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International Atomic Energy Agency

# Integrated Research Reactor Utilization Review (IRRUR) Guidelines

Vienna, June 2023

**IAEA Services Series 48**

INTEGRATED RESEARCH REACTOR  
UTILIZATION REVIEW (IRRUR)  
GUIDELINES

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IAEA SERVICES SERIES No. 48

INTEGRATED RESEARCH REACTOR  
UTILIZATION REVIEW (IRRUR)  
GUIDELINES

INTERNATIONAL ATOMIC ENERGY AGENCY  
VIENNA, 2023

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INTEGRATED RESEARCH REACTOR  
UTILIZATION REVIEW (IRRUR) GUIDELINES  
IAEA, VIENNA, 2023  
IAEA-SVS-48  
ISSN 1816-9309

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Printed by the IAEA in Austria  
June 2023

## FOREWORD

The Integrated Research Reactor Utilization Review (IRRUR) is an IAEA review service available to Member States to assist them in performing a thorough assessment of the utilization of their research reactors, including their existing and potential capabilities and constraints. The review service also identifies further utilization areas, research and development, and products and services that a research reactor can provide. IRRUR peer reviews are available, upon request, to operating organizations in all Member States with research reactors in operation, or in temporary or extended shutdown.

IRRUR missions can be directed to all the major activities of a research reactor or limited to specific utilization areas. Findings of these missions, including conclusions and recommendations, can be used to inform a Member State's decision making process in terms of a research reactor's long term sustainability. The findings can also be used in the development of a strategy towards the sustainable operation — or in the support of national position for a permanent shutdown — of a research reactor. The assessment considers the application of IAEA guidance and international best practices on strategic planning, applications and utilization of research reactors.

The purpose of this publication is to provide information on the preparation, implementation and reporting of IRRUR missions, including pre-IRRUR missions and follow-up missions. The information provided may also be used for utilization self-assessments by the operating organization of a research reactor facility.

The IAEA is grateful to all the contributors to this publication, in particular R.A. Crone (United States of America). The IAEA officer responsible for this publication was N. Pessoa Barradas of the Division of Physical and Chemical Sciences.

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# 1. INTRODUCTION

## 1.1. BACKGROUND

The research reactor community worldwide faces significant issues that challenge the long term sustainability of these facilities. Even though there is often increased pressure towards greater self-sustainability of research reactors or towards justification of continued funding, a strategy for their utilization is often lacking. To ensure a high impact of these research reactor facilities, a strategy for optimized utilization is essential. Irrespective of the research reactor mission, its complexity, power or size, ownership or regulatory model, a well-considered strategy requires a thorough assessment of the reactor utilization, of its existing and potential capabilities and quantification of the stakeholders' needs for the research and development (R&D) and products and services that the research reactor can provide. This assessment can provide additional insight regarding the need for a long term investment for facility refurbishment and modernization, or eventual shutdown.

The IAEA has published a number of guides and technical documents [1–8] that provide a sound framework of information that can be used by Member States (MS) to perform an assessment, including self-assessment, of the utilization and potential capabilities of their facilities.

Given the importance of such assessment process, which serves as the basis for further decisions on the utilization (and, sometimes, also for the continued operation) of a research reactor and the complexity of the issue and need for diverse expertise, many operating organizations may not have the capabilities on their own to perform an integrated review of their research reactor utilization and potential. Therefore, the IAEA has developed a peer review service named Integrated Research Reactor Utilization Review (IRRUR) [9]. The main objective of the IRRUR service is to assist MSs in performing a thorough assessment of the research reactor utilization, of its existing and potential capabilities and to identify further utilization areas, R&D and products and services that the research reactor can provide.

The outcome of such a peer review mission can be efficiently used to assist MSs in their decision-making process, and, eventually, in the development of a strategy towards sustainable operation, or in the support of national position for a permanent shutdown, of the research reactor. This mission complements other IAEA peer review services for research reactors [10], such as the Integrated Safety Assessment of Research Reactors (INSARR) [11], Integrated Nuclear Infrastructure Review for Research Reactors (INIR-RR) [12] and Operation and Maintenance Assessment for Research Reactors (OMARR) [13], in order to assist MSs to enhance research reactors performance.

The IRRUR mission considers all aspects in assessing a research reactor's utilization programme and strategy for enhanced utilization and addresses the topical areas described in IAEA Nuclear Energy Series No. NG-T-3.16 Strategic Planning for Research Reactors [1]. In particular, the IRRUR service will:

- Review the research reactor strategic plan (SP) and corresponding action plans;
- Review the utilization level through mission specific key performance indicators (KPI) and utilization assessment criteria, and against available capabilities of the research reactor facility;
- Review the potential capabilities identified already in the SP document, given the needs for R&D, products and services in the country (or region) and the constraints

that may limit the further development of research reactor R&D, services and products;

- Identify the gaps and areas of improvement towards effective, efficient and sustainable utilization of the facility;
- Identify opportunities to strengthen the research reactor user community and to enlarge the utilization stakeholder base.

IRURR peer reviews are available to operating organizations in all MSs with research reactors in operation or in temporary or extended shutdown.

## 1.2. OBJECTIVE

The purpose of this publication is to provide guidance on the preparation, implementation and reporting of IRRUR missions, including follow-up missions.

## 1.3. SCOPE

The guidance on the preparation of the mission is intended for both the host organization and the review team. The guidance on the conduct of the mission is mainly directed to the review team. The guidelines may also be used for utilization self-assessment conducted by the operating organization of a research reactor facility.

## 1.4. STRUCTURE

This publication consists of three main sections, two Appendices and two Annexes. Section 1 presents introductory material on IRRUR missions. Section 2 presents guidance on the preparation, conduct and follow-up for an IRRUR mission. Section 3 presents detailed guidelines on the scope and review areas that may be covered in a comprehensive IRRUR review.

Appendix I provides a questionnaire to guide the IRRUR team when gathering on-site information, which may also be used by the operating organization to conduct a self-assessment evaluation prior to the missions.

Appendix II provides the general format of the main IRRUR mission report and guidance on the information the report should include for each area reviewed.

A set of KPIs for assessment of research reactor utilization are given in Annex I and assessment criteria for the utilization self-assessment report (USAR) are given in Annex II.

## **2. CONDUCT OF INTEGRATED RESEARCH REACTOR UTILIZATION REVIEW MISSIONS**

This section provides information on the conduction of IRRUR missions, including general considerations and the different mission stages.

### **2.1. GENERAL**

This section provides general information relevant to the conduction of IRRUR missions.

#### **2.1.1. Mission objectives**

The main objective of the IRRUR service is to assist MSs in performing a thorough assessment of the research reactor utilization, of its existing and potential capabilities and to identify further utilization areas, R&D and products and services that the research reactor can provide.

#### **2.1.2. Mission scope**

The IRRUR service can be directed to all the major activities of the research reactor or limited to specific utilization areas. The research reactor operating organization should indicate the scope when requesting the review. The review scope of the IRRUR service will be adjusted to the information available to the IAEA, following discussions with the research reactor operating organization.

IRRUR missions are available to operating organizations in all MSs with research reactors in operation or temporary or extended shutdown.

#### **2.1.3. Mission stages**

A three-stage approach is used for a complete IRRUR mission:

- A pre-IRRUR mission to present the IRRUR methodology, to discuss and define with the host organization the utilization areas to be reviewed and the information to be provided to the IAEA before the main mission;
- The main IRRUR mission to conduct the review and provide a report on the findings;
- A follow-up IRRUR mission to determine the status of actions taken by the host organization in response to the main mission findings, to clarify any misunderstandings in response to mission findings, to obtain feedback on the effectiveness of the IRRUR and to provide guidance on mid-course correction in case of new issues encountered.

#### **2.1.4. Initiating missions**

Informal discussions concerning IRRUR might take place between Member States and the IAEA in advance of a formal request for such a mission. During these discussions appropriate information on the flexibility in the conduct and scope of the mission will be exchanged. An IRRUR mission is then initiated with a formal request from the MS operating organization to the IAEA. The request should specify the research reactor for which the mission is requested. It may specify the desired mission scope, tentative time frame and other relevant information.

An IRRUR mission might be an agreed activity within an IAEA technical cooperation project. In some cases, the IAEA might recommend that a country requests such a mission.

Upon receipt of a request for an IRRUR mission, the IAEA begins a dialogue with the operating organization regarding the scope and extent of the topics to be addressed during the mission. The IAEA provides to the operating organization these guidelines and all relevant information deemed necessary.

In the planning and preparation for an IRRUR mission, it is important that tasks and activities specifically related to research reactor utilization are the subject of review. Reactor utilization activities [1–3] interface across a broad spectrum of facility topical areas like safety [4, 5], operation and maintenance (O&M) [6] radiation protection [14], ageing management [15] and waste management [16], which are covered under other IAEA peer review missions. The guidelines provided in this document address these areas only as related to their interfaces and influences on the facility utilization (such as availability and reliability). The planning of the IRRUR mission should recognize missions for these other topics may be independent of, or in conjunction with, an IRRUR mission.

### **2.1.5. Funding**

Necessary funding arrangements should be discussed and agreed upon between the requesting counterpart and the IAEA before scheduling an IRRUR mission. The funding available from the IAEA varies on a case-by-case basis. For some IRRUR reviews, financial obligations may be shared by the IAEA (for example, travel expenses and daily allowances for the review team members) and the MSs requesting the review. The counterpart may be asked to provide local transportation for the review team members, expedite local administrative arrangements and logistics and, in some cases, contribute towards local accommodation costs.

## **2.2. PRE-MISSION**

This section provides general information relevant to the conduction of pre-IRRUR missions.

### **2.2.1. General**

The implementation of an IRRUR mission starts with a pre-IRRUR mission. The pre-IRRUR mission generally is implemented in virtual format, takes place 3 to 6 months prior to the main IRRUR mission and is typically of a 2 to 3 days duration. The review team may consist of an IAEA staff member and one or two international experts.

### **2.2.2. Objective**

The objective of the pre-IRRUR mission is to present the IRRUR methodology, reach a common understanding with the operating organization on the scope and methodology to conduct the main IRRUR mission and determine all the details to ensure that the main IRRUR mission is carried out effectively.

### **2.2.3. Preparation**

In preparation for the pre-IRRUR mission, the review team members discuss, in virtual format, the main features of the IRRUR, the facility's preparation for the review, including the availability of the necessary documentation and the review methods to be used.

#### **2.2.4. Conduct of mission**

The pre-IRRUR mission is conducted by the review team, together with the operating organization. The tasks to be performed should include:

- Presentation by the review team covering:
  - Introduction, main features and objectives of the overall IRRUR mission;
  - Experience feedback from previous IRRUR missions in other MSs.
- Presentation by facility managers covering:
  - Overview of the facility and its experimental facilities;
  - Overview of the current utilization of the research reactor;
  - Overview of the SP of the research reactor and priority utilization areas and applications;
  - Overview of the main existing and potential users and other key stakeholders.
- Preparation for the main IRRUR mission including
  - Scope of the mission indicating the topics and utilization areas to be reviewed;
  - Overview of the advance information and documentation package to be provided prior to the main mission and timetable for its availability;
  - Preliminary definition of internal and external users and other key stakeholders to be interviewed during the main IRRUR mission;
  - Definition of experts' profiles and preliminary identification of experts to be part of the review team;
  - Logistic support and financial arrangements;
  - Work plan for the operating organization and for the IAEA to be performed before the main mission.

### **2.3. MAIN MISSION**

This section provides general information relevant to the conduction of main IRRUR missions.

#### **2.3.1. General**

The main IRRUR mission is conducted typically three to six months after the pre-IRRUR mission. Its duration depends upon the review scope, the size and complexity of the facility's utilization programme and issues identified during the pre-IRRUR mission and is usually 5 to 7 days.

#### **2.3.2. Preparations**

Preparation for the on-site IRRUR mission includes the confirmation that:

- Management, operations and utilization staff are available during the review period;
- The access to research reactor and its experimental and production facilities within the scope of the mission is granted;
- The key research reactor facility users and other key research reactor stakeholders have been identified and meetings with them are arranged.

Subsequent to the pre-IRRUR mission, but before the main mission, the IAEA should appoint a mission team leader and the counterpart organization should appoint a mission main coordinator. Both should agree on the following aspects:

#### *2.3.2.1. Selection of review team members*

The preparation of the review is organized by the mission team leader, with active participation of the counterpart organization.

The mission team leader will usually be an IAEA staff member with broad experience in all aspects of research reactor utilization.

The main review team may consist of one or two IAEA staff members and two to five experts depending on the type of facility, utilization programme, mission scope, expertise needed, etc. The team may also include one or two observers, with the mutual agreement of the IAEA and the operating organization. Observers participate in the main IRRUR mission to gain insight into the IRRUR review process.

The mission team leader, in consultation with the counterpart, determines the composition and size of the main review team. The prime requirements of members of the team are:

- Independence;
- Broad scientific, managerial and operational expertise and experience related to research reactor utilization and applications;
- Familiarity with the IAEA standards, guides and other publications and international best practices that form the basis of the review;
- Familiarity with the type of facility to be reviewed;
- Familiarity with the applications within the scope of the review;
- Local language capability.

The selection process should pay special attention to avoid any potential conflict with the MS's interests by the nationality of the experts as well as potential conflicts of interest from staff of a competitive facility, or private company.

The review team members should be recruited considering their experience with similar facilities and with the topics that they will review. As the IRRUR service is a holistic review of all aspects that influence utilization of the research reactor, all team members contribute to the review of all areas within the scope of the mission. At the same time, assignment of specific tasks within the review team can be made in accordance with the special competences of the individual members. The ability of the review team members to prepare their contributions to the final mission report should also be considered.

#### *2.3.2.2. Key research reactor facility users*

The host organization should identify and provide a list of the existing and potential research reactor internal and external users and other key research reactor stakeholders to be interviewed during the main IRRUR mission. The list should identify the institutions and organizations, if applicable their relevant internal units, and their existing or potential work or area of interest in the research reactor. To the extent possible, the individuals who will take

part in the meetings and their responsibilities within the organization should also be identified.

#### *2.3.2.3. Advance information/documentation package for the review team*

The advance information and documentation package required for the main mission implementation should be prepared by the host organization and sent, preferably in electronic format, to the review team leader. The language of the documentation should be English, except if agreed otherwise. Its contents should be based on the objectives and scope of the mission as agreed to during the pre-IRRUR mission. The team leader then coordinates the distribution of the advance information and documentation package prior to the main mission to the team members.

The team leader also provides both the draft agenda and draft work plan, at the same time, to the team members. Since the team's preliminary review of the documentation can influence the work plan for the review, the advance information and documentation package should be obtained and distributed about a month before the main mission to permit timely finalization of the agenda and work plan.

The advance information and documentation package from the host organization should comprise, as a minimum, the following applicable documents as agreed and based on the review areas:

- An updated SP document developed in accordance with IAEA publication Nuclear Energy Series No. NG-T-3.16, Strategic Planning of Research Reactors [1], or equivalent methodology;
- A set of research reactor KPIs for utilization [1] (see Annex I);
- A USAR based on utilization assessment criteria [1, 2], for at least the past 3 operating years (see Annex II);
- A list of identified existing and potential research reactor facility users and other key stakeholders (see paragraph 2.3.2.2); and
- Reports on the results of any recent (2–5 years) reviews or self-assessments of the research reactor utilization.

For research reactors in extended shutdown, the KPIs are replaced by planned utilization targets and the USAR is replaced by an assessment of potential of each utilization area and associated constraints.

During the conduct of the main mission, the advance information and documentation package may be supplemented with additional information as required to support the mission and the subsequent report.

#### *2.3.2.4. Agenda and work plan development*

The agenda and work plan prepared during the pre-IRRUR meeting should be expanded to detail the tasks required during the mission. This revised agenda and work plan should identify all tasks which are to be performed before, during and after the main mission. Any specific tasks allocated to individual review team members should be described in a manner such that each team member who is assigned such tasks will have a clear understanding of the specific objectives and deliverables for the tasks.



The team leader and the mission main coordinator should develop a work plan, after which the other members of the review team and of the host organization are consulted and involved in the finalizing of the agenda and work plan. Proper planning should ensure that all tasks will be executed according to procedures and that a proper schedule will allow sufficient time for any contingencies as a result of examination of particular topics, discussions with counterparts, review team meetings, preparation of the exit meeting report and an exit meeting. The team leader has the overall responsibility for fulfilling the objectives of the mission and ensuring that the final agenda and work plan are followed.

Regardless of the mission specific objectives, the agenda and work plan provided should comprise, as a minimum:

- Mission objectives, scope and expected output;
- Work plan for the mission;
- Timing of the assessment activities;
- References to relevant IAEA standards, guides and other publications that will form the basis of review;
- Relevant information from previous missions, if used as a basis of review.

The final agenda and work plan are agreed by the team leader and the mission main coordinator, in advance of the main mission, such that the host organization can commit to make the necessary staff and documentation and other logistical needs available at the appropriate time. The team leader then ensures that the team members are provided with the agreed final agenda and work plan, prior to commencement of the main mission.

Given the holistic nature of the IRRUR service, some flexibility in the conduction of IRRUR missions is needed. As the mission work progresses, it may become necessary to hold additional meetings with management, users and other stakeholders. Therefore, the agenda may need to be revised during the main mission at site.

#### *2.3.2.5. Finalization of logistical matters*

Prior to convening the main mission, the logistical matters will be confirmed by the team leader with the host organization; particularly the following issues should be considered:

- Accommodation for team members;
- Local transport for the team;
- Meals during the working hours;
- Working room for team members;
- Internet / photocopying / printing.

#### *2.3.2.6. Briefing of the review team prior to convening the main mission*

The team leader is responsible for ensuring that the team is adequately prepared. The scope of the preparation will depend on the type of mission and the previous experience of team members. In all cases, communications via virtual means in the weeks prior to the main mission should ensure that all members of the team (including any clerical support staff) are fully aware of the objectives and the scope of the mission and of the specific roles and responsibilities of each team member. Any residual financial and other administrative arrangements and procedures should also be finalized with team members. The team members

should have a clear understanding of the mission outputs and their format prior to convening the main mission.

The team leader is responsible for ensuring that team members are informed of any changes to the final arrangements before they embark on travel.

### **2.3.3. Conduct of the main mission**

#### *2.3.3.1. General*

From the preliminary review of the advance information and documentation package, the team members will have some knowledge of the facility and its utilization programme. Depending upon the extent and quality of the SP and other documentation provided by the counterpart and the review preparation time, the team will also have some specific information on the potential and constraints for further development and expansion of the facility's utilization programme. The team leader will have reviewed any relevant IAEA historical mission files to check on the implementation status of previous mission recommendations and suggestions.

Activities of the mission start with an entry meeting. The entry meeting will allow the introduction of IRRUR team members, observers (if any) and counterparts, and a review of the agenda details.

The IRRUR team will acquire information by review of documentation; interviews with senior management of the research reactor operating organization, staff responsible for research reactor operation, staff responsible for research reactor utilization, and external users and other key stakeholders of the facility; facility walk-through and direct observation of activities. Throughout the mission, detailed discussions with the counterparts are carried out to gather information on current and potential utilization of the research reactor facility in the areas defined in the scope of the mission, taking identified opportunities and constraints into account, to ensure an understanding of identified issues in order to formulate recommendations for improvement.

The IRRUR team should meet each morning with the mission main coordinator and at the end of the day or during the evening to discuss the daily activities and to develop a consensus on emerging issues. These discussions help to ensure that all members benefit from the observations of other members and develop a common understanding of the issues. These meetings are also an opportunity for the team leader to review, if needed, the mission methodology and agenda compliance and to propose eventual changes to the agenda.

As the review proceeds, assessments of individual utilization areas are completed. Team members with special competence in a given utilization area, or the team leader, draft an initial summary of the assessment and findings for that area. The assessment of general areas relevant to utilization (section 3.1) is holistic, and an initial summary of the assessment and findings for each general area is drafted by the team leader or by an assigned team member.

Consensus among the IRRUR team on the assessment of the individual utilization areas and of general areas relevant to utilization is established in a meeting of the review team at the end of the assessment phase, for inclusion in the mission report and for possible inclusion in the executive summary report, presented at the mission exit meeting.

At the end of the review mission, a period is reserved for completing and presenting the executive summary report at the exit meeting and for rechecking any open topics and for starting the preparation of the draft mission report. Final preparation and editing of the main report are made by the review team leader with the assistance of the review team members after the mission.

An example agenda of a main IRRUR mission is given below:

- Entry meeting of the IRRUR review team and operating organization;
- Facility walk-through and observations of on-going activities;
- Examine documentation of the reactor facility, including SP, KPIs and USAR;
- Discussions with:
  - Senior management of the research reactor operating organization;
  - Staff responsible for research reactor operation (e.g., reactor manager and senior team);
  - Staff responsible for research reactor utilization, R&D, offering products & services;
  - External users and other key stakeholders of the facility.
- IRRUR review team meeting to establish assessments and recommendations;
- Exit meeting.

#### 2.3.3.2. *Activities*

A description of the activities is provided below.

##### (a) Entry meeting with counterpart and facility technical and utilization staff

Prior to starting the mission activities, the counterpart, facility staff and others who may be involved in the team's activities, need to be adequately briefed. This briefing, which is the responsibility of the team leader, should be in the form of an entry meeting and should address the following administrative items:

- Introduction of the team members to the counterpart;
- The needs of the team, especially for technical documentation and staff communications;
- Outline of the methodology to be used, the achievements expected and the organization of the mission;
- The method of communicating and reporting the results of the review;
- Discussion of the final agenda and approval.

At the entry meeting the agenda containing the detailed work schedule will be discussed and finalized. If the preparation process has been timely and no unforeseen circumstances have occurred at the facility, there would be only few changes expected to the agenda. Minor changes during the week may be expected; these are incorporated into the final agenda, which is documented in the mission report.

##### (b) Facility walk-through

Direct observation of the research reactor facilities via a walk-through to observe experimental setups in use and being installed, available beam ports and irradiation

capabilities, and relevant ancillary facilities, is an important aspect of the review process. Observation of the research reactor facilities and discussions with the utilization team(s) during the walk-through is intended to allow the review team to obtain a general appreciation of the reactor conditions and utilization capabilities.

#### (c) Review of records and documentation

The examination and assessment of the documentation relevant to the objectives and scope of the mission is essential to the effectiveness of the review. Initial review of the provided documentation by the team members should have preceded convening the main mission. This first review of documentation during the mission is usually limited to reviewing or highlighting specific items. However, in some missions, further documentation is often made available during the entry meeting or shortly after. Therefore, further time during the main mission may be necessary to examine relevant information that was not previously provided or that requires clarification .

#### (d) Technical discussions

Interviews with senior management of the research reactor operating organization, staff responsible for research reactor operation, staff responsible for research reactor utilization, external users and other key stakeholders of the facility are the key component of the IRRUR mission and constitute a major part of the review activities to gather on-site information.

Appendix I provides sets of questions for each of these groups, as examples that can be used by the review team to guide the discussions. The list of questions is not exhaustive, some may not be relevant to the host research reactor and additional questions may be needed.

The interviews should be conducted separately with each group of people, in order to obtain the views of each group on different aspects that affect utilization of the research reactor. In some research reactors these groups are not fully separated. For instance, in organizations where the operating organization is a large national laboratory or university, it may be the reactor manager, and not the organization's senior management, who is available for the IRRUR mission. In small research reactors, the operations staff may also be involved in utilization activities.

Due to the potential high number of stakeholders in each group and possible difficulties in gathering all at the mission site the interviews can be organized in virtual or hybrid mode.

To promote a frank and open attitude to the discussions, these discussions should be conducted in a cooperative manner and not have the character of an interrogation.

#### (e) Review team meeting

An IRRUR review team meeting is conducted prior to the exit meeting, during which the assessment of general areas relevant to utilization and of the individual utilization areas within the scope of the review is finalized, and a holistic, integrated set of recommendations for the facility is established. These recommendations should identify those activities that have a potential opportunity for growth and that have little to no constraints.

#### (f) Exit meeting

The IRRUR mission will terminate with an exit meeting during which the main findings of the mission, including main conclusions, recommendations, suggestions and good practices will be orally conveyed by the review team to representatives of the operating organization.

The attendees at the exit meeting are determined by the counterpart organization. However, as a minimum, those with significant executive responsibilities for the reactor operation and utilization should attend, including the reactor manager.

An executive summary report is provided to the operating organization during the exit meeting. The executive summary provided during the exit meeting should be considered a preliminary compilation of the main conclusions, recommendations and good practices the team has identified. Suggestions are not normally included in the executive summary at this time.

The exit meeting should be conducted in a free and open manner, without censure of negative findings.

During the exit meeting, commitment and follow-up may be discussed, but it is up to the host organization to decide on its response to the final mission report, when it is issued. There may be a number of minor technical items that still remain to be clarified by facility staff. Items such as these are normally expected to be communicated to the review team leader as soon as possible after the mission, for inclusion in the final mission report.

#### (g) Outputs and reporting

There are three general outputs of the main mission:

- Oral feedback provided by review team members via discussions with the counterparts throughout the mission;
- An executive summary report, presented at the exit meeting, providing immediate advice to the counterpart organization, summarizing the main conclusions and recommendations of the review;
- A final mission report (the main output) providing recommendations, suggestions and good practices for the host organization.

#### (h) Mission report

To document the findings of the reviewing process the team leader will compile a mission executive summary, taking into account input from all team members and comments from the counterpart.

Following the mission, the executive summary report is developed and incorporated in a final mission report, in order to provide a permanent record of the review. The final IRRUR mission report is normally prepared under the responsibility of the team leader, who will coordinate the production of the report with the team members.

The draft mission report including discussions held during the exit meeting will be sent to the counterpart for review within four weeks from the finalization of the mission. The counterpart should check that technical information related to the facility is correct and provide comments

and views on the findings to the IAEA within four weeks from the receipt of the draft report. The IAEA will review the comments of the counterpart and prepare a final report to be delivered to the counterpart within eight weeks from the receipt of the comments of the counterpart.

The format of the main IRRUR mission report is provided in Appendix II. Chapter 1 of the mission report provides background information on the facility and the IRRUR mission scope. Chapter 2 describes the conduct of the mission, including the method of conducting the review and the review criteria. Chapter 3 discusses the conclusions and main recommendations of the mission and should show to what extent the objectives of the mission were achieved and, as such, provide a starting point for future reviews.

The final mission report also contains annexes that include the mission agenda and a list of the persons met during the mission.

The final IRRUR mission report is submitted by the IAEA through the official channels to the counterpart. The report will be designated as a restricted distribution IAEA document, not to be released to the public. The research reactor operating organization is encouraged to share the report with other stakeholders or general public as deemed necessary.

After the report is received by the counterpart, it is expected that the operating organization develops an Action Plan, based on the report findings and their own operating experience, to address the mission recommendations and suggestions.

Recommendations, suggestions and good practices are defined as follows:

- Recommendations are team advice for enhancing the utilization level of the research reactor facility. Recommendations are generally based on proven methods for achieving excellence. The recommendations are designated with the letter “R” in the mission report.
- Suggestions are team proposals that may be provided in conjunction with a recommendation, or they may stand on their own. Suggestions are generally additional proposals that may contribute to enhance the utilization level of the research reactor. The suggestions are designated with the letter “S” in the mission report.
- Good practice is a performance, activity or use of equipment, which the team considers to be markedly superior to that observed elsewhere and fit for emulation by other facilities. The good practices are designated with the letters “GP” in the mission report.

## 2.4. FOLLOW-UP MISSION

This section provides general information relevant to the conduction of follow-up IRRUR missions.

### 2.4.1. General

The research reactor operating organization may request a follow-up IRRUR mission after a certain period of time to check on progress.

The follow-up IRRUR mission generally takes place from 12 to 18 months after the main mission and is conducted only at the request of the MS. The duration of the follow-up mission

and the size of the mission team depend on the scope of the mission and are decided by the review team leader (if possible, the same person who conducted the main mission) in consultation with the host organization.

#### **2.4.2. Objective**

The objective of the follow-up IRRUR mission is an evaluation of the progress of implementation of the main IRRUR mission recommendations and suggestions, the feedback from counterparts and revision of the action plan if required.

#### **2.4.3. Preparations**

The follow-up IRRUR mission should be organized following the same procedures as for the main review, but the scope of the follow-up mission is limited to examination of the areas where weak points were identified. The following documentation should be sent, by the facility to the follow-up IRRUR mission team, for revision as a part of preparations before the mission:

- Action plan for implementation of the main IRRUR mission recommendations and progress report;
- Brief report on difficulties faced in implementation of the main IRRUR mission recommendations and needs for mid-course correction;
- Any new plans for upgrades or improvements including identification of new users or new utilization needs.

#### **2.4.4. Conduct of mission**

The follow-up IRRUR mission is conducted on site by the review team, together with the operating organization. The mission should include:

- Presentation by the facility staff on progress in implementation of main IRRUR mission recommendations covering the areas which need attention for review;
- Walk-through of the facility including areas where modification or upgrade of experimental capabilities, recommended in the main IRRUR mission, have been carried out or are in progress;
- Discussion and identification of main mission findings which needed correction;
- Review of fresh issues and advice on modification of action plan as necessary;
- Exit meeting;
- Reporting.

### **3. GUIDELINES FOR ASSESSMENT OF REVIEW AREAS**

This section provides a comprehensive list of review areas and associated detailed guidelines for an IRRUR review. The coverage will depend on the scope and objectives of the review, as determined by the counterpart in conjunction with the review team leader.

The comprehensive list of review topics and reactor utilization areas, from which any individual IRRUR scope can be formulated, is based upon the IAEA guidelines and inputs provided by the facility.

The main IAEA publications on research reactor utilization are Refs. [1–3]. Refs. [4–8] should also be taken into account for the review. Depending on the utilization areas within the scope of the review, other IAEA publications are also relevant (e.g., Refs. [17–36].) and should be taken into account by the review team.

The IRRUR review team should conduct the mission, together with the operating organization, covering the agreed scope, which is at least but not limited to general findings, assessment of individual utilization areas and a global assessment and prioritization of utilization areas.

#### **3.1. GENERAL FINDINGS**

The IRRUR team should provide the host facility with an assessment of general areas, focusing on those aspects that are relevant to utilization of the research reactor. The assessment focuses on the current situation and identifies opportunities for improvement that can lead to enhancement of utilization of the research reactor. These general areas can include, for instance:

- Strategy and vision;
- Financing;
- Organization and personnel;
- Stakeholders and their needs;
- Outreach and marketing;
- Capabilities;
- Output and impact.

Different and/or additional areas may be considered depending on the complexity of the host research reactor activity, institutional setting, national, regional and international networks and cooperation, and mission and strategic goals of the operating organization.

##### **3.1.1. Strategy and vision**

###### *3.1.1.1. Objective*

To provide a basis for assessing the vision, mission and strategic goals of the operating organization for the research reactor, and the effectiveness of research reactor strategic planning towards advancing the objective of enhanced utilization of the facility.



### *3.1.1.2. Guidelines*

The IRRUR mission should verify that the general principles and approaches established in [1] have been taken into account when developing the facility's strategy.

The IRRUR mission should review the research reactor vision, mission and strategic goals, and assess whether:

- The strategy establishes clear objectives for the utilization of the facility;
- There is a mechanism to assess whether existing and planned activities fit within the strategy;
- Risks to the existing and planned utilization of the facility have been identified and assessed;
- All staff were involved in the development of the mission and vision;
- Internal and external users and other key stakeholders were considered for planning the reactor utilization;
- The Government is aware of the mission, purpose and utilization of the facility, including eventual changes;
- There is a mechanism to review and revise the research reactor strategy.

## **3.1.2. Financing**

### *3.1.2.1. Objective*

To provide a basis for assessing whether the financial management of the facility enables the achievement of the facility's vision, mission and strategic goals, including supporting current activities and the development of new capabilities.

### *3.1.2.2. Guidelines*

The IRRUR mission should review the financing and funding mechanisms of the operating organization, and assess whether:

- Funding is adequate to ensure required operation, maintenance and utilization of the facility. This includes but is not limited to:
  - Safely operating the research reactor facility and its ancillary facilities;
  - Recruiting new and retaining existing staff;
  - Operating and servicing existing instruments and experiments;
  - Replacing existing or acquiring new instruments and experiments;
  - Mid and long term stability of the budget, with consideration of risks in the facility's strengths, weaknesses, opportunities and threats (SWOT) analysis that may affect the budget.
- Managerial mechanisms are in place to determine the costs and pricing for use of the instruments and facilities, and for products and services;
- External users and other key stakeholders contribute to the realization of new utilization experiments and facilities;
- Long term commitments required by the development or expansion of some applications, such as large scale radioisotope production, are understood.

### **3.1.3. Organization and personnel**

#### *3.1.3.1. Objective*

To provide a basis for assessing the personnel resources available to perform the various required activities. This includes an assessment of the organizational structure of the research reactor and how responsibilities are allocated. The main categories of staff that impact the utilization of the facility are: O&M; safety and radiological protection; reactor utilization staff (including staff for industrial relations, outreach and marketing); and external users.

#### *3.1.3.2. Guidelines*

##### **Organizational structure**

The IRRUR mission should review the organizational structure and allocation of responsibilities of the research reactor facility, and assess whether:

- The organizational structure is designed and adequate to optimize the operation of the facility and the fulfilment of its vision, mission and strategic goals;
- An adequate management system is in place. Operational and utilization requirements are considered and integrated;
- Management of R&D, Education and Training (E&T), and services and products is established and organized;
- Communication channels between research reactor operations staff and utilization internal and external staff are established.

##### **Personnel**

The IRRUR mission should review the number, category, competencies and potential for further development of staff, and assess whether:

- Staff involved in reactor utilization, including instrument/facility specialists, are available and are sufficient in number and competencies for the utilization requirements;
- Recruitment and development of staff, including early career staff, with the skills to perform the necessary operations and work is undertaken;
- Issues of staff retention, staff turnover including due to ageing, and continuity of operation and utilization activities are considered and actively addressed by management;
- Personnel development is a requirement for all staff engaged with utilization of the facility, and addresses present and future utilization needs;
- A knowledge management system is in place, including knowledge transfer from experienced staff to new staff.

### **3.1.4. Stakeholders and their needs**

#### *3.1.4.1. Objective*

To provide a basis for assessing whether existing and potential new users and other key stakeholders are identified and whether their needs and requirements have been determined,

are incorporated in the facility's vision, mission and strategic goals, and are met by the current and planned activities. While all stakeholders have an impact on the utilization of the research reactor, this includes first and foremost the users of the facility.

This area is closely related to outreach and marketing, which is covered in more detail in Section 3.1.5. Depending on the breadth and scope of facility stakeholders and of outreach and marketing activities, the two areas could be combined into a single heading, for instance "Expanding the user base".

#### *3.1.4.2. Guidelines*

##### **Existing stakeholders**

The IRRUR mission should review the existing stakeholders and how their needs are being met, and assess whether:

- Major institutional stakeholders are involved and their needs are appropriately taken into account. This includes but is not limited to assessing the following:
  - The Government, or an umbrella organization under which the research reactor operates, sets requirements that define or constrain the vision, mission and strategic goals, and the utilization of the facility;
  - There is regular communication between the operator and the regulator on issues affecting facility utilization.
- Managerial mechanisms have been established and implemented to identify stakeholders, assess their needs and whether they are being met;
- The main users and other key stakeholders are identified, their needs are known and adequately satisfied;
- The reactor operation planning takes the users' needs into account and the users know the research reactor operating schedule;
- User communities, including internal and external users, are established and support the utilization of the facility;
- In particular for research reactors that function as user facilities, adequate support is given to external users, including in preparing and running the experiments and in interpreting the experimental data.

##### **New stakeholders**

The IRRUR mission should review the mechanisms to identify new stakeholders and assess and prioritize their potential needs, and assess whether:

- Managerial mechanisms have been established and implemented to identify new stakeholders and assess their potential needs;
- Management evaluated engagement with potential new users not currently served by the facility;
- The needs of new users have been evaluated for the potential impact of new activities on operations;
- Adequate support is provided to new users, including in development and installation of new experimental facilities and capabilities;
- The facility is involved in national and international scientific and technical networks and participates in international technical and scientific events, and:

- It keeps track of international trends in research reactor capabilities, applications, products and services;
- Cooperation agreements are leveraged to assist in making strategic decisions to serve gaps in the needs of the user community.

### **3.1.5. Outreach and marketing**

#### *3.1.5.1. Objective*

To provide a basis for assessing the methodologies used by the facility to increase awareness of its work and impact on society, and to attract new users, including for R&D, E&T and services and products.

This area is closely related to stakeholders and their needs, which is covered in more detail in Section 3.1.4. Depending on the breadth and scope of facility stakeholders and of outreach and marketing activities, the two areas could be combined into a single heading, for instance “Expanding the user base”.

#### *3.1.5.2. Guidelines*

##### **Outreach**

The IRRUR mission should review the outreach programme of the research reactor facility, and assess whether:

- The facility capabilities are promoted among the general public and through targeted outreach activities to specific potential user groups;
- Adequate and diverse promotional material has been developed;
- Initiatives are taken to identify and attract new users;
- Managerial mechanisms have been established and implemented to assess user satisfaction;
- Management is aware of best practices in outreach for research reactors;
- The operating organization has a dedicated office to support outreach.

##### **Marketing**

The IRRUR mission should review the marketing methodologies of the research reactor facility, and assess whether:

- The market demand for the research reactor products and services has been evaluated, and potential customers have been identified;
- Readiness for commercialization of proposed research reactor products and services, including required quality standards, has been assessed;
- Marketing methodologies have been established and implemented to market the reactor capabilities among potential customers of the products and services that the research reactor can provide;
- Managerial mechanisms have been established and implemented to assess customer satisfaction;
- The operating organization has a mechanism, such as a dedicated office, to support technology transfer.

### **3.1.6. Capabilities**

#### *3.1.6.1. Objective*

To provide a basis for assessing the utilization capabilities of the facility, the extent to which they are available and effectively used to support the facility's vision, mission and strategic goals, and the potential for development of new capabilities taking into account existing and future stakeholder needs. The capabilities of ancillary facilities and units that support utilization activities, including those external to the operating organization, should be included in the assessment.

Prioritization of allocation of resources to existing capabilities and investment in new capabilities is usually driven by an analysis of stakeholders and their needs, which is covered in more detail in Section 3.1.4.

#### *3.1.6.2. Guidelines*

##### **Existing capabilities**

The IRRUR mission should review the existing utilization capabilities of the facility and assess whether:

- A process is in place to set priorities for investment and allocation of resources in the current capabilities and take into account the need to maintain and expand the user base;
- Maintenance and ageing management programmes, including for experimental equipment, are adequate to ensure continued operation of the existing capabilities;
- The operations schedule is aligned with user and market requirements, and there is a mechanism to solve scheduling conflicts between different users or applications;
- Documented procedures are in place for use of research reactor facilities, instruments and experiments. Supporting education and training material is available to users;
- Technical, organizational and infrastructure constraints to utilization of the existing capabilities are identified, including availability of trained staff, ageing of equipment, regulatory requirements, operational, maintenance and safety requirements, life limiting factors, availability of financial and technical support resources, industrial (i.e. not nuclear) health and safety programme, labour law, and others.

##### **Potential capabilities**

The IRRUR mission should review the potential utilization capabilities of the facility, and assess whether:

- A process is in place to set priorities for investment and allocation of resources in new capabilities and take into account the need to maintain and expand the user base;
- Procedures to be followed for development of new capabilities are in place;
- Potential capabilities have been identified or are being already implemented;
- The number and characteristics (neutron flux and neutron spectrum) of irradiation facilities and beam tubes is adequate for current and planned activities;
- Required competencies and technical support, including for O&M, needed for the new capabilities have been identified and either exist or a plan is in place to acquire them;

- Ancillary facilities and units that support utilization activities are adequate to support the new capabilities;
- The operations schedule is sufficiently flexible to incorporate the new activities;
- Technical, organizational and infrastructure constraints to development of new capabilities are identified, including availability of trained staff, ageing of equipment, regulatory requirements, operational, maintenance and safety requirements, life limiting factors, availability of financial and technical support resources, industrial health and safety programme, labour law, and others.

### **3.1.7. Output and impact**

#### *3.1.7.1. Objective*

To provide a basis for assessing the output and impact of the facility, including scientific output and products and services provided. The assessment should focus on holistic issues and opportunities that involve more than one particular research reactor application. Guidelines for the detailed assessment of each utilization area are provided in Section 3.2.

#### *3.1.7.2. Guidelines*

The IRRUR mission should review the scope and breadth of the scientific output of the research reactor facility and the products and services it provided. These considerations include but are not limited to:

- The institutional culture of the operating organization encourages and enables utilization improvement. For instance:
  - Goals and timelines for utilization improvement have been set;
  - The major objectives are communicated to and discussed with staff;
  - There is a system to reward staff performance;
  - Revenue generated by utilizing the research reactor can be used to support operation and development of the experimental and irradiation facilities.
- Plans in multiple subject areas are integrated to ensure accomplishment of the facility's objectives;
- KPIs for utilization have been defined, with metrics for utilization and scientific output, including also the scientific output of external users;
- Partnerships are established to promote utilization, including:
  - Joint scientific endeavours with research institutions and universities;
  - Partnerships with external companies for provision of products and services;
  - The facility staff works collaboratively with external users resulting in joint scientific outputs.

## **3.2. ASSESSMENT OF INDIVIDUAL UTILIZATION AREAS**

Utilization areas are initially assessed one by one separately.

### **3.2.1. Objective**

To provide a basis for assessing the current situation and the potential for growth and constraints that may limit the further development of each utilization area within the scope of the IRRUR mission. The assessment is made separately for each utilization area, while noting

existing or potential interlinkages between areas. The assessment of general areas given in Section 3.1, and in particular the constraints therein identified, strongly influences the assessment of individual utilization areas.

The utilization areas are those agreed within the scope of the IRRUR mission. They may include the following and additional areas:

- Education;
- Training;
- Neutron activation analysis;
- Prompt gamma activation analysis;
- Neutron depth profiling;
- Radioisotope production:
  - Applied R&D;
  - Commercial production.
- Geochronology;
- Neutron transmutation doping;
- Gem coloration;
- Neutron imaging;
- Neutron scattering;
- Neutron therapy:
  - Boron neutron capture therapy;
  - Other techniques.
- Testing:
  - Instrumentation and control;
  - Nuclear fuels and materials.
- Nuclear data measurements;
- Other.

### **3.2.2. Guidelines**

#### *3.2.2.1. Current situation*

The IRRUR mission should review the current status of the utilization area under consideration, and identify:

- The users and other key stakeholders;
- The current level of activity in the utilization area under consideration, such as:
  - Education and training. If appropriate education and training may be reviewed separately;
  - The main scientific and research areas, each reviewed separately;
  - The products and services provided, each reviewed separately.
- The adequacy of available resources;
- The existence of partnerships and collaborations in the utilization area under consideration.

#### *3.2.2.2. Potential and constraints*

The IRRUR mission should review the potential for expansion (or to start a new activity) in the utilization area under consideration given the identified needs for that utilization area and

the constraints that may limit its further development, and assess whether expansion is feasible and would have a positive impact on the facility. The factors to consider include, but are not limited to, the following:

- The strategy and overall priorities of the operating organization;
- Existence of identified or potential unsatisfied user needs;
- The potential capacity and opportunities for growth or diversification, including through partnerships and collaborations;
- The resources needed to realize the potential and their availability;
- Other constraints, e.g. administrative, technical, regulatory, legal, and others.

### 3.3. GLOBAL ASSESSMENT AND PRIORITIZATION OF UTILIZATION AREAS

The assessment of utilization areas in separate is followed by a global assessment of the utilization areas and their prioritization.

#### 3.3.1. Objective

To provide a holistic high-level summary of recommendations for the facility that can maximize its utilization and impact, including the current and potential assessment of each utilization area within the scope of the IRRUR mission and the establishment of a categorization in: 1) areas which are considered to be priority; 2) areas where significant investment or growth is not recommended; and 3) areas where ceasing operation is recommended.

#### 3.3.2. Guidelines

The review team should provide a holistic, integrated set of recommendations for the facility. These recommendations should identify those individual or integrated activities that have little to no constraints and have an identified potential opportunity for growth. The review team should consider the following when developing these recommendations:

- General findings;
- Individual assessments for each utilization area;
- Gaps and areas for improvement in utilization;
- Overall opportunities for growth given the external research reactor environment;
- Constraints that affect the facility's overall ability to implement the recommendations.

The IRRUR mission should also establish a global consensus categorization for the utilization areas within the scope of the mission, dividing the utilization areas in three categories according to their priority:

- (1) Utilization activities that the review team considers would provide the reactor with a future that is well diversified, has high impact, positive public perception, are practical and achievable, and reflect the core mission of the operating organization.
- (2) Utilization activities that the review team does not consider essential to the future of the reactor. Significant investment or growth is not recommended.



- (3) Utilization activities that the review team does not consider essential to the future of the reactor. Ceasing operation in these areas is recommended.

If appropriate, a separate summary table can be made for each of the categories, following the model given in Table 1, with assessment from “unsatisfactory” to “excellent”. In general, this is more useful for research reactors which already have significant utilization in a number of applications which they are seeking to expand, and less useful for research reactors engaged in a restricted number of applications, or that are utilized significantly below their potential. In this case, for each research reactor application, two summary assessments are given:

- According to the current perception of the mission being conducted or the progress being made towards achieving mission readiness for each given utilization area;
- Corresponding to the potential that the reactor could achieve in the mid-term, if performing at maximum research and operational efficiency, taking identified opportunities and constraints into account.

TABLE 1. MODEL SUMMARY TABLE FOR THE ASSESSMENT OF UTILIZATION AREA CATEGORIES

| Utilization area     | Current | Potential |
|----------------------|---------|-----------|
| Utilization area 1   |         |           |
| Utilization area 2   |         |           |
| Utilization area ... |         |           |

The definition of the assessments to be given in Table 1 is:

- Excellent:** Utilization performance exceeds expectations and is leading within peer group; improvement is driven from within and is class leading.
- Above Average:** Utilization performance meets internal expectations and is better than most in peer group; incremental improvement could be identified and achieved.
- Average:** Utilization performance is meeting most but not all expectations and is average for peer group; targeted effort for improvement is needed for better utilization.
- Below Average:** Few utilization expectations are being met and output significantly lags peer group; substantial and broad improvement is needed to reach better utilization.
- Unsatisfactory:** Utilization expectations are not being met and output is at the bottom of the peer group; improvement is needed in all areas to reach better utilization.
- N/A:** Utilization area not implemented.

## **APPENDIX I. GUIDANCE FOR THE MISSION TEAM**

These sets of questions, provided here as examples only, can be used to assist the review team members for the site visit during the IRURR mission. They follow and are organized according to the items given in IAEA publication Nuclear Energy Series No. NG-T-3.16, Strategic Planning of Research Reactors.

Each set of questions in sections I.1 to I.4 of this Appendix is directed at specific groups of stakeholders:

- (1) Senior management of the research reactor operating organization
- (2) Staff responsible for research reactor operation (e.g. Reactor Manager and senior team)
- (3) Staff responsible for research reactor utilization, R&D, offering products & services
- (4) Users and other key stakeholders and utilization areas of the facility

In some research reactors these groups are not fully separated. For instance, where the operating organization is a large national laboratory or university, its senior management may not be available, and the research reactor management usually answers the corresponding questions. In some research reactors, the reactor manager will answer for groups (1) and (2), and possibly also 3, if e.g. the operating staff are responsible for the products and services provided. In some research reactors there are well developed user offices that will respond for (3), while in other research reactors it can be users of a given instrument that do R&D and offer products and services to customers. Finally, in some cases the three first groups might be the same, often small, group of people.

## I.1. QUESTIONS TO THE SENIOR MANAGEMENT OF THE RESEARCH REACTOR OPERATING ORGANIZATION

This list of questions is provided to guide the interviews and discussions with the senior management of the research reactor operating organization. The list is not exhaustive, additional questions may be needed and some of the questions listed may not be relevant. The questions follow and are organized according to the items given in IAEA publication Nuclear Energy Series No. NG-T-3.16, Strategic Planning of Research Reactors.

| NES NG-T-3.16 section                         | Questions to senior management   |
|---|--|
| 3.3 Vision and Mission                        | <ul style="list-style-type: none"> <li>• Who participated in the development of the mission and vision? Was it top down; ownership driven, or were all staff involved?</li> <li>• Was the mission statement developed such that internal and external stakeholders were considered for understanding the reactor utilization?</li> <li>• Does it establish a clear picture of the future utilization of the facility?</li> <li>• How frequently is the mission statement reviewed?</li> <li>• Is the Government aware of changes in the mission, purpose and utilization of the facility?</li> <li>• How is the mission compared with the good practices of other similar reactors?</li> </ul> |
| 3.5 Stakeholders and their needs              |  |
| 3.5.1 Identification of existing stakeholders | <ul style="list-style-type: none"> <li>• Does the Government, or an umbrella organization under which the research reactor operates, set requirements that define or constrain the utilization of the facility (such as radioisotope production, capacity building for a nuclear power programme, etc)?</li> <li>• What management mechanisms have been established to ensure that all current stakeholders are regularly engaged?</li> </ul>  |
| 3.5.2 Identification of new stakeholders      | <ul style="list-style-type: none"> <li>• Has management evaluated engagement with potential new stakeholders, not currently served by the facility?</li> </ul>   |
| 3.7 Capabilities                              |  |
| 3.7.1 Existing Capabilities                   | <ul style="list-style-type: none"> <li>• How does management make decisions on investing or divesting in the current capabilities?</li> <li>• How are priorities set?</li> <li>• How does investment on the mission capability compare to the investment on the facility?</li> </ul>   |
| 3.7.2 Potential Capabilities                  | <ul style="list-style-type: none"> <li>• Is the management open to new utilization and adding capabilities to the reactor?</li> <li>• How does management review investment into new potential capabilities?</li> </ul>  |
| 3.8 SWOT and Risk Evaluation                  |  |
| 3.8.1 SWOT                                    | <ul style="list-style-type: none"> <li>• Has management promoted the development of a SWOT analysis for the research reactor facility, and is it aware of its results?</li> </ul>  |

| NES NG-T-3.16 section                                    | Questions to senior management  |
|--|---|
| 3.8.2 Assessment of risk                                 | <ul style="list-style-type: none"> <li>• What does management consider the highest risk to the mission of the facility?</li> <li>• Are risks ranked and used by facility staff to make decisions?</li> <li>• What plans are in place to mitigate realized risks?</li> </ul>   |
| 3.8.3 Life limiting factors                              | <ul style="list-style-type: none"> <li>• Has the lifetime of the facility been determined and has consideration been given to the scope and scale of ageing management activities if needed?</li> <li>• Is the facility operation license subject to periodic renewal and what actions does management take to ensure no regulatory threat of shutdown?</li> <li>• Is fuel available, or can be procured, for the life time of the facility?</li> </ul>   |
| 3.9 Decisions and Strategy                               | <ul style="list-style-type: none"> <li>• How are decisions and strategy communicated?</li> </ul>  |
| 3.10 Strategic considerations                            |   |
| 3.10 (ix) Technical cooperation and information exchange | <ul style="list-style-type: none"> <li>• How does management ensure that the facility is actively engaged with other facilities that perform similar work?</li> <li>• Have national or regional cooperation mechanisms been established by the research reactor operating organization?</li> <li>• How are cooperation agreements used to make strategic decisions to serve gaps/niches in the user community?</li> <li>• Does management ensure that best practices for utilization have been benchmarked by engagement with similar research reactor facilities?</li> </ul> |
| 3.11 Objectives  |   |
| 3.11.1 Major objectives                                  | <ul style="list-style-type: none"> <li>• How did the updated SWOT analysis affect the development of the major objectives?</li> <li>• How does management communicate the major objectives to staff?</li> <li>• Have the identified major objectives had a significant impact on facility utilization?</li> </ul>   |
| 3.11.2 Specific or lower level objectives                | <ul style="list-style-type: none"> <li>• How does management ensure that lower level objectives are aligned with the overall strategy and the major objectives?</li> <li>• How does management monitor progress of lower level objectives?</li> <li>• How does management ensure that resources are appropriately applied to objectives?</li> </ul>   |
| 3.12 Action plans for specific objectives                | <ul style="list-style-type: none"> <li>• Has management identified clear roles and responsibilities to ensure actions will be completed?</li> <li>• Have the required resources been allocated to execute the action plans?</li> <li>• Were action plans developed with the staff responsible for execution?</li> <li>• How is progress tracked?</li> <li>• How are plans in multiple subject areas integrated to ensure mission success?</li> </ul>  |

| NES NG-T-3.16 section                           | Questions to senior management   |
|---|--|
| 3.14 Organization and personnel                 |  |
| 3.14.1 Organizational structure of the facility | <ul style="list-style-type: none"> <li>• Is the organizational structure set in place to optimize the mission and the operation of the facility? Is there a need for change?</li> <li>• Is management aware of organizational structures of similar facilities?</li> <li>• How is the operating and mission scope of the organization integrated?</li> <li>• What are the criteria for leadership positions in the organization?</li> <li>• Is a management system in place at your organization/facility?</li> </ul>  |
| 3.14.2 Personnel development                    | <ul style="list-style-type: none"> <li>• Is personnel development a requirement for all staff engaged with utilization of the facility?</li> <li>• Are cooperative agreements with other reactors or related utilization areas utilized to assist with personnel development?</li> <li>• How are personnel developed for future capabilities?</li> <li>• How successful is the facility in retaining staff that are critical to utilization?</li> <li>• Is a knowledge management system in place at your organization/facility?</li> <li>• Is knowledge transfer from experienced staff to new staff actively addressed by the management team?</li> <li>• Does management have a plan to recruit and develop early career staff with the skills to perform the necessary operations and mission work?</li> </ul> |
| 3.15 Financing                                  | <ul style="list-style-type: none"> <li>• What are the main sources of your budget? How stable are they?</li> <li>• Are there pressures (e.g. from government or umbrella organization) to increase revenue from commercial activities?</li> <li>• Does the base financing cover the costs of O&amp;M of the research reactor, and does it also include utilization activities?</li> <li>• To what extent is financing of utilization dependent on competitive R&amp;D grants?</li> <li>• Can income generated by the research reactor be used for the research reactor (e.g. investment, rewarding staff performance, etc)?</li> <li>• How do financial constraints affect recruiting new staff?</li> </ul>  |
| 3.16 Outreach and marketing                     |  |
| 3.16.1 Outreach approaches                      | <ul style="list-style-type: none"> <li>• How does management assess customer/user satisfaction with the facility engagement?</li> <li>• Does management have targeted outreach activities with professional societies and associations that benefit from reactor mission programmes?</li> <li>• What does management do to organize advocacy for reactor?</li> </ul>   |
| 3.16.2 Marketing methodologies                  | <ul style="list-style-type: none"> <li>• What communication means have been produced to ensure the facility's potential and impact is known by existing and potential users and other key stakeholders?</li> <li>• How does management ensure that marketing activities are being performed to grow the utilization of the reactor?</li> </ul>   |

| NES NG-T-3.16 section  | Questions to senior management   |
|------------------------|--|
| 3.17 Change management | <ul style="list-style-type: none"> <li>• Please explain the change management plan that has been developed to expand reactor utilization.</li> <li>• Is there a plan to repeat the SWOT analysis after the change has been implemented?</li> <li>• Has management established a clear timeline for improvement and developed a sense of urgency regarding the increase in utilization?</li> <li>• How is management motivating leadership to achieve the utilization improvement?</li> <li>• Explain the goals for utilization improvement.</li> <li>• How is the plan for improved utilization been communicated internally and externally of the reactor facility/organization?</li> </ul> |

## I.2. QUESTIONS FOR STAFF RESPONSIBLE FOR RESEARCH REACTOR OPERATION

This list of questions is provided to guide the interviews and discussions with the research reactor staff responsible for operation. The list is not exhaustive, additional questions may be needed and some of the questions listed may not be relevant. The questions follow and are organized according to the items given in IAEA publication Nuclear Energy Series No. NG-T-3.16, Strategic Planning of Research Reactors.

| NES NG-T-3.16 section                         | Questions for staff responsible for research reactor operation  |
|---|---|
| 3.3 Vision and Mission                        | <ul style="list-style-type: none"> <li>• How has the original purpose of the facility changed compared to what the purpose is currently?</li> <li>• How is the operating staff involved in achieving the vision and mission of the facility?</li> </ul>   |
| 3.5 Stakeholders and their needs              |   |
| 3.5.1 Identification of existing stakeholders | <ul style="list-style-type: none"> <li>• Who are your main users and other key stakeholders and are their needs adequately satisfied?</li> <li>• Are there formal channels to interact with stakeholders?</li> <li>• How is their satisfaction evaluated?</li> <li>• How does the reactor operation planning take the stakeholders' needs into account?</li> </ul>  |
| 3.5.2 Identification of new stakeholders      | <ul style="list-style-type: none"> <li>• What initiatives are taken to identify and attract new users and other key stakeholders?</li> <li>• How have the needs of new users and other key stakeholders been evaluated for the potential impact on operations?</li> </ul>   |
| 3.6 Facility description                      | <ul style="list-style-type: none"> <li>• What was the intended design operating schedule of the reactor?</li> <li>• How does the actual operating schedule compare to that?</li> <li>• How is the operating schedule decided and communicated?</li> </ul>   |
| 3.7 Capabilities                              |   |
| 3.7.1 Existing Capabilities                   | <ul style="list-style-type: none"> <li>• How does the existing number and competency of staff relate to the actual needs to operate all existing scientific/mission capabilities?</li> <li>• What are your maintenance/ageing management programmes to ensure continued operation of your existing scientific/mission capabilities?</li> <li>• How are your existing scientific/mission capabilities affected by regulatory requirements?</li> <li>• Which resources do you have to support under-utilized existing scientific/mission capabilities?</li> <li>• To what extent is the operations schedule aligned with user and market requirements?</li> <li>• How do you resolve scheduling conflicts between different users and/or missions?</li> </ul> |

|   |  |
|---|--|
| NES NG-T-3.16 section   | Questions for staff responsible for research reactor operation   |
| 3.7.2 Potential Capabilities  | <ul style="list-style-type: none"> <li>• Is the licensing/regulatory process for potential capabilities clear and well established?</li> <li>• Are there any potential capabilities identified or being implemented at the moment?</li> <li>• Which procedures have to be followed for development of new capabilities?</li> </ul>   |
| 3.8 SWOT and Risk Evaluation  |  |
| 3.8.1 SWOT  | <ul style="list-style-type: none"> <li>• How was the operating staff involved in the SWOT analysis during the strategic planning process?</li> </ul>   |
| 3.8.2 Assessment of risk  | <ul style="list-style-type: none"> <li>• Are there any licensing/regulatory restrictions that may limit your ability to meet the mission requirements of your user community?</li> </ul>   |
| 3.8.3 Life limiting factors   | <ul style="list-style-type: none"> <li>• What is the expiration date of your operating license? Can it be extended?</li> <li>• Which other factors require re-evaluation of your license?</li> <li>• How close is the facility near the design lifetime?</li> <li>• The currently available fuel allows operation of the reactor at current level for how long?</li> <li>• How did you communicate lifetime limit to your users or management and are they addressing the potential consequences?</li> </ul> |
| 3.9 Decisions and Strategy  | <ul style="list-style-type: none"> <li>• How is operating staff included in decision making and planning?</li> <li>• How does the regulatory environment affect decisions made?</li> </ul>   |
| 3.10 Strategic considerations   |  |
| 3.10 (v) Maintenance  | <ul style="list-style-type: none"> <li>• How is scheduled or unscheduled maintenance prioritized with respect to users' needs?</li> </ul>  |
| 3.10 (vi) Licensing and regulation<br>(vii) Quality Management<br>(viii) Health, safety and the environment | <ul style="list-style-type: none"> <li>• Have the appropriate codes and standards been applied to the systems and equipment to carry out the mission?</li> </ul>   |
| 3.10 (ii) Stakeholder and user relations  | <ul style="list-style-type: none"> <li>• How frequent is the communication between the operator and the regulator?</li> </ul>  |
| 3.10 (vii) Quality management   | <ul style="list-style-type: none"> <li>• How is the quality of the maintenance activities on the operations and/or scientific instruments ensured?</li> <li>• How is the fuel cycle managed to ensure continuity in operations to support the mission?</li> <li>• How could the facility quality programme impact the scientific programmes?</li> <li>• How often is your management system reviewed by the regulator?</li> </ul>  |
| 3.10 (ix) Technical cooperation and information exchange  | <ul style="list-style-type: none"> <li>• How does the operating organizing engage with similar reactors in order to exchange information on providing improved operations for utilization?</li> </ul>  |



| NES NG-T-3.16 section                     | Questions for staff responsible for research reactor operation  |
|---|---|
| 3.11 Objectives                           |   |
| 3.11.1 Major objectives                   | <ul style="list-style-type: none"> <li>• How have the major scientific/mission objectives of the facility been communicated to operating staff?</li> <li>• In your opinion, are the major scientific/mission objectives realistic/achievable considering the current staff, operating license, etc.</li> </ul>  |
| 3.11.2 Specific or lower level objectives | <ul style="list-style-type: none"> <li>• How were operating staff involved in determining the specific objectives for the facility mission?</li> <li>• How do you measure achievement of specific objectives?</li> </ul>  |
| 3.12 Action plans for specific objectives | <ul style="list-style-type: none"> <li>• How do the action plans affect the operations of the facility?</li> <li>• How realistic is the timescale and estimation of resources needed?</li> </ul>  |
| 3.13 Review and status reporting          | <ul style="list-style-type: none"> <li>• How were operating and utilization staff involved in determining KPIs for the facility and for utilization?</li> <li>• Does the facility have KPIs for utilization, including both internal and external users?</li> <li>• What metrics for utilization and scientific output are used in the facility?</li> <li>• Is there a system to reward staff performance?</li> </ul> |
| 3.14 Organization and personnel           |   |
| 3.14.1 Organizational structure           | <ul style="list-style-type: none"> <li>• What is the basis of the current organizational structure?</li> <li>• How is deputizing of key personnel organized?</li> <li>• How does the line of communication work?</li> </ul>   |
| 3.14.2 Personnel development              | <ul style="list-style-type: none"> <li>• Which programme for education and training exists for your operating staff?</li> <li>• What is your recruitment procedure for operating staff?</li> <li>• How do you value e.g. service attitude or a general interest in the mission work to be performed vs. professional (technical/scientific) competence in the selection of new staff?</li> </ul>                      |
| 3.15 Financing                            | <ul style="list-style-type: none"> <li>• Who covers for the operating and maintenance costs of the facility?</li> <li>• Is the funding adequate to ensure required O&amp;M of the facility?</li> <li>• How do financial constraints affect recruiting new staff?</li> </ul>   |
| 3.16 Outreach and marketing               |   |
| 3.16.1 Outreach approaches                | <ul style="list-style-type: none"> <li>• Has the facility been involved in the development of promotional material?</li> <li>• Is the facility aware of best practices in outreach for research reactors?</li> </ul>  |
| 3.16.2 Marketing methodologies            | <ul style="list-style-type: none"> <li>• What methodologies are used to market your capabilities?</li> </ul>  |

### I.3. QUESTIONS FOR STAFF RESPONSIBLE FOR R&D, OFFERING PRODUCTS & SERVICES, AND KEY STAKEHOLDERS AND USERS OF THE FACILITY

This list of questions is provided to guide the interviews and discussions with the staff responsible for R&D, offering products & services, and users and other key stakeholders of the facility. The list is not exhaustive, additional questions may be needed and some of the questions listed may not be relevant. The questions follow and are organized according to the items given in IAEA publication Nuclear Energy Series No. NG-T-3.16, Strategic Planning of Research Reactors.

| NES NG-T-3.16 section                         | Questions for staff responsible for R&D, offering products & services, and users and other key stakeholders of the facility  |
|---|--|
| 3.3 Vision and Mission                        | <ul style="list-style-type: none"> <li>• How do you assess if existing and planned activities fit within the mission/vision statements? How do you handle requests that do not fit?</li> <li>• How frequently do changes in products and services offered lead to a need to review the mission/vision statement?</li> </ul>  |
| 3.5 Stakeholders and their needs              |  |
| 3.5.1 Identification of existing stakeholders | <ul style="list-style-type: none"> <li>• How did your existing external users and other key stakeholders (external users from e.g. external universities, industry and research institutes and/or organizations asking for training) come to you?</li> <li>• How did you assess the existing and future needs of these external stakeholders? How do you know if these needs will be for short or long term?</li> <li>• How are the needs specified/quantified?</li> <li>• What are the alternatives for these stakeholders besides your reactor?</li> <li>• How do internal users of the research reactor facility collaborate with external users and other key stakeholders?</li> <li>• What kind of quality management is required by your stakeholders (e.g., ISO-9001, ISO/IEC 17025, GLP-GMP, IAEA PTs and round robins, etc...)</li> <li>• What are the activities (workshops, websites, blogs...) of your current user communities?</li> <li>• How do your stakeholders know when your research reactor is operating?</li> <li>• Do you have any contracts made with your stakeholders?</li> <li>• Who is doing the interpretation of the measurement data?</li> <li>• How often were you not able to report/deliver by schedule? And how do you handle such situations?</li> </ul> |
| 3.5.2 Identification of new stakeholders      | <ul style="list-style-type: none"> <li>• Which existing and future capabilities may attract new users and other key stakeholders?</li> <li>• How do you explore if (international) trends in your capabilities might also be of interest for your existing and future stakeholders?</li> <li>• How did you assess the potential new stakeholders and their potential needs?</li> <li>• How do the new stakeholders define their specifications?</li> <li>• What kind of quality management is required by these new stakeholders (e.g., ISO-9001, ISO/IEC 17025, GLP-GMP...)</li> </ul>  |

|                              |  |
|------------------------------|--|
| NES NG-T-3.16 section        | Questions for staff responsible for R&D, offering products & services, and users and other key stakeholders of the facility  |
| 3.6 Facility description     | <ul style="list-style-type: none"> <li>• Is the number and characteristics (neutron flux and neutron spectrum) of irradiation facilities and beam tubes adequate for current and planned activities?</li> <li>• Are the reactor's ancillary equipment and structures adequate for current and planned activities (e.g. hot cells)?</li> <li>• Is the operation schedule adequate for current and planned activities?</li> </ul>  |
| 3.7 Capabilities             |  |
| 3.7.1 Existing Capabilities  | <ul style="list-style-type: none"> <li>• How frequently do you evaluate the status of your capabilities? Who is involved in this?</li> <li>• Which (scientific/technical) core competencies do you need for operating your research reactor facilities (e.g., nuclear physics, reactor physics, neutron physics, radiochemistry...)</li> <li>• What are the limiting factors of your existing capabilities?</li> <li>• Which technical support resources (e.g. workshops, IT, electronic) are needed to run and further develop your experimental facilities and/or training/education capabilities?</li> <li>• How do you ensure that your research reactor facilities are used by qualified, competent persons?</li> <li>• What are your limiting factors for achieving your mission (e.g. ageing equipment, training of newcomers, funding, etc.)?</li> <li>• Do you have supporting education and training material for users?</li> <li>• Are stakeholder requirements reflected in your logbooks, results, measurement reports, etc.?</li> <li>• How is maintenance of experimental equipment organized?</li> <li>• How do you sustain the scientific and technical expertise?</li> <li>• Do you have documented procedures for use of research reactor facilities/instruments/experiments etc.?</li> <li>• In which international scientific networks are you involved and how frequent are you active in these (e.g. by visiting conferences)?</li> </ul> |
| 3.7.2 Potential Capabilities | <ul style="list-style-type: none"> <li>• How do you keep track of international trends in research reactor capabilities/applications/products and services (e.g. via literature, conferences, networks, internet, etc.)?</li> <li>• How would you expand your mission/production capacity?</li> <li>• Which competencies/technical support do you have/need to expand neutron beam research/isotope production/training</li> <li>• How will you maintain new instruments/facilities?</li> <li>• If you are considering radioisotope production, do you have infrastructure for preparation and delivery?</li> </ul>  |
| 3.8 SWOT and Risk Evaluation |  |
| 3.8.1 SWOT                   | <ul style="list-style-type: none"> <li>• Do you have the SWOT or similar analysis of each instrument/research reactor capability?</li> <li>• If available: who has been involved in drafting the SWOT?</li> <li>• If not existing, why not?</li> <li>• What are your conclusions from the SWOT?</li> </ul>   |

| NES NG-T-3.16 section                                    | Questions for staff responsible for R&D, offering products & services, and users and other key stakeholders of the facility   |
|--|---|
| 3.8.2 Assessment of risk                                 | <ul style="list-style-type: none"> <li>• Have you done a risk assessment to ensure your mission remains relevant?</li> <li>• How was the gap analysis done?</li> </ul>  |
| 3.8.3 Life limiting factors                              | <ul style="list-style-type: none"> <li>• What is the age of your instruments?</li> <li>• Does the performance of the instruments meet the functional requirements of the users?</li> <li>• What is the replacement plan?</li> <li>• How are priorities for replacement set?</li> <li>• Who decides on it?</li> <li>• Which spare parts do you have?</li> <li>• How is procurement organized (e.g. buying the requested item or buying the cheapest product)?</li> <li>• In your opinion, what are the main limitations to your capabilities (e.g. the technical, organizational, infrastructural, other)? Please provide details</li> </ul> |
| 3.10 Strategic considerations                            |   |
| 3.10 (ii) Stakeholder and user relations                 | <ul style="list-style-type: none"> <li>• How do users interact with operating personnel?</li> <li>• How do users communicate their (changing or new) needs?</li> </ul>  |
| 3.10 (v) Maintenance                                     | <ul style="list-style-type: none"> <li>• Are users aware of maintenance activities that could impact the ability to perform their mission?</li> </ul>   |
| 3.10 (vii) Quality management                            | <ul style="list-style-type: none"> <li>• Which international standards are applied for quality management of mission performance?</li> <li>• If none, how do you ensure competence of staff, request evaluation, validity of results, etc.?</li> </ul>  |
| 3.10 (ix) Technical cooperation and information exchange | <ul style="list-style-type: none"> <li>• How do you follow-up on technical cooperation efforts, i.e. such as finished IAEA Coordinated Research Projects (CRPs) and/or Technical Cooperation projects?</li> <li>• Have technical cooperation projects increased your utilization?</li> <li>• How do you assess the effectiveness of training and education? How is new expertise shared and being preserved?</li> </ul>   |
| 3.11 Objectives  |   |
| 3.11.1 Major objectives                                  | <ul style="list-style-type: none"> <li>• How was the priority setting done? Who was involved in this process?</li> <li>• If only bottom-up: do you have top-down commitment for getting the resources?</li> <li>• If only top-down: did you ensure that the objective is technically feasible?</li> </ul>   |
| 3.12 Action plans for specific objectives                | <ul style="list-style-type: none"> <li>• What resources do you have for doing the action plan?</li> <li>• Which feasibility studies were done?</li> <li>• How does the action plan(s) affect your current activities and current stakeholders?</li> <li>• How is the status of the action plan monitored?</li> </ul>  |
| 3.13 Review and status reporting                         | <ul style="list-style-type: none"> <li>• How do you keep track of your input for the KPI index?</li> <li>• Which alternative KPIs do you have/suggest?</li> </ul>   |

|                                 |   |
|---------------------------------|---|
| NES NG-T-3.16 section           | Questions for staff responsible for R&D, offering products & services, and users and other key stakeholders of the facility   |
| 3.14 Organization and personnel |   |
| 3.14.1 Organizational structure | <ul style="list-style-type: none"> <li>• How are research, development and services organized? Which instrument/facility specialists do you have?</li> <li>• How is the communication between researchers in R&amp;D and research reactor operations organized?</li> </ul>  |
| 3.14.2 Personnel development    | <ul style="list-style-type: none"> <li>• How do you assess/anticipate the needs for training R&amp;D and mission performance personnel, and what are your opportunities to realize these?</li> <li>• How do you evaluate the effectiveness of training?</li> </ul>  |
| 3.15 Financing                  | <ul style="list-style-type: none"> <li>• What is your budget for replacing/expansion of instruments?</li> <li>• What is your budget for personnel?</li> <li>• Is your budget adequate to meet your mission?</li> <li>• How do you determine the costs and price for use of the research reactor instruments/facilities and for products and services? Do you apply full cost recovery model?</li> <li>• How do external users and other key stakeholders contribute in the realization of new R&amp;D facilities?</li> <li>• For how many successive years is your budget assured?</li> </ul> |
| 3.16 Outreach and marketing     |   |
| 3.16.1 Outreach approaches      | <ul style="list-style-type: none"> <li>• Do you have brochures or other promotion material for outreach?</li> <li>• Where and at which occasions do you promote your research reactor capabilities?</li> <li>• Is the outreach organized for the entire facility or just the R&amp;D mission?</li> <li>• How frequently do you visit your external stakeholders at e.g. their own premises or somewhere else? How often did they visit your facilities?</li> <li>• Do you have technology transfer office support for your research reactor?</li> </ul>                                       |
| 3.16.2 Marketing methodologies  | <ul style="list-style-type: none"> <li>• How do you do your market assessment?</li> <li>• What is your business model and plan for market penetration?</li> <li>• Have you used professional assistance in marketing?</li> <li>• How do you assess the satisfaction and gather input from internal and external stakeholders?</li> </ul>  |
| 3.17 Change management          | <ul style="list-style-type: none"> <li>• After you perform a significant change, do you re-perform a SWOT analysis to ensure effectiveness?</li> </ul>  |

## I.4. QUESTIONS TO USERS AND ON UTILIZATION AREAS

### I.4.1. Questions on utilization areas

This list of questions is provided to guide the interviews and discussions on each utilization area of the research reactor, to address common issues in a similar systematic way for all utilization areas. The list is not exhaustive, and additional questions may be needed. Depending on the size and complexity of the operating organization, the questions may be directed at the senior management, staff responsible for research reactor operation, staff responsible for research reactor utilization, external users and other key stakeholders of the facility.

- How are users found?
- Who are and what is the relative weight of internal users, external users seen as partners, and external users seen as customers?
- What are the main scientific/research areas?
- What and how much products and services are provided?
- What is the current level of production (number of samples, activity of radioisotopes, kg of Si, etc)?
- Are available resources adequate for the current level of production (number of staff, funding, equipment)?
- What is the potential capacity? Is development of a new facility, acquisition of experimental equipment, or new staff or other resources needed?
- Which opportunities for growth or diversification are identified?
- Who is your competition?
- Do you have partnerships in this utilization area?
- How do you make outreach and marketing of this activity? Does the organization have information on the reactor's current and potential capabilities (e.g. a brochure, web site, etc.) available?
- What other constraints exist, e.g. administrative, technical, regulatory, legal?
- How does this utilization area fit in the overall priorities of the reactor?
- How do you see the evolution of this activity in the next 5 years?

### I.4.2. Questions to users and other key stakeholders of the facility

This list of questions is provided to guide the interviews and discussions with users and other key stakeholders of the facility. The list is not exhaustive, and additional questions may be needed.

- Are you aware of how nuclear applications can be useful for your purposes?
- Did anyone ask you about your needs?
- Do you know of other applications of your R&D/Product that the facility is not aware of?
- Are existing capabilities meeting your needs?
- Do you know the new capabilities that would enhance performance of facility?
- Do you plan to continue using this facility? If no, why not?
- Do you publish with the facility's in-house science staff? If no, why not?
- How do you operate with facility operators? Are you treated well?
- Is facility status readily available?

- Do you view this facility as key to your development /scientific research?
- Do you recommend this facility to your colleagues? If so, how?
- Does this facility host workshops that improve your collaboration / current research /subject matter expertise, etc?
- Do you have resources needed to conduct your work at this facility?
- Is your input solicited and valued by the facility staff?

**APPENDIX II.**  
**COMMON FORMAT FOR THE MAIN MISSION REPORT**

Executive Summary

1. BACKGROUND

- 1.1. Short description and history of the facility
- 1.2. Summary of the Pre-IRRUR mission
- 1.3. Objectives and scope of the mission
- 1.4. Basis for the review and documents provided by the counterpart

2. CONDUCT OF THE MISSION

- 2.1. Review criteria
- 2.2. Method of conducting the review

3. MAIN CONCLUSIONS

- 3.1. General findings
- 3.2. Utilization areas
  - 3.2.1. Utilization area 1
  - 3.2.2. Utilization area 2
  - 3.2.... Utilization area ...

- 3.3. Global assessment and prioritization of utilization areas

RECOMMENDATIONS, SUGGESTIONS, GOOD PRACTICES

ANNEX 1: AGENDA

ANNEX 2: LIST OF PERSONS MET DURING THE MISSION





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## ANNEX I. KEY PERFORMANCE INDICATORS

These KPIs are derived from those given for utilization in Annex IV of Nuclear Energy Series NG-T-3.16, Strategic Planning for Research Reactors, IAEA (2017). C15, D15 and D16 were added. The KPIs are to be provided for at least the last 3 years.

|  | 20xx | Year<br>20xx | 20xx |
|--|------|--------------|------|
| C. Utilization data  | 20xx | 20xx         | 20xx |
| C1 Neutron flux monitoring operation hours                           |      |              |      |
| C2 In-core irradiation (channels, rigs, loops, etc.) operation hours |      |              |      |
| C3 Pool side irradiation operation hours                             |      |              |      |
| C4 Pneumatic irradiation operation hours                             |      |              |      |
| C5 Material irradiation operation hours                              |      |              |      |
| C6 Radioisotope production operation hours                           |      |              |      |
| C7 Neutron scattering operation hours                                |      |              |      |
| C8 Neutron radiography operation hours                               |      |              |      |
| C9 Neutron activation analysis operation hours                       |      |              |      |
| C10 NTD of Si irradiation operation hours                            |      |              |      |
| C11 Gemstone irradiation operation hours                             |      |              |      |
| C12 Student training/experiment operation hours                      |      |              |      |
| C13 Operator training operation hours                                |      |              |      |
| C14 General guided tour/visit operation hours                        |      |              |      |
| C15 Medical R&D and patient treatment operation hours                |      |              |      |
| ...  |      |              |      |
| D. Utilization results   | 20xx | Year<br>20xx | 20xx |
| D1 Neutron flux monitoring, number of experiments                    |      |              |      |
| D2 In-core irradiation, number of experiments                        |      |              |      |
| D3 Pool side irradiation, number of experiments                      |      |              |      |
| D4 Pneumatic irradiation, number of experiments                      |      |              |      |
| D5 Material irradiation, number of experiments                       |      |              |      |
| D6 Radioisotope production, total activity in GBq                    |      |              |      |
| D7 Neutron scattering, number of experiments                         |      |              |      |
| D8 Neutron radiography, number of experiments                        |      |              |      |
| D9 Neutron activation analysis, number of samples                    |      |              |      |
| D10 NTD of Si irradiation, mass in kg                                |      |              |      |
| D11 Gemstone irradiation, mass in kg                                 |      |              |      |
| D12 Student training/experiments, number of experiments              |      |              |      |
| D13 Operator training, number of operators                           |      |              |      |
| D14 General guided tours/visits, number of events                    |      |              |      |
| D15 Education, total number of students educated                     |      |              |      |
| D16 Training, total number of people trained                         |      |              |      |
| ...  |      |              |      |



## ANNEX II. UTILIZATION SELF-ASSESSMENT

For those criteria that are numerical, the values are to be provided for at least the last 3 years, but the facility may decide to provide a longer period, up to 5 years. For each criterion, the facility elaborates a self-assessment based on the numerical values and other data and factors considered to be relevant.

- (1) Productivity:
  - (a) Publications, all related to research reactor, both internal and external (F6)<sup>1</sup>
  - (b) Isotope production quantities (with respect to capability and target amount) include R&D production (D6)<sup>1</sup>
  - (c) Number of activation samples and analyses (D9)<sup>1</sup>
  - (d) Kilograms of Si doped (D10)<sup>1</sup>
  - (e) Number of visitors or guided tours (D14)<sup>1</sup>
  - (f) Numbers of trainees, degrees achieved (D13, F7– F9)<sup>1</sup>
  - (g) Commercial income
  - (h) Services provided for national good or mutual benefit (G9)<sup>1</sup>
  - (i) Subscription rate: Number of research proposals received vs. proposals accepted; irradiation demand vs. irradiation space/time
  - (j) Internal competition of facility usage – e.g. Number of research groups vs. number of beam ports/instruments/irradiation spaces
  - (k) Number of experiments conducted (D1 – D4, D7, D8, D12)<sup>1</sup>
- (2) Vitality
  - (a) Succession plan
    - What is the succession plan for knowledge transfer between experienced and new staff?
    - Rate of recruitment vs retirement
  - (b) Age distribution of supervisors, operators and utilization scientists/researchers/engineers (histogram of number of people <30, 31-40, 41-50, 51-60, >60)
  - (c) Are the primary scientific endeavours growing in scope – Is the demand for your services increasing/decreasing/stable?
  - (d) Does the reactor have a clear future? (NG-T 3.16 Section 3.8.3)
    - Limiting factors for future of reactor (e.g. funding, operating license, fuel supply, national position, etc.)
  - (e) Does the scientific programme lead in technology development, e.g. instrument or method development?
  - (f) Is the research reactor an important link in a larger scientific effort?
- (3) Relevance
  - (a) Average H index of resident research staff (local, i.e. from the research reactor facility)
  - (b) Top 5 publications, as chosen by the research reactor facility
  - (c) Number of externally funded projects and total amount of external funding
  - (d) Number of engagements by international users
  - (e) Users, both internal and external (A3 and A4)<sup>1</sup>
  - (f) Number of positive national and international media articles/interviews
  - (g) Particular missions that make your country self-sufficient in the given utilization area
  - (h) Involvement in national/international strategic plans – stable funding for reactor operation and mission performance

- (i) Social-economic impact – contribution of your research reactor to socio-economic issues, e.g. medicine, agriculture, etc.
- (4) Quality
  - (a) Percentage of positive feedback from stakeholders
  - (b) Peer review feedback during scientific review
  - (c) Proficiency testing (Interlaboratory comparison) outcomes
  - (d) Number of publication citations
  - (e) Application of quality programmes to mission management (Number of applications/services accredited)
  - (f) Number of patents in recent years (e.g. 3-5 years)
- (5) Benchmarking-Outreach-Community Engagement
  - (a) Number of workshops hosted in last 3 years (At least 1 day long)
  - (b) Education efforts (Is the reactor included in university curricula?)
  - (c) Number of visits (and organization/country distribution if available) to research reactor website
  - (d) Novel applications of nuclear science
  - (e) Number of presentations (posters, talks etc) at international conferences
  - (f) Number of formal cooperative agreements such as memorandums of understanding
  - (g) Number of external assessments/benchmark visits
  - (h) Number of publications co-authored by resident staff and external users
- (6) Potential other users for your reactor
  - (a) Other mission applications for research reactor that have been considered
- (7) Constraints/Threats. Please note any concern on any of the following areas related to research reactor sustainability
  - (a) Regulatory environment
  - (b) research reactor design limitations
  - (c) Funding
  - (d) Public opinion/community support
  - (e) Ability to attract/recruit staff
  - (f) Ability to obtain new/different fuel and dispose old/spent fuel
  - (g) Governmental policy (local & federal & international)

<sup>1</sup> Reference to the items in Table (Annex) IV-1 in IAEA NG-T-3.16

## LIST OF ABBREVIATIONS

|         |  |
|---------|--|
| CRP     | Coordinated research project                                   |
| E&T     | Education and training   |
| INIR-RR | Integrated Nuclear Infrastructure Review for Research Reactors |
| INSARR  | Integrated Safety Assessment of Research Reactors              |
| IRRUR   | Integrated Research Reactor Utilization Review                 |
| KPI     | Key performance indicator                                      |
| MS      | Member State   |
| O&M     | Operation and maintenance                                      |
| OMARR   | Operation and Maintenance Assessment for Research Reactors     |
| R&D     | Research and development                                       |
| SP      | Strategic plan   |
| SWOT    | Strengths, weaknesses, opportunities and threats               |
| USAR    | Utilization self-assessment report                             |





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13–17 November 2017, IAEA Headquarters, Vienna, Austria  
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### **Pilot IRRUR mission**

Laboratory of Applied Nuclear Energy, University of Pavia, 1–5 April 2019, Pavia, Italy

### **IRRUR missions**

RECH-1, Chilean Nuclear Energy Commission, Chile, 4–8 July 2022, Santiago, Chile  
RP-10, Peruvian Institute of Nuclear Energy, 29 August – 2 September 2022, Lima, Peru  
SAFARI-1, South African Nuclear Energy Corporation, 21–25 November 2022, Pretoria, South Africa





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