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INTEGRATED REGULATORY REVIEW SERVICE (IRRS)

MISSION

TO

SINGAPORE

Singapore

10-19 October 2022

DEPARTMENT OF NUCLEAR SAFETY AND SECURITY

Integrated Regulatory Review Service

IRRS

Integrated
Regulatory
Review Service
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INTEGRATED REGULATORY REVIEW SERVICE (IRRS) MISSION
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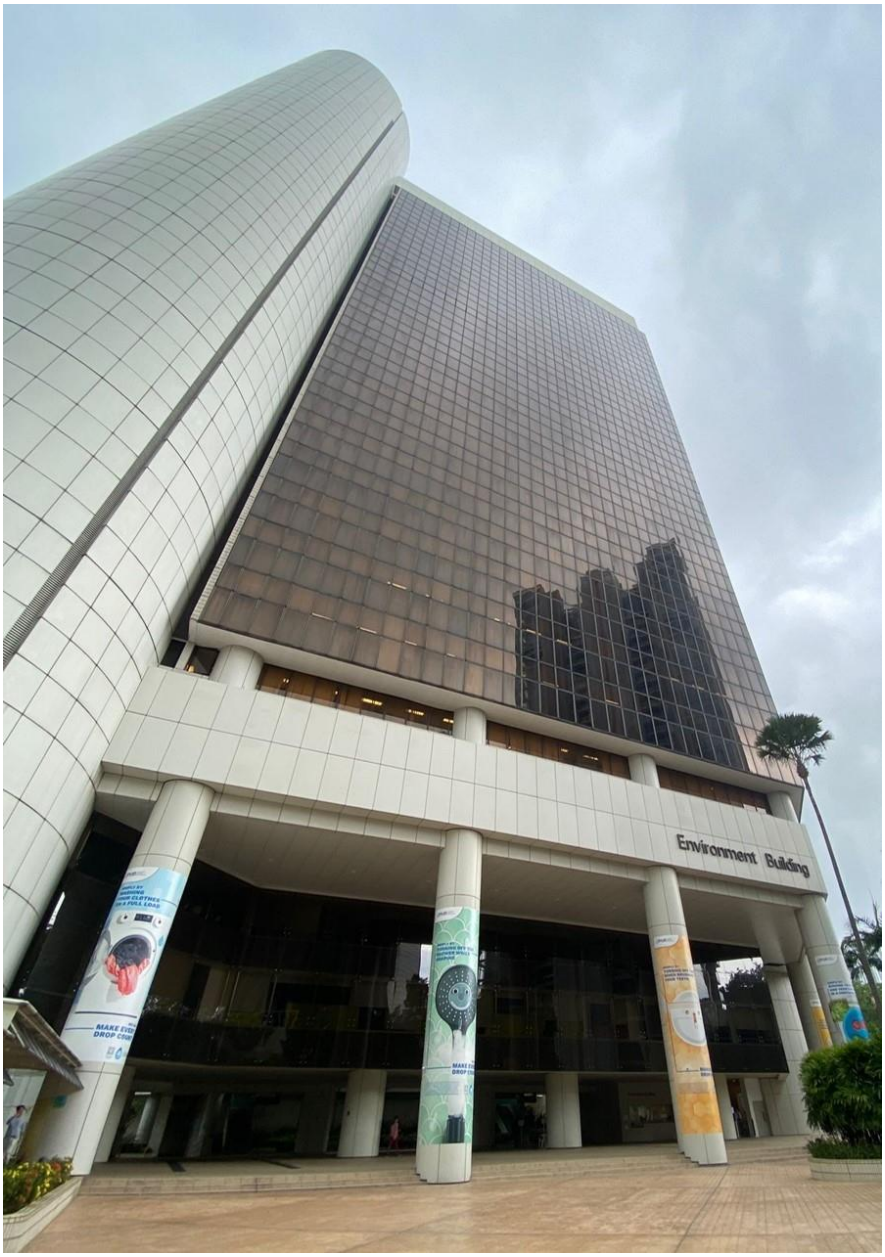

REPORT OF THE
INTEGRATED REGULATORY REVIEW SERVICE (IRRS) MISSION
TO
SINGAPORE

Mission dates:	**10 – 19 October 2022**
Regulatory body visited:	*National Environment Agency*
Location:	*Singapore*
Regulated facilities, activities, and exposure situations in the mission scope:	*Radiation sources facilities and activities, waste management facilities, decommissioning, transport of radioactive material, medical exposure, occupational exposure and public exposure*
Organized by:	*IAEA*

IRRS TEAM

BLY Ritva	Team Leader (Finland)
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NICKEL Chris	Reviewer (Australia)
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IAEA-October 2022

The number of recommendations, suggestions and good practices is in no way a measure of the status of the national infrastructure for nuclear and radiation safety. Comparisons of such numbers between IRRS reports from different countries should not be attempted.

CONTENTS

EXECUTIVE SUMMARY

At the request of the Government of Singapore, an international team of senior safety experts met representatives of the National Environment Agency (NEA) from 10 to 19 October 2022 to conduct an Integrated Regulatory Review Service (IRRS) mission. The purpose of this IRRS mission was to review Singapore's radiation safety governmental, legal and regulatory framework and activities against the relevant IAEA safety standards to report on effectiveness of the regulatory system and to exchange information and experience between IRRS team members and Singapore counterparts in the areas covered by the IRRS.

The IRRS team consisted of 12 senior regulatory experts from 12 IAEA Member States, 3 IAEA staff members. The IRRS team carried out the review in the following areas: responsibilities and functions of the government; the global nuclear safety regime; responsibilities and functions of the regulatory body; the management system of the regulatory body; the activities of the regulatory body including the authorization, review and assessment, inspection and enforcement processes; development and content of regulations and guides; emergency preparedness and response; control of occupational exposure, control of medical exposure, public and environmental exposure; transport of radioactive material and decommissioning. In addition, one policy issue was discussed: "Best practices in regulatory control of medical exposures and roles of NEA and Ministry of Health".

NEA conducted a self-assessment in preparation for the mission and prepared a preliminary Action Plan. The results of NEA's self-assessment and supporting documentation were provided to the IRRS team as advance reference material for the mission. During the mission the IRRS team performed a systematic review of all topics within the agreed scope through review of the Singapore advance reference material, conducted interviews with management and staff from NEA and observed NEA`s regulatory activities. The IRRS team also observed on-site inspections conducted by NEA at industrial and medical facilities: Setsco Services Pte Ltd and Singapore General Hospital and visited the radioactive waste storage facility operated by NEA. A meeting with the representative of the Ministry of Health took place. The IRRS team was impressed by the extensive preparation and dedication of Singapore. The IRRS team was extended full cooperation in the regulatory, technical, and policy discussions with the management and staff of NEA, in a very open and transparent manner. Throughout the mission, the administrative and logistical support was outstanding.

The IRRS team report includes several recommendations and suggestions to improve the regulatory system and the effectiveness of the regulatory functions in line with IAEA safety standards. The IRRS team recognizes that many of its findings confirm the actions for further improvement that were identified in NEA´s self-assessment.

The IRRS team concluded that the following issues are representative of those which, if addressed by the Government of Singapore and NEA, should further enhance the overall performance of the regulatory system.

The government should:

- Establish a national policy and strategy for safety and a national policy and strategy for the management of radioactive waste;
- Establish a regulatory framework for existing exposure situations and for the decommissioning and management of radioactive waste;
- Further develop coordination of the authorities that have responsibilities for safety;
- Continue building and maintaining the competence of the persons having responsibilities in relation to safety.

The NEA should:

- Continue promulgating legislation and regulations on radiation safety that are aligned with IAEA safety standards and proceed to further develop appropriate guides;
- Continue building competence in safety significant areas;
- Further develop its regulatory activities with the application of a graded approach;

- Include safety assessments into the regulatory practice of authorization;
- Continue documenting regulatory processes in the management system;
- Establish a comprehensive inspection programme and enhance the enforcement policy;
- Improve the regulating of the emergency preparedness and response.

The IRRS team identified several notable performance that are worthy of the attention of other regulatory bodies as a model for implementation.

The IRRS team believes that the recommendations and suggestions, if acted upon, will contribute to meeting these challenges and enhance radiation safety in Singapore. To conclude, in inviting the IAEA to conduct this IRRS mission and providing a transparent self-assessment, the Government of Singapore and the NEA have demonstrated their commitment to continuous improvement, a basic principle for excellence in radiation safety. This report, in particular its recommendations and suggestions, should be viewed in that context. The IRRS team findings are summarized in Appendix V. An IAEA press release was issued at the end of the IRRS mission.

I. INTRODUCTION

At the request of the Government of Singapore, an international team of senior safety experts met representatives of the National Environment Agency (NEA) from 10 to 19 October 2022 to conduct an Integrated Regulatory Review Service (IRRS) mission. The purpose of this peer review was to review the Singapore governmental, legal and regulatory framework for nuclear and radiation safety. The review mission was formally requested by the Government of Singapore in February 2019. An information meeting and self-assessment workshop was conducted on 18-20 February 2020 at NEA Headquarters, where the IAEA presented on the IAEA self-assessment methodology and demonstrated the Self-Assessment of Regulatory Infrastructure for Safety (SARIS) tool. A preparatory meeting was conducted on 9-10 March 2022 to discuss the purpose, objectives, detailed preparations of the review in connection with regulated facilities and activities in Singapore and their related safety aspects, and to agree the scope of the IRRS mission. All facilities and / or activities were included in the scope of the IRRS mission.

The IRRS team consisted of 12 senior regulatory experts from 12 IAEA Member States, 2 IAEA staff members and 1 IAEA administrative assistant. The IRRS team carried out the review in the following areas: responsibilities and functions of the government; the global nuclear safety regime; responsibilities and functions of the regulatory body; the management system of the regulatory body; the activities of the regulatory body including the authorization, review and assessment, inspection and enforcement processes; development and content of regulations and guides; emergency preparedness and response; control of occupational exposure, control of medical exposure, public and environmental exposure; transport of radioactive material and waste management and decommissioning. In addition, one policy issue was discussed: “Best Practices in Regulatory Control of Medical Exposures and Roles of NEA and Ministry of Health”.

NEA conducted a self-assessment in preparation for the mission and prepared a preliminary Action Plan. The results of NEA self-assessment and supporting documentation were provided to the IRRS Team as advance reference material for the mission. During the mission the IRRS Team performed a systematic review of all topics within the agreed scope through review of the Singapore advance reference material, conduct of interviews with management and staff from NEA and direct observation of NEA regulatory activities at regulated facilities. A meeting with representatives of the Ministry of Health was also organized.

All through the mission the IRRS Team received excellent support and cooperation from NEA.

II. OBJECTIVE AND SCOPE

The purpose of this IRRS mission was to review Singapore's radiation safety governmental, legal and regulatory framework and activities against the relevant IAEA safety standards to report on effectiveness of the regulatory system and to exchange information and experience in the areas covered by the IRRS. The agreed scope of this IRRS review included all facilities and activities regulated in Singapore. It is expected that this IRRS mission will facilitate regulatory improvements in Singapore and other Member States, utilising the knowledge gained and experiences shared between NEA and IRRS reviewers and the evaluation of the Singapore regulatory framework for nuclear safety, including its good practices.

The key objectives of this mission were to enhance the national legal, governmental and regulatory framework for nuclear and radiation safety, and national arrangements for emergency preparedness and response through:

a) providing an opportunity for continuous improvement of the national regulatory body through an integrated process of self-assessment and review;
b) providing Singapore (regulatory body and governmental authorities) with a review of its regulatory technical and policy issues;
c) providing Singapore (regulatory body and governmental authorities) with an objective evaluation of its regulatory infrastructure with respect to IAEA safety standards;
d) promoting the sharing of experience and exchange of lessons learned among senior regulators;
e) providing key staff in Singapore with an opportunity to discuss regulatory practices with IRRS team members who have experience of other regulatory practices in the same field;
f) providing Singapore with recommendations and suggestions for improvement;
g) providing other states with information regarding good practices identified in the course of the review;
h) providing reviewers from Member States and IAEA staff with opportunities to observe different approaches to regulatory oversight and to broaden knowledge in their own field (mutual learning process);
i) contributing to the harmonization of regulatory approaches among states;
j) promoting the application of IAEA Safety Requirements;
k) providing feedback on the use and application IAEA safety standards.

III. BASIS FOR THE REVIEW

A) PREPARATORY WORK AND IRRS TEAM

At the request of the Government of Singapore, a preparatory meeting for the Integrated Regulatory Review Service (IRRS) was conducted from 9 to 10 March 2022. The preparatory meeting was carried out by the appointed Team Leader Ms Ritva Bly and IAEA Coordinator, Mr Ronald Pacheco.

The IRRS mission preparatory team had discussions regarding regulatory programmes and policy issues with the senior management of NEA represented by Mr Ang Kok Kiat, Director (Radiation Protection and Nuclear Science Division) of NEA, and other management and staff. It was agreed that the regulatory framework with respect to the following facilities and activities would be reviewed during the IRRS mission in terms of compliance with the applicable IAEA safety requirements and compatibility with the respective safety guides:

- Waste management facilities;
- Radiation sources facilities and activities;
- Decommissioning;
- Transport of radioactive material;
- Control of medical exposure;
- Occupational radiation protection;
- Public and Environmental exposure control; and
- Selected policy issues.

NEA staff made presentations on the national context, the current status of NEA and the self-assessment results to date.

IAEA staff presented the IRRS principles, process and methodology. This was followed by a discussion on the tentative work plan for the implementation of the IRRS in Singapore in October 2022.

The proposed composition of the IRRS Team was discussed and tentatively confirmed. Logistics including meeting and workplaces, counterparts and Liaison Officer identification, proposed site visits, lodging and transportation arrangements were also addressed.

The Liaison Officer Mr Leow Poh Chuan for the IRRS mission was confirmed and later substituted by Mr Neo Zhipeng as Liaison Officer.

NEA provided IAEA with the advance reference material (ARM) for the review in August 2022. In preparation for the mission, the IAEA review team members reviewed the Singapore advance reference material and provided their initial impressions to the IAEA Team Coordinator prior to the commencement of the IRRS mission.

B) REFERENCES 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 VII.

C) CONDUCT OF THE REVIEW

The initial IRRS Team meeting took place on Sunday, 9 October 2022 in Singapore, directed by the IRRS Team Leader and the IAEA Coordinator. Discussions encompassed the general overview, the scope and specific issues of the mission, clarified 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 team. As required by the IRRS Guidelines, the reviewers presented their initial impressions of 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 Monday, 10 October, 2022, with the participation of senior management and staff from NEA, Ministry of Health and Ministry of Sustainability and the Environment. Opening remarks were made by Mr Luke Goh, Chief Executive Officer NEA and Ms Ritva Bly, IRRS Team Leader. Mr Neo Zhipeng, Liaison Officer, gave an overview of the Singapore context, NEA activities and the Action Plan prepared as a result of the pre-mission self-assessment.

During the IRRS mission, a review was conducted for all review areas within the agreed scope with the objective of providing Singapore and NEA with recommendations and suggestions for improvement and where appropriate, identifying good practice. The review was conducted through meetings, interviews and discussions, visits to facilities and direct observations regarding the national legal, governmental and regulatory framework for safety.

The IRRS team performed its review according to the mission programme given in Appendix II.

The IRRS exit meeting was held on 19 October 2022. The opening remarks at the exit meeting were presented by Mr Luke Goh, CEO of NEA and were followed by the presentation of the results of the mission by the IRRS Team Leader Ms Ritva Bly. Closing remarks were made by Mr Peter Johnston, Director, Division of Radiation, Transport and Waste Safety IAEA.

An IAEA press release was issued at the end of the mission.

1. RESPONSIBILITIES AND FUNCTIONS OF THE GOVERNMENT

The responsibility and mandate for establishing and maintaining a national framework for radiation safety in Singapore falls within the jurisdiction of the National Environment Agency (NEA). The National Environment Agency Act 2002 (NEAA), which established and incorporated NEA, stipulates the wide-ranging functions, duties and powers of NEA amongst which is the authority to control and regulate radioactive materials and irradiating apparatus. The Radiation Protection Act 2007 (RPA) is the primary legislation addressing the matter of the control of radiation. The primary regulations supporting the RPA in the area of radioactive materials and ionizing irradiating apparatus are the Radiation Protection (Ionizing Radiation) Regulations (RP(IR) Regulations) for safety, and the Radiation Protection (Transport of Radioactive Materials) Regulations (RP(TRM) Regulations) for safety during the transport of radioactive material. The RP(IR) Regulations is undergoing significant revisions and the amended regulations are expected to be promulgated in the near future. Under Section 4 of the RPA, the Director-General of Environmental Protection, is charged with the general administration of the RPA and has been granted the authority to exercise the powers and duties under the Act, including the authority to delegate some or all of his/her duties to any authorised officer.

The NEA, as the regulatory body, is empowered to issue authorizations and does so in the form of licences issued to facilities, activities and individuals as well as registrations of persons as radiation workers. The powers to inspect licensed activities, and take enforcement actions are provided for in the RPA.

1.1. NATIONAL POLICY AND STRATEGY FOR SAFETY

Singapore has not promulgated a national policy and strategy for safety that expresses its long-term commitment to safety as stipulated in Requirement 1 of GSR1. GSR1 distinguishes the National Policy from the National Strategy. With regards to the policy, it states that: *"The national policy shall be promulgated as a statement of the government's intent."* And it further states that: *"The strategy shall set out the mechanisms for implementing the national policy."* (Emphasis added). To this end, the RPA and the RP(IR) Regulations address some of the elements that form part of a national strategy for safety in the form of statutory or regulatory requirements. Additional evidence of the government's commitment to safety was provided in the form of statements made in NEA Integrated Sustainability Report 2022 and the Hansards of the Radiation Protection Bill in 1991, 2007 and 2014. However, an overarching statement about government's intent or about the objects of the RPA is not promulgated. There is a draft Policy and Strategy for Radioactive Waste Management that is expected to be published following the issuance of the amended RP(IR) Regulations.

The establishment of the national policy and strategy for safety was identified in the self-assessment and is part of the Action Plan.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
Observation: *Legislation and regulations contain certain elements of the national policy and strategy for safety. However, there is no national policy and strategy on safety that contains an expressed commitment to safety by the Government. The issue was identified in the self-assessment and is part of the Action Plan.*	
(1)	**BASIS: GSR Part 1 (Rev.1) Requirement 1, para. 2.3 states that** *"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…"*
R1	**Recommendation: The Government should establish a national policy and strategy for safety.**

1.2. ESTABLISHMENT OF A FRAMEWORK FOR SAFETY

The RPA and the RP(IR) Regulations clearly stipulate that the primary responsibility for safety rests with the licence holder. Regulations stipulate the activities that require a licence from the regulatory body. Inspectors have broad powers under the RPA, including the power for search and seizure. A graded approach has been adopted for

determining appropriate inspection frequencies for some activities and enforcement actions. The IRRS team noted that NEA has not fully implemented the graded approach to licensing activities and facilities and there are areas within the inspection strategy that could also be further improved. These are discussed in other parts of this report.

The framework for safety provides for, among other things, an interface with the system of accounting for, and control of, nuclear material, an interface with security and an interface for public involvement and sets out requirements for transport and import and export of radioactive materials. On the other hand, some other required elements are not addressed in the regulatory framework for safety. This includes, but is not limited to, the fundamental safety principles of justification (Principle # 4), optimization (Principle # 5), and protection of the environment (part of Principle # 7). Ref: Fundamental Safety Principles (SF-1)

The framework for safety, though extensive, is not complete and the IRRS team noted gaps in a number of areas which should be addressed. Specific information related to missing or incomplete requirements is found in **Recommendations 21-31 in Section 9** of this report and will not be repeated here. Additionally, the IRRS team noted that the Government has not established in statutes, the body or bodies with the authority to control and regulate situations with existing or unregulated radiation risks. Existing exposure situations include exposure to natural background radiation that is amenable to control; exposure due to residual radioactive material that derives from past practices that were never subject to regulatory control; and exposure due to residual radioactive material deriving from a nuclear or radiological emergency after an emergency has been declared to be ended. NEA has not identified any significant existing exposure situations that require control at the present time in Singapore, the potential exists that such a situation could arise, the legislative framework for safety should provide clarity concerning the roles and responsibilities of all of the organizations tasked with responding in these situations.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
Observation: *For existing exposure situations, the Government has not established a regulatory framework for safety.*	
(1)	**BASIS: GSR Part 3 Requirement 2. Para 2.13 states *that "The government shall establish and maintain an appropriate and effective legal and regulatory framework for protection and safety in all exposure situations. This framework shall encompass both the assignment and the discharge of governmental responsibilities, and the regulatory control of facilities and activities that give rise to radiation risks. The framework shall allow for the fulfilment of international obligations."***
R2	**Recommendation: The Government should establish a regulatory framework for safety for existing exposure situations.**

1.3. ESTABLISHMENT OF A REGULATORY BODY AND ITS INDEPENDENCE

Establishment of a Regulatory Body:
The NEA has been established under NEAA as a body with authority to promulgate regulations and control the use of radiation emitting devices and substances. The NEAA also provides NEA with authority for obtaining financial and human resources for the purposes of fulfilling its mandate. The RPA, RP(IR) Regulations and RP(TRM) Regulations are the principal legal instruments that set out the regulatory framework for safety in Singapore. Functionally, the Regulation Division (RD) of the Radiation Protection and Nuclear Science Group (RPNSG) is charged with the administration of the bulk of the regulatory oversight activities. Staff in the Central Licensing Branch (CLB) of the Licensing & Environmental Assessment Department (LEAD) under the Development Control and Licensing Division, under the instruction of the RD are authorized to approve applications.

The NEA has the legal authority to fulfil its statutory obligations. The RPA and RP(IR) Regulations set out the requirements for different activities to be licensed at a high level. Processes to be used to conduct regulatory activities are addressed in lower-tier documents Standard Operating Procedures (SOP) and Work Instructions (WI). For low-risk applications and straightforward renewals, the licence application is processed by the CLB. More complex

applications and new licences are reviewed and assessed by individuals in the RD and approved by persons authorized in writing by the Director-General of Environmental Protection (DGEP).

NEA is one of three statutory boards under the Ministry of Sustainability and the Environment. There have been recent (as recently as July 2022) changes to the organizational structure of NEA, resulting in changes to the reporting structure of the organizational unit for radiation protection. It is stated in the ARM (p.10) that there are plans to amend the RPA for alignment with the reporting structure.

1.4. RESPONSIBILITY FOR SAFETY AND COMPLIANCE WITH REGULATIONS

The prime responsibility for safety is assigned to the licensee in various sections of part 5 of the RPA. Duties of licensees to employees are set out in section 10 of the RPA: "Every licensee must provide and maintain, so far as is practicable, for the licensee's employees who are exposed or likely to be exposed to radiations a working environment that is safe and without risks to health." Section 10(5) of the RPA in defining the term "employee" sets out that the obligations extend to independent contractors directly under the supervision of the licensee or under the supervision of a contractor hired by the licensee. Obligations of licensees include the requirement to provide training, personal protective equipment and a safe working environment to all employees, and to investigate and report accidents and events to the regulator. Workers are required to comply with work instructions and regulatory requirements. All radiation workers are required to be registered by NEA and in order to do so, have to undergo training and may be required to pass a test administered by NEA.

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

The NEA interacts with a number of other government departments who have overlapping or complementary responsibilities. For example:

- The Ministry of Transport (Civil Aviation Authority, and Maritime and Port Authority) for the enforcement of transport regulations, RP(TRM) Regulations;
- The Ministry of Health for the delivery of diagnostic and therapeutic radiation;
- The Ministry of Home Affairs, Immigration and Checkpoints Authority and the Ministry of Finance, Singapore Customs in relation to import and export regulations and for response to unregulated sources of radiation; and
- The Singapore Civil Defence Force for regulatory control during emergency response.

The NEA does not have any memoranda of understanding with partner authorities in the corresponding ministries, but under the general framework of the Singapore Public Service's whole-of-government (WOG) collaboration, it engages with other agencies, maintains contact through official channels, and sharing relevant information with appropriate departments.

Specifically, in the case of NEA's regulation of medical exposures, the IRRS reviewers noted that there is significant interaction with the regulatory requirements under the Ministry of Health (MOH). The IRRS team noted that there are some requirements in NEA and MOH regulations where there is a clear overlap of functions e.g. requirements regarding unintended and accidental exposures and requirements pertaining to some records. Furthermore, MOH and NEA are empowered to carry out inspections of medical facilities and activities and sometimes inspect the same items.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES
Observation: *NEA and MOH cooperate in controlling medical exposures. However, there is overlap in regulatory activities.*

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
(1)	**BASIS: GSR Part 1 (Rev.1) Requirement 7, states that** *"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."*
R3	**Recommendation: The Government should make provision for the effective coordination of NEA's and MOH's regulatory activities, to avoid any omissions or undue duplication and to avoid conflicting requirements being placed on authorized parties.**

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
Observation: *NEA interacts with a number of other authorities that have responsibility for safety. There are no formal procedures for coordination between NEA and these authorities.*	
(1)	**BASIS: GSR Part 1 Requirement 7 para. 2.18 states that "…***This coordination and liaison can be achieved by means of memoranda of understanding, appropriate communication and regular meetings. Such coordination assists in achieving consistency and in enabling authorities to benefit from each other's experience."*
S1	**Suggestion: The Government should consider ensuring that there is coordination of NEA's activities with other authorities and should set up appropriate formal mechanisms for cooperating and sharing information so as to avoid potentially conflicting or overlapping requirements and duplication.**

1.6 SYSTEM FOR PROTECTIVE ACTIONS TO REDUCE EXISTING OR UNREGULATED RADIATION RISKS

The Singapore Government has implemented a system for detection of unregulated radiation sources entering or leaving Singapore through portal monitors deployed at Singapore's border checkpoints, such as at land borders, maritime ports, and airports. A radiation portal monitor is also deployed at the municipal solid waste (MSW) waste-to-energy plant to detect unregulated sources that are disposed of. NEA responds and provides advice to the relevant agency and will as a last resort take control or possession of a source if necessary. Under section 14 of the RPA, the DGEP has the power to take control of a situation where a radioactive source is at risk of being unlawfully disposed of. NEA has provision under RPA to dispose of such disused radioactive sources and recover money from the occupier or owner where applicable.

NEA has not identified any significant existing exposure situations that require control. However, potential existing exposure situations could include residues, such as from the oil and gas industry, or situations of natural origin, such as exposure to radon gas in homes, workplaces or in underground transport stations.

For existing exposure situations, it is not explicit who would be responsible for protective actions including remediation actions and accepting remediation. The regulatory body should provide any necessary inputs for protective actions, advising or exercising regulatory control on protective actions, and establish the regulatory requirements and criteria. **Refer to Recommendation R2 in Section 1.2**.

1.7. PROVISIONS FOR THE DECOMMISSIONING OF FACILITIES AND THE MANAGEMENT OF RADIOACTIVE WASTE

Since Singapore has neither nuclear power plants nor research reactors, there is no inventory of spent nuclear fuel. Disused radioactive sources are returned to the supplier whenever possible and only radioactive material that has decayed below exemption levels can be disposed as non-radioactive waste or discharged to the environment. There

are small amounts of disused radioactive sources stored at some licensees' premises. In addition, NEA manages a radioactive waste store which houses small quantities of orphan and disused radioactive sources as well as conditioned radioactive waste.

In Singapore to date, no facilities that give rise to radiation exposure during decommissioning have undergone decommissioning, and no such facilities are scheduled to undergo decommissioning in the immediate future. There are no disposal facilities for radioactive waste in Singapore, and there are currently no plans to develop a disposal facility.

NEA has drafted a Policy and Strategy for Management of Radioactive Waste in Singapore, which establishes a waste management hierarchy including waste prevention, minimisation, reuse and recycling, disposal/discharge (only for radioactive material that has decayed below exemption levels) and indefinite storage. Further, the planned Policy and Strategy for Management of Radioactive Waste in Singapore, assigns the financial responsibility for the costs of pre-disposal management and disposal of the radioactive waste to radioactive waste producers and owners. NEA plans to publish and implement the policy and strategy after the upcoming amended RP(IR) Regulations are gazetted. The upcoming amended RP(IR) Regulations are intended to cover the safety requirements for the management of radioactive waste. There are also plans for NEA to publish a national policy and strategy for safety (see related Recommendation R1). The IRRS team would like to emphasise the importance of the upcoming amended RP(IR) Regulations and the Policy and Strategy for Management of Radioactive Waste in Singapore being in line with the national policy and strategy for safety.

The current governmental, legal and regulatory framework for safety, the planned Policy and Strategy for Management of Radioactive Waste in Singapore and the upcoming amended RP(IR) Regulations do not contain adequate provisions for the safe decommissioning of facilities and for the disposal of radioactive waste. In addition, the current governmental, legal and regulatory framework and the planned updates do not provide for adequate financial provisions for the decommissioning of facilities (e.g. for the gamma knife facility, sterilisation facility and cyclotrons). This also applies to the safe management of radioactive waste including radioactive waste generated in a nuclear or radiological emergency and disused radioactive sources, for which all efforts to reuse, recycle or return the source to the supplier have been exhausted and decay storage is not a feasible solution. This has been identified by the IRRS team as a potential concern particularly for the orphan and disused radioactive sources and the conditioned radioactive waste currently stored in the storage facility that is managed by NEA.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
Observation: *There is no national policy and strategy for the management of radioactive waste, including disused radioactive sources and radioactive waste generated during decommissioning and radioactive waste generated as a result of a nuclear or radiological emergency. The legal and regulatory framework does not contain appropriate provisions to ensure safety in the management of radioactive waste, including disposal for cases for which all efforts to reuse, recycle or return the source to the supplier have been exhausted and decay storage is not a feasible solution. There is no mechanism in place to ensure that adequate financial resources are available when necessary for safe decommissioning and for the management of the radioactive waste.*	
(1)	**BASIS: GSR Part 5 Requirement 2 states that** *"To ensure the effective management and control of radioactive waste, the government shall ensure that a national policy and strategy for radioactive waste management are established…"*
(2)	**BASIS: GSR Part 1 (Rev.1) Requirement 10, para. 2.28 states that** *"Decommissioning of facilities and the safe management and disposal of radioactive waste shall constitute essential elements of governmental policy and the corresponding strategy over the lifetime of facilities and the duration of activities…"*
(3)	**BASIS: GSR Part 7 Requirement 7, para. 5.84 states that** *"The national policy and strategy for radioactive waste management [19] shall apply for radioactive waste generated in a nuclear or radiological emergency, with account taken of paras 5.85 to 5.88."*

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
(4)	**BASIS: GSR Part 1 (Rev.1) Requirement 10, para. 2.33 states that** *"Appropriate financial provision shall be made for:* *(a) Decommissioning of facilities;* *(b) Management of radioactive waste, including its storage and disposal;* *(c) Management of disused radioactive sources and radiation generators;* *…"*
R4	**Recommendation: The Government should establish a national policy and strategy and, an appropriate legal and regulatory framework for the management of radioactive waste, including disused radioactive sources and radioactive waste generated during decommissioning and in a nuclear or radiological emergency, and should make appropriate financial provisions for decommissioning and the predisposal management and disposal of radioactive waste.**

1.8. COMPETENCE FOR SAFETY

Section 10(2)(b) of the RPA stipulates the obligation of licensees to provide employees with the requisite training. Regulation 13(2)(b) of the RP(IR) Regulations sets out the requirement for registered radiation workers to undergo appropriate training. Regulation 6 of the RP(IR) Regulations sets out the pre-requisites for granting licences and includes the requirement for medical professionals to have appropriate professional training and accreditation, and for other persons to have adequate training.

The Singapore Environment Institute (SEI), which is part of NEA, provides support to NEA for the development, training and knowledge management of the regulatory body. The SEI also supports departments' regulatory courses for industries and works with institutes of higher learning to develop training programmes for the local environmental services industry. The NEA departments, stakeholders and trainers are involved in the curation of content, design and delivery methods. The Republic Polytechnic conducts the Basic Ionizing Radiation Safety (General) course as well as Basic Ionizing Radiation Safety (Industrial Radiography). These courses are available to authorised parties (including prospective authorised parties), as well as new officers in NEA's RPNSG. Other academic institutions (e.g. the National University of Singapore), training institutes (e.g. the Civil Service College), the IAEA, as well as the United States Nuclear Regulatory Commission (NRC), under an Implementing Agreement also provide training to staff in the regulatory body in Singapore. Singapore has adequate provisions for building and maintaining the competence of its workers.

NEA has established technical committees with different industry sectors with a view to establishing a curriculum in radiation safety to train different professionals whose work involves radiation. In the ARM, and its initial Action Plan, NEA has identified the need for developing comprehensive training program for licensees and radiation workers, establishing these in the curriculum of study for these professions and performing outreach to ensure broad implementation.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES
Observation*: The NEA has identified the need for developing radiation protection training for workers in industry and medical sectors. To this end, it has established technical committees charged with developing a curriculum for training of professionals in different areas of specialization, which when completed, will be incorporated into the syllabus at the corresponding institutions of higher learning. The issue was identified in the self-assessment and is part of the Action Plan.*

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
(1)	**BASIS: GSR Part 1 (Rev.1) Requirement 11, states that** *"The government shall make provision for building and maintaining the competence of all parties having responsibilities in relation to the safety of facilities and activities.*
S2	**Suggestion: The Government should consider ensuring that radiation protection training programs are established for all parties having responsibilities in relation to the safety of facilities and activities.**

1.9. PROVISION OF TECHNICAL SERVICES

The Radiation Monitoring and Services Division (RMSD) provides personal dosimetry services for all authorised users of radiation in Singapore. This free service provides thermoluminescent dosimeters for gamma and neutron dose measurements and is used by all radiation workers. There are no requirements for authorization of the personal dosimetry service in Singapore. Personal dosimetry is an activity of high safety significance and this activity should be subject to regulatory authorization and scrutiny. The RMSD also operates the Secondary Standards Dosimetry Laboratory (SSDL) and provides calibration services to licensees across Singapore. This activity involves the use of an irradiator with sealed sources and is subject to the requirements of the RPA and of the RP(IR) Regulations but regulatory requirements are not enforced because the facility is not required to hold a licence.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
Observation: *There are no legal provisions for authorization of technical services that may have significance for safety.*	
(1)	**BASIS: GSR Part 1 (Rev.1) Requirement 13, para. 2.41 states that "…** *The regulatory body shall authorize technical services that may have significance for safety, as appropriate."*
R5	**Recommendation: The Government should ensure that NEA is empowered to authorise technical services that have significance to safety.**

1.10. SUMMARY

Singapore has established NEA under NEAA as the regulatory body for radiation protection. Furthermore, Singapore has granted it the requisite powers and authorities to regulate activities related to radioactive materials and ionizing radiation taking place in Singapore. The regulatory framework for safety empowers NEAA to enact regulations, issue licences, conduct compliance verification activities and enforce regulatory requirements. The framework is extensive and sets out regulatory requirements for most types of situations encountered in Singapore at this time.

However, some areas for further improvement to the framework have been identified:

- Establishment of a national policy and strategy for safety;
- Establishment of a national policy and strategy for management of radioactive waste;
- Establishment in legislation of the authorities empowered to take regulatory actions to control existing exposure situations;
- Ensure better coordination and cooperation between the MOH and NEA in the area of medical exposures;
- Establishment of regulatory requirements for waste management and decommissioning; and
- Ensure the regulatory framework for safety is in compliance with the IAEA standards.

2. THE GLOBAL SAFETY REGIME

2.1. INTERNATIONAL OBLIGATIONS AND ARRANGEMENTS FOR INTERNATIONAL COOPERATION

The primary liaison between Singapore and the IAEA is NEA through the RPNSG. Singapore has acceded to several multilateral international conventions and agreements, and actively implements programmes to fulfil its obligations to these conventions and agreements. Singapore has acceded to the Convention on Nuclear Safety, Convention on the Physical Protection of Nuclear Material and affirmed its political commitment to the Code of Conduct on the Safety and Security of Radioactive Sources as well as its Addenda (in September 2022).

Singapore is a member of the Association of Southeast Asian Nations (ASEAN) Network of Regulatory Bodies on Atomic Energy (ASEANTOM) since it was established in 2012. Singapore is a member of the IAEA Nuclear Safety Standards Committee (NUSSC), Radiation Safety Standards Committee (RASSC), Transport Safety Standards Committee (TRANSSC) and the Emergency Preparedness and Response Standards Committee (EPReSC). Singapore is a member of the Asian Nuclear Safety Network (ANSN) established by the IAEA in 2012. Singapore collaborates with IAEA to build regional capacity in nuclear safety through the Singapore-IAEA Third Country Training Programme (TCTP). Singapore also has cooperation agreements with several mature regulators, including US NRC, Finnish Radiation and Nuclear Safety Authority (STUK), Australian Radiation Protection and Nuclear Safety Agency (ARPANSA), and technical support organisation, such as French Institute for Radiological Protection and Nuclear Safety (IRSN). Singapore has not acceded to the Joint Convention on the Safety of Spent Fuel Management and the Safety of Radioactive Waste Management (Joint Convention). Singapore has acknowledged in the drafting of the national policy and strategy for management of radioactive waste and the proposed amendments to the RP(IR) Regulations, the importance of these emerging areas and would benefit from participation in the Joint Convention.

The IRRS team noted that despite the limited scope of activities conducted in Singapore and the relatively modest workforce, NEA is an active participant in the IAEA initiatives and technical committees, regional networks and associations, and has acceded to key IAEA conventions that overall contribute to the development of a global safety regime. **The IRRS team considers this a notable practice.**

In preparation for the IRRS mission, in addition to the self-assessment against IAEA Safety Standards, NEA conducted a self-assessment against the IAEA Code of Conduct on the Safety and Security of Radioactive Sources (Code). Through this process, NEA identified that Singapore had not yet made the political commitment to guidance that supplements the Code, namely, Guidance on the Import and Export of Radioactive Sources and Guidance on the Management of Disused Radioactive Sources. These actions were identified in the Action Plan prepared for the IRRS mission. In September 2022, before the start of the IRRS mission, Singapore fulfilled this action by notifying the IAEA of this political commitment. NEA has already started taking action to implement the commitment. The IRRS team considers this a notable practice on two fronts, firstly because it is an implementation of an Action Plan before the start of the mission, and secondly because it signals another important safety commitment at the level of international undertakings.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
Observation: *Singapore is party to several IAEA conventions, codes and committees, is an active participant in regional networks, and has cooperation agreements with several mature regulators. However, Singapore has not acceded to the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management. The issue was identified in the self-assessment and is part of the Action Plan.*	
(1)	**BASIS: GSR Part 1 (Rev.1) Requirement 14, para. 3.2 states that "***The features of the global safety regime include:*

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
	(a) International conventions that establish common obligations and mechanisms for ensuring protection and safety; …"
S3	**Suggestion: The Government should consider acceding to the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management.**

2.2. SHARING OF OPERATING EXPERIENCE AND REGULATORY EXPERIENCE

As part of the IAEA United System for Information Exchange (USIE) and Incident and Trafficking Database (ITDB), NEA receives incident notifications submitted by other member states and disseminates them to relevant local authorities. In Singapore, NEA disseminates information to licensees and other stakeholders through emails, one-on-one meetings, presentations at industry association meetings and workshops and through Advisory committee meetings.

Although practices exist to share event reports, outcomes of international meetings, conferences and workshops, the IRRS team also noted during the interviews, that NEA has not implement a formal procedure to use the results of inspections to inform the regulatory process**. A recommendation R8 related to this finding has been made in Section 4.5.**

2.3. SUMMARY

Singapore is signatory to many international conventions and codes, participates in regional associations and networks and has technical cooperation agreements with mature regulators. However, the following areas for further improvement have been identified:

- Singapore is encouraged to consider acceding to the Joint Convention; and
- NEA's practice of disseminating relevant information received from its international and national networks to internal and external stakeholders would benefit from formalizing the process of information sharing.

Singapore's active participation in international activities contributes positively to a global safety regime. This, together with NEA's diligence in the proactive implementation of the Action Plan are acknowledged by the **IRRS team as notable practices.**

3. RESPONSIBILITIES AND FUNCTIONS OF THE REGULATORY BODY

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

The NEAA (section 3) establishes NEA as the regulatory body for facilities and activities posing radiation risk. NEA is a direct administrative body under the supervision of the Ministry of Sustainability and the Environment (MSE). MSE is headed by the Minister for Sustainability and the Environment. Within NEA, there are four pillars with various divisions and departments that carry out the following functions: Planning, Corporate and Technology (PCT), Environmental Protection (EP), Public Health (PH), and Meteorological Services and Radiation Protection (MSRP). There are two standalone divisions in NEA, the Internal Audit Division (IAD) and the Legal Division (LD). On 1st July 2022 the Meteorological Services and Radiation Protection (MSRP) pillar was reorganised to bring under the same pillar two areas of specialised domains the meteorological services (weather/climate science) and radiological/nuclear science.

The organisational structures of NEA and RPNSG are approved by MSE. RPNSG is a unit of NEA which is responsible for the regulatory oversight of radiation safety. RPNSG is split into two divisions, the Regulation Division (RD) and RMSD. RD is divided into three Departments: the Ionizing Radiation Control Department (IRCD), the Non-ionizing Radiation Control Department and the Nuclear Science and Technology Department. Regulatory functions are performed by IRCD. RMSD is divided into three departments/branches: Radiation Monitoring & Modelling Branch, National Radiochemistry Laboratory and Radiation Services Branch. Inspection is within IRCD. RD is responsible for applying and enforcing the Radiation Protection Act 2007 (RPA) and its subsidiary legislation. RPNSG is headed by a Group Director and supported by two Directors - one overseeing RD and the other overseeing RMSD. MSE approves the appointment of the Group Director of the RPNSG and the organisational structure of NEA, including RPNSG.

Section 4 of the Radiation Protection Act (RPA) specifies that the Director-General of Environmental Protection (DGEP) of NEA is in charge of general administration of the RPA and can exercise the powers conferred and duties imposed by the RPA. The DGEP of NEA may also appoint in writing any public officer, or any officer of the Agency or any other statutory authority, to be an authorised officer for the purposes of the RPA (Section 4 of RPA). The DGEP and the Group Director of RPNSG represent the RPNSG in Singapore in international institutions, bodies, and organizations.

The RPNSG reports to the Assistant Chief Executive of Meteorological Services and Radiation Protection for all matters and seeks the necessary approval from the DGEP of NEA for matters relating to powers and duties under the RPA. To fulfil tasks and functions of RPNSG, the Group Director has the right to issue internal procedures for effective work of RPNSG within the management system. The approved organisational structure of the RPNSG includes 70 employees (the current number of employees in the RPNSG is 65) including the Group Director of the RPNSG. Within IRCD there are 12 officers with the powers delegated by the DGEP of NEA, of which 6 are inspectors and 6 have other responsibilities for ionizing radiation.

NEA RPNSG is funded from the state budget. It develops a budget plan for one year. Financial resources for RPNSG are allocated annually by NEA as a separate budget line within NEA budget which gets approved by the CEO of NEA. In the case that RPNSG needs additional funding for new activities, such as equipment procurement for early warning network, these expenses are also covered through the budget of NEA. Resources are allocated proportionally to each division of RPNSG, as set out and recommended by the Group Director of RPNSG.

3.2. EFFECTIVE INDEPENDENCE IN THE PERFORMANCE OF REGULATORY FUNCTIONS

As discussed in Section 1 of this report and the previous section, the NEAA (section 3) establishes NEA as the regulatory body for facilities and activities posing radiation risk in connection with the RPA which defines regulatory activities. Within NEA and with the reorganised MRSP, RPNSG is the national authority for radiation protection in Singapore and serves to protect the public, radiation workers, patients and the environment from harmful effects of radiation. The Regulation Division (RD) of RPNSG is the primary body for developing policies and requirements for radiation protection and safety. RD undertakes the responsibility of administering and enforcing the RPA and its subsidiary legislation. RPNSG is the national contact point for matters relating to radiation protection and nuclear safety. The RPA empowers the DGEP of NEA and all authorised officers appointed by the DGEP to independently carry out the regulatory functions of RPNSG.

Administrative and regulatory measures for prevention and resolution of potential conflicts of interest in the decision-making process is the public service's code of conduct. Officers are committed to ensure that there is no conflict of interest between official duties and personal interests. Officers are required to make declarations on property, indebtedness, shares and interest in business. These declarations are required to be completed on an annual basis, or as soon as possible after circumstances change. In the case that any significant risk is identified concerning the integrity of staff of the regulatory body, the Human Resource and Organisation Development Division of NEA intervene. The IRRS team was informed that NEA RPNSG does not have a written policy regarding employing staff from licensees, but they have unwritten rules that if such a case occurs the employee does not conduct proceedings for the former employer.

In addition to the administration and enforcement of the RPA, RPNSG lists as its key responsibility to "monitor radiation exposures for radiation workers" and "provide radiation related consultancy services". This is the responsibility of the Radiation Monitoring and Services Division. RD and RMSD are in the same organizational unit under the Group Director, RPNSG. Though functionally distinct from the RD, its reporting structure is identical. RMSD, as the only Secondary Standards Dosimetry Laboratory in Singapore, provides calibration services for radiation survey instruments. It offers laboratory services to analyse wipe test samples for any radioactive contamination. RMSD also manages the storage facility for disused and orphan sources. These services entail the storage or use of radioactive material and although subject to the RPA, are not licenced in accordance with the regulatory requirements. This is discussed in Section 5.1. However, in the context of regulatory independence, given that the facilities conduct licensable activities, NEA should ensure that RPNSG can clearly separate the functions of RD and RMSD and that there is no potential for a conflict of interest.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
Observation: *The Radiation Monitoring and Services Division under the Radiation Protection and Nuclear Science Group is responsible for the operation of the waste storage facility, the Secondary Standards Dosimetry Laboratory and of the National Radiochemistry Laboratory. RMSD is also responsible for providing technical services relating to safety in radiation work. RD and RMSD are in the same organizational unit under the Group Director, RPNSG.*	
(1)	**BASIS: GSR Part 1 (Rev.1) Requirement 17, para. 4.9 states that** *"To maintain its effective independence, the regulatory body shall ensure that it has a clear separation from organizations or bodies that have been assigned responsibilities for facilities or activities or for their promotion."*
(2)	**GSR Part 1 (Rev.1) Requirement 4, para. 2.11 states that "***In the event that a department or agency of government is itself an authorized party operating an authorized facility or facilities, or conducting authorized activities, the regulatory body shall be separate from, and effectively independent of, the authorized party."*
R6	**Recommendation: NEA should ensure that there is a clear separation between the Regulation Division and any division with assigned responsibility for any activity subject to regulatory oversight under the Radiation Protection Act.**

3.3. STAFFING AND COMPETENCE OF THE REGULATORY BODY

GSR Part 1 (Rev.1) requires that NEA RPNSG has sufficient and competent staff to perform its functions and to discharge its responsibilities. The IRRS team reviewed the staffing and competence of the regulatory body. NEA RPNSG, at the time of the mission, employed 65 persons including the Director of the RPNSG, 44 employees in the Regulation Division (RD) and 21 employees in the Radiation Monitoring and Services Division (RMSD). Within the RD Ionizing Radiation Control Department (IRCD) there are 12 officers with powers delegated by the DGEP of NEA, of which 6 are inspectors. In 2022, 5 additional employees are expected to join RPNSG.

In the Central Licensing Branch (CLB) of the Licensing & Environmental Assessment Department (LEAD) in the Development Control and Licensing Division (DCLD) there are also 5-8 authorised officers who perform the backend administrative licensing work under instructions from the RD, among which 3-4 officers are responsible for ionizing radiation licences. Licensing officers of DCLD perform administrative tasks such as data entry and carrying out preliminary checks on applications to ensure that required information and documents are provided and also has the powers to authorize applications.

NEA's Human Resource and Organisation Development Division (HRODD) has policies in place for organisational matters to ensure that they have sufficient, qualified and competent officers to perform its functions. In the self-assessment, NEA RPNSG identified that the RD employs sufficient numbers of qualified and competent staff to perform regulatory functions. The IRRS team was informed that an assessment of the necessary staff was done during a period of three to five years for all organisational structure of NEA.

NEA has developed a Job Competency Matrix (JCM) to identify the necessary skills and knowledge required for each NEA officer, including the RPNSG staff. The JCM includes detailed descriptions of requirements for each position, recruitment, rotation of staff and departure of staff. Based on the JCM an individual training programme for every member of RPNSG staff has been developed and implemented every year through NEA Training Budget. Additional training is provided under the IAEA TC project for areas that do not exist in the country. NEA RPNSG has a measure upon the departure of qualified staff, whereby the posting for recruitment is opened by NEA both internally and externally. This procedure is prescribed in the procedure for recruitment of staff of the HRODD's policy on appointment of staff.

During the IRRS mission the IRRS team observed that NEA RPNSG has trained staff, who receive regular theoretical training via an established and implemented system that is described in this section. However, the IRRS team observed that NEA has a limited number of staff with technical expertise and training for the conduct and review of in-depth safety assessments and submissions from applicants and technical bodies, and for inspecting complex or high-risk activities. Under the proposed draft regulations, safety assessment will be part of the application and the regulatory body should develop the capacity to assess these.

The IRRS team was also informed that inspectors and licensing officers in RPNSG have a general and theoretical training programme about radiation safety. This training provides minimal knowledge about practices in medical facilities. The training programme of Ministry of Health inspectors on radiation safety involves only on-the-job training during inspections supervised by a senior inspector. These training inspections are set out for diagnostic radiology and nuclear medicine imaging for a period of 6 to 12 months or as necessary for radiotherapy.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
Observation: *NEA has established and implemented a system for the training of its staff. However, there is limited technical expertise for review and assessment and inspection of facilities and activities commensurate with the radiation risks involved.*	
(1)	**BASIS: GSR Part 1 (Rev.1) Requirement 18 states that** *"The regulatory body shall employ a sufficient number of qualified and competent staff, commensurate with the nature and the number of*

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
	facilities and activities to be regulated, to perform its functions and to discharge its responsibilities."
(2)	**BASIS: GSR Part 1 (Rev.1), Requirement 18, para. 4.13 states that** **"***A process shall be established to develop and maintain the necessary competence and skills of staff of the regulatory body, as an element of knowledge management. This process shall include the development of a specific training programme on the basis of an analysis of the necessary competence and skills. The training programme shall cover principles, concepts and technological aspects, as well as the procedures followed by the regulatory body for assessing applications for authorization, for inspecting facilities and activities, and for enforcing regulatory requirements".*
R7	**Recommendation: NEA should ensure there are enough qualified and competent staff, commensurate with the nature and the number of facilities and activities to be regulated, and allocate human resources commensurate with the radiation risks associated with facilities and activities.**

3.4. LIAISON WITH ADVISORY BODIES AND SUPPORT ORGANIZATIONS

The IRRS team reviewed the regulatory body's liaisons with advisory bodies and support organizations. Section 5 of the RPA establishes the legal basis for the appointment of advisory or technical committees, as necessary for the purpose of advising NEA for any matters arising from the application administration of the RPA. According to the RPA composition of technical committees and the terms of appointment of members shall be approved by NEA.

NEA has appointed the Advisory Committee on Radiation Protection and Nuclear Science. It is composed of representatives from government agencies, local industry, and academia, to provide advice in the different areas such as technical knowledge and expertise in sectors that use nuclear technology, strategy for control of radioactive and nuclear materials, etc.

In addition to the Advisory Committee on Radiation Protection and Nuclear Science, NEA has obtained NEA Board's resolution on 19 Mar 2021 for the formation of three Technical Committees for *industrial applications*, *medical & dentistry, and veterinary*. These Technical Committees work with NEA RPNSG to establish requirements and guides for radiation safety and security to develop and implement education and training programmes for radiation workers. These technical committees are also established for a limited time period, with a clear scope of work.

As discussed in Section 3.2 of this report, the Radiation Monitoring and Services Division (RMSD) under RPNSG is responsible for providing technical services relating to radiation safety. It is possible that these arrangements could generate conflicts of interest which could compromise regulatory independence in decision-making when obtaining technical or other expert professional advice or services internally. **A recommendation R5 regarding this issue is made in Section 1.9.**

3.5. LIAISON BETWEEN THE REGULATORY BODY AND AUTHORIZED PARTIES

NEA RPNSG has established formal and informal mechanisms of communication with authorised parties. Information about the regulatory process, criteria and conditions are available on NEA's website.

The RPA and its subsidiary legislation are publicly available on NEA's webpage. Applicants and authorised parties can apply for authorisations and provide other information online through the online platform, which is a single point of access for citizens and businesses in Singapore to access Government e-services and resources. The applications are received by NEA and processed on NEA's custom-developed backend processing system which is called Radiation Protection and Laboratory Management System (RPLMS).

During the authorisation process NEA RPNSG staff communicate with applicants in the event of missing or insufficient information. Following the review of an application, and prior to issuing a new licence to possess a radiation source, NEA RPNSG conduct a pre-licensing inspection to ensure regulatory compliance.

Additionally, NEA's engagement with authorised parties is done via different modes of communication such as meetings, e-mails and letters. Transparency of communication with authorised parties is conducive to achieving their common objectives in ensuring safety.

Singapore's information sharing policies and information and communications technology (ICT) infrastructure support an integrated authorisation process. This includes the GoBusiness Licensing Portal, a centralised application platform, and Singapore's 'no-wrong door' policy ensuring that people are guided to the right area rather than rejected. A notable collaboration is that during building development approval RPNSG is consulted, which ensures radiation protection is considered by technical experts in the design stage and that the regulator can engage with potential licence holders pre-licencing. The digitalised licencing process allows for tracking of licence applications, effective retention and retrieval of licence holder and radiation source data, as well as built-in mechanisms to ensure checks and balance for authentication of licence applicant information. Integrations also include the Singapore Customs platform for Trade declaration, which allow import and export of irradiating apparatus and radioactive materials to be regulated through a collaborative approach. **The IRRS team considers this notable practice.**

3.6. STABILITY AND CONSISTENCY OF REGULATORY CONTROL

The IRRS team reviewed the mechanisms to ensure the stability and consistency of regulatory control. NEA RPNSG makes regulatory decisions based on the Radiation Protection Act (RPA) and its subsidiary legislation which are publicly available on NEA's webpage. A detailed description of the licensing processes with guidance for the applicants is published on the NEA website. The criteria and processes for authorisation are also available on NEA's webpage.

NEA RPNSG has Standard Operating Procedures (SOPs) and Work Instructions (WIs) under the ISO 9001 Standard Management System, and internal guidelines which document the work procedures staff must strictly adhere to for issuance of licences and when conducting inspections and enforcement work. There are RPNSG SOPs about how to evaluate a licence and perform an inspection (SOP-RD-01; Issuance of Radiation Licences; SOP-RD-02 Inspection of Radiation Equipment, Material and Facilities; WI-RD-Inspection-001 Inspection Frequency Guideline; WI-RD-Inspection-002 Inspection Report; WI-RD-Licence-001 Licence Condition Guideline; WI-RD-Licence-002 Licence Approval Guideline; WI-RD-Licence-003 Guidelines for Issuance of L5, L6 and R1 Licence/Certificate). These internal documents define procedures for making decisions, reviewing documents and performing inspections. However, the internal procedures do not cover all aspects of regulatory work especially for the assessment of complex cases, which may cause inconsistencies. **A recommendation R8 regarding this issue is made in Section 4.5**.

3.7. SAFETY RELATED RECORDS

The IRRS team reviewed the mechanisms for collecting and maintaining records related to safety of facilities and activities. Radiation Protection Act (RPA) (section 16) and Radiation Protection (Ionizing Radiation) Regulations RP(IR) Regulations (regulations 15, 26, 35, 38 and 46) define requirements for licensees to maintain safety-related records. In the RP(IR) Regulations, the legal basis is given that NEA can includes additional requirements for record keeping as a licence conditions.

These requirements stipulate that the following records are kept and information related to their activities are reported on: records of dose, records of radioactive materials, records of the protective clothing used, records of the dose output of irradiating apparatus, records of radiation levels in working areas where unsealed radioactive sources are handled, records of annual wipe tests, and records of annual calibration of radiation area monitors and personal dosimeters.

There is no regulatory requirement that authorized parties maintain records that might be necessary for the shutdown and decommissioning (or the closure) of facilities, records of events (including non-routine releases of radioactive material to the environment) and records of inventories of radioactive waste.

Regulation 10 of the RP(IR) Regulations defines the responsibility of NEA RPNSG to keep and maintain a register of licenses and premises where the person may carry out activities authorized by his/her licence. In addition, NEA has developed internal database on the Radiation Protection and Laboratory Management System (RPLMS). These records, which include information on the facilities, activities, irradiating apparatus/radioactive materials, assist the RPNSG in keeping track of and providing an overview of the licenses issued for radiation facilities and activities. These records are used to support the RPNSG's regulatory functions and to support the enforcement of regulatory requirements.

However, GSR1 Requirement 35 paragraph 4.63, additionally requires that the regulatory body make provision for establishing and maintaining the following main registers and inventories:

- Registers of sealed radioactive sources and radiation generators;
- Records of doses from occupational exposure;
- Records relating to the safety of facilities and activities;
- Records that might be necessary for the shutdown and decommissioning (or closure) of facilities;
- Records of events, including non-routine releases of radioactive material to the environment; and
- Inventories of radioactive waste and of spent fuel.

A suggestion S10 regarding this issue is made in Section 9.1.

3.8. COMMUNICATION AND CONSULTATION WITH INTERESTED PARTIES

The IRRS team reviewed the practices of communication and consultation with interested parties. NEA RPNSG has established mechanisms of communication with interested parties through different channels. NEA maintains a website that provides general information on the agency and its activities, with references to relevant legislation. The website includes a section for members of the public, which provides general information for public of understanding radiation. They also provide reporting of the results of environmental radiation monitoring on their website. Further the website includes information for applicants and authorised parties, including links to NEA's digital services platform (ePortal). An annual report on the work of NEA, including the work of the RPNSG, is also published on the NEA website.

MSE and NEA occasionally organizes press conferences and through other media provides reports on their activities, for example, contents of the state budget. For communication with the public, they use a public consultation platform which is the same for all government agencies.

As discussed in Section 9, during the preparation of legislation, NEA RPNSG communicated with the public. This process includes an obligation for NEA to consult with interested parties in the preparation of draft regulations.

NEA RPNSG also communicates with neighbouring countries. Singapore has a bilateral arrangement with Malaysia to return orphan sources or contaminated material if they are found on the border.

As a member of the ASEAN Network of Regulatory Bodies on Atomic Energy (ASEANTOM), NEA RPNSG participated in the development of the regional technical cooperation project concept with the International Atomic Energy Agency to support building of capability in nuclear emergency preparedness and response for ASEAN countries (Brunei Darussalam, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand and Viet Nam).

NEA has identified radon exposure as an existing exposure situation, studies conducted have shown that radon exposure in Singapore is not a significant risk/concern. Two studies have been performed one in 1995 and a smaller

in 2014. The average results obtained were well within the recommended reference limits as established by the international organisations. However, NEA has not published information on the level of risk to the public in Singapore, including reference levels for Radon, typical exposure and information on health risks.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
Observation: *NEA does provide information on natural radiation on their website. However, Information on exposure due to radon and associated health risks is missing. This was identified in the self-assessment and is part of the Action Plan.*	
(1)	**BASIS: GSR Part 3 Requirement 50, para. 5.19 states that** *"As part of its responsibilities, as required in para. 5.3, the government shall ensure:"… (b) Relevant information on exposure due to radon and the associated health risks, including the increased risks relating to smoking, is provided to the public and other interested parties; (c)…".*
S4	**Suggestion: NEA should consider publishing information on exposure due to radon and associated health risks.**

3.9. SUMMARY

The NEAA establishes NEA as the regulatory body for facilities and activities posing radiation risk. Within NEA functionally the Regulation Division of Radiation Protection Nuclear Science Group is charged with the regulatory oversight of facilities and activities.

The IRRS team identified a notable practice for Singapore: the information sharing policies and technology integrate processes to provide for efficient and effective oversight for authorisation.

The IRRS team identified areas for improvement and recommends that NEA:

- ensure there are enough qualified and competent staff to perform its functions and to discharge its responsibilities;
- establish legal framework for the regulatory body and authorized parties should make provision for establishing and maintaining all records important for safety;
- further develop SOPs, WIs and internal guidelines supporting the decision-making process for more complex cases to prevent subjectivity and ensure consistency in regulatory control; and
- published information on the exposure due to radon and associated health risks.

4. MANAGEMENT OF THE REGULATORY BODY

4.1. RESPONSIBILITY AND LEADERSHIP FOR SAFETY

The leadership for and commitment to safety by the senior management is stated in the National Environment Agency (NEA)´s Workplace Safety and Health (WSH) Policy, which contains fundamental components for NEA safety. To keep the workforce safe during the COVID-19 pandemic, NEA put in place a Safe Management System comprising three aspects – Risk Management, Surveillance, and Staff Awareness. A range of Safe Management Measures (SMMs) were swiftly introduced in 2020, including split team arrangements, contact tracing, safe distancing reminders and provision of hand sanitisers at high touchpoints.

There are various platforms for staff to voice concerns e. g. on safety issues without fear of harassment, intimidation, retaliation or discrimination, such as during monthly branch meetings, department/division staff meetings, as well as divisional meetings with the Deputy CEO(PCT). NEA also maintains a zero-tolerance policy towards fraud and misconduct. This covers not only all NEA officers but applies to all vendors, customers and partners to the extent that NEA resources are involved or affected.

Under NEA's Whistleblowing Policy, when staff suspect that fraud or misconduct has occurred, they have a duty to report the incident to their supervisor. Alternatively, they may contact the Director of the Internal Audit Division (IAD), complete the whistleblowing form on NEA Intranet and send it to the Director of IAD or Chairman of the Audit Committee, or complete the online whistleblowing form on NEA corporate website. IAD brings such reports of fraud to the attention of the CEO and Audit Committee of NEA. Reports on significant fraud or misconduct may be reported to NEA Board upon validation or referral to external law enforcement agencies for investigation. The Audit Committee decides on the cases to be escalated to NEA Board.

All disclosures are treated with confidence and the identity of the employee is not revealed. Staff may also choose to make an anonymous report. This ultimately ensures an environment in which officers may raise possible incidents of fraud or misconduct without fear of harassment, intimidation, retaliation or discrimination.

4.2. RESPONSIBILITY FOR INTEGRATION OF SAFETY INTO THE MANAGEMENT SYSTEM

NEA's management system is aligned with its safety goals and contributes to their achievement. NEA has maintained ISO 9001 Quality Management System (QMS) certification since 2007.

In addition, NEA has also established the Radiation Protection and Laboratory Management System (RPLMS), a centralised intranet system utilised by officers in the regulatory body for the processing, review and assessment of radiation licence applications, as well as for provision of radiation services.

NEA has established the Workplace Safety and Health (WSH) Strategy Map, which outlines the key strategies and strategic outcomes to enable the realisation of the WSH Vision: "Safety and Health through work". The WSH Strategy Map guides NEA's efforts to ensure a safe and healthy workplace for all employees and it is endorsed by the Enterprise Risk and Safety Steering Committee (ERSSC). The strategic outcomes and strategies are as follows:

Strategies:

1. Build strong capabilities in managing WSH
2. Track WSH performance and share WSH best practices
3. Enhance efforts to build a Safety and Health culture

Strategic Outcomes

1. Reduction in workplace incidents
2. A Safety and Health culture

4.3. THE MANAGEMENT SYSTEM

NEA has established and is applying an integrated management system. Although the name of the management system is Quality Management System, the IRRS team noted that in practice it integrates its elements, including safety, health, environmental, security, quality, human-and-organizational-factor, societal and economic elements. The organizational structures, processes, responsibilities, accountabilities, levels of authority, and regulatory body interfaces are specified in the management system.

The divisional Enterprise Risk and Safety Steering Committee (ERSSC) is the platform where NEA seeks endorsement for major decisions with regards to safety. In addition, some NEA installations (e. g. incineration plants) also have outsourced safety officers appointed on the premises, who provide advice on safety matters.

NEA has put in place a formal programme requiring that departments conduct regular risk assessments to identify and manage risks in their processes. The top priority risks are monitored by the ERSSC and more significant risk issues are tabled at the CEO Staff meetings. The Management provides an annual update to the Board on the top priority strategic risks. As such, where conflicts may arise in the decision-making process, they could be escalated to the next level of reporting under by NEA's Chief Risk Officer, to NEA Management Meetings, and finally to the NEA Board of Directors, where a Chief Risk Officer also resides at Board level.

At Group level, e.g., within the Radiation Protection and Nuclear Science Group (RPNSG) of NEA, the Group Director is the arbitrator with the responsibility to resolve different opinions.

Separately, while there are no formalised processes for resolution of conflicts arising in decision-making processes (see R8 in the Section 4.5) as part of the Radiation Protection and Laboratory Management System (RPLMS), any conflict may be resolved through discussions within the regulatory team and/or with supervisors. Officers may at times express differences of opinions during the decision-making process, which might not be able to be resolved within the team. In such cases, the issues may be escalated to management (e. g. Group Director) for discussion and advice on how the issue may be resolved without compromising safety or security.

Under the management system framework, the documents are developed using a graded approach as follows:

- For the Quality Manual (QM-NEA-01), the Approving Officer is the DCEO(PCT) or equivalent;
- For the Standard Operating Procedures (SOP), the Approving Officer is the Head of Department or equivalent (for Department SOP), Division Director (for Division SOP), or the Group Director (for Group SOP); and
- For Working Instructions (WI), the Approving Officer is the Manager or equivalent

As part of the management system, various SOPs and WIs have been developed and implemented to ensure radiation safety in Singapore. Specifically, under the WI-RD-Inspection-001 on Inspection Frequency Guideline, the inspection frequency for routine inspection of radioactive materials is applied on a graded approach as follows:

- IAEA Category 1 and 2 source licensees – Twice a year;
- IAEA Category 3 and 4 source licensees – Once a year; and
- IAEA Category 5 source licensees – Once every two years

Elements of a graded approach are also applied for licensing decisions, for example, certain licences are only granted following a pre-licensing inspection whereas low risk licences do not require a review by an individual from RD. The Radiation Protection and Laboratory Management System (RPLMS) integrates this process.

NEA's management system is documented, and all the documents are available on NEA intranet for download by all NEA officers. Processes and activities (such as authorisation, review and assessment, inspection, enforcement, etc.) are documented in SOPs and the necessary supporting documentation (such as WIs).

The documentation of NEA's management system is controlled in accordance with SOP-QMS-01 on Control of Documents. The retention of records is documented in the Quality Records Master List (QRML), and is consistent with the requirements stated under the Quality Manual. In accordance with the Quality Manual, all records have a defined retention period and are stored in a manner which maintains their legibility and prevents their deterioration, damage or loss during the period of retention. The retention of records on radiation matters are documented in RPNSG's Quality Records Master List (QRML).

The IRRS team observed that although NEA's Management system has a graded approach, the IRRS team noted, that the graded approach has not been applied systematically for all regulatory activities. This is addressed in R8 in Section 4.5. and elsewhere in this report.

4.4. MANAGEMENT OF RESOURCES

The senior management of NEA determines the competencies and resources necessary to carry out the activities of the regulatory body safely and provides them.

There are existing frameworks in NEA to review the department's workforce and work plan (e.g. to identify and develop the workforce capacity to meet its objectives), and the competency of each job role in the department periodically (i.e. every three years).

NEA employs staff with relevant qualifications and training/experience in the field of radiation protection. Further to the hiring criteria, NEA also sends its staff on training programmes on an ongoing basis to improve the competency and knowledge of staff.

NEA has made arrangement for the training of its staff through internal inhouse learning and external resources. And NEA has developed a Job Competency Matrix (JCM) to identify the necessary skills and knowledge required for NEA officers in their course of work. The IRRS team identified some areas of improvement of staff competencies. This is discussed in detail in sections 1.8. and 3.3. of this report.

NEA has established a WSH governance structure, where there is a network of WSH stakeholders (WSH committees, WSH reps, first aiders) across the organisation, who report to a cross-Divisional Enterprise Risk and Safety Steering Committee (ERSSC). The committee looks at WSH performance, strategic and systemic interventions, and WSH capability- and culture-building. The ERSSC meets every quarter to review key strategic and operational risks facing NEA and the progress of risk treatment plans for these identified risks. The ERSSC also reviews the effectiveness of these risk treatment plans, and studies the trends and emerging issues that may impact the risks confronting NEA.

The ERSSC reports to the CEO at NEA Management Meetings on key risk management issues and recommendations. The ERSSC also reports to the Audit Committee and NEA Board on the ERM programme, ERM initiatives and top priority strategic risks. The ERSSC then obtains the Board's guidance on any further development of the ERM programme. Hence, this provides the opportunity for independent assessment of NEA's leadership for safety and safety culture by the Audit Committee, as well as NEA Board (in which a Chief Risk Officer also resides at Board level). NEA has resources for development and improvement of the management system.

4.5. MANAGEMENT OF PROCESSES AND ACTIVITIES

Processes and activities are identified and documented in SOPs and the necessary supporting documentation (such as WIs) is maintained. As part of the preparation and review of the SOPs and WIs, the respective process owners take into consideration interactions with other relevant processes and workflows. Any modification to the existing

documentation on processes is carried out in accordance with the SOP-QMS-01 on Control of Documents and approved by the appropriate Approving Authority. Any modification to the documents is documented under the section on "Document Change Details" in the SOPs and WIs. NEA does not outsource any processes relating to the functions of the Radiation Protection and Nuclear Science Group to external organisations.

The IRRS team noted, that not all processes that provide consistency of NEA regulatory activities are identified, developed and documented in NEA's management system (see Sections 2.2, 3.6, 4.3, 5.1, 6.1.1, 6.3, 7.2, 7.3, 8.1, 10.2).

Apart from transport activities, NEA has not established the process for review of on-site EPR arrangements in licence applications.

The following are some examples.

- NEA has not established guidance for the assessment and review of specific complex activities that define the criteria for assessment of licence applications, guidance for suspension, and revocation of licenses and guidance for approval of manufacture or design of packages for radioactive materials; and
- NEA has not issued guidance to inspectors for all types of inspections and regarding all of the steps in the compliance enforcement process. This is partly identified in the Action Plan.

Generally, the IRRS team is of the opinion that SOPs, WIs and internal guidelines should be further developed to support the decision-making process and should be expanded to provide more comprehensive coverage to prevent subjectivity and to ensure consistency in regulatory control.

There is no process in place for national and international operational and regulatory feedback collection, analysis, dissemination and for informing regulatory processes.

There is also a need to develop processes to manage organisational change and for the resolution of conflicts arising in decision-making processes.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
Observation: *Not all processes relevant to safety are identified and documented in NEA's management system. This was identified in the self-assessment and is part of the Action Plan. Further, NEA's management system does not document adequate provisions to identify any changes (including organizational changes) that could have significant radiation safety implications.*	
(1)	**BASIS: GSR Part 2 Requirement 10, para 4.28 states that** *"Each process shall be developed and shall be managed to ensure that requirements are met without compromising safety. Processes shall be documented and the necessary supporting documentation shall be maintained. It shall be ensured that process documentation is consistent with any existing documents of the organization. Records to demonstrate that the results of the respective process have been achieved shall be specified in the process documentation."*
(2)	**BASIS: GSR Part 2 Requirement 6, para 4.13 states that** *"Provision shall be made in the management system to identify any changes (including organizational changes and the cumulative effects of minor changes) that could have significant implications for safety and to ensure that they are appropriately analysed."*
(3)	**BASIS: GSR PART 2 Requirement 7 states that "***the management system shall be developed and applied using graded approach"*

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
R8	**Recommendation: NEA should ensure that all processes relevant to safety are identified, developed and documented in the management system using graded approach, and make provision to identify any changes that could have significant implications for safety.**

4.6. CULTURE FOR SAFETY

The IAEA model for a strong safety culture are considered in the WSH Policy as part of NEA's management system. Individuals in NEA, from senior managers downwards, foster a strong safety culture. The leadership for and commitment to safety by the senior management is stated in NEA´s WSH Policy, which contains fundamental components for NEA safety. The common understanding of safety and safety culture, and expected attitudes and behaviours are defined and communicated in NEA's WSH Policy. The reporting of wrong-doing by NEA's staff is strongly encouraged with several methods for reporting in place. NEA has implemented a Whistleblowing Policy and provides for employees to make anonymous reports of wrongdoing. For more details, see section 4.1 of this report.

Encouragement of NEA employees' questioning and learning attitude is embedded in NEA's Learning Policy which supports ownership by individuals of their learning and development and encourages sharing of lessons learnt.

Apart from active tracking of WSH performance, NEA incentivises holistic WSH performance with internal WSH Awards, strong WSH programmes and innovation, and with safe work practices. The NEA Workplace Safety and Health (WSH) Awards is an annual award recognising outstanding staff efforts in upholding high standards of safety & health at the workplace.

4.7. MEASUREMENT, ASSESSMENT AND IMPROVEMENT

As part of NEA's management system, SOPs and WIs are reviewed once a year, or as needed, to ensure that they continue to meet the requirements and needs of NEA and its stakeholders. The review is carried out by NEA's ISO Quality Management Committee (QMC) in accordance with the Quality Manual.

As part of the review, appropriate data is collected and analysed to evaluate the continuing suitability and effectiveness of the SOPs and WIs and to identify improvement opportunities.

Any amendments to Internal Documents such as SOPs and WIs that are prepared by the process owners are independently reviewed and approved by the Approving Officer.

In accordance with SOP-QMS-03 on the internal quality audit, NEA conducts an internal quality audit (IQA) to ensure the effective implementation of the management system and to identify opportunities for improvement. IQA auditors provide independent assessment as they do not audit their own area of work.

The IRRS team was informed that NEA, using a survey methodology, has conducted assessments for leadership for safety and safety culture in 2021 and also in September 2022. The result of assessment was evaluated and communicated to NEA's staff via email and/or briefings.

Audit findings from the internal audit are reported to the ISO Quality Management Committee (QMC) at the Management Review Meeting. The Management Review Meeting is chaired by a member of senior management, i.e. Deputy CEO (Planning, Corporate and Technology).

All information connected to the measurement, assessment, and monitoring activities (internal and external audits) are gathered and documented on the Intranet. The outcomes of the audits are communicated via email to ISO Quality Management Committee Members and nominated Representatives.

4.8. SUMMARY

NEA has established and implemented an integrated management system. The management system defines NEA's core and supporting functions that are established to be in compliance with the ISO 9001 QMS requirements. The management system's processes are open and transparent and is aligned with safety goals.

The IRRS team has identified the following areas of improvement:

- Although NEA's Management system is applied using a graded approach, in some regulatory functions it has been not fully implemented; and
- NEA has identified and documented most of its processes relevant to safety, but not all processes that shall provide consistency of NEA regulatory activities are identified, developed and documented in NEA's management system, such as inter alia review and assessment, inspection, enforcement or management of organizational changes.

5. AUTHORIZATION

5.1. GENERIC ISSUES

The main uses of radiation sources in Singapore are medicine (diagnostic and interventional radiology, nuclear medicine, and radiotherapy) and industrial. Industrial uses make up about 50% of the licences issued for radiation sources and includes industrial radiography, research, education, manufacturing, radioisotope production, testing and analysis, industrial irradiators, sterilisation, nuclear gauges, well logging and inspection or screening. Singapore does not have nuclear power plants or research reactors.

The import, export, sale, possession and use of radiation sources (irradiating apparatus and radioactive material, including nuclear material), as well as transport of radioactive materials, are regulated under the RPA and its subsidiary Regulations, administered by RPNSG of NEA under the Ministry of Sustainability and the Environment (MSE).

Radiation sources for medical use, and healthcare establishments using radiation, are also regulated under the Health Products Act 2007, and the Private Hospitals and Medical Clinics Act 1980 and Healthcare Services Act 2020, respectively, and their subsidiary Regulations, under the purview of the Ministry of Health (MOH).

According to the RPA and its subsidiary Regulations, the import, export, sale, possession and use of radiation sources, as well as transport of radioactive materials require a licence. However, NEA currently grants licences for possession of radiation sources to organizations and separately to individuals for the use of the radiation sources.

The storage of disused radioactive sources and of conditioned radioactive waste at the waste storage facility managed by RMSD, although subject to the RPA, is not authorized. Similarly, the Secondary Standards Dosimetry Laboratory (SSDL) operated by RMSD are not licensed or otherwise authorised.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
Observation: *NEA grants licences for possession of radiation sources to organizations and for use of radiation sources to individual persons. Licences issued by NEA to the legal person responsible for a facility do not include all the activities taking place at the facility. Rather, licences for use of radiation sources are exclusively granted to individuals, not to facilities. This was identified in the self-assessment and is part of the Action Plan.*	
(1)	**BASIS: GSR Part 1 (Rev.1) Requirement 23 states that** "Authorization by the regulatory body, including specification of the conditions necessary for safety, shall be a prerequisite for all those facilities and activities that are not either explicitly exempted or approved by means of a notification process".
(2)	**BASIS: GSR Part 1 (Rev.1) Requirement 24, para. 4.30 states that "***Authorization for a facility shall include authorization of the activities taking place at the facility."*
(3)	**BASIS: GSG-13, para. 3.89 states that** "*The authorized party is the legal person or organization that has prime responsibility for safety and retains this responsibility even if the validity of an authorization expires or lapses, or if the authorization is revoked by the regulatory body. However, the responsibilities conferred by the authorization may be transferred to a different authorized party (e.g., upon change of ownership, where this has been approved by the regulatory body)".*
R9	**Recommendation: NEA should authorize all facilities. Authorization for a facility should include authorization of the activities taking place at the facility.**

The national regulatory framework includes specific requirements for the renewal, suspension, and revocation of the licenses granted by NEA. All licenses are subject to renewal at least once every two years. It is the responsibility of

the licensee to apply for the renewal of a licence in due time before its expiry date. Nevertheless, NEA sends out reminders to licensees 3 months and 1 month before the corresponding licence expiry date.

If no changes have occurred during the licence period, the licensee is not required to submit any safety related information to NEA as part of an application for renewal of a licence. However, in the case of applications for amendment due to changes in the facility and/or activities compared to the initial authorization, NEA performs a non-routine inspection.

The current system for licensing is not flexible and does not apply a graded approach in considering the licence period or types of authorizations that NEA can grant. For example, the concept of notification alone being sufficient for authorization of low-risk activities, as given in GSR Part 3 has not been explored as an option for low-risk sources. For all other practices, a licence is required as registration is not an authorization option. According to RP(IR) Regulations only notification is required for the possession of sealed sources (not exceeding 100 times national exemption levels for activity or activity concentration) in educational institutions and the possession of up to 3 sealed sources (activity not exceeding 175kBq). For all other practices, a licence is required as registration is not an authorization option.

Further, the regulatory framework does not require different types of authorisations for the different stages in the lifetime of facilities or for the duration of activities. This gap was identified in the self-assessment and is part of the Action Plan. NEA has identified, ad hoc, certain uses of radiation sources where greater oversight is required at the different stages in the lifetime of the respective facilities (e.g., site evaluation, design, construction, operation, and commissioning).

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
Observation: *Although NEA has some indications of notification in the regulation, NEA has still not established a notification activity for relevant radiation facilities and activities. NEA uses licensing for all authorizations without graded approach.*	
(1)	**BASIS: GSR Part 3 Requirement 7 states that** *"Any person or organization intending to operate a facility or to conduct an activity shall submit to the regulatory body a notification and, as appropriate, an application for authorization".*
(2)	**BASIS: GSR Part 3 Requirement 7, para. 3.7 states that** *"Any person or organization intending to carry out any of the actions specified in para. 3.5 shall submit a notification to the regulatory body of such an intention. Notification alone is sufficient provided that the exposures expected to be associated with the practice or action are unlikely to exceed a small fraction, as specified by the regulatory body, of the relevant limits, and that the likelihood and magnitude of potential exposures and any other potential detrimental consequences are negligible".*
R10	**Recommendation: NEA should ensure that any person or organization intending to operate a facility or to conduct an activity shall submit to NEA a notification and, as appropriate, an application for authorization (registration or licensing) based on graded approach**.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES
Observation: *NEA does not issue different types of authorisations for the different stages in the lifetime of facilities or the duration of an activity. This was identified in the self-assessment and is part of the Action Plan.*

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
(1)	**BASIS: GSR Part 1 (Rev.1) Requirement 24, para. 4.29 states that** *"Different types of authorization shall be obtained for the different stages in the lifetime of a facility or the duration of an activity…"*
(2)	**BASIS: GSR Part 1 (Rev.1) Requirement 24, para. 4.35 states that** *"Some of the stages in the lifetime of a facility or the duration of an activity (see para. 4.29) may require specific hold points at which separate authorizations are required."*
R11	**Recommendation: NEA should ensure that different types of authorizations are obtained for the different stages in the lifetime of a facility or the duration of an activity, according to graded approach.**

Applications for licence are submitted through the common Government e-service system for businesses, GoBusiness Licensing Portal, and from this system they are received by NEA. Administrative processing is carried out through the RPLMS. The GoBusiness Licensing portal also provides access to basic information on current licensees based on a unique identifier (CorpPass UEN or individual identification number).

Applicants for licences are only required to submit a Radiation Protection Plan (RPP) and SOPs to demonstrate commitment to radiation protection and safety. A typical RPP includes information on certain aspects, such as: assignment of responsibilities, classification of areas, applied safety measures, training programs for new and existing staff, the radioactive waste disposal plan, storage areas, etc. Applicants for a licence concerning higher risk radiation sources are required to provide more analytical details to demonstrate safety.

The licence documents issued by NEA include details about the licence holder, the purpose of the licence, on the particulars of the radiation source and on the related licence conditions.

Under the existing legislation, not all licensees are required to inform NEA of significant modifications to an installation that may affect the measures for protection and safety. This is addressed in the Action Plan. The need for the notification of significant modifications to NEA will be addressed either by including related conditions in the licences or by introducing appropriate provisions in the draft amended RP(IR) Regulations. **Recommendation R21 in Section 9.1 addresses this issue.**

Regarding procedures for suspension, and revocation of licenses, as already identified in the self-assessment and as part of the Action Plan, NEA should prepare related WIs to support the personnel involved in the corresponding procedures. **Recommendation 8 in Section 4.5 addresses this issue.**

The IRRS team noted, there are no regulatory requirements for the submission to NEA of a safety assessment by the applicants for a licence nor for the independent verification of the safety assessment. The issue was partly identified in the self-assessment and addressed in the Action Plan. A related requirement is expected to be included in the revised RP(IR) Regulations.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
Observation: *The applicants for a licence are not required to carry out and submit a safety assessment of facilities or activities to NEA which also addresses risks that are not related to radiation. Moreover, license holders are not required to periodically review and update the safety assessment and to carry out an independent verification of the safety assessment before it is used by the operating organization or submitted to NEA.*	
(1)	**BASIS: GSR Part 1 (Rev.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*

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
	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 3 Requirement 13 states that** *"The regulatory body shall establish and enforce requirements for safety assessment, and the person or organization responsible for a facility or activity that gives rise to radiation risks shall conduct an appropriate safety assessment of this facility or activity."*
(3)	**BASIS: GSR Part 3 Requirement 3, para. 3.31 states that** *"Safety assessments shall be conducted at different stages, including the stages of siting, design, manufacture, construction, assembly, commissioning, operation, maintenance and decommissioning (or closure) of facilities or parts thereof, as appropriate…"*
(4)	**BASIS: GSR Part 4 (Rev.1), Requirement 1 states that** "A graded approach shall be used in determining the scope and level of detail of the safety assessment carried out at a particular stage for any particular facility or activity, consistent with the magnitude of the possible radiation risks arising from the facility or activity".
(5)	**BASIS: GSR Part 4 (Rev.1), Requirement 21 states that** *"The operating organization shall carry out an independent verification of the safety assessment before it is used by the operating organization or submitted to the regulatory body."*
(6)	**BASIS: GSR Part 4 (Rev.1), Requirement 24 states that** *"The safety assessment shall be periodically reviewed and updated".*
R12	**Recommendation: NEA should ensure that,** • **the applicant submits a safety assessment prior to the granting of an authorization;** • **the safety assessment is periodically reviewed and updated according to the graded approach; and** • **operating organizations, according to the graded approach, carry out an independent verification of the safety assessment before it is used by the operating organization or submitted to NEA.**

5.2. AUTHORIZATION OF RADIOACTIVE WASTE MANAGEMENT FACILITIES

There are small amounts of disused radioactive sources stored at some of the licensees' premises. In addition, NEA manages a radioactive waste store which houses small quantities of orphan and disused radioactive sources as well as conditioned radioactive waste. However, these storage facilities are not licenced as predisposal waste management facilities and there are currently no other licensed predisposal waste management facilities in the country. **Recommendation R9 in Section 5.1 addresses this issue**.

There are no disposal facilities for radioactive waste in Singapore and there are currently no plans to develop any. This has been identified by the IRRS team as a potential concern for radioactive waste, for which all efforts to reuse, recycle or return the source to the supplier have been exhausted and where decay storage is not a feasible solution, e.g., orphan and disused radioactive sources and the conditioned radioactive waste currently stored in the storage facility that is managed by NEA. **Recommendation R4 in Section 1.7 addresses this issue**.

5.3. AUTHORIZATION OF RADIATION SOURCES FACILITIES AND ACTIVITIES

The various types of licences issued by NEA concerning the import, export, sale, possession, and use of radiation sources, and transport of radioactive materials are specified in RP(IR) Regulations as follows:

L1: to manufacture, possess for sale or deal in irradiating apparatus
L2: to manufacture, possess for sale or deal in radioactive materials
L3: to keep or possess an irradiating apparatus for use (other than sale)
L4: to keep or possess radioactive materials for use (other than sale)
L5: to use irradiating apparatus (other than sale)
L6: to use, handle and transport radioactive materials (other than sale)
L6A: to handle and transport radioactive materials
L7: to import or export a consignment of irradiating apparatus
L8: to import or export a consignment of radioactive materials

L5/L6 licences are issued to individuals. In most cases an L5/L6 licence is specific to an a L3/L4 licence for the possession of a radiation source. In cases of companies providing technical services, at least for the senior personnel an L5/L6 licence is required, which might be coupled to a L1/L2 licence. All radiation workers are required to be registered (R1 registration) and work under the supervision of an individual with a L5/L6 licence. In 2021, 1659 new licences, 357 licence amendments and 3779 licence renewals were issued.

There is no legislative provision to ensure that the licences issued by NEA concern only justified practices. The issue of the justification of practices is addressed in the draft RP(IR) Regulations.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
Observation: *NEA does not require that only justified practices are authorized.*	
(1)	**BASIS: GSR Part 3, Requirement 10, par. 3.16 states that** *"The government or the regulatory body, as appropriate, shall ensure that provision is made for the justification of any type of practice and for review of the justification, as necessary, and shall ensure that only justified practices are authorized".*
R13	**Recommendation: NEA should establish appropriate provisions to ensure that only justified practices are authorized.**

Import and export of radioactive sources are controlled by the Singapore Customs (SC) and all related applications for licensing are submitted through SC's TradeNet Portal, where they are automatically approved when meeting the approval criteria set by NEA. Applications that are incomplete, inaccurate, or concerning Category 1 or 2 radioactive sources are referred to NEA for further assessment.

NEA has drafted a WI for internal use, which describes the process for the import/export of Category 1 and 2 sources and follows the related provisions of the Code of Conduct on the Safety and Security of Radioactive Sources. This draft WI should be made a formal internal procedure referenced in NEA Management System. **Recommendation R8 in Section 4.5 addresses this issue.**

NEA keeps a database in the RPLMS of the licensed organizations and users of radiation sources in the country. The database includes, among others, detailed information on the number and type of the radiation sources possessed and/or used at national level. However, for sealed sources only a maximum activity and not the actual activity value on a specific date is registered. **Suggestion S10 in Section 9.1 addresses this issue**.

There are no legislative provisions concerning orphan sources. However, Singapore has implemented an inter-agency response plan titled "Response Plan for Stolen or Lost Radioactive Source Incidents". The document was last updated in July 2022 and provides guidance to relevant officers on the response to stolen or lost radioactive source incidents, in order to: a) protect the public against unnecessary exposure to radiation, b) ensure that the response team operates competently in a safe environment, and c) identify, isolate and secure the radioactive sources, and mitigate impacts where possible.

5.4. AUTHORIZATION OF DECOMMISSIONING ACTIVITIES

In Singapore, no facilities have been decommissioned that give rise to radiation exposure and there are no such facilities planned to be decommissioned in the near future. The national governmental, legal, and regulatory framework lacks provisions specific to the decommissioning of facilities and NEA would assess decommissioning activities on a case-by-case basis. **Recommendation R4 in Section 1.7 addresses this issue**.

Moreover, there are no requirements related to the content of an application for authorization for decommissioning. NEA plans to establish requirements for decommissioning, such as the preparation of a decommissioning plan and the need to comply with end state criteria, as part of the licence conditions for certain facilities, which may generate radioactive waste due to the activation of materials (e.g., proton beam therapy facilities). **Recommendation R26 in Section 9.4 addresses this issue**. Similarly, NEA has not established requirements for the safety assessment for all facilities that require decommissioning, using a graded approach. However, the planned requirements for proton beam therapy facilities address safety assessments for the decommissioning phase and the upcoming amended RP(IR) Regulations require the submission of a safety assessment when applying for a licence. **Recommendation R12 in Section 5.1 addresses this issue.**

The IRRS team has identified that NEA's current and planned practices, for ensuring the requirements are met for all facilities and activities involving radiation risks are not in line with IAEA requirements, as requirements are applied selectively instead of using a graded approach **Recommendation R9 and R10 in Section 5.1 address this issue**.

5.5. AUTHORIZATION OF TRANSPORT

NEA is responsible for the regulatory oversight of the transport of radioactive material within Singapore. The current RP(TRM) Regulations are based upon the IAEA Regulations for the Safe Transport of Radioactive Material ST-1, 1996 Edition, which has since been superseded by SSR-6 2018 Edition.

All transports of radioactive material require the transporter to possess a licence issued by NEA. For the transport of any radioactive source the initial license application is subject to detailed review. However, this is not the case for renewals of the transport licences

Organisations applying for a licence to transport radioactive materials are required to submit a Transport Emergency Response Plan (TERP) as part of their application and individuals from RD will review the TERP prior to the issuance of the licence for adequacy of information provided and robustness of plan. Applications with plans that are deemed to be unsatisfactory will be rejected. For Category 1 sources there is active involvement of NEA in the process of transport licensing as inspections will be conducted for each instance of transport involving such sources.

A transport licence is issued for a maximum period of 2 years. At the end of the licence period the licensee may apply for a licence renewal. If any inspections conducted have indicated serious non-conformances, NEA may not renew the transport licence. As inspections are only conducted on transportation involving Category 1 sources, non-conformances may not be identified for transportation of other sources. Thus, the licences may be simply renewed at each application. Nonetheless, NEA will investigate and verify feedback or reports of non-compliances received for transport-related activities.

Fissile material is not transported within Singapore. Neither has NEA ever had to consider a request for a "Special Arrangement". The transport of NORM ores within the country is also not permitted.

Moreover, there are no manufacturers of special form radioactive material within the country. NEA is responsible for issuing approvals and for the validation of the original certificates issued by the competent authority of the country of origin of the design or shipment in line with the IAEA ST-1. However, no guidance is available for those applying for an approval based on IAEA ST-1. Type B packages, of foreign design, are validated by NEA. However, validation certificates are not issued. The applicant is simply granted permission to use the Type B(U) packaging and **Recommendation 8 in Section 4.5 address this issue**.

The criteria for the exemption of radioactive material contained in the RP(IR) Regulations are identical to those defined in IAEA ST-1. However, they are applied to all uses of radioactive material and not just to transport. The exemption quantities in the RP(IR) Regulations should be in line with GSR Part 3. **This is addressed in recommendation 30 in section 9.6.**

Finally, the IRRS team noticed that there are no requirements for the licensee to conduct a safety assessment for any transport activity. **Recommendation R12 Section 5.1 addresses this issue**.

5.6. AUTHORIZATION ISSUES FOR OCCUPATIONAL EXPOSURE

NEA issues authorizations for applicants intending to perform or carry out radiation work with irradiating apparatus or radioactive materials, designated R1 Registration – as a radiation worker and working under the supervision of an individual with an L5/L6 licence. Requirements for such an authorization involve passing the relevant qualifying tests administered by NEA and having an appropriate Medical Certificate specific for fitness for radiation work. NEA's website includes information on training courses for radiation workers; however, these are not mandatory requirements, as long as applicants pass the tests. A maximum of 2 test attempts are allowed for the qualifying test, failing which the application will be considered unsuccessful. Holders of L5 and L6 licenses are exempted from the need of having an additional R1 Registration. As of the date of the Mission, Singapore has 10130 radiation workers with R1 registration, and there are 4025 L5 licensees for the use of radiation generators, and 650 L6 licensees for the use of radioactive sources.

The RP(IR) Regulations establish dose limits for occupational exposure. However, these are not fully in line with those prescribed in GSR Part 3 (e.g., the limit for equivalent dose to the lens of the eye is 150 mSv per year and this is not in agreement with Schedule III of GSR Part 3). This also applies to special arrangements for the protection of female workers. These requirements are currently based on limiting the equivalent dose to the surface of the woman's abdomen to 2 mSv for the duration of the pregnancy and on restricting intakes to a fraction of the annual limits on intake for workers. The requirements should instead, ensure that the embryo or foetus, or the breastfed infant is afforded the same broad level of protection as is required for members of the public, as prescribed in GSR Part 3. Furthermore, dose constraints are not used as tools for optimization of exposure, as they are not stipulated in the RP(IR) Regulations. The IRRS team was informed that updated RP (IR) Regulations have been drafted to stipulate provisions in these areas in line with GSR Part 3. **Recommendation 21 in Section 9.1 addresses this issue**.

While the existing regulations include several duties for authorized parties, they do not include the need to cooperate to the extent necessary for compliance with the requirements for protection and safety. The IRRS team was informed that updated Regulations have been drafted to include such duty of cooperation and to bring these provisions in line with GSR Part 3. **Recommendation 21 in Section 9.1 addresses this issue**.

There are arrangements for assessment and recording of occupational exposure. NEA maintains a central dose registry of radiation workers and their occupational doses. Dosimeters are provided by NEA's dosimetry service, for all persons registered as radiation workers (R1 registration), or holding L5 or L6 individual authorizations.

Arrangements are also in place regarding health surveillance of workers. This involves initial and annual examinations, and a mandatory full blood test. In accident situations involving workers, authorised party is required by law to inform NEA of the accident within 24 hours of the event. The IRRS team encourages NEA to further coordinate with relevant authorities in the development of guidance on the contents and scope of such health surveillance programmes.

Records of occupational exposure for each worker are maintained during and after the worker's working life, at least until the former worker attains the age of 75 years, and for not less than 30 years from cessation of the work in which the worker was subject to occupational exposure. The regulations ensure that workers have access to such information. However, it was noted that there is no specific duty of confidentiality for such records, and that general Data Protection provisions apply. The IRRS team was informed that updated Regulations have been drafted to clarify the situation and to ensure confidentiality of such records.

While the existing regulations include provisions for labelling of radiation areas and are generally in line with the concept of controlled areas, these do not address the wider concepts and requirements applicable to controlled areas stated in GSR Part 3 (e.g. the requirement that authorized parties: take into account the magnitude of the exposures expected in normal operation, the likelihood and magnitude of exposures in anticipated operational occurrences and in accident conditions, and the type and extent of the procedures required for protection and safety, in defining their boundaries; or provide appropriate information, instruction and training for persons working in controlled areas). Additionally, the concept of a supervised area is not part of the current regulations, however, the proposed new regulations will bring these topics in line with GSR Part 3. **Recommendation 21 in Section 9.1 addresses this issue**.

Regulations require employers and licensees to ensure that no person under the age of 16 years is or could be subjected to occupational exposure. However, regulations also state that no individual below the age of 18 years shall be engaged in radiation work. The regulations also include an exemption from the requirements for registered or enrolled students of an educational institution who, in the course of his/her studies, performs any experiment or carries out any research involving the handling or use of irradiating apparatus or radioactive materials, under the direct supervision of a licensee authorised to conduct such experiment or research. As such there are no special arrangements for occupational exposure of persons under 18 years of age who are undergoing training for employment involving radiation. This is addressed in the updated Regulations. **Recommendation 30 in Section 9.6 addresses this issue.**

5.7. AUTHORIZATION ISSUES FOR MEDICAL EXPOSURE

There are 1409 medical facilities using radiation sources in Singapore including approximately 1383 radiology facilities (of which 1061 are dental facilities), 16 nuclear medicine and 10 radiotherapy facilities (of which 1 is a gamma-knife facility). While NEA is the national authority for radiation protection, the healthcare sector is regulated by the Ministry of Health (MOH).

NEA licenses/registers:

a) health professionals to use radioactive sources and irradiating apparatus for certain medical purposes, ensuring that they are authorized to assume their roles and responsibilities, and
b) the organizations to possess these radioactive sources and irradiating apparatus.

Currently, only health professionals who are registered under the Allied Health Professions Act 2011, Dental Registration Act 1999 and Medical Registration Act 1997 respectively are regulated by the MOH and NEA. However, medical physicists are not regulated as health professionals neither by MOH nor NEA. The IRRS team was informed that updated regulations have been drafted to address this issue.

The Healthcare Services (Nuclear Medicine Assay Service and Nuclear Medicine Imaging Service) Regulations nominate the physicist as a radiation physicist and requires at least one radiation physicist to have 3-years work

experience in nuclear medicine imaging. The regulations do not require that a medical physicist is specialized in any other areas of radiation medicine. **Recommendation R31 in Section 9.7 addresses this issue**

Under HCSA, MOH requires that only a referring health professional is able to prescribe a diagnostic radiological procedure. Moreover, the licensees shall ensure that no patient, whether symptomatic or asymptomatic, undergoes a medical exposure unless a) the radiological procedure has been requested by an appropriate referring health professional and is to be done in accordance to that request/prescription, or b) the medical exposure has been justified through consultation between the radiological medical practitioner and the referring health professionals, as appropriate.

5.8. AUTHORIZATION ISSUES FOR PUBLIC EXPOSURE

The NEA requires authorization of many activities that could result in public exposure. This includes the need for requirements to limit exposure to the public and to require the need to apply for permission to dispose of sources.

While assessments of safety are submitted, there is no explicit requirement for the content of these assessments to include items such as identification of public exposure hazards or the identification of design criteria. **Recommendation R12 in Section 5.1 addresses this issue**. Environmental monitoring requirements are also not covered by the current regulations. This is recognized in the advanced reference material and the proposed regulations take this into account. **Recommendation R21 in Section 9.1 addresses this issue**.

For foodstuffs, fertilisers, pharmaceutical goods, cosmetics, toys, or waste where radioactive material of any concentration is intentionally added, the exemption thresholds do not apply. Therefore, a licence, or specific exemption, is required for any sale and import. During this process NEA can ensure that consumer products are not made available to the public unless their use by members of the public has been justified, and either their use has been exempted or their provision to the public has been authorized. As such NEA could impose requirements such as labelling on the provider of the products under a licence and could exempt the sources from the need for user licencing under regulation 3 of the RP(IR) Regulations. However, this is not part of any procedure.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
Observation: *The current process for approval to ensure only justified products are permitted is not explicit. However, the regulations currently do provide for licencing or exemption of certain consumer products. This was identified in the self-assessment.*	
(1)	**BASIS: GSR Part 3 Requirement 33, para. 3.139 states that** *"Upon receipt of a request for authorization to provide consumer products to the public, the regulatory body:* *(a) Shall require the provider of the consumer product to provide documents to demonstrate compliance with the requirements in paras 3.138–3.144;* *(b) Shall verify the assessments and the selection of parameters presented in the request for authorization;* *(c) Shall determine whether the end use of the consumer product can be exempted;* *(d) Shall authorize the provision to the public of the consumer product, where appropriate, subject to specific conditions of authorization."*
S5	**Suggestion: NEA should consider establishing a process for authorizing the provision to the public of the consumer product.**

There are currently only limited operational limits and conditions relating to public exposure in the regulations. This includes the need for environmental monitoring for public radiation protection purposes and clearance of material

from regulatory control. This is expected to be addressed by the proposed amendments to the regulations. **Recommendation R21 in Section 9.1 addresses this issue**.

NEA requires approval for each discharge in the form of a disposal authorization. In practice, sources that are below the exemption limits may be disposed of or discharged to sewer or air via a disposal application. However, there is currently no approvals for routine discharge of material. **Recommendation R14 in Section 5.8 addresses this issue.**

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
Observation: The NEA does not currently establish or approve limits for discharges. Instead, the provision for disposal is used to cover each discharge. This was identified in the self-assessment and is part of the Action Plan**.**	
(1)	**BASIS: GSR Part 3 Requirement 29, para. 3.123 states that** *"3.123. The regulatory body shall establish or approve operational limits and conditions relating to public exposure, including authorized limits for discharges..."*
R14	**Recommendation: NEA should establish or approve facility-specific authorized limits for discharges.**

There are limited provisions requiring optimization of planned public exposure including no provision for the setting of dose or risk constraints. Instead, prescriptive requirements exist to ensure public exposure is kept below certain levels specified in the current regulations. The requirement for an authorization holder to optimize public exposure is covered in the proposed draft amendment of RP(IR) Regulations. **Recommendation R21 in Section 9.1 addresses this issue**. However, the associated concept of a dose constraint for public exposure, and a process for the regulatory body to establish or approve dose constraints have not been defined. **Recommendation R22 in Section 9.1 addresses this issue.**

There is currently no explicit requirement for licensees regarding the performance of source and environmental monitoring for public exposure. However, the RP(IR) Regulations require certain licensees to do so. The draft updated RP(IR) Regulations provide for explicit requirements (**Recommendation R21 in Section 9.1 addresses this issue**.), however, the regulatory processes for establishing or approving them has not yet been defined. **Recommendation 8 in Section 4.5 addresses this issue**.

5.9. SUMMARY

According to the RPA and its subsidiary Regulations, the import, export, sale, possession and use of radiation sources, as well as transport of radioactive materials in Singapore, require a license.

NEA grants licenses for the possession of radiation sources by organizations and the use of radiation sources by individuals. The regulatory framework also includes specific requirements for the renewal, suspension, and revocation of these licenses.

However, the following areas for further improvement have been identified:

- Ensuring that all facilities are authorized for all activities taking place, and that facility and activity authorizations incorporate the graded approach. Ensuring that only justified practices are authorized;
- Ensuring that applicants submit a safety assessment prior to the granting of an authorization which is periodically reviewed and updated according to a graded approach; and
- Establishing or approving facility-specific authorized limits for discharges.

6. REVIEW AND ASSESSMENT

6.1. GENERIC ISSUES

6.1.1. MANAGEMENT OF REVIEW AND ASSESSMENT

Before issuing a licence, applications are first reviewed by NEA's licensing officers who check the completeness of the related submissions. If the completeness of the application is confirmed, the licensing officers make a recommendation and send the application for approval. Applications requiring further assessment are forwarded to scientific officers who carry out further review and assessment. The scientific officers will then advise the licensing officers on the licence application, in consultation with the Deputy Director of the Ionizing Radiation Control Department. Depending on the assessed facility or activity, the licensing or scientific officer may also route the application to NEA inspectors to verify the information provided by the applicant.

NEA uses procedures, work instructions and internal guides, implemented in the management system, for review and assessment of licence applications in terms of completeness and against the requirements for the relevant application type and purpose. However, these are not commensurate with the radiation risks of all facilities and activities reviewed and assessed, and do not cover all aspect of regulatory work, which may lead to inconsistencies in NEA's judgements, decisions and actions. **Related Recommendation R8 is provided in Section 4.5.**

NEA conducts review and assessment over the lifetime of a facility or over the duration of an activity through the periodical renewal of licences, and when modifying an authorization due to changes in the licensed activities. However, not all modifications with significant implications for safety are subject to authorization and hence, they are not subject to review and assessment by NEA. **Related Recommendation R21 is provided in Section 9.1**. While not required by the current legal and regulatory framework, the upcoming amended RP(IR) Regulations contain provisions for periodic safety reviews upon request by the regulatory body. **Related Recommendation R12 is provided in Section 5.1.**

6.1.2. ORGANIZATION AND TECHNICAL RESOURCES FOR REVIEW AND ASSESSMENT

The licensing and scientific officers who carry out the review and assessment of applications and submitted documentation are trained by senior NEA officers to ensure that knowledge is retained among the younger or newer officers. As the IRRS team observed, while there are qualifications and competencies required under the JCM, NEA staff participating in the review and assessment procedure may not have obtained all the necessary qualifications or competencies required, but they are guided by senior staff. Moreover, there is no formal training procedure on conducting review and assessment for the new reviewers who are usually trained by NEA's senior staff. Overall, gaps were identified with respect to the training programme and the number of trained NEA officers, for instance in review and assessment of applications for authorization. **Related Recommendation R7 is provided in Section 3.3.**

Arrangements are also in place for NEA to obtain technical advice or services in the field of radiation protection and nuclear safety, as necessary, through the Advisory Committee for Radiation Protection and Nuclear Science, Technical Committees for Radiation Safety and Security.

6.2. REVIEW AND ASSESSMENT FOR WASTE MANAGEMENT FACILITIES

There are no specific requirements or processes established for review and assessment of waste management facilities and activities for the different stages in their lifetime nor for the duration of a waste management activity. This is related to the fact, that the storage facilities for radioactive waste at some of the licensees' premises and the storage facility managed by NEA are not authorised as predisposal waste management facilities under the RPA. **Related Recommendations R8, R9 and R25 are provided in Sections 4.5, Section 5.1 and 9.2.** The general criteria and

principles applied by NEA in review and assessment are not documented as part of procedures, work instructions and internal guides. This also applies to the depth and scope of review and assessment processes to reflect the application of a graded approach. **Related Recommendation R8 is provided in Section 4.5.**

In addition, NEA does not require and review periodic safety reviews of waste management facilities. However, the upcoming amended RP(IR) Regulations contain provisions for periodic safety reviews upon requested the regulatory body. **Related Recommendation R12 is provided in Section 5.1.**

6.3. REVIEW AND ASSESSMENT FOR RADIATION SOURCES FACILITIES AND ACTIVITIES

NEA applies specific criteria and principles when assessing applications for the licensing of facilities and activities with radiation sources and the related documentation. These criteria are related to the categorization of radioactive sources that may be used. However, the IRRS team noted that they are not fully documented as part of any regulation, SOP, WI, or internal guide. Moreover, while there are SOPs, WIs and internal guides to provide guidance to licensing and scientific officers, the scope and depth of this guidance is limited as it mostly covers administrative requirements and no details related to risk or safety considerations are provided. **Related Recommendation R8 is provided in Section 4.5.**

6.4. REVIEW AND ASSESSMENT FOR DECOMMISSIONING ACTIVITIES

In the current legal and regulatory framework, no requirements exist for licensees to select a decommissioning strategy nor to prepare and maintain decommissioning plans for all facilities based on a graded approach. In addition, there are no provisions in the legal and regulatory framework that ensure that decommissioning plans are periodically reviewed by the regulatory body. The same applies to final decommissioning plans, including supporting safety assessments.

The upcoming amended RP(IR) Regulations contain some aspects relevant to the planning of decommissioning actions and NEA has imposed additional requirements for proton beam therapy facilities, e.g., related to the preparation of decommissioning plans prior to facility commissioning and to the assessment of safety during the operation and decommissioning phase. However, the IRRS team noted that both the upcoming amended RP(IR) Regulations and the additional requirements for proton beam therapy facilities are not sufficient to adequately ensure safety during decommissioning of all facilities for which decommissioning is necessary, based on a graded approach. **Related Recommendation R26 is provided in Section 9.4.**

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
Observation: *Decommissioning plans for all facilities for which decommissioning is necessary, based on a graded approach, are not required and reviewed periodically by NEA. NEA does not require, review and approve final decommissioning plans and supporting safety assessments for all facilities for which decommissioning is necessary, based on a graded approach, prior to the conduct of decommissioning actions. This has been identified by NEA as part of the self-assessment.*	
(1)	**BASIS: GSR Part 6 Requirement 8 states that** *"The licensee shall select a decommissioning strategy that will form the basis for the planning for decommissioning. The strategy shall be consistent with the national policy on the management of radioactive waste."*
(2)	**BASIS: GSR Part 6 Requirement 5, para. 3.3 states that** *"The responsibilities of the regulatory body shall include:* *— Establishing requirements for planning for decommissioning, including:* *● Establishment of the review process for decommissioning plans and supporting documents (as prescribed in national regulations) and the timeframe for such reviews;*

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
	●*Review of the initial decommissioning plan and updates, review and approval of the final decommissioning plan and supporting documents, and review and approval of updates after the final decommissioning plan has been approved; …"*
(5)	**BASIS: GSR Part 6 Requirement 11 states that** *"Prior to the conduct of decommissioning actions, a final decommissioning plan shall be prepared and shall be submitted to the regulatory body for approval."*
R15	**Recommendation: NEA should review decommissioning plans for all facilities requiring decommissioning using a graded approach, and should perform regulatory review of updated plans and approve final decommissioning plans, supported by safety assessments developed by the licensee.**

6.5. REVIEW AND ASSESSMENT FOR TRANSPORT

An applicant for a transport licence is required to submit for review, a TERP which must detail, amongst other things, the following;

- A description of the vehicle;
- A description of the package to be used;
- Routes of transportation;
- Radioactive material to be transported;
- Approved packaging number;
- Emergency procedures;
- Photo of approved vehicle;
- Valid hazardous materials transport driver permit; and
- This licence will not be approved unless this TERP is deemed satisfactory by NEA.

NEA had imposed a licence condition in all L6A licences requiring licensees to maintain their TERP to ensure that the information within are up-to-date. This is verified during the submission of licence amendment applications or on an ad-hoc basis, such as when licensees intend to transport Category 1 radioactive sources. Currently, there is no requirement for inspections of transportation of Category 2 to Category 5 sources.

Currently there is no requirement for a licence application for transport to be supported by a safety assessment. **Related Recommendation R12 is provided in Section 5.1.**

6.6. REVIEW AND ASSESSMENT FOR OCCUPATIONAL EXPOSURE

NEA conducts review and assessment of authorization applications and supporting documents that are submitted by the applicant. These supporting documents include a Radiation Protection Plan (RPP) that the applicant is required to prepare based on guidance issued by NEA through its website. The scope of the RPP includes, according to this guidance:

- Assignment of responsibilities;
- Functions of qualified personnel;
- Classification of areas;
- Safety measures (local rules, radiation monitoring, etc.);

- Accounting of sources / apparatus;
- Training programme for new and existing workers; and
- Actions to be taken in the event of an emergency.

While the RPP is required to address the areas listed above, requirements on information relating to verification of compliance on the control of occupational exposure are limited. It is noted that the information contained in the RPPs should be supported by a safety assessment to be carried out by the applicant, which is not required by the current regulations. **Related Recommendation R12 is provided in Section 5.1.**

The review of the application, including the RPP, is carried out by NEA staff, taking into account the general contents outlined above, but there are no documented internal procedures detailing the expectations regarding its contents. These procedures should guide the review and assessment of the implementation of the optimization principle, of the monitoring programme proposed by the applicant, the expected occupational exposures to be incurred by workers, as well as the proposed classification of areas, and other relevant safety requirements for occupational exposure. Related **Recommendation R8 is provided in Section 4.5.**

6.7. REVIEW AND ASSESSMENT FOR MEDICAL EXPOSURE

There are provisions in the MOH and NEA regulations related to review and assessment during the authorization/licensing process as well as during the lifetime of the service provided regarding medical exposure. However, the IRRS team observed that in comparison with the IAEA Safety Standards, some review and assessment regarding optimization of medical exposures are not included in the regulations. This includes, operational considerations, quality assurance, design, dosimetry of patients, calibration, diagnostic reference levels, dose constraints. **Related Recommendation R31 is provided in Section 9.7.**

Some records are required in the MOH regulations, and the retention period is specified in MOH circular (MH 92:02) (dated 2015) National Guidelines for Retention Periods of Medical Records and MOH Circular (MH78:04/4-2_V15) on Amendments to the National Guideline for Retention Periods of Medical Records. The document is legally binding as of the Amendments to the National Guideline for Retention Periods of Medical Records in 2022. However, NEA does not specify the period over which all records should be maintained. Additionally, the following records are neither ~~not~~ expressly specified to be retained nor do not have a retention period specified:

- Records of any delegation of responsibilities;
- Records of the results of the calibrations and periodic checks of the relevant physical and clinical parameters selected during treatment of patients;
- Records of dosimetry of patients;
- Records of local assessments and reviews made with regard to diagnostic reference levels;
- Records associated with the quality assurance programme, as required in GSR Part 3 Req.38 para. 3.171(d);
- For diagnostic radiology, information necessary for retrospective assessment of doses, including the number of exposures and the duration of fluoroscopic radiological procedures;
- For image-guided interventional procedures, information necessary for retrospective assessment of doses, including the duration of the fluoroscopic component and the number of images acquired;
- For nuclear medicine, the types of radiopharmaceutical administered and their activity;
- For external beam radiation therapy or brachytherapy, a description of the planning target volume, the absorbed dose to the centre of the planning target volume, and the maximum and minimum absorbed doses delivered to the planning target volume, or equivalent alternative information on absorbed doses to the planning target volume, and the absorbed doses to relevant tissues or organs as determined by the radiological medical practitioner; and in addition, for external beam radiation therapy, the dose fractionation and the overall treatment time;and
- Exposure records for volunteers subject to medical exposure as part of a programme of biomedical research.

6.8. REVIEW AND ASSESSMENT FOR PUBLIC EXPOSURE

Requirements for optimisation of public exposure as well as the framework for existing exposure situations and monitoring programmes for public or environmental exposure are not yet in the legislation**. Related Recommendation R21 is provided in Section 9.1**. Therefore, the review and assessment associated with these exposure situations are also not established.

Reference levels for commodities

Reference levels for commodities other than drinking water, such as construction materials and food have not been established. Nevertheless, the RP(IR) Regulations have provisions in place for the control of foodstuffs, fertilisers, pharmaceutical goods, cosmetics or toys where radioactive material has been intentionally added, including at levels lower than the exemption values. Materials containing natural radioactive material above typical background is currently not considered in this category. The proposed regulation will add additional commodities (food, feed, beverages, cosmetics or other commodity or product intended for intake) and consumer products (such as household beddings, toys, personal jewellery or adornments), with a deliberate addition of radioactive substances. **Related Recommendation R21 is provided in Section 9.1.**

As reference values have not been established, commodities are not reviewed and assessed against reference values. Therefore, individual decisions need to be made on a case-by-case basis which could introduce inconsistencies and uncertainty. This also makes detection and screening of materials of concern more difficult. An example of the use of reference levels for construction material is provided in IAEA S*afety Standard Protection of the Public against Exposure Indoors due to Radon and other Natural Sources of Radiation* (SSG-32) section 4.19-4.27. Similarly for food, further information can be found in Safety Report Series No 114 "Exposure due to Radionuclides in Food Other Than During a Nuclear or Radiological Emergency. Part 1: Technical Material", and IAEA-TECDOC-2011 "Exposure due to Radionuclides in Food Other Than During a Nuclear or Radiological Emergency. Part 2: Considerations in Implementing Requirement 51 of IAEA GSR Part 3".

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
Observation: *Reference levels for commodities other than drinking water, such as construction materials and food have not been established. This was identified in the self-assessment.*	
(1)	**BASIS: GSR Part 3 Requirement 51, para. 5.22 states that** *"The regulatory body or other relevant authority shall establish specific reference levels for exposure due to radionuclides in commodities such as construction materials, food and feed, and in drinking water, each of which shall typically be expressed as, or be based on, an annual effective dose to the representative person that generally does not exceed a value of about 1 mSv."*
R16	**Recommendation: The regulatory body should set reference levels for commodities other than drinking water.**

Note: There is a recommendation R2 in Section 1.2 to establish a regulatory framework for existing exposure situations. Responsibilities to regulate existing exposure situation have not yet been clearly assigned to the specific regulatory body, NEA or MOH. Thus, recommendation R19 is addressed to the "regulatory body".

Exposure to radon

NEA has identified exposure to radon as an existing exposure situation and studies conducted have shown that exposure to radon in Singapore is not a significant risk. A survey was first performed in 1995. Under a study initiated by NEA and supported by the IAEA in 2014, indoor radon measurements were carried out in 20 locations in residential, office and underground premises across Singapore. The average results obtained were well within the recommended reference limits as established by the international organisations including World Health Organization

(WHO), Commission of the European Communities (CEC) and United States Environmental Protection Agency (US EPA). The radon survey supported the conclusion that the average radon concentration for indoor premises in Singapore were not of a health concern. However, it also highlighted radon levels of 500 Bq/m^3 and 570 Bq/m^3 in the Secondary Standards Dosimetry Laboratory (SSDL). The survey may not sufficiently highlight areas where a radon hazard could exist such as specific areas of concern or in poorly ventilated spaces. Singapore adopts the acceptable limit of 100 Bq/m3 for 8-hour occupancy period, which is published in the Singapore Standard Code of Practice for Indoor Air Quality for Air-conditioned Buildings (SS554: 2016), which applies to certain situations. However, the Government has not published specific reference levels for radon including for homes and workplaces, nor any other information on radon such as typical exposures or on health risks. The advanced reference material also identified that NEA is presently working on establishing radon testing and detection capabilities such as procurement of passive, and active radon monitoring systems and training of staff. This would facilitate preparing an action plan if places where radon presents as a public health concern are found. Further information on representative surveys can be found in Safety Reports Series No. 98 *Design and Conduct of Indoor Radon Surveys*, which notes maps can be created identifying high radon areas, and also ANNEX I of SSG-32 which provides more information on mapping of Radon prone areas.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
Observation: *A survey was conducted by Singapore's Ministry of Health (MOH) in 1995, and a study initiated by NEA in 2014. This survey may not be a representative radon survey as it was not clear if sufficient locations were selected based on radon risk.*	
(1)	**BASIS: GSR Part 3 Requirement 50, para. 5.19 (a) states that** *"As part of its responsibilities, as required in para. 5.3, the government shall ensure that: (a) Information is gathered on activity concentrations of radon in dwellings and other buildings with high occupancy factors for members of the public through appropriate means, such as representative radon surveys; (b)..."*
(2)	**BASIS: SSG-32 para. 3.20 states that** *"…There are two principals to be considerations in undertaking a national radon survey: (a) To identify areas where a greater portions of homes are expected to have high concentrations of radon indoors…(b) To estimate the average exposure due to radon,…"*
S6	**Suggestion: The Government should consider ensuring that a representative radon survey is conducted to identify areas expected to have high concentrations of radon indoors.**

6.9. SUMMARY

NEA's licensing officers review licence applications for completeness and, where necessary, scientific officers carry out further review and assessment to check the application for compliance with legal and regulatory requirements. NEA conducts review and assessment over the lifetime of a facility or the duration of an activity through the periodical renewal of licenses and when modifying an authorization due to changes in the licence details.

The IRRS team has identified areas for improvement:

- Further development of procedures, work instructions and other internal guides used in review and assessment;
- Review and assessment of modifications of facilities with significant implications for safety;
- Review and assessment of decommissioning plans and supporting safety assessments periodically;
- Review and assessment of commodities against established reference values;
- Identification of areas expected to have high radon concentrations indoors through a representative radon survey.

7. INSPECTION

7.1. GENERIC ISSUES

NEA carries out inspections of radiation facilities and activities. to verify compliance with the regulatory requirements established in the Radiation Protection Act 2007 (RPA), and the conditions specified in the respective licenses. The powers and the procedure for the designation of NEA inspectors are also specified in the RPA.

NEA has 6 inspectors conducting different types of inspections, depending on the type of facilities or activities. The types of inspections conducted are captured in "SOP-RD-02 – Inspection of Radiation Equipment, Material and Facilities", and include:

a) Pre-licence inspections for new licence applications.
b) Enforcement inspections concerning routine inspections conducted to premises where radiation sources are stored or used.
c) Non-routine inspections conducted to licensed or unlicensed activities arising from feedback or complaints received regarding the use of radiation sources.

NEA conducts routine enforcement inspections to licensees possessing radioactive sources. Their frequency, as captured in the document "WI-RD-Inspection-001 – Inspection Frequency Guideline", is:

a. Twice a year for category 1 and 2 radioactive materials;
b. Once a year for category 3 and 4 radioactive materials; and
c. Once every 2 years for category 5 radioactive materials.

In 2021, NEA performed: 583 pre-licence, 190 routine and 167 non-routine inspections respectively.

The IRRS team was informed that the routine inspections performed annually by NEA for category 1 and 2 radioactive sources are unannounced.

All L2, L3 and L4 licensees are subject to inspection. However, NEA performs only pre-licensing inspections to licensees possessing irradiating apparatus. Inspections cover areas such as radiation safety, standard operating procedures, and inventory of radiation sources.

NEA conducts inspections over the lifetime of a facility. As part of inspections, NEA inspectors review and assess information provided by the licensee and check on physical measures put in place to ensure that a facility complies with the relevant regulatory requirements and that all information associated with the respective licence is accurate and up to date.

Inspectors are provided with the Integrated Field Operations system (iFOS) via a mobile tablet to assist them during the conduct of inspections. The iFOS system allows inspectors to capture key information as they can generate appropriate inspection checklists for their reference when conducting inspections. These checklists are customised for inspections of different types of radiation sources and their use. The document "WI-RD-Inspection-002" provides guidance on preparing inspection reports.

The IRRS team noted that not all regulated facilities and activities are covered by a common inspection programme, and that a graded approach is not applied consistently in the inspection programme.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
Observation*: NEA has an inspection programme. However, it is not based on the graded approach and does not cover all regulated facilities and activities.*	
(1)	**BASIS: GSR Part 1 (Rev.1): Requirement 29: 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 (including scheduled inspections and unannounced inspections), and shall stipulate the frequency of inspections and the areas and programmes to be inspected, in accordance with a graded approach."*
(2)	**BASIS: GSR Part 1 (Rev.1): Requirement 29: para 4.52 states that** *" Regulatory inspections shall cover all areas of responsibility of the regulatory body, and the regulatory body shall have the authority to carry out independent inspections... These inspections may include, within reason, unannounced inspections. The manner, extent and frequency of inspections shall be in accordance with a graded approach."*
S7	**Suggestion: NEA should consider further developing its inspection programme to encompass all regulated facilities and activities, in accordance with graded approach.**

According to Section 20 of the RPA, the inspectors do not have access to facilities and activities without the consent of the owner, or of the person in control of the facility, except under a warrant issued under Section 25 or 26.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
Observation: *Inspectors need the consent of the owner or a warrant from a magistrate to enter premises for inspection.*	
(1)	**BASIS: GSR Part 1 (Rev.1) Requirement 29, para. 4.52 states that** *"...Provision shall be made for free access by regulatory inspectors to any facility or activity, at any time, within the constraints of ensuring operational safety at all times and other constraints associated with the potential for harmful consequences..."*
R17	**Recommendation: The Government should establish provision allowing inspectors free access to any facility or activity at any time, within appropriate constraints for safety.**

7.2. INSPECTION OF WASTE MANAGEMENT FACILITIES

It is noted that there are no disposal facilities for radioactive waste in Singapore and there are currently no plans to develop such facilities. The storage of radioactive waste, at some of the licensees' premises and the storage facility managed by NEA, are not authorised as predisposal waste management facilities. Therefore, there are no processes for inspections from the specific viewpoint of predisposal waste management. **Related Recommendation R8 is provided in Section 4.5.** Instead, radioactive waste is currently treated as radioactive material and NEA applies the requirements and procedures for inspection of radioactive materials. **Related Recommendation R23 is provided in Section 9.2.**

7.3. INSPECTION OF RADIATION SOURCES FACILITIES AND ACTIVITIES

NEA carries out a "surveillance" programme concerning the conduct of inspections to sites where unlicensed ionizing irradiating apparatus are more likely to be found. Currently, the programme covers industrial, dental, and veterinary applications, where each application will be subject to 24 random unannounced inspections over a period of a year. As stipulated in Section 41 of the RPA, NEA can regain control of radioactive sources that have been abandoned, lost, misplaced, stolen, or otherwise transferred without proper authorisation.

The IRRS team noticed the inspection outcomes are not forwarded to the inspected licensee unless non-compliances have been identified. Neither are they used for the improvement of the regulatory services. Non-compliances detected and recommendations given to applicants and licensees during the inspection process are only recorded in the case files of the RPLMS. Obtaining any statistics on the types of non-compliances observed would therefore require a considerable effort of going through the case files. NEA may benefit from preparing a summary of the lessons learned from inspections, including the statistics on the numbers of issues and severity of non-compliances identified for different types of practices, sources, and facilities as an input to the process of setting up inspection planning. In this way, inspection resources may be focused to where non-compliances are more severe or more often observed. **A related suggestion regarding the inspection plan is provided in Section 7.1**

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
Observation: *NEA does not provide the applicant/licensee with the results of inspections unless non compliances have been identified. Moreover, NEA does not use the results of inspections as feedback information for the regulatory processes.*	
(1)	**BASIS: GSR Part 1 (Rev.1), Requirement 29, para. 4.51 states that** *"… Results of inspections shall be used as feedback information for the regulatory process and shall be provided to the authorized party".*
R18	**Recommendation: NEA should forward the results of inspections to the inspected licensee, even in cases where no non-conformances have been identified and use the results of inspections as feedback information for the regulatory processes.**

Site Visit to NEA's Storage Facility for Radioactive Waste

The IRRS team participated in a site visit to NEA's storage facility, where conditioned and unconditioned disused radioactive sources are stored since 1990's. The facility is operated by NEA but is not licensed under the Radiation Protection Act and no regular and systematic inspections are carried out. From the visual impression gained during the site visit, inspecting the stored radioactive waste might be challenging due to space limitations. NEA is in the phase of constructing a new facility for radioactive waste processing and storage with an increased storage capacity. The current plan is to transfer the radioactive waste stored at NEA's storage to the new facility in 2025. Neither the design nor the construction of NEA's new waste management facility have been licensed under the RPA.

Site Visit to a Non-Destructive Testing Facility

The IRRS team observed the inspection performed by NEA at SETSCO, a Non-Destructive Testing (NDT) facility. The observed inspection was announced. It was based on the related authorisation documents and performed according to the inspection plan.

SETSCO company conducts Non-Destructive Testing (NDT) with the use of radioactive sources, i.e., Se-75, Ir-192, x-ray generators and Troxler gauges. The company also performs analytical measurements with Ni-63 gas chromatography devices.

During the initial meeting, the SETSCO representatives were informed on the scope of the visit. The Senior manager and SETSCO staff members were involved in the inspection. The inspection was carried out according to the IRCD Inspection protocol. However, the iFOS checklist was not used for the inspection and previous inspection report was used instead as a basis by NEA inspector. The inspector performed, professionally, the necessary radiation safety measurements using NEA's appropriate measuring instruments.

At the end of the inspection, NEA inspector orally presented the findings to the SETSCO representatives. After the inspection, the IRRS team interviewed the SETSCO representatives who underlined the useful interaction and cooperation with the inspectors and the availability and prompt response of NEA personnel in general.

As the IRRS team noted, while there is an inspection protocol, there is a lack of detailed guidance to inspectors on how perform the inspections and evaluate the compliance with the regulatory requirements. This was also identified in the self-assessment and reflected in the Action Plan. **Recommendation R8 in Section 4.5 addresses this issue**. Furthermore, NEA has not established a training programme for its inspectors on the basis of an analysis of the necessary competence and skills. **Recommendation R7 in Section 3.3 addresses this issue.**

Site visit to a Nuclear Medical Facility

The IRRS team observed the inspection performed by NEA at Singapore General Hospital. The observed inspection was announced. The inspection started with an entrance meeting setting out the scope of the inspection. The inspection covered areas including documentation, inventory control and waste management within a nuclear medicine practice. Results of the dose monitoring for radiation workers was presented by the licence holder on request. Inspectors conducted themselves in a friendly and professional manner.

The inspection might have been enhanced through the use of checklists or planned requirements for the inspection, to guide the inspector in exploring specific issues. The NEA inspector closed the inspection by providing the results of the inspection to the facility.

The licence holder described the relationship as good working relationship, collaborative and open to feedback. The licence holder informed the IRRS team:

- The operator recommended establishing national Diagnostic Reference levels as the facility is working toward establishing FRL (facility reference level).
- The licence holder felt that NEA has insufficient resources for a timely response to applications (such as worker registration of 4-8 weeks) however they work together to ensure timeframes for important applications such as the new CT scanner recently licensed.
- NEA using a checklist during the inspection may also be useful for the operator to give greater clarity.
- To the operator there is an evident distinction with NEA focusing on safety and security of sources while MOH concentrates on patient factors. Duplication of reporting of incidents, which is manageable, but the operator has to know what to report where which is only described in internal procedures.

7.4. INSPECTION OF DECOMMISSIONING ACTIVITIES

In Singapore, no facilities have been decommissioned and there are no facilities planned to be decommissioned in the near future. Neither the current regulations nor the upcoming amended RP(IR) Regulations contain provisions specific to the decommissioning of facilities that give rise to radiation risks.

In this context, appropriate provisions are missing to ensure that decommissioning actions are inspected and reviewed against safety objectives and criteria defined in the final decommissioning plan, the results and conclusions of the associated safety assessment, and the limits and conditions of the authorisation for decommissioning.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES
Observation: *Neither the current legal and regulatory framework nor the upcoming amended RP(IR) Regulations contain appropriate provisions that the decommissioning actions are inspected and reviewed to*

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
ensure that they are being carried out in accordance with the safety objectives and criteria defined in the final decommissioning plan, the results and conclusions of the associated safety assessment, the limits and conditions of the authorization for decommissioning, and with other requirements for which the regulatory body has responsibility for oversight. This has been identified by NEA as part of the self-assessment.	
(1)	**BASIS: GSR Part 6 Requirement 5, para. 3.3 states that** *"The responsibilities of the regulatory body shall include:* *- ...* *- Inspecting and reviewing decommissioning actions and taking enforcement actions in the case of non-compliance with the national legal and regulatory framework, or with the authorization or licence conditions and safety requirements established by the regulatory body;..."*
(2)	**BASIS: GSR Part 6 Requirement 12, para. 8.5 states that** *"The regulatory body shall make arrangements for and shall implement the inspection and review of the decommissioning actions to ensure that the are being carried out in accordance with the final decommissioning plan and the authorization to conduct decommissioning, and with other requirements for* *which the regulatory body has responsibility for oversight. If safety requirements and the conditions for authorization to conduct decommissioning are not met, the regulatory body shall take appropriate enforcement actions."*
R19	**Recommendation: NEA should make arrangements for and should implement the inspection and review of the decommissioning actions to ensure that they are carried out in accordance with the final decommissioning plan and associated safety assessment, and the authorization for decommissioning and licence conditions.**

7.5. INSPECTION OF TRANSPORT

Inspections are only carried out for transport of Category 1 sources. The transport of other categories sources is not inspected. The IRRS team was informed that the frequency of transports of Category 1 sources is about one every 3 years, when a new Category 1 source arrives in the country or when an old one leaves the country, in which case an inspection is carried out. Outside of this period, no transport inspections are carried out. There is a Suggestion made, that NEA should further develop its inspection programme. As part of this, a revision of the current transport-inspection programme should occur. **Suggestion S7 in Section 7.1 addresses this issue.**

7.6. INSPECTION OF OCCUPATIONAL EXPOSURE

While preparing for the inspection, it was observed that inspectors did not review the information regarding workers of the authorized party. The IRRS team was informed that, instead, NEA's dosimetry services directly interacted with the authorised parties if any unusual occurrences were identified in their worker's dosimeters, and that inspectors did not have access to such information. The Radiation Monitoring and Services Division (RMSD) will notify IRCD on any anomaly or overdose registered by authorised party.

During the site visit the IRRS team observed that the inspection protocol does not include a review of the results of the monitoring programme of authorized parties with regard to occupational exposure. Additionally, compliance with the optimization requirement or with the dose limits, the existence of related policies, procedures, organizational arrangements, procedural and technical arrangements related to controlled and supervised areas were not addressed.

The IRRS team encourages NEA to further revise inspection procedures taking into account optimization of exposure to the persons involved.

As no requirements have been set regarding occupational exposure in existing exposure situations, compliance with requirements on existing exposure situations is not included in the inspection programme. **Recommendation 30 in Section 9.6 relates to this issue.**

7.7. INSPECTION OF MEDICAL EXPOSURE

MOH and NEA are empowered to carry out inspections in medical facilities and activities. Nevertheless, some requirements provided in MOH, and NEA regulations are the same and the IRRS team was informed that there is an overlap of functions and some aspects are checked by both authorities.

MOH has not formalised an inspection programme, however, an inspection checklist was developed and is available for the inspectors and used during their inspection. However, these check lists are only for diagnostic radiology and nuclear medicine services. NEA has an inspection programme based on graded approach taken into account only the category of sources, radioactive material, and therefore facilities which only have radiation generator is not part of the programme.

An inspection checklist was developed and is available for the inspectors to use during the inspection, however, the IRRS team noted during the inspection visit to the Singapore General Hospital that the checklist was not used. The results of the inspections are communicated to the authorised representative on site after conducting the inspection.

7.8. INSPECTION OF PUBLIC EXPOSURE

Monitoring programmes

The regulations currently do not require for licence holders to perform source monitoring and reporting of public exposures or environmental monitoring reports. **Related Recommendation R21 is provided in Section 9.1.**

The regulatory body through inspection verifies that certain provisions relating to public exposure are in place. This includes reviewing of records relating to disposals. The regulatory body also independently verifies that provisions for public exposure, such as the requirement for certain places accessible to the public is below 10µSv/hr, are complied with. There is not currently any publication of the results of public exposure monitoring or verification activities.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
Observation: *The NEA confirms through inspection some public exposure requirements such as dose rates in areas accessible to the public. However, NEA does not currently implement provisions such as review, independent verification, and publication of monitoring results. This is particularly relevant to authorised discharges, once established. This was identified in the self-assessment.*	
(1)	**BASIS: GSR Part 3 Requirement 32, para. 3.135 states that** *"The regulatory body shall be responsible, as appropriate, for:* *(a) Review and approval of monitoring programmes of registrants and licensees, which shall be sufficient for:* *(i) Verifying compliance with the requirements of these Standards in respect of public exposure in planned exposure situations;* *(ii) Assessing doses from public exposure.* *(b) Review of periodic reports on public exposure (including results of monitoring programmes and dose assessments) submitted by registrants and licensees.* *(c) Making provision for an independent monitoring programme.* *(d) Assessment of the total public exposure due to authorized sources and practices in the State on the basis of monitoring data provided by registrants and licensees and with the use of data from*

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
	independent monitoring and assessments. *(e) Making provision for maintaining records of discharges, results of monitoring programmes and results of assessments of public exposure.* *(f) Verification of compliance of an authorized practice with the requirements of these Standards for the control of public exposure."*
(2)	**BASIS: GSR Part 3 Requirement 32, 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."*
R20	**Recommendation: NEA should review, approve and publish or should make available on request, as appropriate, results from source monitoring and environmental monitoring programmes and assessments of doses from public exposure.**

7.9. SUMMARY

As part of inspections, NEA inspectors review and assess information provided by the licensee and check on physical measures put in place to ensure that a facility continuously complies with the relevant regulatory requirements and that all information associated with the respective licence is accurate and up to date.

- Both NEA and MOH are regulatory authorities responsible for medical exposures.
- However, areas for further improvement to the framework have been identified.
- Establishment of an inspection programme which encompasses all regulated facilities and activities. Such a programme should be designed using a graded approach.
- Implementation of the practice of providing the results of inspections to the inspected licensee, even in cases where no non-conformances have been identified and use the results of inspections as feedback information for the regulatory processes.
- Establishment of the provision to allow inspectors free access to any facility or activity at any time, within appropriate constraints for safety, without requiring a warrant.

8. ENFORCEMENT

8.1. ENFORCEMENT POLICY AND PROCESS

The RPA and its subsidiary Regulations provide enforcement powers to NEA. The enforcement actions employed by NEA depend on the degree of the non-compliance.

The NEA has implemented an Enforcement Policy, applying a graded approach based on a combination of risk (according to type of apparatus or source) and on whether it is a first time or repeated offence. However, the Enforcement Policy only covers expired/missing licence, insufficient shielding and lost radioactive sources. In these instances, the enforcement actions of NEA stipulated in the Enforcement Policy include an advisory letter, a warning letter or prosecution. According to the ARM report and interviews, enforcement actions in other cases are decided on a case-to-case basis. The RP(IR) Regulations provides for amending, suspending or revoking the authorization.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
Observation: *The Enforcement policy of NEA covers only non-compliances relating to expired/missing licence, insufficient shielding and lost radioactive sources.*	
(1)	**BASIS: GSR Part 1 (Rev.1) Requirement 30 states that** *"The regulatory body shall establish an enforcement policy within the legal framework for responding to non-compliance by authorized parties with regulatory requirements or with any conditions specified in the authorization."*
S8	**Suggestion: NEA should consider extending the Enforcement Policy to include a comprehensive list of non-compliances.**

Overall guidance for inspectors on the processes for enforcement actions are included in 'SOP-RD-02 - Inspection of Radiation Equipment, Material and Facilities'. However, the management system does not contain other guidance on enforcement actions, for instance guidelines containing criteria to be used in the process of deciding on the time period granted to the licensee for completing corrective actions, where there is no immediate risk to safety, and how the authorised parties are required to document implemented corrective actions to NEA. **Recommendation R8 in Section 4.5 addresses this issue.** GSG-13 paras. 3.295-3.319 provides guidance on enforcement processes and implementation that might be useful in the development of the management system.

In case of the imminent likelihood of safety significant events, NEA inspectors are empowered to order immediate corrective actions, in line with GSR Part 1 Requirement 31, para. 4.58. Regulation 54 of the RP(IR) Regulations empowers the Director General to order immediate cessation of the activity or the shutdown of a facility, of which the power to do so is delegated to all inspectors through the general appointment of inspectors, in accordance with Section 20(2) of the RPA. The remaining provisions regarding inspections and inspectors are given in the RPA. The fact that power to order immediate corrective actions is present in RP(IR), however, is missing in RPA was identified in the self-assessment and is part of the Action Plan. In the planned review of the need for changes in the RPA, it would be relevant to assess, if the provisions should be moved to the RPA.

8.2. ENFORCEMENT IMPLEMENTATIONS

The IRRS team was informed that consistent follow-up on expiry of licences is not performed. According to Regulation 9(4) of the RP(IR) Regulations, it is the responsibility of the licensee to submit the application for renewal of licence in due time before the expiry of the licence. NEA sends a first reminder to the licensee three month before expiry of the licence and a second reminder one month before expiry, if an application for renewal has not yet been received. In the case of licensees possessing radioactive sources (L4 licences), where planned inspections are performed, the licensee with the expired licence will still be subject to inspection, and the missing licence will be added to the inspection report as a non-compliance and followed-up. However, the time span before the next

inspection might be up to two years. For the case of licensees possessing radiation generators (L3 licences), where no planned inspections are performed, enforcement actions are not routinely applied. Enforcement of the need to renew the licence will only occur if it falls under the unannounced "surveillance" inspections carried out by NEA or, for some areas of medical exposure, the lack of licence from NEA is detected as part of MOH licensing processes.

Consequently, as the expired licence will not be considered active anymore, the associated radiation generator will also not be part of the national registry of currently used radiation generators. Nonetheless, NEA retains the records of such expired licences in RPLMS. **Suggestion 10 in Section 9.1 addresses this issue**.

The IRRS team was informed during interviews, that inspections on transport activities are only carried out for Category 1 sources. Consequently, the only possible enforcement actions arising directly from findings from inspection of transport-related activities will be for Category 1 sources. Nonetheless, enforcement action can be taken at any time if there are any observed regulatory non-compliances, which could arise in response to feedback or reports received. **This was also addressed in Suggestion S7 in Section 7.1.**

Furthermore, regarding inspections of sources, facilities and activities, the IRRS team was informed that often issues found at inspections were rectified on the spot and verified through subsequent communications such as e-mail, and not reflected as a non-compliance. This approach is commonly applied for pre-licensing inspections, if an issue is found which is rectified at the follow-up inspection, but also applied for other types of inspections. In some cases, fulfilment of the required corrective actions is checked through a follow-up inspection, mainly in the case of pre-licensing inspections. Information about the handling and all e-mails will be added to the inspection report sent to the Deputy Director (Ionizing Radiation Control Department) for approval. The inspection report will in this case also include documentation for the corrective actions carried out, for example, pictures of improvements. The IRRS team was informed that enforcement actions following inspections are rare. In 2021, 940 inspections were performed for sources and facilities, and enforcement actions were only applied in about 30 cases. The action used in these cases was mainly email correspondence with the authorised party as described above.

Only in cases where inspectors find issues that they consider serious, will they include recommendation for formal enforcement to the inspection report sent to the Deputy Director (Ionizing Radiation Control Department) for approval.

Prosecution is rare, as there has been one case in 2022 and before that in 2018.

8.3. SUMMARY

The legal framework provides enforcement powers to NEA. NEA has developed and implemented an enforcement policy as well as the basic procedures for enforcement actions.

The IRRS team identified areas for improvement and recommends that NEA:

- develops further internal guidance to inspectors on a range of aspects related to enforcement actions, and
- ensures that the national registry reflects the currently used radiation generators.

Including further types of non-compliances in the Enforcement Policy, has the potential to improve effectiveness of enforcement actions.

9. REGULATIONS AND GUIDES

9.1. GENERIC ISSUES

Although there are established arrangements for the review and revision of regulations, the regulations currently in force (i.e., RPA and RP(IR) Regulations) are not fully in compliance with the IAEA Safety Standards. This was identified in the self-assessment and is part of the Action Plan.

NEA has developed limited guides for limited types of facilities on the format and content of the documents to be submitted by the applicants in support of an application for a licence. This was identified in the self-assessment and is part of the Action Plan.

Moreover, NEA has developed guides for safety, for both NEA staff and licence holders. However, these guides do not cover all facilities and activities.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
Observation: *NEA has established a limited number of guides for safety. This was identified in the self-assessment and is part of the Action Plan.*	
(1)	**BASIS: GSR Part 1 (Rev.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."*
S9	**Suggestion: NEA should consider further developing or adopting guides for safety.**

NEA has developed a draft amendment of the RP(IR) Regulations. These regulations specify the requirements and associated criteria for safety for various applications of radiation sources. NEA aims to gazette the draft RP(IR) Regulations by the end of 2022 to improve consistency with international safety standards. The amendments proposed in the draft RP(IR) Regulations is intended to cover the following areas aligned with international safety standards:

- Clearance of radiation sources within notified or authorised practices from the regulatory control;
- Arrangements for radiation protection for breast-feeding patient;
- Optimisation of public exposure;
- Requirements for visitors to controlled and supervised areas;
- Safety assessments addressing potential exposure to the members of the public; and
- Applications for modification of an existing facility with significant safety implications to the regulatory body for review and assessment.

In addition, the proposed amendments to the RP(IR) Regulations is intended to include missing requirements on the safe management of radioactive waste relating to, among others:

- Interdependencies between the steps in predisposal management of radioactive waste as well as and the impacts on the anticipated disposal option;
- Waste acceptance criteria for processing, storage and disposal;
- Identification, control and minimisation of radioactive waste;
- Classification and characterization of radioactive waste;
- Application of management systems for all steps and elements of the predisposal management of radioactive waste;
- Processing of radioactive waste based on the characteristics of the waste and the demands imposed by the different steps in its management;

- Design and production of waste packages that ensure containment of radioactive material both during normal operation and accident conditions that could occur during waste management activities;
- Construction of predisposal waste management facilities in accordance with the design described in the safety case and approved by the regulatory body;
- Storage of waste in a manner such that it can be inspected, monitored, retrieved and preserved in a condition suitable for its subsequent management; and
- Maintenance of predisposal waste management facilities to ensure their safe performance.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
Observation: *NEA has developed a draft amendment of the Radiation Protection (Ionizing Radiation) Regulations (RP(IR) Regulations). This amendment of the regulation is intended to cover the generic radiation safety requirements as well as the specific safety requirements related with the management of radioactive waste aligned with international safety standards. However, this amendment has not been enacted yet.*	
(1)	**BASIS: GSR Part 1 (Rev. 1) Requirement 33 states that** *"Regulations and guides shall be reviewed and revised as necessary to keep them up to date, with due consideration of relevant international safety standards and technical standards and of relevant experience gained."*
R21	**Recommendation: NEA should enact the amendment of the Radiation Protection (Ionizing Radiation) Regulations (RP(IR) Regulations).**

The regulatory framework for safety includes requirements for authorized parties and for the regulatory body to maintain a limited number of safety related records necessary for the safe operation of facilities and the safe conduct of activities. Moreover, the period that the records kept by the authorised parties should be maintained has not been specified.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
Observation: *The regulatory framework provides requirements for authorised parties and regulatory body to maintain some safety related records necessary for the safe operation of facilities and the safe conduct of activities. Additionally, the period for which records should be maintained by the authorised parties has not been specified for all facilities and activities. This was identified in the self-assessment.*	
(1)	**BASIS: GSR Part 1 (Rev.1) Requirement 35, para. 4.63 states that** *"The regulatory body shall make provision for establishing and maintaining the following main registers and inventories:* *a) Registers of sealed radioactive sources and radiation generators;* *…* *b) Records that might be necessary for the shutdown and decommissioning (or closure) of facilities;* *c) Records of events, including non-routine releases of radioactive material to the environment;* d) *Inventories of radioactive waste and of spent fuel."*
(2)	**BASIS: GSR Part 1 (Rev.1) Requirement 35, para. 4.64. states that:** *"The regulatory body may or may not be the sole entity responsible for the maintenance of these registers and inventories, but it shall be involved in their proper retention and use. The authorized party shall be responsible for maintaining its own records. The authorized party shall maintain all the records necessary for the safe operation of facilities and the safe conduct of activities, as specified in the authorization. This includes maintaining an inventory of radioactive sources and inventories of radioactive waste and of spent fuel, as well as records of doses from occupational exposure. The requirement for the*

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
	regulatory body to maintain records cannot diminish the responsibility of authorized parties to keep their own records."
(3)	**BASIS: GSR Part 1 (Rev.1) Requirement 35, para. 4.65 states that:** *"Applicants shall be responsible for ensuring the recording of information relating to facilities and activities in registers and inventories, and analysing it, where relevant, for the purposes of demonstrating safety. Moreover, the regulatory body shall use such records in support of its regulatory functions and to support the enforcement of regulatory requirements."*
(4)	**BASIS: GSR Part 3 Requirement 42, para. 3.183 states that "***Registrants and licensees shall maintain for a period as specified by the regulatory body and shall make available, as required, the following personnel records:* *(a) Records of any delegation of responsibilities …"*
(5)	**BASIS: GSR Part 3 Requirement 42, para. 3.184 states that** "Registrants and licensees shall maintain for a period as specified by the regulatory body and shall make available, as required, the following records of calibration, dosimetry and quality assurance: (a) Records of the results of the calibrations and periodic checks…"
(6)	**BASIS: GSR Part 3 Requirement 42, para. 3.185 states that** "Registrants and licensees shall maintain for a period as specified by the regulatory body and shall make available, as required, the following records for medical exposure: (a) For diagnostic radiology, information necessary for retrospective assessment of doses …"
S10	**Suggestion: the regulatory body should consider making provisions for:** • **establishing and maintaining all necessary records by the regulatory body and authorised parties for all facilities and activities, and** • **specifying the period of maintaining the records for all facilities and activities by the authorised parties.**

Note: NEA and MOH both are the regulatory bodies for medical exposure. There is a recommendation R4 in Section 1.5 to the Government to make provision for the effective coordination of NEA's and MOH's regulatory activities, to avoid any omissions or undue duplications. Thus, ***suggestion S10 and recommendation R31 are addressed to the "regulatory body".***

The concept of dose constraints for public and occupational exposure, as well as a process to establish them, have not been defined in the regulations. Furthermore, the current proposed draft RP(IR) Regulations only considers dose constraints for the protection of carers and comforters and for persons subject to exposure as part of biomedical research.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
Observation: *The concept of dose constraints for public and occupational exposure, or a process for establishing them have not been defined in the regulations.*	
(1)	**BASIS: GSR Part 3 Requirement 11, para. 3.22 (c) states that** *"The government or the regulatory body: (a)...(c) Shall establish or approve constraints*[1] *on dose and on risk, as appropriate, or shall*

[1] For occupational exposure, the relevant dose constraint is on individual doses to workers, established and used by registrants and licensees to set the range of options in optimizing protection and safety for the source. For public exposure, the relevant dose constraint is a source related value established or approved by the government or the regulatory body, with account

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
	establish or approve a process for establishing such constraints, to be used in the optimization of protection and safety."
(2)	**BASIS: GSR Part 3 Requirement 29, para. 3.119 states that** *"3.119. The government or the regulatory body shall establish and enforce requirements for the optimization of protection and safety for situations in which individuals are or could be subject to public exposure.*
(3)	**BASIS: GSR Part 3 Requirement 29, para. 3.120 states that** *"The government or the regulatory body shall establish or approve constraints on dose and constraints on risk to be used in the optimization of protection and safety for members of the public. When establishing or approving constraints in respect of a source within a practice, the government or the regulatory body shall take into account, as appropriate:* *(a) The characteristics of the source and of the practice that are of relevance for public exposure;* *(b) Good practice in the operation of similar sources;* *(c) Dose contributions from other authorized practices or from possible future authorized practices, estimated at the design and planning stage, so that the total dose to members of the public is not expected to exceed the dose limit at any time after the start of operation of the source;* *(d) The views of interested parties.*
R22	**Recommendation: NEA should update the regulations to include the establishment of dose constraints for public and occupational exposure.**

9.2. REGULATIONS AND GUIDES FOR WASTE MANAGEMENT FACILITIES

RPA defines radioactive waste separately from radioactive material and the current RP(IR) Regulations require that certain contaminated articles shall be discarded and treated as radioactive waste. However, radioactive material for which no further use is foreseen is not processed as radioactive waste but continues to be licensed and controlled as radioactive material.

While the current legal and regulatory framework for safety does not include requirements for the safe management of radioactive waste, NEA has developed and plans to publish amended RP(IR) Regulations and a Policy and Strategy for Management of Radioactive Waste in Singapore, which, in their current form, will ensure compliance with most of the requirements relating to predisposal waste management facilities. This is part of the Action Plan. However, there is no provision made for the safety of disposal facilities and activities in the current regulatory framework nor in the currently planned improvements This has been identified by NEA as part of the self-assessment.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
Observation: *In the current legal and regulatory framework, radioactive material for which no further use is foreseen, including reuse, recycling and return to supplier, and with characteristics that make it unsuitable for authorized discharge, authorized use or clearance from regulatory control, is not processed as radioactive waste but continues to be treated as radioactive material and is licensed and controlled accordingly. This has been identified by NEA as part of the self-assessment.*	
(1)	**BASIS: GSR Part 5 Requirement 10 states that** *"Radioactive material for which no further use is*

taken of the doses from planned operations of all sources under control. The dose constraint for each particular source is intended, among other things, to ensure that the sum of doses from planned operations for all sources under control remains within the dose limit.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
	foreseen, and with characteristics that make it unsuitable for authorized discharge, authorized use or clearance from regulatory control, shall be processed as radioactive waste…"
R23	**Recommendation: NEA should require that the radioactive material for which no further use is foreseen and with characteristics that make it unsuitable for authorized discharge, authorized use, or clearance from regulatory control, is processed as radioactive waste.**

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
Observation: *There are not adequate provisions for the safety of disposal facilities and activities in the current regulatory framework nor in the currently planned improvements. This has been identified by NEA as part of the self-assessment.*	
(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."*
R24	**Recommendation: NEA should establish the safety requirements for the development of radioactive waste disposal facilities and activities in accordance with a graded approach.**

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
Observation: *The draft amendments to RP(IR) Regulations relating to the predisposal radioactive waste management facilities do not cover some of the IAEA GSR Part 5 requirements.*	
(1)	**BASIS: GSR Part 5 Requirement 4 states that** *"Operators shall be responsible for the safety of predisposal radioactive waste management facilities or activities. The operator shall carry out safety assessments and shall develop a safety case, and shall ensure that the necessary activities for siting, design, construction, commissioning, operation, shutdown and decommissioning are carried out in compliance with legal and regulatory requirements."*
(2)	**BASIS: SSG-45, para. 3.23 states that** *"The regulatory body will require the operator to submit safety documentation in support of an application for a licence or other type of authorization involving the management of radioactive waste. The safety case will include a supporting safety assessment commensurate with the complexity of the facility."*
(3)	**BASIS: GSR Part 5 Requirement 17 states that** *"Predisposal radioactive waste management facilities shall be located and designed so as to ensure safety for the expected operating lifetime under both normal and possible accident conditions, and for their decommissioning."*
(4)	**BASIS: GSR Part 5 Requirement 5 states that** *"Measures shall be implemented to ensure an integrated approach to safety and security in the predisposal management of radioactive waste."*
(5)	**BASIS: GSR Part 5 Requirement 19 states that** *"… Emergency preparedness and response plans, if developed by the operator, are subject to the approval of the regulatory body."*
R25	**Recommendation: NEA should establish requirements to:** • **develop and maintain a safety case, including supporting safety assessment, for predisposal radioactive waste management facilities or activities throughout the lifetime of the facility or duration of the activity;**

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
	• **locate and design predisposal waste management facilities so as to ensure safety during their decommissioning; and** • **ensure an integrated approach to safety, security and nuclear materials accounting for predisposal waste management facilities.**

9.3. REGULATIONS AND GUIDES FOR RADIATION SOURCES FACILITIES AND ACTIVITIES

Not all the essential regulatory provisions concerning the radiation safety of facilities and activities are covered in the current regulations, and the upcoming draft regulations will not cover all the outstanding issues. **Recommendations R11 and R12 in Section 5.1 and recommendation R21 in Section 9.1 address this issue**.

In particular, as the IRRS team noted, while exemption levels are specified in RP(IR) Regulations, they are not fully in line with the IAEA Safety Standards. Moreover, clearance levels have not been specified separately, and exemption levels are also used for the clearance of radiation sources. Both these issues are expected to be appropriately addressed in the draft version of the RP(IR) Regulations. **Recommendation R21 in section 9.1 addresses this issue.**

9.4. REGULATIONS AND GUIDES FOR DECOMMISSIONING ACTIVITIES

Currently, the regulatory framework does not make specific provisions for the safe decommissioning of facilities. NEA has developed additional requirements to be applied as licence conditions for proton beam therapy facilities, including the requirement to prepare a decommissioning plan and to comply with end state criteria. However, the provisions in the current legal and regulatory framework as well as in the draft RP(IR) Regulations are not adequate to ensure safety during decommissioning of all facilities in accordance with a graded approach. In particular, this includes requirements relating to the selection of a decommissioning strategy, the preparation and maintenance of decommissioning plans, and the preparation of final decommissioning plans and supporting documents.

Further, neither the current legal and regulatory framework nor upcoming amended RP(IR) Regulations contain provisions a) explicitly ensuring that exposure during decommissioning activities is considered as a planned exposure situation, and b) ensuring that radioactive waste present in a facility after its permanent shutdown is removed prior to the conduct of decommissioning actions.

In addition to the requirements for decommissioning for all facilities for which decommissioning is necessary, based on a graded approach, NEA should establish associated guides. **Related Suggestion S9 is provided in Section 9.1.**

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
Observation: *Besides the additional requirements imposed on the upcoming proton beam therapy facilities, there are no provisions specifically for the safe decommissioning of all facilities based on a graded approach.*	
(1)	**BASIS: GSR Part 6 Requirement 5 states that** *"The regulatory body shall regulate all aspects of decommissioning throughout all stages of the facility's lifetime, from initial planning for decommissioning during the siting and design of the facility, to the completion of decommissioning actions and the termination of authorization for decommissioning. The regulatory body shall establish the safety requirements for decommissioning, including requirements for management of the resulting radioactive waste, and shall adopt associated regulations and guides. The regulatory body shall also take actions to ensure that the regulatory requirements are met."*
(2)	**BASIS: GSR Part 6 Requirement 8 states that** *"The licensee shall select a decommissioning strategy that will form the basis for the planning for decommissioning. The strategy shall be consistent with the*

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
	national policy on the management of radioactive waste."
(3)	**BASIS: GSR Part 6 Requirement 5, para. 3.3 states that** *"The responsibilities of the regulatory body shall include:* *e) Establishing requirements for planning for decommissioning, including:...* *f) Specification of the typical content of decommissioning plans and supporting documents for review or approval;* *g) Establishment of the review process for decommissioning plans and supporting documents (as prescribed in national regulations) and the timeframe for such reviews;* h) *Review of the initial decommissioning plan and updates, review and approval of the final decommissioning plan and supporting documents, and review and approval of updates after the final decommissioning plan has been approved;…"*
(4)	*i) BASIS: GSR Part 6 Requirement 6, para. 3.4 states that "The responsibilities of the licensee shall include:* *j) Selecting a decommissioning strategy as the basis for preparing and maintaining the decommissioning plans (i.e. the initial decommissioning plan and the final decommissioning plan) throughout the lifetime of the facility.* *k) Preparing and submitting an initial decommissioning plan and its updates for review by the regulatory body.* *...* *l) Submitting a final decommissioning plan and supporting documents for review and approval by the regulatory body, in accordance with national regulations, in order to obtain an authorization to conduct decommissioning…"*
R26	**Recommendation: NEA should establish requirements for decommissioning for all facilities, including the selection of a decommissioning strategy, the preparation and maintenance of decommissioning plans, and the preparation of final decommissioning plans and supporting documents, commensurate with the radiation risks involved.**

In addition, neither the current legal and regulatory framework nor the draft RP(IR) Regulations contain provisions to ensure that exposure during decommissioning activities is considered as a planned exposure situation and that radioactive waste present in a facility after its permanent shutdown is removed prior to the conduct of decommissioning actions.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
Observation: *There are currently no regulations that require decommissioning activities to be considered as a planned exposure situation. This has been identified by NEA in the self-assessment.*	
(1)	**BASIS: GSR Part 6 Requirement 1 states that** *"Exposure during decommissioning shall be considered to be a planned exposure situation and the relevant requirements of the Basic Safety Standards shall be applied accordingly during decommissioning."*
R27	**Recommendation: NEA should make provisions in the regulatory framework that exposure during decommissioning activities is considered as planned exposure situations.**

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
Observation: *Currently, there are no requirements established in the legal and regulatory framework relating to the removal of radioactive waste present in a facility after its permanent shutdown prior to the conduct of decommissioning actions.*	
(1)	**BASIS: GSR Part 6 Requirement 14, para. 8.10 states that** *"If operational radioactive waste or nuclear fuel is present in the facility after its permanent shutdown, such material shall be removed prior to the conduct of decommissioning actions and shall be transported to an authorized facility in compliance with the applicable transport regulations..."*
R28	**Recommendation: NEA should require that if operational radioactive waste or nuclear fuel is present in the facility after its permanent shutdown, such material is removed and transported to an authorised facility prior to the conduct of decommissioning actions.**

9.5. REGULATIONS AND GUIDES FOR TRANSPORT

NEA has established Transport Regulations which are based upon the IAEA Regulations for the Safe Transport of Radioactive Material ST-1 1996 Edition. Therefore, the regulations should be amended in order to be in line with IAEA SSR-6, the 2018 Edition (Revision 1).

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
Observation: *The NEA has established Transport Regulations which are based upon the IAEA Regulations for the Safe Transport of Radioactive Material ST-1 1996 Edition. There is a need to amend these Regulations to be in line with SSR-6, the 2018 Edition. (Revision 1). The issue was identified in the self-assessment and is part of the Action Plan.*	
(1)	**BASIS: GSR Part 1 (Rev.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."*
R29	**Recommendation**: **NEA should amend the Transport Regulations to be in line with the International Atomic Energy Agency Regulations for the Safe Transport of Radioactive Material SSR-6 2018 Edition (Revision 1).**

NEA has not established the guidance on the transport of radioactive materials. **Related suggestion S9 is provided in Section 9.1.**

9.6. REGULATIONS AND GUIDES FOR OCCUPATIONAL EXPOSURE

General provisions are in place ensuring the need to provide and maintain, as far as is practicable, a working environment that is safe and without risks to health, for workers.

Regarding existing exposure situations, there are no regulations addressing exposure of workers involved in activities such as remedial actions, radon in workplaces or aircrews. For occupational exposure to radon in workplaces, the IRRS team was informed that a reference level of 1000 Bq/m^3 for radon is used in decision-making purposes, based on two studies previously carried out on radon concentrations, but this reference level has not been formalised in regulations nor in a protection strategy. Moreover, the IRRS team noted that these previous studies may not be representative and may not sufficiently highlight areas where a radon hazard could exist such as in poorly ventilated spaces or if there are specific locations of concern.

NEA also has not determined whether the assessment of the exposure of aircrew is warranted or not. Similarly, a framework for radiation protection that applies to individuals in space-based activities that is appropriate for the exceptional conditions of space has not been established, since Singapore does not conduct such activities.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
Observation: *(a) Although dose limits have been established, the limit for equivalent dose to the lens of the eye is 150 mSv per year and this not in agreement with Schedule III of GSR Part 3. Additionally, the special measures for protection of female workers that are in place are based on limiting the equivalent dose to the surface of the woman's abdomen to 2 mSv for the duration of the pregnancy and restricting intakes to a fraction of the annual limits on intake for workers, instead of ensuring that the embryo or fetus, or the breastfed infant is afforded the same broad level of protection as is required for members of the public. This was identified in the self-assessment and is part of the Action Plan.* *(b) There is currently no regulatory requirement for employers and authorised parties to cooperate to the extent necessary for compliance with the requirements for protection and safety. This was identified in the self-assessment and is part of the Action Plan.* *(c) The concept and requirements for controlled areas are not fully in line with requirements set in GSR Part 3. Furthermore, there are no requirements for classification of supervised areas, for explicit establishment of local rules. This was identified in the self-assessment and is part of the Action Plan* *(d) There are no regulations addressing exposure of workers due to existing exposure situations, such as remedial activities, radon in workplaces or aircrews. This was identified in the self-assessment and is part of the Action Plan* *(e) While the regulations establish that no person under 16 years can be subjected to occupational exposure, they also determine that no individual below the age of 18 years shall be engaged in radiation work. As such there are no arrangements for occupational exposure of persons between 16 and 18 years of age who are undergoing training. This was identified in the self-assessment and is part of the Action Plan.*	
(1)	**BASIS: GSR Part 3 Requirement 12, para. 3.26 states that** *"The government or the regulatory body shall establish and the regulatory body shall enforce compliance with the dose limits specified in Schedule III for occupational exposures and public exposures in planned exposure situations"*
(2)	**BASIS: GSR Part 3 Requirement 28, para. 3.114 states that** *"Notification of the employer by a female worker if she suspects that she is pregnant or if she is breast-feeding shall not be considered a reason to exclude the female worker from work. The employer of a female worker, who has been notified of her suspected pregnancy or that she is breast-feeding, shall adapt the working conditions in respect of occupational exposure so as to ensure that the embryo or fetus or the breastfed infant is afforded the same broad level of protection as is required for members of the public."*
(3)	**BASIS: GSR Part 3 Requirement 23, para. 3.85 states that** *"If workers are engaged in work that involves or that could involve a source that is not under the control of their employer, the registrant or licensee responsible for the source and the employer shall cooperate to the extent necessary for compliance by both parties with the requirements of these Standards."*
(4)	**BASIS: GSR Part 3 Requirement 24, states that** *"Employers, registrants and licensees shall establish and maintain organizational, procedural and technical arrangements for the designation of controlled areas and supervised areas, for local rules and for monitoring of the workplace, in a radiation protection programme for occupational exposure."*
(5)	**BASIS: GSR Part 3 Requirement 28, para. 3.116 states that** *"Employers, registrants and licensees shall ensure that persons under the age of 18 years are allowed access to a controlled area only under supervision and only for the purpose of training for employment in which they are or could be subject to occupational exposure or for the purpose of studies in which sources are*

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
	used."
(6)	**BASIS: GSR Part 3 Requirement 52, para. 5.26 states that** *"Employers shall ensure that the exposure of workers undertaking remedial actions is controlled in accordance with the relevant requirements on occupational exposure in planned exposure situations as established in Section 3."*
(7)	**BASIS: GSR Part 3 Requirement 52, para. 5.27 states that** *"The regulatory body or other relevant authority shall establish a strategy for protection against exposure due to 222Rn in workplaces, including the establishment of an appropriate reference level for 222Rn. The reference level for 222Rn shall be set at a value that does not exceed an annual average activity concentration of 222Rn of 1000 Bq/m3, with account taken of the prevailing social and economic circumstances."*
(8)	**BASIS: GSR Part 3 Requirement 52, 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."*
R30	**Recommendation:** • **NEA should update the existing regulations on dose limits and protection of female workers in line with GSR Part 3.** • **NEA should establish provisions to ensure employers and authorised parties cooperate to the extent necessary for compliance by all responsible parties with the requirements for protection and safety.** • **NEA should establish requirements for controlled areas and supervised areas, for explicit establishment of local rules, in a radiation protection programme for occupational exposure.** • **NEA should establish and enforce requirements for the occupational protection in existing exposure situations.** • **NEA should establish arrangements for occupational exposure of persons between 16 and 18 years of age who are undergoing training in which they are or could be subject to occupational exposure.**

9.7. REGULATIONS AND GUIDES FOR MEDICAL EXPOSURE

The RP(IR) Regulations and HCSA Service Regulations for nuclear medicine and radiological services require the licensee to make arrangements for radiation protection in cases where a female patient is pregnant. But there are no requirements in case she is breast-feeding. **Recommendation R21 in Section 9.1 addresses this issue.**

Diagnostic Reference Levels (DRLs) have not been established in Singapore for medical imaging and image guided interventional procedures. as well as dose constraints for carers, comforters and volunteers participating in a programme of biomedical research have not been established in Singapore. This issue was identified in the self-assessment.

NEA and MOH regulations do not include safety provisions for individuals incurring a medical exposure as carers or comforters and do not require the licensee to provide relevant information on radiation protection and radiation risks prior to their exposure.

Regarding the release of patients who are undergoing treatment with any sealed or unsealed source, RP(IR) Regulations requires that hospitalised patients must not leave the ward or treatment room without the approval of the radiologist in charge of the treatment. However, the regulations do not establish the criteria to the licensee apply to decide to release these patients.

The IRRS team observed that the following regulatory requirements related to the optimisation of protection and safety (i.e., operational considerations, calibration, diagnostic reference levels, quality assurance, dose constraints and dosimetry for patients) are not in line with the IAEA Safety Standards:

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
Observation: *(a) It is not required that a carer or comforter receive relevant information on radiation protection and radiation risks prior to providing care and comfort to an individual undergoing a radiological procedure. This was identified in the self-assessment and is part of the Action Plan.* *(b) A set of national diagnostic reference levels is not established and implemented for the optimisation of protection and safety. This was identified in the self-assessment and is part of the Action Plan.* *(c) There are no requirements to ensure the optimisation of protection and safety for medical exposure regarding operational considerations, calibration, dosimetry of patients, diagnostic reference levels and dose constraints, quality assurance.* *(d) The regulations do not specify criteria for the release of patients who have undergone therapeutic radiological procedures using unsealed sources or patients who still retain implanted sealed sources.* *(e) The regulations do not require medical physicists to be specialised in the appropriate area.* *(f) There are no requirements to ensure that all responsibilities delegated by the principal party with respect to medical exposure is documented.*	
(1)	**BASIS: GSR Part 3 Requirement 36, para. 3.153 states that** *Registrants and licensees shall ensure that no individual incurs a medical exposure as a carer or comforter unless he or she has received, and has indicated an understanding of, relevant information on radiation protection and information on the radiation risks prior to providing care and comfort to an individual undergoing a radiological procedure. Registrants and licensees shall ensure that the requirements specified in para. 3.173 are fulfilled for the optimization of protection and safety for any radiological procedure in which an individual acts as a carer or comforter.*
(2)	**BASIS: GSR Part 3 Requirement 34, para. 3.148 states that** *The government shall ensure, as part of the responsibilities specified in para. 2.15, that as a result of consultation between the health authority, relevant professional bodies and the regulatory body, a set of diagnostic reference levels is established for medical exposures incurred in medical imaging, including image guided interventional procedures. In setting such diagnostic reference levels, account shall be taken of the need for adequate image quality, to enable the requirements of para. 3.169 to be fulfilled. Such diagnostic reference levels shall be based, as far as possible, on wide scale surveys or on published values that are appropriate for the local circumstances.*
(3)	**BASIS: GSR Part 3 Requirement 38 states that** *Registrants and licensees and radiological medical practitioners shall ensure that protection and safety is optimized for each medical exposure.*
(4)	**BASIS: GSR Part 3 Requirement 34 states that:** *The government shall ensure that relevant parties are authorized to assume their roles and responsibilities, and that diagnostic reference levels, dose constraints, and criteria and guidelines for the release of patients are established.*
(5)	**BASIS: GSR Part 3 Requirement 34, para. 3.149 (b) states that** *"The government shall ensure that, as a result of consultation between the health authority, relevant professional bodies and the regulatory body, the following are established: (a)… (b)Criteria and guidelines for the release of patients who have undergone therapeutic radiological procedures using unsealed sources or patients who still retain implanted sealed sources."*
(6)	**BASIS: GSR Part 3 Requirement 40, para. 3.178 states that "***The radiological medical practitioner shall ensure that no patient who has undergone a therapeutic radiological procedure*

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
	with a sealed source or an unsealed source is discharged from a medical radiation facility until it has been established by either a medical physicist or the facility's radiation protection officer that: (a) *The activity of radionuclides in the patient is such that doses that could be received by members of the public and family members would be in compliance with the requirements set by the relevant authorities (para. 3.149(b)); and* (b) *The patient or the legal guardian of the patient is provided with:* (i) *Written instructions for keeping doses to persons in contact with or in the vicinity of the patient as low as reasonably achievable and for avoiding the spread of contamination;* (ii) *Information on the radiation risks.*
(7)	**BASIS: GSR Part 3 Requirement 35, para. 3.150 states that** *"The regulatory body shall ensure that the authorization for medical exposures to be performed at a particular medical radiation facility allows personnel (radiological medical practitioners, medical physicists, medical radiation technologists and any other health professionals with specific duties in relation to the radiation protection of patients) to assume the responsibilities specified in these Standards only if they:* *(a) Are specialized in the appropriate area; (b)...*
(8)	**BASIS: GSR Part 3 Requirement 36, para. 3.154 states that** *Registrants and licensees shall ensure that (a)…(f)* Any delegation of responsibilities by a principal party is documented.
R31	**Recommendation:** • **The regulatory body should establish requirement to ensure that all carers and comforters receive relevant information on radiation protection and the radiation risks prior to their exposure.** • **NEA in consultation with MOH and relevant professional bodies, should ensure that a set of national diagnostic reference levels is established.** • **The regulatory body should establish requirements for operational considerations, calibration, dosimetry of patients, diagnostic reference levels and dose constraints, quality assurance to ensure the optimisation of protection and safety.** • **The regulatory body should establish criteria for the release of patients who have undergone therapeutic radiological procedures using unsealed or sealed sources** • **The regulatory body should establish requirements to ensure that the medical physicists are specialized in the appropriate area.** • **The regulatory body should establish requirements to ensure that every licensee responsible for medical exposure document any delegation of responsibilities**

9.8. REGULATIONS AND GUIDES FOR PUBLIC EXPOSURE

Regarding public exposure, the current regulations do not:

- explicitly ensure consumer products are not made available to the public unless their use by members of the public has been justified and their provision to the public has been authorized. However, consumer products are not covered by exemptions even if they are below the exemption activity concentration or activity limits. As such there are provisions for providers of consumer products to be licensed, and specific exemptions are granted for products which could be used to allow NEA to ensure only justified products are permitted. This was identified in the self-assessment and is part of the Action Plan.
- require registrants and licensees to monitor public exposure (i.e., source and environmental monitoring) record the results made them available.

- allow for control of certain commodities and goods such as construction materials and feed.
- specify requirements for visitors to controlled and supervised areas. This includes the need for supervision, provision of information, and signage.
- include a requirement for a licence holder to optimise public exposure, only to ensure that prescriptive requirements are met.

The draft RP(IR) Regulations are expected to cover all the above issues. Furthermore, Recommendation R21 in Section 9.1 addresses this issue.

9.9. SUMMARY

NEA has established or adopted regulations, but it has established only a limited number of guides for safety. Areas for improvements are, inter alia:

- Guidance for facilities on the format and content of the documents to be submitted by the applicants in support of an application for a licence;
- Provisions for establishing and maintaining all necessary records and specifying the period of maintaining the records by the authorized parties;
- Update the regulations to include the establishment of dose constraints for public and occupational exposure,
- Provisions for the safety of disposal facilities and activities;
- Update the regulations to include the establishment of dose constraints for public and occupational exposure;
- Establishing safety requirements for the development of radioactive waste disposal facilities and activities in accordance with a graded approach;
- Provisions specifically for the safe decommissioning of all facilities based on a graded approach;
- Provisions in the regulatory framework that exposure during decommissioning activities is considered as planned exposure situations;
- Guide on how to meet the requirements of the establishment of transport regulations;
- Regulations and guides relating for occupational and public exposure; and
- Enact the amendment of the Radiation Protection (Ionizing Radiation) Regulations (RP(IR) Regulations).

With the promulgation of the regulatory amendments, the RP(IR) Regulations will address several of the remaining gaps and this will move Singapore’s legal and regulatory framework closer to full compliance with IAEA Safety Standards.

10. EMERGENCY PREPAREDNESS AND RESPONSE (EPR) – REGULATORY ASPECTS

10.1. AUTHORITY AND RESPONSIBILITIES FOR REGULATING ON-SITE EPR OF OPERATING ORGANIZATIONS

The functions and duties of the NEA are exercised via the Ionizing Radiation Control Department (IRCD) of the Regulation Division under the Radiation Protection and Nuclear Science Group (RPNSG). Sections 11(1)(v) and 12 of the NEA Act set out, broadly, the powers of NEA for the purpose of discharging its functions and duties related to radiation control, i.e., "to control and regulate the import, export, possession, storage, transportation, sale and use of radioactive materials and irradiating apparatus". However, the authority and responsibilities assigned to NEA to regulate the on-site EPR of operating organizations do not explicitly derive from the NEA Act. Under the Fire Safety Act Sections 37 and 38, designated operating organisations are required to provide Emergency Response Plan and set up company emergency response teams. Under the Fire Safety (Emergency Response Plan) Regulations, the owner or occupier of designated premises shall prepare an Emergency Response Plan according to the General Guidelines for Emergency Response Plan, prescribed by the Singapore Civil Defence Force (SCDF). The Guidelines detail the various measures and operational actions that need to be undertaken by the company in the event of any fire or other emergencies such as Hazmat (hazardous materials and items), including radiological incidents, that occur within the installation in order to minimize injury to personnel and damage to property.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
Observation: *While the authority and responsibilities assigned to SCDF to regulate EPR arrangements for designated premises are explicitly derived from the Civil Defence Act, the authority and responsibilities assigned to NEA to regulate the on-site EPR arrangements of operating organizations do not explicitly derive from NEA Act 2002.*	
(1)	**BASIS: Safety Fundamentals SF-1, para. 3.10 states that** *"The regulatory body must:* *— Have adequate legal authority, technical and managerial competence, and human and financial resources to fulfil its responsibilities; …".*
(2)	**BASIS: GSR Part 7, Requirement 2 states that** *"The government shall make provisions to ensure that roles and responsibilities for preparedness and response for a nuclear or radiological emergency are clearly specified and clearly assigned".*
R32	**Recommendation: The Government should provide, through the national legislative framework, the appropriate authority and responsibilities to NEA to regulate the on-site EPR arrangements of operating organizations.**

The existing legislative framework integrates some of the basic elements of exercising this authority only as concerns on-site EPR for the transport of radioactive materials, i.e. (a) through establishing regulations and guides; (b) verifying compliance of operating organizations against the regulatory requirements; (c) ensuring that the operator's emergency arrangements are submitted to the regulatory body for approval; and (d) evaluating some of exercises conducted by the operating organizations. The IRRS team noted that these elements do not apply for on-site EPR of operating organizations for any regulated facility or activity.

Operating organizations applying for an L6A (transport) licence are required to submit to NEA a Transport Emergency Response Plan (TERP) that details the various preventive measures and operational actions that are to be taken in case of an accident. The TERP is required to be kept up to date and NEA should be informed of any significant changes to the TERP. For other regulated facilities and activities not under the designated premises under the Fire Safety (Emergency Response Plan) Regulations, there are no arrangements in place requiring the operating organization to review and, as necessary, revise on-site EPR arrangements. With respect to Recommendation R33, paras 3.328 to 3.331 in GSG-13 provide relevant guidance on the issue.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
Observation: *Apart from transport activities and designated premises under Fire Safety (Emergency Response Plan) Regulations, arrangements requiring the operating organization for any other regulated facility or activity to establish, review and, as necessary, revise the emergency arrangements, specifying criteria and procedures, are not in place. This was identified in the self-assessment and is part of the Action Plan.*	
(1)	**BASIS: GSR Part 7 para. 4.11 states that** *"The government shall ensure that arrangements for preparedness and response to a nuclear or radiological emergency for facilities and activities under the responsibility of the operating organization are dealt with through the regulatory process".*
(2)	**BASIS: GSR Part 7 para. 4.13 states that** *"The regulatory body shall require that arrangements … be in place for the on-site area for any regulated facility or activity that could necessitate emergency response actions. Appropriate emergency arrangements shall be established by the time the source is brought to the site, and complete emergency arrangements shall be in place before the commencement of operation of the facility or commencement of the activity. The regulatory body shall verify compliance with the requirements for such arrangements".*
(3)	**BASIS: GSR Part 7 para. 4.26 states that** *"The government through the regulatory body shall ensure that operating organizations review appropriately and, as necessary, revise the emergency arrangements (a) prior to any changes in the facility or activity that affect the existing hazard assessment and (b) when new information becomes available that provides insights into the adequacy of the existing arrangements".*
R33	**Recommendation: NEA should:** • **require that arrangements for on-site EPR arrangements are in place for any regulated facility or activity that could necessitate EPR actions and that are other than transport activities and designated premises under Fire Safety (Emergency Response Plan) Regulations ;** • **verify through the regulatory process the compliance and adequacy against regulatory requirements of the on-site EPR arrangements of the operating organization; and** • **make arrangements to ensure that the operating organization reviews and, as necessary, revises the emergency arrangements**.

Currently no applicants other than for transport activities are required to submit an emergency plan providing for the prompt identification of an emergency and for determining the appropriate level of on-site emergency response. With respect to **Recommendation R34, paras 3.322 and 3.333-3.336 in GSG-13 provide relevant guidance on the issue.**

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
Observation: *There are not in place provisions for an applicant for a licence other than in transport activities to prepare an emergency plan. Hence, NEA does not provide approvals for such emergency plans nor does it verify that the on-site emergency arrangements are coordinated with, and/or integrated to, those of all other bodies with responsibilities for off-site emergency arrangements.*	
(1)	**BASIS: GSR Part 7 para. 4.14 states that** *"Before commencement of operation of the facility or commencement of the activity, the regulatory body shall ensure, for all facilities and activities under regulatory control that could necessitate emergency response actions, that the on-site emergency arrangements: (a) Are integrated with those of other response organizations, as appropriate; (b) Are integrated with contingency plans … and with security plans …; (c) Provide, to the extent practicable, assurance of an effective response to a nuclear or radiological emergency".*

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
(2)	**BASIS: GSR Part 7 para. 6.19 states that** *"The operating organization of a facility or for an activity in category I, II, III or IV shall prepare an emergency plan. This emergency plan shall be coordinated with those of all other bodies that have responsibilities in a nuclear or radiological emergency, including public authorities, and shall be submitted to the regulatory body for approval".*
R34	**Recommendation: NEA should ensure that the operating organization:** • **prepares an emergency plan;** • **makes provisions for coordinating and/or integrating, as applicable, this plan with those of all other bodies that have responsibilities in EPR, including those of other response organizations, as well as with operating organization's contingency plans and security plans; and** • **submits this plan to NEA for approval.**

The IRRS team noted that arrangements need to be in place for coordination with other authorities that may be impacted by the relevant judgements and decisions of NEA on response actions to be taken on the site and off the site when this responsibility lies with those other authorities.

Licensees' staff and radiation workers are required to be sufficiently qualified to safely handle radioactive materials and/or irradiating apparatus before authorization is given. There are some provisions under Regulation 13(2) of the RP(IR) Regulations requiring that an individual can register as a radiation worker only if has been adequately trained and well informed of the hazards associated with such work. However, there are currently no regulatory provisions related to the protection of emergency workers in an emergency. **Related Recommendation R38 is provided in Section 10.2.**

Currently, there are no provisions in place that allows NEA to verify whether the operating organizations maintain adequate human, financial and other resources, in view of their expected roles and responsibilities and the assessed hazards, in preparing for, and dealing with, a nuclear or radiological emergency, and to what extent the operating organizations identify the knowledge, skills and abilities necessary for their personnel to perform the EPR functions required. Also, there are no provisions in place to allow NEA to verify whether exercise programmes are developed, implemented and evaluated against pre-established objectives by the operating organizations to ensure that all specified functions required are performed for emergency response.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
Observation: *Apart from designated premises under Fire Safety (Emergency Response Plan) Regulations, currently, there are no provisions in place that allows NEA to verify whether any other operating organizations maintain adequate human, financial and other resources, in view of their expected roles and responsibilities in EPR. Also, there are no provisions in place to allow NEA to verify whether exercise programmes are developed, implemented and evaluated against pre-established objectives by any other operating organizations to ensure that all specified functions required for emergency response are performed.*	
(1)	**BASIS: GSR Part 7 para. 4.8 states that** *"The government shall ensure that personnel relevant for emergency response shall take part in regular training, drills and exercises to ensure that they are able to perform their assigned response functions effectively in a nuclear or radiological emergency".*
(2)	**BASIS: GSR Part 7 para. 6.30 states that** *"Exercise programmes shall be developed and implemented to ensure that all specified functions required to be performed for emergency response, all organizational interfaces for facilities in category I, II or III, and the national level programmes for category IV or V are tested at suitable intervals. … The exercises shall be systematically evaluated and some exercises shall be evaluated by the regulatory body. Programmes shall be subject to review and revision in the light of experience gained".*

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
R35	**Recommendation: NEA should ensure that, as concerns the operating organizations:** • **personnel relevant for EPR takes part in regular training, drills and exercises;** • **exercise programmes are developed and implemented to ensure that all specified functions required for emergency response are performed;** • **such exercises are systematically evaluated against pre-established objectives of emergency response to demonstrate that response actions can be performed effectively to achieve the goals of emergency response;** • **such exercise programmes are reviewed and revised in the light of experience gained; and** • **some of the exercises conducted are evaluated by NEA or other relevant bodies.**

Singapore has adopted various emergency plans at the whole-of-government (WOG) level (see Section 10.4) that are based on different emergency scenarios. This indicates that identification of hazards and the potential consequences of an emergency in Singapore has been carried out in the past. IRRS team was informed that hazard assessment at the national level is the area of responsibilities of the Ministry of Home Affairs.

Apart from designated premises under Fire Safety (Emergency Response Plan) Regulations, the IRRS team was not able to observe any arrangements made at the level of operating organizations, so that the magnitudes of hazards and the possible development of hazardous conditions are assessed initially and throughout a nuclear or radiological emergency, in order to promptly identify, characterize or anticipate, as appropriate, new hazards or the extent of hazards and to revise the protection strategy accordingly.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
Observation: *Various emergency plans at the whole-of-government (WOG) level have been adopted. No arrangements are made at the level of operating organizations, so that the magnitudes of hazards and the possible development of hazardous conditions are assessed initially and throughout a nuclear or radiological emergency.*	
(1)	**BASIS: GSR Part 7, Requirement 9 states that** *"The government shall ensure that arrangements are in place to assess emergency conditions and to take urgent protective actions and other response actions effectively in a nuclear or radiological emergency".*
(2)	**BASIS: GSR Part 7 para. 5.31 states that** *"Arrangements shall be made so that the magnitudes of hazards and the possible development of hazardous conditions are assessed initially and throughout a nuclear or radiological emergency in order to promptly identify, characterize or anticipate, as appropriate, new hazards or the extent of hazards and to revise the protection strategy".*
R36	**Recommendation: NEA should ensure that arrangements are in place so that the magnitudes of hazards and the possible development of hazardous conditions are assessed by operating organizations, initially and throughout a nuclear or radiological emergency, in order to promptly identify, characterize or anticipate, as appropriate, new hazards or the extent of hazards.**

10.2. REGULATIONS AND GUIDES ON ON-SITE EPR OF OPERATING ORGANIZATIONS

There are provisions stipulated under Regulation 50(1) in the current RP(IR) Regulations that require the licensee, the radiation safety officer or an appointed authorised officer by the licensee to take response actions. There are also provisions under the RP(TRM) Regulations on emergency response arrangements for the transport of radioactive material and for the operating organization to promptly take necessary actions on-site to mitigate the consequences of an emergency. No other regulations on on-site EPR exist.

Apart from a guide to L6A (transport) licence applicants that NEA has issued in the form of a template of the Transport Emergency Response Plan (TERP) and NEA RPNSG's internal response plans for each of the WOG response plans (see Section 10.4), no other guides for on-site EPR arrangements for licence applicants are in use. The existing TERP template also does not specifically require licensees to include emergency arrangements that take into account the potential for other dangerous goods to be present or formed as a result of an accident.

The IRRS team was informed that NEA plans to develop such guides in future and intends to apply a graded approach in regulating EPR, reviewing EPR plans and examining the EPR plans periodically during regulatory inspections. With respect to Recommendation R38, para. 3.327 in GSG-13 provides relevant guidance on the issue.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
Observation: *Apart from the transport regulations and the TERP template, there is lack of regulations and guides on on-site EPR arrangements of the operating organizations other than those designated premises under Fire Safety (Emergency Response Plan) Regulations. This was identified in the self-assessment and is part of the Action Plan.*	
(1)	**BASIS: GSR Part 7 para. 4.5 states that** *"The government shall make adequate preparations to anticipate, prepare for, respond to and recover from a nuclear or radiological emergency at the operating organization, local, regional and national levels… These preparations shall include adopting legislation and establishing regulations for effectively governing the preparedness and response for a nuclear or radiological emergency at all levels…".*
(2)	**BASIS: GSR Part 7 para. 4.12 states that** *"The regulatory body is required to 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. These regulations and guides shall include principles, requirements and associated criteria for emergency preparedness and response for the operating organization".*
R37	**Recommendation: NEA should establish regulations and guides on on-site EPR arrangements of the operating organizations, following a graded approach, to specify the principles, requirements and associated criteria for safety for the operating organizations and ensure that these are reviewed or revised, as necessary, and kept up to date.**

Moreover, the IRRS team was informed that NEA is in the process of developing an internal guide for the review of L6A licence applications. As part of the proposed guide, NEA will request the licensee to provide their TERP for review whenever an amendment of application is submitted to ensure that all information within the document is up to date. No other internal guides for NEA personnel have been issued, however the IRRS team was informed that it is NEA's intention to issue further such guides for regulatory staff in future. This has been identified in the self-assessment and is part of the Action Plan. The need for NEA to develop within its management system internal guidance on the processes and procedures to be followed to carry out regulatory functions, including on-site EPR arrangements for facilities and activities of the operating organizations, in an effective and efficient manner, is addressed in **Recommendation R8 in Section 4.5**. With respect to this **Recommendation, paras 3.72, 3.191, 3.192, 3.262, 3.263, 3.312 and 3.337 in GSG-13 provide relevant guidance on the issue**.

The IRRS team also noted that the national policy and strategy for radioactive waste management, referred to under Section 1.7, does not apply for radioactive waste generated in a nuclear or radiological emergency.
Related Recommendation R5 is provided in Section 1.7.

10.3. VERIFYING THE ADEQUACY OF ON-SITE EPR OF OPERATING ORGANIZATIONS

Apart from the transport of radioactive materials and designated premises under Fire Safety (Emergency Response Plan) Regulations, the regulatory body (RB) does not verify the arrangements of operating organizations for EPR for the on-site area for any other regulated facility or activity that could necessitate emergency response actions. NEA reviews the TERP prior to the issuance of the licence for adequacy of information provided and robustness of plan based on a graded approach. NEA verifies that the TERP is kept up to date and that NEA is kept informed of any significant changes to the TERP during the submission of licence amendment applications, or on an ad-hoc basis such as when licensees intend to transport Category 1 radioactive sources**. Related Recommendation R33 is provided in Section 10.1.**

10.4. ROLES OF THE RB IN A NUCLEAR OR RADIOLOGICAL EMERGENCY

Singapore has adopted a Homefront Crisis Management Structure. Singapore has developed three WOG inter-agency emergency response plans, each one of which addresses a different nuclear or radiological emergency scenario and documents the procedures and other arrangements to effectively execute expected emergency response roles and responsibilities. The role of NEA is defined under each national inter-agency emergency plan, as following:

- Large-scale Nuclear or Radiological Emergency: to provide technical advice, assess the emergency, monitor the radioactivity levels in the environment, carry out decontamination and advise whether the site of emergency can be declared as safe;
- Nuclear Power Plant Response Plan (For overseas nuclear power plant incidents not in the vicinity): to coordinate inter-agency response, conduct radiation monitoring and advise Crisis Management Group (Environment) and Homefront Crisis Executive Group (HCEG) on radiation protection; and
- Response Plan for Stolen or Lost Radioactive Source Incidents (smaller scale incidents): to provide technical advice, gather facts from licensees and search to locate source; identify non-compliances if any, file incident reports, issue joint media release with Singapore Police Force (SPF) and support radiation monitoring.

NEA has been defined as the Incident Manager for the Nuclear Power Plant Response Plan (for overseas nuclear power plant incidents not in the vicinity), while for the Large-scale Nuclear or Radiological Emergency the Incident Manager is the Singapore Civil Defence Force (SCDF). The IRRS team was informed that the plans are binding for NEA, since the Ministry of Sustainability and Environment is the Ministry responsible for NEA also leads the Crisis Management Group. NEA's RPNSG has established its own internal response plans for each WOG response plan. NEA has set out and incorporated in its response plans relevant intervention levels in compliance with GSR Part 7 and GSG-2.

NEA's RPNSG has developed:

- a set of criteria, in terms of (a) operations plans, (b) manpower and (c) system/equipment, for different types of nuclear or radiological emergency in order to assess its readiness in EPR; and
- an associated workplan of activities to ensure that the various roles and responsibilities within RPNSG are effectively executed in order to meet the criteria set.

NEA can access local technical expertise, through the Advisory Committee on Radiation Protection and Nuclear Science, comprising representatives from government agencies, local industry and academia, to provide advice, among others, in EPR planning to deal with possible radiological or nuclear incidents or fallout affecting Singapore.

Under NEA RPNSG's organization structure, there is a dedicated EPR team (Radiological Incident Management Branch under the Nuclear Science and Technology Department), which regularly reviews and enhances the internal response plans, maintains the EPR equipment and tools, and arranges or runs training sessions to ensure that officers from RPNSG and other supporting divisions have the necessary capabilities. The IRRS team was informed that reviews, revisions and enhancement of internal response plans are carried out sporadically, for instance when new IAEA safety standards are published or to integrate lessons learnt after exercises, however no documented criteria and procedures have been established to trigger the initiation of such a review, update or revision.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
Observation: *Reviews, updates or revisions of NEA's internal response plans are carried out, however this is not carried out periodically and there are no criteria and procedures in place that would trigger such a review, update or revision, as appropriate.*	
(1)	**BASIS: GSR Part 7 para. 6.18 states that** *"The appropriate responsible authorities shall ensure that: … (e) Emergency plans and procedures are periodically reviewed and updated".*
(2)	**BASIS: GSR Part 7 para. 6.36 states that** *"Arrangements shall be made to maintain, review and update emergency plans, procedures and other arrangements and to incorporate lessons from research, operating experience (such as in the response to emergencies) and emergency exercises".*
S11	**Suggestion: NEA should consider establishing within its management system arrangements to maintain and periodically review, update or revise, as appropriate, emergency plans, procedures and other arrangements, including establishing criteria to trigger their review, update or revision.**

NEA has set up an environmental sampling programme through its National Radiochemistry Laboratory (NRL) (operational since 2018) and the Ambient Radiation Monitoring Network (ARMNet) (commissioned in 2019), which formulate Singapore's baseline on monitoring radiation in the environment and also acting as the early warning system of the country in case of a nuclear or radiological emergency. ARMNet comprises a network of 40 real-time air and water radiation monitoring stations deployed across Singapore, equipped with automatic continuous analysers, and measures a range of radiological parameters in the environment.

A training and building capacity programme for regulatory staff has been put in place. A WOG exercise under the inter-agency radiological emergency plan was held in 2019, testing effective communication and clear understanding of the roles and functions of response organizations. The IRRS team was informed that such exercises are conducted every 2-3 years. One of the criteria for readiness is that personnel have to participate in at least one Tabletop Exercise (TTX) or Ground Deployment Exercise (GDX) to engage on NEA's plans and competency, in order to achieve staff's operational capability. NEA also participates in IAEA ConvEx exercises.

The IRRS team was demonstrated a detailed exercise programme based on NEA's internal plans up to 2025. NEA conducts, under its internal plans, one major exercise per year on average. NEA sets up pre-established objectives to evaluate its own performance against exercises to identify where and what further improvements are necessary in its emergency arrangements. However, as described in Sections 10.1, 10.2 and 10.3, operational EPR interfaces between operating organizations (apart from designated premises under Fire Safety (Emergency Response Plan) Regulations), NEA, and authorities responsible for the response to conventional emergencies and to nuclear security events, have not been developed and coordinated.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
Observation: *No arrangements have been developed for the coordination of EPR and of protocols for operational interfaces between operating organizations (apart from designated premises under Fire Safety (Emergency Response Plan) Regulations), NEA, and other authorities responsible for the response to conventional emergencies and to nuclear security events.*	
(1)	**BASIS: GSR Part 7, Requirement 22 states that** *"The government shall ensure that arrangements are in place for the coordination of preparedness and response for a nuclear or radiological emergency between the operating organization and authorities at the local, regional and national levels, and, where appropriate, at the international level".*

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
(2)	**BASIS: GSR Part 7 para. 6.12 states that** *"Arrangements shall be developed, as appropriate, for the coordination of emergency preparedness and response and of protocols for operational interfaces between operating organizations and authorities at the local, regional and national levels, including those organizations and authorities responsible for the response to conventional emergencies and to nuclear security events…".*
R38	**Recommendation: The Government should make arrangements to ensure that operational EPR interfaces between operating organizations and other authorities are developed and coordinated, as appropriate.**

Resources are made available to ensure that NEA maintains its capability to fulfil its responsibilities in EPR. NEA carries out capacity building activities for its personnel and the personnel of other response organizations, through hosting EPR-related training courses and workshops and in cooperation with IAEA's Technical Cooperation and the European Commission, intending among others to the development of a regional radiological data exchange database and EPR framework in South East Asia and to culminate in more harmonized emergency plans, decision making and response measures between ASEAN Member States. Singapore has also collaborated through ASEANTOM with the US Department of Energy to enhance ASEAN Member States' capabilities to prevent, counter and respond to acts of radiological and nuclear terrorism. Moreover, Singapore initiated the establishment of, and participates in, the five dedicated technical working groups (TWGs) since July 2021 under ASEANTOM, to develop a structured approach for capacity-building development in specific areas that would better prepare ASEAN to handle nuclear and/or radiological incidents in the future. Singapore also collaborates with IAEA to build regional capacity that considers EPR harmonization under the Singapore-IAEA Third Country Training Programme (TCTP). Singapore's active involvement in promoting international and regional cooperation on EPR and in strengthening Singapore's and regional preparedness for nuclear or radiological emergencies is considered by the IRRS team as a notable practice.

10.5. SUMMARY

Arrangements addressing the regulatory aspects of on-site EPR of operating organizations are in place in Singapore, nevertheless the IRRS team identified areas of potential improvements to ensure compliance with the IAEA safety standards:

- The authority and responsibilities assigned to NEA to regulate the on-site EPR arrangements of operating organizations are not explicitly derived from the legislative framework.
- Apart from transport activities and designated premises under Fire Safety (Emergency Response Plan) Regulations, NEA does not require submission of on-site EPR plan hence, do not verify through the regulatory process the compliance of the on-site EPR.
- Operating organizations are not required to assess the magnitudes of hazards and the possible development of hazardous conditions.
- NEA has not set out criteria and procedures for the review, update or revision of its internal emergency plans, procedures and other arrangements.
- Apart from designated premises under Fire Safety (Emergency Response Plan) Regulations, there are no arrangements for the coordination of EPR and of protocols for operational interfaces between operating organizations, NEA, and other authorities responsible for the response to conventional emergencies and to nuclear security events.
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The IRRS team acknowledges Singapore's active involvement in promoting international and regional cooperation on EPR and in strengthening Singapore's and regional EPR as a notable practice.

11. POLICY ISSUES

The policy issue discussions took place on 14 October 2022. Representatives from NEA and MOH participated in the discussions with the IRRS team.

The focus was regulation of medical exposure, and the objective from the host was to seek views on regulatory approaches adopted in other countries of similar circumstances or with similar institutional arrangements and best practices.

In Singapore, NEA is the national authority for radiation protection, while the healthcare sector is regulated by the MOH. As such, NEA and MOH are both involved in regulatory control of medical exposure, and there are areas where a need to identify the agency to take the lead has been identified.

The main areas where inputs from the IRRS team was requested were:

- Education and training of health professionals in use of radiation on patients
- Development and implementation of diagnostic reference levels (DRLs)
- Justification of medical exposure

Background information on the two national authorities and their responsibilities as well as on the three topics was provided as part of the ARM material.

Education and training of health professionals in use of radiation on patients.

The two main issues identified were 1) establishing and implementing the requirements for education and training of non-radiological specialists and 2) approaches in regulating health professionals using radiation sources in general. The experts shared the following information:

- Publication no. 175 in the European Commission's Radiation Protection series, 'Guidelines on radiation protection education and training of medical professionals in the European Union', provides guidelines on training for a range of different health professionals, including for nurses and other healthcare workers not directly involved in the use of ionizing radiation. For all groups of health professionals, learning outcomes are given in terms of knowledge, skills and competences.
- Both ILO and IAEA recommends recognition of medical physicists as health professionals.
- From several countries, the need for both academic courses as well as residency in hospitals as part of the education of medical physicists was stressed. Similarly, accreditation from national organizations is seen as important, and in general cooperation with professional bodies is encouraged.
- Continuous education, especially with focus on new technologies, is important and should be a requirement in regulations. Continuous education should be focused on the needs of the health professionals, and the needs should be assessed regularly to ensure, that the topics covered are relevant and provides new insights.
- One example was provided of a regulator having developed online training modules for health professionals not working primarily with radiation. Occupational exposure was the primary focus, but patient protection was also included.
- Inspections should include checking for compliance with requirements for training and continuous education.

Development and implementation of diagnostic reference levels (DRLs)

Singapore does not have any DRLs established, and there are no plans yet to establish these. The authorities are seeking information on the approach taken by other countries in the process of establishing DRLs. The following information was shared by the experts:

- An example was presented, where the application of DRLs has been a driver for optimisation of patient doses, and a lowering of the average level of patient doses as well as a narrowing of the distribution of doses between different hospitals has been observed.
- For starting the process of establishing DRLs, the following general advice was provided:
- Selecting only a few representative types of examinations, preferably well-defined including the indication for the examination, is a good starting point.
- Liaisons with different groups of health professionals in the hospitals is essential, as these groups will be instrumental in the collection of the data on patient doses.
- For initial more simple data collections, providing templates is very valuable, while more advanced systems are very useful at later stages.
- Careful assessment and analysis of the collected data is important for setting meaningful DRLs
- After DRLs have been established, dialogue about optimisation of patient doses, for instance during inspections, may be initiated through dialogue of measured patient doses compared to DRLs.
- At a later stage, when processes are well established, DRLs for more challenging areas such as interventional radiology and examinations of children can be established.
- It should be remembered, that setting DRLs is a continuous process, where review of DRL values is very important, as techniques and equipment evolves over time. Review may be necessary every 3-5 years.
- Typically the actual setting of DRLs is done by the regulatory body, but involvement of health authorities is advisable
- Guidance on the process may also be obtained from the IAEA website, where both a training course and a recording of a recent webinar are available.

Justification of medical exposure

In Singapore, there is a requirement for a referral for all medical exposure, but no national referral guidelines exist, and there are no requirements for using international referral guidelines. There are no requirements for consultation between referrer and the radiological medical practitioner. More detailed information was provided in the background document and based on this, the experts' assessment and guidance was requested, and the following was provided:

- It was recognised that justification is a key issue, and an issue where guidance is often needed.
- The Heads of the European Radiological Protection Competent Authorities (HERCA) have also addressed the topic, and a position paper has been issued, which may be found on the HERCA website.
- In the European Union, the availability of referral guidelines is increasing, and a number national guidelines have been developed, while there is also recognition of the fact that development and maintenance of referral guidelines is a very large task. The iGuide system, an evidence based system developed by European Society of Radiology containing also decision support, is being adopted in several countries.
- An area that is becoming increasingly important is justification of asymptomatic individuals, not only in general screening programs, but also as part of more individualized health assessments.
  Clinical audit is an important tool to follow-up on justification.

APPENDIX I – LIST OF PARTICIPANTS

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GROUP PHOTO

APPENDIX II – MISSION PROGRAMME

IRRS MISSION TO SINGAPORE

10-19 October 2022

MISSION PROGRAMME

SINGAPORE IRRS MISSION PROGRAMME, 9 to 19 October 2022		
Sunday 9 October 2022 2018		
Initial IRRS Review Team Meeting		
13:00 - 18:30	See Initial Team Meeting Agenda	Venue: Royal Plaza on Scotts (25 Scotts Road, Singapore 228220) Hotel meeting room - Claymore Room, Level 2 Participants: the IRRS team + the LO
Monday 10 October 2022		
IRRS Entrance Meeting		
08:45 – 11.00	See Entrance Meeting Agenda	Venue: NEA, 40 Scotts Road, Environment Building, Level 25 MSE Hall, Function Room 1 Participants: Government Official, NEA Management and staff, Officials from relevant organizations, the IRRS team + the LO

SINGAPORE IRRS MISSION PROGRAMME, 9 to 19 October 2022		
11:00 – 17:00	Interviews and Discussions with Counterparts (parallel discussions) with the break for standing lunch from **12:00 to 13:00**	Venue: NEA, 40 Scotts Road, Environment Building, Level 25 MSE Hall (see IRRS interviews schedule) Participants: IRRS team + Counterparts
17:00 - 18:00	Daily IRRS Review Team meeting	Venue: NEA, 40 Scotts Road, Environment Building, Level 25 MSE Hall, Function Room 2 Participants: the IRRS team + the LO
20:00- 24:00	Writing the report	IRRS team
Tuesday 11 October 2022		
Daily Discussions / Interviews		
09:00 – 17:00	Interviews and Discussions with Counterparts (parallel discussions)	Venue: NEA, 40 Scotts Road, Environment Building, Level 25 MSE Hall (see IRRS interviews schedule) Participants: IRRS team Reviewers + Counterparts
12:00 – 13:00	Lunch	
17:00 – 18:00	Daily IRRS Review Team meeting. Preliminary findings discussions	Venue: NEA, 40 Scotts Road, Environment Building, Level 25 MSE Hall, Function Room 2 Participants: the IRRS team + the LO

SINGAPORE IRRS MISSION PROGRAMME, 9 to 19 October 2022		
18:30-	Writing the report	IRRS Team
IRRS MISSION PROGRAMME		
Wednesday 12 October 2022		
Daily Discussions / Interviews		
09:00 – 15:00	Interviews for the IRRS Team members who do not participate in the site visits	Venue: NEA, 40 Scotts Road, Environment Building, Level 25 MSE Hall (see IRRS interviews schedule) Participants: IRRS Team Reviewers + Counterparts
09:00 – 15:00	Site Visits to observe inspections	NEA Inspectors and IRRS Team Members for Modules 5-9
15:00 – 16:00	Report drafting	IRRS Team Members
12:00 – 13:00	Lunch	
16:00 16:00 – 17:00	Deliver First draft of written preliminary findings Rs, Ss and GPs to be complied to report to the Administrative Assistant (AA) AA compiles and disseminates preliminary findings	IRRS Team AA

SINGAPORE IRRS MISSION PROGRAMME, 9 to 19 October 2022		
17:00 – 18:00 extended as needed	Quick briefing on site visits Daily IRRS Review Team meeting: discussion of findings (Rs, Ss and GPs)	Venue: NEA, 40 Scotts Road, Environment Building, Level 25 MSE Hall, Function Room 2 After 18:00 – Hotel meeting room - Claymore Room, Level 2 Participants: the IRRS Team + the LO
20:00- 24:00	Writing the report	
Thursday 13 October 2022		
Daily Discussions / Interviews		
9:00 -16:00	Follow-up Interviews and Discussions with Counterparts (parallel discussions), as appropriate	Venue: NEA, 40 Scotts Road, Environment Building, Level 25 MSE Hall (see IRRS interviews schedule) Participants: the IRRS Team + Counterparts
9:00 – 11:00	Meeting with the MOH representatives	Venue: NEA, 40 Scotts Road, Environment Building, Level 25 MSE Hall, Function Room 1 Participants: M1 Reviewer supported by M5-9 Reviewer for medical Sources, M5-9 Reviewer for medical exposure, Team Leader
12:00 – 13:00	Lunch	

SINGAPORE IRRS MISSION PROGRAMME, 9 to 19 October 2022		
16:00 – 18:00 extended as needed	Daily Team Meeting: • Briefing from site visits • Discussion of findings – feedback from discussion with Counterparts	Venue: NEA, 40 Scotts Road, Environment Building, Level 25 MSE Hall, Function Room 2 After 18:00 – Hotel meeting room - Claymore Room, Level 2 Participants: IRRS Team + the LO
Friday 14 October 2022		
Daily Discussions / Interviews		
09:00 – 15:00	Follow up interviews and discussion of the report text with counterparts	Venue: NEA, 40 Scotts Road, Environment Building, Level 25 MSE Hall (see IRRS interviews schedule) Participants: IRRS Team + Counterparts
09:00 – 12:00	AA and TC writes ab introductory part	TC + AA
12:00 -13:00	Lunch	
13:00 – 15:00	Follow-up interviews if necessary /Report preparation	Venue: NEA, 40 Scotts Road, Environment Building, Level 25 MSE Hall, Function Room 2 Participants: IRRS Team

SINGAPORE IRRS MISSION PROGRAMME, 9 to 19 October 2022		
15:00 – 17:00	Policy issue discussion	Venue: NEA, 40 Scotts Road, Environment Building, Level 25 MSE Hall, Function Room 1 Participants: Reviewers and Counterparts
17:00 – 18:00 Extended as needed	Daily Team Meeting: Finalization of the findings' "boxes": observations, basis, R/S/GP	Venue: NEA, 40 Scotts Road, Environment Building, Level 25 MSE Hall, Function Room 2 After 18:00 – Hotel meeting room - Claymore Room, Level 2 Participants: IRRS Team + LO
Saturday 15 October 2022		
09:00 – 11:00	Individual report inputs finalizing and submission to AA	Venue: Royal Plaza on Scotts (25 Scotts Road, Singapore 228220) Hotel meeting room - Claymore Room, Level 2 Participants: IRRS Team
11:00 – 12:00	AA complies the report	-'-
12:00 – 13:00	Lunch	-'-
13:00 – 18:00	Cross reading and report editing	-'-
18:00 – 22:00	Tl, TC, "editors" and AA continue to edit the report	Participants: TL, TC, AA and 'editors'
Sunday 16 October 2022		

SINGAPORE IRRS MISSION PROGRAMME, 9 to 19 October 2022		
09:00	IRRS Team rest day and Social Event	
Monday 17 October 2022		
Report commenting and discussions		
09:00 – 11:00	TL, TC, AA and 'editors' finalise the report	Venue: NEA, 40 Scotts Road, Environment Building, Level 25, MSE Hall, Function Room 2 Participants: IRRS Team
11:00	Submission of draft report to NEA	
11:00 – 18:00	TL, TC draft executive summary	Venue: NEA, 40 Scotts Road, Environment Building, Level 25, MSE Hall, Function Room 2 Participants: TL, TC
Tuesday 18 October 2022		
Report reviewing and finalization		
09:00 – 10:00	TL, TC draft exit presentation and coordinate press release preparation	Venue: NEA, 40 Scotts Road, Environment Building, Level 25, MSE Hall, Function Room 2 Participants: TL, TC
10:00 – 11:00	Collecting feedback on the IRRS process and IAEA standards	Venue: NEA, 40 Scotts Road, Environment Building, Level 25, MSE Hall, Function Room 2 Participants: IRRS Team Participants: IRRS Team

SINGAPORE IRRS MISSION PROGRAMME, 9 to 19 October 2022		
11:00 11:00 – 12:00	NEA submits written comments IRRS Team reviews NEA comments individually	Venue: NEA, 40 Scotts Road, Environment Building, Level 25, MSE Hall, Function Room 2 Participants: IRRS Team Participants: IRRS Team
12:00- 13:00	Lunch	
13:00- 16:00	IRRS team revises report online	Venue: NEA, 40 Scotts Road, Environment Building, Level 25, MSE Hall, Function Room 2 Participants: IRRS Team
16:00 – 18:00	Discussion with Hosts on findings, if required	Venue: NEA, 40 Scotts Road, Environment Building, Level 25, MSE Hall, Function Room 2 Participants: IRRS Team, LO, Counterparts, NEA management
18:00 – 19:30	Report editing and executive summary finalization	Venue: Hotel Participants: TL, TC
19:30 – 22:00	Official dinner	TBD
Wednesday 19 October 2022		
IRRS mission exit meeting		

SINGAPORE IRRS MISSION PROGRAMME, 9 to 19 October 2022		
10:00 -12:00	• Main findings of the IRRS mission (Team Leader) • Remarks by NEA in response to the mission findings • Closing remarks by IAEA Official IAEA press release	Venue: NEA, 40 Scotts Road, Environment Building, Level 25 MSE Hall, Function Room 1 Participants: Government officials, NEA management and staff, officials from relevant organisations, the IRRS Team + LO
12:00- 13:00	Lunch	

APPENDIX III – SITE VISITS

Information on site visits (12 October 2022)

NEA has arranged observation by IRRS team members of the 2 inspections: to industrial facility and to the medical facility. As Singapore does not have facility specifically authorised for radioactive waste predisposal management, a visit was organised to the radioactive waste and disused sources storage facility operated by NEA that is located at the medical facility's site.

	Site visit (industrial facility)	**Site visit: (medical facility and NEA storage site)**
Location	Setsco Services Pte Ltd 531 Bukit Batok Street 23, Singapore 659547	Singapore General Hospital Block 2 Basement 1, Singapore 169078

APPENDIX IV – LIST OF COUNTERPARTS

	IRRS EXPERTS	Lead Counterpart	Support Staff
1.	**LEGISLATIVE AND GOVERNMENTAL RESPONSIBILITIES**		
	Kavita Murthy	Kok Kiat ANG	
2.	**GLOBAL NUCLEAR SAFETY REGIME**		
	Kavita Murthy	Jingwei TEH	
3.	**RESPONSIBILITIES AND FUNCTIONS OF THE REGULATORY BODY**		
	Igor Osojnik	Kok Kiat ANG	
4.	**MANAGEMENT SYSTEM OF THE REGULATORY BODY**		
	Elizabeth Zoltanne Bodis	Chye Peng ANG	
5-9	**RADIATION SOURCES**		

	IRRS EXPERTS	Lead Counterpart	Support Staff
	Sotiris Economides Hanne N. Waltenburg	Darren KOH	Chiang Yap CHAI Gabriel YEAP
5-9	**WASTE MANAGEMENT AND DECOMMISSIONING**		
	Heidar Gharbieh	Wee Teck HOO	
5-9	**TRANSPORT**		
	Paul Hinrichsen	Kia Seng CHIA	
5-9	**MEDICAL EXPOSURE**		
	Flavia Cristina da Silva Teixeira	Samantha TEO	Bee Tin CHEW Gek Hong TAN Simin ZENG Jie Han FOO
5-9	**OCCUPATIONAL EXPOSURE**		
	Pedro Rosário	Kiat Huei YEO	
5-9	**PUBLIC EXPOSURE**		
	Chris Nickel	Wendy SU	

	IRRS EXPERTS	Lead Counterpart	Support Staff
10.	**EMERGENCY PREPAREDNESS AND RESPONSE**		
	Michael Tzortzis	Chye Peng ANG	

APPENDIX V – RECOMMENDATIONS (R), SUGGESTIONS (S) AND GOOD PRACTICES (GP)

AREA	R: Recommendations S: Suggestions G: Good Practices	Recommendations, Suggestions or Good Practices
1. LEGISLATIVE AND GOVERNMENTAL RESPONSIBILITIES	R1	The Government should establish a national policy and strategy for safety.
	R2	The Government should establish a regulatory framework for safety for existing exposure situations.
	R3	The Government should make provision for the effective coordination of the NEA's and MOH's regulatory activities, to avoid any omissions or undue duplication and to avoid conflicting requirements being placed on authorized parties
	S1	NEA should consider coordination of its activities with other authorities and should set up appropriate formal mechanisms for cooperating and sharing information so as to avoid potentially conflicting or overlapping requirements and duplication.
	R4	The Government should establish a national policy and strategy and, an appropriate legal and regulatory framework for the management of radioactive waste, including disused radioactive sources and radioactive waste generated during decommissioning and in a nuclear or radiological emergency, and should make appropriate financial provisions for decommissioning and the predisposal management and disposal of radioactive waste.
	S2	The Government should consider ensuring that radiation protection training programs are established for all parties having responsibilities in relation to the safety of facilities and activities.
	R5	The Government should ensure that NEA is empowered to authorise technical services that have significance to safety
	S3	The Government should consider acceding to the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management.

AREA	R: Recommendations S: Suggestions G: Good Practices	Recommendations, Suggestions or Good Practices
2. RESPONSIBILITIES AND FUNCTIONS OF THE REGULATORY BODY	R6	NEA should ensure that there is a clear separation between the Regulation Division and the any division with assigned responsibility for any activity subject to regulatory oversight under the Radiation Protection Act.
	R7	NEA should ensure enough qualified and competent staff, commensurate with the nature and the number of facilities and activities to be regulated and, with allocation of human resources commensurate with the radiation risks associated with facilities and activities
	S4	NEA should consider publishing information on exposure due to radon and associated health risks.
3. MANAGEMENT SYSTEM OF THE REGULATORY BODY	R8	NEA should ensure that all processes relevant to safety are identified, developed and documented in the management system using graded approach, and make provision to identify any changes that could have significant implications for safety.
4. AUTHORIZATION	R9	NEA should authorize all facilities. Authorization for a facility should include authorization of the activities taking place at the facility.
	R10	NEA should ensure that any person or organization intending to operate a facility or to conduct an activity shall submit to the NEA a notification and, as appropriate, an application for authorization (registration or licensing) based on graded approach.
	R11	NEA should ensure that different types of authorizations are obtained for the different stages in the lifetime of a facility or the duration of an activity, according to graded approach.

AREA	R: Recommendations S: Suggestions G: Good Practices	Recommendations, Suggestions or Good Practices
	R12	NEA should ensure that, • the applicant submits a safety assessment prior to the granting of an authorization; • the safety assessment is periodically reviewed and updated according to the graded approach; • operating organizations, according to the graded approach, carry out an independent verification of the safety assessment before it is used by the operating organization or submitted to NEA.
	R13	NEA should establish appropriate provisions to ensure that only justified practices are authorized
	S5	NEA should consider establishing a process for authorizing the provision to the public of the consumer product.
	R14	NEA should establish or approve facility-specific authorized limits for discharges.
5. REVIEW AND ASSESSMENT	R15	NEA should review decommissioning plans for all facilities requiring decommissioning using a graded approach, and should perform regulatory review of updated plans and approve final decommissioning plans, supported by safety assessments developed by the licensee.
	R16	The regulatory body should set reference levels for commodities other than drinking water.
	S6	The Government should consider ensuring that a representative radon survey is conducted to identify areas expected to have high concentrations of radon indoors
6. INSPECTION	S7	NEA should consider further developing its inspection programme to encompass all regulated facilities and activities, in accordance with graded approach.
	R17	The Government should establish provision allowing inspectors free access to any facility or activity at any time, within appropriate constraints for safety.

AREA	R: Recommendations S: Suggestions G: Good Practices	Recommendations, Suggestions or Good Practices
	R18	NEA should forward the results of inspections to the inspected licensee, even in cases where no non-conformances have been identified and use the results of inspections as feedback information for the regulatory processes.
	R19	NEA should make arrangements for and should implement the inspection and review of the decommissioning actions to ensure that they are arried out in accordance with the final decommissioning plan and associated safety assessment, and the authorization for decommissioning and licence conditions.
	R20	NEA should review, approve and publish or should make available on request, as appropriate, results from source monitoring and environmental monitoring programmes and assessments of doses from public exposure.
7. ENFORCEMENT	S8	NEA should consider extending the Enforcement Policy to include a comprehensive list of non-compliances.
8. REGULATION AND GUIDES	S9	NEA should consider further developing or adopting guides for safety.
	R21	NEA should enact the amendment of the Radiation Protection (Ionizing Radiation Regulations (RP(IR) Regulations).
	S10	The regulatory body should consider making provisions for: • establishing and maintaining all necessary records by the regulatory body and authorized parties for all facilities and activities, and • specifying the period of maintaining the records for all facilities and activities by the authorized parties
	R22	NEA should update the regulations to include the establishment of dose constraints for public and occupational exposure.
	R23	NEA should require that the radioactive material for which no further use is foreseen and with characteristics that make it unsuitable for authorized discharge, authorized use or clearance from regulatory control, is processed as radioactive waste.

AREA	R: Recommendations S: Suggestions G: Good Practices	Recommendations, Suggestions or Good Practices
	R24	NEA should establish the safety requirements for the development of radioactive waste disposal facilities and activities in accordance with a graded approach.
	R25	NEA should establish requirements to: • develop and maintain a safety case, including supporting safety assessment, for predisposal radioactive waste management facilities or activities throughout the lifetime of the facility or duration of the activity; • locate and design predisposal waste management facilities so as to ensure safety during their decommissioning; • ensure an integrated approach to safety, security and nuclear materials accounting for predisposal waste management facilities.
	R26	NEA should establish requirements for decommissioning for all facilities, including the selection of a decommissioning strategy, the preparation and maintenance of decommissioning plans, and the preparation of final decommissioning plans and supporting documents, commensurate with the radiation risks involved.
	R27	NEA should make provisions in the regulatory framework that exposure during decommissioning activities is considered as planned exposure situations.
	R28	NEA should require that if operational radioactive waste or nuclear fuel is present in the facility after its permanent shutdown, such material is removed and transported to an authorized facility prior to the conduct of decommissioning actions.
	R29	NEA should amend Transport Regulations to be in line with the International Atomic Energy Agency Regulations for the Safe Transport of Radioactive Material SSR-6 2018 Edition (Revision 1).

AREA	R: Recommendations S: Suggestions G: Good Practices	Recommendations, Suggestions or Good Practices
	R30	• NEA should update the existing regulations on dose limits and protection of female workers in line with GSR Part 3. • NEA should establish provisions to ensure employers and authorized parties cooperate to the extent necessary for compliance by all responsible parties with the requirements for protection and safety. • NEA should establish requirements for controlled areas and supervised areas, for explicit establishment of local rules, in a radiation protection programme for occupational exposure. • NEA should establish and enforce requirements for the occupational protection in existing exposure situations. • NEA should establish arrangements for occupational exposure of persons between 16 and 18 years of age who are undergoing training in which they are or could be subject to occupational exposure.

AREA	R: Recommendations S: Suggestions G: Good Practices	Recommendations, Suggestions or Good Practices
	R31	• The regulatory body should establish requirement to ensure that all carers and comforters receive relevant information on radiation protection and the radiation risks prior to their exposure. • NEA in consultation with MOH and relevant professional bodies, should ensure that a set of national diagnostic reference levels is established. • The regulatory body should establish requirements for operational considerations, calibration, dosimetry of patients, diagnostic reference levels and dose constraints, quality assurance to ensure the optimization of protection and safety. • The regulatory body should establish criteria for the release of patients who have undergone therapeutic radiological procedures using unsealed or sealed sources • The regulatory body should establish requirements to ensure that the medical physicists are specialized in the appropriate area. • The regulatory body should establish requirements to ensure that every licensee responsible for medical exposure document any delegation of responsibilities.
9. EMERGENCY PREPAREDNESS AND	R32	The Government should provide, through the national legislative framework, the appropriate authority and responsibilities to NEA to regulate the on-site EPR arrangements of operating organizations.

AREA	R: Recommendations S: Suggestions G: Good Practices	Recommendations, Suggestions or Good Practices
RESPONSE – REGULATORY ASPECTS	R33	NEA should: • require that arrangements for on-site EPR arrangements are in place for any regulated facility or activity that could necessitate EPR actions and that are other than transport activities and designated premises under Fire Safety (Emergency Response Plan) Regulations; • verify through the regulatory process the compliance and adequacy against regulatory requirements of the on-site EPR arrangements of the operating organization; and • make arrangements to ensure that the operating organization reviews and, as necessary, revises the emergency arrangements.
	R34	NEA should ensure that the operating organization: • prepares an emergency plan; • makes provisions for coordinating and/or integrating, as applicable, this plan with those of all other bodies that have responsibilities in EPR, including those of other response organizations, as well as with operating organization's contingency plans and security plans; and • submits this plan to NEA for approval.

AREA	R: Recommendations S: Suggestions G: Good Practices	Recommendations, Suggestions or Good Practices
	R35	NEA should ensure that, as concerns the operating organizations: • personnel relevant for EPR takes part in regular training, drills and exercises; • exercise programmes are developed and implemented to ensure that all specified functions required for emergency response are performed; • such exercises are systematically evaluated against pre-established objectives of emergency response to demonstrate that response actions can be performed effectively to achieve the goals of emergency response; • such exercise programmes are reviewed and revised in the light of experience gained; and • some of the exercises conducted are evaluated by NEA or other relevant bodies.
	R36	NEA should ensure that arrangements are in place so that the magnitudes of hazards and the possible development of hazardous conditions are assessed by operating organizations, initially and throughout a nuclear or radiological emergency, in order to promptly identify, characterize or anticipate, as appropriate, new hazards or the extent of hazards.
	R37	NEA should establish regulations and guides on on-site EPR arrangements of the operating organizations, following a graded approach, to specify the principles, requirements and associated criteria for safety for the operating organizations and ensure that these are reviewed or revised, as necessary, and kept up to date.
	S11	NEA should consider establishing within its management system arrangements to maintain and periodically review, update or revise, as appropriate, emergency plans, procedures and other arrangements, including establishing criteria to trigger their review, update or revision.
	R38	Government should make arrangements to ensure that operational EPR interfaces between operating organizations and other authorities are developed and coordinated, as appropriate.

APPENDIX VI – COUNTERPART'S REFERENCE MATERIAL USED FOR THE REVIEW

List of Reference Documents

(A) Legislation

1. Building Control Act 1989
2. Building Control Regulations 2003
3. Health Products (Medical Devices) Regulations 2010
4. Healthcare Services (Clinical Laboratory Service and Radiological Service) Regulations 2021
5. Healthcare Services (General) Regulations 2021
6. Healthcare Services (Nuclear Medicine Assay Service and Nuclear Medicine Imaging Service) Regulations 2021
7. Healthcare Services Act 2020
8. Human Biomedical Research Act 2015
9. Medical Registration Act 1997
10. National Environment Agency Act 2002 (NEA Act)
11. Private Hospitals and Medical Clinics Act 1980
12. Private Hospitals and Medical Clinics Regulations
13. Public Sector (Governance) Act 2018
14. Radiation Protection (Ionizing Radiation) Regulations (RP(IR) Regulations)
15. Radiation Protection (Transport of Radioactive Materials) Regulations (RP(TRM) Regulations)
16. Radiation Protection Act 2007 (RPA)
17. Strategic Goods (Control) Act 2002
18. Upcoming amended Radiation Protection (Ionizing Radiation) Regulations
19. Workplace Safety and Health (Medical Examinations) Regulations 2011

(B) Standard Operating Procedure (SOP), Work Instruction (WI) and Guidelines

1. 2016 Edition SMC Ethical Code and Ethical Guidelines
2. BreastScreen Singapore Audit Guidelines and Standards for Screening Centre
3. Building Plan Consultation with Technical Departments
4. DCD Checklist - General requirements for plan submission
5. Draft Guidelines for issuance of L6A licence
6. Enforcement Policy
7. Guidelines for building plan submission (development control)
8. Guidelines on Management of Radioactivity Detections at Border Checkpoints
9. Guidelines on Management of Radioactivity Detections at TSIP
10. HRODD's Appendix A2: Procedure for Recruitment of Staff
11. HRODD's Building Career Strengthening Capabilities
12. HRODD's Learning and Development Handbook
13. Inspection Categories and Checklists
14. Inspection Protocol
15. JOD Circular 01-2022 – NEA Incident Management and Reporting Framework
16. Key Task List for IRCD
17. MOH Nuclear Medicine Inspection Checklist
18. MOH X-ray Inspection Checklist
19. NAS 05_2013 Retention Schedule for Dose Reports
20. NAS 22_2013 Retention Schedule for L2 and L4 licences for Radioactive Materials
21. NEA Additional Licensing Information
22. NEA Guidelines for Licence Application
23. NEA Learning Policy No. 01/2020
24. NEA Workplace Safety and Health Policy
25. NEA Workplace Safety and Health Strategy Map
26. NEA's Whistleblowing Policy

27. Policy and Strategy for Management of Radioactive Waste in Singapore
28. Procedure Manual for Amendment of Subsidiary Legislation
29. Procedure Manual for Enactment/Amendment of Bill
30. Proposed draft Licence Conditions for Nuclear Medicine Services
31. Proposed draft Licence Conditions for Radiological Services
32. QM-NEA-01 Quality Manual
33. Quality Records Master List
34. Regulatory Terms and Conditions for Proton Beam Therapy
35. Requirements for proper disposal of radioactive waste
36. Requirements on Establishment of Proton Beam Therapy Facilities
37. Response Plan for Stolen or Lost Radioactive Source Incidents
38. SOP-PASD-01 Management of Quotation Process
39. SOP-PASD-02 Management of Tender Process
40. SOP-QMS-01 Control of Documents
41. SOP-QMS-02 Control of Quality Records
42. SOP-QMS-03 Internal Quality Audit
43. SOP-QMS-04 Management Review Meeting
44. SOP-QMS-05 Corrective and Improvement Action
45. SOP-RD-01 Issuance of Radiation Licences
46. SOP-RD-02 Inspection of Radiation Equipment, Material and Facilities
47. SOP-RMSD-03 Processing of Thermo-Luminescent Dosimeters (TLD)
48. Standards for the provision of nuclear medicine, imaging, therapy and assay services
49. Technical Notes M1-001 Specific Criteria for Medical Imaging
50. TERP Radioactive Material template
51. WI-RD-Equipment-001 Control of Monitoring and Measuring Equipment
52. WI-RD-Inspection-001 Inspection Frequency Guideline
53. WI-RD-Inspection-002 Inspection Report
54. WI-RD-Licence-001 Licence Condition Guideline
55. WI-RD-Licence-002 Licence Approval Guideline
56. WI-RD-Licence-003 Guidelines for Issuance of L5, L6 and R1 Licence / Certificate
57. WI-RMSD-Equipment-002 Quality Assurance and Control of Thermo-Luminescent Dosimeter (TLD) Reader

(C) Other Supporting Documents

1. 8th CNS RM National Report - Singapore
2. About URA
3. Additional Protocol (AP)
4. Annex A - TOR for Advisory Committee on Radiation Protection and Nuclear Science
5. Board’s resolution email for the formation of three technical committees
6. Building plan submission (BCA)
7. Comprehensive Safeguards Agreement 1977 (CSA)
8. Correspondences with IAEA IEC
9. CPF 2021 – 2025
10. Hazmat Transport Driver Permit (HTDP) - NTUC Learning Hub
11. L5 Licence Application
12. Media Releases - Singapore Hosts Meeting of ASEAN Members States to Strengthen Nuclear Safety, Security and Safeguards
13. Media Releases - Tender for Ambient Radiation Monitoring Network
14. Media Releases - Tender for RadioChemistry Laboratory Equipment
15. Modified Small Quantities Protocol (MSQP)
16. MOH circular (MH 92:02) on 2015 National Guidelines for Retention Periods of Medical Records

17. MOH Circular (MH78-04 4-2_V15) Amendments to the National Guideline for Retention Periods of Medical Records
18. NEA Customer TouchPoints
19. NEA Integrated Sustainability Report
20. NEA Organisation Chart
21. Notice from NEA – Dental
22. Notice from NEA – Industrial
23. Notice from NEA – Vet
24. Online Application Form - Attachments
25. Powers and duties of authorised officers in CLB
26. Powers and duties of authorised officers in RPNSD
27. Radon Review and Indoor Survey in Singapore
28. Report on 2014 Radon Survey in Singapore
29. Report on ISK Singapore Pte Ltd
30. RPNSD and CLB Manpower Projection
31. RPNSD Duty Personnel Briefing
32. RPNSD IRCB JCM
33. RPNSD RIMB JCM
34. RPNSG Organisation Chart
35. Sample Online Application Form
36. Screening Test Review Committee Mar 2019 Report
37. Service request form for radiation dose monitoring service
38. TOR for TCRSS(IA)

APPENDIX VII – IAEA REFERENCE MATERIAL USED FOR THE REVIEW

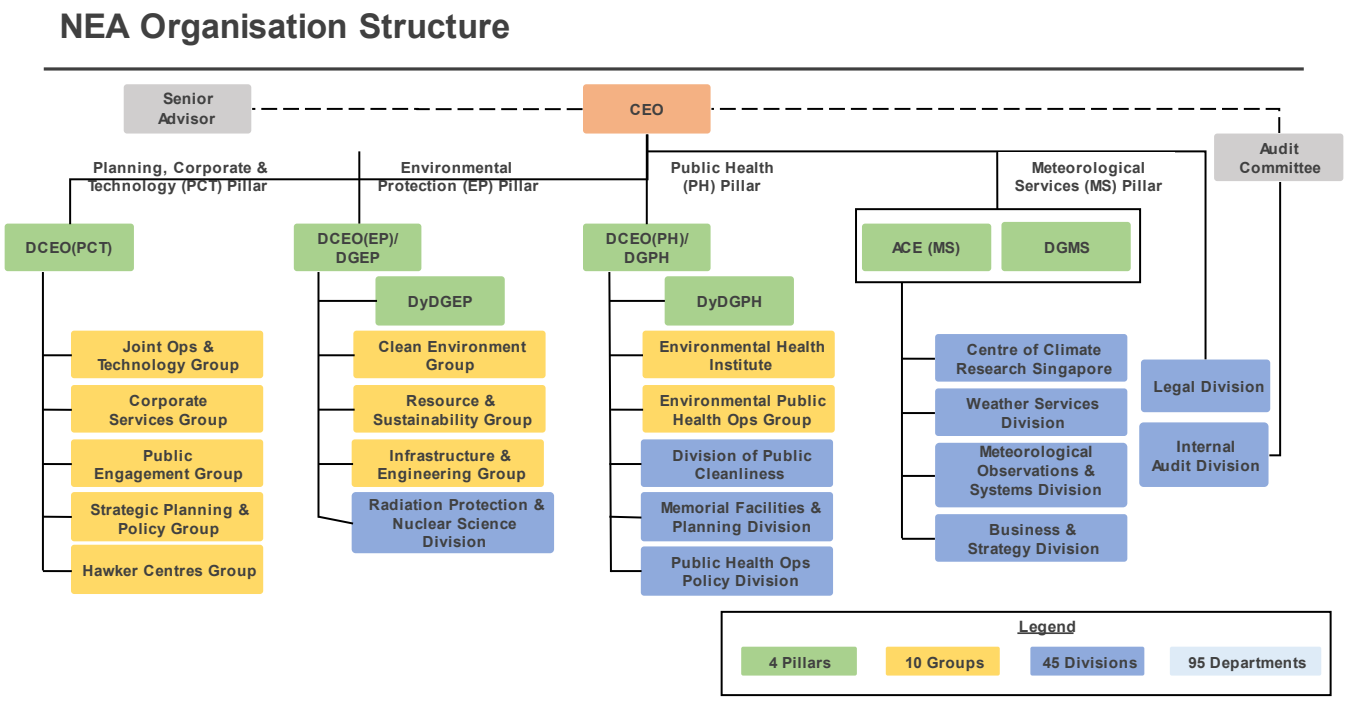
1.	**INTERNATIONAL ATOMIC ENERGY AGENCY** - Fundamental Safety Principles, No SF-1, IAEA, Vienna (2006)
2.	**INTERNATIONAL ATOMIC ENERGY AGENCY -** Governmental, Legal and Regulatory Framework for Safety, General Safety Requirements Part 1, No. GSR Part 1 (Rev. 1), IAEA, Vienna (2016)
3.	**INTERNATIONAL 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.	**INTERNATIONAL ATOMIC ENERGY AGENCY -** Classification of Radioactive Waste, General Safety Guide No. GSG-1, IAEA, Vienna (2009)
18.	**INTERNATIONAL ATOMIC ENERGY AGENCY** - Criteria for Use in Preparedness and Response for a Nuclear or Radiological Emergency, Safety Guide Series No GSG-2, IAEA, Vienna (2012)

19.	**INTERNATIONAL ATOMIC ENERGY AGENCY** - Communication and Consultation with Interested Parties by the Regulatory Body, General Safety Guide Series No. GSG-6, IAEA, Vienna (2017).
20.	**INTERNATIONAL ATOMIC ENERGY AGENCY** - Occupational Radiation Protection, Safety Guide Series No. GSG-7 , IAEA, Vienna (2018)
21.	**INTERNATIONAL ATOMIC ENERGY AGENCY** - Regulatory Control of Radioactive Discharges to the Environment, Safety Guide Series No GSG-9, IAEA, Vienna (2018)
22.	**INTERNATIONAL ATOMIC ENERGY AGENCY** - Organization, Management and Staffing of the Regulatory Body for Safety, General Safety Guide Series No. GSG-12, IAEA, Vienna (2018).
23.	**INTERNATIONAL ATOMIC ENERGY AGENCY** - Functions and Processes of the Regulatory Body for Safety, General Safety Guide Series No. GSG-13, IAEA, Vienna (2018).
24.	**INTERNATIONAL ATOMIC ENERGY AGENCY** - Arrangements for Preparedness for a Nuclear or Radiological Emergency, Safety Guide Series No. GS-G-2.1, IAEA, Vienna (2007)
25.	**INTERNATIONAL ATOMIC ENERGY AGENCY** - The Management System for the Disposal of Radioactive Waste, Safety Guide Series No GS-G-3.4, IAEA, Vienna (2008)
26.	**INTERNATIONAL ATOMIC ENERGY AGENCY** - Criteria for use in Preparedness and Response for a Nuclear or Radiological Emergency, General Safety Guide Series No. GSG-2, IAEA, Vienna 2011)
27.	**INTERNATIONAL ATOMIC ENERGY AGENCY** - A System for the Feedback of Experience from Events in Nuclear Installations, Safety Guide Series No. NS-G-2.11, IAEA, Vienna (2006)
28.	**INTERNATIONAL ATOMIC ENERGY AGENCY** - Modifications to Nuclear Power Plants, Safety Guide Series No NS-G-2.3, IAEA, Vienna (2001)
29.	**INTERNATIONAL ATOMIC ENERGY AGENCY** - Recruitment, Qualification and Training of Personnel for Nuclear Power Plants, Safety Guide Series No NS-G-2.8, IAEA, Vienna (2002)
30.	**INTERNATIONAL ATOMIC ENERGY AGENCY** - Environmental and Source Monitoring for Purposes of Radiation Protection, Safety Guide Series No. RS-G-1.8, IAEA, Vienna (2005)
31.	**INTERNATIONAL ATOMIC ENERGY AGENCY** - Safety of Radiation Generators and Sealed Radioactive Sources, Safety Guide Series No. RS-G-1.10, IAEA, Vienna (2008)
32.	**INTERNATIONAL ATOMIC ENERGY AGENCY** - Borehole Disposal Facilities for Radioactive Waste, Safety Guide Series No SSG-1, IAEA, Vienna (2009)
33.	**INTERNATIONAL ATOMIC ENERGY AGENCY** - Deterministic Safety Analysis for Nuclear Power Plants, Specific Safety Guides Series No. SSG-2, IAEA, Vienna (2010)
34.	**INTERNATIONAL ATOMIC ENERGY AGENCY** - Development and Application of Level 1 Probabilistic Safety Assessment for Nuclear Power Plants, Specific Safety Guide Series No. SSG-3, IAEA, Vienna (2010)
35.	**INTERNATIONAL ATOMIC ENERGY AGENCY** - Development and Application of Level 2 Probabilistic Safety Assessment for Nuclear Power Plants, Specific Safety Guide Series No. SSG-4, IAEA, Vienna (2010)
36.	**INTERNATIONAL ATOMIC ENERGY AGENCY** - Safety of Conversion Facilities and Uranium Enrichment Facilities, Specific Safety Guide Series No. SSG-5, IAEA, Vienna (2010)

37.	**INTERNATIONAL ATOMIC ENERGY AGENCY** - Safety of Uranium Fuel Fabrication Facilities Specific Safety Guide Series No. SSG-6, IAEA, Vienna (2010)
38.	**INTERNATIONAL ATOMIC ENERGY AGENCY** - Safety of Uranium and Plutonium Mixed Oxide Fuel Fabrication Facilities, Specific Safety Guide Series No. SSG-7, IAEA, Vienna (2010)
39.	**INTERNATIONAL ATOMIC ENERGY AGENCY** - Licensing Process for Nuclear Installations, Specific Safety Guide Series No. SSG-12, IAEA, Vienna (2010)
40.	**INTERNATIONAL ATOMIC ENERGY AGENCY** - Geological Disposal Facilities for Radioactive Waste Specific Safety Guide Series No. SSG-14, IAEA, Vienna (2011)
41.	**INTERNATIONAL ATOMIC ENERGY AGENCY** - Storage of Spent Nuclear Fuel, Safety Guide Series No SSG-15 (Rev. 1), IAEA, Vienna (2020)
42.	**INTERNATIONAL ATOMIC ENERGY AGENCY** - Periodic Safety Review for Nuclear Power Plants, Safety Guide Series No SSG-25, IAEA, Vienna (2013)
43.	**INTERNATIONAL ATOMIC ENERGY AGENCY** - Advisory Material for the IAEA Regulations for the Safe Transport of Radioactive Material, Specific Safety Guide No SSG-26, IAEA, Vienna, (2014)
44.	**INTERNATIONAL ATOMIC ENERGY AGENCY** - Commissioning for Nuclear Power Plants, Safety Guide Series No. SSG-28, IAEA, Vienna (2014)
45.	**INTERNATIONAL ATOMIC ENERGY AGENCY** - Predisposal Management of Radioactive Waste from Nuclear Power Plants and Research Reactors, Safety Guide Series No SSG-40, IAEA, Vienna (2016)
46.	**INTERNATIONAL ATOMIC ENERGY AGENCY** - Predisposal Management of Radioactive Waste from Nuclear Fuel Cycle Facilities, Safety Guide Series No SSG-41, IAEA, Vienna (2016)
47.	**INTERNATIONAL ATOMIC ENERGY AGENCY** - 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.	**INTERNATIONAL ATOMIC ENERGY AGENCY** - Radiation Protection and Safety in Medical Uses of Ionizing Radiation, Safety Guide Series No SSG-46, IAEA, Vienna (2018)
49.	**INTERNATIONAL ATOMIC ENERGY AGENCY** - Decommissioning of Nuclear Power Plants, Research Reactors and Other Nuclear Fuel Cycle Facilities, Safety Guide Series No SSG-47, IAEA, Vienna (2018)
50.	**INTERNATIONAL ATOMIC ENERGY AGENCY** – 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.	**INTERNATIONAL ATOMIC ENERGY AGENCY** –Decommissioning of Medical, Industrial and Research Facilities, Safety Guide Series No SSG-49, IAEA, Vienna (2019)
52.	**INTERNATIONAL ATOMIC ENERGY AGENCY** – 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.	**INTERNATIONAL ATOMIC ENERGY AGENCY** - Planning and Preparing for Emergency Response to Transport Accidents Involving Radioactive Material, Safety Guide No TS-G-1.2 (2002)
55.	**INTERNATIONAL ATOMIC ENERGY AGENCY** - Radiation Protection Programmes for the Transport of Radioactive Material, Safety Guide No TS-G-1.3, IAEA, Vienna, (2007)
56.	**INTERNATIONAL ATOMIC ENERGY AGENCY** - The Management System for the Safe

	Transport of Radioactive Material Safety Guide No TS-G-1.4, IAEA, Vienna, (2008)
57.	**INTERNATIONAL ATOMIC ENERGY AGENCY** - Compliance Assurance for the Safe Transport of Radioactive Material, Safety Guide No TS-G-1.5, IAEA, Vienna, (2009)
58.	**INTERNATIONAL ATOMIC ENERGY AGENCY** - 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.	**INTERNATIONAL ATOMIC ENERGY AGENCY** - Storage of Radioactive Waste, Safety Guide Series No WS-G-6.1, IAEA, Vienna (2006)
60.	**INTERNATIONAL ATOMIC ENERGY AGENCY** - Safety Assessment for the Decommissioning of Facilities Using Radioactive Material, Safety Guide Series No.WS-G-5.2, IAEA, Vienna (2009)
61.	**INTERNATIONAL ATOMIC ENERGY AGENCY** - Storage of Radioactive Waste, Safety Guide Series No. WS-G-6.1, IAEA, Vienna (2006)

APPENDIX VIII – ORGANIZATIONAL CHART



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