and which can serve as examples of their relevant experience. This information should also include the value of bidder's participation in these references. The bidders should also be requested to clearly indicate the role and responsibilities they had in each project. In the case of an association of companies or a consortium, the expertise has to be demonstrated for each participant.

The owner should also request the bidders to provide detailed information of their relevant experience in the owner's country.

IV.7. REFERENCE PLANT(S) AND TECHNOLOGIES

Concerning the design, the safety features, the quality and the scope of supply and services, the owner should request the bidders to specify the reference plant(s) or reference technologies for major systems of the plant. For the reference plant(s) and technologies the bidders should provide the respective technical documentation as well as detailed information on its construction and performance history. Further, the owner should inform the bidders about his intention to visit the reference plant(s) and discuss the relevant experience with its owner.

The owner should request the bidders to provide the relevant chapters of the safety analysis report of the reference plant(s).

The owner should also request the bidders to clearly state all significant improvements/deviations of their proposals from the reference plant(s) and technologies, giving in the bid the justifications/reasons and basic/conceptual documentation for each of these improvements/deviations.

IV.8. LIST OF MAIN SUBCONTRACTORS

The owner should request the bidders to provide a list of the names, activities and experience of their main subcontractors and indicate their potential scope of responsibility in the project. This list should include in particular local subcontractors with whom the bidder may fulfill requirements for national participation if these are specified by the owner.

IV.9. DEVIATIONS AND EXCEPTIONS

The owner should request that the bidders provide complete information on all deviations and/or exceptions from the BIS; to refer in their list of deviations and/or exceptions to the appropriate section and statement in the BIS; to submit in their bids a specific statement regarding their acceptance of all requirements and conditions of the BIS not specifically referred to in the list of deviations and exceptions.

The owner should request the bidders to provide the following detailed information regarding each proposed deviation and/or exception, as far as applicable:

— Definition of the departure from the BIS;
— Reasons and justification for the departure;
— Extent to which the overall warranties are affected;
— Extent to which the safety and licensability requirements are affected;
— Cost implications;
— Project schedule implications;
— Consequences of rejecting the proposed departure from the BIS by the owner.

Appendix V

FIRST EVALUATION LEVEL OF DESIGN FEATURES

The evaluation of the overall technical design covers items which are of importance for the performance and safety of the plant, such as:

— Proven technology;
— Standardization;
— Simplification;
— Safety and licensability;
— Plant lifetime;
— Availability;
— Operability and manoeuvrability;
— Inspectability and maintainability;
— Refuelling schedules;
— Waste management and decommissioning;
— Security and physical protection;
— Emergency preparedness;
— Safeguards.

The evaluation of the above technical design features should be based not only upon the plant related information but also, as applicable, upon the evaluation of actual operational experience of plants of similar design.

The above features are discussed in more detail in the following subsections.

V.1. PROVEN TECHNOLOGY

Proven technology refers to structures, systems and components, and design and analysis methods and techniques, featuring characteristics, materials, manufacturing processes, working conditions and plant environment conditions that are identical or similar to those that have demonstrated successful operation, preferably over a span of several years, in existing nuclear power plants.

Ensuring that proven technology is used extends to all aspects and areas of the plant, from the design of structures, systems and components to equipment manufacturing, construction techniques, and operability and maintenance features.

Verification of proven technology use typically covers the following areas of the evaluation:

— Plant is designed and constructed using structures, systems and components already proven in other nuclear plants with acceptable failure rate;
— Structures, systems and components of new or recent design may be acceptable only if satisfactory operation can be demonstrated for conditions similar to those of the new plant;
— Extrapolation of the design, size, capacity, duty, etc. of proven structures, systems and components to new ones should be reasonable;
— Safety structures, systems and components have been thoroughly tested and preferably been approved by the safety authority of the country of origin of the design, or at least by that of another reliable technology holder country.

Implementation of proven technology seeks to reduce owner’s risk by ensuring cost control, schedule compliance, quality and reliable operation of the plant. However, the proven technology requirement should not be applied too exclusively because it would prevent new and improved technical features from being developed or implemented. Therefore, appropriate research programs and full-scale testing of those new features could be accepted as a substitute for the operation in existing nuclear plants. This is especially valid for safety systems.

V.2. STANDARDIZATION

In the technical bid evaluation, attention should be paid to determining the extent to which meaningful design standardization is applied in the different plant designs.

The concept of nuclear power plant standardization has been defined as a life cycle commitment to uniformity in the design, construction and operation of a family of nuclear power plants.

The benefits of standard design go beyond the design phase of the project itself, as standardization makes the procurement and manufacturing of major components more reliable; plant construction and testing will also become more predictable, due to the experience acquired in the construction of previous plants with the same standard design.

In practical terms, to implement a standard design, plant vendors:

— Use an envelope of site and environmental conditions (e.g. soil characteristics, seismic level, wind velocity, ambient temperatures and humidity, cooling water temperatures, etc.) that will facilitate locating a specific plant on any site, as long as the site specific conditions fall within the envelope values;
— Apply a consistent set of codes, standards and regulatory requirements that correspond to the reactor vendor's country of origin;
— May use information from preselected subcontractors to advance the standard plant detail design.

With regards to plant equipment, well-defined standardization should:

— Ensure the interchangeability of components;
— Limit the different types of components to a reasonable number to facilitate plant operation and maintenance (e.g. standard valves, piping components such as flanges, gaskets, bolting, instruments, etc.).

Standardization requirements should not apply where diverse components are required for safety reasons; e.g. to prevent common mode failures.

V.3. SIMPLICITY

Design simplicity facilitates plant construction, operation and maintenance. The following are examples of design simplifications that should be verified during the bid evaluation:

— Use of a minimum number of structures, systems and components (e.g. pumps, valves, instruments, electrical components, etc.) to comply with the functional requirements;
— Simplified plant layout, pipe routing and equipment arrangement to facilitate construction and maintenance;
— Due consideration having been given to the human–machine interface to facilitate the operator's work;
— Simplified system design and control logic.

V.4. SAFETY AND LICENSABILITY

The owner has the responsibility for licensing the plant in accordance with the rules of its country's regulatory authority. However, the contractor should normally be responsible for the licensability of the plant. The evaluation of the licensability should cover the fulfillment of the following requirements:

— Technical aspects of the plant meet all regulatory requirements;
— Licensing documentation is complete and meets all regulatory requirements;
— Licensing documentation will be submitted to the owner on a timely basis so that all relevant licences, permits and authority approvals can be obtained in due time.

A pre-certification of the plant design, which is possible in some countries, may accelerate the licensing process. It is expected that the contractor will support the owner until the successful completion of the licensing process.

The evaluation should cover key safety features such as:

— Conformity with applicable regulations, codes, standards and guides;
— Concept of multiple barriers and defence in depth for prevention and mitigation of accidents;
— Concept of deterministic safety design: failure criteria, redundancy, diversity, and physical separation;
— Concept of postulated initiating events and the minimization of the plant's sensitivity to such events;
— Concept of design basis and beyond design basis accidents including severe accidents;
— Internal and external hazards;
— Systematic consideration to human factors, including the human–machine interface;
— Verification of the balanced design by means of probabilistic analyses;
— Safety classification of systems, structures and components and the correlation of safety classes versus requirements on quality and reliability;
— Utilization of proven codes and standards for design of systems, structures and components;
— Active versus passive safety functions;
— Safety aspects of digital I&C systems;
— Optimisation of personnel exposure.

V.5. PLANT DESIGN LIFETIME

In the technical evaluation, design lifetime aspects should be taken into account. The bid should include analyses and data necessary to support the design lifetime. Special attention should be paid to material issues such as fatigue, corrosion, thermal aging, and radiation embrittlement effects.

Current international utility requirement compilations (such as CUC [10], EUR [11] and URD [12]) specify that future plants shall be designed so that they can be operated for 60 years. Over this life span, some components will need to be replaced. Therefore, the design should include features to permit necessary component replacements.

V.6. AVAILABILITY

Availability is mainly dependent on the following items:
Durations (breaker- to- breaker) of planned outages such as:

— Refueling and maintenance outage;
— Major plant outages such as periodic turbine–generator overhaul and replacement of ageing main components;
— In-service inspection outages imposed by regulations;
— Refuelling only outage.

Level of unplanned outages:

— Frequency of unplanned reactor scrams;
— Annual forced unavailability factor considered.

The evaluation of availability should be based on the above data given by the bidders in their bids. In addition, it should be evaluated how plant design provisions would make it feasible to meet the durations assumed for the various outages.

V.7. OPERABILITY AND MANEUVERABILITY

The following are the main items to be reviewed when evaluating operability and maneuverability of a plant:

— Automatic power control capability of the plant, and percentage of rated output for the purpose;
— Remote dispatch capability of the plant for load following (if required in the BIS);
— Normal grid frequency control capability (if required in the BIS);
— Time required to go from cold shutdown condition to hot standby at full pressure and temperature;
— Plant cooldown time required from reactor critical at full pressure and temperature to the beginning of refuelling operations;
— Plant capability to take on full or partial generator load rejection without reactor or turbine trip and be able to continue stable operation with electrical house loads;
— Plant load cycling capability;
— Load change response (expressed as a percentage of rated output per minute) and step load change (expressed as a percentage of output to the grid);
— Plant operating capability following the failure of an auxiliary equipment item;
— Percentage of rated power output at which the plant can continue operation following auxiliary equipment failures (e.g. loss of feedwater pump, loss of condenser circulating water pump, etc.);
— Complete set of transient cycles for which the plant is designed.

V.8. INSPECTABILITY AND MAINTAINABILITY

The following are the main items to be reviewed when evaluating the inspectability and maintainability of the plant:

— Standardization of equipment and components;
— Low maintenance equipment;
— Equipment designed to ensure that routine shutdown inspection and maintenance requirements are consistent with the proposed fuel cycle length;
— Plant designed to reduce occupational exposure;
— Plant layout to facilitate access to equipment, pull-out and laydown space, rigging equipment and tooling required to support inspections, testing, repairs and replacements for the entire life cycle of the plant;
— Plant designed so that equipment maintenance and inspection can be performed under satisfactory work conditions;
— Automated maintenance and inspection machines (e.g. automated refuelling, automatic control, remote handling, automatic control rod drive handling, automated inservice inspection, etc) to improve plant maintainability and to contribute to the reduction of occupational exposure.

V.9. REFUELING SCHEDULES

The refueling schedules provided by the bidders for off-load refueled reactors in their bids need to be evaluated to see that they correspond to the requirements of the owner as regards energy production, first cycle length, refueling periods and end of cycle reactivity. The schedules provide further basic input data for determining the fuel cycle costs and data for an overall fuel evaluation (number of fuel elements, amount of fuel, burnups, enrichments, loading time in the reactor, etc.). The data are normally indicated for the first core and a number of reloads up to a time that a basic equilibrium is reached in the reactor core.

The refueling schedule needs to be evaluated to ensure that the fuel can operate within the constraints of a fuel safety analyses.

V.10. WASTE MANAGEMENT AND DECOMMISSIONING

The following are the main items to be reviewed when evaluating radioactive waste generation:

Gaseous radioactive waste: leakage from the coolant, the moderator systems or the reactor itself; degasification systems for the coolant; condenser vacuum air ejectors or pumps; the exhaust from turbine gland seal systems; and activated or contaminated ventilated air.

Liquid radioactive waste: reactor coolant let-down, evaporator concentrates, equipment drains, floor drains, laundry waste, contaminated oil and waste arising from the decontamination and maintenance of facilities and equipment.

Solid radioactive waste: spent ion exchange resins; cartridge filters and pre-coat filter cake; particulate filters from ventilation systems; charcoal beds; tools; contaminated metal scrap; core components; debris from fuel assemblies or in-reactor components; and contaminated rags, clothing, paper and plastic.

Processing (pretreatment, treatment and conditioning) systems for radioactive waste should also be evaluated to ensure that authorized discharge limits will not be exceeded. Waste packages resulting from the conditioning of radioactive waste should meet the applicable requirements for handling, transport, storage and disposal.

It should be verified that sufficient storage capacity has been made available for all the radioactive waste and spent fuel.

It should also be verified that decommissioning aspects have been taken into account in the design.

V.11. SECURITY AND PHYSICAL PROTECTION

The following main issues should be addressed in the bid evaluation:

— Definition of external and internal threats considered in the design and their acceptability from the point of view of the country and site specifics.
— Verification that the plant security concept is inherent to plant design. This means that the plant should already include features such as:
  • Segregation of vital plant zones and their access routes;
  • Physical separation of safety systems and equipment;
  • Protection and confinement of vital plant systems and equipment;
  • Walls that can withstand the impact of external missiles in vital buildings and zones;
  • Security zones separated by security doors with the same resistance characteristics as the surrounding wall;
  • Assurance that the plant maintains reactor shutdown capability and reactor core residual heat removal function during acts of sabotage.
— Design verification to ensure the provision of barriers and other interception features against all potential threats to the plant, including:
  • A clear definition of the restricted access zone;
  • Controlled access points for persons and vehicles;
  • Location of the basic security control and alarm centres.
— Review of the physical protection system design features and equipment of the plant (if included in contractor's scope of supply and services), including:
  • Access control equipment (personnel access control, metal and explosive detectors, portable search equipment, etc.);
  • Detection aids to ensure immediate detection of an intrusion;
  • Locking devices;
  • Closed-circuit TV monitoring system;
  • Security-dedicated communication systems;
  • Auxiliary systems dedicated to the physical protection system, such as security power supply, air conditioning and lighting.

Physical protection arrangements are of a confidential and sensitive nature and access to this information should be given only to authorized persons.

V.12. SAFEGUARDS

The following main issues should be considered in the bid evaluation:

— The plant is designed in a way that reduces the need of inspectors to physically visit the facility, by the installation of, for example, remote monitoring systems;
— The plant is laid out so that its physical structure and boundaries can be mapped onto material balance areas and that key measurement points for nuclear material accountancy can be easily determined;
— The design of the plant facilitates establishing and maintaining the continuity of knowledge with regard to nuclear material accountancy and, if required, its restoration;
— The transfer of nuclear material in the facility is streamlined, making the transfer path more simple so that safeguards can be implemented in an easier manner.

Appendix VI

EVALUATION OF PROJECT IMPLEMENTATION

The evaluation of the project implementation should cover at least the following items:

— Project structure and organization;
— Project schedule;
— Construction and commissioning;
— Documentation and configuration management;
— Management system;
— Risk management.

The above items are discussed in more detail in the following subsections.

VI.1. PROJECT STRUCTURE AND ORGANIZATION

In the review of the proposed project organizations special attention should be paid to the following aspects:

— Clarity of the responsibility split between various organizational units (and between consortion members if the bidder is a consortium);
— Relations between the site organization and the head office(s) of the contractor;
— Number of proposed project staff and its development during project implementation;
— Expertise and experience of the key persons in the project organization;
— Functions that are using a matrix organization;
— Functions that have been subcontracted;
— Number of subcontractors and their experience.

A sizeable matrix organization can challenge priorities and schedule. A large number of subcontractors require specific attention to items like previous experience with the same subcontractors, the differences in the business practices and technologies of subcontractors, the risk distribution between the bidder and its subcontractors, and the integration function in the bidders' organizations, etc.

VI.2. PROJECT SCHEDULE

The time schedules proposed by the bidders should be evaluated to be sure that the schedules are realistic. There may be differences between schedules proposed by the bidders. The reasons for differences should be evaluated and understood.

The time schedule proposed by a bidder should be based on the condition that the major portion of the detailed design is ready before the start of construction and that the equipment and services to be provided by subcontractors are available at times specified in the schedule. Therefore, the feasibility of the schedule should be extended to a review of the supply chain, its capacity and previous commitments.

In turnkey contracts there are also some services that may be provided by the owner, such as access roads and other transportation facilities, connection to the electric grid, water supply, and water and sewage treatment plants. It has to be checked that the owner is able to provide those services at specified times.

It is important to verify the time allocations related to the review and approval of the project, quality and licensing documentation during various project phases. The review of the design, manufacturing, test, installation and commissioning documentation can be a very time consuming effort that must be considered in the schedules.

In many cases the startup of nuclear power plants has been delayed because the necessary licenses and authority acceptances for construction or operation have either not been properly scheduled, or issued as expected. Usually it is the responsibility of the owner to obtain those licenses and acceptances by relying on the

documentation provided by the contractor. A reasonable time has to be allocated in the time schedule for the review of this documentation by the owner and the authorities.

VI.3. CONSTRUCTION AND COMMISSIONING

A proper constructability is a key contributor in achieving a short construction period and minimizing the risk for construction delays. The fulfilment of the following typical constructability requirements should be addressed in the bid evaluation:

- Detail designs should be substantially complete, and a high percentage of construction drawings shall be available before construction starts;
- Construction should make proper use of modern construction techniques (such as modularization and large capacity cranes) as much as practical and feasible in the owner's country;
- Construction and erection planning, and space allocation when developing the plant site layout, should take into account modular construction techniques;
- The construction schedule should be prepared in collaboration with the plant designer, construction management team, contractor(s), plant testing group and major module manufacturers.

The compatibility of the construction techniques and modularization proposed by the bidders should be compared against the existing infrastructure and fabrication capabilities available in the owner's country. The advantages and drawbacks of site module fabrication as opposed to shop fabrication must also be evaluated, as well as the special transportation that may be required to convey large shop fabricated modules to site.

The evaluation of commissioning should cover the technical conditions and procedures proposed for preoperational tests, commissioning, demonstration tests and acceptance tests, including the programmes for each of these steps and the relevant documentation.

VI.4. DOCUMENTATION AND CONFIGURATION MANAGEMENT

The adequacy of the technical and administrative documentation which the bidders propose to submit during project execution for the supervision of the project and for the licensing of the plant should be evaluated. Also, the configuration management system proposed by the bidders for the project and its compatibility to the corresponding system of the owner should be evaluated.

VI.5. MANAGEMENT SYSTEM

The management system proposed by the bidders should be evaluated against the requirements in Ref. [21] to determine the extend to which those requirements are fulfilled.

VI.6. RISK MANAGEMENT

Risk management should be evaluated based upon the risk management plan that each bidder submits as part of the bid. This part of the evaluation should focus on the scope of identified risks, including the risks not indicated or identified by the bidder but which the owner is aware of, the suggested risk mitigation programs and their expected results. The risk management plan is often a good indicator of how well the bidder understands the project, its environment and its specific challenges.

Appendix VII

SELECTION OF ECONOMIC EVALUATION ELEMENTS

The methods of economic evaluation provided in this publication and the related IAEA software BIDEVAL-3 enables a full-scale economic evaluation including all required elements and parameters and resulting with LDEGC as the criteria for ranking. However, if substantial differences (in technical properties, financing, commercial elements, national participation etc.) are not evident among the bids, a simplified method and evaluation criteria from BIDEVAL-3 may be applied. This includes also the selection of elements, cost categories that must be included in the evaluation and those that could be excluded.

What qualifies some of these cost categories or economic parameters for exclusion or limited consideration in the economic bid evaluation? Here are a few examples:

(a) Estimations of a number of cost categories could be excluded whenever the technical evaluation indicates that the characteristics of the related technical elements/properties show no or very limited differences that could have an impact on the economics of the plant during its life cycle. A good example of this could be the decommissioning costs, but it potentially applies to any cost element;
(b) The evaluation of the national economies of the bidders' countries might indicate that the expected fluctuations of national economic parameters (inflation rates or exchange rates) in the next 5–6 years are either not needed (the same contract currency) or, do not necessarily require an adjustment of TCIC;
(c) Whenever the ranking of the bids that is based upon TCIC, including the first core and a number of reloads, is changed after an economic category requiring long term estimation has been introduced in the evaluation, the evaluators have to consider whether and how to apply this specific parameter.

The selection of the evaluations elements will also depend on:

— The number of received bids;
— The information available to the owners from the previous analyses of vendors such as technology assessment or feasibility study;
— The schedule of the evaluation process;
— The contracting approach;
— The level of details required or obtained by BIS;
— The quality of the bids, etc.

In line with the above, the following assessments should be done in order to determine the scope, method and ranking criteria of the detailed economic evaluation:

(1) Assessment of whether and to what degree the calculation of O&M costs will be required as a part of bid evaluation:
The considerations of O&M costs as a part of bid evaluation is appropriate only if there are material differences among various offered technologies as to these costs. The differences in number of components, the size of the organization, the concept of in- service inspection, the number of unscheduled outages (if available), duration of outages etc. represent a reason for and inputs to this assessment. This assessment could also result in exclusion of a number of O&M cost categories and reduce the volume of the input data for economic evaluation that is based upon estimates.
(2) Assessment of whether and to what degree the calculation of fuel cycle costs will be required as a part of bid evaluation:
Usually the fuel related costs for the first core and a number of reloads is included in the plant bid and contract. It should be therefore analyzed as a part of the TCIC. Future fuel supplies do not have to be associated with the reactor supplier and the largest part of the fuel can be procured independently from such a third party provider of the fuel (uranium, conversion, enrichment). For this reason, fuel cycle costs for the lifetime of the plant need only be considered if there are differences identified by the technical evaluation that could have an impact on the fuel economy. But even then, the evaluation should consider only those elements

of the fuel cost and fuel cycle that reflect the differences in technical properties of offered fuels such as burnup. On the other hand, it might be questionable whether to consider the material impact of these differences on the economics of the back end of the cycle. The evaluation of this economics is by definition questionable for reasons that are to a large degree not related to the properties of a given fuel.

(3) Assessment of whether and to what degree the calculation of owner's costs needs to be integrated in bid evaluation:
Once the scope equalization process is completed, the size of the owner's costs is usually not impacted by the bids. Therefore, it is very likely that they will not need to be considered in the economic evaluation of bids. This would eliminate from the evaluation an estimated cost category which would provide no added value to the economic evaluation.

(4) Assessment of whether the calculation of decommissioning costs needs to be done as a part of bid evaluation: Decommissioning costs will typically incur approximately 70–120 years after the bid evaluation. Decommissioning legislation and decommissioning technology will almost certainly change in the meantime, resulting in an impact on the economics of decommissioning. From the plant design point of view, when evaluating similar technologies there likely will not be a significant difference in the volume and properties of the inventory for decommissioning, and in these cases it may be advisable to avoid including decommissioning costs in the evaluation, as its inclusion could introduce an almost speculative element in the evaluation of the bids.

(5) Assessment of how to best include plant performance in the economic evaluation i.e. availability, load factor, power output, material properties and workmanship, margins in the design, heat rate, steam conditions, load follow capability, discharge burn up and fuel failure rate, and release of radioactivity, etc.

(6) Assessment of economic parameters — what economic parameters require consideration in the overall economic evaluation of the plant and how have these parameters should be taken into account.

(7) Assessment of commercial and contractual conditions — what deviations from the BIS requirements have to be addressed in the overall economic evaluation of the plant and how these deviations have to be addressed and evaluated. (i.e. warranties, project time, date of completion or start of commercial operation, payment conditions, insurances, deviations from draft contract requirements, etc.)

(8) Assessment of whether and to what degree the differences in the offered financing require consideration in the economic evaluation, and how should these differences be evaluated.

(9) Assessment of whether and to what degree the differences in the offered national participation and technology transfer require consideration in the economic evaluation, and how should these differences be evaluated.

(10) Assessment of whether and to what degree could other differences in the bids have a potential impact on economic evaluation, and if they require consideration in the economic evaluation, and how these differences should be evaluated.

(11) Identification of uncertainties and risks (technical and commercial or financing).

(12) Assessment of whether the project language and contract law could have an impact on the project, its risk and certain related costs.

(13) The assessment of differences between the bids related to the above and other elements will enable the owner to define the scope, method of economic bid evaluation as well as the ranking criteria for the final decision. The bid evaluation manual should incorporate the results of the above analyses and assessments and the whole process should be well documented and become a part of the evaluation documentation.

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ABBREVIATIONS

BIS	Bid invitation specification
BOO	Build-own-operate
BOOT	Build-own-operate-transfer
BOP	Balance of plant
BWR	Boiling water reactor
CI	Conventional island
EUR	European utility requirements
I&C	Instrumentation and control
IDC	Interest during construction
IT	Information technology
LDEGC	Levelized discounted electricity generation cost
N/A	Not applicable
NI	Nuclear island
NPP	Nuclear power plant
O&M	Operation and maintenance
PWR	Pressurized water reactor
Q/A	Questions and answers
QC	Quality control
SAR	Safety analyses report
TCIC	Total capital investment cost
TG	Turbine generator
URD	Utility requirements document

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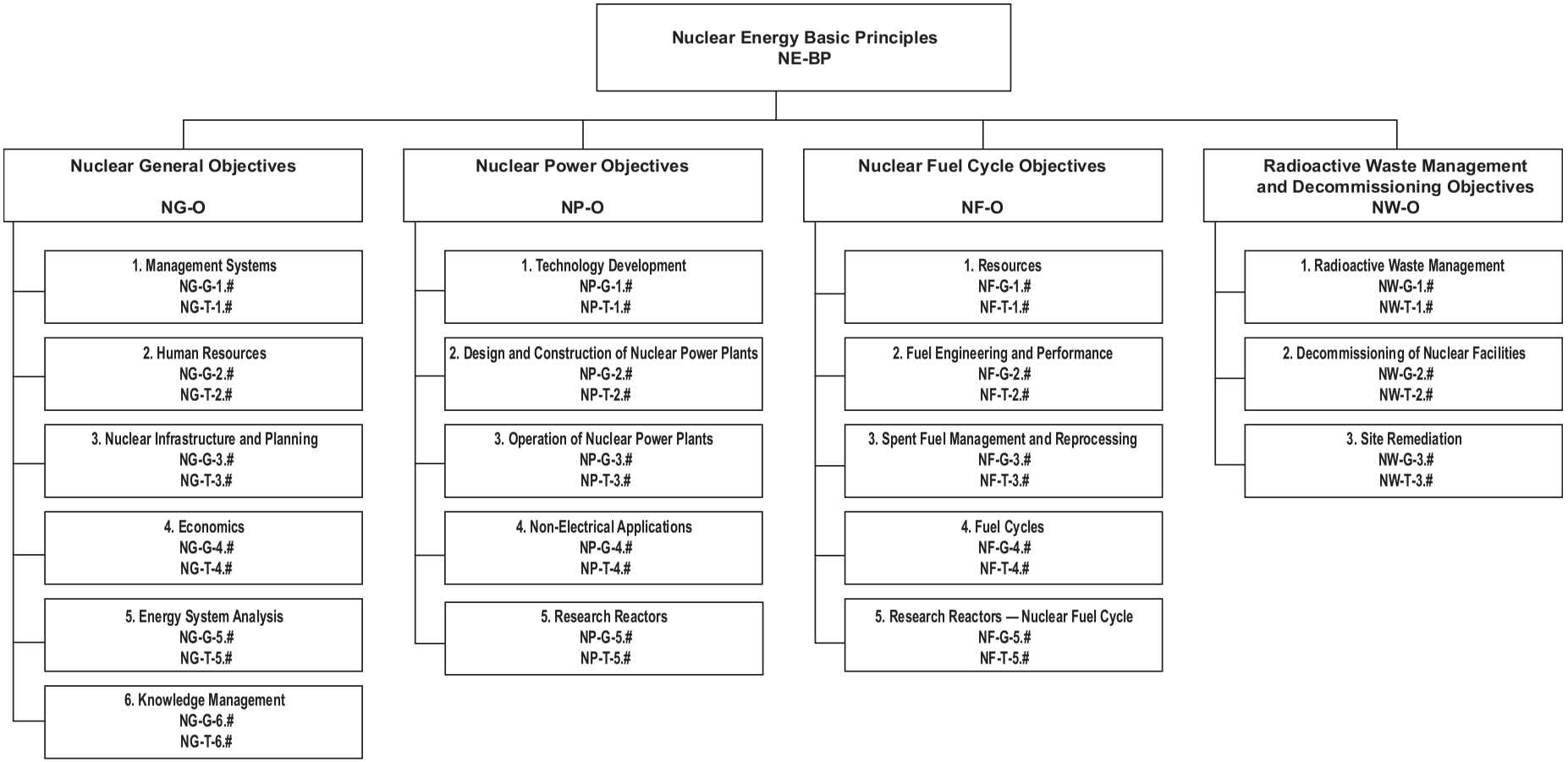

Key

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