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INTEGRATED REGULATORY REVIEW SERVICE (IRRS)

FOLLOW-UP MISSION

TO

PAKISTAN

Islamabad, Pakistan

28 February to 7 March 2022

DEPARTMENT OF NUCLEAR SAFETY AND SECURITY

Integrated Regulatory Review Service

IRRS

Pakistan Nuclear Regulatory Authority

IAEA Integrated Regulatory Review Service IRRS

INTEGRATED REGULATORY REVIEW SERVICE (IRRS)
FOLLOW-UP REPORT TO
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Mission dates:	*28 February to 7 March 2022*
Regulatory body visited:	*Pakistan Nuclear Regulatory Authority (PNRA)*
Location:	*Islamabad, Pakistan*
Regulated facilities and activities in the mission scope:	*Nuclear Power Plants, Research Reactors, Waste Management Facilities, Radiation Sources Applications and Facilities, Decommissioning Activities.*
Organized by:	*International Atomic Energy Agency (IAEA)*

IRRS REVIEW TEAM	
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The number of recommendations, suggestions and good practices is in no way a measure of the status of the regulatory body. Comparisons of such numbers between IRRS reports from different countries should not be attempted.

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EXECUTIVE SUMMARY

At the request of the Government of Pakistan, an international team of senior safety experts visited Islamabad in March 2022 where they met representatives of the Pakistan Nuclear Regulatory Authority (PNRA) to conduct an Integrated Regulatory Review Service (IRRS) follow-up mission. The purpose of this mission was to review the progress made against the recommendations and suggestions identified in the full scope IRRS initial mission to Pakistan, which was conducted in May 2014. The scope of the IRRS follow-up mission was the same as that of the initial mission in 2014. The IRRS team comprised seven senior safety experts from six IAEA Member States and four IAEA staff members.

The IRRS team reviewed the progress in implementing the recommendations and suggestions that were documented in the IRRS initial mission report in 2014. These findings were made in the following areas: responsibilities and functions of the government; responsibilities and functions of the regulatory body; the management system of the regulatory body; the activities of the regulatory body related to regulation of nuclear and radiation facilities and activities, including authorization, review and assessment, inspection, enforcement, the development and content of regulations and guides; emergency preparedness and response; occupational radiation protection; control of discharges; and environmental monitoring for public radiation protection.

The mission included interviews and discussions with PNRA staff, and representatives from the Ministry of Foreign Affairs (MoFA) and Pakistan Atomic Energy Commission (PAEC). In preparation for the IRRS follow up mission, PNRA conducted a self-assessment of the status of recommendations and suggestions set out in the initial IRRS mission report. The results of the self-assessment and supporting documentation were provided to the IRRS team as Advance Reference Material (ARM) prior to the mission.

The IRRS team concluded that the recommendations and suggestions detailed in the IRRS initial mission report have been given due consideration and have been addressed through the implementation of a comprehensive action plan. The IRRS team determined that all 13 recommendations, and 29 out of 31 suggestions, identified in the 2014 mission report have been adequately addressed and are therefore closed. This has resulted in clear improvements to the regulatory infrastructure in Pakistan making it more efficient and effective.

Notable achievements since 2014 include the following:

- PNRA has enhanced its credibility through successful regulation of the construction and commissioning of three new Nuclear Power Plants (NPPs);
- National policies and strategies have been issued and are supported by a comprehensive suite of new and updated regulations, thereby providing a firm policy and strong legal basis for regulation of all nuclear facilities and activities;
- Establishing the means by which adequate resources can be accumulated to deal with future nuclear liabilities, through establishing segregated funding arrangements for decommissioning and radioactive waste management, pending solutions for radioactive waste disposal being identified; and
- The completion of the major modernisation of the National Radiation Emergency Coordination Centre (NRECC) providing a valuable addition to Pakistan's ability to plan for, and respond to, a nuclear or radiological emergency.

The PNRA staff should be commended for the efforts they have made to address the findings from 2014.

For the two suggestions that remain open, the Government and PNRA have made some progress but have not fully implemented all the necessary actions to allow the IRRS team to consider these findings to be closed. The IRRS team believes that it is important that the Government and PNRA should continue to focus on these remaining areas together with some comments made in this report that may facilitate further improvements but did not result in formal findings.

The IRRS team also made the following general observations:

- A national policy is in place for the safe management of radioactive waste and spent fuel, decommissioning and waste disposal. However, becoming a Contracting Party to the Joint Convention and inviting an IAEA ARTEMIS mission should be considered further in order to bring added focus to these important areas;
- Openness and transparency are important aspects of regulation as they can enhance public trust and public confidence in the regulatory body. Several improvements have been made by PNRA to better communicate regulatory activities aimed at improving public trust. While the improvements made to date are commendable, including the communication strategy set up for the period 2019-2023, the team considered that PNRA could explore further opportunities to engage the public in its decision-making; and
- PNRA recognises that the use of a graded approach within its regulatory activities is important for its efficiency and effectiveness as a regulator. The IRRS team observed, in some cases, where the application of the graded approach could be further refined, such as in relation to the use of the categorization of inspection findings, according to their safety significance, and including it explicitly in its Inspection Policy.

The PNRA's preparation for the follow-up mission was very thorough, and the administrative and logistical support was excellent. The IRRS team was extended full cooperation by its Pakistan counterparts during the technical discussions. The counterparts presented clear evidence of the actions they have taken, or are still to take, to successfully address the IRRS initial mission findings from 2014. Completing this work should lead to sustainable improvements to the regulatory and nuclear safety framework within Pakistan.

At the end of the mission, an IAEA press release was issued.

I. INTRODUCTION

At the request of the Government of Pakistan, an international team of senior safety experts met representatives of the Pakistan Nuclear Regulatory Authority (PNRA) from 28 February to 7 March 2022 to conduct an Integrated Regulatory Review Service (IRRS) follow-up mission. The mission took place at PNRA Headquarters in Islamabad. The purpose of this peer review was to review the Pakistan's progress in implementing the recommendations and suggestions identified in the initial IRRS mission which was carried out from 28 April to 9 May 2014.

The follow-up review mission was formally requested by the Government of Pakistan on 21 April 2021. A preparatory mission was conducted virtually on 23-25 November 2021 to discuss the purpose, objectives, and detailed preparations of the follow-up review in connection with regulated facilities, activities and exposure situations in Pakistan and their related safety aspects and to agree the scope of the IRRS follow-up mission.

The IRRS Team consisted of 7 senior regulatory experts from 6 IAEA Member States, 3 IAEA staff members and 1 IAEA administrative assistant. The IRRS team carried out the review in the areas covered by the initial mission.

In preparation for the IRRS follow-up mission, Pakistan conducted a self-evaluation of the status of recommendations and suggestions set out in the initial IRRS mission report and prepared a self-assessment follow-up report accordingly. This report and supporting documentation were provided to the IRRS team as advance reference material (ARM) for the mission. During the mission, the IRRS team performed a systematic review of all topics by reviewing the ARM, additional information provided, and by conducting interviews with management and staff of PNRA. The IRRS team also met with Mr Muhammad Kamran Akhtar, Director General in the Ministry of Foreign Affairs (MoFA) along with his team, to discuss the Joint Convention on the safety of spent fuel management and on the safety of radioactive waste management.

Throughout the mission, the IRRS team received the full cooperation by all parties. In particular, the staff of PNRA provided excellent assistance and demonstrated extensive openness and transparency.

II. OBJECTIVE AND SCOPE

The purpose of this Integrated Regulatory Review Service (IRRS) follow-up mission was to conduct a review of the implementation of the thirteen recommendations and the thirty-one suggestions that were given to Pakistan during the IRRS initial mission conducted from 28 April to 9 May 2014.

The IRRS follow-up mission scope was the same as the scope of the initial mission covering the following areas: responsibilities and functions of the government; responsibilities and functions of the regulatory body; the management system of the regulatory body; the activities of the regulatory body related to regulation of nuclear and radiation facilities and activities, including authorization, review and assessment, inspection, enforcement, the development of regulations and guides, emergency preparedness and response, occupational radiation protection, control of radioactive discharges, and environmental monitoring associated with authorized practices for public radiation protection.

The review was carried out by comparison of existing arrangements against the IAEA safety standards.

It is expected that the IRRS follow-up mission will facilitate regulatory improvements in Pakistan and in other Member States from the knowledge gained and experiences shared between Pakistan Counterparts and IRRS reviewers, and through the evaluation of the effectiveness of Pakistan's regulatory infrastructure for nuclear and radiation safety.

III. BASIS FOR REVIEW

A) Preparatory work and IAEA Review Team

At the request of the Government of Pakistan, a preparatory meeting for the Integrated Regulatory Review Service (IRRS) follow-up mission was conducted from 23 to 25 November 2021. The preparatory meeting was attended by the appointed Team Leader Mr. Jun Yu, Deputy Team Leader Mr. Rob Campbell, the IAEA Coordinator Mr. Jean-René Jubin, and IAEA Deputy Coordinator Mr. Jovica Bosnjak. Subsequently, due to COVID-19 related circumstances, Mr. Campbell took on the role of team leader.

The IRRS follow-up mission preparatory team had discussions regarding regulatory programmes and policy issues with the senior management of PNRA represented by Mr. Faizan Mansoor, Chairman of PNRA, other senior management and staff. The discussions resulted in agreement that the scope of the review would be the same as the initial mission conducted from 28 April to 9 May 2014.

Mr. Naveed Maqbul, Member Corporate of PNRA, delivered presentation on the national context for nuclear and radiation regulatory framework and Mr. Naeem Arshad, Liaison Officer, presented the result of the self-evaluation of the status of recommendations and suggestions made in 2014.

IAEA staff presented the IRRS principles, follow-up mission process and methodology. This was followed by a discussion on the tentative work plan for the implementation of the IRRS follow-up mission in Pakistan in March 2022.

During the preparatory meeting, the proposed composition of the IRRS team was discussed. Logistics of the mission, including meetings, workplaces, designation of module counterparts and Liaison Officer, proposed site visits, lodging and transportation arrangements were also addressed.

PNRA informed that Pakistan appointed Mr. Naeem Arshad as Liaison Officer (LO). The roles and responsibilities of IRRS Team members, LO and the counterparts were also agreed upon during the meeting.

PNRA provided IAEA with the ARM for review on 14 January 2022. In preparation for the mission, the IAEA review team members reviewed the ARM and provided their initial impressions to the IAEA Coordinator prior to the commencement of the IRRS follow-up mission.

B) Reference for the review

The relevant IAEA safety standards and the Code of Conduct on the Safety and Security of Radioactive Sources were used as review criteria. The complete list of IAEA publications used as the references for this mission is provided in Appendix VI.

C) Conduct of the review

The initial IRRS Team meeting took place on Monday, 28 February 2022 at PNRA Headquarters in Islamabad, directed by the IRRS Team Leader and the IAEA Coordinator. Discussions encompassed the general overview, the scope and specific issues of the mission, clarification of the bases for the review and the background, context and objectives of the IRRS programme. The understanding of the methodology for review was reinforced. The agenda for the mission was presented to the IRRS team. As required by the IRRS Guidelines, the reviewers presented their initial impressions on the ARM and highlighted significant issues to be addressed during the mission.

The host Liaison Officer was present at the initial IRRS Team meeting, in accordance with the IRRS Guidelines, and presented logistical arrangements planned for the mission.

The IRRS entrance meeting was held on Tuesday, 1 March 2022, with the participation of PNRA senior management and staff, Mr Waseem Azhar, Director General of the Safety Department of PAEC (Pakistan Atomic Energy Commission), and officials from the Strategic Plans Division (SPD) and the Ministry of Foreign Affairs. Opening remarks were made by Mr. Faizan Mansoor, Chairman of PNRA and Mr. Rob Campbell, IRRS Team Leader. Mr. Jean-René Jubin, IAEA Coordinator briefed the participants on the IRRS follow-up mission programme. Mr. Naveed Maqbul, Member Corporate and team leader of the IRRS mission from PNRA, gave an overview of the Pakistan context, regulated facilities and activities, and national legal and regulatory framework for safety as well as the main changes which had happened since the IRRS initial mission in 2014. He also presented the results of PNRA's follow-up self-assessment, the main conclusions drawn from it and the action plan prepared as a result of the pre-mission self-assessment.

During the IRRS follow-up mission, a review was conducted for all review areas within the agreed scope with the objective of reviewing Pakistan and PNRA's response to the recommendations and suggestions identified during the initial mission in 2014. The review was conducted through meetings, interviews and discussions. The IRRS team performed its review according to the mission programme given in Appendix II.

The IRRS exit meeting was held on Monday, 7 March 2022. The exit meeting formally started with the opening remarks of Mr. Naveed Maqbul, PNRA Team Leader for the IRRS follow-up mission, followed by a presentation from IAEA Coordinator, Mr. Jean Rene Jubin on the IRRS follow-up process and preparation of preliminary mission report. Afterwards, the IRRS Team Leader Mr. Rob Campbell presented the results of the mission which were followed by farewell remarks of Mr. Faizan Mansoor, Chairman of PNRA. At the end, Ms. Anna Bradford, Director of Division of Nuclear Installation Safety at IAEA delivered the closing remarks of the mission.

An IAEA press release was issued in the aftermath of the exit meeting.

1. RESPONSIBILITIES AND FUNCTIONS OF THE GOVERNMENT

1.1. NATIONAL POLICY AND STRATEGY FOR SAFETY

2014 MISSION RECOMMENDATIONS, SUGGESTIONS	
Observation: *The safety objective in the Ordinance does not explicitly mention the scope of its application (for all civilian facilities and activities) and duration of its application (all stages over the lifetime of a facility or an activity). Fundamental safety principles such as priority for safety, leadership and management for safety or protection of present and future generations are not fully embedded in the Pakistan legislative framework for safety.*	
Observation: *The principle of prime responsibility for safety is not completely addressed in the framework for safety.**(reference to R1 is made in Section 1.4)***	
(1)	**BASIS: GSR Part 1 Requirement 5 states that** *"The Government shall provide a national policy and strategy for safety, the implementation of which shall be subject to a graded approach in accordance with national circumstances and with the radiation risks associated with facilities and activities, to achieve the fundamental safety objective and to apply the fundamental safety principles established in the Safety Fundamentals."*
(2)	**BASIS: GSR Part 1 Requirement 6 states that** *"The government shall stipulate that compliance with regulations and requirements established or adopted by the regulatory body does not relieve the person or organization responsible for a facility or an activity of its prime responsibility for safety."**(reference to R1 is made in Section 1.4)***
R1	**Recommendation:** The Government should ensure that the fundamental safety objective and fundamental safety principles of IAEA SF-1 are incorporated in the Pakistan framework for safety.
Observation: *A national safety strategy is not envisaged by the government (long term safety strategy on nuclear and radiation safety) that would reflect existing Energy Security Plan and associated PAEC Nuclear Power Development Program.*	
(1)	**BASIS: GSR Part 1 Requirement 1, para 2.3 states that** *"The government shall establish a national policy and strategy for safety", "National policy and strategy for safety shall express a long term commitment to safety", "The national policy shall be promulgated as a statement of the government's intent. The strategy shall set out the mechanisms for implementing the national policy."*
S1	**Suggestion:** The Government should consider developing a long-term strategy for safety that would include necessary safety measures to reflect the development plans for the nuclear power programme of Pakistan.

Changes since the initial IRRS mission

Recommendation 1: PNRA has issued a National Safety Policy (NP-02/2020) and revised regulation PAK/908 (Rev. 1 dated December 2019) to clearly assign the prime responsibility for safety and security to the licensees of nuclear and radiation facility or activities. The safety objective stipulated by the National Safety Policy covers all safety-related aspects for the different stages in the lifetime of a facility or the duration of an activity. The National Safety Policy and corresponding PNRA regulations establish the fundamental safety principles, including prime

responsibilities for safety, leadership and management for safety, and protection of present and future generations. A new PNRA regulation on Leadership and Management for Safety (PAK/921) has been approved for notification in the official Gazette of Pakistan. This new regulation is expected to be published shortly.

Suggestion 1: The National Policy and Strategy for safety in Pakistan is established through the PNRA Ordinance, the National Safety Policy (NP-02/2020), the PAEC Ordinance, the National Command Authority Act and the PNRA regulations. Furthermore, PNRA has issued a "National Policy on Safe Management of Radioactive Waste, Decommissioning and Spent Nuclear Fuel in Islamic Republic of Pakistan - (RWP-01/2018)" and PAEC has published corresponding strategies for the safe management of spent nuclear fuel (DGNR-NRID-ST-001, Rev 00), the safe decommissioning of nuclear facilities (DGNR-NRID-ST-002, Rev 00) and on the safe management of radioactive waste (DGNR-NRID-ST-003, Rev 01). Since 2014, three reactors have been commissioned (C-3, C-4 and K-2) and a fourth (K-3) is currently under commissioning. Unit K-1 was permanently shut down in August 2021; PNRA is currently reviewing its final decommissioning plan. The Energy Security Plan 2030 which foresaw an increase of nuclear power to 8800 MWe has been revised and currently there is no plan to construct any further reactors after K-3 with the possible exception of C-5 in the foreseeable future. The long-term human resource plans of PNRA and PAEC have been revised accordingly.

PNRA Regulations PAK/912 and PAK/913 require that the nuclear installations are staffed with competent managers and qualified personnel having proper awareness of the technical and administrative requirements for safety and motivated to be safety conscious.

Status of the initial mission findings

Recommendation 1 (R1) is closed as the Government has incorporated the fundamental safety objective and fundamental safety principles of IAEA SF-1 into its legal framework.

Suggestion 1 (S1) is closed as the national strategy for safety is anchored in the Pakistan legal and regulatory framework for safety.

1.2. ESTABLISHMENT OF A FRAMEWORK FOR SAFETY

2014 MISSION RECOMMENDATIONS, SUGGESTIONS	
Observation: *Responsibilities and obligations for the management of the Central Radioactive Waste Management Fund envisaged by the National Policy on Control and Safe Management of Radioactive Waste are not stipulated in the national legislative framework.*	
(1)	**BASIS: GSR Part 1 para 2.5 (16) states that** *"Framework for safety shall set out… responsibilities and obligations in respect of financial provision for the management of radioactive waste and of spent fuel, and for decommissioning of facilities and termination of activities …"*
R2	**Recommendation:** The Government should ensure that relevant parts of the legislative framework stipulate legal responsibilities and obligations in respect of financial provisions for the management of radioactive waste, spent fuel and decommissioning of facilities.

Changes since the initial IRRS mission

Recommendation 2: PNRA revised the following regulations to establish requirements for financial provisions for the management of radioactive waste, spent fuel and decommissioning of facilities:

- Regulation on Decommissioning of Facilities Using Radioactive Material - PAK/930 Clause -8 (Issued in 2016);
- Regulation on Radioactive Waste Management - PAK/915 Rev-1 Clause 5-d (Issued in 2019);
- Regulation for Safe Management of Spent Nuclear Fuel - PAK/918 Clause 10 (Issued in 2020).

According to PAK/930 Clause 8(4), the licensee shall provide adequate financial resources to cover the costs associated with safe decommissioning, including the management of the resulting waste, which shall be available even in the event of premature shutdown of the facility. Each nuclear installation is responsible for establishing and maintaining its own decommissioning fund. If a nuclear installation fails to adequately manage its financial resources for decommissioning, even in the event of premature shutdown, the Government of Pakistan will ultimately be responsible for the provision of adequate financial and human resources to cover the costs associated with safe decommissioning, including the waste management.

According to PAK/915 (Rev.1) Clause 5(d), the licensee is responsible for establishing and maintaining a mechanism to provide and ensure adequate financial resources needed to ensure the safe management of radioactive waste. PAEC has established a mechanism addressed in the Radioactive Waste Management Fund (RWMF), for long term management of radioactive waste in the country. Regarding spent nuclear fuel, PAK/918 clause 10 states that the licensee shall allocate adequate financial resources to fulfil its prime responsibility for safety and to comply with the regulatory requirements. In May 2020, PAEC developed a national strategy for the safe management of spent nuclear fuel which indicates that the RWMF should also cover the costs for the management of spent nuclear fuel from NPPs. For research reactors, the expenditure will be covered by the respective licensees.

Status of the initial mission findings

Recommendation 2 (R2) is closed as PNRA has established regulatory requirements for financial provisions for the safe management of radioactive waste and spent fuel, and decommissioning of nuclear facilities.

1.3. ESTABLISHMENT OF A REGULATORY BODYAND ITS INDEPENDENCE

There were no findings in this area in the initial IRRS mission.

1.4. COMPLIANCE WITH REGULATIONS AND RESPONSIBILITY FOR SAFETY

Reference is made to Recommendation 1 in Section 1.1.

1.5. COORDINATION OF AUTHORITIES WITH RESPONSIBILITIES FOR SAFETY WITHIN THE REGULATORY FRAMEWORK

2014 MISSION RECOMMENDATIONS, SUGGESTIONS	
Observation: *Coordination and liaison between PNRA and other authorities having responsibility for safety are not formalised in all cases.*	
(1)	**BASIS: GSR Part 1 Requirement 7states that** *"The Coordination of different authorities with responsibilities for safety within the regulatory framework for safety. Where several authorities have responsibilities for safety within the regulatory framework for safety, the government shall make provision for the effective coordination of their regulatory functions, to avoid any omissions or undue duplication and to avoid conflicting requirements being placed on authorized parties."*
(2)	**BASIS: GSR Part 1 (Rev.1) para. 2.18 states that** *"Where several authorities have responsibilities for safety within the regulatory framework for safety, the responsibilities and functions of each authority shall be clearly specified in the relevant legislation. The government shall ensure that there is appropriate coordination of and liaison between the various authorities concerned in areas such as: …"*
R3	**Recommendation:** PNRA should ensure that appropriate and documented coordination and liaison between PNRA and other authorities having responsibility for safety are formalized where appropriate or needed.

Changes since the initial IRRS mission

Recommendation 3: PNRA has revised its Management System Manual (PNRA-MSM-001 (Rev.1)) to clarify the responsibilities for coordination and liaison with government organizations in Section 3.9 (Interface) and in the management process MP-5 on communication with interested parties and licensees. PNRA has also issued a procedure describing the process for coordination and liaison with various authorities and organizations having responsibilities for safety (PNRA-WP-062 dated October 2021). Furthermore, PNRA has formalised liaison and cooperation with several national authorities by signing Memoranda of Understanding, attaching liaison officers and other means of formalised channels.

Status of the initial mission finding

Recommendation 3 (R3) is closed as PNRA has revised its management system manual and developed an internal procedure describing its process and clarifying responsibilities for coordination and liaison with other national authorities.

1.6. SYSTEM FOR PROTECTIVE ACTIONS TO REDUCE UNREGULATED RADIATION RISKS

There were no findings in this area in the initial IRRS mission.

1.7. PROVISIONS FOR DECOMMISSIONING AND MANAGEMENT OF RADIOACTIVE WASTE AND SPENT FUEL

2014 MISSION RECOMMENDATIONS, SUGGESTIONS	
Observation: *A policy for nuclear spent fuel management and decommissioning is not established.*	
(1)	**BASIS: GSR Part 1 para 2.28 states that** "*The decommissioning of facilities and the safe management and disposal of radioactive waste shall constitute essential elements of the governmental policy and the corresponding strategy over the lifetime of facilities and the duration of activities. The strategy shall include appropriate interim targets and end states…"*
(2)	**BASIS: GSR Part 1 para 2.30 states that** "*Radioactive waste generated in facilities and activities shall be managed in an integrated, systematic manner up to its disposal. The interdependences of the steps in the entire management process for radioactive waste, and likewise for spent fuel, shall be recognized"*
S2	**Suggestion:** The Government should consider including the policy for decommissioning of facilities and the safe management of spent nuclear fuel in the existing radioactive waste management policy.
Observation: *The Pakistan Government approved the National Policy on Control and Safe Management of Radioactive Waste. However, the corresponding national strategy prepared by PAEC is not in full compliance with the requirements of GSR Part 1. The document is not promulgated at governmental level. Strategies for decommissioning of facilities and safe management of spent nuclear fuel are not established.*	
(1)	**BASIS: GSR Part 1 para 2.28 states that** "*The decommissioning of facilities and the safe management and disposal of radioactive waste shall constitute essential elements of the governmental policy and the corresponding strategy over the lifetime of facilities and the duration of activities. The strategy shall include appropriate interim targets and end states…"*
S3	**Suggestion:** The Government should consider developing a national strategy for the decommissioning of facilities and for the safe management and disposal of radioactive waste with appropriate interim targets and end states.

Changes since the initial IRRS mission

Suggestion2: The Government has included policies for decommissioning of facilities and the safe management of spent nuclear fuel in the existing radioactive waste management policy in the "National Policy on safe management of radioactive waste, decommissioning and spent nuclear fuel" (RWP-01/2018) in 2018. The said national policy supersedes the previous "National Policy on Control and Safe Management of Radioactive Waste". The policy is available on the PNRA web site.

Suggestion3: PAEC has developed national strategies for the decommissioning of facilities, for the safe management and disposal of radioactive waste and for the safe management of spent nuclear fuel with appropriate interim targets and end states. PAEC has issued the following strategic documents, which have been reviewed by PNRA:

- Safe Management of Spent Nuclear Fuel (DGNR-NRID-ST-001,Rev 00);
- Safe Decommissioning of Nuclear Facilities (DGNR-NRID-ST-002, Rev 00);
- Strategy on Safe Management of Radioactive Waste including disused sealed radioactive sources(DSRS) (DGNR-NRID-ST-003, Rev 01).

In relation to disposal of spent nuclear fuel, RWP-01/2018 states that the Government of Pakistan considers spent nuclear fuel as a valuable asset. Currently, spent fuel is stored at licensed nuclear facilities. A decision regarding the disposition of spent nuclear fuel will be made in due course by the Government of Pakistan.

Examples of interim targets and end states are provided under Section 5.4 of this report.

Status of the initial mission findings

Suggestion2 (S2) is closed as the Government has issued the "National Policy on safe management of radioactive waste, decommissioning and spent nuclear fuel".

Suggestion3 (S3) is closed as PAEC has developed national strategies for the decommissioning of facilities, for the safe management and disposal of radioactive waste and for the safe management of spent nuclear fuel with appropriate interim targets and end states.

1.8. COMPETENCE FOR SAFETY

There were no findings in this area in the initial IRRS mission.

1.9. PROVISION OF TECHNICAL SERVICES

There were no findings in this area in the initial IRRS mission.

2. GLOBAL NUCLEAR SAFETY REGIME

2.1. INTERNATIONAL OBLIGATIONS AND ARRANGEMENTS FOR INTERNATIONAL COOPERATION

2014 MISSION RECOMMENDATIONS, SUGGESTIONS	
Observation: *Pakistan is not party to the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management.*	
(1)	**BASIS: GSR Part 1 Requirement 14 states that** *"The government shall fulfil its respective international obligations, participate in the relevant international arrangements, including international peer reviews, and promote international cooperation to enhance safety globally."*
(2)	**BASIS: GSR Part 1 para. 3.2 states that** *"The features of the global safety regime include a) international conventions that establish common obligations and mechanisms for ensuring protection and safety …"*
S4	**Suggestion:** The Government should consider becoming party to the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management.

Changes since the initial IRRS mission

Suggestion 4: A team comprising officials from PAEC, PNRA and SPD was established in 2018 with the aim of evaluating whether Pakistan should join the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (the Joint Convention). This team identified certain queries accordingly that were discussed with IAEA in a virtual workshop in 2021. Currently, the issue is still under consideration at the Government level. Pakistan has made some progress since the initial mission in 2014 but there is still no clear roadmap and commitment from the Pakistan to become a contracting party of the Joint Convention. Representatives from the Ministry of Foreign Affairs explained that processes to join international conventions are taken seriously and, therefore, take a long time in Pakistan due to legal vetting and clarification of responsibilities and possible adaptations to the national legal framework.

The IRRS team observed that PNRA and PAEC have made significant progress by developing regulations, policies and strategies for spent fuel and radioactive waste management, including disused radioactive sources. PAEC has developed technical concepts and implemented technical solutions for spent fuel storage in dry casks. Furthermore, sites have been identified for two near surface disposal facilities for low level radioactive waste. The end-state for K-1 has been determined according to the decommissioning strategy. In this regard, it was recognized that hosting an ARTEMIS peer review mission would be beneficial for Pakistan to possibly improve the national programme for spent fuel and radioactive waste management and to collect experience feedback from other IAEA members for instance for the dismantling of CANDU type reactors.

Status of the initial mission finding

Suggestion 4 (S4) remains open as the Government has made no decision yet to become a Contracting Party to the Joint Convention.

2.2. SHARING OF OPERATING EXPERIENCE AND REGULATORY EXPERIENCE

There were no findings in this area in the initial IRRS mission.

3. RESPONSIBILITIES AND FUNCTIONS OF THE REGULATORY BODY

3.1. ORGANIZATIONAL STRUCTURE OF THE REGULATORY BODY AND ALLOCATION OF RESOURCES

There were no findings in this area in the initial IRRS mission.

3.2. EFFECTIVE INDEPENDENCE IN THE PERFORMANCE OF REGULATORY ACTIVITIES

2014 MISSION RECOMMENDATIONS, SUGGESTIONS	
Observation: *The draft regulation to establish the tribunal on dispute resolution between PNRA and its licensee has not been approved.*	
(1)	**BASIS: GSR Part 1 Requirement 21 states that** *"The regulatory body shall establish formal and informal mechanisms of communication with authorized parties on all safety related issues, conducting a professional and constructive liaison."*
R4	**Recommendation:** PNRA should approve the regulation that allows PNRA to formally resolve conflicts between PNRA and its licensees through the establishment of special tribunals.

Changes since the initial IRRS mission

Recommendation 4: PNRA issued "Regulations on Dispute Resolution- (PAK/949)" in 2019. These regulations prescribe the process for resolving disputes between the PNRA Directorates and licensees through the establishment of special tribunals. The tribunals may be established when required by the Chairman on behalf of the Authority.

These regulations provide that "the Chairman's determination on decision taken by any of the tribunals, pursuant to these regulations, is final and deemed to be a decree of civil court under the Code of Civil Procedure, 1908 (Act V of 1908). Aggrieved party may further file an appeal under the Code of Civil Procedure, 1908 (Act V of 1908)". Since issuing these regulations, no appeal has been received by PNRA on which a tribunal needed to be established.

Status of the initial mission finding

Recommendation 4 (R4) is closed as PNRA issued the "Regulations on Dispute Resolution" (PAK/949) which includes the establishment of tribunals to resolve disputes which may arise between the licensee and PNRA.

3.3. STAFFING AND COMPETENCE OF THE REGULATORY BODY

There were no findings in this area in the initial IRRS mission.

3.4. LIAISON WITH ADVISORY BODIES AND SUPPORT ORGANIZATIONS

2014 MISSION RECOMMENDATIONS, SUGGESTIONS	
Observation: *PNRA does not have a process to ensure that there is no conflict of interest for those organizations that provide the regulatory body with advice or services.*	
(1)	**BASIS: GSR Part 1 Requirement 20, para 4.20 states that** *"Arrangements shall be made to ensure that there is no conflict of interest for those organizations that provide the regulatory body with advice or services. If this is not possible domestically, then the necessary advice or assistance shall be sought from organizations in other States or, as and where appropriate, from international organizations which have no such conflicts of interest."*
R5	**Recommendation:** PNRA should develop arrangements to ensure that there is no conflict of interest for those organizations that provide the regulatory body with advice or services.

Changes since the initial IRRS mission

Recommendation 5: PNRA Ordinance Section 15 authorizes PNRA to obtain services from advisors and consultants.

In 2016, PNRA revised its Management System Manual (MSM) in accordance with the IAEA standards GSR Part 2. The revised MSM now includes provisions for dealing with conflicts of interest. Chapter 3.11 "Conflict Management" states that "to avoid conflicts of interest, while taking advice or services of other organizations, PNRA ensures that necessary arrangements are in place. Top management is responsible for ensuring that such arrangements are implemented accordingly. "Chapter 5.4 "Control of Outsourced Activities" states that "PNRA is responsible to ensure that the (outsourced) activities are performed according to the relevant requirements of the management system and PNRA decides on the use of the output from the outsourced processes/activities in regulatory decision making.

PNRA has also developed an internal procedure "Organizational Arrangements to Avoid Conflict of Interests While Taking Advice or Services for support in Regulatory Decision Making (PNRA-WP-060). The procedure, issued in 2021, has been established to ensure that there is no conflict of interest while taking advice or services of other organizations.

The IRRS team noted that PNRA has technical support centres. PNRA has never needed technical support or advice from external organizations other than the nuclear regulatory body of China. In the case that some external services are necessary, PNRA obtains them in compliance with Government rules.

Status of the initial mission finding

Recommendation 5 (R5) is closed as PNRA has made arrangements in the management system for the resolution of conflicts arising in regulatory decision-making processes.

3.5. LIAISON BETWEEN THE REGULATORY BODY AND AUTHORIZED PARTIES

There were no findings in this area in the initial IRRS mission.

3.6. STABILITY AND CONSISTENCY OF REGULATORY CONTROL

There were no findings in this area in the initial IRRS mission.

3.7. SAFETY RELATED RECORDS

There were no findings in this area in the initial IRRS mission.

3.8. COMMUNICATION AND CONSULTATION WITH INTERESTED PARTIES

2014 MISSION RECOMMENDATIONS, SUGGESTIONS	
Observation: *A suitable programme to communicate with authorities, licensees and the public in regions of interest regarding regulatory and operational issues at facilities does not exist and there is no mechanism for feedback of information to PNRA from these affected areas.*	
(1)	**BASIS: GSR Part 1 para 4.66 states that** *"The regulatory body shall establish, either directly or through authorized parties, provision for effective mechanisms of communication, and it shall hold meetings to inform interested parties and the public ...."*
(2)	**BASIS: GSR Part 1 para 4.67 states that** *"The regulatory body, in its public informational activities and consultation, shall set up appropriate means of informing interested parties, the public and the news media about ...."*
(3)	**BASIS: GSR Part 1 para 4.69 states that** *"Public information activities shall reflect the radiation risks associated with facilities and activities, in accordance with a graded approach."*
R6	**Recommendation:** PNRA should develop effective mechanisms of communication, and hold meetings to inform interested parties, the public and the media to keep these parties informed on the decision-making process and on the risk of radiation, in accordance with the graded approach.

Changes since the initial IRRS mission

Recommendation 6: PNRA has set up a process for communication with interested parties, including the public and the licensees, under its management system. This process MP-5 is described in the management system manual (MSM). In 2014, PNRA had already assigned an official spokesperson and alternate spokesperson to act as a consistent voice on behalf of the organisation. "Procedure of PNRA Spokesperson's Interaction with Media" (PNRA-WP-010) was developed in 2021 accordingly. In addition, the document "Task and Functions of PNRA Departments" (PNRA-MED-3405) identifies the generic tasks assigned to departments in relation to communication and consultation with interested parties, namely:

- Implementation of PNRA management system;
- Dissemination of relevant information within PNRA;
- Maintaining and updating a portal on the intranet;
- Organize coordination meetings and corporate level meetings.
- Review and update relevant information on the PNRA Webpage.
- Plan and implement the public awareness programme

Additionally, PNRA also developed two procedures related to communication with interested parties:

- "Procedure for the Conduct of Coordination and Corporate Level Meetings (PNRA-NSD-WP-117)";
- "Procedure for Public Awareness Program in Universities/Colleges (PNRA-NISAS-WP-009)".

The "Strategic Plan for the Years 2019 – 2023" includes a dedicated section which sets out in broad terms stakeholder communication activities with associated timeframes for implementation. In addition, PNRA also participates in Pakistan Environmental Protection Agency (EPA) led public hearings.

Status of the initial mission finding

Recommendation 6 (R6) is closed as PNRA has developed mechanisms for communication with interested parties.

4. MANAGEMENT SYSTEM OF THE REGULATORY BODY

4.1. IMPLEMENTATION AND DOCUMENTATION OF THE MANAGEMENT SYSTEM

2014 MISSION RECOMMENDATIONS, SUGGESTIONS	
Observation: *The Management System Manual does not include some key issues required by GS-R-3, namely Safety Culture, Graded Approach, Responsibility of the Organization for the Management System, Authorities and Responsibilities of Process Owners, The Control of Processes Contracted to External Organizations, and Managing Organizational Changes.*	
(1)	**BASIS: GS-R-3 para. 2.5 states that** *"The management system shall be used to promote and support a strong safety culture …"*
(2)	**BASIS: GS-R-3 para. 2.6 states that** *"The application of management system requirements shall be graded so as to deploy appropriate resources…"*
(3)	**BASIS: GS-R-3 para. 2.7 states that** *"Grading of the application of management system requirements shall be applied to the products and activities of each process."*
(4)	**BASIS: GS-R-3 para. 3.14 states that** *"The organization shall retain overall responsibility for the management system when an external organization is involved in the work of developing all or part of the management system."*
(5)	**BASIS: GS-R-3 para. 5.6 states that** *"For each process a designated individual shall be given the authority and responsibility for…"*
(6)	**BASIS: GS-R-3 para. 5.10 states that** *"The control of processes contracted to external organizations shall be identified within the management system. The organization shall retain overall responsibility when contracting any processes."*
(7)	**BASIS: GS-R-3 para. 5.28 states that** *"Organizational changes shall be evaluated and classified according to their importance to safety and each change shall be justified."*
(8)	**BASIS: GS-R-3 para. 5.29 states that** *"The implementation of such changes shall be planned, controlled, communicated, monitored, tracked and recorded to ensure that safety is not compromised."*
S5	**Suggestion:** PNRA should consider issuing the new revision of the PNRA Management System Manual, which incorporates • Safety Culture, • Graded Approach, • Responsibility of the Organization for the Management System, • Authorities and Responsibilities of Process Owners, • The Control of Processes Contracted to External Organizations • and Managing Organizational Changes, in accordance with its self-assessment action plan.

Changes since the initial IRRS mission

Suggestion 5: PNRA updated its management system in 2010 to align it with the IAEA safety standard GS-R-3. The management system manual (MSM) was updated in 2016 to give due consideration to the new IAEA Safety Standard GSR Part 2 "Leadership and Management for Safety". The IRRS team concluded that the updated MSM includes all missing elements which were identified during the IRRS mission in 2014, including those related to:

- Safety culture;
- Graded approach;
- Responsibility of the organization for the management system;
- Authorities and responsibilities of process owners;
- The Control of processes contracted to external organizations;
- Management of changes.

Status of the initial mission finding

Suggestion 5 (S5) is closed as PNRA revised its MSM which now includes all of the missing elements identified during the initial mission in 2014.

4.2. MANAGEMENT RESPONSIBILITY

There were no findings in this area in the initial IRRS mission.

4.3. RESOURCE MANAGEMENT

There were no findings in this area in the initial IRRS mission.

4.4. PROCESS IMPLEMENTATION

2014 MISSION RECOMMENDATIONS, SUGGESTIONS	
Observation: *The status of review of some PNRA management system documents is not always evident or identified.*	
(1)	**BASIS: GS-R-3 para 5.12 states that** *"Documents shall be controlled. …"*
S6	**Suggestion:** PNRA should consider documenting the status of review of relevant documents.
Observation: *Several documents containing original signatures, documenting transactions with the operator, and documenting internal reviews and approvals were observed. From discussion with PNRA staff, there does not appear to be in place a process to ensure duplication of such records to assure preservation of the information and retention. This presents a potential vulnerability of information related to the regulatory basis for licensing and related basis for decision.*	
(1)	**BASIS: GS-G-1.4 section 5.22 states that** *"The regulatory body should establish a system to control the preparation, review, approval, issuance, revision, distribution and storage of documents".*
(2)	**BASIS: GS-G-1.4 section 5.26 states that** *"The effectiveness of the document control system should be evaluated on the basis of the capability of retrieving documentation under different conditions and for different search criteria (such as*

2014 MISSION RECOMMENDATIONS, SUGGESTIONS	
	by date, source, type or subject). Numerical indicators relating to the time necessary for retrieving the documentation may be established and monitored, and deviations may be recorded and corrected. Systems and conditions for the storage of records should also be reviewed periodically. Guidance on quality assurance for document control and records is provided in Ref. [6].”
(3)	**BASIS: GS-R-3 para. 5.21 states that** *“Records shall be specified in the process documentation and shall be controlled. All records shall be readable, complete, identifiable and easily retrievable.”*
S7	**Suggestion:** PNRA should consider establishing a document control system to ensure protection and preservation of regulatory related records, which addresses retention and archiving of records.

Changes since the initial IRRS mission

Suggestion 6: PNRA has updated its “Procedure for Development of Procedures and Programs (PNRA-WP-005) (Rev.1)” in order to identify the status and ensure traceability of management system documents. The status of review of procedures and programmes is addressed under section 8 (iv) of this procedure, and the coding system for PNRA documentation is established in Section 11.

This procedure provides guidance to PNRA employees and describes a consistent and systematic approach to be followed at PNRA for developing procedures and programmes. This together with other procedures specifies that all procedures and programmes should be reviewed every two years and revised if necessary. The status of these reviews should be formally documented.

All PNRA procedures (Organization level procedures and Directorate level procedures) are available to all employees through the PNRA Intranet. The approved and signed originals of the procedures and programmes are sent to the central registry for storage.

Similarly, PNRA upgraded procedures related to development of regulations and development of regulatory guides, namely:

- Status of review of regulations is addressed under section 12 of "Procedure for Development of Regulations (PNRA-WP-004) (Rev.2)". Coding system for PNRA Regulation is described in section 7; and
- Status of review of regulatory guides is addressed under section 12 of "Procedure for Development of Regulatory Guides (PNRA-WP-001) (Rev.1)". Coding system for PNRA procedures is described in section 7;

Suggestion 7: PNRA has upgraded its existing document control system to ensure protection and preservation of regulatory related records, which addresses retention and archiving of records. The system is documented in detail in the “Procedure for Control of Regulatory Records” (PNRA-WP-037). Among others, this procedure identifies the different types of records and provides the provisions for control and retrieval of regulatory records in office.

All the original records are in hard-copy and are kept within the responsible departments. The copies of significant records such as licence submissions are sent to the library for record keeping.

Additionally, PNRA has developed a centralized documentation control system using a proprietary platform. It is available over the PNRA Local Area Network (LANs). Currently, the system has been implemented in a number of PNRA departments. However, PNRA intends to make the system available to all the departments.

Status of the initial mission findings

Suggestion 6 (S6) is closed as PNRA has upgraded and implemented the "Procedure for Development of Procedures and Programs (PNRA-WP-005)".

Suggestion 7 (S7) is closed on the basis of progress made and confidence in the effective completion as PNRA's centralized documentation control system is under development and will be completed soon.

4.5. MEASUREMENT, ASSESSMENT AND IMPROVEMENT

There were no findings in this area in the initial IRRS mission.

5. AUTHORIZATION

5.1. GENERIC ISSUES

2014 MISSION RECOMMENDATIONS, SUGGESTIONS	
Observation: *The category of licence issued by PNRA to some of the facilities is not demonstratively consistent with the definition of Nuclear Installation as defined in the Ordinance.*	
(1)	**BASIS: GSR Part 1 Requirement 22 states that** *"The Regulatory body shall ensure that regulatory control is stable and consistent…. The process shall ensure the stability and consistency of regulatory control and shall prevent subjectivity in decision making by the individual staff members of the regulatory body"*
S8	**Suggestion:** PNRA should consider revisiting the current licences and ensure their categorization is consistent with the definition of Nuclear Installation as defined in the Ordinance.
Observation: *A formal documented process to allow appeals against its decisions regarding granting of an authorization to a facility, and activity and conditions attached with the authorization is not in place.*	
Observation: *A mechanism to allow the licensee a right of appeal does not exist. A regulation is being developed and PNRA needs to issue this document.**(reference to R7 is made in Section 8.1)***	
(1)	**BASIS: GSR Part 1 para 4.32 states that** *"The regulatory body shall establish a process that allows the authorized party to appeal against a regulatory decision relating to an authorization for a facility or an activity or a condition attached to an authorization."*
(2)	**BASIS: GSR Part 1 para 2.5 (11) states that** *"The government shall promulgate laws and statutes to make provision for an effective governmental, legal and regulatory framework for safety. This framework for safety shall set out the following:…* *(11) Provision for appeals against decisions of the regulatory body; …"*
(3)	**BASIS: GSR Part 1 para. 2.5 (11) states that** *"The government shall promulgate laws and statutes to make provision for an effective governmental, legal and regulatory framework for safety. This framework for safety shall set out the following:…* *(11) Provision for appeals against decisions of the regulatory body; …"* ***(reference to R7 is made in Section 8.1)***
(4)	**BASIS: GSR Part 1 para. 4.32 states that** *"The regulatory body shall establish a process that allows the authorized party to appeal against a regulatory decision relating to an authorization for a facility or an activity or a condition attached to an authorization."**(reference to R7 is made in Section 8.1)***
R7	**Recommendation:** PNRA should develop procedures for appeal against regulatory decisions.

Changes since the initial IRRS mission

Suggestion 8: PNRA has systematically reviewed operating licences to confirm that the correct classification of Radiation Facilities or Nuclear Installations is in place. The operating licence issued to the Molybdenum Production Facility (MPF) as a Radiation Facility was found to be inconsistent with the definition of Nuclear Installation provided in the Ordinance. Accordingly, the status of MPF was changed from Radiation Facility to Nuclear Installation.

The basis of a new operating licence (OL) was changed from PAK/908 (Regulations for the Licensing of Radiation Facilities other than Nuclear Installation(s)) to PAK/909 (Regulations for Licensing of Nuclear Installations in Pakistan), which provide a new basis for licencing the Molybdenum Production Facility (MPF). In 2015, PNRA amended the operating licence for MPF accordingly.

Recommendation 7: PNRA formulated new Regulations on Dispute Resolution (PAK/949), which were issued in December 2019. These new regulations cover all the important steps and processes for appeals. They establish a well-defined and transparent process. The main sections are:

- Establishment and Composition of Tribunals
- Filing of Appeal for Dispute Resolution
- Requirements for Appeal.
- Initial Assessment of the Appeal
- Respondent's Reply
- Compilation of Information
- Meetings of the Tribunal
- Service of Notice
- Hearing by the Tribunal
- Dispute Withdrawal
- Contents of a Decision
- Determination on the Decision by the Authority
- Communication of the Decision

Status of the initial mission findings

Suggestion 8 (S8) is closed as PNRA has analysed and resolved the inconsistency in licensing.

Recommendation 7 (R7) is closed as PNRA has issued new "Regulations on Dispute Resolution-PAK/949".

5.2. AUTHORIZATION OF NUCLEAR POWER PLANTS

2014 MISSION RECOMMENDATIONS, SUGGESTIONS	
Observation: *PNRA has not developed guidance for licensing submissions defining format and content for nuclear facilities, which may result in applicants not fully understanding the regulatory requirements and expectations.*	
(1)	**BASIS: GSR Part 1 para 4.62 states that** *"The regulations and guides shall provide the framework for the regulatory requirements and conditions to be incorporated into individual authorizations or applications for authorization."*

2014 MISSION RECOMMENDATIONS, SUGGESTIONS	
S9	**Suggestion:** PNRA should consider continuing to develop guidance defining format and technical contents of licensing submissions for nuclear power plants and research reactors.
Observation: *PNRA lacks processes to involve the public in the authorization and licensing processes for NPPs.*	
(1)	**BASIS: SSG-12 para. 2.44 (d) states that** *"Comments from the public should be addressed at all steps of the licensing process."*
S10	**Suggestion:** PNRA should consider developing processes to involve the public in authorization and licensing processes for NPPs.

Changes since the initial IRRS mission

Suggestion 9: PNRA has developed and issued regulatory guides defining the format and content of licensing submissions. Only one regulatory guide remains to be finalized.

The guides are well formulated and cover all the relevant topics that were addressed in the IRRS mission.

Draft 5 of the regulatory guide "RG on format and content of Pre-service/In-service Inspection (PSI/ISI) Programs" (PNRA-RG-909.04) was included in the ARM and draft of the regulatory guide is in its final stage of approval (draft 6 was sent in February 2022, for review and comments by all relevant stakeholders).

Suggestion 10: PNRA does not have a process for conducting a formal public hearing for authorization and licensing of NPPs. PNRA considers that the public hearing undertaken separately by the Environmental Protection Agency early in the process gives sufficient opportunity for public consultation.

The IRRS team explored how issues concerning "non-environmental" aspects can be examined in these public hearings and was informed that the public is kept informed of PNRA licensing decisions through its website. The public will also be informed through print media regarding issuance of licences (construction licence, operating licence, etc.) to nuclear installations. The public always has the opportunity to send to PNRA concerns or questions through email, letters, etc. which are then addressed systematically.

In response, PNRA was asked to provide recent examples of such questions sent by the public for K-2/K-3 sites. PNRA provided lists of received questions and showed that these are addressed.

The IRRS team acknowledged that there are processes/possibilities for the public to approach PNRA regarding questions and concerns. Nevertheless, there is no actual systematic involvement of the public in the authorization and licensing processes. The coverage and scope of the EPA process and its public hearings is not considered sufficiently broad to involve public in all steps of the licensing process of Nuclear Power Plants.

Status of the initial mission findings

Suggestion 9 (S9) is closed on the basis of progress made and confidence in the effective completion as the draft 6 was sent for review and comments by the stakeholders.

Suggestion 10 (S10) remains open as there is no actual systematic involvement of the public in the authorization and licensing processes.

5.3. AUTHORIZATION OF RESEARCH REACTORS

There were no findings in this area in the initial IRRS mission.

5.4. AUTHORIZATION OF RADIOACTIVE WASTE MANAGEMENT FACILITIES

2014 MISSION RECOMMENDATIONS, SUGGESTIONS	
Observation: *Regulatory requirements for the development of different types of disposal facilities for radioactive waste are not yet in place.*	
(1)	**BASIS: SSR-5 Requirement 2 states that** *"The regulatory body shall establish regulatory requirements for the development of different types of disposal facility for radioactive waste and shall set out the procedures for meeting the requirements for the various stages of the licensing process. It shall also set conditions for the development, operation and closure of each individual disposal facility and shall carry out such activities as are necessary to ensure that the conditions are met".*
S11	**Suggestion:** PNRA should consider finalising regulations on the different types of disposal facilities for radioactive waste.
Observation: *PNRA is using PAK/913 for the safety of spent nuclear fuel stored at NPP but there is no specific regulations/requirements for the safe management of spent nuclear fuel covering steps beyond the current conditions of storing spent fuel in the spent fuel pool.*	
(1)	**BASIS: GSR Part 1 Requirement 32 states that** *"Regulatory body shall establish or adopt regulations and guides to specify the principles, requirements and associated criteria for safety upon which its regulatory judgments, decisions and actions are based".*
S12	**Suggestion:** PNRA should consider finalising specific requirements for the safe management of spent nuclear fuel in anticipation of storing spent fuel outside the existing spent fuel pools.

Changes since the initial IRRS mission

Suggestion 11: In 2014, regulatory requirements or guidance for licensees or potential operators of radioactive waste disposal sites were not given in detail in Regulations on Radioactive Waste Management (PAK/915 Rev. 0). Furthermore, there were no operational radioactive waste disposal sites in Pakistan at that time. Radioactive waste and spent fuel accumulating from operation of the two licensed NPP sites at Karachi and Chashma were being stored on these sites, pending their final disposal and this remains the case. In addition, the Pakistan Institute of Nuclear Science and Technology (PINSTECH) accumulates and stores radioactive waste being generated from its own activities, and from radiation facilities located in northern regions of the country. Whereas waste generated from radiation facilities in southern region of the country is being stored at K-1 site. Since 2014, the capacity for Low-Level Radioactive Waste (LLW) storage has been increased at Chashma site through construction of an extension to the original store. Eventually, all this radioactive waste will need to be safely disposed of.

PNRA has the necessary expertise for regulating the operation of predisposal radioactive waste management facilities and in July 2019, PNRA revised its Regulations on Radioactive Waste Management - PAK/915 (Rev. 1). In its revision PNRA has considered aspects of IAEA SSR 5 related to disposal. Notably the scope of PAK/915 (Rev. 1) now clearly specifies its application to different types of disposal facilities such as landfill, near-surface, geological, and borehole. Furthermore, in Section 16 requirements for the characterization and classification of Radioactive Waste are set out and the classifications detailed further in Schedule II. In Sections 22 and 26 both generic and more detailed requirements for disposal of radioactive waste are set out.

At the time of the follow-up mission, PAEC (the responsible body for safe radioactive waste and spent fuel management) had identified two disposal sites for the increasing amounts of LLW accumulating from nuclear and radiation facilities and activities in Pakistan. PNRA is actively discussing the technical and safety provisions needed for the sites with PAEC. One site is at the Karachi NPP on the existing licensed site and the other is in the Punjab region approximately 100 km from the Chashma NPP site. These sites, when constructed, will facilitate LLW disposal on a regional basis minimising the transportation of LLW from its points of generation. Initial indications are that the two disposal facilities will be constructed near-surface and lined with concrete in a modular configuration, so that any future waste arising from an expanding industry can be accommodated. PAEC is well advanced in its process of site evaluation and had entered into technical discussions with PNRA on waste acceptance criteria for disposal purposes and other aspects that will enable PNRA to eventually licence both facilities in accordance with regulations PAK/909.

In addition, PAEC issued a national strategy for the management of radioactive waste in August 2021 (DGNR-NRID-ST-003, Rev 0) consistent with regulations PAK/915 (Rev. 1) regarding waste classification and providing for each class of waste options for treatment, conditioning and disposal.

In relation to spent fuel management, arrangements for safe interim storage are being progressed pending a disposal solution becoming available in Pakistan (see Suggestion 12).

Suggestion 12: At the time of the initial mission, spent nuclear fuel was being stored in fuel ponds at the licensed reactor sites. This remains the case today for the operating NPP units at Karachi and Chashma and for the Research Reactors at PINSTECH. The licences for the newer units at both NPP sites also include provision for on-site storage of spent fuel.

In 2014, PNRA cited PAK/913, related to the safety of NPP operation, as the legal basis for the safety of storage of spent fuel following its discharge from the reactor cores, however this was restricted in scope to storage only in the associated reactor spent fuel pools; the scope of PAK/913 is unchanged.

In 2018, PNRA developed and issued the “National Policy on Safe Management of Radioactive Waste, Decommissioning and Spent Nuclear Fuel in Islamic Republic of Pakistan” (RWP-01/2018). This policy states that “spent nuclear fuel is a valuable asset. Currently, the spent nuclear fuel is stored at licensed nuclear facilities”. A final decision on the disposal of spent fuel has yet to be made by PAEC who are responsible in the interim for its safe and secure management.

In accordance with the National Policy, PNRA developed new regulations entitled the "Regulations for Safe Management of Spent Nuclear Fuel (PAK/918)" which came into force in September 2020. The scope of these regulations includes all aspects of both dry (cask) and wet storage for the safe management of spent fuel once it has been removed from the spent fuel pools at the reactor sites. The regulations set out requirements for longer-term interim safe storage of spent fuel pending identification of a final disposal route or other solution. The regulations

stipulate that the design approval certificate for a storage cask is issued by PNRA for a duration of up to twenty years and can subsequently be revalidated for a further twenty years.

Now that the first NPP unit K-1 is permanently shut down and undergoing Phase I of its decommissioning lifecycle stage, which is principally focused on the safe management of spent fuel, practical implementation measures are in place for interim safe storage of the spent fuel being removed from the reactor core. Following a suitable cool downtime in the spent fuel pool due to decay heat (estimated at 10 years for the last spent fuel assembly) the licensee is placing the spent fuel bundles into dry storage casks. The removal of all spent fuel from the core is anticipated to take about two years. At the time of the follow-up mission, 10 casks had been filled and placed in dry cask storage building located at K-1 site. In addition, the dry cask storage building will accommodate more than 300 casks necessary to remove all of the spent fuel from the K-1 reactor core and spent fuel pool, thereby allowing K-1 to enter the next phase of decommissioning (a deferral period of 30 years). PNRA has reviewed, assessed and approved both the dry casks and the interim storage building. The interim storage building has been licensed within the existing licence scope for K-1. The Final Decommissioning Plan of K-1 submitted in 2021 is currently under review by PNRA. A similar interim storage facility is being constructed on the Chashma site in anticipation of the need for cask storage of spent fuel for casks of a different design because of difference in fuel bundle configuration.

Status of the initial mission findings

Suggestion 11 (S11) is closed as PNRA revised and issued the regulation PAK/915 Rev. 1 in 2019 by including different types of disposal facilities in the scope and set out the requirements that the licensee should follow.

Suggestion 12 (S12) is closed as PNRA issued the Regulations for the Safe Management of Nuclear Fuel-PAK/918, in September 2020 which clearly sets out the regulatory requirements for spent fuel management.

5.5. AUTHORIZATION OF RADIATION SOURCES FACILITIES

2014 MISSION RECOMMENDATIONS, SUGGESTIONS	
Observation: *The qualification criteria issued by PNRA for radiation workers do not cover the qualification requirements for all radiation workers. The full set of criteria of qualification in protection and safety for radiation workers in all types of activities with radiation sources is in draft form as a part of Rev. 1 of Regulations PAK/908.*	
(1)	**BASIS: GSR Part 3 para. 2.32. states that** *"The regulatory body shall ensure the application of the requirements for education, training, qualification and competence in protection and safety of all persons engaged in activities relevant to protection and safety. "*
S13	**Suggestion:** PNRA should consider finalising and issuing the regulation to establish a full set of qualification criteria in protection and safety for radiation workers in all types of applications of radiation sources.
Observation: *Optimisation of regulatory resources/efforts in the authorization of radiation facilities is not fully implemented. Validity of licences for all types of activities is the same (1 year) despite the associated level of risk.*	

2014 MISSION RECOMMENDATIONS, SUGGESTIONS	
(1)	**BASIS: GSR Part 1 para 4.3 states that***"... The performance of regulatory functions shall be commensurate with the radiation risks associated with facilities and activities, in accordance with a graded approach."*
(2)	**BASIS: GSR Part 1 para. 4.5 states, that** *"... The regulatory body shall allocate resources commensurate with the radiation risks associated with facilities and activities, in accordance with a graded approach...."*
S14	**Suggestion:** PNRA should consider optimising the duration of licences for activities with radiation sources.

Changes since the initial IRRS mission

Suggestion 13: In December 2020, PNRA issued the "Regulations on Radiation Protection-PAK/904 (Rev.1)" which established a full set of qualification criteria in protection and safety for professionals of radiation workers in all types of applications for radiation sources.

Section 9 of the Regulations specify that all personnel engaged in radiation protection and safety should be qualified and appropriately trained to fully understand their duties and responsibilities to perform their tasks based on defined procedures.

Section 11 of the regulations imposes an obligation on the licensee to designate only professionals who meet the qualification criteria and to implement training and retraining program for professionals. Qualification criteria for professionals, including required experience and training, as well as content of the training are provided in Schedules II and III of the revised Regulation PAK/904.

The IRRS team noted that the PNRA requires the applicant to provide evidence of appropriate education, training, qualification and competence in protection and safety when applying for a licence.

Suggestion 14: In December 2019, PNRA issued the revised Regulation PAK/908 (Rev.1). In order to address the optimisation of the duration of the licence, the regulations introduced a new requirement for small radiation facilities, e.g. X-ray facilities and CT scanners.

PNRA grants the initial licence for one year when all applicable requirements are met. However, the optimisation has been introduced in the next stage, during licence renewal. The licence may be renewed for a maximum period of five years. The IRRS team considered that a very large number of facilities belongs into that category and that this approach can significantly reduce the regulatory burden associated with renewals.

However, the criteria for determining the duration of a renewed licence for small facilities have not been set yet. The IRRS team was informed that in practice the duration of the renewal of the licence for small radiation facilities from one to five years is determined based on the request of the licensees. The IRRS team is of the view that this criterion is not based on the radiation risk, which should be the basis for applying a graded approach, and believe that an additional guidance, clearly defining the criteria for different licence durations, would be useful to PNRA as well as the licensees.

Status of the initial mission findings

Suggestion 13 (S13) is closed as the revised "Regulations on Radiation Protection-PAK/904 (Rev.1)" which incorporates detailed set of qualification criteria to address the suggestion has been issued.

Suggestion 14 (S14) is closed as PNRA has issued the revised "Regulations-PAK/908 (Rev.1)", thereby optimizing the duration of licence validity.

5.6. AUTHORIZATION OF DECOMMISSIONING ACTIVITIES

2014 MISSION RECOMMENDATIONS, SUGGESTIONS	
Observation: *The list of documents to be submitted with the application for the licence for decommissioning does not include a plan for the remediation of the site. See also observation in Section 6.6.*	
Observation: *The detailed specific regulations on decommissioning (PAK/930) are at the final stages of approval.* ***(reference to S15 is made in Section 6.6)***	
(1)	**BASIS: SSG-12 para. 3.83 states that** *"Decommissioning comprises: the preparation and approval of a detailed decommissioning plan; the actual decommissioning activities; the management of waste arising from these activities; demonstration that the decommissioning end point is achieved; and the updating of all existing safety related documents, as appropriate, including documents on physical protection and emergency response and the plan for remediation of the site".*
(2)	**BASIS: GSR Part 1 Requirement 32 states that** *"The regulatory body shall establish or adopt regulations and guides to specify the principles, requirements and associated criteria for safety upon which its regulatory judgments, decisions and actions are based"* ***(reference to S16 is made in Section 6.6)***
S15	**Suggestion:** PNRA should consider finalising and issuing the proposed regulation PAK/930 addressing site remediation considerations and decommissioning of facilities using radioactive material.

Changes since the initial IRRS mission

Suggestion 15: In 2014, there were no prospects of decommissioning any nuclear facility. However, the licensee (PAEC) for Karachi NPP was expected, in the near-term, to make an application to PNRA to authorize the decommissioning of Unit K-1 at the site. However, Unit K-1 remained operational for several years. Then in 2018, PNRA was notified of the licensee's intention to finally shutdown Unit K-1 to prepare for its decommissioning lifecycle stage, and in August 2021 Unit K-1 was permanently shut down. PAEC submitted an application for a decommissioning licence to PNRA along with the final decommissioning plan in September 2021.

Prior to final shutdown PNRA began discussions with the licensee to finalize the safety and other related documentation that is required to be submitted to gain PNRA approval to commence decommissioning of Unit K-1. As this will be the first NPP to undergo decommissioning in Pakistan, PNRA has conducted a thorough review and assessment of the PAEC final

decommissioning plan raising many technical queries that the licensee is addressing. PNRA anticipates, resolution of these issues will take some time before it will be in a position to approve the K-1 final decommissioning plan. PAEC has included a clear justification for taking a deferred dismantling approach in its plan. The first phase will take 15 years and is in essence involves spent fuel removal for interim storage in dry casks within a facility constructed on the site. This will be followed by a period of 30 years of surveillance to accrue the benefits of radioactive decay and to accumulate more funds and learn from others' experience. The extent of surveillance will be reviewed prior to entering the 30-year quiescent period.

At the time of the initial mission in 2014, various regulations (i.e. PAK/909; PAK/913 and PAK/923) contained regulatory requirements relating to the decommissioning stage of a facility's lifecycle. New Regulations titled "Regulations on Decommissioning of Facilities Using Radioactive Material-PAK/930" was in draft form at that time. Following the initial mission PNRA finalized these regulations, taking account of the requirements contained in IAEA GSR Part 6, and these came into force in December 2016 thus providing a comprehensive legal basis for decommissioning activities at nuclear facilities.

During this process PNRA considered that, in addressing Suggestion 15, it would be more appropriate to include aspects of site remediation in another regulation, namely the Regulations on Radiation Protection (PAK/904). These regulations were revised and re-issued in October 2020 and there is now a clear delineation between the safe decommissioning and dismantling of a facility and the site's final clean-up to meet radiation safety requirements. Specifically, Section 53 of PAK/904 Rev 1 outlines the requirements for site remediation and takes account of the requirements in IAEA GSR- Part 3 for existing exposure situations.

Status of the initial mission finding

Suggestion 15 (S15) is closed as PNRA has issued the Regulations PAK/930 and revised the regulation PAK/904 Rev1 to provide a clear legal basis for safe decommissioning activities and for final site clean-up and remediation respectively.

6. REVIEW AND ASSESSMENT

6.1. GENERIC ISSUES

There were no findings in this area in the initial IRRS mission.

6.2. REVIEW AND ASSESSMENT FOR NUCLEAR POWER PLANTS

There were no findings in this area in the initial IRRS mission.

6.3. REVIEW AND ASSESSMENT FOR RESEARCH REACTORS

There were no findings in this area in the initial IRRS mission.

6.4. REVIEW AND ASSESSMENT FOR WASTE MANAGEMENT FACILITIES

There were no findings in this area in the initial IRRS mission.

6.5. REVIEW AND ASSESSMENT FOR RADIATION SOURCES APPLICATIONS

2014 MISSION RECOMMENDATIONS, SUGGESTIONS	
Observation: *A procedure for review and assessment of applications for the licence for radiation facilities has not been finalised. Criteria to determine when documents are to be reviewed in Regional Directorates, and when these should be sent to the Directorates of Headquarters for review are not defined.*	
(1)	**BASIS: GSR Part 1 para 4.33 states that** *"Prior to the granting of an authorization, the applicant shall be required to submit a safety assessment [8], which shall be reviewed and assessed by the regulatory body in accordance with clearly specified procedures. The extent of the regulatory control applied shall be commensurate with the radiation risks associated with facilities and activities, in accordance with a graded approach.*
(2)	**BASIS: GSR Part 1 para 4.28 states that** *"There shall be consistency in the decision making process of the regulatory body."*
S16	**Suggestion:** PNRA should consider finalising and approving the procedure for review and assessment of licence applications for radiation facilities, including the criteria, in which cases submitted documents are to be reviewed in Regional Directorates, and when these submitted documents are to be sent to the Directorates of Headquarters.

Changes since the initial IRRS mission

Suggestion 16: In 2019, PNRA issued "Procedure for review and assessment of licensing submissions for radiation facilities and activities (PNRA-WP-035 (Rev.0)). The Procedure defines tasks and functions and the corresponding responsibilities of all the directorates involved in the review and assessment process, and provides detailed review and assessment criteria of the application documents required by the PNRA Ordinance and Regulations, specifically PAK/908, such as application form, plan, map, layout of the facility, shielding design and quality assurance programme, etc.

The review and assessment process has a series of steps to ensure the authorization/licensing requirements are fully met. After the receipt and review of all required information/documents from the licensee, the relevant RNSDs will distribute the documents to the technical directorates of PNRA for further review and assessment. The technical directorates will review the documents as specified in the established review criteria and send their comments to the RNSDs. The comments received from the technical directorates will be evaluated and communicated to the licensees in the case of deficiencies in the information provided. The licences are granted by the regional directorates.

The IRRS team also noted that the scope of the review criteria depends on the potential risks associated with the facility or activity, and final review decisions are communicated with official correspondence.

Status of the initial mission finding

Suggestion 16 (S16) is closed as PNRA has issued the procedure for review and assessment of licensing submissions for radiation facilities and activities.

6.6. REVIEW AND ASSESSMENT FOR DECOMMISSIONING ACTIVITIES

Reference is made to Suggestion 15 in Section 5.6.

7. INSPECTION

7.1. GENERIC ISSUES

7.1.1. INSPECTION APPROACHES, METHODS AND PLANS

2014 MISSION RECOMMENDATIONS, SUGGESTIONS	
Observation: *PNRA does not have the capability to quantitatively evaluate risk for event-based findings. Human Factors Engineering (HFE) is not sufficiently considered, and is only considered from a qualitative perspective.*	
(1)	**BASIS: GSR Part 1 para 4.54 states that** *"The response of the regulatory body to non-compliances with regulatory requirements or with any conditions specified in the authorization shall be commensurate with the significance for safety of the non-compliance, in accordance with a graded approach."*
S17	**Suggestion:** PNRA should consider developing a tool to systematically include human factors in evaluating risk for event-based findings.

Changes since the initial IRRS mission

Suggestion 17: The inspection findings of nuclear installations are subject to an evaluation process as described in procedure PNRA-NSD-WP-116 According to this procedure each inspection report prepared by the regional directorates is sent to the Nuclear Safety Directorate (NSD) of PNRA for evaluation and feedback. NSD then has the possibility for relevant inspection findings to request the specialist directorates, including the Centre for Nuclear Safety (CNS), to conduct additional technical evaluation of the findings. The result of the technical evaluation is then fed back to NSD for finalizing the evaluation of the inspection report for sharing purpose with the regional directorates.

PNRA developed a Level-1 Probabilistic Safety Analysis (PSA) Regulatory Model in 2016, which covers Human Reliability Analysis (HRA), having capability to model the possible failures of systems and components due to human errors.

Including through this effort of conducting a PSA, PNRA (CNS) has developed the capability to evaluate human factors' contribution quantitatively when assessing the risk for event-based findings. Upon request, CNS evaluates the event-based findings involving human errors using the base PSA model in order to assess the risk increment and contribution of human errors towards core damage frequency. Examples showing the practical implementation of such evaluation were presented to the IRRS team.

Status of the initial mission finding

Suggestion 17 (S17) is closed as PNRA has developed the capability to evaluate, where appropriate, event-based findings to determine the quantitative contribution of human factors to the safety significance of findings.

7.1.2. INSPECTION PROCESSES AND PRACTICES

There were no findings in this area in the initial IRRS mission.

7.1.3. INSPECTORS

There were no findings in this area in the initial IRRS mission.

7.2. INSPECTION OF NUCLEAR POWER PLANTS

There were no findings in this area in the initial IRRS mission.

7.3. INSPECTION OF RESEARCH REACTORS

2014 MISSION RECOMMENDATIONS, SUGGESTIONS	
Observation: *Inspection of PARR-1 research reactor was not specific enough and lacked technical depth and safety focus.*	
(1)	**BASIS: GSR Part 1 para 4.50 states that** *"The regulatory body shall develop and implement a programme of inspection of facilities and activities, to confirm compliance with regulatory requirements and with any conditions specified in the authorization. In this programme, it shall specify the types of regulatory inspection …"*
S18	**Suggestion:** PNRA should consider defining the scope of inspections more clearly before the activity to assure that appropriate focus on safety and technical details are achieved.

Changes since the initial IRRS mission

Suggestion 18: In 2016, PNRA issued the revision 2 of the inspection programme for nuclear installations (PNRA-WP-00011). This new version provides the improved provisions for guiding inspectors when preparing and conducting regulatory inspections. In particular, it provides a comprehensive list of inspection areas for nuclear installations. For research reactors, all of the inspection areas have to be covered over either one or two years, depending on the thermal power of the research reactor. For example, for the research reactor PARR–I (Pakistan Research Reactor I), PNRA has developed the inspection procedure (PNRA-RNSD-1-WP-012) to complement the inspection programme. This complementary procedure, issued in 2018, gives detailed guidance to regional inspectors for inspecting PARR–I.

The IRRS team is in the view that the inspection programme and relevant implementation procedures establish a strong basis for defining appropriate scope of inspections and for guiding PNRA staff to conduct regulatory inspections on programmatic and technical issues. The inspection reports provided to the IRRS team support this conclusion.

The IRRS team reviewed the PNRA Inspection Policy available at the beginning of the inspection programme (PNRA-WP-011 (Rev. 2)). It was noted that this policy does not address the consideration for application of graded approach in inspections. However, use of a graded approach has been addressed in the text of the inspection programme. The IRRS team was informed that PNRA Inspection Policy will be revised soon to cover the graded approach concept.

Status of the initial mission finding

Suggestion 18 (S18) is closed as the inspection programme and relevant procedures were revised to make the scope of inspections clearer when preparing them.

7.4. INSPECTION OF WASTE MANAGEMENT FACILITIES

There were no findings in this area in the initial IRRS mission.

7.5. INSPECTION OF RADIATION SOURCES FACILITIES

2014 MISSION RECOMMENDATIONS, SUGGESTIONS	
Observation: *Some licensees do not perform quality control tests of radiology equipment and workplace monitoring. PNRA conducts some measurements during the inspections that are adopted by the licensee as a substitute for their own measurements.*	
(1)	**BASIS: GSR Part 1 para 4.49 states that** *"Regulatory inspection cannot diminish the prime responsibility for safety of the authorized party, and cannot substitute for the control, supervision and verification activities conducted under the responsibility of the authorized party."*
R8	**Recommendation:** PNRA should enforce the regulatory requirement that the licensees conduct their own QC measurements.
Observation: *Findings in the inspection report do not take into consideration safety significance of inspection findings.*	
(1)	**BASIS: GSR Part 1 para 4.51 states that** *"The regulatory body shall record the results of inspections and shall take appropriate action (including enforcement actions as necessary). Results of inspections shall be used as feedback information for the regulatory process and shall be provided to the authorized party."*
S19	**Suggestion:** PNRA should consider issuing a procedure to establish categorization of inspection findings using graded-approach to ensure timely enforcement action is taken.

Changes since the initial IRRS mission

Recommendation 8: PNRA ensures through regulatory inspections that the licensees perform their own Quality Control (QC) tests and has also established a process for enforcement under Regulations PAK/950.

The activities undertaken have two aspects, the first related to improving the enforcement of licensees to conduct their own QC tests, while the second is related to raising awareness, as well as the ability of licensees to implement this requirement.

The IRRS team noted that inspections of radiation facilities and activities for ensuring compliance with regulatory requirements are performed according to the established methodology and in line with the annual inspection plan of the regional directorates. As part of its inspection plan, PNRA inspect whether licensees' perform QC measurements independently as specified in the safety requirements. Some of the actions taken by PNRA for enforcing the regulatory requirements related to QC of radiology equipment are:

- Post Inspection Reports to instruct the licensee to conduct QC tests;
- Submission of records of their QC tests;
- Work stop notice in case of serious non-compliance;

- Notice to do a QC test with formal letters.

PNRA provides training through the National Institute of Radiation Safety and Security to further improve the capabilities of licensees. The training also includes practical demonstration and hands on training to familiarize them with the operation of the equipment.

The IRRS team was informed that large hospitals in Pakistan possess a qualified and competent workforce capable of performing QC tests of equipment and carrying out workplace monitoring, as those hospitals have more advanced radiology equipment. However, performing QC measurement of radiology equipment is challenging for a considerable number of small radiation facilities across the country due to limited availability of service providers, QC equipment and qualified experts. PNRA provides guidance to small radiation facilities on how to reach qualified service providers and requests them to submit their records whatever constraints they faced.

The IRRS team is of the opinion that significant progress has been made, both in improving the enforcement process and in raising awareness and capabilities of licensees to perform quality control tests. PNRA expects that the newly revised regulations on technical services in the radiation safety area will help them to expand the network of experts and private companies who could offer these services.

Suggestion 19: In 2019, PNRA issued guidance procedure (PNRA-RNSDs-WP-008 (Rev.0)) for categorization of inspection findings for radiation facilities. This procedure highlights the areas that require more attention and also provides guidance to inspectors to take appropriate enforcement actions based on their safety significance. In addition, categorization of inspection findings is addressed in section 13.4 of the "Inspection Programme for Radiation Facilities and Activities". The IRRS team noted that the recorded findings during inspections are categorized based on graded approach to determine the time frame for implementation of corrective actions following this procedure. The IRRS team reviewed the inspection plans for the previous and the current year and noted that the frequency for conducting inspections of radiation facilities and activities demonstrates a graded approach. The final inspection findings are forwarded to the licensee for its information and records and used as a basis for corrective actions to be taken.

Status of the initial mission findings

Recommendation 8 (S8) is closed on the basis of progress made and confidence in the effective completion as PNRA has improved the enforcement of regulatory requirements for licensees to conduct their own QC measurements.

Suggestion 19 (S19) is closed as PNRA issued the procedures for categorization of inspection findings for radiation facilities taking into account safety significance of the non-compliance using a graded approach.

7.6. INSPECTION OF DECOMMISSIONING ACTIVITIES

There were no findings in this area in the initial IRRS mission.

8. ENFORCEMENT

8.1. ENFORCEMENT POLICY AND PROCESSES

Reference is made to Recommendation 7 in Section 5.1.

2014 MISSION RECOMMENDATIONS, SUGGESTIONS	
Observation: *Follow-up inspections are carried out rarely in the inspection practice for radiation sources. A compliance report received from the licensee is usually accepted as proof that corrective actions are performed.*	
(1)	**BASIS: GS-G-1.5 para 3.76 states that** *"… The regulatory body shall ensure that the operator has effectively implemented any remedial actions."*
(2)	**BASIS: GS-G-1.5 para 3.88 states that** *"Regulatory procedures should state the circumstances under which it is appropriate to carry out further inspections to check whether the operator has responded to regulatory and enforcement measures."*
S20	**Suggestion:** PNRA should consider establishing a procedure for follow-up inspections to ensure that corrective actions have been implemented for safety significant issues.

Changes since the initial IRRS mission

Suggestion 20: PNRA issued the inspection programme (PNRA-IP-001 Rev.0) for radiation facilities and activities in 2019, which covers the provisions for follow-up inspections. According to this programme, an inspector can propose a follow-up inspection when safety conditions in a facility or of an activity warrant, in addition to the required formal report of the inspected licensee on the fulfilment of corrective measures to address the inspection findings.

In the course of the follow-up mission, an example was presented to illustrate and prove the actual implementation of these new provisions.

PNRA has established Procedure (PNRA-RNSDs-WP-008) in 2019 for categorizing inspection findings for radiation facilities as critical, major or minor according to clearly specified criteria. The objective, based on this categorization, is to facilitate allocation of PNRA resources for follow-up review, enforcement action and to ensure timely implementation of corrective actions. In practice, the IRRS team was informed that this categorization is used to determine the regulatory actions to be taken to address the findings, including to decide whether to conduct a follow-up inspection. In addition, PNRA has planned to document further the use of categorization of inspection findings for determining regulatory follow-up actions according to a graded approach.

Status of the initial mission finding

Suggestion 20(S20) is closed as provisions for follow-up inspections have been established and follow up inspections can be conducted where appropriate.

8.2. ENFORCEMENT IMPLEMENTATION

There were no findings in this area in the initial IRRS mission.

9. REGULATIONS AND GUIDES

9.1. GENERIC ISSUES

2014 MISSION RECOMMENDATIONS, SUGGESTIONS	
Observation: *A mechanism to consult with interested parties for preparing and revising guides is not in place.*	
(1)	**BASIS: GSR Part 1 para 4.61 states that** *"… These processes shall involve consultation with interested parties in the development of the regulations and guides, with account taken of internationally agreed standards and the feedback of relevant experience. …"*
R9	**Recommendation:** PNRA should establish a mechanism for consultation with interested parties in the preparation of regulatory guides.
Observation: *Implementation/transition plans for new requirements introduced in amended regulations were not present. The lack of such a process may contribute to differing opinions regarding interpretation of regulatory compliance.*	
(1)	**BASIS: GSR Part 1 para. 2.5 (9) states that** *"The government shall promulgate laws and statutes to make provision for an effective governmental, legal and regulatory framework for safety. This framework for safety shall set out the following: The authority and responsibility of the regulatory body for promulgating (or preparing for the enactment of) regulations and preparing guidance for their implementation;"*
S21	**Suggestion:** PNRA should consider developing plans/procedures for implementing the new requirements arising from new or amended regulations.

Changes since the initial IRRS mission

Recommendation 9: PNRA clearly has a comprehensive process for the development of its regulatory guides including rigorous internal reviews at different levels within the organisation which is followed by inviting comments from other interested parties.

PNRA revised its Procedure for Preparation and Revision of Regulatory Guides (Procedure for Development of Regulatory Guides - (PNRA-WP-001) (Rev.1)). The recommended mechanism for consultation with interested parties has been added in a suitable way as "Step-6: Review by Stakeholders" in section 11 of PNRA-WP-001 (Rev.1).

Some examples of Step-6 were reviewed by the team, and they noted that the review and comment period for stakeholders was rather short (only 1 month). The two examples reviewed however, demonstrated that even comments received late were also taken into account.

Suggestion 21: PNRA revised the procedure for the development of regulations (PNRA-WP-004 Rev 02) to address the process for implementation of new or amended regulations. Furthermore, the practice has also been executed for new/amended requirements identified in PAK/911 (Rev. 2), PAK/913 (Rev. 2), and PAK/904 (Rev 1). In addition, PNRA shares new/amended regulations with the licensees for the implementation of the requirements.

To understand how the procedure is implemented the IRRS team examined two examples which demonstrated that the regulations are made available to all stakeholders for comment at different stages throughout the drafting process.

Status of the initial mission findings

Recommendation9 (R9) is closed as PNRA has established a mechanism for consultation with interested parties when preparing regulatory guides.

Suggestion 21 (S21) is closed as PNRA revised the procedure for the development of regulations.

9.2. REGULATIONS AND GUIDES FOR NUCLEAR POWER PLANTS

<table>
<tr><th colspan="2">2014 MISSION RECOMMENDATIONS, SUGGESTIONS</th></tr>
<tr><td colspan="2">Observation: PAK 911 does not include the following design requirements:
1. For the Fundamental Safety Functions: the function of removal of heat from the fuel store.
2. For the Plant States: The DEC (Design Extension Conditions)
3. For the Design Limits: A set of design limits for all operational states and accident conditions.</td></tr>
<tr><td>(1)</td><td>BASIS: SSR 2/1 Requirement 4 states that “the safety function includes “(ii) removal of heat from the reactor and from the fuel store”.</td></tr>
<tr><td>(2)</td><td>BASIS: SSR 2/1 Requirement 13 states that “the Plant states shall typically cover: (d) Design extension conditions, including accidents with significant degradation of the reactor core.”</td></tr>
<tr><td>(3)</td><td>BASIS: SSR 2/1 Requirement 15 states that “a set of design limits consistent with the key physical parameters for each item important to safety for the nuclear power plant shall be specified for all operational states and for accident conditions.”</td></tr>
<tr><td>S22</td><td>Suggestion: PNRA should consider finalising and issuing PAK/911 to include removal of heat from the fuel store, Design Extension Conditions and a set of design limits for all operational states and accident conditions.</td></tr>
<tr><td colspan="2">Observation: PAK 913 does not include the following design requirements:
1. Monitoring and review of safety performance.
2. For the Accidents Management: The Accidents Management.
3. For the Maintenance, testing, surveillance, inspection,
- The requirement of surveillance program.
- The requirement of cooperation between different maintenance groups.
- The requirement of not to overburden of stuff.
- The requirement of maintenance under the DID principle.
- The requirement of maintenance using the PSA.</td></tr>
<tr><td>(1)</td><td>BASIS: SSR 2/2 Requirement 9 states that “The operating organization shall establish a system for continuous monitoring and periodic review of the safety of the plant and of the performance of the operating organization.”</td></tr>
</table>

2014 MISSION RECOMMENDATIONS, SUGGESTIONS	
(2)	**BASIS: SSR 2/2 Requirement 19 states that** *"The operating organization shall establish an accident management programme for the management of beyond design basis accidents."*
(3)	**BASIS: SSR 2/2 para 8.2 states that** *"The operating organization shall establish surveillance programmes for ensuring compliance with established operational limits and conditions and for detecting and correcting any abnormal condition before it can give rise to significant consequences for safety."*
(4)	**BASIS: SSR 2/2 para 8.11 states that** *"The Coordination shall be maintained between different maintenance groups."*
(5)	**BASIS: SSR 2/2 para 8.12 states that** *"A management system for managing and correcting deficiencies shall be established and shall be used to ensure that operating personnel are not overly burdened."*
(6)	**BASIS: SSR 2/2 para 8.13 states that** *"The operating organization shall ensure that maintenance work during power operation is carried out with adequate defence in depth."*
S23	**Suggestion:** PNRA should consider finalising and issuing PAK/913 to include monitoring and review of safety performance, accidents management and complete surveillance programme.

Changes since the initial IRRS mission

Suggestion 22: PNRA revised PAK/911 in a systematic manner to include the missing requirements identified in 2014. In particular the requirements in section-27 Design Extension Conditions" are clear and comprehensive.

PNRA has introduced the following requirements into its routine work:

- Requirement regarding "Removal of heat from the reactor and from the fuel storage".
- Requirement regarding "Design Extension Conditions including accidents with significant degradation of the reactor core".
- Requirement regarding "Set of design limits for all operational states and accident conditions".

Suggestion 23: The suggested additions/amendments identified in 2014 were introduced in the regulations by issuing a revision to Regulations on the Safety of Nuclear Power Plant Operation - PAK/913 (Rev.2) in September 2020.

The revision was completed in a systematic manner. However, the requirements are sometimes framed broadly leaving room for interpretation. For example, Section 40(14) states that: *"The plant management shall ensure that maintenance work during power operation is carried out with adequate defence- in-depth. PSA shall be used, as appropriate, to demonstrate that the risks are not significantly increased."*

PNRA explained that the more detailed requirements and criteria as well as corresponding boundary conditions are contained in the operational documentation of the licensee that have to be approved by PNRA.

Status of the initial mission findings

Suggestion 22 (S22) is closed as PNRA revised PAK/911 accordingly.

Suggestion 23 (S23) is closed as PNRA revised PAK/913 accordingly.

9.3. REGULATIONS AND GUIDES FOR RESEARCH REACTORS

There were no findings in this area in the initial IRRS mission.

9.4. REGULATIONS AND GUIDES FOR WASTE MANAGEMENT FACILITIES

There were no findings in this area in the initial IRRS mission.

9.5. REGULATIONS AND GUIDES FOR RADIATION SOURCES FACILITIES

2014 MISSION RECOMMENDATIONS, SUGGESTIONS	
Observation: *The regulation on radiation protection (PAK/904) does not comply with GSR Part 3. The supplementing set of guides for radiation protection for all types of radiation sources is not finalized and approved.*	
Observation: *A strategy for establishing control of 222Rn exposure and its reference level is not in place. PNRA has not determined whether assessment of the aircrew exposure due to cosmic radiation is warranted.* ***(reference to R10 is made in Section 11.1)***	
Observation: *A regulation for the general responsibility of radiation workers is not in place.* ***(reference to R10 is made in Section 11.1)***	
(1)	**BASIS: GSR Part 1 Requirement 32 states that** *"The regulatory body shall establish or adopt regulations and guides to specify the principles, requirements and associated criteria for safety upon which its regulatory judgements, decisions and actions are based."*
(2)	**BASIS: GSR Requirement 33 states that** *"Regulations and guides shall be reviewed and revised as necessary to keep them up to date, with due consideration taken of relevant international safety standards…."*
(3)	**BASIS: GSR Part 3 para 5.27 states that** *"The regulatory body or other relevant authority shall establish a strategy for protection against exposure due to ^{222}Rn in workplaces, including the establishment of an appropriate reference level for ^{222}Rn. [….]."* ***(reference to R10 is made in Section 11.1)***
(4)	**BASIS: GSR Part 3 para 5.30 states that** *"The regulatory body or other relevant authority shall determine whether assessment of the exposure of aircrew due to cosmic radiation is warranted."* ***(reference to R10 is made in Section 11.1)***

2014 MISSION RECOMMENDATIONS, SUGGESTIONS	
(5)	**BASIS: GSR Part 3 Requirement 22 states that** *"Workers shall fulfil their obligations and carry out their duties for protection and safety."* ***(referenceto R10 is made in Section 11.1)***
(6)	**BASIS: GSR Part 3 para 3.83 (a) to (f) states that** *"Workers: (a) Shall follow any applicable rules and procedures for protection and safety as specified by the employer, registrant or licensee; […] (f) Shall accept such information, instruction and training in protection and safety as will enable them to conduct their work in accordance with the requirements of these Standards."* ***(reference to R10 is made in Section 11.1)***
R10	**Recommendation:** PNRA should revise and issue a regulation for radiation protection that is in compliance with GSR Part 3.
S24	**Suggestion:** PNRA should consider developing and issuing supplementary radiation protection guides for all types of applications of radiation sources.
Observation: *The regulation for the Licensing of Radiation Facilities other than Nuclear Installations – (PAK/908) is under revision. The supplementing set of guides on radiation protection for different types of radiation sources application is not finalized and approved.*	
(1)	**BASIS: GSR Part 1 Requirement 24 para 4.33 states that** *"Prior to the granting of an authorization, the applicant shall be required to submit a safety assessment, which shall be reviewed and assessed by the regulatory body in accordance with clearly specified procedures. The extent of the regulatory control applied shall be commensurate with the radiation risks."*
(2)	**BASIS: GSR Part 1 Requirement 24 para. 4.34 states that** *"The regulatory body shall issue guidance on the format and content of the documents to be submitted by the applicant in support of an application for an authorization".*
S25	**Suggestion:** PNRA should consider finalising and issuing the revised regulations for authorization of radioactive facilities and supplementary guides taking into account graded approach.

Changes since the initial IRRS mission

Recommendation 10: Since the initial mission, PNRA has systematically reviewed and updated its regulatory framework for radiation safety in order to bring it in line with GSR Part 3. A major revision of the regulations was carried out to address all types of exposure situations. Planned exposure situation and existing exposure situation are addressed in revised "Regulations on Radiation Protection (PAK/904 Rev. 1)", issued in 2020, while the emergency exposure situations are addressed in revised "Regulations on Management of a Nuclear or Radiological Emergency (PAK/914 Rev. 1)". Section 7 of Regulations PAK/904 assigns the prime responsibility of safety to the licensee and further requires that the licensee shall establish and implement management system to ensure and enhance protection and safety.

Furthermore, improvements have been made to the generic requirements in planned exposure situations, including the establishment of requirements for investigation and operating experience

feedback, as well as the requirements of human imaging using radiation for purposes other than medical diagnosis, medical treatment or biomedical research. Also, the harmonization of dose limit value for lens of eye is addressed in Schedule VI. The responsibilities of workers are addressed in Section 24 of Regulations PAK/904 in terms of licensees' responsibility to ensure the compliance.

A graded approach is taken into account in the application of several requirements established in Regulations PAK/904, such as qualification criteria and training period for workers and Radiation Protection Officers (RPO), exemption criteria and categorisation for sealed sources used in common practices.

The IRRS team was informed that radon exposure to members of the public in homes is not a matter of concern in Pakistan as shown by the results of studies conducted at the national level. Since the initial mission, improvements have been introduced in the part related to the control of exposure to radon in the workplace. Article 55 of Regulations PAK/904 set out the reference level as the annual average activity concentration of 1000 Bq/m3. It is further stated that, if the activity concentration of Rn-222 in workplaces remains above the reference level, the relevant requirements for occupational exposure in planned exposure situations shall apply. PNRA initiated a pilot project to further evaluate and assess the radon (Rn-222) exposure of workers at coal and salt mines. The average annual effective doses due to exposure of radon are being assessed in order to determine the average Radon level in mines. The study is expected to be completed by end of 2024.

Section 13 and Schedule IV of Regulations PAK/904 specify the clearance criteria which are in line with Regulations PAK/915 which establishes the clearance requirements of radioactive waste from regulatory control.

PNRA has not yet established requirements for the control of exposure of aircrew and space crew due to cosmic radiation. The IRRS team was informed that a pilot study for the assessment of air crew exposures has been submitted to the PNRA management for approval. Based on the results, the requirements related to control of radiation doses to air crew members will be specified in Regulations PAK/904.

Suggestion 24: PNRA has developed and issued several supplementary regulatory guides (RG) for various types of applications of radiation sources. The purpose of these guides is to provide recommendations on meeting the requirements for the safe use of ionizing radiation which are established in the Ordinance and the associated PNRA regulations. The following guides have been issued so far: RG on Radiation Protection and Safety in Radiotherapy, RG on Protection of Patients in Diagnostic Radiology, RG on Radiation Safety in Industrial Radiography and RG on Management of Contaminated and Overexposed Individuals during a Nuclear or Radiological Emergency.

The IRRS team was informed that two more regulatory guides related to radiation sources and applications are under development: RG on Preparation of License and Authorization Applications for Radiation Facilities and RG on Radiation Safety and Regulatory Requirements in Medical and Diagnostic X-ray facilities.

PNRA revised internal Procedure for Development of Regulatory Guides (PNRA-WP-001) specifying the criteria for identifying the need for new guide and the review of the existing guides.

Suggestion 25: "The Regulations for the Licensing of Radiation Facilities other than Nuclear Installations-(PAK/908 Rev.1)" was revised and issued in 2019. PAK/908 specifies the responsibilities of the licensee and defines various regulatory processes, including notification, registration, licensing and review and assessment. PAK/908 also provides requirements for renewal of license and authorization for transit or transport of radioactive material.

A graded approach in regulatory control is taken into account mostly through the extent of the information that has to be provided in the submission of application for licence to demonstrate the safety of the facility. Schedule I provides the list of documents to be submitted for various facilities and activities with radiation sources.

Typical validity of a licence is one year. However, in case of small radiation facilities e.g., X-ray facility, CT scanner, teaching and research institutes, the licence for operation may be renewed for a maximum period of five years. The criteria on the basis of which the duration of the licence is determined has not been clearly established, and the IRRS team identified room for improvement in this area (see Suggestion 14 in Section 5.5).

A number of guides on the format and content of the documents to be submitted to apply for an authorization have been issued, including RG on Preparation of Radiation Emergency Plan for Radiation Facilities and Activities-(PNRA-RG-914.02), RG on Format and Content of Radioactive Waste Management Program for Nuclear Medical Centres (PNRA-RG-915.01), RG on Format and Content of Radiation Protection Program (PNRA-RG-904.06) and RG on Format and Content of Physical Protection Plan for radiation facilities having radioactive sources (PNRA-RG-926.01). There are a few more guides that are under development, such as RG on Format and Content of Safety Analysis Report of Radiation Facilities and RG on Format and Content of Decommissioning Plan of Radiation Facilities.

Status of the initial mission findings

Recommendation10 (R10) is closed as PNRA has extensively updated regulations on radiation protection to comply with GSR Part 3, and as the remaining activities are in the implementation phase.

Suggestion 24 (S24) is closed as PNRA has issued several supplementary radiation protection guides for various types of applications of radiation sources and a few more are under development.

Suggestion 25 (S25) is closed as PNRA has revised regulations for authorization of radioactive facilities and issued supplementary guides on the format and content of the documents to be submitted by the applicant, taking into account a graded approach.

9.6. REGULATIONS AND GUIDES FOR DECOMMISSIONING ACTIVITIES

There were no findings in this area in the initial IRRS mission.

10. EMERGENCY PREPAREDNESS AND RESPONSE– REGULATORY ASPECTS

10.1. GENERAL EPR REGULATORY REQUIREMENTS

2014 MISSION RECOMMENDATIONS, SUGGESTIONS	
Observation: *Pakistan does not yet have a national radiation emergency response plan. There is draft plan which contains important elements of a national radiation emergency response plan, but it is yet to be completed and promulgated.*	
(1)	**BASIS: GS-R-2 para. 5.13 states that** *"Plans or other arrangements shall be made for co-ordinating the national response to the range of potential nuclear and radiological emergencies. These arrangements for a co-ordinated national response shall specify the organization responsible for the development and maintenance of the arrangements; shall describe the responsibilities of the operators and other response organizations; and shall describe the co-ordination effected between these arrangements and the arrangements for response to a conventional emergency…."*
S26	**Suggestion:** The Government should consider finalizing and promulgating the National Nuclear and Radiological Emergency Response Plan.
Observation: *According to the hazard assessment section of the Self-Assessment "probabilistic safety assessment is not currently used to assess the adequacy of the operator's emergency response arrangement."*	
(1)	**BASIS: GS-R-2 para. 3.13 states that** *"In designing a threat category I facility "[a] probabilistic safety analysis of the [facility] shall be carried out in order… to assess the adequacy of [the operator's] emergency [response arrangements]".*
R11	**Recommendation:** PNRA should require that licensees in hazard category I utilise probabilistic safety analysis for the purpose of assessing the adequacy of their emergency response arrangements.

Changes since the initial IRRS mission

Suggestion 26: The National Radiological Emergency Response Plan (NRERP) was developed by the Government's Strategic Plans Division (SPD) and issued in February 2021. SPD serves as the secretariat of the National Command Authority (NCA) which is headed by the Prime Minister of Pakistan. The NRERP has been prepared in line with the "all hazards approach", where the National Disaster Management Authority is the lead agency for all emergencies, which, with the support of Provincial and District Authorities, coordinates and implements protective actions. The NRERP engages all relevant agencies by clearly defining their roles and responsibilities in the event of a nuclear or radiological emergency. It is the top document in the hierarchy as well as defining the emergency response roles and responsibilities of stakeholders at the national level.

PNRA provides advice about protective actions and other information to the Oversight Committee, which is the highest decision-making body at national level, headed by the Secretary of the NCA, and operates from the Nuclear and Radiological Emergency Support Centre (NURESC). The NURESC also coordinates the input from all stakeholders in the preparation and review of the NRERP. The comprehensiveness (completeness) of NRERP is ensured by reviewing it against the

relevant requirements in IAEA GSR Part 7. The NRERP was tested during the ConvEx-3 exercise in October 2021.

Recommendation 11: The basis for R11 was from GS-R-2 and requires "carrying out probabilistic safety analysis for the purpose of assessing the adequacy of the operator's emergency response arrangements for threat category (currently Emergency Preparedness Category - EPC) I facilities". This requirement no longer exists in IAEA GSR Part 7. The GS-R-2 requirement was a quotation from another obsolete Agency's standard.

PNRA addressed the probabilistic safety analysis (PSA) in Section 51 (7) of the Regulation on the Safety of Nuclear Power Plant Design, PAK/911, which requires the NPPs (EPC I) that "the design shall take due account of the probabilistic safety analysis of the plant for all modes of operation and for all plant states, including shut down, with particular reference to: … (f) Assessing the adequacy of plant emergency procedures".

This provision of PAK/911 entirely meets the purpose of Recommendation 11, as well as the current basis (IAEA SSR-1, paragraph 4.7). This provision is being implemented during the review of the adequacy of PSA, submitted in the licensing process, for its use and impact on the NPPs' emergency procedures.

Status of the initial mission findings

Suggestion 26 (S26) is closed as the National Radiological Emergency Response Plan (NRERP) was adopted in February 2021.

Recommendation 11 (R11) is closed as the basis for this recommendation does not exist in GSR Part 7 and the national regulations require that the probabilistic safety analysis, submitted in the licensing process, shall be used for development of the NPPs' emergency procedures.

10.2. FUNCTIONAL REGULATORY REQUIREMENTS

2014 MISSION RECOMMENDATIONS, SUGGESTIONS	
Observation: *Operational Interventional Levels (OILs) are in use in Pakistan, in compliance with the IAEA standards. However, the actual values of these OILs are based on an earlier IAEA document and are not consistent with the new concepts and frameworks published in GSG-2.*	
(1)	**BASIS: GS-R-2 para. 4.71 states that** *"For the precautionary action zone and the urgent protective action planning zone, arrangements shall be made for promptly assessing any radioactive contamination, releases of radioactive material and doses for the purpose of deciding on or adapting the urgent protective actions to be taken following a release of radioactive material. This capability shall …".*
(2)	**BASIS: GSG-2 para. 5.13 states that** *"Appendix II provides selected examples of default OILs for deposition, levels of individual contamination, and contamination levels for food, milk and water, together with a plain language explanation of the OILs".*
S27	**Suggestion:** PNRA should consider reviewing and revising the OILs where necessary.

Changes since the initial IRRS mission

Suggestion 27: The requirement for deriving OILs (Operational Intervention Levels) from defined Generic Criteria has been incorporated in the current draft of the Regulations on Management of a Nuclear or Radiological Emergency - (PAK/914), Rev. 1. The set of OILs with values and corresponding protective actions have been introduced in the sections in the Off-site Radiological Emergency Plan (KOFREP) and the On-site Radiological Emergency Plan (KONREP). These OILs are in line with IAEA GSG-2, while the OILs were also introduced in the National Nuclear and Radiological Emergency Response Plan (NRERP). The OILs from the latter are based on the IAEA EPR-NPP Protective Actions. The PNRA is aware of these differences between OILs in different documents and explained that at the application for the licence, the applicant is instructed, which non-domestic standards and reference documents shall be used including OILs, thus alleviating the situation, that the applicant should choose which set of OILs are applicable.

Status of the initial mission finding

Suggestion 27 (S27) is closed on the basis of progress made and confidence in the effective completion as the draft Regulations on Management of a Nuclear or Radiological Emergency - (PAK/914), Rev-1 (Draft-10) is in the final stage of approval and appropriate OILs values will be defined by the PNRA in the licensing process.

10.3. REGULATORY REQUIREMENTS FOR INFRASTRUCTURE

2014 MISSION RECOMMENDATIONS, SUGGESTIONS	
Observation: *PNRA is progressing with the preparation of a regulatory guide that will provide detailed description on how to prepare emergency response plans and implement related regulatory requirements for radiation facilities belonging to hazard category III and IV.*	
(1)	**BASIS: GS-R-2 para. 3.9 states that** *"In fulfilling its statutory obligations, the regulatory body… shall establish, promote or adopt regulations and guides upon which its regulatory actions are based;… shall provide for issuing, amending, suspending or revoking authorizations, subject to any necessary conditions, that are clear and unambiguous and which shall specify (unless elsewhere specified):… the requirements for incident reporting;… and emergency preparedness arrangements."*
S28	**Suggestion:** PNRA should consider finalising and issuing the regulatory guide for hazard categories III and IV.
Observation: *A quality assurance program is explicitly required by GS-R-2 for all hazard categories, but PAK/914 established the requirements only for categories I-III.*	
(1)	**BASIS: GS-R-2 para. 5.37 states that** *"The operator of a facility, practice or source in threat category I, II, III or IV and the off-site response organizations shall establish a quality assurance programme, in accordance with international standards, …"*
R12	**Recommendation:** PNRA should revise its relevant regulation to include quality assurance for EPR requirements of category IV radiation activities.

Changes since the initial IRRS mission

Suggestion 28: At the time of the initial mission, PNRA was already planning issuance of the regulatory guide "Preparation of Radiation Emergency Plan for Radiation Facilities and Activities (No. PNRA-RG-914.02)". In 2016 this Regulatory Guide was issued.

The regulatory guide comprehensively addresses the EPC III category facilities, while for the EPC IV facilities and activities, the regulatory guide is also applicable. However, the licensee for EPC IV has to identify the appropriate provisions from the guide. In the next revision of the regulatory guide the distinction between the provisions for EPC III and EPC IV could be clarified to facilitate its use. The regulatory guide is due to be revised soon.

Recommendation 12: PNRA included quality assurance for EPR of category IV radiation activities by making compulsory the IAEA GSR Part 7 requirements, 6.34, 6.35 and 6.37, for all licensees. These requirements were transposed into Section 6, paragraphs (4)-(6), of the draft Regulations on Management of a Nuclear or Radiological Emergency - (PAK/914), Rev-1 (Draft-10).

The revision of PAK/914 started in 2017 and is in the final stage of approval by the Authority. PAK/914 is expected to be issued shortly.

Status of the initial mission findings

Suggestion 28 (S28) is closed as the regulatory guide "Preparation of Radiation Emergency Plan for Radiation Facilities and Activities No. PNRA-RG-914.02" was issued in 2016.

Recommendation 12 (R12) is closed on the basis of progress made and confidence in the effective completion as the draft Regulation on Management of a Nuclear or Radiological Emergency - (PAK/914), Rev-1 (Draft-10) is in the final stage of approval.

10.4. ROLE OF REGULATORY BODY DURING RESPONSE

2014 MISSION RECOMMENDATIONS, SUGGESTIONS	
Observation: *The National Radiation Emergency Coordination Centre located at PNRA has limited physical space, given its emergency response role. The implementation of EPR assessment and coordination is largely paper-based and consequence analysis and decision-making aids and tools are not state-of-the-art.*	
(1)	**BASIS: GS-R-2 para. 5.25 states that** *"Adequate tools, instruments, supplies, equipment, communication systems, facilities and documentation (such as procedures, checklists, telephone numbers and manuals) shall be provided for performing the functions specified in Section 4. These items and facilities shall be selected or designed to be operational under the postulated conditions …"*
R13	**Recommendation:** The Government should continue supporting the modernisation of PNRA's National Radiation Emergency Coordination Centre.

Changes since the initial IRRS mission

Recommendation 13: The Government of Pakistan approved a project for modernization of PNRA's National Radiological Emergency Coordination Centre (NRECC) in March 2015. The NRECC is housed in a newly constructed building next to the PNRA Headquarters. It consists of

an integrated office space for carrying out the different functions of NRECC. Among these functions, NRECC ensures 24/7 availability in its role as National Warning Point under the Early Notification and Assistance Conventions. An area for technical support groups with all technical facilities has also been designated for technical experts from different directorates of PNRA for assessing the emergency and its possible consequences. It also provides office space for all staff of NRECC and some technical directorates. The upgraded NRECC was officially declared operational on 30 June 2021.

The NRECC operates different systems to perform radiological consequence assessment (e. g. Real-time Online Decision Support System (JRODOS), InterRAS and Hotspot), it has provision for receiving data from an early warning system of fixed radiation monitors and has signed an MoU with the Pakistan Meteorological Department for online sharing of meteorological data. The project for online sharing of plant safety parameters from NPPs to NRECC is in progress. In addition to standard communication means such as telephones, mobile phones and fax machines etc. some advance communication facilities like satellite phones and video communication systems have also been installed.

PNRA has also established two Regional Radiological Emergency Coordination Centres (RECCs) in Mianwali and Karachi to support NRECC and provide technical advice to local response organizations and licensees during a possible emergency.

Since its completion in June 2021, the NRECC has been tested through one integrated NPP exercise and an international ConvEx-3 exercise; future exercises will allow the NRECC to refine its capabilities and improve its functionality to enhance the national preparedness and response in the event of a nuclear emergency.

Status of the initial mission finding

Recommendation 13 (R13) is closed as the National Radiological Emergency Coordination Centre (NRECC) has been modernized and made operational in a new building and it provides a state-of-the-art facility.

11. ADDITIONAL AREAS

11.1. OCCUPATIONAL RADIATION PROTECTION

Reference is made to Recommendation 10 in Section 9.5.

2014 MISSION RECOMMENDATIONS, SUGGESTIONS	
Observation: *An authorization or approval system for dosimetry service providers by the regulatory body is not in place.*	
(1)	**BASIS: GSR Part 3 Requirement 2 states that** *"The regulatory body shall establish and enforce requirements for the monitoring and recording of occupational exposures in planned exposure situations."*
(2)	**BASIS: GSR Part 3 para 3.73 (c) states that** *"The regulatory body shall be responsible, as appropriate, for authorization or approval of service providers for individual monitoring and calibration services"*
S29	**Suggestion:** PNRA should consider the need for approval or authorization of service providers for individual monitoring and calibration services.

Changes since the initial IRRS mission

Suggestion 29: The process of authorization and approval for dosimetry and calibration service providers is addressed in the PNRA draft "Regulations for Authorization of Service Providers to Nuclear Installations and Radiation Facilities (PAK/906)", which specify the general requirements and authorisation process for providers of technical services in relation to safety. Schedule III of the draft PAK/906 provides a list of documents and information that has to be submitted to PNRA by the applicant in support of an application for the authorization for service providers for personal/radiation dosimetry and calibration of radiation apparatus and monitors.

The IRRS team was informed that the development of Regulations PAK/906 is at an advanced stage and is anticipated to be completed by the end of 2022.

Status of the initial mission finding

Suggestion 29 (S29) is closed on the basis of progress made and confidence in the effective completion as PNRA has developed the Regulations-PAK/906 that includes requirements for authorization of service providers for individual monitoring and calibration services, which is expected to be issued by the end of 2022.

11.2. CONTROL OF DISCHARGES, MATERIALS FOR CLEARANCE, AND CHRONIC EXPOSURES; ENVIRONMENTAL MONITORING FOR PUBLIC RADIATION PROTECTION

2014 MISSION RECOMMENDATIONS, SUGGESTIONS
Observation: *Small users (non-nuclear installations) are not complying with the requirement to provide information about the expected radiological impact to the public when applying for an authorization.*

2014 MISSION RECOMMENDATIONS, SUGGESTIONS	
(1)	**BASIS: GSR Part 3 para 3.132 states that** *"Registrants and licensees, in cooperation with suppliers, in applying for an authorization for discharges, as appropriate: … (b) Shall determine by an appropriate pre-operational study all significant exposure pathways by which discharged radionuclides could give rise to exposure of members of the public; (c) Shall assess the doses to the representative person due to the planned discharges; (d) Shall consider the radiological environmental impacts in an integrated manner with features of the system of protection and safety, as required by the regulatory body; …"*
S30	**Suggestion:** PNRA should consider consistently enforcing the implementation of its requirement for all users to provide information about the expected radiological impact to the public.
Observation: *Public information through PNRA annual reports does not include information on results of environmental monitoring programmes nor assessments of doses to the public due to releases.*	
(1)	**BASIS: RS-G-1.8 para 3.18 states that** *"In view of the increasing public awareness of environmental issues, the regulatory body…should make available to the public summary information on environmental monitoring with an adequate explanation of its significance."*
(2)	**BASIS: GSR Part 3 para. 3.136 states that** *"The regulatory body shall publish or shall make available on request, as appropriate, results from source monitoring and environmental monitoring programmes and assessments of doses from public exposure."*
S31	**Suggestion:** PNRA should consider making available to the public summary information on the results of environmental monitoring programmes and assessments of doses to the public due to releases.

Changes since the initial IRRS mission

Suggestion 30: PNRA conducted several activities, starting with the analysis of existing radiation facilities (small users) that could have a potential radiological impact on the public. 70 nuclear medicine centres (NMC) that use unsealed radioactive sources in diagnostics and therapy that generate radioactive discharges were identified.

In April 2017, PNRA performed a survey to evaluate the need of radiological impact assessment due to discharges from NMCs. The survey concluded that radiation dose in the immediate vicinity of sewage pipes, on the ground, is at background levels and there is no need to perform special environmental impact assessment. Furthermore, the exposure pathways at nuclear medicine facilities are minimized through administrative controls and that specific authorization for discharges from NMCs is not required.

PNRA regulatory framework for small users was revised. New NMCs are being licensed under "PNRA Regulations for the Licensing of Radiation Facility(ies) other than Nuclear Installation(s) - (PAK/908) (Rev.1)", which now includes the provisions that these facilities have to submit a detailed Safety Analysis Report (SAR) and Radioactive Waste Management Program (RWMP) when applying for a licence.

Suggestion 31: The summary results of environmental monitoring programmes and assessments of doses to the public due to discharges are included in the PNRA Annual Reports. The Annual Reports are made publicly available through the PNRA website.

Status of the initial mission findings

Suggestion 30 (S30) is closed as PNRA updated relevant regulations, including the provisions that an applicant is required to submit a detailed Safety Analysis Report, and the expected radiological impact to the public, in support of its application for an authorization.

Suggestion 31 (S31) is closed as PNRA includes the results of the environmental monitoring programme and doses to the public due to discharges in its publicly available annual reports.

IRRS FOLLOW-UP MISSION TEAM

APPENDIXI-LIST OF PARTICIPANTS

INTERNATIONAL EXPERTS:		
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APPENDIXII-MISSION PROGRAMME

<table>
<tr><th>Time</th><th>MON 28.02</th><th>TUE 01.03</th><th>WED 02.03</th><th>THU 03.03</th><th>FRI 04.03</th><th>SAT 05.03</th><th>SUN 06.03</th><th>MON 07.03</th></tr>
<tr><td>9:00-10:00</td><td rowspan="3">Arrival of Team Members</td><td rowspan="2">Entrance Meeting</td><td rowspan="3">Interviews</td><td rowspan="2">TM write Report
TL and DTL review introductory part</td><td rowspan="3">Discussion Counterpart/Expert

Finalisation</td><td></td><td></td><td rowspan="2">Exit Meeting

Press release
Farewell</td></tr>
<tr><td>10:00-11:00</td><td rowspan="2">Written comments by the Host</td><td rowspan="5">Social Event</td></tr>
<tr><td>11:00-12:00</td><td>Interviews</td><td>Draft text to TL</td></tr>
<tr><td>12:00-13:00</td><td>Lunch</td><td>Lunch</td><td>Lunch</td><td colspan="2">Lunch</td><td>Lunch</td><td>Lunch</td></tr>
<tr><td>13:00-14:00</td><td rowspan="4">Initial Team Meeting
Refresher training
Initial IRRS Team Briefing
(Attended by the LO)</td><td rowspan="4">Interviews</td><td rowspan="4">Interviews</td><td rowspan="4">Cross-reading

Secretariat edits the report</td><td colspan="2">Submission of the Draft to the Host</td><td rowspan="2">Team meeting to discuss and resolve Host comments</td><td rowspan="4">Departure of IRRS Team Members</td></tr>
<tr><td>14:00-15:00</td><td rowspan="3">Host reads Draft and prepares written comments

TL finalises the presentation

TC drafts the Press Release</td></tr>
<tr><td>15:00-16:00</td><td rowspan="2">Plenary (Team + Host) to discuss Host comments and finalize the report</td></tr>
<tr><td>16:00-17:00</td><td>Written preliminary findings delivered</td><td>Preliminary Draft Report Ready</td><td colspan="2">Discussion of Executive Summary</td><td rowspan="2">Presenting the final Draft of the Report to the Host</td><td rowspan="2">Finalisation of the Report</td></tr>
<tr><td>17:00-18:30</td><td>Daily Team Meeting</td><td>Daily Team Meeting:
Discussion of findings</td><td>Daily Team Meeting</td><td colspan="2">Team discusses the Mission and provides IAEA with feedback</td></tr>
<tr><td>18:30-19:30</td><td rowspan="2">Dinner</td><td>Dinner</td><td>Dinner</td><td>Dinner</td><td colspan="2" rowspan="2">Dinner</td><td rowspan="2">Dinner</td><td rowspan="2">Official Dinner</td></tr>
<tr><td>19:30</td><td>Writing of the report</td><td>Secretariat edits Report
TM write Report</td><td>TM Read Draft</td></tr>
</table>

APPENDIX III-MISSION COUNTERPARTS

	IRRS Experts	COUNTERPART
1.	**RESPONSIBILITIES AND FUNCTIONS OF THE GOVERNMENT**	
	NILSSON Hugo	Mr Shahid Rashid
2.	**THE GLOBAL SAFETY REGIME**	
	NILSSON Hugo	Mr Shahid Rashid
3.	**RESPONSIBILITIES AND FUNCTIONS OF THE REGULATORY BODY**	
	SLOKAN DUSIC Darja	Ms Samina Kanwal
4.	**MANAGEMENT SYSTEM OF THE REGULATORY BODY**	
	SLOKAN DUSIC Darja	Mr M. Masaood Hashmi
5.	**AUTHORIZATION**	
	SOARE Gabriel, FRANCOIS Patrice, ASFAW Berihun	Mr Nasir Mughal
6.	**REVIEW AND ASSESSMENT**	
	ASFAW Berihun	Mr Nasir Mughal
7.	**INSPECTION**	
	JUBIN Jean Rene, ASFAW Berihun	Mr Muhammad Qayyum
8.	**ENFORCEMENT**	
	JUBIN Jean Rene	Mr Muhammad Qayyum
9.	**REGULATIONS AND GUIDES**	
	SOARE Gabriel, BOSNJAK Jovica	Mr Waqas Sherani
10.	**EMERGENCY PREPAREDNESS AND RESPONSE – REGULATORY ASPECTS**	
	GRLICAREV Igor	Mr Nadeem Hussain

	IRRS Experts	COUNTERPART
11.	**ADDITIONAL AREAS**	
	BOSNJAK Jovica	Dr Ameena Bano

APPENDIXIV -RECOMMENDATIONS (R) AND SUGGESTIONS (S) FROM THE PREVIOUS IRRS MISSION THAT REMAIN OPEN

Section	Module	R/S	Recommendation/Suggestion
2.1	**2**	**S4**	The Government should consider becoming party to the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management.
5.2	**5**	**S10**	PNRA should consider developing processes to involve the public in authorization and licensing processes for NPPs.

APPENDIX V-REFERENCE MATERIAL PROVIDED BY PNRA

GENERAL DOCUMENTS

- Annual Report of PNRA
- PNRA Organizational Structure

LEGAL DOCUMENTS

- PNRA Ordinance No. III 2001
- PNRA Regulations

	Title & Number
1.	Pakistan Nuclear Regulatory Authority Enforcement Regulation (PAK/950)
2.	Regulations on the Safety of Nuclear Research Reactor(s) Operation (PAK/923)
3.	Regulations for the Safe Transport of Radioactive Material - (PAK/916)
4.	Regulations on Radioactive Waste Management (PAK/915) amended up to March 8, 2010
5.	Regulations on Management of a Nuclear or Radiological Emergency - (PAK/914)
6.	Regulations on Safety of Nuclear Power Plants-Operation (PAK/913) amended up to November 3, 2008
7.	Regulations on the Safety of Nuclear Power Plants-Quality Assurance (PAK/912)
8.	Regulation on the Safety of Nuclear Power Plant Design (PAK/911)
9.	Regulations on the Safety of Nuclear Installations – Site Evaluation (PAK/910)
10.	Regulation for Licensing of Nuclear Installation(s) in Pakistan (PAK/909)
11.	Regulations for the Licensing of Radiation Facilities other than Nuclear Installations (PAK/908)
12.	Regulations for Licensing of Nuclear Safety Class Equipment and Components Manufacturers – (PAK/907)
13.	Regulations on Radiation Protection (PAK/904)
14.	Regulations on Transaction of Business of Pakistan Nuclear Regulatory Authority - (PAK/901)
15.	Regulations on Licensing Fee by Pakistan Nuclear Regulatory Authority – (PAK/900)
16.	Regulations for the Safe Management of Spent Nuclear Fuel - (PAK/918)
17.	Regulations on Physical Protection of Nuclear Material and Nuclear Installations - (PAK/925)
18.	Regulations on Security of Radioactive Sources - (PAK/926)
19.	Regulations on Decommissioning of Facilities Using Radioactive Material - (PAK/930)
20.	Regulations on Dispute Resolution - (PAK/949)

APPENDIX VI - IAEA REFERENCE MATERIAL USED FOR THE REVIEW

1.	**INTERNATIONAL ATOMIC ENERGY AGENCY** - Fundamental Safety Principles, No SF-1, IAEA, Vienna (2006)
2.	**INTERNATIONAL ATOMIC ENERGY AGENCY** - Governmental, Legal and Regulatory Framework for Safety, General Safety Requirements Part 1, No. GSR Part 1 (Rev. 1), IAEA, Vienna (2016)
3.	**INTERNATIONAL ATOMIC ENERGY AGENCY –** Leadership and Management for Safety, General Safety Requirements Part 2, No. GSR Part 2, IAEA, Vienna (2016)
4.	**INTERNATIONAL ATOMIC ENERGY AGENCY** - Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards, General Safety Requirements Part 3, No. GSR Part 3, IAEA, Vienna (2014).
5.	**INTERNATIONAL ATOMIC ENERGY AGENCY** - Safety assessment for facilities and activities, General Safety Requirements Part 4, No. GSR Part 4 (Rev. 1), IAEA, Vienna (2016)
6.	**INTERNATIONAL ATOMIC ENERGY AGENCY** - Predisposal Management of Radioactive Waste, General Safety Requirement Series Part 5, No. GSR Part 5, IAEA, Vienna (2009)
7.	**INTERNATIONAL ATOMIC ENERGY AGENCY** - Decommissioning of Facilities, General Safety Requirement Series No. GSR Part 6, IAEA, Vienna (2014)
8.	**INTERNATIONAL ATOMIC ENERGY AGENCY** - Preparedness and Response for Nuclear or Radiological Emergency, General Safety Requirement Series No. GSR Part 7, IAEA, Vienna (2015)
9.	**INTERNATIONAL ATOMIC ENERGY AGENCY** - Site Evaluation for Nuclear Installations, Specific Safety Requirement Series No. SSR-1, IAEA, Vienna (2003)
10.	**INTERNATIONAL ATOMIC ENERGY AGENCY** - Safety of Nuclear Power Plants: Design, Specific Safety Requirements Series No. SSR-2/1 (Rev. 1), IAEA, Vienna (2016)
11.	**INTERNATIONAL ATOMIC ENERGY AGENCY** - Safety of Nuclear Power Plants: Commissioning and Operation, Specific Safety Requirements Series No. SSR-2/2 (Rev. 1), IAEA, Vienna (2016)
12.	**INTERNATIONAL ATOMIC ENERGY AGENCY** - Safety of Research Reactors, Specific Safety Requirements Series No. SSR-3, IAEA, Vienna (2016)
13.	**INTERNATIONAL ATOMIC ENERGY AGENCY** - Safety of Nuclear Fuel Cycle Facilities, Specific Safety Requirements Series No. SSR-4, IAEA, Vienna (2017)
14.	**INTERNATIONAL ATOMIC ENERGY AGENCY** - Disposal of Radioactive Waste, Specific Safety Requirements Series No. SSR-5, IAEA, Vienna (2011)
15.	**INTERNATIONAL ATOMIC ENERGY AGENCY** – Regulations for the Safe Transport of Radioactive Material, Specific Safety Requirements Series No. SSR-6, IAEA, Vienna (2012)
16.	**INTERNATIONAL ATOMIC ENERGY AGENCY** -Regulations for the Safe Transport of Radioactive Material, 2018 Edition, Specific Safety Requirements Series No. SSR-6 (Rev. 1), IAEA, Vienna (2018)
17.	**INTERNATIONALATOMICENERGYAGENCY** - Classification of Radioactive Waste, General Safety Guide No. GSG-1, IAEA, Vienna (2009)
18.	**INTERNATIONALATOMICENERGYAGENCY** - Criteria for Use in Preparedness and Response for a Nuclear or Radiological Emergency, Safety Guide Series No GSG-2, IAEA, Vienna (2012)
19.	**INTERNATIONALATOMICENERGYAGENCY** - Communication and Consultation with Interested Parties by the Regulatory Body, General Safety Guide Series No. GSG-6, IAEA, Vienna (2017).
20.	**INTERNATIONALATOMICENERGYAGENCY** - Occupational Radiation Protection, Safety Guide Series No. GSG-7, IAEA, Vienna (2018)

21.	**INTERNATIONALATOMICENERGYAGENCY** - Regulatory Control of Radioactive Discharges to the Environment, Safety Guide Series No GSG-9, IAEA, Vienna (2018)
22.	**INTERNATIONALATOMICENERGYAGENCY** -Organization, Management and Staffing of the Regulatory Body for Safety, General Safety Guide Series No. GSG-12, IAEA, Vienna (2018).
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25.	**INTERNATIONALATOMICENERGYAGENCY** - The Management System for the Disposal of Radioactive Waste, Safety Guide Series No GS-G-3.4, IAEA, Vienna (2008)
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27.	**INTERNATIONALATOMICENERGYAGENCY** - A System for the Feedback of Experience from Events in Nuclear Installations, Safety Guide Series No. NS-G-2.11, IAEA, Vienna (2006)
28.	**INTERNATIONALATOMICENERGYAGENCY** - Modifications to Nuclear Power Plants, Safety Guide Series No NS-G-2.3, IAEA, Vienna (2001)
29.	**INTERNATIONALATOMICENERGYAGENCY** - Recruitment, Qualification and Training of Personnel for Nuclear Power Plants, Safety Guide Series No NS-G-2.8, IAEA, Vienna (2002)
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31.	**INTERNATIONALATOMICENERGYAGENCY** - Safety of Radiation Generators and Sealed Radioactive Sources, Safety Guide Series No. RS-G-1.10, IAEA, Vienna (2008)
32.	**INTERNATIONALATOMICENERGYAGENCY** - Borehole Disposal Facilities for Radioactive Waste, Safety Guide Series No SSG-1, IAEA, Vienna (2009)
33.	**INTERNATIONALATOMICENERGYAGENCY** - Deterministic Safety Analysis for Nuclear Power Plants, Specific Safety Guides Series No. SSG-2, IAEA, Vienna (2010)
34.	**INTERNATIONALATOMICENERGYAGENCY** - Development and Application of Level 1 Probabilistic Safety Assessment for Nuclear Power Plants, Specific Safety Guide Series No. SSG-3, IAEA, Vienna (2010)
35.	**INTERNATIONALATOMICENERGYAGENCY** - Development and Application of Level 2 Probabilistic Safety Assessment for Nuclear Power Plants, Specific Safety Guide Series No. SSG-4, IAEA, Vienna (2010)
36.	**INTERNATIONALATOMICENERGYAGENCY** - Safety of Conversion Facilities and Uranium Enrichment Facilities, Specific Safety Guide Series No. SSG-5, IAEA, Vienna (2010)
37.	**INTERNATIONALATOMICENERGYAGENCY** - Safety of Uranium Fuel Fabrication Facilities Specific Safety Guide Series No. SSG-6, IAEA, Vienna (2010)
38.	**INTERNATIONALATOMICENERGYAGENCY** - Safety of Uranium and Plutonium Mixed Oxide Fuel Fabrication Facilities, Specific Safety Guide Series No. SSG-7, IAEA, Vienna (2010)
39.	**INTERNATIONALATOMICENERGYAGENCY** - Licensing Process for Nuclear Installations, Specific Safety Guide Series No. SSG-12, IAEA, Vienna (2010)
40.	**INTERNATIONALATOMICENERGYAGENCY** - Geological Disposal Facilities for Radioactive Waste Specific Safety Guide Series No. SSG-14, IAEA, Vienna (2011)
41.	**INTERNATIONALATOMICENERGYAGENCY** - Storage of Spent Nuclear Fuel, Safety Guide Series No SSG-15 (Rev. 1), IAEA, Vienna (2020)
42.	**INTERNATIONALATOMICENERGYAGENCY** - Periodic Safety Review for Nuclear Power Plants, Safety Guide Series No SSG-25, IAEA, Vienna (2013)

43.	**INTERNATIONALATOMICENERGYAGENCY** - Advisory Material for the IAEA Regulations for the Safe Transport of Radioactive Material, Specific Safety Guide No SSG-26, IAEA, Vienna, (2014)
44.	**INTERNATIONALATOMICENERGYAGENCY** - Commissioning for Nuclear Power Plants, Safety Guide Series No. SSG-28, IAEA, Vienna (2014)
45.	**INTERNATIONALATOMICENERGYAGENCY** - Predisposal Management of Radioactive Waste from Nuclear Power Plants and Research Reactors, Safety Guide Series No SSG-40, IAEA, Vienna (2016)
46.	**INTERNATIONALATOMICENERGYAGENCY** - Predisposal Management of Radioactive Waste from Nuclear Fuel Cycle Facilities, Safety Guide Series No SSG-41, IAEA, Vienna (2016)
47.	**INTERNATIONALATOMICENERGYAGENCY** - Management of Waste from the Use of Radioactive Material in Medicine, Industry, Agriculture, Research and Education, Safety Guide Series No SSG-45, IAEA, Vienna (2019)
48.	**INTERNATIONALATOMICENERGYAGENCY** - Radiation Protection and Safety in Medical Uses of Ionizing Radiation, Safety Guide Series No SSG-46, IAEA, Vienna (2018)
49.	**INTERNATIONALATOMICENERGYAGENCY** - Decommissioning of Nuclear Power Plants, Research Reactors and Other Nuclear Fuel Cycle Facilities, Safety Guide Series No SSG-47, IAEA, Vienna (2018)
50.	**INTERNATIONALATOMICENERGYAGENCY** – Ageing Management and Development of a Programme for Long Term Operation of Nuclear Power Plants, Safety Guide Series No SSG-48, IAEA, Vienna (2018)
51.	**INTERNATIONALATOMICENERGYAGENCY** –Decommissioning of Medical, Industrial and Research Facilities, Safety Guide Series No SSG-49, IAEA, Vienna (2019)
52.	**INTERNATIONALATOMICENERGYAGENCY** – Operating Experience Feedback for Nuclear Installations, Safety Guide Series No SSG-50, IAEA, Vienna (2019)
53.	**INTERNATIONAL ATOMIC ENERGY AGENCY** - Accident Management Programmes for Nuclear Power Plants, Safety Guide Series No SSG-54, IAEA, Vienna (2019)
54.	**INTERNATIONALATOMICENERGYAGENCY** - Planning and Preparing for Emergency Response to Transport Accidents Involving Radioactive Material, Safety Guide No TS-G-1.2 (2002)
55.	**INTERNATIONALATOMICENERGYAGENCY** - Radiation Protection Programmes for the Transport of Radioactive Material, Safety Guide No TS-G-1.3, IAEA, Vienna, (2007)
56.	**INTERNATIONALATOMICENERGYAGENCY** - The Management System for the Safe Transport of Radioactive Material Safety Guide No TS-G-1.4, IAEA, Vienna, (2008)
57.	**INTERNATIONALATOMICENERGYAGENCY** - Compliance Assurance for the Safe Transport of Radioactive Material, Safety Guide No TS-G-1.5, IAEA, Vienna, (2009)
58.	**INTERNATIONALATOMICENERGYAGENCY** - Schedules of Provisions of the IAEA Regulations for the Safe Transport of Radioactive Material (2009 Edition), Safety Guide No TS-G-1.6 (Rev.1), IAEA, Vienna, (2014)
59.	**INTERNATIONALATOMICENERGYAGENCY** - Storage of Radioactive Waste, Safety Guide Series No WS-G-6.1, IAEA, Vienna (2006)
60.	**INTERNATIONALATOMICENERGYAGENCY** - Safety Assessment for the Decommissioning of Facilities Using Radioactive Material, Safety Guide Series No.WS-G-5.2, IAEA, Vienna (2009)
61.	**INTERNATIONALATOMICENERGYAGENCY** - Storage of Radioactive Waste, Safety Guide Series No. WS-G-6.1, IAEA, Vienna (2006)

APPENDIX VII -PNRAORGANIZATIONALCHART