IAEA
International Atomic Energy Agency

Guidelines for the Operation and Maintenance Assessment for Research Reactors (OMARR)

Vienna, November 2020

IAEA Services Series 44

GUIDELINES FOR THE OPERATION AND MAINTENANCE ASSESSMENT FOR RESEARCH REACTORS (OMARR)

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IAEA SERVICES SERIES No. 44

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INTERNATIONAL ATOMIC ENERGY AGENCY
VIENNA, 2020

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For further information on this publication, please contact:

Research Reactor Section
International Atomic Energy Agency
Vienna International Centre
PO Box 100
1400 Vienna, Austria
Email: Official.Mail@iaea.org

GUIDELINES FOR THE OPERATION AND MAINTENANCE ASSESSMENT FOR RESEARCH REACTORS (OMARR)
IAEA, VIENNA, 2020
IAEA-SVS-44
ISSN 1816–9309

Printed by the IAEA in Austria
November 2020

FOREWORD

The IAEA's Operation and Maintenance Assessment for Research Reactors (OMARR) peer review service provides advice and assistance to Member States, upon request, to improve the operation and maintenance (O&M) of their research reactors to reach high levels of reliability, availability and performance. OMARR peer reviews are available, upon request, to operating organizations in all Member States with research reactors under construction, in the commissioning stage or in operation.

OMARR missions are performance oriented and adopt approaches to O&M management that represent good practices. Recommendations and potential solutions are provided on items of direct relevance to O&M. OMARR considers all aspects of assessing the effectiveness of a research reactor's O&M programmes and experience feedback. The assessment considers the application of IAEA and international standards and related technical reports. Reactor O&M activities interact with a broad range of facility processes, including processes for which IAEA assessment guidance and information has been previously published. The guidelines provided in this publication address such processes only in their relation to the facility O&M.

The purpose of this publication is to provide information on the preparation, implementation and reporting of OMARR missions, including follow-up missions. The information provided may also be used for O&M self-assessment conducted by the operating organization of a research reactor facility.

The IAEA is grateful to all the contributors to this publication, in particular D. Jinchuk (Argentina) who led the preparation of this publication. The IAEA officer responsible for this publication was R. Sharma from the Division of Nuclear Fuel Cycle and Waste Technology

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1. INTRODUCTION

1.1.GENERAL BACKGROUND

For over six decades now, research reactors (RRs) have served an important role within several fields of the basic sciences; in the development of nuclear science and technology; in the production of radioisotopes for medical and industrial purposes; and in the development of human resources and skills. At present, according to IAEA's Research Reactors Database (RRDB)[2], 220 RRs are effectively utilized in supporting sustainable development within more than 50 countries worldwide. These RRs vary in type, design, power level, utilization, operation cycle, and management aspects.

The sustainability of the lifecycle of an RR is an issue of major concern. According to RRDB, approximately 60% of the operating RRs in the world are more than 40 years old. Adequate operation and maintenance (O&M) plans, as well as management system, need to be in place to ensure the optimization of operational performances of existing RRs. Considering the general trend of funding reduction for such facilities and limited reactor succession planning, development and implementation of sound O&M as well as life management programs are vital to ensure for the existing facilities a cost-effective completion of their assigned missions. Member States (MSs) are increasingly seeking IAEA's assistance in addressing the challenges related to sustainable operation and effective utilization of RRs as well as in building new and accessing existing RRs for developing their national nuclear programs and strategies, provision of diverse services and products, including for development of human capital.

To assist MSs to reach high operational standards and performance of their RRs, the IAEA has in place a service of peer review titled 'Operation and Maintenance Assessment for Research Reactors (OMARR). The aim of this IAEA service is to provide advice and assistance to MSs how to improve the operation and maintenance practices of their reactor facilities, thereby optimizing availability, reliability and the efficient application of human and financial resources throughout their facility's operational life cycle, from commissioning to preparation of decommissioning. This mission complements other IAEA's peer review services for RRs[3], such as the Integrated Safety Assessment of Research Reactors (INSARR), Integrated Nuclear Infrastructure Review for Research Reactors (INIR-RR), Integrated Research Reactor Utilization Review (IRRUR), etc., in order to assist MSs to enhance RRs performance.

OMARR missions might be also useful during or after a major refurbishment or modernization of a RR facility in identifying ways to improve O&M programs and procedures.

The OMARR Mission considers all aspects in assessing the effectiveness of a research reactor's O&M program and addresses the topical areas described in IAEA Nuclear Energy Series No. NP-T-5.4 [1] Optimization of Research Reactor Availability and Reliability-Recommended Practices. It identifies areas for improvement, addresses specific operational challenges, and creates a space for sharing experiences and good practices. An OMARR mission promotes exchange of knowledge and experience between international experts and

[2] www.iaea.org/resources/databases/research-reactor-database-rrdb

[3] www.iaea.org/services/review-missions

facility personnel, as well as development of self-assessment capabilities and continuous improvement of an RR facility. Moreover, special aspects of O&M for RRs are assessed by experts on a case by case basis.

OMARR missions are performance oriented and adopt approaches to O&M management that represent good practices and may contribute to ensuring a good operational performance including enhancing the availability and reliability of a RR facility. Recommendations and possible solutions are provided on items of direct relevance to O&M with a principal aim to improve RR performance. Though OMARR missions focus on operational performance, it may also have indirect influence on enhancing of RR safety. To extend the benefits of missions to the larger community of RRs, relevant O&M improvements, good practices and lessons learned identified at a given facility may be communicated (anonymously or facility specific) to other facilities after approval by the Operating Organisation of the reviewed facility.

OMARR Peer Reviews were initiated in 2012 with two pilot missions, one at National Institute of Standards and Technology (NIST) in the USA, and the other at the Applied Nuclear Energy Laboratory (LENA) of the University of Pavia in Italy. These reactors were chosen as pilots due to their difference in power, 20 MW versus 250 kW, and their volunteering to participate.

To date several OMARR missions have been undertaken and MSs show increasing interest in OMARR services. Hence, based on experience gained, it was thought necessary to have a guidance publication dedicated to OMARR missions.

1.2.PURPOSE AND SCOPE OF THIS GUIDE

The purpose of this publication is to provide guidance on the preparation, implementation, reporting of OMARR missions, including follow-up missions. 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 O&M self-assessment conducted by the Operating Organization (OO) of a RR facility.

1.3.STRUCTURE OF THIS GUIDE

This publication consists of three main sections and two Appendices. Section 1 presents introductory material on OMARR missions. Section 2 presents guidance on the preparation, conduct and follow-up for an OMARR mission. Section 3 presents detailed guidelines on the scope and review areas that may be covered in a comprehensive OMARR review. The guidance is structured to permit a review plan and program to be structured according to the needs of the requesting OO and as defined in the Mission scope and review. Appendix I provides a questionnaire for OMARR mission reviewers assessment, as well as for the OO to conduct a self-assessment evaluation prior to the missions. Appendix II provides the general format of the main OMARR mission report, and guidance on the information the report should include for each area reviewed.

2. CONDUCT OF OMARR MISSION

2.1. GENERAL

The aim of this IAEA service is to provide advice and assistance to MSs to improve the O&M practices of their RRs thereby enhancing availability, reliability and utilization time throughout its operational life cycle.

OMARR missions are available to OOs in all MSs with RRs in operation.

A three-stage approach is used for a complete OMARR mission[4]:

- A pre-OMARR mission to present the OMARR methodology, to discuss and define with the host organization the topics to be reviewed and the information to be provided to the IAEA before the main mission;
- The main OMARR mission to conduct the review and provide a report on the findings;
- A follow-up OMARR 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 OMARR and provide guidance on mid-course correction in case of new issues encountered.

OMARR missions are initiated with a formal request from the MS OO to the IAEA.

Subsequent to the pre-OMARR mission and prior to the conduct of the main OMARR mission, it is strongly recommended that the facility conducts a self-assessment of their O&M status and practices to identify potential weaknesses, as well as strengths, to be discussed with the main OMARR mission team during its visit.

In the planning and preparation for an OMARR mission, it is important that tasks and activities specifically related to RR O&M are the subject of review. Reactor O&M activities interface across a broad spectrum of facility topical areas like, safety [2],[3], radiation protection [4], ageing management [5] and waste management [6], which are also 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 O&M (such as availability and reliability). The planning of the OMARR mission should recognize missions for these other topics may be independent of, or in conjunction with, an OMARR mission.

Necessary funding arrangements should be discussed and agreed upon between the requesting MS counterpart and the IAEA before scheduling an OMARR mission. The funding available from the IAEA varies on a case-by-case basis. For some OMARR 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 MS counterpart may be asked to provide local transportation for the review team members, expedite local

[4] www.iaea.org/sites/default/files/omarr.pdf

administrative arrangements and logistics and, in some cases, contribute towards local accommodation costs.

2.2. PRE-OMARR MISSION

2.2.1. General

Any peer review, regardless of the defined scope and necessary resources, must have adequate preparations prior to any visit to the facility. The success of a specific assessment and the efficiency with which personnel, time and financial resources are used depend on the attention which has been given to the mission preparation.

2.2.2. Objective

During the pre-OMARR all the details are determined to ensure that the main OMARR mission is carried out effectively, and to reach a common understanding on its scope and how to conduct it.

2.2.3. Preparations

The implementation of an OMARR mission starts with a pre-OMARR mission. This generally takes place 4 to 12 months prior to the main OMARR mission, is typically of a 2 to 3 days duration and is conducted by one or two IAEA staff members and one or two external experts.[5]

The team members discuss the main features of the main OMARR review, the scope of the review, 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 at site

The pre-OMARR mission team and the Operating Organization will jointly conduct the pre-mission meeting at the reactor site which should include:

1) Introduction and main features of the overall OMARR mission

2) Presentation by facility managers including:

    a) Overview of the facility design and modifications

    b) Overview of the operation and maintenance aspects, including performance

    c) Future plans for operation and utilization

    d) Upgrades, modification and refurbishment plans

    e) O&M issues for which the Operating Organization requests particular attention during the main OMARR mission review.

[5] It is preferred but not mandatory, that all or part of the pre-mission team members also are members of the main mission team for efficiency and continuity of the review.

3) Presentation by pre-OMARR mission team on experience feedback from previous missions in other MS.

4) Walk-through of the facility

5) Preparation of the plan for main OMARR mission including:

   a) Scope of the mission indicating the topics/areas to be reviewed

   b) Overview of the advance information and documentation package to be provided prior to the main mission and timetable for its availability

   c) Logistic support and financial arrangements

   d) Work plan for the Operating Organization and for the IAEA to be completed before the main mission

   e) Agenda and work plan for conduct of the main mission.

   f) Reporting during and at the end of the main mission

2.3. MAIN OMARR MISSION

2.3.1. General

The main OMARR mission is conducted typically 4 to 12 months after the pre-OMARR mission.[6] It may have a duration of 5 to 7 days depending upon the size of the facility and issues identified during pre-OMARR mission.

2.3.2. Preparations

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

2.3.2.1. Selection of main OMARR 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 be, usually, an IAEA staff member with broad experience in all aspects of RR facilities.

The main mission team may consist of one or two IAEA staff members and two to four experts depending on the type of facility, mission scope, and expertise needed, etc.

[6] The time gap between the pre-mission and main mission may be greater depending upon the proposed scope of the review and planned activities and operation schedules of the facility to support the review.

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

- Independence;
- Expertise and experience in the topics to be reviewed;
- Familiarity with the standards, guides and other IAEA publications that form the basis of the review;
- Familiarity with the type of facility to be reviewed;
- 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 commercial conflicts from staff of a competitive facility, or private company. Observers can be invited, but only with the mutual agreement of the IAEA and the Operating Organization.

The mission team members should be recruited considering their experience with similar facilities and with the topics that they will review. Therefore, the assignment of specific tasks within the review team should be made in accordance with the special competencies 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. Advance information/documentation package for the mission review team members

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-mission meeting.

The information and documentation package should provide to the mission team leader all agreed information, based on the review areas of the main mission, to facilitate adequate technical preparation. The team leader then co-ordinates the distribution of the advance information package prior to the main mission to the team members. The team leader also provides the agenda and work plan, at the same time, to the team members. Since the team's preliminary review of the documentation can influence the working plan for the review, the information and documentation package should be obtained and distributed about a month before the main mission to permit timely finalization of the agenda and working plan.

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

- List of documents included in the advance information package.
- General description of the main technical, nuclear, thermal-hydraulic and operational characteristics of the research reactor

- Results of any recent (2-3 years) self-assessments of the research reactor O&M status and practices
- The performance reports of the facility for last 4-5 years
- Organizational chart of the organization
- Status of Management System
- The Quality Assurance program and Internal Audit reports
- The procedures for conduct of operations, maintenance and modifications
- Status reports on Non-Destructive Examination (NDE), In Service Inspection (ISI) and Ageing Management Program
- Report on implementation of recommendations of regulatory inspections and previous expert or peer reviews of O&M
- Procedures for training and qualification of plant personnel.

During the conduct of main mission, the initial advance information and documentation package may be supplemented with additional information as required to support the mission reviews and the subsequent written report(s). Maintenance, test and operational records, operational procedures, operational flow sheets, drawings of buildings, systems and equipment, and electrical and instrumentation schematics would be typical of this type of additional information.

2.3.2.3. Agenda and work plan development

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

The team leader develops an initial expanded plan and then members of review team, as well as the host organization, are consulted and involved in the finalizing of the agenda and work plan by the team leader. Proper planning should ensure that all tasks will be executed according to procedures and 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 provided by the team leader should comprise, as a minimum:

- Mission objectives, scope and expected output;

- Work plan for the mission;
- Timing of the assessment activities, including hold points, together with any interdependence identified;
- References to relevant IAEA standards, guides, and other documents, 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 provided by the team leader to the host organization for approval, in advance of the main mission, such that the counterpart 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 approved final agenda and work plan, prior to commencement of the main mission.

2.3.2.4. 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,
- Provision of local transport for the team,
- Meals during the working hours,
- Working room for team members,
- Internet / photocopying / printing in the facility,

2.3.2.5. 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 e-mail 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 mission at site

2.3.3.1. Activities

From the preliminary review of the advance information documentation package, the team members will have some knowledge of the facility and the mission scope. Depending upon the extent and quality of the mission-specific documentation provided by the counterpart and the

review preparation time, the team will also have some specific information on the condition of the facility. The team leader should have reviewed the 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 OMARR team members, observers (if any) and counterparts and a review of the agenda details. The OMARR team will acquire mission information by review of documentation, interviews with facility staff, facility walk-through and direct observation of activities and status of systems and equipment. Throughout the mission, detailed discussions with the counterparts of the host organization are carried out to ensure an understanding of identified issues in order to formulate recommendations for improvement.

The OMARR team should meet each morning with the counterparts and alone during the evening to discuss the daily activities and to develop a consensus on emerging issues. These discussions of the team help to ensure that all members are well informed of the progress of the review and benefit from the observations of other members. These meetings are also an opportunity for the team leader to review, if needed, the mission methodology and agenda compliance. Those issues for which the team has reached consensus are presented to the counterpart, preferably at the next morning meeting giving the facility representatives an opportunity to express their views regarding the issues.

As the assessment proceeds, each team member drafts a summary on their review area and findings, which could be presented in the form of an issue page (see Appendix II) 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 assessment phase, 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.

2.3.3.2. Scope

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

a) Entry meeting of the OMARR mission team and operating organization

b) Facility walk-through and observations of on-going activities.

c) Examine O&M documentation of the reactor facility to compare program implementation with procedural guidance:

- Review operational records and performance of the reactor, if possible observing operations such as start-up and shutdown

- Review maintenance records, computer-based systems for routine maintenance and breakdown maintenance support, if possible observing maintenance practices and reporting such as routine calibrations, and breakdown servicing of major equipment

- Review training records and, if possible, observes classroom, simulator or on-the-job training in practice

d) Discuss technical and procedural details with the responsible personnel, operational engineering and maintenance staff.

e) Exit meeting.

A description of these activities is provided below:

2.3.3.2.1. Entry meeting with counterpart and facility technical staff

Prior to starting the mission, the counterpart, facility staff and others who may be involved in the team's activities, must 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:

a) Introduction of the team members to the counterpart;

b) The needs of the team, especially for technical documentation and staff communications;

c) The method of communicating and reporting the interim- and final-results of the review;

d) 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 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 main mission report.

2.3.3.2.2. Facility Walk-through

Direct observation of the research reactor facilities via a walk-through to observe reactor Structures, Systems and Components (SSCs) is an important aspect of the review process. Observation of the RR facilities is intended to allow the review team to obtain a general appreciation of the reactor conditions and the visual status of the SSCs. Being part of the observations of the general condition of the SSCs, the walk-through should extend to support facilities and structures outside the reactor building such as emergency power supplies, cooling water supplies, spent fuel storage facilities and laboratories.

Appendix I provides a checklist for a facility walk-through. The list is not intended to be used as part of a strict audit process, but rather as a guide to assist the reviewer during a walk-through.

2.3.3.2.3. 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.

2.3.3.2.4. Discussions

Discussions with the management, operating staff and other reactor support staff provide important inputs for the review. The discussions should be used to:

a) Obtain additional information not covered by the available documentation;

b) Obtain answers to questions and clarify issues that may have arisen from the documentation review, observations of operational activities and the facility walk-through;

c) Identify methods and approaches for O&M staff training.

Discussions with the facility staff are to be used to exchange information between team members and counterparts. 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.

2.3.3.2.5. Exit Meeting

Before the review team leaves the research reactor facility, an exit meeting is conducted during which the team leader orally conveys the main recommendations and areas of good practice to representatives of the operating organization. A team meeting is conducted prior to the exit meeting, during which the results of the team member's individual assessments are discussed and consolidated.

The attendees at the exit meeting are determined by the counterpart organization. As a minimum, those with significant executive responsibilities for the O&M 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 and 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 indicating censure for significant events which may have been discussed, or for very negative findings.

During the exit meeting, commitment and follow-up actions necessary to enhance O&M may be discussed but it is up to the host organization to decide on its response to the formal 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.

2.3.3.2.6. Outputs and Reporting

While conducting the review, team members should provide written notes on the main issues found during their reviews. These notes form the basis for discussions during the daily meetings of the team members, as well as the basis for preparation of the mission report, which should contain details on the facts, recommendations, suggestions and good practices observed by the team members (see Appendix II).

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.

2.3.3.2.7. Mission Report

Following the mission, the executive summary report is developed into a final mission report, in order to provide a permanent record of the review. The final OMARR mission report is normally prepared under the responsibility of the team leader, who will co-ordinate the production of the report with the team members. The counterpart is provided with a draft copy during final review to check that technical information related to the facility is correct and to provide counterpart views on the findings for the individual issues in case resolution of these findings were not completed during the mission discussions.

The format of the main OMARR mission report is provided in Appendix II. Chapter 1 of the report provides background information on the facility and the OMARR mission scope. Chapter 2 describes the method of conducting the review, the review criteria and the results of the facility walk down. 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.

Appendix 1 of the mission report contains note pages covering the issues in each of the review areas in the scope of the mission. The note pages include observations, references, counterpart views on the findings, recommendations, suggestions and good practices. The final mission report also contains annexes that include the mission agenda and a list of the persons contacted/interviewed during the mission.

The final OMARR 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. However, the facility may wish to use and promulgate the document in an unrestricted manner.

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 improving O&M performance and focusing on how to resolve identified deficiencies in performance, addressing root causes rather than the effects of the issues. 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 indirectly contribute to improvements in O&M performance. 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 OMARR MISSION

2.4.1. General

The follow-up OMARR 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 and the size of the follow-up mission team depends upon the scope of the mission and it is decided by the IAEA team leader who conducted the main mission in consultation with facility management.

2.4.2. Objective

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

2.4.3. Preparations

The follow-up OMARR 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 OMARR mission team, for revision as a part of preparations before the mission:

a. Action plan for implementation of main OMARR mission recommendations and progress report

b. Brief report on difficulties faced in implementation of main OMARR mission recommendations and needs for mid-course correction

c. Any new requirements for upgrades or improvements including recommendations of safety authorities or regulatory body.

2.4.4. **Scope**

The follow-up OMARR team and operating organization should jointly conduct the mission at site which should include:

a. Presentation by the facility staff on progress in implementation of main OMARR mission recommendations covering the areas which need attention for review.

b. Walk-through of the facility including areas where modifications, recommended in the main OMARR mission, have been carried out or are in progress.

c. Discussion and identification of main mission findings which needed correction.

d. Review of fresh issues and advice on modification of action plan as necessary.

e. Exit meeting

f. Reporting

3. GUIDELINES FOR ASSESSMENT OF REVIEW AREAS

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

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

Main OMARR team and facility management should jointly conduct the mission covering at least but not limiting to the following areas:

3.1.STRATEGIC PLAN

Elements of this section are based on Ref. [1] [7]

Objective:

To provide a basis for assessing the vision, mission and strategic goals of the operating organization and effectiveness of RR O&M plans in meeting the requirements of strategic plan of the facility.

Guidelines:

The OMARR mission should review

- The purpose, utilization and services that the reactor facility provides.
- The needs of stakeholders and their fulfilment.
- Facility needs and their fulfilment.
- An established reactor schedule has been prepared taking into consideration facility needs and stakeholder expectation, and is communicated to all stakeholders
- The facility has a supportive action plan aligned with the strategic plan.
- Major capital upgrades and refurbishments are identified.
- The organization has adequate financial sustainability plans.
- That the facility has an asset management policy and strategic asset management plan (SAMP).

3.2.DESIGN CONSIDERATIONS FOR OPERATIONS AND MAINTENANCE

Elements of this section are based on Ref. [1][8]

Objective:

To provide a basis for assessing that the design of the facility enables the achievement of the strategic plan, including availability, reliability, product and service targets. This includes current facility design and any future upgrades or facility modifications.

Guidelines:

3.2.1. Compliance with current design requirements

The OMARR mission should review:

- That the current practice of O&M at the facility is justified and complies with the facility design requirements.
- That the documentation of the design features shows that is appropriate to not adversely impact availability and reliability.

3.2.2. Design for availability

The OMARR mission should review:

- The design has adequate flexibility incorporated such that availability targets can be achieved. This may include, if needed, but is not limited to:
    - Ability to perform necessary maintenance during operation;
    - Fuel cycle and refuelling requirements within the reactor cycle;
    - The capability to manage spent fuel with the reactor during operation, including potential shipment;
    - The ability to perform physical changes on the reactor during operation;
    - The ability to perform testing and inspection;
    - The ability to load and unload target materials or perform experiments with the reactor during operation

3.2.3. Design for reliability

The OMARR mission should review:

- The design has adequate flexibility incorporated such that reliability targets can be achieved. This may include but is not limited to:
    - Reliability of current SSCs, subcomponents and failure modes;

- Incorporations of lessons learnt from other organizations on SSC reliability improvements;
- Reliability of support services such as electrical supply, compressed air, water supply.
- The capability to test SSCs as required;
- The ability to inspect SSCs as required

3.2.4. Design for maintainability

The OMARR mission should review that the design considered appropriate accessibility to SSCs, adequate shielding of SSCs, remote handling, SSCs decontamination spares and required tools without impacting availability and reliability.

3.2.5. Review of the design for integration of modifications and upgrades

The OMARR mission should review:

- The operating organization have processes to identify and integrate necessary upgrades or refurbishments into the existing facility with minimal adverse availability and reliability impacts. These considerations include but are not limited to:
  - Development of adequate additional procedures;
  - Manuals of facility upgraded systems from original equipment manufacturers, experience feedback for incorporation in facility documentation/configuration systems.

3.2.6. Classification of SSCs

The OMARR mission should review:

- The facility SSCs are classified in a manner that supports the facility availability and reliability targets. This classification may include:
  - Integrated Logistic Support or Critical equipment/spares management taking into consideration the lead time and financial requirements to obtain the SSC.
  - Documented process for SSCs to be maintained during normal operation based on impact and or risk it imposes on reactor availability

3.3.MANAGEMENT SYSTEM

The elements of this section are based on Ref. [9]

3.3.1. Management responsibility

Objective:

To provide a basis to assess the commitment of senior management for the Management System to the O&M performance. This includes the setting of general objectives and plans; a clear understanding and communication of roles and responsibilities to the operation; the availability of information at different staff levels.

Guidelines:

The OMARR mission should review the following:

- Senior management develops and disseminates throughout the organization a documented set of policies that establish the management's plans, objectives and priorities about safety, health, environmental, quality and economic considerations.

- Responsibilities and authorities are clearly assigned; it is ensured that the individuals have the capabilities and the appropriate resources to discharge these responsibilities effectively.

- Through the organizational structure, individuals are aware of and accept their responsibilities, and they know how their responsibilities relate to responsibilities of others in the organization.

- The individual(s) having responsibility for the management system have the authority to raise issues relating to the management system for reporting at senior management level.

- Job descriptions for each function within the organization are available. This includes a definition of the specific competences required for each function defined within the organizational chart.

- A documented procedure is in place for control of documents. This includes a description on the preparation, review, approval, issuing, distribution, revision and validation of documents. Review that individuals involved in preparing, revising, reviewing or approving documents have demonstrated competency for this task. Review that users of documents are aware of and use appropriate and current documents. Review external documents relevant for the organization are kept under appropriate control

- A process for records control is established. In this process records are categorized; registered upon receipt; readily retrievable; indexed and placed in their proper locations in the files of the record facility with the retention times clearly specified; stored in a controlled and safe environment; stored in appropriate storage media such that they remain unchanged under normal circumstances.

- There is a clear process for identification and disposal of unnecessary documents, as applicable.

- The facility has a process to administer procedural use and compliance.

3.3.2. Resource management

3.3.2.1. Human resource management

Objective:

To provide a basis for assessing the management of human resources at the facility. Typical requirements of the program for personnel training and retraining at research reactor are provided in [10].

Guidelines:

The OMARR mission should review the following aspects:

- **Planning**. The amount of resources necessary to carry out the activities of the organization is determined.

- **Succession planning**. Future needs for competence of the organization are taken into account such as future demands in relation to strategic and operational plans and objectives; as well as anticipated needs for succession for the management and the workforce.

- **Recruitment, selection and appointment**. Procedures for selection of personnel is available and includes definition of initial requirements for organizational function, including:[7]

    - Reactor Operators
    - Reactor Shift Supervisor
    - Reactor Manager
    - Maintenance personnel (Mechanical, Electrical, Instrumentation and Controls)
    - QA personnel
    - Engineering
    - Support services

- **Training and qualification**. Examine the facility training and qualification program. Review that the competence requirements for individuals at all levels are identified and

[7] These positions may not be present or may be combined for small reactor facilities.

a training program to achieve the required level of competence is planned. Review that there is adequate provision of resources for training.

- Review that the effectiveness of training and qualification process is evaluated at the facility.
- Review training records and certificates.
- Review the qualification process of operators includes theoretical knowledge and walk through assessment appropriate for the facility.
- Review the training and qualification process in case of temporary workers or outsourcing utilization. Review that training needs are evaluated and training activities carried out at the necessary level of competency for the intended work.

- **Re-qualification**. Review if the facility conducts re-qualification on a regular basis. sufficient to support facility requirements. Review if requalification of operators based on absence from duty for an extended period is taken into account.
  - Review if re-training is conducted on a regular basis sufficient to support facility work processes;
  - Review whether training is provided in cross cutting areas not specifically required for a position.
  - Review if the training plan of the organization is subject to ongoing review to determine its effectiveness.

3.3.2.2. Measurement, Equipment and infrastructure

The review of resources related to measurement, equipment and infrastructure are discussed in section 3.6, Maintenance.

3.3.2.3. Finance resources

The review related to finance resources management is discussed in section 3.1 Strategic Plan.

3.3.3. Process Implementation

Objective:

To provide a basis for the assessment of the process implementation as identified in the scope of the Management System. In this respect, 'process implementation' is referred to as the 'production' or ''realization' process of the organization. It may refer to the processes required to perform activities and to ensure the fulfilment of objectives and requirements. Additional explanation of the terminology can be found in [9].

This area includes also the assessment of a set of generic support processes.

Guidelines:

3.3.3.1. Generic management system processes

Control of products/services

- The OMARR mission should review that:
    - Production process is carried out under controlled conditions. This may include verification of production i.e. planned vs actual, design and development of new products/services (such as new experiments, irradiations, training courses, etc.), authorizations, handling and release of irradiated products, communication with the users/stakeholders, etc.
    - Proper activities are in place for inspection, testing, verification and validation of products during implementation of the production process and before the acceptance or release of products.
    - The tools and measuring equipment used for the above mentioned activities are of the proper range, type, accuracy and precision and are under control by means of a dedicate program.
    - Products are uniquely identified to ensure their traceability and correct use.
    - Products are handled, transported, stored, maintained and operated according to specification in order to prevent their damage, loss, deterioration or inadvertent use.

Additional information about implementing the control of products can be found in [9][11]

Procurement

The OMARR Mission should review that:

- Suppliers of products are selected and their performances are evaluated based on specified criteria i.e. a documented supplier evaluation and qualification process.
- Purchasing requirements are identified, verification that requirements have been met is carried out before the purchased product is used, and records of the purchasing process including final verification are available.
- A procedure is in place for reporting and handling non-conformances within the procurement process as well as determining acceptance criteria of components deviating from original requirements.

Additional information about managing a typical purchasing process can be found in [9][11].

Communications

- The review areas related to the communication process are discussed in section 3.4 Communication.

Managing organizational change

The OMARR Mission should review that:

- In case organizational changes are needed, their impact on reactor availability and reliability is evaluated and changes are identified accordingly.

- Organizational changes are planned, controlled, communicated, monitored, tracked and recorded to ensure that availability and reliability is not compromised.

Additional description of managing organizational change is provided in Ref. [12].

3.3.3.2 Common Processes

A set of other process common to all research reactor can be identified and addressed during OMARR mission including but not limited to:

- Project management
- Supplier / Quotation qualification
- Preparation of technical reports
- Numerical calculations
- Incoming and outgoing correspondence
- Archiving
- Software administration
- Administration and maintenance of equipment and installations (for review refer to section 3.3.2, Resource Management review area)
- Operation of installations and laboratories (for review refer to section 3.5.3 of Operation review area)
- Handling of radioactive waste (for review refer to section 3.5.4 of Operation review area)
- Health, safety and environmental aspects of operations. (for review refer to section 3.5.4 of Operation review area)
- Deviations from normal operation (for review refer to section 3.5.5 of Operation review area)
- Emergency Procedures (for review refer to section 3.5.5 of Operation review area)

Guidelines for some of the above mentioned processes are provided in the present publication in the review areas they refer to. Information useful for better understanding and examples about how to develop the remaining processes can be found in Ref [9] [11].

3.3.4. Performance measurement and monitoring, assessment, and improvement

Objective:

To provide a basis for assessing the process of measuring and monitoring performance, including the effectiveness of the management system to confirm the ability of the processes to achieve the intended results and to identify opportunities for improvement.

This area can also be assessed during the OMARR in order to evaluate the performance monitoring process for individual areas of interest (such as operational performance monitoring, maintenance performance monitoring, radiation protection program performance monitoring, etc.).

Guidelines:

3.3.4.1. Measurement and monitoring of the Management System Performance

The OMARR mission should:

- Review the process of performance measuring and monitoring of the Management System. This includes but is not limited to the following:
    - Verification that standards of performance, directly related to the product provided by the organization and based on the objectives set by Senior Management, are established
    - Verification that performances are measured against the established standards. Measurement can be based on performance indicators or other appropriate methods of measurement.
    - Verification that performance measurements results are monitored regularly to indicate trends and detect whether improvements in the quality of the product or process are necessary.

3.3.4.2. Audits and Assessments of the Management System

- Review how the organization carries out the self-assessment process
    - Discuss how the Senior Management and management at all other levels in the organization carry out self-assessment to evaluate the performance of work. The guidance for conduct of a proper self-assessment is provided in Ref. [9] [11]
- Review the process of independent assessment and internal audits. This process includes the following:
    - Internal Audits are conducted regularly on behalf of senior management. Internal Audits program carried out should address the effectiveness of processes in fulfilling goals, strategies, plans, objectives; and to identify opportunities for improvement.

- An organizational function is established with the responsibility for conducting independent Internal Audits.
- A schedule of internal audits is established and endorsed by the senior management.
- Individuals conducting Internal Audits do not assess their own work.
- Senior management evaluates the results of the independent assessments and takes any necessary actions.

- Review that the organization conducts periodic Management system reviews, including the following:
  - A management system review is conducted at planned intervals to ensure the continuing suitability and effectiveness of the management system and its ability to reach the objectives of the organization to be accomplished.
  - Typical input and output of the Management review are provided in Ref. [9][11] and can be used as a guideline during OMARR assessment.
  - The output of the Management review are identified, such as to determine any need to make changes to reviewed policies, goals, strategies, plans, objectives and processes.

3.3.4.3. Non-Conformances, Corrective Actions and Preventive Actions

- Review the implementation of Non-conformances, Corrective Actions and Preventive Actions management:
  - A documented procedure exists for handling of Non-conformances (NC), and assures that NC are properly identified, recorded, and managed.
  - A formal reporting system of NC is implemented.
  - Categorization of NC based on their impact on reactor operation, safety, performance is in place.
  - A documented procedure for Corrective Actions (CA) for eliminating NCs is available and implemented.
  - A documented procedure for Preventive Actions (PA) to eliminate the causes of potential NCs is available and implemented.

Principles of NC, CA, PA are detailed in Ref. [11] and can be used as guideline during OMARR.

3.3.4.4. Continual Improvement

- Review that the organization implements a continual improvement of processes, including the following:

- Opportunities for the improvement of the management system are identified and actions to improve the processes are selected, planned and recorded.
- Improvement plans include plans for the provision of adequate resources.
- Examples of continual improvement actuated within the organization at different levels (working level, process level, organizational level)
- The scheme the organization utilizes to actuate an improvement plan. This may include aspects such as reason for improvement, current situation analysis, possible solution, evaluation of effects, implementation and standardization of a solution, evaluation of the effectiveness and efficiency of the solution.

3.4.COMMUNICATION

The elements of this section are based on Ref. [1]

Objective:

To provide a basis to assess the effectiveness of communication to stakeholders important to the facility operation. Engaged stakeholders may be influential both positively and negatively in impacting availability and reliability.

Guidelines:

3.4.1. Visits

The OMARR mission should review that:

- There is a program for conducting facility tours.
- Possible target groups are identified.

3.4.2. Internal communications

The OMARR mission should review that:

- There are routine and sufficient meetings, awareness sessions, staff forums or other forms of internal communication such that staff are informed of facility activities and are engaged.
- The lines of communication within the organization are clearly defined and indicated in the organizational chart

3.4.3. External communications

The OMARR mission should review that:

- There is transparent and consistent communication provided to stakeholders.

- There is active community outreach by the facility to inform public about the facility activities.

3.4.4. Peer networking

The OMARR mission should review that:

- The facility actively participates in peer networking opportunities. This may include but is not limited to IAEA meetings, industry collaborations, research reactor working groups.

- Retired and senior personnel of the facility are engaged or consulted if needed /as required

3.5.OPERATIONS

The elements of this section are based on Ref. [1]

3.5.1. Fuel Cycle

Objective:

To provide a basis to assess fuel inventory is sufficient to ensure availability and reliability of the reactor in accordance with the strategic plan. Fuel utilization, storage and ultimate disposition may also impact the facility strategic objectives.

Guidelines:

3.5.1.1. Front end

The OMARR mission should review that:

- The facility has appropriate access to fresh fuel in order to meet its strategic objectives.

- The facility has considered diversification of fresh fuel supply or has appropriate risk management strategies in place.

3.5.1.2. Core utilization

The OMARR mission should review that:

- The facility has appropriate competency available for undertaking core management planning and configuration in order to support the reactor schedule.

- There are controls for the movement and management of fuel.

- Optimum utilization of the reactor fuel is in place

- Adequate failed fuel handling and management is in place

- The facility has adequate storage to defuel the core if required

3.5.1.3. Back end

The OMARR mission should review that the reactor facility has an ultimate disposal route for their spent fuel or has sufficient permanent storage capacity available in order to not adversely impact reliability or availability for the anticipated remaining operational lifetime.

3.5.1.4. Non-uranium bearing strategic materials

The OMARR mission should review that the facility has a robust and sustainable supply chain of materials in order to facilitate the ongoing supply of products and services in accordance with the facility strategic plan. This may include but is not limited to target materials for radioisotope production, in core materials, rigs, tooling and reactor canning materials, irradiation vials, chemicals required for operation (e.g., pH control).

3.5.2. Conduct of operations

Objective:

To provide a basis to assess conduct of operations including that operation of the reactor facility is performed in accordance with the prepared and developed reactor schedule. Appropriately trained and authorized reactor operational personnel ensure that the reactor facility is kept in accordance with the approved design configuration which may have a significant impact on availability and reliability.

Guidelines:

3.5.2.1. Development of the Reactor Schedule

The OMARR mission should review that there is an established practice/process to develop and issue the reactor schedule well in advance in accordance with the strategic plan. Depending on the needs of the stakeholder needs for the facility, this may need to take into consideration maintenance, fuel cycle, Operating and Limiting Conditions (OLCs), internal and external production services, and other external influences on a schedule.

3.5.2.2. Maintaining effective control for the conduct of operations

The OMARR mission should review that:

- There is a process whereby authority levels are clear for reactor operating staff including but not limited to Shift Supervisors, Reactor Operators, and Plant Operators.
- Appropriate operational procedures are in place for reactor state/mode changes.
- There is an appropriate and effective process for releasing SSCs for maintenance and returning them to reliable operation.
- Appropriate record keeping for operational data is in place.
- The facility has appropriate processes in place for chemical control of applicable systems

- There is a process for internal feedback, assessment and periodic review for conduct of operations

3.5.2.3. Radiological Monitoring and Protection

The OMARR mission should review that:

- The facility has in place approved radiological protection manual/procedures.

3.5.2.4. Minimum Staffing

The OMARR mission should review that:

- There is sufficient staff available to meet minimum staffing requirements.
- There are appropriate plans in place to manage succession of reactor operating staff.
- There is a program of re-qualification for operating staff such that availability and reliability is not adversely affected.

3.5.2.5. Surveillance, monitoring and trending

The OMARR mission should review that:

- There is a program of surveillance, monitoring and trending analysis of critical operational parameters.
- The facility has mechanisms for monitoring instrument checks, functional checks and response checks /calibrations.
- There is a process for implementing short term or temporary surveillance, trending and monitoring of abnormal states and conditions of SSCs as applicable.

3.5.3. Operation of Installations and laboratories

The OMARR mission should review that installations and laboratories that could affect the operation of the reactor facility are available and appropriately controlled.

3.5.4. Handling of Radioactive Waste

The OMARR mission should review that:

- There is a process in place for minimization, handling and transfer of solid waste, liquid and gaseous effluents.
- There is a procedure in place for the categorization and quantification of generated waste.
- The facility has a program in place for monitoring and trending of the solid waste, liquid and gaseous effluents

- The handling of radioactive waste is efficient and optimized upon expectations.

3.5.5. Deviations from normal operation

The OMARR mission should review that:

- Deviations from the standard operating configuration, reporting and actions to revert to normal condition affecting availability are in place
- Root cause analysis of deviations from the standard operating configuration and corrective / mitigatory actions to prevent recurrence are in place
- Procedures for anticipated operational occurrences are in place.

3.5.6. Utilization

The OMARR mission should review that:

- There are appropriate controls in place to ensure that utilization activities will not adversely impact on reactor availability and reliability. This includes but is not limited to:
    - Undertaking irradiations
    - Experimental facilities
    - Test facilities
    - Education and training activities with the reactor
- The facility has a process for reporting when utilization requirements are fulfilled / met

3.5.7. Operational Performance Monitoring

The review of the Operational Performance Monitoring should be conducted in accordance to what is described in 3.3.4 for the process of performance measuring and monitoring.

The OMARR mission should review that:

- There is a program of operational performance evaluation. Examples of key performance indicators include:
    - Availability (target versus actual operating time)
    - Reliability (schedule compliance)
    - Power level (planned vs actual)
    - Completion of shutdown activities tracking (shutdown plan vs post shutdown completed activities)
    - Unplanned trips/shutdowns

- Utilization (planned experiments/hours vs actual)
- Maintenance or modification backlog
- Maintenance or modification rework
- Completion of ageing modifications
- Incidents, events and deviations
- Time span in operating modes

3.6.MAINTENANCE

The elements of this section are based on Ref. [13].

3.6.1. General

Objective:

To provide a basis to assess that facility SSCs function in accordance with design intents and requirements in order to provide confidence for the availability and reliability of the reactor.

Guidelines:

The OMARR mission should review that:

- A systematic maintenance program is in place and consists of predictive, preventive, and corrective maintenance categories. These categories may include condition monitoring, off-service and in-service inspections, testing, SSC services and overhauls, and replacement processes for the purpose of enhancing equipment reliability, detecting incipient conditions and preventing subsequent failures, and ensuring the facility SSCs remain capable of performing their intended function.
- For all SSCs in the facility, there is an overarching strategy detailing what maintenance is performed, why it is performed, how it is performed, and when it is performed.
- The maintenance programs for the facility SSCs has been established using a graded approach.
- The bases for predictive and preventive maintenance activities and frequencies are provided. Specific SSC historical data and information is used in the improvement of the preventive maintenance program.
- A process is in place for verification of performance of the SSC after completion of maintenance to ensure that it meets its functional criteria before it is returned to service.
- Corrective actions for SSC problems identified during predictive and preventive maintenance activities are implemented in a timely manner.
- Adequate provisions are available to conduct corrective activities on an urgent basis if needed.

- Timely testing is performed, at fixed or variable intervals, to review SSC availability, and detect abnormal conditions before significant degradation or failure consequences arise.

- A process exists that examines SSCs for deterioration. This examination is conducted on a periodic schedule and includes assessments of the acceptability of as-found conditions as well as steps to be taken for any necessary remedial actions. Acceptance criteria for equipment performance include margins for uncertainties.

- Routine inspections of SSCs are conducted. Acceptable techniques of inspection include: equipment observation, measurement of process parameters or response time, off-line and on-line monitoring of equipment conditions, non-destructive testing, sampling analysis, etc.

3.6.2. Maintenance program

Objective:

To provide a basis to assess the maintenance program documentation and its implementation.

Guidelines:

The OMARR mission should review that:

- The maintenance program includes management of resources, process implementation and assessment, of testing and inspection requirements, etc.

- The maintenance program considers maintenance issues, manages records, plans, prioritises and schedules work, includes spares/tools management. throughout the asset lifecycle.

- The maintenance program ensures appropriate work control, equipment management, results and trending are used for continuous improvement, contractor management and supplier qualification, training and development of maintenance personnel.

- Process implementation specific to maintenance requirements are in place.

- Maintenance-specific measurement, assessment, and improvement processes are in place that considers the scope and frequency of maintenance performed, in-service inspection, return to service testing, including conformity to requirements, and maintenance requirements during modification of SSCs.

3.6.3. Maintenance Program Organization and Responsibilities

Objective:

To provide a basis to assess if the maintenance program describes a maintenance organization and associated responsibilities for, periodic testing, and inspection activities that is appropriate to the type, size, and overall operating organization.

Guidelines:

The review should be conducted in accordance to what is described in 3.3.1.

The OMARR mission should review that:

- The reactor operating organization has established specific responsibilities for the maintenance of the reactor. Depending on the reactor characteristics, this responsibility may be assigned to operating staff, a maintenance dedicated staff, outside contractors, or some combination of each.

- Other organizational interface descriptions to maintenance are discussed, including the operating organization, regulatory body, safety body, and contractors.

- Individual staff responsibilities for implementing the maintenance, periodic testing, and inspection program are described.

3.6.4. Qualification of maintenance personnel

Objective:

To provide a basis for assessing the qualification of maintenance staff; this includes the selection of staff on the basis the individual's competency to complete the necessary tasks. A process for selection of competent individuals as well as necessary training to ensure and enhance competency is to be available. The competency of external contractor's staff should be addressed.

The review should be conducted in accordance to what is described in 3.3.2.

Guidelines:

The OMARR mission should review that:

- The maintenance group consists of individuals that are competent and trained to correctly complete maintenance, periodic testing, and inspection tasks in manner that does not compromise reactor availability and reliability.

- The program includes training on general topics relevant to all maintenance staff as well as those specific to the SSCs.

Additional details for this area are found in Ref. [11].

3.6.5. Technical procedures and administrative controls

Objective:

To provide a basis to assess that activities associated with the maintenance program and periodic testing, and inspection of reactor SSCs are conducted according to written procedures and controls. These procedures and controls are maintained, revised, validated, and issued for use in accordance with the applicable program requirements.

The review should be conducted in accordance to what is described in 3.3.3

Guidelines:

The OMARR mission should review that:

- Maintenance activities are conducted according to pre-approved specific technical procedures to reduce errors during the maintenance and ensure the SSCs will be restored to their design condition upon completion of the work.

- Maintenance is performed to SSCs utilized for specific and unique activities in the facility.

Additional details for this area are found in Ref. [11].

3.6.6. Selection of SSCs and scheduling

Objective:

To provide a basis for assessing and ensuring that the maintenance program and periodic testing, and inspection activities are conducted on appropriate equipment and in a timely manner. The frequencies of activities are based on an SSC graded approach, design and manufacturer recommendations, reactor requirements, and operating experience. The frequency basis for SSCs is documented to permit routine review for improvements to SSC reliability. The scheduling of SSC maintenance is consistent with reactor operating schedules.

Guidelines:

The OMARR mission should review that:

- The program specifies the SSCs that are subjected to maintenance activities and specifies the frequency for performance of the activities.

- Maintenance activities for SSCs important to availability and reliability have all of them respective frequencies assigned.

- The program documents the justification for each SSC assigned frequency, including justification for any flexibility assigned to the frequency.

- The program considers reactor experience in the assignment of frequency.

- The scheduling of maintenance is coordinated with the operation of the reactor prior to commencement of the maintenance activities.

3.6.7. Review and verification of the maintenance program

Objective:

To provide a basis for assessing and ensuring that the maintenance program and periodic testing, and inspection activities, processes, and procedures are reviewed and verified prior to

their implementation in the facility. Periodic assessments are conducted over the lifetime of the reactor for the purpose of program improvements.

Guidelines:

The OMARR mission should review that:

- The verification, by permitted individuals, of the maintenance program, periodic testing and inspection activities, processes, and procedures are reviewed prior to their implementation in the facility.

- Periodic assessments, by permitted individuals, of the maintenance program, periodic testing and inspection activities, processes, and procedures for continuing improvements are implemented.

3.6.8. Documentation

Objective:

To provide a basis to assess facility documentation required for the maintenance program, periodic testing, and inspection activities of the reactor. A program for issuing, reviewing, approving, and archiving this documentation is established. Required reporting of maintenance program, periodic testing, and inspection results for SSCs important to availability and reliability, including necessary reviews, approvals, and archiving, is identified and described.

Guidelines:

The OMARR mission should review that:

- The program has identified the periodic testing, and inspection activities documentation appropriate for the reactor.

- The program has identified the required reporting of maintenance, periodic testing and inspection activities results for SSCs important to the reactor availability and reliability.

- The program has established a process for the approval and control of documentation and results reporting for maintenance, periodic testing, and inspection, including the specification of mandatory retention schedules.

Additional details on typical documentation and reporting topics are provided in Ref. [11].

3.6.9. Review of results

Objective:

To provide a basis to assess the program review of results of the maintenance program, periodic testing, and inspection actions by the appropriate personnel to ensure the activities have been properly completed, to determine the need for additional actions.

Guidelines:

The OMARR mission should review the program specifies a process for the review and approval of maintenance, periodic testing, and inspection results by the appropriate personnel.

3.6.10. Maintenance facilities

Objective:

To provide a basis to assess the operating organization has adequate facilities, onsite or offsite, for the successful completion of maintenance activities.

Guidelines:

The OMARR mission should review that:

- Adequate facilities, space, and equipment are available to carry out necessary maintenance, periodic testing, and inspection activities.
- Any facilities or areas used for the maintenance of radioactive or contaminated SSCs are designated and controlled for this work.
- If off-site facilities are used, the purpose is described, and adequate availability is demonstrated. If radioactive or contaminated SSCs are relocated to off-site facilities for maintenance, ensure this activity is controlled by procedure.
- Tooling, lifting devices, special equipment, and calibration devices used to perform maintenance activities, including after-maintenance testing, are identified in the appropriate procedure and correctly used.
- The purposes of mock-ups or physical models of the reactor systems or parts, if available, are defined. Ensure the mock-ups or physical models are maintained for the defined purposes if continued use is expected.

3.6.11. Procurement and storage of spare parts

Objective:

To provide a basis to assess procurement and storage of spare or replacement SSCs and spare parts and materials are in accordance with requirements.

Guidelines:

The OMARR mission should review:

- The program includes processes for procurement of spare or replacement SSCs, spare parts, and other materials necessary for the completion of planned maintenance activities
- The procurement responsibilities are clearly defined and technical and quality specifications of SSCs, spare parts, and other material are defined and available to the procurement processes. Ensure receipt inspections are completed in accordance with management system requirements and processes.

- Suppliers are certified as necessary to meet plant or design requirements.

- Storage responsibilities are defined and appropriate storage control measures are provided for environment, inventory management and access, maintenance of inventory and shelf-life, and usage rates and disposal.

3.7.INSPECTION AND MONITORING OF SSCS

3.7.1. In-Service Inspection and Non-Destructive Examination

3.7.1.1. In-Service Inspection (ISI)

The elements of this section are based on Ref. [14].

Objective:

To have an in-service inspection program in order to monitor the state of facility SSCs at predefined periods to maintain facility availability and reliability targets.

Guidelines:

The optimal basis for the ISI program is the pre-service inspection and commissioning records. In case this information is not available, a reconstitution should be made to the extent possible as a basis.

The OMARR mission should review that:

- A well-defined in-service inspection program is available.

- The periodicity of the inspection program is adequate. (Should not to be confused with routine maintenance and inspection tasks. A periodicity of 10 years is typical for certain components).

- All components and structures that are considered important to operation should be included. Special attention to be given to:

    - Pressure retaining boundaries (for pressurized reactors)
    - Core and core support structures
    - Pool and other civil structures
    - Heat removal systems
    - Leak tightness requirements (pool structures, containment requirements) Non-isolatable and inaccessible components

- The ISI program takes into account:

    - Material degradation due to irradiation. A material surveillance program may provide useful information
    - Effects of low cycle fatigue (pressure and thermal cycling)
    - Corrosion
    - Erosion and wear.
    - Other degradation mechanisms

- A clear set of acceptance criteria for the tests are available

- A strategy is available to deal with non-conforming test results. Examples are:

    - Define a repair or replacement strategy
    - Increase inspection periodicity or provide additional surveillances
    - Develop a less conservative approach
    - Develop a "leak before break" strategy

3.7.1.2. Non-Destruction Examination (NDE)

Objective

To ensure that NDE inspection methods are clearly defined

Guidelines

Inspection methods for metallic components include visual inspection, ultrasonic inspection, radiography, eddy current inspection, dye penetrant, replica, thermography. Methods for electrical cable include insulation resistance, continuity and impedance, and visual inspection or mechanical and chemical testing of cable insulation.

The OMARR mission should review that:

- For each of the inspections, clear acceptance criteria are provided.
- The NDE inspection is planned in accordance with the reactor operation schedule and appropriate planning measures are provided.
- Accessibility is considered during planning.
- Criteria are available to decide whether findings are acceptable.
- Repair strategies are pre-planned to the extent possible.
- Components that are non-compliant with the acceptance criteria are not be kept in service without establishing justification for continued operation.

3.7.1.3. Non-destructive examination (concrete structures)

Most reactors have major concrete structures such as pool walls and building walls (which may include containment). These structures should be inspected periodically. Possible issues are:

- Differential displacement between building parts that change during time
- Cracks and spalling in concrete that are observed to be growing
- Presence of moisture
- Carbonation of concrete
- Uncovering of reinforcement bars
- Chemical or biological attack to concrete
- Corrosion resistance

3.7.2. Online Monitoring of Instrumentation

The elements of this section are based on Ref. [15].

Objective:

To provide a basis to assess that the facility has an appropriate program of condition based online monitoring of instrumentation in order to effectively and efficiently achieve reliability and availability in accordance with the facility strategic objective.

3.7.2.1. Online Monitoring Program

The OMARR mission should review that:

- The facility has considered condition based maintenance strategies using online monitoring;
- There is an appropriate data acquisition system in place that will enable the facility to implement online monitoring.
- Data acquisition techniques have considered manual, computer download and automatic techniques or combinations of each;
- Sample rates and intervals have been appropriately considered;
- Data qualification has been appropriately applied;
- Self-diagnostics (finite impulse testing) has been considered
- The maintenance strategy of online equipment has considered optimisation based on reliability and availability considering:
    - Time based
    - Reactive / Corrective
    - Predictive / Condition Based / RCM
- Applications where online monitoring of instrumentation may be applied includes:
    - Electrical Power
    - Primary Cooling System
    - Secondary Cooling System
    - Water purification and chemistry
    - HVAC
    - Radiation Monitoring
    - Reactor Protection System
    - Nuclear instrumentation
    - Reactor control system
- A cost benefit assessment of improvements in online monitoring of the facility has been considered;

3.7.3. Online Monitoring of Rotating Equipment

The elements of this section are based on Ref. [16]

Objective:

To provide a basis to assess that the facility has an appropriate program of condition based online monitoring of rotating equipment in order to effectively and efficiently achieve reliability and availability in accordance with the facility strategic objective.

3.7.3.1. Online Monitoring Program

The OMARR mission should review that:

- The operating organization has considered condition-based maintenance strategies as appropriate for the facility needs;
- Methods of data collection have been appropriately considered including the use of continuous online data acquisition or temporary hand-held data acquisition:
- Collection of equipment performance data has been appropriately considered including but not limited to:
    - Vibration monitoring;
    - Ultrasound;
    - Temperature analysis
    - Lubrication analysis;
    - Motor current signature;
    - Water chemistry.
- Appropriate data analysis techniques are employed including diagnostic and prognostic techniques
- Equipment importance has been considered;
- The reactor reliability and availability requirements in accordance with the strategic objective of the facility have been used in decision making of equipment importance;
- Cost benefit analysis has been considered in moving to a condition based strategy

3.8. AGEING MANAGEMENT

The elements of ageing management in this section are based on Ref. [5]

3.8.1. Elements of ageing management programs

Objective:

To provide a basis to assess the management and technological aspects of an ageing management program that could impact on the availability and reliability of the research reactor.

Guidelines:

3.8.1.1. Screening of SSCs for ageing

The OMARR mission should review that the reactor management has developed a documented process of screening SSCs for susceptibility to ageing and prioritized attention based on a graded approach. This document may need periodical updates upon changes in the facility.

3.8.1.2. Identification and analysis of ageing degradation mechanisms

The OMARR mission should review that:

- The ageing management plan has identified and analysed the ageing degradation mechanisms and its effect on SSCs.

- The operating organization has projected future ageing degradation conditions for SSCs.

- The operating organization has identified new ageing mechanisms for SSCs important to availability and reliability, and how the activities are planned and could be improved based on the latest technological developments in this area.

3.8.1.3. Minimization of expected ageing degradation

The OMARR mission should review that minimization methods are in place to limit ageing degradations, this may include but is not limited to:

- effectiveness of current maintenance and restoration methods and practices to control ageing degradation;
- appropriate operating condition;
- changes to design, material and environmental conditions.

3.8.1.4. Detection, monitoring, and trending of ageing degradation

The OMARR mission should review that the methods of timely detection, monitoring and trending of ageing are updated to the current technological developments and appropriate. This may include in-site inspections, remote and local monitoring, performance testing, periodic testing, NDE, etc.

3.8.1.5. Mitigation of ageing degradation

The OMARR mission should review that the appropriate ageing mitigation techniques, strategies and methods are in place and updated to the current technological developments.

3.8.1.6. Continuous improvement of ageing management program

The OMARR mission should review that steps for the continuous improvement of the ageing management program are in place and effectiveness of the ageing management program is reviewed periodically.

3.8.1.7. Record keeping

The OMARR mission should review that the operating organization has developed active data collection and record keeping systems for the ageing management process.

3.8.2. Obsolescence, Lifetime and Refurbishment

Objective:

To provide a basis to assess if a program to manage the obsolescence, refurbishment and upgrades of SSCs throughout the remaining lifetime of the reactor facility is available such that obsolescence issues do not adversely impact availability and reliability.

Guidelines:

3.8.2.1. Management of obsolescence

The OMARR mission should review how the operating organization manage obsolescence due to:

- Changes in technology;
- Lack of updated documentation following modifications of SSCs or changes in the utilization program;
- Shortage of supplies.

3.8.2.2. Residual Lifetime Assessment

The OMARR mission should review:

- How the operating organization has identified the remaining/anticipated operating life of the reactor
- That the facility has undertaken a program to assess the actual life conditions and remaining lifetime of critical SSCs.

3.8.2.3. Refurbishment and Modernization

The OMARR mission should review that the operating organization has identified and has a plan in place to refurbish and modernize the SSCs affected by ageing.

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[14] INTERNATIONAL ATOMIC ENERGY AGENCY, Application of Non-Destructive Testing and In-Service Inspection to Research Reactors, IAEA TECDOC – 1263, IAEA, Vienna (2001).

[15] INTERNATIONAL ATOMIC ENERGY AGENCY, On-Line Monitoring of Instrumentation in Research Reactors, IAEA TECDOC – 1830, IAEA, Vienna (2017).

[16] INTERNATIONAL ATOMIC ENERGY AGENCY, Condition Monitoring and Incipient Failure Detection of Rotating Equipment in Research Reactors, IAEA TECDOC – 1920, IAEA, Vienna (2020).

APPENDIX I. QUESTIONAIRE FOR COMPLIANCE ASSESSMENT

This appendix aggregates the review guidelines described in section 3 of this publication and provides them in a format useful for OMARR mission reviewers, as well as for the Operating Organisation to conduct a self-assessment evaluation. A self-assessment is strongly encouraged to be performed prior to a planned OMARR mission or as an evaluation independent of OMARR for the reasons of self-improvement and best practices.

The numbering of questions in the following table correspond to applicable paragraphs of section 3.

Question 3.1	Answer	
a) Is the vision, mission and strategic goals of the operating organization and effectiveness of O&M plans in meeting the requirements of strategic plan of the facility defined? b) Are the stakeholder and facility needs for short and long term operation defined and communicated? c) Is the operating schedule consistent with strategic plan? Is an adequate facility asset management policy established? **Points for consideration** • A description of the purpose, utilization and services provided by the reactor facility. • The identification of current stakeholders involved in using the reactor or its products as well as potential future stakeholders. • The identification of facility needs based on current and future stakeholder requirements. • The availability of a reactor operation schedule meeting stakeholder expectations and evidence this schedule is regularly communicated to stakeholders. • The availability of a facility action plan that is aligned with the facility strategic plan. • The availability of a facility financial plan that is aligned with the facility strategic plan for major capital upgrades and refurbishments. • Documentation that demonstrates the organization has adequate financial support for short and long term operation consistent with the strategic plan. • The availability of a facility asset management policy and strategic asset management plan (SAMP), or equivalent.	Yes Partly No	
Evidence	Gaps identified & remarks	

Question 3.2.1	**Answer**	
a) Is the facility design compliant with current design requirements? **Points for consideration** • Compliance of the current plant configuration with intended and documented design requirements. • Appropriate documentation demonstrating design requirements have been met for original design as well as design changes.	Yes	
	Partly	
	No	

Evidence	Gaps identified & remarks

Question 3.2.2	Answer	
a) Are availability targets established? b) Is there sufficient flexibility in facility design to achieve these targets? **Points for consideration** • The SSC design incorporates flexibility to perform necessary maintenance during operation. • The flexibility of design to adopt changes to the fuel cycle and refueling requirements within reactor cycle. • SSC design allows the operator flexibility in the management of spent fuel during reactor operation, including potential shipment. • The design allows operations to perform physical changes to the reactor during operation. • That SSC design allows necessary testing and inspection. • That SSC design allows the loading and unloading of target materials or the performance of experiments during reactor operation.	Yes Partly No	
Evidence	Gaps identified & remarks	

Question 3.2.3	Answer	
a) Are reliability targets established? b) Is there sufficient flexibility in facility design to achieve these targets? **Points for consideration** • SSC design has considered component reliability, including subcomponent failures and reasonably expected failure modes. • SSC design has incorporated lessons learnt from other organizations on reliability improvements. • SSC design has considered component reliability of support services such as electrical supply, compressed air, water supply. • SSC design allows testing of the SSCs to be performed as required. • SSC design allows inspections to be performed as required.	Yes	
	Partly	
	No	

Evidence	Gaps identified & remarks

Question 3.2.4	Answer	
a) Is there sufficient flexibility in facility design to achieve a high level of equipment maintainability? **Points for consideration** • The installed SSCs are provided sufficient maintenance support including adequate spare parts, maintenance tool availability, and maintenance access to the SSC during operation as well as during the maintenance period. • That maintainability through maintenance activities includes consideration of shielding, remote access, and decontamination needs.	Yes	
	Partly	
	No	

Evidence	Gaps identified & remarks

Question 3.2.5	Answer	
a) Do processes exist to identify and integrate necessary upgrades or refurbishments into the existing facility design with minimal availability and reliability impacts? **Points for consideration** • The operating organization has procedures for the integration of new upgrades or refurbishment into an existing facility. • The documentation for facility upgrades and modifications includes original equipment manuals and experience feedback and has been incorporated into the facility documentation/configuration system.	Yes	
	Partly	
	No	

Evidence	Gaps identified & remarks

Question 3.2.6	**Answer**	
a) Are the SSCs classified in a manner that supports the facility availability and reliability targets?	Yes	
Points for consideration	Partly	
• The facility has classified SSCs for availability and reliability requirements. • That facility SSCs are classified based on Integrated Logistic Support (e.g., consideration of lead time and financial ability to obtain the SSC). • That facility SSCs maintainability classifications are based on facility impacts or risk assessment.	No	

Evidence	Gaps identified & remarks

Question 3.3.1	Answer	
a) Are the organizational structure and responsibilities of the operating organization adequately defined and implemented? b) Are all the operating organization requirements (safety, health, environmental, security, quality and economic) considered together? c) Are individuals aware of and accept their responsibilities and know how their responsibility relate to the responsibilities of others in the organization? **Points for consideration** • That senior management has developed and disseminated policies that establish the management's plans, objectives and priorities with regard to safety, health, environmental, security, quality and economic considerations. • That organizational responsibilities and authorities clearly and appropriately assigned. • That individuals are aware of and accept their responsibilities and know how their responsibility relate to the responsibilities of others in the organization.	Yes	
• The individual(s) is aware of his or her authority to raise issues relating to the management system for reporting at senior management level as part of his responsibility to management system. • That job descriptions include a definition of the specific competences required for each function defined within the organizational chart. • That procedures for the control of documents include a description on the preparation, review, approval, issuing, distribution, revision and validation of documents. • That sufficient competency is demonstrated for individuals involved in preparing, revising, reviewing or approving maintenance or operations documents. • That document users are aware of and use appropriate and correct (for example, correct revision) documents. • That external documents relevant for the organization are kept under appropriate controls. • A process for records control has been established in accordance written document controls and includes document classification and indexing, superseding and obsolescence, receipt controls, storage and retrievability controls, and appropriate record storage facilities. • That document retention times clearly specified.	Partly	
• That documents are stored in a controlled and safe environment that is consistent with the document classification. • That appropriate storage media is used such that the documents remain unchanged under normal circumstances for the required period of storage time. • A clear disposal process of unnecessary or obsolete documents is provided. • The facility has a process in place for proper administration of procedure use and compliance.	No	

Question 3.3.1	**Answer**
Evidence	Gaps identified & remarks

Question 3.3.2.1	Answer	
a) Is there appropriate human resource management in place? b) Is there a formal training and qualification program available? c) Are requalification and retraining well defined and implemented?	Yes	
	Partly	
Points for consideration • The operating organization has sufficient resources to carry out the activities of the organization • The operating organization considers future staffing demands of the reactor in order to achieve and maintain strategic and operational plans and objectives. • The operating organization anticipates future staffing needs of the management and the workforce for the purposes of succession planning. • Procedures are in place for selection of essential personnel. As a minimum, initial requirements are defined for the positions of: ✓ Reactor Operator ✓ Reactor Shift Supervisor ✓ Reactor Manager ✓ Maintenance personnel ✓ Quality Assurance personnel ✓ Radiation Protection/Health Physics personnel ✓ Engineering personnel • A facility training and qualification program that is consistent with the staffing needs of the facility. • Competency requirements for all staff levels are defined and documented • Adequate resources and staff to support the defined training and qualification program. • The training and qualification process is periodically evaluated for effectiveness. For example, assess how well the required level of competency is achieved. • The training records and certifications are properly maintained. • That temporary or outsourced workers are verified to have the necessary competency for the intended work. • Staff re-qualification is conducted on a schedule sufficient to support facility requirements. • An operator re-qualification process is in place for the following circumstances: ✓ Extended absence from duty ✓ Previous disqualification ✓ Previous suspension	No	

Evidence	Gaps identified & remarks

Question 3.3.3.1.	Answer	
Control of products a) Are there basic measures for verification and validation of products during the production process and before the acceptance or release of products? **Points for consideration** • The facility production process is carried out under controlled conditions or procedures. • Activities are in place for necessary inspection, testing, verification and validation of products during the production process and before the acceptance or release of products. • Tools and measuring equipment used in the production process are of the proper range, type, accuracy and precision and are under control by means of a dedicate program. • Products are uniquely identified to ensure their traceability and proper use. • Products are handled, transported, stored, maintained and operated to prevent their damage, loss, deterioration or inadvertent use. **Procurement** a) Is there a formally implemented process to carry out procurement activities in a way to ensure that the suppliers are capable of supplying the products and services as they are specified by the requirements? **Points for consideration** • Facility suppliers have been selected based on evaluation against specified performance criteria. • The requirements have been met before the purchased item is used and records of the purchased item includes this final requirement verification. • A formal process for reporting and handling of non-conformances within the procurement process as well as determining acceptance criteria of components that deviate from original requirements. **Managing organizational change** a) Are the organizational changes managed in such a way to not compromise the operational and maintenance performance of the facility? **Points for consideration** • When organizational changes are needed, the impacts on reactor operation are evaluated. • That organizational changes are planned, controlled, communicated, monitored, tracked and recorded to ensure that reactor availability and reliability is not compromised.	Yes	
	Partly	
	No	

Evidence	Gaps identified & remarks

Question 3.3.3.2	**Answer**	
a) Are there a set of processes, which can be commonly found in most of research reactors, formally implemented and documented?	Yes	
	Partly	
Points for consideration • Review for the presence of the following examples of management processes, taking into account the life cycle of the research reactor, the organization's size and structure and the nature of the activities that are carried out: ✓ Project management ✓ Supplier/Quotation qualification ✓ Preparation of technical reports ✓ Numerical calculations ✓ Incoming and outgoing correspondence ✓ Archiving ✓ Software administration ✓ Administration and maintenance of equipment and installations ✓ Operation of installations and laboratories ✓ Waste management ✓ Health, safety and environmental aspects of operations ✓ Deviations from normal reactor operation ✓ Accident and/or emergency conditions at the facility	No	

Evidence	Gaps identified & remarks

Question 3.3.4.1	**Answer**	
a) Is there a formally implemented and documented process to periodically measuring the performance of the management system or the ability of the processes to achieve planned results?	Yes	
	Partly	
Points for consideration • That standards of performance are available that directly relate to the products provided by the organization and are based on objectives established by Management • That facility performance is periodically measured against established standards based on performance indicators or other appropriate methods of measurement • The results of performance measurements are monitored to identify trends and determine if improvements in the product process or quality is needed	No	

Evidence	Gaps identified & remarks

Question 3.3.4.2	Answer	
• Are the management processes for the operating organization periodically audited and assessed?	Yes	
	Partly	
• **Points for consideration** • That internal audits and assessments are regularly conducted on behalf of Management. • That internal audits and assessments address the effectiveness of processes in fulfilling goals, strategies, objectives and to identify opportunities for improvement • An organizational function is established with the responsibility and independence for conduction internal audits and assessments • Internal audits and assessments are routinely scheduled and endorsed by Management • That individuals conducting or participating to internal audits and assessments do not evaluate their own work • Management evaluates the results of internal audits and assessments for any necessary actions • That the organization conducts periodic Management system reviews, including the following: • Management system reviews are conducted at periodic intervals • These management reviews are focused on Management system effectiveness and suitability as well as its ability to achieve organizational objectives. • The results of such reviews are examined for potential changes to system policies, strategies, plans, objectives and processes.	No	

Evidence	Gaps identified & remarks

Question 3.3.4.3	Answer	
a) Is there a formally implemented and documented process for managing of Non-Conformances, Corrective Actions, and Preventive Actions? b) Are the responsibilities and authorities defined for dealing with non-conformances formally established? c) Are the actions, that were adopted to eliminate the cause of a detected non-conformance, appropriate documented? **Points for consideration** • A written procedure that provides instructions for the identification, recording, and managing of Non-Conformance (NC) conditions including evidence of its implementation. • That NCs are categorized according to their impact on reactor operation and maintenance performance. • A formal reporting system for NCs is available and is in use. • A written procedure that provides instructions for identification of NC causes, corrective actions (CA), and preventive actions (PA) including evidence of its implementation.	Yes	
	Partly	
	No	

Evidence	Gaps identified & remarks

Question 3.3.4.4	Answer	
a) Is the continual improvement a clearly understood and properly defined strategic objective of the operating organization? b) Is the continual improvement of processes developed in order to enhance the availability and reliability of the facility? **Points for consideration** • Availability of Improvement Plans, including aspects such as reason for improvement, current situation Gaps identified & remarks, possible solution, evaluation of effects, implementation and standardization of a solution, evaluation of the effectiveness and efficiency of the of the solution. • Examples of continual improvement actuated within the organization at different levels (working level, process level, organizational level)	Yes	
	Partly	
	No	

Evidence	Gaps identified & remarks

<table>
<tr><td>Question 3.4.1</td><td colspan="2">Answer</td></tr>
<tr><td rowspan="3">a) Is there a program for conducting facility tours?
b) Is there appointed a visits coordinator?
c) Were the possible target groups identified?

Points for consideration
• A program for facility tours is available.
• An organizational point of contact for facility tours is identified.
• That stakeholders having influence on the effective operation of the facility have been identified for possible outreach.</td><td>Yes</td><td></td></tr>
<tr><td>Partly</td><td></td></tr>
<tr><td>No</td><td></td></tr>
<tr><td><u>Evidence</u></td><td colspan="2"><u>Gaps identified & remarks</u></td></tr>
</table>

Question 3.4.2	Answer	
a) Is there a process ensuring that appropriate communications are established within the organization? **Points for consideration** • That routine meetings, awareness sessions, staff forums or other forms of internal communication in place such that staff are informed of and engaged in facility activities. • That lines of communication within the organization are clearly defined. • The facility staff is aware of and using these internal lines of communication.	Yes	
	Partly	
	No	

Evidence	Gaps identified & remarks

Question 3.4.3	Answer	
a) Are there processes in place to assess the effectiveness of communication to users/stakeholders important to the facility operation? **Points for consideration** • A transparent and consistent line of communication is available to stakeholders. • An active community outreach by the facility to local community events in order to inform the public of facility purpose and activities and promote community goodwill.	Yes	
	Partly	
	No	

Evidence	Gaps identified & remarks

Question 3.4.4	Answer	
a) Do the operating personnel of the facility actively participate in peer networking activities such as IAEA meetings, industry collaborations, research reactor working groups, etc. ?	Yes	
	Partly	
Points for consideration • The facility is actively participating in peer networking opportunities. • The facility senior and retired personnel are engaged or consulted as necessary.	No	

Evidence	Gaps identified & remarks

Question 3.5.1	Answer	
a) Does the facility have appropriate fuel inventory and fuel cycle management in place in order to meet its strategic objective?	Yes	
	Partly	
Points for consideration • Appropriate access to fresh fuel in order to meet its strategic objectives. • Consideration of diversification of fresh fuel supply or appropriate risk management strategies • Appropriate competency available for undertaking core management planning and configuration in order to support the reactor schedule • controls for the movement and management of fuel • Optimum utilization of the reactor fuel • Adequate failed fuel handling and management • adequate storage to defuel the core if required • An ultimate disposal route for spent fuel or permanent fuel storage capacity • Supply of non-uranium strategic materials	No	

Evidence	Gaps identified & remarks

Question 3.5.2	Answer	
a) Does the facility management have an appropriate conduct of operations in place in order to not adversely impact facility availability and reliability?	Yes	
	Partly	
Points for consideration • A process to develop and issue a Reactor Schedule to, available to applicable stakeholders • Clear levels of authority for operating staff • Appropriate operational procedures for state/mode changes • Processes for releasing SSCs for maintenance and returning them to reliable operation • Record keeping for operational data • Processes for chemical control • Processes for internal feedback, assessment and periodic review for conduct of operations • Radiological protection processes • Sufficient availability of trained staff • Succession planning for operating staff • A program of re-qualification for operating staff • A program of surveillance, monitoring and trending analysis of critical operational parameters • mechanisms for monitoring instrument checks, functional checks and response checks /calibrations • Processes for implementing short term or temporary surveillance, trending and monitoring of abnormal states and conditions of SSCs as applicable	No	

Evidence	Gaps identified & remarks

Question 3.5.3	**Answer**	
a) Does the facility have available and appropriately controlled installations and laboratories that could affect the operation of the reactor? b) Are the associated facilities (e.g. research or radioisotope production) activities managed in conjunction with reactor operation? **Points for consideration** • That installations and laboratories that could affect the operation of the reactor facility are available and appropriately controlled.	Yes	
	Partly	
	No	

Evidence	Gaps identified & remarks

Question 3.5.4	Answer	
a) Does the facility have appropriate radioactive waste management in place such that adverse impacts on reactor availability and reliability are minimized? **Points for consideration** • A process in place for minimization, handling and transfer of solid waste, liquid and gaseous effluents. • Categorization and quantification of generated waste. • Monitoring and trending of the solid waste, liquid and gaseous effluents. • The handling of radioactive waste is efficient and optimized upon expectations.	Yes	
	Partly	
	No	

Evidence	Gaps identified & remarks

Question 3.5.5		**Answer**	
a) Does the facility have appropriate management in place to remediate deviations from normal operation?		Yes	
Points for consideration		Partly	
• Deviations from the standard operating configuration, reporting and actions to revert to normal condition affecting availability. • Root cause analysis of deviations from the standard operating configuration and corrective / mitigatory actions to prevent recurrence is available. • Procedures for anticipated operational occurrences.		No	
Evidence	Gaps identified & remarks		

Question 3.5.6	**Answer**	
a) Does the facility have appropriate controls in place to ensure that utilization activities will not adversely impact on reactor availability and reliability?	Yes	
	Partly	
Points for consideration Utilization activities include, but are not limited to: • Irradiation activities • Experimental facilities • Test facilities • Education and training activities of the reactor • Processes for reporting of utilization activities	No	

Evidence	Gaps identified & remarks

Question 3.5.7	Answer	
a) Does the facility have a program of performance monitoring in place including monitoring and measurement of key performance indicators that could affect facility reliability or availability?	Yes	
	Partly	
Points for consideration Key performance measures and indicators may include, but are not limited to: • Availability • Reliability • Power Level • Shutdown activities • Unplanned shutdown • Utilization • Maintenance • Ageing • Incidents, events or deviations • Time in operating modes	No	

Evidence	Gaps identified & remarks

<table>
<tr><td colspan="2">Question 3.6.1</td><td colspan="2">Answer</td></tr>
<tr><td colspan="2" rowspan="3">a) Does the facility have an effective maintenance management program in place?
Points for consideration

• A systematic maintenance program that consists of preventative, predictive and corrective maintenance.
• A strategy describing maintenance performed, why it is performed, how it is performed, and when it is performed.
• An established maintenance programs for the facility
• A bases for SSC predictive and preventive maintenance activities and frequencies
• A corrective actions process for problems identified during predictive and preventive maintenance activities are implemented in a timely manner and that the corrective maintenance program includes the identification and repair/replacement of degraded or failed SSCs.
• A process that describe the provisions to conduct corrective activities on an urgent basis.
• A process for verification of performance of the SSC after completion of maintenance to ensure it meets its functional criteria before being returned to service.</td><td>Yes</td><td></td></tr>
<tr><td>Partly</td><td></td></tr>
<tr><td>No</td><td></td></tr>
<tr><td><u>Evidence</u></td><td colspan="3"><u>Gaps identified & remarks</u></td></tr>
</table>

Question 3.6.2	Answer	
a) Does the facility have maintenance program and comprehensive implementation steps and/or procedures to implement that program? **Points for consideration** • Includes management of resources, process implementation, measurement and assessment; • Maintenance issues, manages records, plans, priorities and schedules work, includes spares/tools management; • Ensures that appropriate work control, equipment management, results and trending are used for continuous improvement. • Contractor management and supplier qualification. • Training and development of maintenance personnel. • Process implementation specific to maintenance requirements are in place.	Yes Partly No	

Evidence	Gaps identified & remarks

Question 3.6.3	Answer	
a) Does the facility maintenance program describe a maintenance organization and associated responsibilities? **Points for consideration** • Specific group of the reactor organization is assigned responsibilities for maintenance of the reactor. • The individual staff responsibilities for implementing the maintenance, periodic testing, and inspection program are properly described. • Activities, frequency, responsibilities and authorizations are clearly defined. • Details and authorizations are in line the importance to availability and reliability targets of the facility.	Yes	
	Partly	
	No	

Evidence	Gaps identified & remarks

Question 3.6.4	**Answer**	
a) Does the facility have a program / procedures / training methods in place to provide a basis for assessing the qualification of maintenance staff, selection of staff to perform tasks on SSCs? **Points for consideration:** • The maintenance group consists of individuals that are competent and trained to correctly complete maintenance, periodic testing, and inspection tasks. • The training on general topic relevant to all maintenance staff as well as those specific to the SSCs.	Yes	
	Partly	
	No	

Evidence	Gaps identified & remarks

Question 3.6.5	**Answer**	
a) Are there procedures and controls that provide the basis for maintenance, periodic testing and inspection and are these procedures and controls maintained and updated regularly to be in line with applicable requirements? **Points for consideration:** • Maintenance activities are conducted according to pre-approved procedures. • Maintenance, testing, and inspection procedures include activities to ensure SSCs are restored to their design condition upon completion of the work. • Maintenance is performed to SSCs utilized for specific and unique activities in the facility.	Yes	
	Partly	
	No	

Evidence	Gaps identified & remarks

Question 3.6.6	Answer	
a) Does the facility have documentation in place that shows that selection of SSCs for maintenance is consistent with reactor operation schedules and is conducted on appropriate equipment in a timely manner?	Yes	
	Partly	
Points for consideration: • SSCs subject to maintenance, testing, and inspection activities and outlines the frequency of performance. • SSCs important to availability, and reliability have frequencies assigned. • The justification for each assigned SSC frequency, as well as any flexibility assigned to the frequency. • Incorporation of reactor experience in the assignment of maintenance frequencies on selected SSCs. • Scheduling of maintenance, testing, and inspection activities are coordinated with reactor operation prior to commencement of the maintenance activity.	No	

Evidence	Gaps identified & remarks

Question 3.6.7	Answer	
a) Does the facility have evidence in place that the maintenance program is periodically reviewed and updated?	Yes	
	Partly	
Point for consideration: • Documented evidence that shows that the review and verification of maintenance program, testing and inspection processes and procedures by permitted individuals prior to implementation in the reactor exists.	No	

Evidence	Gaps identified & remarks

Question 3.6.8	Answer	
a) Does the facility have established processes to assess, approve, and control maintenance program documentation, including the specification of mandatory retention schedules?	Yes	
	Partly	
Points for consideration • The program has identified the periodic testing, and inspection activities documentation appropriate for the reactor. • The program has identified the required reporting of maintenance, periodic testing and inspection activities results for SSCs important to the reactor availability and reliability. • The program has established a process for the approval and control of documentation and results reporting for maintenance, periodic testing, and inspection, including the specification of mandatory retention schedules.	No	

Evidence	Gaps identified & remarks

Question 3.6.9	Answer	
a) Does a facility process exist where maintenance, testing and inspection results are reviewed and approved by the appropriate personnel? **Points for consideration** • Verification by inspection, witnessing and surveillance. • Verification of the effective implementation should be carried out by personnel not directly responsible for maintenance activities.	Yes	
	Partly	
	No	

Evidence	Gaps identified & remarks

Question 3.6.10	Answer	
a) Does the operating organisation have adequate facilities, on site or offsite to maintain, handle radioactive waste activities during maintenance as required?	Yes	
b) Does the operating organisation have adequate tooling and ancillary devices available for maintenance?	Partly	
Points for consideration • Facilities, space, and equipment are sufficient to carry out necessary maintenance, testing and inspection activities. • Facilities or areas used for the maintenance, testing and inspection of radioactive or contaminated SSCs are designated and controlled for this work. • Use of off-site facilities, the purpose of facilities described, and adequate availability is demonstrated. • Tooling, lifting devices, special equipment and calibration devices used to perform maintenance, testing and inspection, including after-maintenance testing, is identified in the appropriate procedure and correctly used. • For purposes of mock-ups or physical models of the reactor systems or parts, if available, are defined and the mock-ups/models are maintained for the defined purposes if continued use is expected	No	

Evidence	Gaps identified & remarks

Question 3.6.11	Answer	
a) Does the facility have procurement and storage of spare parts control mechanism in place and the evidence to show a well-established process to control and manage procurement and storage of reactor spare parts?	Yes	
	Partly	
Points for consideration • Formal documented Processes for procurement of spare or replacement SSCs, spare parts, and other materials necessary for adequate support of planned maintenance activities. • Procurement responsibilities are clearly defined and technical and quality specifications of SSCs, spare parts, and other material are defined and available to the procurement processes. • That receipt inspections are completed in accordance with management system requirements and processes. • That storage responsibilities clearly defined and appropriate storage control measures provided for environment, inventory management and access, maintenance of inventory and shelf-life, and usage rates and disposal.	No	

Evidence	Gaps identified & remarks

Question: 3.7.1.1	Answer	
a) Does the facility have an ISI program in place, with clear acceptance criteria and strategy for non-conformance? **Points for consideration** • The ISI program includes as applicable: ✓ Pressure retaining boundaries (for pressurized reactors) ✓ Core and core support structures ✓ Pool and other civil structures ✓ Heat removal systems ✓ Leak tightness requirements (pool structures, containment requirements) ✓ Non-isolatable and inaccessible components • The ISI takes into consideration: ✓Material degradation due to irradiation. ✓ Effects of low cycle fatigue (pressure and thermal cycling) ✓ Corrosion ✓ Erosion and wear. ✓ Other degradation mechanisms	Yes Partly No	

Evidence	Gaps identified & remarks

Question: 3.7.1.2	**Answer**	
a) Does the facility have an appropriate NDE program in place? **Points for consideration** • The NDE inspection methods are clearly defined. Inspection methods for metallic components include visual inspection, ultrasonic inspection, radiography, eddy current inspection, dye penetrant, replica, thermography. Methods for electrical cable include insulation resistance, continuity and impedance, and visual inspection or mechanical and chemical testing of cable insulation. • For each of the inspection, clear acceptance criteria should be provided. • The NDE inspection is planned in accordance with the reactor operation schedule. Since these inspections can be extensive, appropriate planning measures should be provided. Accessibility should also be considered during planning. • Criteria should be available to decide whether findings are acceptable. Repair strategies should be pre-planned to the extent possible. • Components that are non-compliant with the acceptance criteria should not be kept in service without establishing justification for continued operation.	Yes Partly No	

Evidence	Gaps identified & remarks

Question: 3.7.1.3	Answer	
a) Does the facility have an appropriate NDE program for concrete structures in place? **Points for consideration** • Differential displacement between building parts that change during time • Cracks and spalling in concrete that are observed to be growing • Presence of moisture • Carbonation of concrete • Uncovering of reinforcement bars • Chemical or biological attack to concrete • Corrosion resistance	Yes	
	Partly	
	No	

Evidence	Gaps identified & remarks

Question: 3.7.2.1	**Answer**	
a) Does the facility have an appropriate online monitoring program for instrumentation in place?	Yes	
Points for consideration	Partly	
• The facility has considered condition based maintenance strategies using online monitoring; • There is an appropriate data acquisition system in place that will enable the facility to implement online monitoring. • Data acquisition techniques have considered manual, computer download and automatic techniques or combinations of each; • Sample rates and intervals have been appropriately considered; • Data qualification has been appropriately applied; • Self-diagnostics (finite impulse testing) has been considered • The maintenance strategy of online equipment has considered optimisation based on reliability and availability considering: ✓ Time based ✓ Reactive / Corrective ✓ Predictive / Condition Based / RCM • Applications where online monitoring of instrumentation may be applied includes: ✓ Electrical Power ✓ Primary Cooling System ✓ Secondary Cooling System ✓ Water purification and chemistry ✓ HVAC ✓ Radiation Monitoring ✓ Reactor Protection System ✓ Nuclear instrumentation ✓ Reactor control system • A cost benefit assessment of improvements in online monitoring of the facility has been considered;	No	

Evidence	Gaps identified & remarks

Question: 3.7.2.2	Answer	
a) Does the facility have an appropriate online monitoring program for rotating equipment in place? **Points for consideration** • The operating organization has considered condition-based maintenance strategies as appropriate for the facility needs; • Methods of data collection have been appropriately considered including the use of continuous online data acquisition or temporary hand-held data acquisition: • Collection of equipment performance data has been appropriately considered including but not limited to: ✓ Vibration monitoring; ✓ Ultrasound ✓ Temperature analysis ✓ Lubrication analysis; ✓ Motor current signature ✓ Water chemistry; • Appropriate data analysis techniques are employed including diagnostic and prognostic techniques • Equipment importance has been considered; • The reactor reliability and availability requirements in accordance with the strategic objective of the facility have been used in decision making of equipment importance; • Cost benefit analysis has been considered in moving to a condition based strategy	Yes Partly No	

Evidence	Gaps identified & remarks

Question 3.8.1.1:	Answer	
a) Is an ageing management program in place that identifies and mitigates the effects of ageing on SSCs that could impact on availability and reliability and to provide a basis for evaluating the effectiveness of ageing management? **Points for consideration** • The operating organization has a process for screening and prioritizing SSCs for monitoring of conditions related to ageing.	Yes	
	Partly	
	No	

Evidence	Gaps identified & remarks

Question 3.8.1.2	Answer	
a) Does the ageing management program identify ageing degradation? **Points for consideration** • The operating organization has identified and analysed potential ageing degradation of prioritized SSCs for effects on availability and reliability. • The operating organization has a process for projecting future ageing degradation for SSCs for effects on availability and reliability. • The operating organization has identified new ageing mechanisms for SSCs important to availability and reliability, and how the activities are planned and could be improved based on the latest technological developments in this area.	Yes	
	Partly	
	No	

Evidence	Gaps identified & remarks

Question 3.8.1.3	Answer	
a) Are processes and methods in place to limit ageing degradation of equipment? **Point for consideration** • Methods are in place to limit ageing degradation such as effectiveness of maintenance, appropriate operating conditions, and needed changes to design, material and environmental conditions.	Yes	
	Partly	
	No	

Evidence	Gaps identified & remarks

Question 3.8.1.4	Answer	
a) Are there processes for detection, monitoring and trending of ageing degradation of equipment?	Yes	
	Partly	
Point for consideration • Timely monitoring and trending of ageing conditions is available. This may include inspections, monitoring, performance testing, periodic testing, NDT, etc	No	

Evidence	Gaps identified & remarks

Question 3.8.1.5	Answer	
a) Are appropriate techniques, strategies, and methods for mitigation actions in place?	Yes	
	Partly	
Point for consideration • Maintenance. • Refurbishment and periodic replacement of components. • Modifications of SSCs. • Alteration of operating conditions. • Practices that may affect the rate of ageing degradation of components.	No	

Evidence	Gaps identified & remarks

Question 3.8.1.6	Answer	
a) Is a continuous improvement program in place for ageing management?	Yes	
	Partly	
Point for consideration • Provisions are in place for performance review and continuous improvement of the ageing management programme. • Ageing evaluations and condition assessments are periodically reviewed and updated. • The effectiveness of ageing management activities for individual SSCs are periodically evaluated in the light of current knowledge and adjusted as appropriate.	No	

Evidence	Gaps identified & remarks

Question 3.8.1.7		**Answer**	
a) Does the facility have an active data collection and record keeping system for the ageing management program?		Yes	
Point for consideration		Partly	
• The operating organization has a data collection and record keeping system, in order to provide information for the ageing management activities.		No	
Evidence	Gaps identified & remarks		

Question 3.8.2.1	Answer	
a) Is a program to manage the obsolescence, refurbishment and upgrades of SSCs throughout the remaining lifetime of the reactor facility available?	Yes	
	Partly	
Point for consideration • Obsolescence of SSCs should be identified, and corrective actions should be taken before the occurrence of any decline in availability or reliability.	No	

Evidence	Gaps identified & remarks

<table>
<tr><td colspan="2">Question 3.8.2.2</td><td colspan="2">Answer</td></tr>
<tr><td colspan="2" rowspan="3">a) Is there a process in place for assessing equipment residual lifetimes?

Points for consideration

• The operating organization has a process for the identification of the remaining/anticipated operating life of the reactor SSCs.
• The facility undertaken a program to assess the health of critical SSCs.</td><td>Yes</td><td></td></tr>
<tr><td>Partly</td><td></td></tr>
<tr><td>No</td><td></td></tr>
<tr><td>Evidence</td><td colspan="3">Gaps identified & remarks</td></tr>
</table>

Question 3.8.2.3	Answer	
a) Has the operating organization identified and developed a plan for refurbishing and modernizing SSCs affected by ageing mechanisms? **Point for consideration** • A plan to refurbish and modernize SSCs affected by ageing mechanisms is important to prevent the occurrence of any decline in availability or reliability of the RR.	Yes	
	Partly	
	No	

Evidence	Gaps identified & remarks

APPENDIX II. TYPICAL FORMAT FOR THE MAIN MISSION REPORT

1. BACKGROUND
   - 1.1 History of the facility
   - 1.2 Summary descriptions of the facility and the utilization program
   - 1.3 Summary of the Pre-OMARR mission
   - 1.4 Objectives and scope of the mission
   - 1.5 Basis for the review and documents provided by the counterpart
2. CONDUCT OF THE MISSION
   - 2.1 Method of conducting the review
   - 2.2 Review criteria
   - 2.3 Results of the facility walk-through
3. CONCLUSIONS AND MAIN RECOMENDATIONS

APPENDIX 1: ISSUE PAGES
ANNEX 1: AGENDA
ANNEX 2: LIST OF PERSONS MET DURING THE MISSION

ISSUE PAGE FORMAT

REVIEW AREA
ISSUE 01:
OBSERVATIONS:
EVIDENCES AND REFERENCES:
COUNTERPART'S VIEW AND MEASURES ON THE FINDINGS:
RECOMMENDATIONS: **R1:**
SUGGESTIONS: **S1:**
GOOD PRACTICES: **GP1:**

LIST OF ABBREVIATIONS

CA	Corrective Actions
HVAC	Heating Ventilation and Air Conditioning
INIR-RR	Integrated Nuclear Infrastructure Review for Research Reactors
IRRUR	Integrated Research Reactor Utilization Review
INSARR	Integrated Safety Assessment of Research Reactors
ISI	In Service Inspection
MS	Member States
NC	Non-conformances
NDE	Non-Destructive Examination
O&M	Operation and maintenance
OLCs	Operating and Limiting Conditions
OMARR	Operation and Maintenance Assessment for Research Reactors
OO	Operating organization
PA	Preventive Actions
QA	Quality assurance
RR	Research reactor
SAMP	Strategic asset management plan
SSCs	Structures, Systems and Components

CONTRIBUTORS TO DRAFTING AND REVIEW

Mr. BROLLO, Fabricio	CNEA, Argentina
Ms. CAGNAZZO, Marcella	TU, Austria
Mr. CHAKOVSKI, Jason	ANSTO, Australia
Mr. JINCHUK, Dario	IAEA
Mr. LINN, Mark	ORNL, USA
Mr. MALAKA, Sammy	NECSA, South Africa
Mr. PANE, Jupiter	BATAN, Indonesia
Mr. SHARMA, Ram	IAEA

IAEA Consultancy Meetings held to support this publication

25 February – 1 March 2019, IAEA Headquarters, Vienna

27 – 30 January 2020, IAEA Headquarters, Vienna

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