English Version

The People's Republic of China
Fifth National Report
for the
Joint Convention
on the Safety of Spent Fuel Management
and
on the Safety of Radioactive Waste Management

Prepared for the Seventh Review Meeting

September, 2020

Beijing, China

Preface

Chinese Government has consistently accorded high priority to the safety of spent fuel management and the safety of radioactive waste management. The 21st Session of the Standing Committee of the 10th National People's Congress, the People's Republic of China, decided to access to the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (hereinafter referred to as Joint Convention), which was adopted on September 5, 1997 by a Diplomatic Conference convened by the International Atomic Energy Agency and，at the same time, stated that the Joint Convention is not, for the time being, applicable to the Macao Special Administration Region of the People's Republic of China, unless otherwise stated by Chinese Government. On September 13, 2006, China sent its submission of accession instrument to the Depositary. The Joint Convention entered into force to China from the day of December 12, 2006 on.

National Reports of the People's Republic of China on the fulfillment of the obligations of the Joint Convention were submitted to the Review Meetings of the Contracting Parties 2008, 2011, 2014, and 2017.

This report is provided, according to the Article 32 of the Joint Convention, as the 5th National Report of the People's Republic of China to the 7th Review Meeting of the Contracting Parties. This Report describes the situation of how the obligations of the Joint Convention is implemented in China, and is composed of two parts. The Part 1 is the status report of Joint Convention fulfillment by the Central Government of the People's Republic of China, and the Part 2 is the status report of Joint Convention fulfillment by the Hong Kong Special Administrative Region of the People's Republic of China. The data on the inventory and checklist provided in the present report was gathered as of December 31, 2019.

This report does not include information of Taiwan Province of the People's Republic of China.

CONTENTS

PART 1

A. INTRODUCTION

A.1 Theme of the Report

A-1 This report describes the fundamental policies on, and practices of, the safety of spent fuel management and the safety of radioactive waste management in China.

A-2 The aim of spent fuel management and radioactive waste management in China is to achieve and maintain the high level safety and, at present and in future, to protect individuals, society and the environment against the harmful impacts of ionization radiation and promote the sustainable development and peaceful use of nuclear energy and nuclear technology. In China, it has been adhering by the basic principles of ionizing radiation protection, radiation source safety, spent fuel management safety and radioactive waste management safety, making efforts to establish well and improving legislative system, clarifying and allocating safety management responsibilities, enhancing and raising regulatory capabilities, attach importance to and actively participating with international cooperation, so as to ensure the safety of spent fuel management and the safety of radioactive waste management.

A.2 Concerned Facilities

A-3 In accordance with the Joint Convention, the Part 1 of this report is focused on a wide range of management facilities, such as on-site and/or away-from-reactor storage facilities erected for spent fuel generated from nuclear power plants (NPPs) and research reactors, radioactive waste treatment and storage facilities for nuclear facilities, radioactive waste storage facilities for nuclear technology applications, and the facilities for treating, storing and disposing radioactive waste.

A.3 Structure

A-4 As required by the *Guidelines regarding the Form and Structure of National Reports* (INFCIRC/604/Rev.3), the Part 1 of this report describes China's fulfillment of the obligations of each article of the Joint Convention in each section. Every section begins with the corresponding Articles, given in the Joint Convention, enclosed with a box and underlying dark lines. The contents, following the Introduction, are listed as below:

Section B. Policies and Practices (Article 32-1)

Section C. Scope of Application (Article 3)

Section D. Inventories and Lists (Article 32-2)

Section E. Legislative and Regulatory System (Articles 18 to 20)

Section F. Other General Safety Provisions (Articles 21 to 26)

Section G. Safety of Spent Fuel Management (Articles 4 to 10)

Section H. Safety of Radioactive Waste Management (Articles 11 to 17)

Section I. Transboundary Movement (Article 27)

Section J. Disused Sealed Sources (Article 28)

Section K. General Efforts to Improve Safety

Section L. Annexes

A-5 To avoid the overlapping of the relevant parts in Chapters G and H, the general laws and regulations governing the safety of spent fuel management and the safety of radioactive waste management are addressed in Chapter E, as required in the INFCIRC/604/Rev.3.

A.4 Response and Answer to Suggestions, Challenges and Generic Issues Identified at the Sixth Review Meeting

A-6 During the Sixth Review Meeting of Contracting Parties, the Country Group where China was in identified five challenges China confronting and provided one suggestion on spent fuel and radioactive waste management. Since then, follow-up actions have been carried out in many ways to respond these challenges and suggestion in China.

A-7 As stated by the Sixth Review Meeting Summary Report, the national reports for the Seventh Review Meeting should, as appropriate, address the following four generic issues. These issues are comprehensively addressed in this National Report based on the current Chinese laws/regulations and practices.

A.4.1 Response to the Suggestion

A-8 During the Sixth Review Meeting, it was proposed that a mechanism should be developed in China for to make regular assessment of cost estimate associated with the long term liabilities for the radioactive waste disposal program and the decommissioning program.

A-9 During this period of implementation, *Law of the People's Republic of China on Nuclear Safety* (LNS) has been promulgated and implemented. According to Article 48 of the LNS, "the operating organization of nuclear facilities shall withhold the decommissioning costs of nuclear facilities and the disposal costs of radioactive waste, and shall include them in the investment

budget and production costs; withholding shall be used exclusively for the decommissioning of nuclear facilities and radioactive waste disposal. The specific provisions shall be formulated by the competent finance department and the competent price department of the State Council in conjunction with the nuclear safety regulatory department, the competent department of nuclear industry and the energy department of the State Council."

A-10 In accordance with the provisions of the LNS, the Ministry of Finance (MoF), jointly with relevant departments of the State Council, is working out the *Interim Measures for the Management of Expenses for Nuclear Facility Decommissioning and Radioactive Waste Disposal*. At present, the research work has been completed and the first version has been drafted. A mechanism for periodic cost assessment of nuclear facility decommissioning, including self-assessment by nuclear facility operators and assessment and review by the regulatory authorities of decommissioning expense management, and a pricing mechanism for radioactive waste disposal are considered in the first draft.

A-11 Research on Periodic Cost Assessment of Nuclear Facility Decommissioning was launched by National Nuclear Safety Administration (NNSA) in 2019 to explore the techniques and methodologies for cost assessment under China's situation and support the establishment of such a mechanism.

A-12 Details can be found in F2.2 and K1.6.

A.4.2 Response to Challenges

(1) Progress in the HLW disposal program including the finalization of the URL

A-13 In February 2017, the State Council approved the *13th Five-year Plan and 2025 Vision for Nuclear Safety and Radioactive Pollution and Control* (TFP2025VNSRPC), which calls for speeding up the research on the disposal of high level waste (HLW), starting the construction of the underground laboratory, promoting site selection and investigation of HLW repository, studying engineering barriers, disposal technologies, geochemistry and safety assessment, clarifying the safety objectives and principles of HLW geological disposal, and considering the technical safety criteria for site selection of HLW geological repository in China.

A-14 In May 2019, China Atomic Energy Authority (CAEA) approved the Project Proposal on Underground Research Laboratory for Geological Disposal of HLW in China, which proposed to build an internationally advanced

underground research laboratory for geological disposal of HLW in Xinchang section of Beishan, Gansu Province. In December 2019, CAEA approved the establishment of chief commander and chief designer system for construction of the underground laboratory. At present, CAEA is making arrangement for the construction and related research work in the construction process of the underground laboratory.

A-15 During this period of implementation, continuous efforts have been made to research on developing the technologies for geological disposal of HLW, including the suitability of candidate sites in key pre-selected sections of Beishan, Gansu Province, and developing safety objectives, conceptual design, disposal engineering, geochemistry and safety evaluation of geological disposal. Meanwhile, selection and evaluation of candidate clay rock sites have been made to initially form a technical system for the research and development of geological disposal of HLW in China.

A-16 China attaches great importance to international cooperation in the field of geological disposal of HLW. By the end of 2019, cooperation with more than 20 management and research institutions in other countries has been established, and a number of IAEA technical cooperation projects related to geological disposal of HLW have been undertaken. During the 63rd Regular Session of the IAEA General Conference on September 19, 2019, jointly with IAEA, a side event marking the 20th anniversary of technical cooperation on geological disposal of HLW was hosted by CAEA in Vienna, Austria. The event summarized the progress and achievements of technical cooperation projects in HLW geological disposal in China during the past two decades, and promoted China's successful practices in technical cooperation projects to other member states.

A-17 Details can be found in B.5 and K.1.1.

(2) **Completion of the LILW disposal site selection to timely attend the needs of the nuclear program**

A-18 CAEA is leading the preparation of site selection of low and intermediate level waste (LILW) disposal sites, and consulting and coordinating with relevant authorities at the local and provincial levels. A number of new disposal sites of LILW are planned to build in areas where NPPs are relatively concentrated, and extension are made to the LILW disposal sites in operation.

A-19 During this period of implementation, preliminary preparations for the site selection of LILW disposal sites have been made in areas where NPPs are

relatively concentrated. Great efforts are made in site selection of disposal sites for some nuclear power projects in Liaoning Province, Guangdong Province, Guangxi Autonomous Region and other places. In addition, multi-channel disposal of LILW from NPPs are sought by some academic organizations such as the China Nuclear Energy Association (CNEA) to promote the solution of the problems.

A-20 Details can be found in B.5 and K.1.2.

(3) Enhancement of regulator's role in communication to the public of the disposal program

A-21 The laws and regulations on public communication of nuclear related projects have been gradually improved in China. Chapter V of LNS specifically provides the information disclosure and public communication. Article 63 of the LNS states that the nuclear safety regulatory department of the State Council shall make public the administrative licensing in relation to nuclear safety and information on the regulatory safety inspection reports of nuclear safety related activities, the overall safety situations and the quality of radiation environment as well as nuclear accidents in accordance with the law. It is also made clear that the nuclear safety information should be timely publicize in accordance with the law via the announcements of governments, websites, and other ways that are easily accessible by the public. Citizens, legal persons and other organizations may apply for access to nuclear safety-related information in accordance with the law to the nuclear safety regulatory department of the State Council and departments designated by the governments of provinces, autonomous regions and municipalities directly under the Central Government where nuclear facilities are located. The operating organizations of nuclear facilities and the governments of the provinces, autonomous regions or municipalities where the facilities are located shall ask for opinions of the stake holders via hearings, seminars, forums, or other forms on the major nuclear safety issues affecting the public interests and provide feedback in a proper form.

A-22 The MEE/NNSA has always paid attention to the establishment of an open and transparent nuclear safety regulation system, and strengthened public communication about nuclear and radiation projects through system construction. During this period of implementation, the MEE amended or issued the *Measures for Public Participation in Environmental Impact Assessment*, *the Plan for Disclosure of Regulatory Information on Nuclear and Radiation Safety*, and *the Guidelines for Public Communication about Nuclear and Radiation Safety*. In accordance with the *Measures* mentioned above, the construction unit

shall disclose relevant information, solicit opinions related to the environmental impact of the project, and form a report on public participation and submit it together with the environmental impact assessment report. Once the environmental impact report of the construction project is received, before the approval is decided, the ecological and environmental authority shall, through its website or otherwise, make public the construction project overview, the main environmental impact and the public participation, and inform the construction unit and interested parties of their right to request a hearing.

A-23 MEE/NNSA guides and urges all technical support organizations, local ecology and environment departments and enterprises to carry out nuclear and radiation safety activities in the community and on campus in a sustained and in-depth manner. A series of popular science popularity activities featuring nuclear and radiation safety, such as Charming Cup National Nuclear Science and Knowledge Competition for Middle School Students, National College Nuclear+X Design Contest, and National College Nuclear Safety Debate Contest, have increasingly had an influence on the public and society. During the events celebrating the National Security Education Day on April 15, the Environment Day on June 5, and the Nuclear Open Day/Week on August 7, more than 200,000 practitioners in nuclear industry and students from hundreds of universities, primary and secondary schools have participated in promotion activities, which had an increasingly wide impact. These activities among different target populations have spread nuclear science and technology, enhanced public understanding of professional knowledge, and increased public confidence in nuclear industry, nuclear safety and nuclear emergency management.

A-24 The MEE/NNSA strictly abides by the above laws and regulations and fulfills its duties to carry out public communication related work in the regulation of radioactive waste disposal projects.

A-25 Details can be found in K.1.3.

(4) Complete and put in force specific regulatory requirements for decommissioning

A-26 The licensing management requirements for decommissioning of nuclear facilities have been specified in the LNS. It is made clear in Article 30 that before a nuclear facility is decommissioned, its operator shall request an application for decommissioning and submit to NNSA: (1) an application for decommissioning of the nuclear facility (2) safety analysis report; (3) environmental impact assessment report; (4) quality assurance documents; (5)

other documentations specified by laws and regulations. When nuclear facilities are decommissioned, the operating organizations shall treat, store and dispose of radioactive waste at nuclear facilities as low as reasonably achievable (ALARA) to reduce the radioactivity of structures, systems and equipment to meet the requirements of the standards. Once nuclear facilities are decommissioned, the ecology and environment departments of the provinces, autonomous regions or municipalities where the facilities are located shall arrange monitoring of the types and concentrations of radionuclides remaining on the sites of nuclear facilities and their surroundings.

A-27 During this period of implementation, NNSA was developing departmental regulations on *Provisions on the Safety Management of Civilian Nuclear Facility Decommissioning* to further clarify the regulatory procedures and requirements for decommissioning of nuclear facilities. At the same time, NNSA is organizing the preparation of nuclear safety guides such as *Safety Assessment for the Decommissioning of Nuclear Facilities, Decommissioning of Nuclear Fuel Cycle Facilities, Decommissioning of Nuclear Power Plants and Research Reactors* and *Decommissioning of Facilities Utilizing Nuclear Technology,* to further refine the regulatory requirements for the decommissioning of nuclear facilities. Among them, *Safety Assessment for the Decommissioning of Nuclear Facilities* and *Decommissioning of Nuclear Fuel Cycle Facilities* have been technically reviewed.

A-28 Details can be found in K.1.4.

(5) Decommissioning technology to be developed in depth taking into account technical, economic and social considerations

A-29 In February 2018, CAEA issued the *Guidelines for Application for Scientific Research Projects on Nuclear Facility Decommissioning and Radioactive Waste Treatment* (2018-2020). In the area of decommissioning, technical support focuses on: 1) reactor decommissioning technologies, including key technologies such as conditioning of damaged spent fuel assemblies, core sealing and consolidation, dismantling and demolition; 2) other technologies for nuclear facility decommissioning, including engineering application of decommissioning technologies in radioactive plant ducts and chimneys; 3) engineering application of decommissioning technologies and development of special equipment, including development of key instruments for decommissioning and remediation, and special equipment for radiation monitoring, dismantling and decontamination. At present, a number of research and development projects on decommissioning technologies, such as the

decommissioning of radioactive process ducts and the stripping of contaminated equipment, are being carried out as planned.

A-30 The decommissioning technologies under development have taken into account such factors as technical feasibility, economic cost and environmental benefits. Research has been carried out on the survey and measurement of decommissioned source terms and the measurement of gamma source term on the inner wall of pipelines. Some equipment and techniques have been developed, including the measurement system and key equipment for in-situ source terms, specialized devices for radioactivity measurement and survey in high dose field, and the methods for remote-control measurement, to provide technical support for investigating source terms safely. The development of remote control manipulators and slurry retrieval robots for dismantling and demolition of facilities can protect the staff while ensuring the feasibility of decommissioning. The strippable gel decontamination technology has been developed and applied to the fixation, removal and site protection of loose contamination on the surface of equipment and buildings during the decommissioning of nuclear facilities, so as to ensure the health of personnel and the safety of the environment. Laser decontamination of pipes has been developed and applied to decontamination of radioactive contamination, especially fixed contamination in decommissioned pipes of nuclear facilities. This can effectively improve decontamination efficiency, and reduce exposure dose to operators and the radioactive waste production.

A.4.3 Brief Answer to the Request of the Review Meeting to be Elaborated in the National Report

(1) Implementation of national strategies for spent fuel and radioactive waste management

A-31 The policy for spent fuel management in China is to reprocess spent fuel to extract and recover uranium and plutonium, so as to maximize the utilization of resources, reduce the amount of HLW, ensure the safety of spent fuel management and the safety of the general public, and lower the long-term radiation risk to future generations.

A-32 In accordance with the needs of nuclear power development, China has made overall plans for the capacity building of spent fuel management throughout the country, actively promoted the research and development of spent fuel storage and reprocessing technologies, and facilitated the project on large commercial reprocessing plant to continuously improve spent fuel storage and reprocessing.

A-33 A capacity-building program has been prepared for spent fuel storage system of NPPs. All NPPs in operation in China have been provided with spent fuel storage facilities to accept the spent fuel generated by the operation of NPPs during a certain period of time and ensure their storage safety. Dry storage facilities of spent fuel have also been built at Qinshan Phase III and Tianwan Nuclear Power Plants. It is required in the *Outline of Thirteenth Five-Year Plan for National Economic and Social Development of the People's Republic of China* (OTFPNESDPRC) that the demonstration and construction of large commercial reprocessing plant will be accelerated. At present, the preliminary work is under way.

A-34 The fund for spent fuel treatment and disposal has been established in China to ensure the implementation of the spent fuel management policy. As stated in Article 48 of the LNS, the operating organizations of nuclear facilities shall pay the costs of spent fuel processing and disposal in accordance with the national regulations, and the costs shall be included in the production cost. The *Interim Procedures on Collection, Utilization and Management of Funds for Treatment and Disposal of Spent Fuel at Nuclear Power Plants* (IPCUMFTDSFNPP), which was issued by MoF, the National Development and Reform Commission and the Ministry of Industry and Information Technology (MIIT), sets up a fund available for spent fuel transport, away-from-reactor storage, reprocessing and the treatment and disposal of HLW from reprocessing. The *Measures for Project-based Management of the Fund for Treatment and Disposal of Spent Fuel at Nuclear Power Plants*, which was issued by CAEA, further standardizes the project-based management of the fund and ensures the steady progress of spent fuel management.

A-35 The reduction of radioactive waste is taken into account from the beginning of the design. The adoption of optimized systems, reasonable design, reliable equipment and strict measures are encouraged to minimize the sources of waste, the amount of waste to be treated and the difficulty of treatment, so as to reduce the final waste production and the costs of waste treatment and disposal.

A-36 Radioactive waste is classified for treatment and disposal in China. As stated in Article 40 of the LNS, radioactive waste shall disposed of by category. LILW shall be disposed by near-surface disposal or intermediate-depth disposal at the sites in compliance with requirements of nuclear safety stipulated by the State. HLW shall be disposed of by centralized deep geological disposal, and monopolized by organizations designated by the State Council. The public

announcement on *Classification of Radioactive Waste* was released by the former Ministry of Environmental Protection (MEP), the MIIT and the China Atomic Energy Authority (CAEA) in November 2017. According to the potential hazards of all types of waste and the degree of confinement and isolation required for disposal, radioactive waste is classified into very short lived waste (VSLW), very low level waste (VLLW), low level waste (LLW), intermediate level waste (ILW) and high level waste (HLW), corresponding to decay storage, landfill disposal, near surface disposal, intermediate depth disposal and deep geological disposal.

A-37 In accordance with the *Guidelines on Research and Development Planning for Geological Disposal of HLW*, which was issued by CAEA, the Ministry of Science and Technology (MST) and the former State Environmental Protection Administration in 2006, the project covering both the research and development and the disposal facility engineering of HLW is divided into three phases: (1) lab-based research and development and disposal facility siting (2006-2020), (2) underground experiment (2021-2040), and (3) prototype disposal facility validation and realistic disposal facility construction (2041- the mid-century). As stated the TFP2025VNSRPC, five disposal sites for LILW will be sited and constructed, a reasonable planning for the disposal of LILW will be developed and the transport and disposal of waste from NPPs will be promoted. At present, steady progress is made in the disposal of all kinds of radioactive waste in China. Details can be found in B.5 and H.

A-38 The development of radioactive waste management system and mechanism is given a high priority in China to ensure the implementation of national radioactive waste management strategy. As stated in the LNS, HLW shall be centralized and disposed in a deep geological repository, which will be exclusively operated by the organization designated by the State Council. It is stated in the *Regulations on the Safety of Radioactive Waste Management* (RSRWM) that research on engineering and safety technology, underground experiments, site selection and construction of deep geological repository shall be implemented by the competent body of nuclear industry of the State Council.

A-39 Details can be found in B.

(2) Safety implications of long-term management of spent fuel

A-40 China attaches importance to the safety of long-term spent fuel management. As stated in Article 39 of the LNS, the organization that produces, stores, transports or reprocesses spent fuel shall take measures to ensure the safety of spent fuel, and bear the responsibility of nuclear safety for the spent

fuel that they hold.

A-41 China has made overall planning for national spent fuel management capacity building, developed the plan for building the capacity of spent fuel storage system, and promoted the projects on spent fuel storage facility and large commercial reprocessing plant to ensure the long-term safety of spent fuel management.

A-42 Except for part of spent fuel from Daya Bay NPP for storage away-from-reactor site, all spent fuel generated from operating NPPs in China is stored at NPPs. By the end of 2019, there are 47 operating nuclear power units in mainland China, of which only 4 units have operated for more than 20 years, with the longest operating time of 28 years. The operating time is less than 10 years for the remaining 43 units. Spent fuel has not yet been exposed to extended periods of storage.

A-43 Attention will be continuously paid to the long-term storage of spent fuel and related research progress in the world, and actions will be timely taken to ensure the safety of long-term spent fuel storage.

A-44 Details can be found in B.2.

(3) Linking long term management and disposal of disused sealed sources

A-45 China attaches importance to and strengthens the safe management of radioactive sources during their entire lifetime. A sound system of laws and regulations has been established. The management requirements have been defined for the production, distribution, use, transfer, import and export, storage and disposal of radioactive sources.

A-46 In 2010, National Radiation Safety Management System for the Utilization of Nuclear Technology was officially put into use, realizing the dynamic monitoring of the whole process of radioactive sources and providing important input for routine monitoring. The management of spent and disused sealed sources is covered in the system, which also realizes the dynamic management of these sources at the same time.

A-47 During this period of implementation, NNSA has taken a national action for safety inspection of radioactive sources. More than 10,000 organizations involving radioactive sources were inspected across the country. More than 3000 spent and disused sealed sources were recovered and stored.

A-48 In 2019, NNSA carried out the research on the strategy for disposal of spent and disused sealed sources and the criteria for acceptance of near-surface disposal, and promoted the safe disposal of some disused sealed sources with low activity. In December 2019, NNSA approved *Plan for Disposal of Spent* ^{192}*Ir and* ^{75}*Se Sources*, which is intended to dispose some disused sealed sources with low activity in near-surface facilities.

A-49 Details can be found in B.3 and J.

(4) Remediation of legacy sites and facilities

A-50 The remediation of legacy sites and facilities is paid much attention in China. Related work has been carried out and great progress has been made.

A-51 The remediation of Qinghai nuclear base has been completed. Qinghai nuclear base has been decommissioned and remediated after the decision not to use it was made by the Chinese government in 1987. The follow-up radiation environment investigation and comprehensive evaluation have showed that the decommissioning meets the limit requirements, and the potential impact on the public and the environment is acceptable. At present, the legacy site has been developed into a tourist attraction.

A-52 Uranium mining and milling facilities have been fully remediated. Relevant technical standards have been developed and applied to the decommissioning and remediation of uranium mining and milling facilities in China. After the facilities have been decommissioned and remediated, the environmental risks and potential threats to the public have been eliminated, the safety and stability have been improved, and the maximum individual dose and collective dose meet national radiation safety requirements.

A-53 The radiation environment status has been surveyed and evaluated at nuclear bases and facilities. The survey and evaluation of the radiation environment status was launched for nuclear facilities in China in 2011. It took about 10 years to complete these works in NPPs at 3 nuclear power bases, research reactors at some research bases, and some nuclear fuel cycle facilities. The impact and trend of the long-term operation of the above-mentioned nuclear bases and facilities on the surrounding environment is evaluated. The results have shown that all nuclear bases and facilities in China have been operating strictly in accordance with national laws, regulations and standards.

A-54 Preparations has begun for the decommissioning of heavy water research reactor. The heavy water research reactor in China first went critical in

May 1958, was safely shut down in December 2007, and was approved for decommissioning in 2019. Decommissioning is expected to start in 2021 and complete by 2030. The decommissioning plan will be implemented in three phases: preparations for pre-decommissioning project and removal of peripheral system; removal of basement process system; and removal of the reactor and support facilities. The end state to be achieved is to retain the main building as a historical memorial of the first nuclear reactor in China, and to keep other systems and components meeting the requirements for limited open access in residual radioactivity. The decommissioning shall be subject to the laws and regulations as follows: LNS, *Law of the People's Republic of China on Prevention and Control of Radioactive Pollution* (LPCRP), *Law of the People's Republic of China on Environmental Protection* (LEP), and *Regulations of the People's Republic of China on Safety Control of Civilian Nuclear Installations* (HAF001). The national standards to be met mainly include *Basic Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources* (GB18871-2002), *Safety Requirements for Decommissioning of Nuclear Facilities* (GB/T19597-2004), *Regulations on Management of Radioactive waste* (GB14500-2002), *Clearance Levels for Recycling and Reuse of Steel, Aluminum, Nickel and Copper from Nuclear facilities* (GB/T17567-2009), and *Activity Concentration of Radionuclides in Materials Exempted from Radiation Protection* (GB27742-2011). In the process of decommissioning, first of all, preparations are made and capacities are built, and source terms are investigated in detail, then systems and facilities are decontaminated and dismantled, and finally waste is treated and disposed. The decommissioning is funded from the funds for the decommissioning of nuclear facilities and the treatment of radioactive waste.

A. 5 Main Updates since Last Report

A-55 This report includes main updates on the safety of spent fuel management and the safety of radioactive waste management in China as of December 31, 2019 since January 1, 2017.

Newly issued and revised laws, regulations and rules

(1) *Law of the People's Republic of China on Nuclear Safety*, issued by the Standing Committee of the National People's Congress in September 2017;

(2) *Classification of Radioactive Waste*, jointly issued by the former MEP, the MIIT, and CAEA in November 2017;

(3) *Safety Licensing Procedures for Nuclear Power Plants, Research*

Reactors and Nuclear Fuel Cycle Facilities, issued by the MEE/NNSA in August 2019;

(4) *Measures for the Management of Safety Licensing of Radioisotope and Radiation Devices* (MMSLRRD), amended by the MEE/NNSA in August 2019; and

(5) *Measures for the Management of Safety Licensing of Radioactive Substance Transport*, revised by the MEE/NNSA in August 2019.

Newly issued programs and action plans

(1) The *13th Five-year Plan and 2025 Vision for Nuclear Safety and Radioactive Pollution and Control* (TFP2025VNSRPC), approved and Issued by the State Council in February 2017; and

(2) The White Paper on Nuclear Safety in China, issued by the State Council Information Office in September 2019.

Newly built facilities

(1) On-site spent fuel storage facilities and radioactive waste treatment and storage facilities associated with eight nuclear power units (see L.1.1 and L.3.1);

(2) 1 dry storage facility for spent fuel (see L.1.1); and

(3) 1 radioactive waste storage facility (see L.3.6).

Issued License

(1) In 2019, NNSA issued the license for radioactive waste storage (GHFFZC[033]) to Gansu Dongfang Ruilong Environmental Remediation Co., Ltd.

Completed Inspection

(1) From October 2016 to May 2017, NNSA organized and completed the special safety inspection of radioactive sources; and

(2) From April to June 2019, NNSA organized and completed the hazards identification of nuclear and radiation safety.

A-56 The inventory and list are updated in this report (see D and L).

A.6 Major Events since Last Report

A-57 This report updates and supplements major events in the safety of

spent fuel management and the safety of radioactive waste management in China as of December 31, 2019, since January 1, 2017.

(1) Institutional reform of the State Council

A-58 Institutional reform of the State Council was carried out in March 2018. The adjusted departments involving the functions of the safety of spent fuel management and the safety of radioactive waste management include former MEP, former National Health and Family Planning Commission (NHFPC) and former State Administration of Work Safety (SAWS).

A-59 The MEE was established, and the MEP was no longer be retained. The functions of nuclear and radiation safety regulation within the MEP were transferred to the newly established MEE. The structure within MEE/NNSA was reorganized, with Division of Nuclear Safety Coordination newly established under Department of Nuclear Installation Safety Regulation, and Division of Operation Safety and Quality Assurance under Department of Nuclear Power Safety Regulation. The other departments remained unchanged both in organization and function.

A-60 The National Health Commission (NHC) was established to integrate the responsibilities of the former NHFPC, Office of Leading Group for Deepening Reform of Medical and Health System and Office of National Working Committee on Aging with the responsibilities of SAWS for occupational safety and health regulation.

(2) Promulgation and implementation of the Law of the People's Republic of China on Nuclear Safety

A-61 The LNS was promulgated in September 2017, and was implemented as of January 1, 2018. With supreme legal authority in the area of nuclear safety, the LNS has further improved the legal system of nuclear safety in China. It is the cornerstone to ensure nuclear safety. The LNS provides for policies, principles, responsibilities, technologies and institutions to ensure nuclear safety; qualification, duties and responsibilities of operators of nuclear facilities; licensing system of nuclear facilities and nuclear materials; system of radioactive waste management; systems of nuclear emergency coordination committee, emergency plan and nuclear accident information release; system of nuclear safety information disclosure and public participation, and their subject and scope; specific measures to oversee and inspect nuclear safety; penalties for violations; and compensation for damages caused by nuclear accident.

A-62 In management of spent fuel and radioactive waste, the LNS has defined the safety responsibilities of the organizations generating, storing and transporting spent fuel; the systems for management of spent fuel transport, classification and disposal of radioactive waste, licensing of radioactive waste management, closure of radioactive waste disposal facility and licensing of nuclear facility decommissioning; and the payment and management requirements for costs of spent fuel treatment and disposal, nuclear facility decommissioning and radioactive waste disposal. It is proposed in the LNS that the deep geological disposal of HLW shall be exclusively operated by the organization designated by the State Council.

(3) Releasing of the White Paper on Nuclear Safety in China

A-63 The White Paper on Nuclear Safety in China was released by the State Council Information Office in September 2019. It is the first White Paper on nuclear safety published by Chinese government. It fully introduces the development process, basic principles and policies, and concepts and practices in nuclear safety regulation in China. It also clarifies the determination and actions in China to promote global nuclear safety governance process. According to the White Paper, radioactive waste is classified for disposal in China; LILW is disposed in near-surface or intermediate-depth sites that meet the requirements for nuclear safety, and HLW is centrally disposed in deep geological repository. Efforts are made in safe storage and treatment of spent fuel, and the capacity in treatment and disposal of radioactive waste is built to ensure the safety of radiation environment.

(4) Participation in international nuclear emergency exercises and carrying out national nuclear emergency exercises

A-64 In June 2017, more than 10 nuclear emergency response teams from China took part in ConvEx-3 exercises held by IAEA, and were highly recognized by IAEA.

A-65 During this period of implementation, more than 100 comprehensive and individual exercises have been conducted by various nuclear emergency response forces at national level.

(5) Special action for national radiation safety inspection

A-66 From October 2016 to May 2017, a special action for national radiation safety inspection was launched in China. More than 10,000 units across the country involving radioactive sources were inspected. More than

3,000 disused sealed sources were collected and stored.

A.7 Good Practices

A-67 In the safety of spent fuel management and the safety of radioactive waste management, China would like to share two good practices with the parties to the Joint Convention.

(1) Peer review of radioactive waste management for the first time

A-68 In June 2018, the first peer review of radioactive waste management, organized by China Nuclear Energy Association (CNEA), was conducted in Nuclear Power Institute of China (NPIC). CNEA formed a team of peer review experts and developed *Performance Objectives and Assessment Criteria for Radioactive Waste Management (Trial)*. According to the assessment criteria and referring to the experience of member states in the past, three areas, including the organization and management of radioactive waste related activities, the implementation of radioactive waste management and the status of safety management, were evaluated. The peer review team has conducted a comprehensive and systematic assessment of the radioactive waste management in NPIC through field inspection, activity observation, interviews and document review. A number of observations were developed. One good practice and six areas for improvement were identified with NPIC. One of the strengths identified in the peer review is the development and application of advanced technologies for radioactive waste minimization, effectively reducing the amount of solid radioactive waste produced.

A-69 In October 2019, CNEA conducted a follow-up peer review visit to NPIC. In the follow-up visit, the implementation of the items for improvement was checked, and suggestions were put forward to help NPIC continuously enhance radioactive waste safety management.

(2) Implementation of waste minimization measures throughout the process

A-70 The Research on Radioactive Waste Minimization Strategy and Top-Level Design was launched from 2008 to 2011. In the project, the strategy and policy for radioactive waste minimization was reviewed, analysis was conducted on the measures for minimization of radioactive waste from the front-end of nuclear fuel cycle facilities, NPPs, the back-end of nuclear fuel cycle facilities, as well as from the utilization of nuclear technology and the use of research reactors, and the technology and equipment for sorting radioactive waste were developed. Based on relevant research results, NNSA issued

Radioactive Waste Minimization at Nuclear Facilities (HAD401/08-2016). The document provides guidance for the design, construction, operation and decommissioning organizations of nuclear facilities to minimize radioactive waste. The measures including source control, recycling and reuse, clearance, optimized treatment and enhanced management, can be taken to keep the generation (volume and activity) of solid radioactive waste as low as reasonably achievable on a basis of cost-benefit analysis.

A-71 In accordance with laws, regulations and guides, NNSA enhances the supervision and management of waste minimization in operating NPPs, strengthens the review of waste minimization sections in environmental impact assessment report, safety analysis report, feasibility study report, annual operation report, ten-year periodic safety assessment, decommissioning applications and other documents of NPPs, and facilitates the implementation of waste minimization in all phases of NPPs at regulatory level..

A-72 Efforts are made to reduce the generation of radioactive waste at the very beginning of design. Measures such as optimized systems, reasonable design, reliable equipment and strict management are taken to control waste from sources, reduce the amount of waste to be treated and make the waste easier to be treated, so as to minimize the generation of resulting waste and the cost of radioactive waste treatment and disposal.

A-73 Great support are provided for the use of advanced and applicable waste minimization technologies, including membrane treatment technology for liquid radioactive waste, drying technology for liquid chemical waste, drying and hot pressing technology for waste resin, wet oxidation and efficient solidification technology for waste resin, combustible waste incineration technology, high integrity container (HIC) technology and mobile treatment equipment for liquid waste. Improvement has been made in the solidification formula of concentrated solution and waste resin to increase the volume containment. The advanced solidification and mixing process of wet waste is adopted to improve the filling rate of waste barrels, and the steel barrel is used as the container of solidified substance to improve the volume utilization. Super compaction device is placed for technical waste to further compact and reduce the volume of primary compacted waste. At the same time, efforts are made to strengthen operation management of nuclear facilities, strictly classify wastes, and implement the waste minimization in the operation phase.

A-74 Nuclear power plants are encouraged to provide mutual technical support for radioactive waste minimization. China National Nuclear Power Co.,

Ltd. (CNNP) organized technical support activities for radioactive waste minimization among all operating NPPs in accordance with *Technical Support Guidelines for Minimization of Radioactive Waste from Nuclear Power Plants in China*. From June to November 2019, technical support activities were completed for waste minimization of Qinshan and Sanmen NPPs. The activities include cross inspection among NPPs, on-site inspection, document access, record review, personnel interview. The aim is to find out the weakness and areas for improvement in radioactive waste management in inspected NPPs, upgrade radioactive waste minimization management in NPPs, and explore potential good practices to be extended to other NPPs. China General Nuclear Power Corporation (CGN Power Co., Ltd.) has set up a peer group in the field of radioactive waste management, which is committed to the implementation of coordinated, professional and intensive management of radioactive waste in operating NPPs, and to promote the realization of radioactive waste minimization. Following the principle "focusing on waste disposal and minimizing waste by technology and management", the peer group investigates and analyzes the advanced performance in the field to systematically eliminate the gap, achieve and maintain the advanced performance level of radioactive waste minimization management. In 2019, CGN Power put forward the control target value of intermediate and long-term generation of radioactive waste from NPPs. Through the peer group, it promoted the implementation of source control of radioactive waste, studied and selected the approach to volume reduction of radioactive waste to ensure the realization of the control target of radioactive waste generation.

A-75 The volume of solid radioactive waste (after conditioning) from PWR nuclear power units in mainland China under normal operating conditions now is no more than 50 m^3 (1,000MWe per unit) through continuous implementation of radioactive waste minimization for many years.

A. 8 Good performances

A-76 Four good performances have been achieved in China in the safety of spent fuel management and the safety of radioactive waste management.

(1) Improving nuclear safety standard system with reference to relevant IAEA safety standards

A-77 During this period of implementation, NNSA, referring to relevant IAEA safety standards in area of radioactive waste management and taking into account national conditions, has improved nuclear safety regulations and standards system for radioactive waste management, and developed 14 guidelines and 3 technical

documents on pre-disposal management, disposal and nuclear facility decommissioning. Two nuclear safety guides have been issued and implemented, Namely *Monitoring and Inspection of Radioactive Waste Disposal Facilities* (HAD401/09-2019) and *Geological Disposal Facilities of Radioactive Waste*. Request for comments on eight nuclear safety guides have been completed.

A-78 The system for radioactive waste classification with emphasis on waste disposal, has been established in China. The public announcement on *Radioactive Waste Classification* was released. The *Regulations on Near Surface Disposal of Low and Intermediate Level Solid Radioactive Waste* (GB9132-2018) was revised to provide for the safety of near surface disposal.

(2) Promoting the disposal of disused sealed sources

A-79 In 2019, NNSA approved the disposal of 18,000 disused sealed sources containing ^{192}Ir and ^{75}Se in two organizations. The sources cannot be released from control due to the presence of ^{63}Ni and ^{60}Co, although the activities of ^{192}Ir and ^{75}Se in the sources have decayed to the level of 10^5 Bq. At present, these disused sealed sources are recycled by those who have produced them for long-term storage. NNSA has reviewed the conditioning and disposal options for these disused sealed sources, and approved to send these sources to the near surface disposal site after being conditioned.

A-80 The disused sealed sources stored in national disused sealed source inventory has been sorted out, classified and characterized according to expected modes of conditioning and disposal. NNSA has organized and implemented the research on safety requirements, acceptance criteria and technical insights for near surface disposal of disused sealed sources. Related management requirements are expected to develop. Meanwhile, the feasibility study of near surface disposal of ^{60}Co and ^{137}Cs disused sources will be carried out to solve the disposal problem of some disused sealed sources.

(3) Promoting market-oriented and specialized storage and treatment of radioactive waste

A-81 In accordance with the LNS, the licensing system for radioactive waste management was established to provide a basis for market-oriented and specialized storage and treatment of radioactive waste. In 2019, the license of radioactive waste storage was granted by NNSA to Gansu Dongfang Ruilong Environmental Remediation Co., Ltd. The company has also submitted the application for construction permit of a low-level solid radioactive waste treatment facility, which is intended for incineration and volume reduction of combustible solid radioactive

waste from NPPs. In addition, two companies are applying for construction permits for radioactive waste treatment facilities. A number of nuclear power base operators are organizing the transport of their accumulated combustible solid radioactive wastes away from the bases for incineration and volume reduction.

(4) Establishing coordination mechanism for NIMBY issues related to nuclear projects

A-82 During this period of implementation, a joint meeting mechanism was set up for risk prevention of NIMBY issues related to nuclear projects, and an interactive mechanism was established for science popularization. In 2017, a joint meeting mechanism was set up by the former MEP, the MIIT and other departments for risk prevention of NIMBY issues related to environmental protection projects, and a coordination group was formed to perform periodic analysis, judgement and response to NIMBY issues related to nuclear projects. The response to major unexpected NIMBY issues are made jointly by government departments, nuclear power group companies and relevant organizations.

A.9 Matrix of Spent Fuel and Radioactive Waste Management in China

Type of Liability	Long-term Management Policy	Funding of Liabilities	Current Practice/Facility	Planned Facilities
Spent fuel	Reprocessing	Funds for the treatment and disposal of spent fuel at NPPs (only limited to PWRs)	Stored in 48 spent fuel pools and 2 dry interim storage facilities for spent fuel from NPPs, and in 3 spent fuel pools for spent fuel from research reactors	1 reprocessing plant and 2 dry storage facilities for spent fuel
Nuclear fuel cycle waste including NPP's waste	Deep Geological disposal	Funds for treatment and disposal of spent fuel at NPPs		1 underground laboratory for geological disposal
	intermediate depth disposal	Provided by the generator	Related research under way	
	Near surface disposal	Provided by the generator	3 operational LILW disposal facilities	5 near-surface disposal facilities
Waste arising from Nuclear Technology	Decay, clearance, storage and by-categorized	Provided by the generator and the related	Stored in 31 temporary storage facilities for waste	

Applications	disposal	government	arising from nuclear technology applications	
Decommissioning liabilities	Immediately demolished, delay in demolition	Provided by the operator and the related government		Decommissioning of the first heavy water research reactor
Spent and disused sources	Returned to original manufacturer, delivered for storage or disposal, clearance, reuse	Provided by the generator and the related government	Stored in 31 temporary storage facilities for waste arising from nuclear technology applications and 1 national centralized disused sealed sources temporary storage facility	

A-83 The MEE directs and urges all technical support organizations, local competent biological environment bodies and enterprises to make effective actions in science popularization for different target groups, make great efforts in spreading nuclear science, knowledge and technology, make nuclear science popularization more scientific, authoritative and effective, help improve the quality of science to the public, enhance public understanding and trust in nuclear science and technology, nuclear safety and nuclear emergency management, and strive to promote the safe and efficient development and peaceful use of nuclear energy in China. In November 2015, the official WeChat account was opened by NNSA to timely update the information on nuclear and radiation safety regulation, current events, industry information and popular science.

B. POLICIES AND PRACTICES (Article 32-1)

In accordance with the provisions of Article 30, each Contracting Party shall submit a national report to each review meeting of Contracting Parties. This report shall address the measures taken to implement each of the obligations of the Convention. For each Contraction Party the report shall also address its:

(i) spent fuel management policy;

(ii) spent fuel management practices;

(iii) radioactive waste management policy;

(iv) radioactive waste management practices;

(v) criteria used to define and categorize radioactive waste.

B.1 Spent Fuel Management Policy

B-1 China's spent fuel management policy is to implement the reprocessing of spent fuel and to extract and recover uranium and plutonium materials, so as to achieve maximum use of resources, reduce the generation of HLW and to ensure the safety of spent fuel management and the public safety, and to lower the risks to the future generations.

B-2 On the basis of the demands of nuclear power expansion in the near and long-term future, China is making efforts to develop overall planning for spent fuel management capability building, encourage enterprises to participate in capability building and scientific research, improve the regulatory system, and train high quality talent team, so as to ensure the smooth implementation of the spent fuel management policy.

B.2 Spent Fuel Management Practices

B-3 At present, spent fuels generated from NPPs and research reactors are stored at reactors. The operators of NPPs and research reactors shall have the overall responsibility over the safety of management of spent fuels generated by them.

B-4 The construction plan on storage system of spent fuel generated from NPPs has been developed by CAEA. With the demands of the generation, transportation, and storage of spent fuel withdrawn from NPPs, this plan has defined the planning and support policy in building spent fuel transportation and storage ability, and put forward spent fuel management principle compatible with national nuclear power expansion.

B-5 The spent fuel storage facilities (based on spent fuel storage pools and complemented by dry storage facilities) have been established to variable extent

at NPPs to accommodate the spent fuel arising from NPPs within a certain period of time and ensure storage safety. The dry storage facility at Tianwan NPP has been completed and put into operation, and the dry storage facility is under construction at Daya Bay NPP. The spent fuel storage facility was built at each of NPPs, with more information found in section L.1.1

B-6 An away-from-reactor dry storage facility of spent fuel has been erected at Qinshan Phase III NPP, consisting mainly of spent fuel preparation zone, transport zone, and dry storage zone. The first, second, and third batch of two modules were put into operation in September 2009, the end of 2013, and April 2018 separately. Details can be found in Chapter G.

B-7 Under the *Regulations on nuclear power plant operation safety* (HAF103) and the *Research reactor operation management* (HAD202/01), the operators of both NPPs and research reactors have responsibilities for all activities of managing reactor core and fuel, including spent fuel. The management procedures for nuclear fuel and reactor-core components are prepared, including handling of irradiated fuel, storage in plant area, and preparatory work for delivery of spent fuel to the outside, which can ensure the safety of fuel using in a reactor and the safety of fuel during the transfer and storage in the plant area.

B-8 Under the HAF103 and the HAD202/01, the operators of NPPs and research reactors have prepared the operational procedures for various steps of spent fuel management and implemented wide variety of activities, such as spent fuel withdrawing operation, radiation measurement, radiation protection supervision, spent fuel storage, management and surveillance of plant building and installations, documentation, water chemistry analysis and quality assurance.

B-9 The fund for treatment and disposal of spent fuel from NPPs has been set up in China and can be available for the transport, storage and reprocessing of spent fuel and the disposal of HLW. In 2010, IPCUMFTDSFNPP were issued by the MoF, the National Development and Reform Commission and the MIIT. In 2014, the *Projects Management Methods of the Fund for Treatment and Disposal of Spent Fuel from Nuclear Power Plants* was issued by CAEA govern the management of the funded-projects, so as to improve the efficient use of the funds.

B-10 To meet the demands of nuclear power expansion, China makes effort, based on an overall planning, to construct the facilities for storage, transport and reprocessing of spent fuel. The ongoing efforts involve the extension of the

research and development of spent fuel dry-storage and reprocessing technologies, the promotion of large commercial reprocessing plant project. The capacity of the storage and reprocessing of spent fuel continued to be constantly improved as needed.

B.3 Criteria Used to Define and Categorize Radioactive Waste

B-11 As specified in the LPCRP, radioactive waste is those that contain, or are contaminated with, radionuclides with activity concentrations or total activity greater than the clearance level as established by the regulatory body without foreseen further use.

B-12 In China, radioactive wastes arise mainly from NPPs, research reactors, nuclear fuel cycle, nuclear technology applications, and mining and uses of uranium (thorium) resources. On November 30, 2017, the former MEP, the MIIT and CAEA jointly released the public announcement on *Classification of Radioactive Waste* to provide guidance for classification of radioactive waste in nuclear industry and nuclear technology applications. With reference to IAEA's General Safety Guide: *Classification of Radioactive Waste* (GSG-1), the new waste classification scheme aims to achieve the final disposal of radioactive waste in a safe way. According to the potential hazards of various types of waste and the degree of containment and isolation for disposal, radioactive wastes are divided into VSLW, VLLW, LLW, ILW and HLW, which are suitable for release from regulatory control after a period of decay storage, landfill disposal, near surface disposal, intermediate depth disposal and deep geological disposal separately, as shown in Figure 1.

B.3.1 Exempt/Clearance waste

B-13 Exempt/clearance waste, with the activity concentration of radionuclides at a very low level, meets the criteria for exemption or clearance, and needs no regulatory control for radiation protection purposes.

B-14 Exempt/clearance waste shall be treated and disposed in a way that satisfies national regulations on solid waste management.

B.3.2 Very Short-Lived Waste (VSLW)

B-15 Very short-lived waste, which main contains radionuclides of very short half-lives (generally, less than 100 days) and with the activity concentration of long-lived radionuclides below clearance level, can be stored for decay over a limited period of up to a few years and subsequently cleared from regulatory control. Example of VSLW are waste from medical use of iodine-131 and other very short-lived radionuclides.

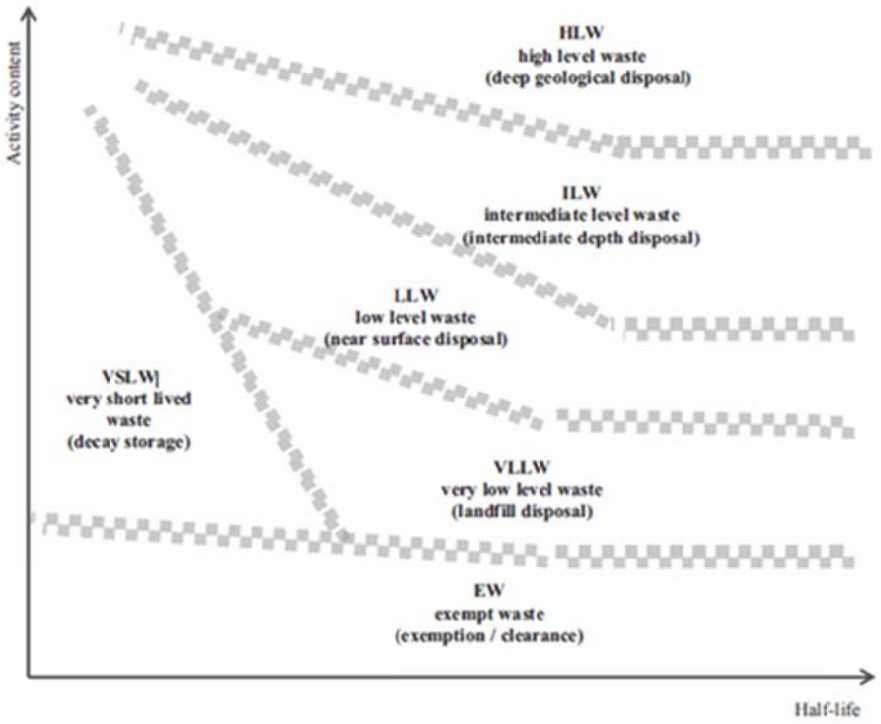

Figure 1. Conceptual illustration of the waste classification scheme

B.3.3 Very Low Level Waste (VLLW)

B-16 Very low level waste, with the activity concentration of radionuclides close to or slightly higher than exempt/clearance level, and the activity concentration of long-lived radionuclides at a very limited level, needs a limited level of containment and isolation, and can be buried in surface landfills or disposed in industrial solid waste landfills according to national regulations on solid waste management.

B-17 The lower limit of activity concentration of VLLW is equivalent to clearance level, and the upper limit is generally 10-100 times of clearance level. Examples of the commonly VLLW are the contaminated soil and construction waste from decommissioning of nuclear facilities.

B.3.4 Low Level Waste (LLW)

B-18 Low level waste, with the activity concentration of short-lived radionuclides at a higher level and the activity concentration of long-lived radionuclides at a relatively low level, requires effective containment and isolation for hundreds of years, and can be disposed in engineered near surface disposal facilities. The depth of near surface disposal facilities is typically from the surface down to 30 meters.

B-19 The lower limit of activity concentration of LLW is equivalent to the

upper limit of activity concentration of VLLW, and the upper limit is shown in Table 1.

Table 1. Upper limit of activity concentration of LLW

Radionuclide	**Half-life**	**Activity concentration（Bq/kg）**
Carbon-14	5.73×10^{3}a	1×10^{8}
Carbon-14 in activated metals	5.73×10^{3}a	5×10^{8}
Nickel-59 in activated metals	7.50×10^{4}a	1×10^{9}
Nickel-63	96.0a	1×10^{10}
Nickel-63 in activated metals	96.0a	5×10^{10}
Strontium-90	29.1a	1×10^{9}
Niobium-94 in activated metals	2.03×10^{4}a	1×10^{6}
Technetium-99	2.13×10^{5}a	1×10^{7}
Iodine-129	1.57×10^{7}a	1×10^{6}
Cesium-137	30.0a	1×10^{9}
Alpha emitting transuranic nuclides with half lives greater than 5 years		4×10^{5}（average） 4×10^{6}（single waste package）

B-20 For radionuclides not listed in Table 1, the upper limit of activity concentration is 4×10^{11} Bq/kg.

B-21 LLW comes from a wide range of sources, such as solidified forms of ion exchange resin and radioactive liquid concentrate produced during normal operation of NPP.

B.3.5 Intermediate level waste (ILW)

B-22 Intermediate level waste, with a considerable number of long-lived nuclides, especially alpha emitting radionuclides, cannot rely on monitoring measures to ensure the safety of waste disposal, but requires a greater degree of containment and isolation than that provided by near surface disposal. ILW requires disposal at a depth of tens to hundreds of meters underground. In general, ILW needs no measurements for heat dissipation during its storage and disposal.

B-23 The lower limit of activity concentration of ILW is equivalent to the upper limit of LLW, and the upper limit is 4×10^{11} Bq/kg, and the heat release rate is less than or equal to 2 kW/m^3. The ILW generally comes from the material operation process containing radionuclide plutonium-239, operation of spent fuel reprocessing facilities and decommissioning process.

B.3.6 High level waste (ILW)

B-24 High level waste with levels of activity concentration high enough to generate significant quantities of heat by the radioactive decay process, or contains large amounts of long-lived radionuclides. Therefore a higher degree of containment and isolation, heat dissipation measures are needed, and deep geological disposal, should be adopted.

B-25 The lower limit of activity concentration of HLW is 4×10^{11} Bq/kg, or the heat release rate is greater than 2 kW/m^3.

B-26 Examples of common HLW are vitrified high-level waste produced by the operation of spent fuel reprocessing facilities and spent fuel without reprocessing.

B.4 Radioactive Waste Management Policy

B-27 The management of radioactive waste must adhere to the concept of safety as the goal and disposal as the core, realize the minimization of radioactive waste, to ensure the safety for now and future generations, without compromising the ability of future generations to meet their needs and aspirations.

B-28 The generators of radioactive wastes shall bear overall safety responsibility.

B-29 Radioactive wastes shall be managed in terms of their classifications.

B-30 Relevant radioactive waste management facilities shall be simultaneously established together with their main technological process facilities in their design, construction and operation. Radioactive waste generated from nuclear technology applications shall be stored in the centralized radioactive waste temporary storage facilities at provincial-, municipal- and autonomous regional-level.

B-31 The release to the environment of gaseous and/or liquid effluent shall be subject to the national standards on radioactive contamination prevention and control. Solid radioactive waste shall be disposed of in accordance with their classification. LILW waste shall be disposed of in near-surface or intermediate-depth disposal facilities. HLW waste shall be centrally disposed of in a deep geological disposal repository.

B-32 During the process of design, construction, operation and decommissioning of nuclear facilities, measures, such as source control, recycling and reuse, clearance, optimized waste treatment and strengthened

management, shall be taken to maintain the resulting production (volume and activity) of solid radioactive waste as low as reasonably achievable in a cost-effective way.

B-33 Solid radioactive waste is prohibited to be disposed of in inland rivers and waters or seas. Both radioactive waste and radioactively-contaminated articles are prohibited to export to, and transfer in, the territory of the People’s Republic of China.

B.5 Radioactive Waste Management Practices

B-34 According to the requirements of "three simultaneousness", auxiliary facilities for radioactive waste management have been built by all operators of nuclear facilities. All nuclear facilities have formulated radioactive waste management program and procedures to implement management of radioactive waste according to classification.

B-35 Generally, the gaseous/liquid radioactive waste shall be treated by the operators of nuclear facilities and released when the standards are met, and maintained as low as reasonably achievable. The radioactive solid waste and the liquid radioactive waste that cannot be purified and discharged shall be treated and put into stable and standardized waste packages that meet the disposal requirements, stored by operators of nuclear facilities and then sent to the license holder for disposal in time. The methods for treatment of gaseous radioactive waste from nuclear facilities include filtration, adsorption, and decay storage; the methods for treatment of liquid radioactive waste include filtration, evaporation, ion exchange, silica gel adsorption and membrane treatment; the methods for treatment of solid waste include cement solidification/immobilization, super compression, HIC, and hot compression.

B-36 Radioactive waste minimization is implemented continuously at the operating NPPs in China. The training and publicity on waste minimization have brought about enhanced awareness to personnel and contractors in this aspect. Wide varieties of minimization technologies are employed, such as pre-compression and super-compression and changing cement-solidified packaging container to metal drum to reduce volume, trial of paper garment and shoe covers made from biodegradable materials and other protective articles. Novel waste treatment technologies and operational models are incorporated into the design of newly constructed NPPs, such as drum drying, waste resin static hot pressing processor, mobile liquid waste processing installation, Site Radioactive Treatment Facility (SRTF), and so on. Under the joint effort of the CAEA and NNSA, the project “study on strategy and top-level design of waste

minimization” was sponsored during 2008 to 2011 by the related research institutions, nuclear fuel cycle enterprises and NPP companies concerned. This study project covered the policy and strategy on radioactive waste minimization, the radioactive waste minimization at front- and back-end of nuclear fuel cycle including NPPs, and the radioactive waste minimization of nuclear technology applications and research reactors, and the development of practical techniques and specific equipment for radioactive waste minimization sorting. The document HAD401/08-2016 was issued by NNSA in 2016 to provide guidance for waste minimization at NPPs.

B-37 China National Nuclear Power Co., Ltd. (CNNP) carries out the technical support activities for radioactive waste minimization of all operating NPPs in accordance with *Guidelines for Technical Support for Minimization of Radioactive Waste from Nuclear Power Plants in China*. In June and November 2019, the technical support activities for waste minimization were completed respectively at Qinshan and Sanmen Nuclear Power Plants. The gaps and areas for improvement have been identified in the radioactive waste management through cross inspection among CNNP's NPPs, specifically on-site inspection, document retrieval, record review, personnel interview, thus enhancing management of radioactive waste minimization at NPPs and extending their potential good practices in waste minimization to other NPPs.

B-38 In 2019, CNNP organized the preparation of four management procedures, including the *Scheme for Establishment of Evaluation Index for Radioactive waste Production of the Operational Nuclear Power Plants in China*. In accordance with the relevant management system, CNNP's operating NPPs carefully examine and approve discharge applications, strengthen discharge monitoring and supervision, control and minimize radioactive waste discharge, and the annual radioactive discharge are far below authorized limits.

B-39 CGN Power Co., Ltd. has set up a peer group in the field of radioactive waste management, which is committed to the implementation of standardized, professional and intensive management of radioactive waste in operating NPPs, and to promote the realization of radioactive waste minimization. Following the principle "focusing on waste disposal and minimizing waste by technology and management", the peer group investigates and analyzes the advanced performance in the field to systematically eliminate the gap, achieve and maintain the advanced performance level of radioactive waste minimization management. In 2019, CGN Power Co, Ltd. put forward the control target value of intermediate and long-term generation of radioactive waste from NPPs.

Through the peer group, CGN promoted the implementation of source control of radioactive waste, studied and selected the approaches of volume reduction of radioactive waste to ensure the realization of the control target of radioactive waste generation.

B-40 China has attached importance to the HLW disposal planning. The *Guidelines on Research and Development Planning for Geological Disposal of HLW* was issued in 2006 under the joint effort the CAEA, the MST and the former State Environmental Protection Administration (SEPA). As stipulated by it, the general objective of China's HLW geological disposal study is to select a site featuring stable geological formation and suitable socioeconomic environment and to complete the country's HLW geological disposal facility by the mid-21 century. With the aid of the confinement and retardation by the engineering and geological barriers, this facility will protect the environment and the public health from unacceptable harms from HLW within a long time period. The research, development and disposal facility construction shall be divided into three phases: (1) laboratory-based research, development and disposal facility siting (2006-2020), (2) underground laboratory-based research (2021-2040), and (3) prototype facility validation and actual facility construction (2041-the middle of the Century). The OTFPNESDPRC gives a clearer description: one underground laboratory for HLW geological disposal shall be constructed during 2016-2020. The TFP2025VNSRPC requires accelerating the research on the disposal of HLW. During the 13th Five-Year Plan period, the construction of underground laboratory for geological disposal of HLW will be started, the site selection and investigation of geological disposal site for HLW will be promoted, and the research on engineering barrier, disposal technology, geochemistry and safety assessment will be carried out to identify the safety objectives and principles for safe disposal of HLW, and study on the technical safety criteria for geological disposal siting of HLW in China.

B-41 CAEA has been developing siting and relevant research efforts for geological repository of HLW. Screening survey was conducted in six pre-selected regions of Eastern China, Southern China, Southwestern China, Inner Mongolia, Xinjiang and Gansu, with emphasis on the study of site characteristics in Beishan pre-selected region.

B-42 In May 2019, CAEA approved *the proposal for Engineering Project on Underground Laboratory for Geological Disposal of HLW in China*, planning to build an underground laboratory for geological disposal of HLW in Xinchang section of Beishan, Gansu Province. With approval from CAEA, the chief

commander and chief designer system was established in December 2019. At present, the construction of the underground laboratory is under way and the related research work in the construction process are organized by CAEA and nine projects on HLW geological disposal research and development were approved, including mechanical excavation equipment for disposal pit of HLW repository, long-term environmental monitoring and impact of underground laboratory site, the preliminary study on the structural layout and disposal concept of demonstration tunnel for underground laboratory, in-situ test and installation technology for buffer material under the condition of underground laboratory, mechanical properties and long-term stability of deep surrounding rock of underground laboratory, key technology for deep rock excavation of underground laboratory, deep geological environment of underground laboratory site, hydrogeological characterization of underground laboratory site and radionuclide release and migration under the condition of deep surrounding rock.

B-43 Chinese government attaches importance to planning and implementation of LILW treatment and disposal facilities. In TFP2025VNSRPC, nine key tasks, covering maintaining a high safety level of NPPs, reducing the risk of research reactors and nuclear fuel cycle facilities, accelerating the decommissioning of earlier nuclear facilities and radioactive waste treatment and disposal are specified; and five key projects, including the decommissioning of nuclear facilities and radioactive waste treatment, are identified. Meanwhile, the planning for LILW disposal sites will be released and implemented and five disposal sites will be sited and constructed to form a rational arrangement and promote the transport of waste from NPPs for disposal. According to the Five-year Plan, a demonstration project for centralized treatment of radioactive waste will be constructed, the technology for incineration of combustible solid waste and smelting of radioactively contaminated scrap will be used, and volume reduction and clearance of the waste from NPPs will be facilitated to realize the minimization of radioactive waste.

B-44 Three LILW disposal sites have been put into operation in China. The efforts for siting of LILW disposal facilities are being conducted, under the organization of CNNC, CGN and SPIC, in provinces, such as Fujian, Zhejiang, Guangxi, Liaoning and Shandong, where multiple NPPs are located.

B-45 Research and exploration on the intermediate depth disposal of radioactive waste is being carried out in China. In October 2019, the CAEA

approved the preliminary scientific research (top-level design stage) project on intermediate depth disposal of radioactive waste.

B-46 Nuclear technology application radioactive wastes temporary storage facilities are constructed in 31 provinces, autonomous regions or municipalities countrywide to store the disused sealed sources arising, within their respective scope, from industry, agriculture, medicine, education and research fields. Provincial ecology and environment departments have set up special-purpose organizations staffed with specialists or professionals who are responsible for oversight disused sealed sources and environmental monitoring. It has been known from the National Radiation Regulation System for Nuclear Technology Applications in operation for many years that, as of December 31, 2019, a total of 61,574 disused sealed sources have been collected and stored in provincial, regional and municipal storage facilities for nuclear technology applications, and 105,428 in the national centralized disused sealed sources temporary storage facilities. Meanwhile, the manufacturers are licensed to undertake the practices of recycling and reuse of Co-60, Cs-137, Am-241/Be and Pu-238/Be disused sealed sources.

C. SCOPE OF APPLICATION (Article 3)

1. This Convention shall apply to the safety of spent fuel management when the spent fuel results from the operation of civilian nuclear reactors. Spent fuel held at reprocessing facilities as part of a reprocessing activity is not covered in the scope of this Convention unless the Contracting Party declares reprocessing to be part of spent fuel management.

2. This Convention shall also apply to the safety of radioactive waste management when the radioactive waste results from civilian applications. However, this Convention shall not apply to waste that contains only naturally occurring radioactive materials and that does not originate from the nuclear fuel cycle, unless it constitutes a disused sealed source or it is declared as radioactive waste for the purposes of this Convention by the Contracting Party.

3. This Convention shall not apply to the safety of management of spent fuel or radioactive waste within military or defense programmers, unless declared as spent fuel or radioactive waste for the purposes of this Convention by the Contracting Party. However, this Convention shall apply to the safety of management of spent fuel and radioactive waste from military or defense programmers if and when such materials are transferred permanently to and managed within exclusively civilian programmers.

4. This Convention shall also apply to discharges as provided for in Articles 4, 7, 11, 14, 24 and 26.

C.1 Applicability to Spent Fuel

C-1 This report shall apply to the management of spent fuel arising from the operation of civilian nuclear reactors, but not to those held at reprocessing facility.

C.2 Applicability to Radioactive Waste

C-2 This report shall apply to the management of radioactive waste arising from the operation of civilian nuclear reactors and civilian nuclear fuel cycle facilities, and to the management of disused sealed sources (including ^{226}Ra disused sealed sources) arising from nuclear technology application, but not to the management of radioactive waste containing naturally occurring radioactive materials (NORM) and those due to nuclear technology applications.

C.3 Applicability to Spent Fuel and Radioactive Waste from Defense or Military Programs

C-3 This report shall not apply to the management of spent fuel and radioactive waste arising from military or defense programs.

C.4 Applicability to Effluent

C-4 This report shall apply to the discharge of gaseous and liquid radioactive effluents described in Articles 4, 7, 11, 14, 24 and 26 of this Convention.

D. INVENTORIES AND LISTS (Article 32-2)

This report shall also include:

i) a list of the spent fuel management facilities subject to this Convention, their location, main purpose and essential features;

ii) an inventory of spent fuel that is subject to this Convention and that is being held in storage and of that which has been disposed of. This inventory shall contain a description of the material and, if available, give information on its mass and its total activity;

iii) a list of the radioactive waste management facilities subject to this Convention, their location, main purpose and essential features;

iv) an inventory of radioactive waste that is subject to this Convention that:

a) is being held in storage at radioactive waste management and nuclear fuel cycle facilities;

b) has been disposed of; or

c) has resulted from past practices.

This inventory shall contain a description of the material and other appropriate information available, such as volume or mass, activity and specific radionuclides;

v) a list of nuclear facilities in the process of being decommissioned and the status of decommissioning activities at those facilities.

D.1 Spent Fuel Management Facilities

D-1 There are a total of 50 spent fuel storage facilities in place to serve, separately, 47 nuclear reactors at 16 NPPs in China, as listed in Annexes L.1.1.

D-2 A total of 3 spent fuel storage facilities were constructed to give the service to 13 research reactors that are operated by 3 operators, as listed in Annexes L.1. 2.

D.2 Inventory of Stored Spent Fuel

D-3 As of December 31, 2019, China’s NPPs have produced a total of 6494.9 tHM of spent fuel held in pool storage on-site, 1986.4 tHM of spent fuel held in dry storage facility, as shown in Annexes L.2.1.

D-4 The spent fuel, 0.663 tU, associated with research reactors are stored in the pool on-site, see Annexes L.2.2.

D-5 As of December 31, 2019, there is not any spent fuel disposal activity occurred in China.

D.3 Radioactive Waste Management Facilities

D.3.1 Radioactive Waste Treatment and Storage Facilities

D-6 Wide variety of radioactive waste treatment and storage facilities have been constructed by the end of December 31, 2019, including 69 by the 16 NPP operators, 11 by the 3 research reactor operators, 14 by the 4 operators of nuclear fuel cycle facilities, and 1 specialized radioactive waste storage facility, as shown in Annexes L.3.1-L.3.4.

D-7 In addition, 31 storage facilities of radioactive waste arising from nuclear technology application have been constructed, together with 1 national centralized storage facility for disused sealed sources, as shown in Annexes L.3.5.

D.3.2 Radioactive Waste Disposal Facilities

D-8 There are three LILW disposal sites in operation, as shown in Annexes L.3.6.

D.4 Radioactive Waste Inventories

D-9 As of December 31, 2019, the conditioned radioactive waste that has been stored is 14689.3 m^3 in the radioactive waste storage facilities by the NPP operators, as listed in Annexes L.4.1.

D-10 As of December 31, 2019, the conditioned radioactive waste that has been stored is 4678.8 m^3 in the radioactive waste storage facilities by the research reactor operators, 147.1 m^3 in those by the operators of nuclear fuel cycle facilities, as listed in Annexes L.4.2.

D-11 As of December 31, 2019, there have been 61,574 disused sealed sources stored in 31 storage facilities of radioactive waste arising from nuclear technology applications and 105,248 in the national centralized disused sealed sources temporary storage facility, listed in Annexes L.4.3.

D-12 As of December 31, 2019, there have been a total of 44,716.83 m^3 of solid radioactive waste accepted at three LILW disposal sites, listed in Annexes L.4.4.

D-13 As of December 31, 2019, there have been 208 m^3 of LLW accepted at one LLW storage facility, listed in Annexes L.4.5.

D.5 List of Nuclear Facilities under Decommissioning

D-14 Since the last report, there has not yet been any nuclear facility in decommissioning.

D-15 In 2019, the proposal for decommissioning of the Heavy Water

Research Reactor (hereinafter referred to as "Reactor 101") operated by China Institute of Atomic Energy (CIAE) was approved by the state. Reactor 101 is the first heavy water research reactor in China and the first one to be decommissioned. The decommissioning project is implemented by CIAE in three phases: from easy to difficult, from peripheral systems and main process systems to reactor itself, and at the same time, engineering research and verification is carried out. This approval aims at phase I, mainly including the preparation for decommissioning and the removal of peripheral systems.

E. LEGISLATIVE AND REGULATORY SYSTEM (Articles 18 to 20)

E.1 Implementing Measures (Article 18)

Each Contracting Party shall take, within the framework of its national law, the legislative, regulatory and administrative measures and other steps necessary for implementing its obligations under this Convention.

E-1 For the purpose of extending the effort to fulfill the China's commitment to the Joint Convention and to implement its obligations under the Joint Convention, the Chinese Working Group for Joint Convention Implementation (CWGJCI) was established, under the approval of the State Council, to undertake the responsibility for organizing and coordinating the fulfillment of the Joint Convention. The CWGJCI is composed of the MEE/NNSA, CAEA, the Ministry of Foreign Affairs (MFA), the Ministry of Public Security (MPS), the NHC and the National Energy Administration (NEA). The CWGJCI is headed by MEE/NNSA, with the CAEA as the deputy Group head. The CWGJCI's Secretariat is based on the Department of International Cooperation under MEE.

E-2 In order to prepare the National Report to the Joint Convention, a National Report Review Committee (NRRC) and a National Report Writing Group (NRWG) were established. The NRRC consists of the experts relevant to the safety of spent fuel management and the safety of radioactive waste management. Under the guidance of the CWGJCI, the NRRC and the NRWG undertake (1) to prepare and review China's National Report to the Joint Convention, (2) to preliminarily review China's questions to the National Reports of other Contracting Parties, (3) to review the response of questions to China's National Reports raised by other Contracting Parties, and (4) to prepare for, take part in, and summarize the Review Meeting to the Joint Convention and to take actions accordingly.

E.2 Legislative and Regulatory Framework (Article 19)

1. Each Contracting Party shall establish and maintain a legislative and regulatory framework to govern the safety of spent fuel and radioactive waste management.

2. This legislative and regulatory framework shall provide for:

(i) the establishment of applicable national safety requirements and regulations for radiation safety;

(ii) a system of licensing of spent fuel and radioactive waste management activities;

(iii) a system of prohibition of the operation of a spent fuel or radioactive waste management facility without a licence;

(iv) a system of appropriate institutional control, regulatory inspection and documentation and reporting;

(v) the enforcement of applicable regulations and of the terms of the licences;

(vi) a clear allocation of responsibilities of the bodies involved in the different steps of spent fuel and of radioactive waste management.

3. When considering whether to regulate radioactive materials as radioactive waste, Contracting Parties shall take due account of the objectives of this Convention.

Safe management of activities involving radioactive materials comprises two inseparable aspects: radiological protection and nuclear safety.

E.2.1 Legislative Framework

E-3 Under the *Legislation Law of the People's Republic of China* and being consistent with the statutory power and procedures, China established and maintained a legislative framework governing the safety of spent fuel management and the safety of radioactive waste management, that incorporates a comprehensive set of the relevant national laws, administrative regulations, departmental rules, management guides and reference documents, as shown in Figure 2. The laws that are applicable to the safety of spent fuel management and the safety of radioactive waste management are developed and promulgated by the National People's Congress Standing Committee (NPCSC); administrative regulations are developed and issued by the State Council as mandated by the National Constitution and the relevant laws; departmental rules are developed and issued by the ecological and environmental authority, nuclear facility authority and health authority, of the State Council, as mandated by the relevant national laws, regulations and responsibilities and assignments of the State Council; the management guides are developed and issued by the relevant

departments of the State Council. Reference documents are developed by the State Council's relevant departments or its mandated agencies, and issued by the State Council' subsidiary departments.

Figure 2. Legislative Framework System in China

E-4 The laws, regulations and rules that have been in effect and applicable to such purpose of the safety requirements for the management of spent fuel and radioactive waste, which include, for example:

- *Law of the People's Republic of China on Nuclear Safety,* enacted by the NPCSC in 2017;

- *Law of the People's Republic of China on Prevention and Control of Radioactive Pollution* (LPCRP), enacted by the NPCSC in 2003;

- *Regulations of the People's Republic of China on Safety Control of Civilian Nuclear Installations* (HAF001), issued by the State Council in 1986;

- *Regulations on Safety and Protection of Radioisotope and Ray-emitting Devices* (RSPRRD), issued in 2005; and

- *Regulations on the Safety of Radioactive Waste Management* (RSRWM),

issued in 2011.

E-5 The laws, regulations, rules, guides applicable for such purpose are listed in detail in L.5.1 ~ L.5.4.

E-6 The LNS was promulgated in September 2017, and was implemented as of January 1, 2018. As supreme legal authority on nuclear safety, the LNS has further improved the legal system of nuclear safety in China. It is the cornerstone to ensure nuclear safety. The LNS stipulates policies, principles, responsibilities, technologies and institutions to ensure nuclear safety; qualification, duties and responsibilities of operators of nuclear facilities; licensing system of nuclear facilities and nuclear materials; system of radioactive waste management; systems of nuclear emergency coordination committee, emergency plan and nuclear accident information release; system of nuclear safety information disclosure and public participation, and their subject and scope; specific measures to oversee and inspect nuclear safety; penalties for violations; and compensation for damages caused by nuclear accident. The regulations under the LNS are being developed or revised by MEE/NNSA. For example, *Safety Licensing Procedures for Nuclear Power Plants, Research Reactors and Nuclear Fuel Cycle Facilities* was formulated and issued by MEE/NNSA in August 2019.

E-7 In addition, a series of technical standards were issued by the relevant governmental departments, which has further defined and clarified the technical requirements for the management of spent fuel and radioactive waste. For example:

- The *Basic Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources* (GB18871-2002) stipulates the basic requirements for radiation protection and radiation source safety, which is applicable to the protection of workers in intervention or practice, and the safety of radiation sources in use.

- The *Regulations for Radioactive Waste Managemen*t (GB14500-2002), stipulates the management objective and basic requirements for the generation, collection, pre-treatment, treatment, conditioning, transportation, storage, disposal and discharge of radioactive waste, and for the decommissioning and other activities related to the environmental remediation, which is applicable to various stages in nuclear fuel cycle and the management of radioactive waste generated by nuclear technology application.

Technical standards that are applicable to the safety of spent fuel

management and the safety of radioactive waste management are listed in Annex L.5.5.

E-8 The laws, regulations, rules, guides issued/amended since the last Review Meeting are as follows:

(1) Laws

Law of the People's Republic of China on Nuclear Safety, enacted by the NPCSC in September 2017;

(2) Departmental rules

Classification of Radioactive Waste, issued by the former MEP, MIIT and CAEA in November 2017;

Safety Licensing Procedures for Nuclear Power Plants, Research Reactors and Nuclear Fuel Cycle Facilities (SLPNPPRRNFCF), issued by MEE/NNSA in August 2019;

Measures for the Management of Safety Licensing of Radioisotope and Radiation Devices (MMSLRRD), amended by MEE/NNSA in August 2019;

Management Measures for Safe Transport of Radioactive Substance, amended by MEE/NNSA in August 2019;

(3) Management guides

Requirements for the Safety Protection System of Urban Radioactive Waste Temporary Storage Facilities (HAD802/01-2017), issued by NNSA on February 4, 2017;

Regular Safety Review of Research Reactors (HAD202/02-2017), issued by NNSA on April 10, 2017

Safety Management of Research Reactors after Long-term Shutdown (HAD202/03-2017), issued by NNSA on April 10, 2017

Physical Protection for Nuclear Installations (HAD501/02-2018), issued by NNSA on February 11, 2018;

Monitoring and Inspection of Radioactive Waste Disposal Facilities (HAD401/09-2019), issued by NNSA on March 22, 2019.

E.2.2 Regulatory Framework

E-9 The followings are implemented under the LPCRP, the LNS, the *Law of*

the People's Republic of China on Prevention and Control of Occupational Diseases (LPCOD), HAF001, RSPRRD, and RSRWM:

(1) The licensing control of spent fuel and radioactive waste management activities has been established in China, spent fuel and radioactive waste management facilities without licenses are prohibited:

- A nuclear facility safety licensing system is implemented in China. The MEE/NNSA is responsible for establishing and approving the granting of nuclear facility safety licenses, which include nuclear facility siting censor position paper，nuclear facility construction license, nuclear facility operation license, and nuclear facility decommissioning permit. Nuclear facilities here refer to NPPs, research reactors, other nuclear fuel cycle facilities, and radioactive waste treatment, storage and/or disposal facilities. The operators of these facilities must apply for the construction and operation license and for authorizations for siting and decommissioning, prior to carrying out such activities.

- A graded licensing system is implemented in China. The operators of production, distribution and use of radioactive sources must apply for radiation safety licenses. The licenses for the producers of radioactive sources and the users of Category I radioactive source (excluding medical users of Category I source) are reviewed, approved, and granted directly by MEE/NNSA, whereas the licenses for the users of Category II, III, IV and V by provincial ecology and environment departments.

- The operators dedicated exclusively to the treatment, storage and disposal of radioactive waste must apply for licenses of such activities. The licenses of such activities are reviewed, approved and granted by the MEE/NNSA.

(2) The system of institutional control, regulatory inspection, and documentation and reporting has been established:

- A radioactive contamination monitoring system is implemented in China, such as gaseous and liquid effluent release licensing system, effluent and environmental monitoring system, and nuclear accident emergency system, and so on. Additionally, certificate management systems are exercised for the regulatory inspection personnel and the qualification management systems are for the technical professionals engaged in critical positions of nuclear safety.

- The NNSA and its regional branches implement routine inspection, non-routine inspection and daily inspection, and dispatch inspection personnel (or group) to the nuclear equipment manufacture, nuclear facility construction

and operation fields for implementation of regulatory missions. Under the LPCRP and the RSRWM, the environmental protection departments of the people's governments at or above county-level, jointly with other related departments, implement regulatory inspection of the safety of radioactive waste treatment, storage and disposal activities.

- The operators of nuclear facilities should implement file management of testing procedures, operational procedures, QA records, testing results and data, operation and maintenance records, defects and abnormal events; the producers, distributors and users of radioactive sources should establish their own relevant management accounts, personal dose files, occupational health surveillance files; the operators of solid radioactive waste treatment, storage, and disposal facilities shall establish records and files of radioactive waste treatment, storage and disposal activity ,accordingly.

- The operators of nuclear facilities, nuclear technology application, and radioactive waste storage should report truthfully, as required by the MEE/NNSA, the status of radioactive waste's generation, treatment, storage, discharge, clearance and delivery for disposal. The operators of radioactive waste disposal facilities are required to report, prior to March 31 every year, to the related departments the situations about waste acceptance and disposal and facility operation in the previous year.

- In the event of a nuclear and radiation emergency, the operators of nuclear facilities must report immediately to the relevant departments; the operators of nuclear technology application should report immediately to the relevant departments if radioactive sources are found lost or stolen.

(3) The regulations and licensing provisions on spent fuel and radioactive waste management are enforced in China. For the license holders who violate the regulations, and/or licensing terms and conditions, the NNSA has the right to take compulsory measures when necessary, or to order the license holders to take safety measures or stop the activity endangering the national safety. Depending on the seriousness, the NNSA shall give warning for improvement with a time limit, or order to halt or stop operations for rectification, or order to revoke license for punishment; for the license holders who would not carry out the decision on punishment and not to prosecute overdue, the NNSA shall apply to the people's court for compulsory execution.

(4) The assignment of responsibilities for various administrative departments on spent fuel and radioactive waste management are clearly defined. The MEE/NNSA exercise overall regulatory control over the radioactive pollution

prevention work throughout the country and is responsible for the safety supervision of radioactive waste management in China. The CAEA is responsible for developing the policy, regulations, plan and standards, and for organizing the related nuclear emergency works and for coordinating and pushing forward the capability construction concerned. Other relevant departments of the State Council and, according to the duties specified by the State Council, are responsible for the oversight and administration of the spent fuel and radioactive waste management (see E.3 and E.4).

E-10 In accordance with the GB18871-2002, the GB27742-2011 and the *Clearance Levels for Recycle and Reuse of Steel and Aluminum from Nuclear Facilities* (GB17567-2009), the MEE/NNSA treats the wastes that containing activity higher than regulatory level as those that shall be under the regulatory control, to ensure that there are effective defense against potential hazards so the individuals, society and the environment are protected from harmful effects of ionizing radiation, now and in the future, which is consistent with the objective of the Joint Convention.

E.3 Regulatory Body (Article 20)

1. Each Contracting Party shall establish or designate a regulatory body entrusted with the implementation of the legislative and regulatory framework referred to in Article 19, and provided with adequate authority, competence and financial and human resources to fulfill its assigned responsibilities.

2. Each Contracting Party, in accordance with its legislative and regulatory framework, shall take the appropriate steps to ensure the effective independence of the regulatory functions from other functions where organizations are involved in both spent fuel or radioactive waste management and in their regulation.

E-11 China’s regulatory bodies involved in spent fuel and radioactive waste management are the MEE/NNSA, the NHC, and the MPS.

E.3.1 Independency of Regulatory Body

E-12 The MEE/NNSA is the independent regulatory body of the nuclear safety and radiation safety, which is responsible for the supervision of the nuclear safety and radiation safety.

E-13 The responsibility assignment of various relevant regulatory bodies is defined clearly in the LNS, the LPCRP, LPCOD, HAF001, RSRWM and RSPRRD to ensure the independency of regulatory bodies. For example, the LNS stipulates that the nuclear safety regulatory department of the State Council shall be responsible for the regulation of nuclear safety; the LPCRP

stipulates that MEE shall implement, by law, countrywide regulatory control of radioactive pollution prevention and control work countrywide; the HAF001 stipulates that the NNSA shall be responsible for making, approving and granting the nuclear facility safety licenses; the RSRWM stipulates that MEE shall carry out overall safety supervision and management of radioactive waste in China.

E.3.2 MEE/NNSA

E.3.2.1 MEE/NNSA Organizational Structure

E-14 MEE/NNSA consists of the headquarter, regional offices of nuclear and radiation safety inspection, and technical support organizations, with its organizational structure illustrated in Figure 3.

E-15 The MEE/NNSA's headquarter is based in Beijing, with six regional branches in Shanghai, Shenzhen, Chengdu, Beijing, Lanzhou, and Dalian, respectively, which are responsible for routine oversight of nuclear safety and radiation safety in designated areas.

E-16 The MEE/NNSA's specific routine work is undertaken, respectively, by its subsidiary Department of Nuclear Facility Safety Regulation, Department of Nuclear Power Safety Regulation, and Department of Radiation Source Safety Regulation.

E-17 In order to fulfill a better implementation of regulatory functions, the MEE/NNSA set up the Nuclear and Radiation Safety Center to provide technical support, and subsequently added a Radiation Environmental Monitoring Technology Center to further strengthen the technical power for the radiation environmental monitoring and management countrywide in 2011. Additionally, the MEE/NNSA has also established long-term and reliable partnership with other organizations for technical support and assistance.

E-18 An Expert Panel of Nuclear Safety has been set up by the MEE/NNSA to provide technical support in drafting nuclear and radiation safety laws and regulations, developing nuclear safety technology/technique and implementing nuclear safety review and oversight.

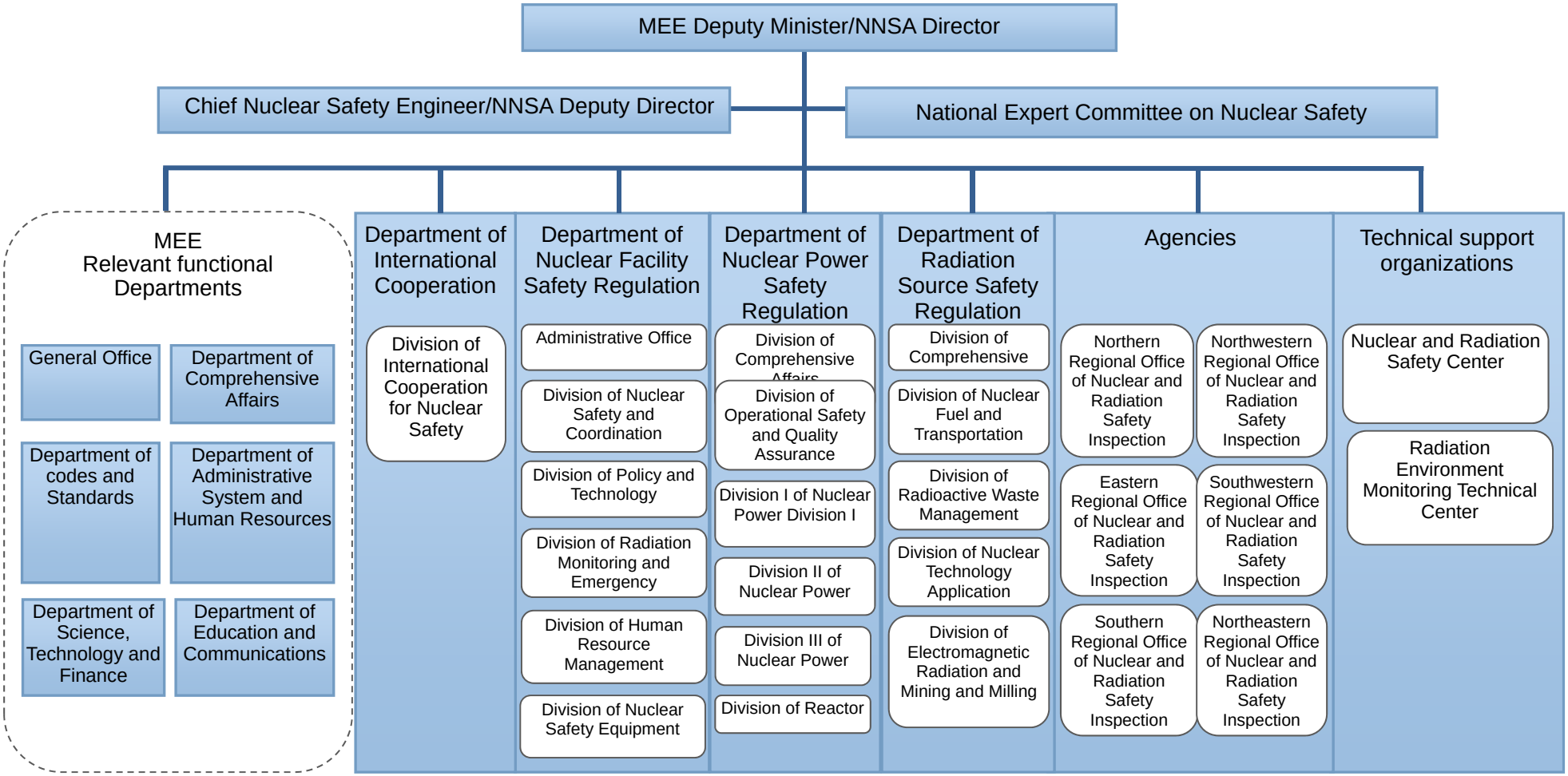

Figure 3. Organization structure of the MEE/NNSA

E.3.2.2 MEE/NNSA Responsibilities

E-19 The MEE/NNSA has the following responsibility over the safety of spent fuel management and the safety of radioactive waste management:

(1) for regulatory control of nuclear and radiation safety; development of policy, planning, laws, administrative regulations, departmental rules, standards and criteria in relation to nuclear and radiation safety, electromagnetic radiation, environmental radiation protection, and nuclear and radiation accident;

(2) for overall regulatory control over nuclear facility safety, radiation safety, and environmental radiation protection;

(3) for regulatory control over the licensing, design, manufacture, assembly, and non-destructive testing of nuclear safety equipment; and for the safety inspection of imported nuclear safety equipment;

(4) for regulatory control of nuclear material regulation and physical protection;

(5) for regulatory control of radiation safety and environmental radiation protection against nuclear technology application projects, uranium (thorium) mines, and NORM; and for radiation protection;

(6) for regulatory control of radioactive waste treatment and disposal safety, and environmental radiation protection work; and for regulatory inspection of radioactive contamination prevention;

(7) for regulatory control of the safety of radioactive material's transportation;

(8) participating in response to nuclear emergencies, and being responsible for response to radiation emergencies;

(9) for management of qualification of reactor operators and special nuclear process workers;

(10) for organizing and implementing of environment radiation monitoring, supervisory monitoring of nuclear facilities and key radiation sources;

(11) for China's fulfillment of international convention on nuclear and radiation safety;

(12) for guiding the work at nuclear and radiation safety oversight stations.

E.3.2.3 Financial and human resources of MEE/NNSA

E-20 The MEE/NNSA's annual financial budget at central headquarter level

in nuclear and radiation safety regulation was 487, 429, and 409 million CNY in 2017, 2018, and 2019, respectively.

E-21 By the end of 2019, there has been nearly 100 staffs in the headquarter office, nearly 1,000 and nearly 10,000 staffs, respectively, at the central level and local level.

E.3.2.4 Integrated Management System

E-22 Based on over thirty years of practices in nuclear and radiation safety regulation, China has gradually developed a set of relatively complete regulatory concepts, mechanisms and approaches, which constitute the nuclear and radiation safety management system of China. The nuclear and radiation management system includes the policies, goals and plans, organization structures and their management responsibilities, safety culture, resources and management required by the implementation of regulatory duties, main works and requirements of critical processes of the management system, and measures required for realizing the system continuous improvement of the MEE (NNSA). It can provide explicit working standard and basis, help the establishment of the systematic perspective and global view and improve the strategic thinking and working efficiency for staffs of the regulatory system. Furthermore, it is conducive to further improving the work quality of the regulatory activities, enhancing the authority and effectiveness of nuclear and radiation safety regulation to continuously improving the nuclear and radiation safety regulatory system of China.

E-23 The nuclear and radiation safety management system covers all relevant elements of the nuclear and radiation safety regulatory functions and management systems undertaken by the MEE(NNSA); covers all relevant departments/organizations of the nuclear and radiation safety regulatory system and their employees, including the central authorities, regional offices and technical support organizations. It is required to take the elements of safety, health, environment, security, quality, staff and organization, society, economy and health into comprehensive consideration to ensure that the principle of “ensuring safety” is always implemented and nuclear safety is always prioritized during the regulatory activities.

E-24 The nuclear and radiation safety management system of China mainly consists of four parts: management responsibility, support and guarantee, process implementation, assessment and improvement.

(1) Management responsibility

The MEE(NNSA) has published the policy, mission, vision, core value, safety goal, regulatory principle and management commitment for nuclear and radiation safety; developed organization strategies and plans; defined the organization structure and responsibility; advocated safety culture, and paid attention to the needs of stakeholders. It is responsible for planning, establishing and implementing the management system, providing the required resources, and performing periodic assessment for self-improvement.

(2) Support and guarantee

Sufficient resources and the effective management help to enhance the capacity building for regulatory body and continually increase the satisfaction of stakeholders by providing powerful support and guarantee for the implementation, maintenance and improvement of the management system. These resources include infrastructure and working environment, human resources, information knowledge, international cooperation, financial resources, scientific and technological research and development, suppliers and external technical support organizations. All categories of resources are properly planned to ensure the resources necessary for the implementation of regulation activities and improvement of the regulatory capability.

(3) Process implementation

Process management involves planning, implementation, control and coordination for general management process and core regulatory process to ensure the quality and efficiency of each activity. Procedures are formulated for interrelated activities in processes to define the transition, interface and completion of activities among different departments to avoid redundancy, conflict or omission.

(4) Assessment and improvement

Based on the self-assessment of the management at all levels, internal and external independent assessment and operating experience, the monitoring and assessment system and self-improving mechanism for management system are established to build a learning organization, and promptly identify issues and deficiencies existing in the management system for the continuous improvement.

E-25 The documents of nuclear and radiation safety management system have been improved by the MEE(NNSA) based on the summarization of the practices and experience of China in nuclear and radiation safety regulation and by reference to the IAEA safety standards. The document is developed for

systematically describing the nuclear and radiation safety management system, improving the management concepts and methods, optimizing the management process, promoting the participation of all relevant personnel and continuous improvement, and providing support for the modernization of regulatory system and capacity building.

E-26 “The process method” advocated by the IAEA safety standards have been fully referred to ensure that each work is a process that can be planned, implemented, evaluated and continuously improved during the documents preparation for nuclear and radiation safety management system. The management system consists of a set of interrelated process networks which has logic and link between each process. The management system shall be continuously improved by the results of identifying, controlling and evaluating process and by making use of the obtained information and operating experience.

E-27 The document of nuclear and radiation safety management system is divided into three levels. Level I is the general introduction that describes the general structure, content and requirements of the management system. Level II is the work guideline and technical management program of various management elements and functional areas, which is further divided into three parts of “work guideline for general management”, “work guideline for business management” and “general technical management program”. Level III includes the working instructions/working procedures, supporting procedures of general technical management program, special technical management program and its supporting procedures, appropriate rules and regulations quoted or referred by documents of Level II.

E.3.3 National Health Commission (NHC)

E-28 The National Health Commission (NHC) was established in 2018 according to the institutional reform plan of the State Council.

E-29 The NHC has, in regard to the safety of spent fuel management and the safety of radioactive waste management, the responsibilities for:

(1) implementing the regulatory control of occupational, radiological, environmental, and other public health within its terms of reference;

(2) undertaking the responses to health emergencies and medical rescues, organizing the preparation of specific response plans, and undertaking the organization, implementation and supervision of drills or exercises; and(3) developing policies and standards related to occupational and radiological

health and organizing their implementation, monitoring main occupational diseases, performing specific investigation, assessing the risk of occupational health and managing the health of occupational workers, and coordinating the prevention and control of occupational diseases.

E.3.4 Ministry of Public Security (MPS)

E-30 The MPS is, in the aspects of the safety of spent fuel management and the safety of radioactive waste management, principally responsible for

(1) reviewing and approving of road transport of spent fuel and HLW;

(2) providing guidance for public security bodies in monitoring the physical protection of road transport of spent fuel and radioactive waste; and

(3) providing guidance for the investigation of the cases of lost and/or stolen radioactive materials.

E.4 Government Authorities for Nuclear Power Expansion

E.4.1 China Atomic Energy Authority (CAEA)

E-31 The CAEA is composed of the Department of Comprehensive Affairs, the Department of Development and Planning, the Department of Systematic Engineering, Department of Nuclear Emergency and Safety, the Department of Technology and Quality, the Department of Foreign Affairs, the Department of International Cooperation, and Department of Coordination, together with National Nuclear Accident Emergency Office, Nuclear Materials Control Office, and Radioisotope Management Office. Among the technical centers affiliated to the CAEA are National Nuclear Emergency Technology Support Center, Nuclear Technology Support Center and National Nuclear Security Center.

E-32 Its main responsibilities are as follows:

(1) studying and proposing the policy and regulations concerning the peaceful use of atomic energy in China;

(2) studying and developing the development program, plan and industry standards concerning the peaceful use of atomic energy in China;

(3) organizing demonstration of major nuclear energy research projects and reviewing and approving of the projects concerning the peaceful use of atomic energy in China, and supervising and coordinating the implementation of the major nuclear energy research projects;

(4) regulating nuclear materials, and conducting physical protection of nuclear facilities;

(5) reviewing and managing the export of nuclear materials;

(6) carrying out inter-governmental and international cooperation and exchange in the nuclear field, and, on behalf of Chinese government, join the IAEA and participating with the activities thereof;

(7) coordinating the responsibility of national nuclear accident emergency administration; and

(8) being responsible for nuclear facility decommissioning and radioactive waste management.

E.4.2 National Energy Administration (NEA)

E-33 The NEA encompasses the Department of Comprehensive Affairs, the Department of Legal System and Structural Reform, the Department of Development and Planning, the Department of Energy Conservation and Technology Equipment Department, the Department of Electricity, the Department of Nuclear Power, the Department of Coal, the Department of Oil and Gas (National Oil Reserve Office), the Department of New and Renewable Energy, the Department of Market Regulation, the Department of Power Safety Regulation and the Department of International Cooperation. China Nuclear Power Development Center has been established under The NEA.

E-34 The responsibilities of the NEA are:

(1) taking the responsibility of nuclear power administration and organizing the development of laws and regulations on nuclear power;

(2) proposing nuclear power expansion program, access conditions, and technical standards, and causing them to be implemented;

(3) providing review comments on geographical distribution of NPPs and other major projects;

(4) organizing, coordinating and providing guidance on research efforts related to nuclear power; and

(5) organizing intergovernmental exchange and cooperation in relation to nuclear power and the foreign negotiation and agreement between governments on peaceful use of nuclear energy.

F. OTHER GENERAL SAFETY PROVISIONS

(Articles 21 to 26)

F.1 Responsibility of the License Holder (Article 21)

1. Each Contracting Party shall ensure that prime responsibility for the safety of spent fuel or radioactive waste management rests with the holder of the relevant license and shall take the appropriate steps to ensure that each such license holder meets its responsibility.

2. If there is no such license holder or other responsible party, the responsibility rests with the Contracting Party which has jurisdiction over the spent fuel or over the radioactive waste.

F.1.1 General Responsibility of the Nuclear Facility Safety License Holder

F-1 Under the LNS and the HAF001, the operators of the following facilities shall obtain the nuclear facility safety licenses:

(1) NPPs and installations, including NPP, nuclear thermo-electric plant, heat and steam supply plant;

(2) reactors other than nuclear power reactors, including research reactor, experimental reactor, critical device;

(3) nuclear cycle facilities involving fuel production, manufacture, storage, and reprocessing;

(4) treatment, storage, and disposal facilities of radioactive waste; and

(5) other nuclear facilities that shall be subject to strict oversight and management.

F-2 Organizations specializing in spent fuel storage, radioactive waste treatment, storage, and disposal shall apply to the NNSA for license; nuclear facility operators, who make use of a spent fuel storage facility or a treatment or disposal facility of radioactive waste which is constructed together with a nuclear facility to treat or store spent fuels or radioactive wastes of their own, shall not be required to apply for a license, separately;

F-3 Under the LNS and the HAF001, the operators of nuclear facilities shall be fully responsible for the safety of the nuclear facilities.

F-4 The following measures shall be taken to ensure the nuclear facility safety license holders to fulfill their responsibilities.

(1) The nuclear facility operators shall have the capability to ensure the safe operation of nuclear facilities, including the establishment of corresponding organizational, management and relevant systems, the allocation of adequate human and financial resources; shall have the necessary technical support and continuous improvement capabilities; and shall have the capability of emergency response and financial guarantee for nuclear damage compensation, etc.

(2) The nuclear facility operators shall, in accordance with the requirements of laws, administrative regulations and standards, set up a defense-in-depth system and conduct regular safety assessment for nuclear facilities, and disclose relevant information of their own.

(3) The MEE/NNSA or its dispatched agencies shall dispatch oversight personnel to the manufacture, construction, operation, and decommissioning sties of a nuclear facilities concerned to implement the regulatory mission of nuclear safety. They are tasked with verifying whether or not the safety documents submitted are consistent with the actual situations, inspecting whether or not the construction works are in accordance with the approved design, checking whether or not the management is in line with the approved QA program, inspecting whether or not the construction and operation of such a nuclear facility comply with the requirements that are provided for in both Nuclear Facility Construction License and Nuclear Facility Operation License, examining whether or not operating personnel have acquired with the ability to carry out safe operation and to exercise emergency plan, etc.; and

(4) The MEE/NNSA are entitled to take the compulsory measures, if necessary, to order a nuclear facility operator to take safety measures, or to terminate the activities endangering the safety. For the license holder who violates the regulations, the MEE/NNSA shall give warning for improvement within a time limit, or order to halt or stop operations for rectification, or order to revoke license for punishment.

F.1.2 General Responsibility of the Radiation Safety License Holder

F-5 Under the RSPRRD, an organization that produces, sells or uses a radioactive source shall obtain a radiation safety license, and the holder of the radiation safety license shall be responsible for the safety and protection of the radioactive sources of its own, and shall be responsible for the radioactive hazards caused by it in accordance with the law.

F-6 The following measures will ensure that the holders of radiation safety licenses fulfill their liabilities or responsibilities.

(1) Organizations that produce, sell, and use radioactive sources shall have the capability to ensure radiation safety, including the establishment of special management agencies, personnel with relevant professional knowledge and protection knowledge, sound rules and regulations, emergency measures for radiation accidents, places, facilities and equipment that meet relevant standards and requirements, personal dose monitoring and occupational health check-ups for relevant staff, and relevant waste treatment capacity or feasible treatment plan, etc.

(2) The holders of the radiation safety license shall conduct an annual assessment of the safety and protection status of the radioactive sources of its own; and if hidden dangers are found, they shall immediately make rectification.

(3) The generators of the used sealed sources shall, in accordance with the agreement or requirements, return the used sealed sources to the producers, to the original exporter, or to the storage or disposal organizations.

(4) The competent ecology and environment departments of the people's governments at or above county-level shall work with other related agencies to implement regulatory inspection of the license holders on their responsibility.

(5) For the license holder who has not complied with the requirements provided for by the original license, the competent ecology and environment departments of the people's governments at or above county-level shall order to make improvement within a time limit, or order to halt or stop operations for rectification, or order to revoke license for punishment. For the license holder who has illegal income, the proceeds concerned shall be confiscated and the appropriate penalties shall be imposed.

F.1.3 General Responsibility of License Holder for Solid Radioactive Waste Treatment, Storage and Disposal

F-7 Under the LNS, RSRWM, and the *Management Measures for the Licensing of Solid Radioactive Waste Storage and Disposal* (MMLSRWSD), the organizations dedicated exclusively to the treatment, storage, and/or disposal of solid radioactive wastes, should obtain the license for solid waste treatment, storage and/or disposal. The license holders shall bear the responsibility for the safety of the solid radioactive wastes they treat, store, and/or dispose of in accordance with the law.

F-8 The following measures ensure the license holder to fulfill their responsibilities for the treatment, storage and/or disposal of solid radioactive

wastes.

(1) The competent ecology and environment departments of the people's governments at or above county-level shall work, with other related agencies, to implement regulatory inspection of the safety of solid radioactive waste treatment, storage, and disposal on their responsibility.

(2) For the license holder who has not complied with the requirements provided for by the original license, the competent ecology and environment departments of the people's governments at or above county-level shall order for improvement within a time limit, or order to halt or stop operations for rectification, or order to revoke license for punishment. For the license holder who has illegal income, the proceeds concerned shall be confiscated and the appropriate penalties shall be imposed; decontamination measures shall be taken within a time limit or a fine shall be imposed about for decontamination.

F.2 Human and Financial Resources (Article 22)

Each Contracting Party shall take the appropriate steps to ensure that:

(i) qualified staff is available as needed for safety-related activities during the operating lifetime of a spent fuel and a radioactive waste management facility;

(ii) adequate financial resources are available to support the safety of facilities for spent fuel and radioactive waste management during their operating lifetime and for decommissioning;

(iii) financial provision is made which will enable the appropriate institutional controls and monitoring arrangements to be continued for the period deemed necessary following the closure of a disposal facility.

F.2.1 Assurance of Qualified Workers

F.2.1.1 Human resource cultivation

F-9 The talent education and training plan has been under the vigorous development to strengthen the cultivation of all kinds of talents. With increasing investments, talent reserves have been enhanced to meet the growing demand of human resources caused by nuclear energy and technology expansion. By the way of government support and cooperation between the higher education institutions and some enterprises, a wide range and variety of professional programs are established, like nuclear engineering, nuclear technology, radiation protection and other related ones in these educational institutions, thus enlarge university enrollment scale of nuclear professionals and optimizing the structure of academic disciplines.

F-10 Nuclear powers groups or enterprises, in combination with universities and research institutions, to explore and develop progressively the "order + joint

cultivation" or "university + enterprise" modes. Based on the "order + joint cultivation" mode, their subsidiary nuclear power enterprises sign employment intention agreement, every year, with a set number of full-time nuclear-related undergraduates at grader three of higher educational institutions. After graduation, these students will go to work in these nuclear power groups or their subsidiary enterprises with which they have signed agreement. The nuclear power groups or enterprises pay educational costs to these educational institutions and provide the scholarships to the students concerned. Under the "university +enterprise" mode, relevant institutions of higher learning enroll examinees of fixed direction allocation, for which nuclear power groups pay the tuition and accommodation fees of students during school and to provide the targeted scholarships of nuclear industry. These students also can enjoy other types of scholarship which the non-fixed direction students enjoy and, after graduation, go to work in nuclear power groups.

F.2.1.2 Recruitment, Training and Examination of Staff in Nuclear Facilities

F-11 Under the LNS and the HAF103, the operators of nuclear facilities implement the system of recruitment, training, examination and delegation of the personnel engaged directly with the management of spent fuel and radioactive waste,

F-12 The operators of nuclear facilities efforts to recruit the professional talents necessary for the spent fuel and radioactive waste management in such manner as high school education, countrywide selection of senior specialists, employment of technicians from conventional power plants and other sectors in the country, and hiring foreign experts and so on.

F-13 The requirements for post qualification are defined in accordance with relevant regulations, guides, and standards and on the basis of the post-specific task analysis. The training and retraining programs and procedures are developed and implemented for those involved directly in spent fuel and radioactive waste management. The relevant personnel can carry out the relevant post with responsibility only after appropriate training, qualification inspection, and acquirement with post qualification certificate or authorization granted.

F-14 Validity period management is applied by the above operators to the qualification and authorization for personnel. After expiration of effective period, the extension and renewal of qualification certificates shall be made in accordance with the post-specific requirements. Furthermore, additional re-training and re-authorization are needed to ensure for the personnel to meet

the post-specific requirements.

F-15 Both Chinese and foreign contractors shall be subject to the same training, authorization and qualification during the operating lifetime of spent fuel and radioactive management facilities. They shall also be subject to strict control and supervision according to the contractor management policy.

F.2.1.3 Training and Examination of Radiation Safety Workers

F-16 Under the RSPRRD, a producer, distributor or user of radioactive sources shall provide training in safety and protection knowledge to its workers directly associated with production, distribution and use of such sources. Inspection shall be given to the trainee. The worker who would not pass the given inspection is not fit the job post with radiation safety related responsibility. The training program, in conjunction with training materials, was developed by the MEE/NNSA in such a way as to have an enhanced training management and consistent training and inspection requirements.

F-17 On the invitation of China, the IAEA has provided training to the trainers at eight national-level training institutions evaluated and recommended accredited by the MEE/NNSA in China. Meanwhile, provincial ecology and environment departments also sponsored radiation safety training within their regions. The trainees are divided into three levels according to the radiation risks they face in radiation safety work involved. The primary radiation safety training is implemented by the provincial level departments and the training at other two levels is undertaken by the above national-level training institutions. The qualified trainees need to accept re-training at four-year intervals.

F-18 According to the *Notice on Matters Related to the Training and Examination for Radiation Safety and Protection in Nuclear Technology Applications* issued by the MEE in December 2019, from January 1, 2020, ecology and environment departments at all levels no longer evaluate and recommend radiation safety training organizations, and personnel engaged in radiation activities such as the production, sale and use of radioisotopes and radiation devices are no longer be required to participate in radiation safety training organized by the above organizations. Personnel with relevant training needs can learn relevant knowledge free of charge through the national training platform for radiation safety and protection in the use of nuclear technologies (http://fushe.mee.gov.cn) organized and developed by the MEE. Starting from January 1, 2020, new personnel engaged in radiation activities and personnel whose original radiation safety training certificates have expired shall register through the training platform and participate in relevant examinations. The

original training certificates obtained before January 1, 2020 shall continue to be valid before expiration.

F-19 From early 2017 to the end of 2019, the MEE/NNSA has organized 217 training sessions on nuclear and radiation safety, which including training for 19,266 person-times.

F.2.1.4 Qualification, Training and Examination for Nuclear and Radiation Safety Regulatory Inspection Staff

F-20 Under the *Management Methods for the Regulatory Inspection Staff Certificate of Nuclear and Radiation Safety*, the MEE/NNSA implements identification of the staff applying for such a Certificate and provides training and examination to them. The qualified will be granted the Certificate for Nuclear Safety Supervisor or Certificate for Radiation Safety Supervisor by the MEE/NNSA. Both certificates are valid for five years.

F-21 The MEE/NNSA pays high attention to the training of nuclear and radiation safety regulatory inspection staff, with continued strengthening the training of nuclear safety and radiation safety regulatory inspection staff in many ways, for example, developing the *Operational Training Guide for Nuclear and Radiation Safety Supervisors*, and the *Outline of Operational Training for Nuclear and Radiation Safety Supervisors*, enhancing the on-the-job training of nuclear and radiation safety regulatory inspection staff, inviting international experts to present lectures on nuclear and radiation safety training in workshop or seminar, dispatching personnel to participate in short-term training workshop sponsored by foreign regulatory agencies and international organizations.

F-22 A certificate holder who applies for renewal of his (her) Certificate shall submit, through an authorized organization where he or she works in, the written application to the MEE/NNSA prior to March 31 or September 30 of each year, and on-the-job training as required by the MEE/NNSA will be attended. After reviewed by the MEE/NNSA, the renewed certificate will be granted when the requirements are met.

F.2.1.5 Registered Nuclear Safety Engineer System

F-23 Under the LPCRP, the qualification management system is applied in China to the professionals involved in radioactive pollution prevention and control. The *Temporary Regulations on Registration Qualification for Nuclear Safety Engineer* (TRRQNSE) was issued in November 2002. Under the TRRQNSE, the certified qualification system is implemented for the technical workers who are on the key positions in the organizations of nuclear energy and

technology and nuclear technology service. The working scope of a Registered Nuclear Safety Engineer involves nuclear safety review, nuclear safety regulatory inspection, manipulation and operation of nuclear facility, nuclear quality assurance, radiation protection, environmental radiation monitoring, and other activities related closely to nuclear safety as provided by the MEE/NNSA.

F-24 The national qualification examination for registered nuclear safety engineers is uniformly organized every year. The qualified examinees shall be granted the Qualification Certificate of the People's Republic of China for Registered Nuclear Safety Engineer, with effective period of 2 years. Registered nuclear safety engineers shall be subject to the continued education system.

F-25 To ensure the safety of storage and disposal of radioactive wastes, the RSRWM and MMLSRWSD clearly provide that the facilities dedicated solely to storage and/or disposal of solid radioactive waste should set up the organization with capability of ensuring the operation safety of such facilities; the solid radioactive waste storage facility should be staffed with more than 3 technicians for radioactive waste management, radiation protection, and environmental monitoring, at least 1 of which is registered nuclear safety engineer; the LILW disposal facility should manned with more than 10 technicians working on radioactive waste management, radiation protection, and environmental monitoring, among which at least 3 are registered nuclear safety engineers; the deep geological disposal facility should have more than 20 technicians working on radioactive waste management, radiation protection, and environmental monitoring, at least 5 of which are registered nuclear safety engineers.

F.2.2 Financial Guarantee

F.2.2.1 Financial Guarantee for Operation and Decommissioning

F-26 In China, the cost required every year for carrying out the activities relating to safe operation of, and safety modification to, nuclear facilities, including spent fuel and radioactive waste management facilities, will be borne by the operators of such nuclear facilities. When a NPP is put into operation, a certain amount of fees shall be raised from the revenues of electricity generation every year, reserving for the safety modification of the plant itself, and the safe operation of spent fuel and radioactive waste management facilities. The yearly planning and financial budget of a nuclear facility attach higher priority to the project associated with safety modification.

F-27 The IPCUMFTDSFNPP was issued in 2010 by the MoF, National Development and Reform Commission (NDRC), and the MIIT. The said funds

are intended for use in the treatment and disposal of spent fuel, involving (1) spent fuel transport, (2) spent fuel away-from-reactor storage; (3) spent fuel reprocessing; (4) treatment and disposal of HLW generated from such reprocessing, (5) construction, operation, modification and decommissioning of reprocessing plant, and (6) other applications related to such treatment and disposal. Funds are collected for the actual online sales electricity generated by NPPs after 5 years commercial operation. Such funds are charged into electricity generation costs for a NPP. By using such funds, the capability building for the spent fuel transport and the maintenance of spent fuel storage facilities are underway by the effort of the CAEA.

F-28 Under the LNS and LPCRP, the accrued expenses for radioactive waste disposal and nuclear facility decommissioning shall be earmarked in the investment estimate and production cost by nuclear facility operators. Measures for the management of disposal and decommissioning expenses are being drafted. At present, nuclear facility operators deliver the solid radioactive wastes which meets the standards after treatment to the storage and disposal organizations who have obtained corresponding storage and disposal licenses, and bear the storage and disposal expenses. Nuclear power plants are preserving funds and setting up special accounts for decommissioning. For example, the Daya Bay NPP of CGN has provided decommissioning reserves equivalent to 10% of the final accounting value of the nuclear island equipment in service, and the interest expenses determined according to the amortization cost of estimated liabilities and the effective interest rate during the life period of NPP are included in the financial expenses. With reference to the international decommissioning experience of NPP, China recognizes that the costs required for the decommissioning of NPP is quite large, and it is difficult to meet the need for decommissioning expenses by providing decommissioning reserves equivalent to 10% of the final accounting value of nuclear island equipment in service. To this end, the MOF, together with other departments, is drafting the *Interim Measures for the Management of Expenses for Nuclear Facility Decommissioning and Radioactive Waste Disposal* to standardize the extraction and management of the decommissioning reserves.

F-29 China has established insurance regime for nuclear incident liability. Under the *State Council's Reply on Nuclear Accident Damage Compensation Liability* (GH[2007]64), all nuclear power operators have bought insurance enough to fulfill their nuclear liabilities, prior to the operation of NPPs or prior to spent fuel storage, transport and reprocessing. As the third-party liability insurance, the highest compensation for injury or damage in the event of a

nuclear incident is limited to 300 million CNY. If exceeding this limit, the highest financial compensation provided by the country is 800 million CNY. The LNS specially provides for the liability insurance of nuclear facility operators, requiring that if a nuclear accident causes personal injury, property loss or environmental damage to others, the nuclear facility operator shall be liable for compensation in accordance with the national nuclear damage liability system. The nuclear facility operator shall make appropriate financial guarantee arrangements by taking out liability insurance and participating in mutual assistance mechanisms to ensure the timely and effective performance of the liability for nuclear damage compensation.

F.2.2.2 Financial Guarantee for Post-closure of Disposal facilities

F-30 For radioactive waste disposal facilities that are closed in a normal condition, the surveillance responsibility for the post-closure active surveillance period rests with the license holder of such facilities, otherwise with the local government during post-closure passive surveillance period. The costs required for the post-closure maintenance, monitoring and emergency response are covered in the disposal fees collected on the part of LILW disposal site.

F-31 Under the RSRWM, when applying for the license for solid radioactive waste disposal, the facility operator exclusively dedicated to the disposal activities of solid radioactive wastes shall (1) provide a matched amount of registered fund, with not less than 30 million CNY for LILW disposal activities and not less than 100 million CNY for deep geological disposal activities; (2) have the capability of financial guarantee to ensure that disposal activities shall persist to the end of safety surveillance period; and (3) the organization supplying financial guarantee shall bear the costs required for facility shutdown and safety surveillance in the case of the operator of the facility bankruptcy or license termination.

F.3 Quality Assurance (Article 23)

Each Contracting Party shall take the necessary steps to ensure that appropriate quality assurance programmers concerning the safety of spent fuel and radioactive waste management are established and implemented.

F.3.1 Basic Quality Assurance Requirements

F-32 The LNS provides that the nuclear facility operators shall have a quality assurance system that meets the requirements of nuclear safety; the nuclear facility operators and organizations who provide equipment, engineering, and services to these operators shall establish and implement a quality assurance system.

F-33 Basic QA requirements are provided for under the *Safety Provisions on Quality Assurance of Nuclear Power Plants* (HAF003), which are applicable to the quality assurance for the management of the spent fuels and radioactive wastes that are generated by NPPs. The quality assurance for the management of spent fuels and radioactive wastes from other nuclear facilities other than NPPs is implemented by reference to such basic requirements. The basic QA requirements are mainly as follows:

(1) to prepare and effectively implement overall QA program for nuclear facility and QA related sub-program for various tasks, to prepare written procedures, detailed rules and drawings and to provide periodic review and revision of them, making periodic management review to determine QA program's status and validity and, if necessary, to take appropriate corrective actions;

(2) establishing a licensed organization and/or body with clearly allocated responsibility and authority as well as and channel of internal and external communication; controlling and coordinating working interfaces between various organizations; controlling the selection, staffing, training and qualification inspection of personnel to ensure that the personnel acquire and maintain adequate technical skills;

(3) controlling the development, review, approval, circulation, and renewal of all the documents necessary for the execution and verification of task in such a manner as to prevent the outdated and inappropriate use of such documents;

(4) controlling the process, interface, change of design, and verifying design to ensure that prescribed design requirements are correctly presented on the technical specifications, drawings, procedures or instructions;

(5) controlling the development of procurement documents, evaluating and selecting the proper suppliers and controlling the procured items and services to ensure the said items are consistent with requirements of procurement documents;

(6) identifying and controlling materials, spare components and components, controlling the loading, unloading, storage, and transportation of items and taking appropriate maintenance related important items to ensure the quality of the said items are properly protected from being damaged;

(7) controlling technological processes affecting quality employed in design, fabrication, construction, test, commissioning and operation of nuclear facility to ensure that such processes are operated by qualified personnel using qualified

equipment in the line with authorized procedures;

(8) establishing and effectively implementing the inspection and test program, verifying satisfaction of items and activity with specified requirements in order to demonstrate that the functions of the structure, system and components are in a satisfactory manner; controlling the selection, calibration, and operating conditions of the measuring and test equipment, and identifying and controlling the inspection, test and operating conditions;

(9) controlling the marking, review and treatment of items that do not satisfy requirements, prescribing the responsibility and authority for reviewing and treating them and making re-inspection of repaired items at work;

(10) identifying and correcting the conditions that may affect or has detracted from quality; for the conditions that has severe detracted from quality, corrective actions should be taken after investigation of cause in order to prevent re-occurrence;

(11) establishing and implementing the QA record system, controlling the codification, collection, indexing, filing, storage, maintenance and disposal of records to ensure that records are such clear, complete and correct as to provide the sufficient evidence to quality of items and activity; and

(12) establishing and implementing internal and external auditing system to verify the implementation and validity of QA program; corrective measures must be taken against the defects discovered during audit and the subsequent actions should be taken for follow-up and verification.

F-34 In addition, 10 QA safety guides have been developed which provide complementary requirements and implementation recommendations for the above-mentioned basic requirements.

F.3.2 Quality Assurance for Spent Fuel Management

F-35 The systematic QA programs were developed by the operator of spent fuel management facilities and submitted to the MEE/NNSA for approval as part of license application documents.

F-36 All matters involved in the design and operation of spent fuel management facilities are implemented strictly as required by QA program. These matters include design and manufacture of important items and systems in spent fuel storage facilities, maintenance of sub-criticality of stored spent fuel, radiation protection, fuel heat removal, fuel shielding, erosion control, related operational procedures of nuclear material or fuel during commissioning, normal operation and in the event of predicated operation incident, maintenance,

test, inspection and check of safety related equipment, record and documentation, radioactive waste management, record-keeping of fuel characteristics during storage, nuclear material safeguard system (when needed), and physical protection system and so on.

F-37 QA bodies, independent of other departments, are responsible for the development, management, supervision, and improvement of the QA program. They implement planned internal and external QA supervision, audit, review, and assessment through which the defects existing in QA system should be found and improved in a timely manner. Meanwhile, further strict management shall be conducted by taking on non-conformance and corresponding corrective measures, collecting and analyzing of QA information and trend, and reporting the followed results periodically to the higher competent authorities. If necessary, the timely corrective actions shall be taken.

F-38 The management department provides periodic scrutiny on the suitability and effectiveness of QA programs. These departments focus attention on the internal and external oversight and inspection results within assessment period, together with the related information, such as quality problems, corrective measures, quality trend, incident and malfunction, personnel qualification and training, among others. Based on the problems found in the above scrutiny, like defects in QA program, management, and quality, they shall, by conducting reason analysis, prepare and implement specific corrective measures and notify the related departments and facilities in written form.

F.3.3 Quality Assurance for Radioactive Waste Management

F-39 Under the GB14500-2002, the following steps are taken, by the operators of both nuclear fuel cycle facilities and nuclear technology application radioactive waste storage facilities, to ensure the development and implementation of QA program relevant to radioactive waste management and/or disused sealed sources.

(1) the operators of waste management facilities have developed QA program according to facility scale and complexity as well as the potential hazards of radioactive waste and/or disused sealed sources and thereby strictly implement management of radioactive waste and disused sealed sources in accordance with the QA program that has been reviewed and approved by the regulatory body;

(2) in order to ensure the implementation of QA program, the designer, constructor and operator of both nuclear fuel cycle facilities and nuclear technology application radioactive waste storage facilities have developed, and

have been implementing, the relevant QA sub-program and other quality-related documents;

(3) in the process of developing and implementing the QA management documents, the above operators focused special attention to the personnel's education and provided training and inspection of these personnel in respect of safety culture; and

(4) QA program consists mainly of quality policy and system; organizations for developing and implementing of QA; control of design, construction, operation and commissioning of facilities; procurement control of materials and services; control of waste generation and sorting; identification and control of radioactive waste and/or disused sealed sources; control of technological parameters in the stages of waste management; control of documents and records; and oversight and inspection.

F.3.4 Quality Assurance for Near Surface Disposal of Radioactive Waste

F-40 There have been three LILW disposal sites in operation. Under the GB9132-2018, the operators have all prepared and implemented QA programs, which provide for the siting, design, construction, operation, closure and organized control period after closure of the disposal sites.

F-41 The QA program takes into account the potential impact of various factors on the safety of disposal sites, and determines the requirements for activities, structures, systems and equipment important to the safe operation and disposal according to the results of the safety assessment for the operation phase and the post-closure phase. The QA program also provides for the update and long-term validity of relevant technical documents.

(1) The QA program for the siting phase provides for the preparation and storage of all documents and supporting materials related to siting, so as to make them accurate, effective and representative. During the design, construction and operation of near-surface disposal site, special attention should be paid to the control of engineering barrier design, waste characteristics and operating procedures, so as to ensure that the safety performance of the disposal site will not be adversely affected. Whenever important parameters change, the safety assessment should be updated in a timely manner.

(2) The QA program shall specify the safety of the disposal site depends not only on the operators, but also on the pre-disposal management by waste generators. Waste generators shall ensure that the delivered waste packages meet the disposal requirements, and shall provide the disposal site with

documents required to meet the QA requirements (such as waste type, characteristics, radionuclide type, radioactivity concentration and activity, coding of waste package and specifications of packaging container, etc.) and other documents that may affect the safety of disposal, and be responsible for the authenticity of these documents. The waste disposal acceptance process is described in the QA program for waste disposal acceptance. The inspection and random test for waste disposal acceptance include document, appearance quality, sign, surface dose rate and surface contamination examination, as well as destructive or non-destructive test of waste package.

(3) The QA program for closure and the organized control period after closure shall provide for the collection and preservation of all information important to the long-term safety of disposal site. Information of all stages of the disposal site from siting to the organized control period after closure shall be preserved, such as site characteristics, engineering design drawings and specifications, waste lists, safety analysis reports and environmental impact assessment reports, environmental monitoring results, and site closure information.

F.3.5 Regulatory Bodies' Primary Activity

F-42 The MEE/NNSA controls QA activities related to spent fuel and radioactive waste management safety in respects of:

(1) reviewing and recognition the QA programs for spent fuel and radioactive waste management and other types of safety related important documents, including their important revisions, as required of QA, safety regulations and other types of safety related guides;

(2) supervising the implementation of the QA program for spent fuel and radioactive waste management with respect to nuclear safety; selecting control points of the related quality plans in respect of the safety and quality-related major activities and overseeing them on-site; organizing technical review and demonstration of the results of such activities;

(3) organizing technical review of major non-conformance and oversee effectively the process of addressing such non-conformance.

F.4 Operational Radiation Protection (Article 24)

1. Each Contracting Party shall take the appropriate steps to ensure that during the operating lifetime of a spent fuel or radioactive waste management facility:

i) the radiation exposure of the workers and the public caused by the facility

shall be kept as low as reasonably achievable, economic and social factors being taken into account;

ii) no individual shall be exposed, in normal situations, to radiation doses which exceed national prescriptions for dose limitation which have due regard to internationally endorsed standards on radiation protection; and

iii) measures are taken to prevent unplanned and uncontrolled releases of radioactive materials into the environment.

2. Each Contracting Party shall take appropriate steps to ensure that discharges shall be limited:

i) to keep exposure to radiation as low as reasonably achievable, economic and social factors being taken into account; and

ii) so that no individual shall be exposed, in normal situations, to radiation doses which exceed national prescriptions for dose limitation which have due regard to internationally endorsed standards on radiation protection.

3. Each Contracting Party shall take appropriate steps to ensure that during the operating lifetime of a regulated nuclear facility, in the event that an unplanned or uncontrolled release of radioactive materials into the environment occurs, appropriate corrective measures are implemented to control the release and mitigate its effects.

F.4.1 Keeping Radiation Exposure ALARA

F-43 Under the GB18871-2002, for radiation exposure from a given source in a practice, the optimization of protection and safety should be achieved. Taking account of socioeconomic factors, the doses to individuals, number of exposed individuals and the possibility of exposure are all kept as low as reasonably achievable (ALARA).

F-44 Under the HAF103, the radiation exposure in nuclear facilities are ensured to have been kept at ALARA through the following measures taken:

(1) developing and practically implementing radiation protection program including prevention measures taken in management and technology, for example environmental radiation monitoring and decontamination on personnel, equipment and structures and so on;

(2) checking whether or not radiation protection program is correctively implemented or the objective of the program is achieved through oversight, inspection and monitoring; and additionally, revising the program as needed;

(3) deploying the qualified health physicists who have acquired with the knowledge of radiological protection in design and operation of spent fuel and radioactive waste management facility;

(4) deploying equipment or devices used for radiation protection monitoring in operational and accidental conditions, like the stationary dose rate meter, the monitoring system for measuring activity concentrations of radioactive materials in the air, the instrument and meter used for measuring surface radioactive contamination and individual dose and contamination;

(5) treating and/or storing spent fuel and radioactive waste in an appropriate way and condition;

(6) taking measures to reduce the amount and concentration of radioactive materials dispersed over on-site or released to the environment at a spent fuel or radioactive waste management facility;

(7) controlling the generation and release of radioactive effluent and waste in a reasonable manner and enhancing management of radioactive waste; and

(8) establishing the control limits for effluent release lower than the national control limits for effluent release stipulated in the *Regulations for Environmental Radiation Protection of Nuclear Power Plant* (GB6249-2011), implementing them upon approval of the MEE/NNSA, and regularly reviewing these control limits in the course of operation; developing methods and procedures to monitor and control the effluent release.

F-45 The principled requirements that should be complied with in radiation protection in nuclear facilities are put forth by MEE/NNSA in a range of rules on the siting, design and operation of nuclear facilities.

(1) in siting of nuclear facilities, the public and the environment should be protected from excess radiation impacts caused by radioactive incident and while account should be taken of radioactive release in normal conditions;

(2) the radiation protection requirements should be incorporated into the design of nuclear facilities, for example, optimizing the facility layout, arranging for shielding and reducing the activities and stay time of workers within radiation zone, and radioactive materials should be treated into proper forms in appropriate ways and conditions;

(3) amount and concentration of radioactive materials released to the site or environment should be reduced by taking measures;

(4) full consideration should be taken of possible accumulation of radiation level with time in worker stay area and minimizing the generation of radioactive waste and so on;

(5) the operators of nuclear facilities should make evaluation and analysis of

radiation protection requirements and situation in such facilities, and develop radiation protection programs to ensure the verification of whether or not such programs are implemented and the established goal is achieved in such manners as oversight, inspection and inspection, take corrective measures when needed; and

(6) functional departments of radiation protection should develop and implement radioactive waste management program and the environmental monitoring program and carry out assessment of environmental radiation impacts.

F.4.2 Dose Limits

F-46 The GB18871-2002 sets forth the radiation protection principles, requirements and the dose limits, which are consistent with the ICRP Publication 60 and the BSS developed by the IAEA.

F-47 The individual dose limits to workers and the members of key group of population are as follows:

— Occupational exposure

(1) annual average effective dose limit of 20 mSv is prescribed by regulatory body, averaged over 5 consecutive years, rather than any traceable average;

(2) annual effective dose limit should not exceed 50 mSv in any single year;

(3) annual equivalent dose limit for lens of the eye is 150 mSv; and

(4) annual equivalent dose limit for extremities or skin is 500 mSv.

— Public exposure

(1) annual effective dose limit is 1 mSv;

(2) in special circumstances a higher effective dose value of 5 mSv could be allowed in a single year, provided that the annual average over defined 5 successive year periods does not exceed 1 mSv;

(3) annual equivalent dose limit for lens of the eye is 15 mSv; and

(4) annual equivalent dose limit for skin is 50 mSv.

F-48 Dose constraints have been respectively set by all nuclear facilities taking account of economic and social factors, which are less than the relevant national limits.

F-49 As has been shown by the monitoring results of occupational exposure, the annual effective doses to workers in China’s operating NPPs are less than

the national relevant limits. Annexes L.6 indicates the annual effective doses to the NPP workers for the time period 2017-2019.

F.4.3 Preventing Unplanned or Uncontrolled Release of Radioactive Materials to the Environment

F-50 Under the GB6249-2011 and the *Management of Radioactive Effluents and Waste Arising from Nuclear Power Plant* (HAD401/01), the following measures are taken by the operators of NPPs to prevent unplanned or uncontrolled release of radioactive materials to the environment:

(1) based on the environmental characteristics at NPP sites and the technological level at which radioactive waste could be treated and in compliance with ALARA principle, the amounts of radioactive effluent to be released are applied to the MEE/NNSA for authorization prior to the first fueling (afterwards reviewing at 5 year intervals), and go into effect upon approval by the MEE/NNSA;

(2) total annual amount released by a NPP is controlled on a quarterly or a monthly basis, with the total quarterly amount released not exceeding half of the annual amount authorized, and the total monthly amount released less than one fifth of the total annual release amount;

(3) pool discharge is employed for liquid effluent while airborne radioactive effluent needs to be purified or stored for decay before released into the environment via stack;

(4) for the purpose of locating the discharge outlet of liquid radioactive effluent, several considerations are taken into account, such as downstream water collection point, and thermal and radionuclide discharge, to keep away from centralized water collection point, aquatic breading site, migratory route, fishery and other environmentally sensitive zones;

(5) discharge of liquid effluent is controlled based on radionuclide concentration, for which optimal practicable technology is considered and is optimized in combination with site condition and operational experience feedback;

(6) liquid radioactive effluent in pool is monitored prior to be discharged with automatic alarm and release control devices are also installed on the discharge pipelines; and

(7) reliable QA system is established, an effluent monitoring program is developed, and the airborne and liquid effluents are monitored according to the program.

F-51 Corresponding measures were taken by the operators of other nuclear facilities to prevent unplanned and uncontrolled release of radioactive materials.

F.4.4 Discharge Limits

F-52 Under Article 40 of the LPCRP, discharge of gaseous and liquid radioactive waste must be consistent with the national standards on prevention and control of radioactive pollution.

Table 2 Control of airborne radioactive effluents (Bq/a)

	LWR	**HWR**
Inert gas	6×10^{14}	
Iodine	2×10^{10}	
Particle (halflife ⩾ 8d)	5×10^{10}	
Carbon 14	7×10^{11}	1.6×10^{12}
Tritium	1.5×10^{13}	4.5×10^{14}

Table 3 Control of liquid radioactive effluents (Bq/a)

	LWR	**HWR**
Tritium	7.5×10^{13}	3.5×10^{14}
Carbon 14	1.5×10^{11}	5.0×10^{11} (other than tritium)
Other nuclides	5.0×10^{10}	

F-53 GB6249-2011 sets forth the specific requirements for the release of air and liquid effluents from on-land stationary NPPs in the normal conditions, as follows:

(1) the effective dose to any individual of the public arising from all nuclear power reactors at any site must be less than 0.25 mSv dose constraint; the dose management goal values for air-borne and liquid effluents should be set, respectively, by the operators of NPPs in accordance with the values of dose constraints authorized by the national regulatory bodies;

(2) the total annual release amount of radioactive effluents should be controlled on the one-reactor basis; the control values for a 3，000 MW (thermal) reactor are shown in Table 2 and 3;

(3) the control values for a larger-than or less-than 3，000 MW (thermal) reactor should be adjusted appropriately; and

(4) for a multi-reactor site with the same reactor type, the annual discharge volume of all units shall be controlled under 4 times of the value prescribed by

Clause (2); for multiple and various types of reactors at one site, the total annual release from all units should be controlled according to the authorization by the MEE/NNSA.

F-54 In the time period 2017-2019, the percentage of annual release of air and liquid effluents from China's NPPs to the annual limit authorized by the MEE/NNSA is shown in Annexes L.7, indicating the releases of effluent from NPPs are all less than relevant national control limits.

F.4.5 Corrective Measures for Unplanned or Uncontrolled Release of Radioactive Materials to the Environment

F-55 Regarding unplanned or uncontrolled release, as have been pointed out in the RSRWM, the operator of solid radioactive waste storage and/or disposal facilities should conduct radioactivity monitoring for groundwater, surface water, soils and air around the facility. If any hidden danger to safety is discovered to have occurred or any radionuclide content in the ambient environment is in excess of relevant national standards, the necessary precautionary measures should be taken immediately after identification of cause while such situation should be reported to the relevant competent body. If a radiation accident would be rated, then emergency response plan for such facility should be activated and accordingly reported to the relevant bodies under the relevant laws and regulations so as to emergency response.

F-56 Since the last Review Meeting, no unplanned or uncontrolled release of radioactive materials has occurred in China.

F.5 Emergency Preparedness (Article 25)

1. Each Contracting Party shall ensure that before and during operation of a spent fuel or radioactive waste management facility there are appropriate on-site and, if necessary, off-site emergency plans. Such emergency plans should be tested at an appropriate frequency.

2. Each Contracting Party shall take the appropriate steps for the preparation and testing of emergency plans for its territory insofar as it is likely to be affected in the event of a radiological emergency at a spent fuel or radioactive waste management facility in the vicinity of its territory.

F-57 China has already developed the emergency plan and conducted emergency exercises at an appropriate frequency, in response to (1) the severe deviations from operational conditions unlikely to occur at nuclear facilities or associated nuclear activities inside and outside the territory of the country, to (2) the potentially resulting radioactive releases, with significant radiological consequences, that are likely occur or would have occurred, and to (3) the

events in which radioactive sources are lost, stolen or out of control, or radioisotope is out of control, therefore leading to abnormal exposure of radiation to person.

F.5.1 Emergency Preparation for Nuclear Accident

F.5.1.1 Emergency plan for nuclear accident

F-58 Under relevant laws and regulations such as the *Law of People's Republic of China on Dealing with Emergency Event* (LDEE), the LNS, the LPCRP, and the *Regulations on Emergency Management of Nuclear Accidents at Nuclear Power Plants* (REMNANPP), three-level organization regime is implemented in China for nuclear emergency response at national, provincial, and facility levels.

F-59 At the national level, the *National Nuclear Emergency Plan* (NNEP, revised) was issued by the State Council in June 2013 and in effect. It is applied to nuclear incidents occurring at nuclear facilities within territory of China and caused by the associated activities, and it can be taken as reference for those that could have occurred outside the territory of China but could have led, and have potentials to lead, to impacts on the mainland of China.

F-60 At the NNAECC members' and provincial level, the members of the NNAECC and authorities at relevant provincial (autonomous region and centrally governed municipality) level all have developed their respective emergency plans in accordance with the NNEP (revised), or provincial nuclear accident emergency plans in their respective administrative regions, or off-site nuclear accident emergency plans specific to certain NPPs within their respective administrative regions.

F-61 At the level of nuclear facility operator, the MEE/NNSA has revised and issued nuclear safety guides such as the *Emergency Preparedness and Response of Nuclear Power Plant Operators*, *Emergency Preparedness and Response of Nuclear Fuel Cycle Facility Operators*, and *Emergency Preparedness and Response of Research Reactor Operators*. Nuclear facility operators have prepared their respective on-site emergency plans and, prior to first fueling, submit them together with the final safety analysis report for review and approval. The emergency plan should be re-reviewed and revised during nuclear facility operation.

F-62 Additionally, at the nuclear group level, the CNNC, CGN and State Power Investment Corporation (SPIC) all establish their respective nuclear accident emergency assistance teams, and meanwhile prepared their emergency plans and related emergency response implementation procedures.

F-63 The Chinese People's Liberation Army and the Chinese People's Armed Police Force shall, in accordance with the provisions of the State Council and the Central Military Commission, establish their own systems to support local emergency plans for nuclear accidents.

F-64 The organization which formulates the emergency plan shall, in accordance with the actual needs and changes in the situation, revise the emergency plan in a timely manner.

F.5.1.2 Nuclear accident emergency exercise

F-65 Under NNEP, the nuclear accident emergency organizations at various levels should carry out nuclear emergency exercise through desktop simulations and actual maneuvers to test, maintain, and enhance emergency ability in response to nuclear accident. The nuclear accident emergency joint exercise at the national level should be implemented with the coordination of the NNAECC, generally once every three to five years. Provincial (autonomous region or centrally governed municipality) level nuclear accident emergency exercise should be organized by provincial nuclear accident emergency committee for implementation, normally once every two to four years. Exercise with a specific purpose should be organized once a year. Nuclear facility emergency exercise should be organized and implemented under the deployment of nuclear facility emergency headquarter, generally once every two years, but with appropriate addition for the site with more than three units. Prior to first fueling, the nuclear facility operators all participate with the onsite and offsite joint exercises organized by provincial nuclear accident emergency committee.

F-66 In June 2017, the Chinese government organized more than 10 national nuclear emergency forces to participate in the three-level convention exercise ConvEx-3 (2017) organized by the IAEA, which was highly appraised by the IAEA. In July 2017, Sanmen Nuclear Power Co., Ltd., in coordination with Zhejiang Nuclear Emergency Response Committee, completed the on-site and off-site joint exercises for nuclear accident emergency response before the first fuel loading for Unit 1 of Sanmen NPP.

F-67 In November 2019, Fuqing Nuclear Power Co., Ltd. and Jiangsu Nuclear Power Co., Ltd., in coordination with Fujian Nuclear Emergency Response Committee and Jiangsu Nuclear Emergency Response Committee respectively, carried out the on-site and off-site joint exercises for nuclear accident emergency response before the first fuel loading for Unit 5 of Fuqing NPP, and Unit 5 of Tianwan NPP.

F.5.1.3 Capability Building for Emergency Response

F-68 The MEE/NNSA has stepped up the capability construction for nuclear and radiation emergency response system. Nuclear and radiation emergency monitoring and dispatching platforms have been built in the headquarter of the MEE, six regional supervision stations, and 31 provincial radiation environment monitoring organizations nationwide. A national-provincial-site three-level nuclear accident emergency monitoring and dispatching network system has been basically formed, and key safety parameters of NPPs can be obtained in real time. Data can be acquired in real-time from the national radiation environment automatic monitoring network, video contact can be achieved, emergency forces can be dispatched, and consequence assessment is carried out, which strengthen the capability to obtain information related to nuclear and radiation accident emergency treatment, and improve the efficiency of organizing and coordinating emergency response forces.

F-69 The MEE/NNSA has established a national radiation environment monitoring network system to carry out daily monitoring and emergency monitoring of the radiation environment nationwide; the MEE/NNSA has also established a national key supervision network system for monitoring the environment around nuclear and radiation facilities to carry out supervision and monitoring for 46 national key regulatory nuclear and radiation facilities, and achieve dual-track on-site and off-site monitoring for important nuclear facilities and their surrounding environment nationwide. In the past three years, the MEE/NNSA has strengthened the construction of national radiation environment monitoring network, and improved the capability of automatic monitoring and aerial survey. In addition to 161 automatic stations put into operation, the construction for 337 automatic stations has started and 102 have been built.

F.5.2 Emergency Preparation for Radiation Accident

F.5.2.1 Emergency Plan for Radiation Accident

F-70 According to the LPCRP, RSPRRD, and *National General Emergency Plan for Environmental Emergency Events* (NGEPEEE), radiation accident refers to those in which radioactive source is lost, stolen or out of control, or to those in which radioisotope is out of control causing abnormal exposure of radiation to person, or to those in which radioactive material is leaked causing environmental contaminated. According to the nature, severity, controllability and impact extent of a radiation accident, they are classified into exceptionally serious radiological accidents, major radiological accidents, serious radiological

accidents and ordinary radiological accidents. The response and treatment of radiological accidents are classified in accordance with the RSPRRD.

F-71 The ecology and environment departments of the people's governments at or above county level should prepare radiation accident emergency plan governing the areas under their jurisdiction in conjunction with departments of public security, hygiene and health, finance, news and press. These departments should submit the prepared emergency plans to the local people's governments at the same level for authorization. Such plans should present emergency agency, responsibility assignment, emergency personnel training, emergency rescue equipment, funds, materials reserve, radiation accident classification, emergency response measures, radiation accident investigation, reporting and treatment procedures, radiation accident information disclosure, pubic communication plan, etc.

F-72 The licensees of radiation safety prepared emergency plans based on the estimated risks of radiation accident to their facilities and get prepared for the emergency.

F.5.2.2 Emergency exercise and drill for radiation accident

F-73 The MEP/NNSA officially launched in 2014 nationwide joint radiation accident emergency exercises and drills at provincial-level on a rotational basis. In 2017 and 2018, the MEP/NNSA coordinated and guided regional supervision stations to supervise the implementation of comprehensive radiation accident emergency exercises in the eco-environmental systems of eight provinces (autonomous regions and centrally governed municipalities), including Xinjiang, Guizhou, Hainan, Shanxi, Hebei, Anhui, Zhejiang and Tianjin'.

F-74 The scenarios of exercises involve different types of radiation emergency activities, such as the safety of radioactive source management, the search and collection of lost radioactive sources, disposal of beyond-standard radioactive items for customs clearance at border areas. These exercises improved the attention of local governments on radiation accident emergency response. The main responsibilities of local government radiation emergency work have been implemented, and the teams have been trained. Emergency plans and facilities and equipment have been tested, and the capability of emergency response and disposal has been improved. In addition, through the on-site and video assessment, the exchange of emergency experience among provinces has been strengthened, and positive and demonstration effects have been achieved by replacing training with practical exercise, taking one or two excellent case(s) as the example for the rest to follow, and learning from each

other. At present, the first round of provincial radiation accident emergency exercises have been completed, and the follow-up exercises will continue to push to the front line, and further strengthen the practicality of exercises.

F.5.3 Emergency Preparation in Response to Radiation Events outside the Boundary

F-75 When a nuclear accident to have occurred outside the boundary may have potential impact upon the country, the NNAECC shall, under the NNEP, make unified arrangements to implement emergency responses, consisting of information gathering and release, radiation monitoring, discussion and coordination between departments, analysis and judgment, control at ports, market control, international notification and assistance etc. If necessary, the national headquarter for nuclear emergency should be formed to implement the unified leadership, organization and coordination of nuclear emergency.

F.6 Decommissioning (Article 26)

Each Contracting Party shall take the appropriate steps to ensure the safety of decommissioning of a nuclear facility. Such steps shall ensure that:

(i) qualified staff and adequate financial resources are available;

(ii) the provisions of Article 24 with respect to operational radiation protection, discharges and unplanned and uncontrolled releases are applied;

(iii) the provisions of Article 25 with respect to emergency preparedness are applied; and;

(iv) records of information important to decommissioning are kept.

F-76 Nuclear facility decommissioning is equipped with qualified personnel. Under the GB/T19597-2004, the management organizations of nuclear facility decommissioning are all provided with proper number of decommissioning experts and original operational and management personnel of the facility to be decommissioned. Among the nuclear facility decommissioning workforce are professionals and experts involved in operation, decontamination, robot or remote manipulator, engineering technology, dismantling and demolition, quality assurance, waste management, and security and safety.

F-77 Nuclear facility decommissioning is provided with enough financial resource. Under the LNS and LPCRP, the decommissioning costs shall be earmarked and included in the cost estimate or production cost. Measures for the management of nuclear facility decommissioning funds are being drafted. At present, decommissioning funds have been pre-appropriated for the operational NPPs in China, including spent fuel and radioactive waste management facilities' decommissioning at the NPP sites. For instance, Daya Bay NPP has

provided decommissioning reserves equivalent to 10% of the final accounting value of the nuclear island equipment in service,

F-78 Radiation safety measures are considered and implemented in nuclear facility decommissioning to ensure limited release. Under the GB/T19597-2004, independent radiation safety organizations have been set up in all nuclear facilities and safety management is implemented in the line with proper safety procedures. In preparatory phase of decommissioning, the radiation protection program was prepared, involving abnormal decommissioning conditions and emergency measures; special radiation safety equipment, technical procedures, administrative procedures are employed in accordance with actual conditions; division of facility zone to be decommissioned, division and management of sub-zone were carried out according to radiation level, contamination level or radionuclides; appropriate safety system and necessary radiation monitoring meters were deployed, including isolation room and/or shutter, to keep the doses to workers and the public ALARA; radiation safety measures are used, like effective ventilation and air purification devices; radiation monitoring is performed including effluent monitoring; limits and control are imposed to doses to worker and the public. Management should be made, as specified by the relevant laws and regulations, of gaseous and liquid effluents from nuclear facilities in the process of decommissioning.

F-79 Emergency preparedness is implemented for nuclear facility decommissioning. Under GB/T19597-2004, the operators of nuclear facilities should, based on specific situations, prepare and implement the emergency plans that might be in response to the abnormal conditions likely to occur. Such emergency plans should incorporate the potential event-related emergency procedures and personnel training among others. Emergency procedures should be updated through emergency drill and test.

F-80 Documentation important to nuclear facility decommissioning should be reserved. Under GB/T19597-2004, the operators should implement appropriate and most recent QA program. In preparing the QA program relating to decommissioning project, attention should be paid to collection and preservation of documents and data. The records on all decommissioning projects should be preserved in long-term.

G. SAFETY OF SPENT FULE MANAGEMENT

(Articles 4 to 10)

G.1 General Safety Requirements (Article 4)

Each Contracting Party shall take the appropriate steps to ensure that at all stages of spent fuel management, individuals, society and the environment are adequately protected against radiological hazards.

In so doing, each Contracting Party shall take the appropriate steps to:

(i) ensure that criticality and removal of residual heat generated during spent fuel management are adequately addressed;

(ii) ensure that the generation of radioactive waste associated with spent fuel management is kept to the minimum practicable, consistent with the type of fuel cycle policy adopted;

(iii) take into account interdependencies among the different steps in spent fuel management;

(iv) provide for effective protection of individuals, society and the environment, by applying at the national level suitable protective methods as approved by the regulatory body, in the framework of its national legislation which has due regard to internationally endorsed criteria and standards;

(v) take into account the biological, chemical and other hazards that may be associated with spent fuel management;

(vi) strive to avoid actions that impose reasonably predictable impacts on future generations greater than those permitted for the current generation;

(vii) aim to avoid imposing undue burdens on future generations.

G-1 In China, the primary responsibility of spent fuel management safety rests with the operators of NPPs, research reactors and spent fuel storage facilities. The LNS stipulates that organizations producing, storing, transporting or reprocessing spent fuels shall take measures to ensure the safety of spent fuels, and shall be responsible for the safety of spent fuels. Under HAF001, the operators shall hold the overall responsibility for nuclear facilities they operate, including spent fuel management facility, and shall be subject to the supervision of the MEE/NNSA.

G-2 The safety of management of spent fuel stored at NPP reactors are subject to the provisions of the *Regulations on Nuclear Power Plant Siting Safety* (HAF101), HAF102, HAF103, *Design Criteria for Pressurized Water Reactor Spent Fuel Storage Facilities at Nuclear Power Plant* (EJ/T883-2006) and the *Regulatory Requirements for the Safety of Spent Fuel Dry Storage*

System at NPPs (Trial) (RRSSFDSSN).

G-3 The safety of management of spent fuel at research reactor shall be subject to the requirements of the *Regulations on Research Reactor Design Safety* (HAF201) and the *Regulations on Research Reactor Operation Safety* (HAF202).

G-4 The safety of management of spent fuel away from reactor shall abide by the provisions of *Regulations on Civilian Nuclear Fuel Cycle Safety* (HAF301) and *Design Criteria for Spent Fuel Storage Pool away from Reacto*r (EJ/T878-2011).

G-5 For the management of spent fuel stored at reactor and/or away from reactor at NPPs and research reactors, the following measures are taken to reduce undue burden over the future generations as much as possible:

(1) avoid as much as possible actions that impose reasonably predictable impacts on future generations greater than those permitted for the current generation. Vitrification shall be implemented of liquid HLW generated from spent fuel reprocessing and the vitrified waste forms shall be disposed of in deep geological formation. Under RSRWM, the deep geological repository for solid HLW should meet the requirements of safe isolation for more than 10,000 years after its closure; and

(2) avoid as much as possible imposing undue burdens on future generations. The CAEA, in conjunction with other related agencies, issued in July 2010 the IPCUMFTDSFNPP. The funds mentioned here are intended for the costs needed for spent fuel transportation, away-from-reactor storage, reprocessing and resultant HLW disposal, the construction, operation, reconstruction and decommissioning of reprocessing plant, and the treatment and disposal of spent fuel. China is striving to construct a large reprocessing plant.

G.1.1 Requirements for Management Safety of Spent Fuel Stored On-site at NPPs

G-6 As required by HAF102, RRSSFDSSN, HAD103/03, and EJ/T 883-2006, the following measures are taken to ensure enough protection of individuals, society and the environment from radioactive hazards during all phases of spent fuel management at NPPs:

(1) to ensure that the criticality issues are solved properly. The major measures to be taken are to comply with the layout that has been approved, meet the requirements for neutron absorbers in storage facilities, to implement relevant QA program, and to ensure that the inventory of spent fuel are less than the maximum capacity of storage. Here, neutron absorber may be fixed thin plate as absorber or boron-containing water in storage pool.

(2) to ensure that the residual heat release are addressed properly. Considerations are taken into account, such as the maximum capacity of storage pool, burnup, decay, cooling capacity of spent fuel pool, so as to ensure the redundancy of cooling system to a certain degree; to provide with suitable systems of water make-up and drainage to achieve forced cooling function and maintain the required water temperature, as well as equipped with restorable ability for the loss of cooling capability; to consider the coolant flow required to derive maximum decay heat of fuel assembly in design of spent fuel rack. The spent fuel dry storage system (NUHOMS®) in Tianwan NPP is imported from the United States. The burnup, cooling time and residual heat of the spent fuel assembly are taken into account when designing the loading scheme for the spent fuel assembly, and the passive heat removal mode is adopted to lower the drum temperature; and

(3) to ensure the amount of radioactive waste generated is kept as low as practicably achievable. The major measures to be taken for the spent fuel pool are to use stainless steel and other materials as fuel pool liner to ensure leak tightness of spent fuel pool; select proper surface roughness of liner for convenient decontamination, consider possibility of container falling on spent fuel assembly in design of container loading and unloading pool to provide collision; provide monitored zone with necessary monitoring and decontamination equipment to prevent occurrence of unacceptable contamination; to prevent contaminated cooling water from leakage; to make the equipment and materials that may contact with water compatible with pool water; to provide damaged fuel with storage equipment. The on-site dry storage facilities do not contain damaged fuel assemblies, so the radioactive wastes are mainly waste water and labor protection supplies produced during the operation of the container. In addition, the on-site dry storage facilities are designed to facilitate the decommissioning, and the production of radioactive wastes can be reduced as much as possible;

(4) to consider interdependent relationship between various steps. The spent fuel drawn from reactors is stored temporarily in storage at NPPs and then sent to the on-site dry storage facility, centralized storage facility, or reprocessing facility. The spent fuel sent to the centralized facility will be also sent to reprocessing facility. Type, burnup, cooling period and other characteristics of spent fuel are all considered in devices and transport operations involved in every stages of the spent fuel management. In this process, the applicants should submit detailed technical documents to evidence the measures taken can ensure the safety of spent fuel management in every stage.

(5) to ensure providing effective protection of individuals, society and the environment. Complying with the Departmental Rules on the siting, design and constructions of NPP, the operators perform management of spent fuel facilities, implement QA program approved by the MEE/NNSA and meet the dose constrains approved by the MEE/NNSA.

(6) to adequately consider potential biological, chemical and other hazards. During the normal operation, the temperature in pool should be kept at safety level to make workers conformable. Fuel plant should be designed and constructed in such a manner to have capability of preventing local fire spread.

G.1.2 Requirements for Management Safety of Spent Fuel Storage at Research Reactor

G-7 Under the HAF201and HAF202, the following measures are taken to ensure enough protection of individuals, society and the environment against radioactive hazards during the all phases of spent fuel management at research reactor:

(1) to ensure that the criticality issues are solved properly. The major measures to be taken are to provide adequate place to store research reactor spent fuel, to store spent fuel assembly in accordance with approved procedures and assessed layout, set fixed absorber (such as boron carbide aluminum plate) in storage pool, or neutron absorber dissolved in pool water, and implement required supervisory and management procedures.

(2) to ensure that the residual heat release issues are dealt with properly. The major measures to be taken are to ensure smooth flow of coolant in the design of rack and storage pool, employ forced or natural circulation approach to release residual heat and set water make-up equipment with some redundancy.

(3) to ensure the amount of radioactive waste generated is kept as low as practicably achievable. The major measures to be taken are to set purification system, control composition of cooling medium, prohibit weights from moving over fuel storage zone, limit crane operation at required minimum height, periodically examine crane, monitor leakage from pool, and individually store and timely treat the damaged and leakage spent fuel.

G-8 Additionally, the interdependent relationship between different steps in spent fuel management is taken into account in much the same way as NPP to ensure provide enough protection of individuals, society and the environment and take full consideration of the potentials of biological, chemical and other hazards relative to spent fuel management.

G.1.3 Requirements for Spent Fuel Storage Away-from-reactor

G-9 Requirements and recommendations on away-from-reactor spent fuel management are provided in the HAF301, and EJ/T878-2011, with special emphasis on the safety of dry storage or pool storage. The main points are as follows:

(1) to maintain the sub-criticality of spent fuel. The basic objective of design away-from-reactor spent fuel pool is to ensure spent fuel to be kept at subcriticality in normal and accidental conditions. The main measures include the analysis of the likelihood and consequences of fuel movement and high-density storage or internal and external events that are likely to affect sub-criticality, by firstly adopting geometrically safe system, then using maximum fuel burnup and taking into account moderator density change in criticality calculation;

(2) to ensure residual heat removal. The design basis of pool water cooling system is aimed at keeping bulk water temperature to be not higher than 40 ℃. After cooling system could have failed to work, the cooling system shall recover to normal conditions before pool water temperature exceeding the design limit;

(3) to ensure the amount of radioactive waste generated is kept at as low as actually achievable. The major measures to be taken include the assurance of integrity of spent fuel cladding, deployment of several systems, such as the multiple secondary barriers and purification system, the cooling systems of primary, secondary, tertiary coolant loops, and the pool water leakage monitoring, collection and return system.

G-10 In addition, through the implementation of measures similar to spent fuel management in NPPs, the interdependence of different steps in spent fuel management was taken into account, effective protection for individuals, society and the environment were ensured, and biological, chemical and other hazards which may be related to spent fuel management were taken into full consideration.

G-11 QNPP III’s spent fuel dry storage facility is an away-from-reactor dry storage facility, with the following main features:

(1) spent fuels removed from HWRs contain too low content of U-235 and Pu-239 to reach criticality;

(2) MACSTOR-400 module is storage container capable of passive heat removal, which can make spent fuel cladding temperature not to exceed the

specified limits under natural convection conditions;

(3) during storage and subsequent transportation, spent fuel is shielded with provided pool water, workbox, transportation cask and concrete. Such shield can assure the safety of workers and the public; and

(4) in addition to spent fuel cladding, both fuel basket and storage cask also provide shield to radioactive materials, thus ensuring the containment of radioactive materials.

G.2 Existing Facilities (Article 5)

Each Contracting Party shall take the appropriate steps to review the safety of any spent fuel management facility existing at the time the Convention enters into force for that Contracting Party and to ensure that, if necessary, all reasonably practicable improvements are made to upgrade the safety of such a facility.

G-12 To ensure the safety of the existing facilities, the MEE/NNSA shall, prior to their construction and operation, conduct the review and on-field inspection of the environmental impact statement submitted by the operators, along with safety analysis report and other related submittals. During operation of a facility, the MEE/NNSA shall, together with its subsidiary regional branch stations, conduct regulatory inspection of nuclear safety on a routine or non-routine basis. Additionally, the operator of a NPP shall conduct re-assessment of safety systems at its NPP at a regular interval.

G.2.1 Review of Facility Safety

G-13 Under the LNS and HAF001, prior to construction and operation, the operators of existing NPPs and research reactors all prepared and submitted to the MEE/NNSA the environmental impact statements, preliminary safety analysis reports, final safety analysis reports, nuclear facility QA programs, nuclear facility commissioning program, nuclear accident emergency plans and other related documents.

G-14 The MEE/NNSA mandates its technical support organizations to review the submittals, such as environmental impact statements and preliminary safety analysis reports, etc., from such operators and to carry out onsite inspection. After such review and inspection, the findings of technical support organizations shall presented to the nuclear and radiation expert panel for further review. Subsequently, the panel shall form review results on the review opinions of the technical support organizations. Based on these findings and review results, the MEE/NNSA shall decide whether or not approve the above application presented by the operators.

G-15 After having approved by the MEE/NNSA, the operators of existing NPPs and research reactors begin construction and operation of such facilities including spent fuel management facilities.

G.2.2 Regulatory Inspection of Facility Safety

G-16 MEE/NNSA, together with its regional branch stations, exercises routine and non-routine inspection of nuclear safety, so as to verifying and overseeing whether or not nuclear operators' facilities, material items and activities meet the regulatory requirements of nuclear safety and license requirements, causing the operators to correct defects and abnormal conditions and ensuring facilities, material items and activities consistent with approved documents and requirements.

G-17 From March to December 2011, a full-range of civilian nuclear facility safety inspection countrywide was conducted including NPPs and research reactors.

G-18 The inspection results have shown that China's NPPs have capability to prevent and mitigate accident occurring to some extent that risks of safety are under control and safety is safeguarded. Based on the discoveries in the inspection, the requirements for safety improvement are proposed. Depending on the importance and feasibility of safety modification, the short- medium- and long-term plans are separately developed, which require and urge the modification task to be completed on the schedule. With aim to normalize the safety modification at various NPPs with common features, MEE/NNSA issued of in June 2012 the *General Technical Requirements for Nuclear Power Plant Modification following Fukushima Accident* (GTRNPPM) (Trial), as guidance on follow-up actions for improvement.

G-19 GTRNPPM (trial) puts forward technical requirements for monitoring of spent fuel pool water, encompassing monitoring method and extent, monitoring meters and availability of systems. It also provides for technical requirements for emergency feedback system and related equipment at NPPs, pointing out that residual heat removal should be carried out using emergency feedback water in secondary and primary loops and in spent fuel pool.

G-20 In compliance with the requirements mentioned above, all operators of NPPs developed implementation procedures. By the end of 2016, all of these operators have completed their own projects of safety improvement on the schedule.

G-21 From April to June 2019, the MEE/NNSA organized the investigation

for the potential risks of nuclear and radiation safety.

G.2.3 Periodic Safety Review of Operational NPPs

G-22 Under HAF103, the operators shall, based on the gained operational experiences and on the new significant safety information from related sources throughout operating lifetime, conduct systematic re-assessment of NPP safety in accordance with management requirements. The HAF103 also specifies that the above re-assessment shall be based on periodic safety review. Periodic safety review targeted at operational NPPs has been listed in the license review requirements for NPPs.

G-23 Safety review, conventional and specific, and periodic (10 years normally) safety review of China's existing NPPs are conducted by their operators under *In-commissioning examination of NPPs* (HAD103/07) and *Periodic safety review for NPPs* (HAD103/11). The period safety review is conducted after 10 years of NPPs' operation, subsequently once a decade or so, until the end of facility lifetime. The periodic safety review covers all aspects of NPP safety, namely all in-plant facilities, structures, system and components covered in the operation license, as well as personnel allocation, organizational structure, emergency plan, radiation environmental impacts and other safety elements relevant to nuclear units, including spent fuel management facilities.

G-24 The second 10-year periodic safety review to the QNPP was conducted in 2011 and the first 10-year review to QNPP II and QNPP III was also conducted in the same year. The second 10-year periodic review to Daya Bay NPP was conducted in 2012. The scope of review related to the safety of spent fuel management covers design and actual aspects of spent fuel handling and storage systems, spent fuel storage pool cooling and purification systems, together with enough relevant documents and records. Modification approaches are suggested to improving the identified deviation and weakness. Timely improvements were made in such a way as to raise the safety and reliability of system.

G.3 Siting of Proposed Facilities (Article 6)

1. Each Contracting Party shall take the appropriate steps to ensure that procedures are established and implemented for a proposed spent fuel management facility:

(i) to evaluate all relevant site-related factors likely to affect the safety of such a facility during its operating lifetime;

(ii) to evaluate the likely safety impact of such a facility on individuals, society and the environment;

(iii) to make information on the safety of such a facility available to members of the public;

(iv) to consult Contracting Parties in the vicinity of such a facility, insofar as they are likely to be affected by that facility, and provide them, upon their request, with general data relating to the facility to enable them to evaluate the likely safety impact of the facility upon their territory

2. In so doing, each Contracting Party shall take the appropriate steps to ensure that such facilities shall not have unacceptable effects on other Contracting Parties by being sited in accordance with the general safety requirements of Article 4.

G.3.1 Review and Approval of Spent Fuel Storage Facility Site

G-25 Under the LNS, HAF001, and SLPNPPRRNFCF, nuclear facility operators shall conduct scientific assessment of geology, earthquake, meteorology, hydrology, environment and population distribution and other factors, and submit siting safety analysis reports to the nuclear safety regulatory department of the State Council on the premise of meeting the requirements of nuclear safety technology evaluation. After the reports are reviewed and considered to meet nuclear safety requirements, the operator of nuclear facility acquires the paper of nuclear facility siting review opinion.

G-26 China has established a complete licensing process for siting:

(1) the applicant shall submit the MEE/NNSA the site safety analysis report and environmental impact statement in the siting phase of a NPP, including the analysis and assessment of spent fuel storage facility;

(2) the MEE/NNSA's technical support organizations shall conduct review of these submittals, giving written comments;

(3) based on applicant's answered questions and revised version of above documents, the reviewing organizations shall write their review comments on above both documents (or review reports) and submit to the MEE/NNSA;

(4) the MEE/NNSA shall organize the expert panel of nuclear safety and the environment to review the both reports revised and presented by the applicant along with the review comments or review report provided by reviewing organizations; and

(5) based on the review comments above, the MEE/NNSA shall grant site use permit and the EIA approval to the applicant and copy them to other related departments.

G.3.2 Siting of Spent Fuel Storage Facilities

G-27 Under the LNS, LPCRP, all nuclear facilities, encompassing both the on-site spent fuel storage facilities (i.e., spent fuel pools and dry storage facilities) and away-from-reactor spent fuel storage facilities built for NPPs and research reactors, have passed scientific demonstration and licensing procedures with respect to their siting. Prior to undergoing licensing procedures, the environmental impact statements have been prepared and submitted to MEE/NNSA for approval.

G-28 Under HAF101, HAF201, HAD301 and other related nuclear safety guides, in the process of siting the existing spent fuel storage facilities, the following tasks are completed:

(1) evaluating the natural and human factors that may influence the safety of spent fuel management facilities in their lifetime. The former includes, such as industrial, transportation and military facilities in the surrounding environment, hurricane, tornadoes, lightning, hail, freezing rain, snow and tropical cyclones, rainfall-caused floods, earthquake-caused waves, broken liquid-retaining structure-caused floods and waves, potential volcano, earthquake rupture, slope instability, ground subsidence, subsidence and uplift, earthquake, soil liquefaction, the plane crash, significant natural phenomena and extreme conditions. The latter includes plane crash, chemicals explosion and other important man-made events, etc.

(2) evaluating the impacts on the safety of personnel, society and the environment arising potentially from spent fuel management facilities. Evaluating potential release of radioactive materials; using suitable models to evaluate the atmospheric dispersion of radioactive materials, the potential impacts of contaminated surface water on local population and the migration of radionuclides in hydrogeological unit, potential impacts of contaminated groundwater on local population and the ability of mitigation measures required to be taken under accident condition, including emergency plan;

(3) providing the pubic with the information on the safety of spent fuel management facilities. Under the LNS, LPRCEIA, GIOGEIACP (Trial) and TMPIEIA, the applicants in the phase of NPP siting shall disseminate the information on NPP project construction to the public at internet websites and on the publicly available media. The information mainly included potential impacts of the construction project on the environment, countermeasures and actions to prevent and mitigate adverse environmental impacts, summary of assessment conclusions. The applicants also initiatively announced the

environmental impact assessment statement to the public and solicited the public comments. For example, before submitting environmental impact assessment report on interim spent fuel dry storage facility, the applicants disseminated the main content of the report to the public through the local media for comment collection. They also held the public meetings, briefing the situation of construction projects, exchanging the main assessment results with each other, collecting and answering questions. Among the stakeholders participating in meetings are professionals, representatives of enamoring communities and surrounding villagers. MEE/NNSA makes all information of the environmental impact assessment statement available to the public when accepting such a statement, make public the proposed comments on approving or disapproving such a statement before final decision, and open the information on licensing process to the public after making final decision.

(4) real-time continuous monitoring points are established around proposed sites for air environment, marine environment, territorial water environment, soil, organisms, and electromagnetic radiation during siting for away-from-reactor spent fuel storage facilities. The data concerned data are made available to the public at regular intervals.

(5) Chinese NPPs are almost located in the eastern and southern coastal areas, with spent fuel storage facilities built on site. No impacts upon any other Contracting Parties could be from its current spent fuel storage facilities, for which appropriate steps have been taken in consistent with the General Safety Requirements as stated in G.1.

G.4 Design and Construction of Facilities (Article 7)

Each Contracting Party shall take the appropriate steps to ensure that:

(i) the design and construction of a spent fuel management facility provide for suitable measures to limit possible radiological impacts on individuals, society and the environment, including those from discharges or uncontrolled releases;

(ii) at the design stage, conceptual plans and, as necessary, technical provisions for the decommissioning of a spent fuel management facility are taken into account;

(iii) the technologies incorporated in the design and construction of a spent fuel management facility are supported by experience, testing or analysis.

G.4.1 Design and Construction of Spent Fuel Management Facility at NPPs

G-29 Under the HAF102, *Management of Core and Fuel at Nuclear Power Plants* (HAD103/03), RRSSFDSSN, GB18871-2002 and GB6249-2011,

GB/T19597-2004 and EJ/T883-2006, the following main measures were taken in the design and construction of spent fuel management facilities at NPPs in addition to preventing criticality and ensuring residual heat removal.

(1) the engineering technological measures were taken for the purpose of release restriction and planned release. These measures include segregation and filtration, controlling iodine and other radioactive materials below the required limits, making airflow to be controlled within fuel building, controlling the release of radioactive substance during fuel handling at minimum limits, filtering gaseous waste before released to stack, installing airborne radioactivity monitoring system, monitoring and controlling airborne effluent, setting drainage sump leading to liquid radioactive waste treatment system, monitoring and controlling liquid radioactive waste release to the environment, and preventing storage facility from being submerged.

(2) conceptual plan of decommissioning was considered. The structures, equipment and systems in spent fuel storage facility were designed to consider future convenient decommissioning of nuclear facility as a whole. The preliminary decommissioning plan for nuclear facility, along with spent fuel management facility, were developed and submitted to the higher competent authorities. The inclusions of the plan encompass considerations of basic safety issues, expected decommissioning strategy, the impacts of the current or proposed technology on facility to be decommissioned, arrangement of systems sheared between the facilities under decommissioning and in service, impacts of decommissioning process on the environment, management of decommissioning wastes, decommissioning costs and their raise, and assurance agencies.

(3) experience, test, and analytical means were used to support the technology to be employed in design and construction of spent fuel management facility. The NNSA-approved engineering design specifications were used as the acceptance criteria of systems and components. Facility design was guided on the basis of operational experiences in combination with safety analysis and safety research outcomes. Design basis for significant safety items were developed and confirmed through iterative process.

G-30 Under RRSSFDSSN issued in 2015, the design and operation of a spent fuel dry storage system, as a newly added auxiliary system to a NPP, must be consistent with the Regulations HAF102, HAF103 and the *Detailed Rules for the Regulations of the People's Republic of China on Regulating Nuclear Materials* (HAF501/01), as well as the Standards GB18871-2002,

GB6249-2011 and *Nuclear Criticality Safety for Fissile Materials outside Reactors* (GB15146). An on-site spent fuel dry storage system (SFDSS) at a NPP shall complies MEE/NNSA's relevant guiding documents with regard to its design, construction, operation and decommissioning.

G.4.2 Design and Construction of Spent Fuel Storage Facilities at Research Reactors

G-31 Under the HAF201, the following main measures were taken in the design and construction of spent fuel management facilities at research reactors in addition to preventing criticality and ensuring residual heat removal.

(1) the measures with capability to prevent radioactive materials from being released to the environment were taken. Adequate systems of containment, ventilation, filtration and decay were put in place in spent fuel storage facility. Both radiation monitoring system and ventilation system, along with necessary filtration system, were installed in place where radioactive concentrations were higher. Adequate sampling measures were provided.

(2) decommissioning of reactors along with their spent fuel storage facility should be put into consideration in the phases of design and construction in order to release the decommissioned site for future unrestricted use. The measures to facilitate decommissioning and demolishing should be considered. Suitable materials were selected as building materials of structures, systems and components required so as to minimize the generation of radioactive wastes and to facilitate decontamination. Account was taken of the facilities necessary for managing radioactive wastes generated from decommissioning.

(3) experience, test, and analytical means were used to support the technology to be employed in design and construction of spent fuel facility. Sufficient safety analysis and assessment were applied to the design of spent fuel storage facilities at research reactors to demonstrate enough safety, and necessary functional tests were conducted for all safety-related important items.

G.4.3 Design and Construction of Away-from-reactor Spent Fuel Storage Facilities

G-32 Under the HAF301 and EJ/T878-2011 the following main measures were taken in the design and construction of nuclear fuel cycle facilities, along with spent fuel management facilities, in addition to preventing criticality and ensuring residual heat removal.

(1) primary barrier system, multiple secondary barrier system, pool water purification system, containment system, ventilation system, waste gas filtration system, and adequate radiation monitoring equipment were put in place to

control concentrations and amounts of radioactive material to be released to the environment.

(2) decommissioning plans were developed, with associated measures being designed, including easy decontamination and demolition of contaminated plants and equipment, minimization of radioactive waste and contaminated equipment generated in amount and number, and keeping radiation dose to workers at ALARA.

(3) the technologies that have been proven by test and engineering to be effective were employed to conduct safety analysis and assessment in respect to design. Account should be taken of ergonomics, especially, operation, control and limitation of the systems and parts important to safety.

G-33 Fuel basket and storage cask within module were designed and manufactured for QNPP III's interim spent fuel dry storage facility to confine radioactive materials during storage of damaged spent fuel bundles. Two different preliminary decommissioning plans were considered for interim spent fuel dry storage facility, postponed module demolition and released site for unrestricted use. Both covered the issues related to demolition, decontamination, and site restoration, including materials selection, facility design and layout, radioactive materials handling and storage, etc.

G.5 Safety Analysis of Facilities (Article 8)

Each Contracting Party shall take the appropriate steps to ensure that:

(i)before construction of a spent fuel management facility, a systematic safety assessment and an environmental assessment appropriate to the hazard presented by the facility and covering its operating lifetime shall be carried out;

(ii) before the operation of a spent fuel management facility, updated and detailed versions of the safety assessment and of the environmental assessment shall be prepared when deemed necessary to complement the assessments referred to in paragraph (i).

G-34 Under the LNS, LPCRP, and HAF001, prior to applying for construction and operation licenses of proposed nuclear facilities and for decommissioning authorization, the operators of such nuclear facilities should prepare environmental impact statement and submit them to the MEE/NNSA for review and approval. Prior to construction, such operators should submit to the MEE/NNSA the written application for nuclear facility construction, preliminary safety analysis report and other related documents. Prior to operation, such operators should submit to the MEE/NNSA the written application for nuclear facility operation, final safety analysis report, and other

related documents. No fueling and commissioning operations can be carried out until the relevant authorizations have been granted.

G-35 In accordance with the SLPNPPRRNFCF, prior to the construction of nuclear facilities, nuclear facility operators shall apply to the MEE/NNSA for construction, and submit (1) the application for the construction of nuclear facilities; (2) preliminary safety analysis report; (3) environmental impact assessment document; (4) quality assurance document; and (5) other materials provided by laws and administrative regulations. Before the first fuel loading or feeding of nuclear facilities, nuclear facility operators shall apply to the MEE/NNSA for operation, and submit (1) the application for the operation of nuclear facilities; (2) final safety analysis report; (3) quality assurance document; (4) emergency plan; and (5) other materials required by laws and administrative regulations.

G-36 Under RRSSFDSSN (Trial) issued in 2015, the operator of a NPP shall provide technical support documents on design demonstration, safety analysis and test validation for SFDSS and submit them to the MEE/NNSA in a form of SFDSS Safety Analysis Report. This Report incorporates the information on location, layout and foundation condition of a SFDSS within plant area, design and operation of related support system, spent fuel handling and transport system. It incorporates also other related inputs incorporating the operation and management of a SFDSS into current management of a NPP, which include, but not limited to, radiation protection, waste management, nuclear material accountancy and physical security, emergency planning, environmental monitoring, operation restriction and conditions, periodic test, and in-service inspection, etc. It also deals with the interfaces of a SFDSS, as an onsite temporary option, with the NPP, transportation system and reprocessing plant and validates the operability. It also provides information on environmental impact assessment of SFDSS and on demonstration of whether or not environmental impact of a newly added SFDSS is consistent with license requirements of such a NPP.

G-37 For existing spent fuel storage facilities, both safety analysis and environmental impact assessment were conducted prior to their construction and operation and associated safety analysis report and environmental impact statement report were prepared, with increasingly extended scope and depth. Safety analysis and environmental impact assessment encompass the description of structures, systems and components; performance criteria for their uses; description of design process; description of facility construction and

management; general description of facility operation; performance predication and analytical and assessment methodology. Regarding performance predication, the models, parameters, boundary conditions, assumptions and reasons used in such analysis and assessment were made clear; potential impacts on spent fuel storage facility of natural conditions and phenomena, in the external man-made events and natural events were confirmed, the natural conditions and phenomena are like weather, climate, hydrogeology, geological conditions, topography and geomorphology, potential natural fire and explosion, etc., external man-made events include explosions, fire, aircraft crash, flying object, downfall of fuel container and weights, release of toxic, hazardous or radioactive materials, etc., and the external natural events are floods, earthquake, subsidence and landslide, etc., together with temporal variation of impacts; based on structure analysis, the integrity of facility's components was demonstrated under the operational conditions (structure and mechanical load, thermal load and process, temporal variation of materials nature, measures incorporated in design) and accident conditions; radioactive and/or non-radioactive impacts of spent fuel storage facilities on human and the environment were analyzed under normal operating and accident conditions, and compared with the developed performance criteria, involving maintenance of sub-criticality, decay heat removal and radiation protection, etc.; the conclusions were drawn on safety analysis and environmental impact assessment.

G-38 Prior to construction of away-from-reactor storage facilities of spent fuel, the operators conducted preliminary safety analysis and preliminary environmental impact assessment of them and prepared and submitted the associated reports to bodies concerned. In these reports, engineering plan was described; on-site strata, structure, rock and soil physical and mechanical properties, and adverse geologic phenomena and groundwater were assessed, indicating the suitability of the site; environmental impacts and doses to workers under normal operating and accident conditions were analyzed to ensure they are entirely below the relevant national limits. Prior to the operation of interim spent fuel dry storage facilities, the operators conducted final safety analysis and environmental impact assessment, and prepared and submitted the associated reports to the relevant bodies. In addition to detailed description of design of spent fuel away-from-reactor storage facilities encompassing fuel bundles, fuel handling equipment, fuel basket, shielded transportation cask, transportation equipment, module structure, structures, auxiliary facilities, such both reports described the seismic and geological properties, gave design

earthquake parameters, analyzed potential impacts of external natural events and human factor-induced events and precautionary measures, assessed possible radiation exposure of workers and the public. About public exposure, the public is exposed directly to spent fuel storage module will not suffer significant radiation impacts. For occupational exposure, radiation doses occur during transfer of spent fuel bundles in storage pool into spent fuel baskets, during operation of spent fuel in shielded workbox and during operation of transportation casks and transfer of spent fuel baskets from transportation canisters to storage modules. Sufficient shielding and monitoring system are taken into consideration in design of spent fuel away-from-reactor storage facilities. A periodic safety analysis of interim spent fuel dry storage facility is performed. Corrective measures are taken according analytical results of safety, if necessary.

G.6 Operation of Facilities (Article 9)

Each Contracting Party shall take the appropriate steps to ensure that:

(i) the licence to operate a spent fuel management facility is based upon appropriate assessments as specified in Article 8 and is conditional on the completion of a commissioning programme demonstrating that the facility, as constructed, is consistent with design and safety requirements;

(ii) operational limits and conditions derived from tests, operational experience and the assessments, as specified in Article 8, are defined and revised as necessary;

(iii) operation, maintenance, monitoring, inspection and testing of a spent fuel management facility are conducted in accordance with established procedures;

(iv) engineering and technical support in all safety-related fields are available throughout the operating lifetime of a spent fuel management facility;

(v) incidents significant to safety are reported in a timely manner by the holder of the licence to the regulatory body;

(vi) programmes to collect and analyse relevant operating experience are established and that the results are acted upon, where appropriate;

(vii) decommissioning plans for a spent fuel management facility are prepared and updated, as necessary, using information obtained during the operating lifetime of that facility, and are reviewed by the regulatory body.

G-39 In China, the operators of nuclear facilities are required to be directly responsible for the safety of the nuclear facilities they operate, and take overall safety responsibility. Organizations which provide equipment, engineering and services to nuclear facility operators shall bear corresponding responsibilities.

Under the LNS and HAF001, prior to construction and operation, such operators shall submit relevant documents to the MEE/NNSA in phases. Only after approved by the MEE/NNSA, can the construction and operation of such facilities be started.

G.6.1 Operation of Spent Fuel Storage Facilities at NPPs

G-40 The operators prepared operation plans for their own respective spent fuel storage facilities (i.e., on-site spent fuel pools and dry storage facilities). Such plans cover commissioning, operation, maintenance and modification, inspection and testing, radiation protection, prevention of radioactive release to the environment, accident and emergency preparation, accident records, reporting and investigation, quality assurance and inspection, training, nuclear materials regulation, physical protection, etc., to the extent that each of such all aspects corresponds to specific system or incident significant to safety.

G-41 In order to manage and control risks to safety within facility, the operators developed, as required by the *OL&C and Operational Procedure for Nuclear Power Plant* (HAD103/01), operational limits and conditions in accordance with the technical specifications for design, test, experience and assessment of spent fuel storage facility. These include spent fuel burnup, cooling time, loading quantity and other limits of dry storage facilities, the reactivity margin, and the radiation monitoring requirements of the storage area; minimum cooling capacity of the cooling system of the spent fuel pool and the minimum water level above spent fuel, prohibition of storing spent fuel in any places outside the specified location, minimum backup storage capacity, reactive remaining redundancy, and radiation monitoring requirements in spent fuel storage area. These limits and conditions all have gained the approval by the MEE/NNSA. Additionally, authorized limits lower than these limits are also established by the operators with a view to prevent violation of such operational limits and conditions as have been approved.

G-42 All operators implement the management of spent fuel storage facilities in accordance with the programs and procedures prepared and approved before they are put into operation. The programs said here cover those concerning operation, periodic maintenance, monitoring, testing and inspection on which the operation safety closely related safety systems and the safety related structures and components are based. The procedures include those related to water chemistry monitoring, fuel handling, sub-criticality maintenance, radiation protection, fuel containment, maintenance and verification of heat removal, shielding maintenance, loosen components and

vibration monitoring, periodic testing, inspection of storage facility, response to operational events and accident conditions, emergency plan, management of periodic review, and other related procedures.

G-43 For the management of spent fuel assemblies in the storage pool, the main assurance conditions are to:

(1) record in detail fuel serial number, storage location, storage time and label them with marks;

(2) monitor water temperature, level and leakage of lining in spent fuel storage pool, maintain normal operation of spent fuel storage pool and cleaning system, carry out periodic water sampling and analysis to keep controlling water quality in terms of various parameters, and recharged water consistent with water quality requirements for desalt water;

(3) maintain normal and continuous operation of radiation monitoring system and ventilation system in plant; and

(4) prohibit fuel hoisting operation and prohibit heavy items other than hoisting and rigging equipment from moving above spent fuel storage pool without written consent, so as to prevent heavy items from falling to damage spent fuel;

(5) carry out the inspection and verification of neutron absorber in the case of adopting high-density storage.

G-44 For the management of spent fuel assemblies in dry storage facilities, the guarantee conditions for operation are as follows:

(1) The loading operation selects assemblies which conform to the combination of burnup and cooling time to ensure that the temperature of the fuel assemblies do not exceed the limit.

(2) Neutron poison is set in the fuel basket to ensure the subcritical state.

(3) Carrying out temperature monitoring and radiation monitoring to prevent personnel from accidental exposure.

G-45 The inspections of irradiated fuel assemblies are managed in such manner as to:

(1) prepare spent fuel inspection plan prior to each shutdown and inspect irradiated fuel assembly in accordance with approved plan;

(2) timely repair the defects of irradiated fuel assembly in accordance with procedures if discovered; and

(3) record the inspection and repair of irradiated fuel assemblies.

G-46 Under the *Organization and operational management of operators of NPPs* (HAD103/06), during their whole operation lifetime, the operators of spent fuel management facilities dedicated to NPPs have been obtaining the engineering and technical supports from various safety-related areas, like fuel management, performance analysis, in-service examination, environmental monitoring, evaluation of design modification or procedure revision, chemical control, overhaul and decontamination. These were achieved through signing contracts with relevant entities of advisory company, engineering company, supplier to NPPs, equipment manufacture and contractor, employing experts in the fields of metallurgy, health physics and seismology, and hiring equipment and devices needed for data processing, training, chemical experiment and radioactive test.

G-47 The operators of NPPs submit their annual operation safety reports to the MEE/NNSA every year. Under HAF001, the accident occurring in spent fuel management should be reported to the MEE/NNSA as part of all production activities at NPPs.

G-48 Pursuant to the *Management Methods for Experience Feedback about Operational NPPs* (MMEFONPP), the MEE/NNSA takes the lead in effort to gather, analyze and release the experience feedback information needed by operational NPPs and issues regulatory requirements; as required by the MEE'NNSA' the NPP operators develops and effectively implements the experience feedback management program or management procedures and responses timely to the experience feedback management requirements made by the MEE/NNSA; the Nuclear and Radiation Safety Center carries out periodic full-range analysis and assessment of domestic and international experience feedback information and performance index data and provides the MEE/NNSA with regulatory recommendations and suggestions; MEE/NNSA's regional branches are responsible for regulatory inspection to the experience feedback work and activities at operational NPPs. The MEE/NNSA built, in November 2014, a NPP experience feedback platform, which has been operating since July 2016. This is an integral part of NPPs experience feedback system and has the functions of information collection and inquiry, incident significance abnormality judgment, mainly useful for gathering and releasing the operational experience feedback information about NPPs.

G-49 Under GB/T19597-2004, the nuclear facility decommissioning mid-term plans should be developed after a period of operation, or after a major

event or accident would have occurred. A very wide range of possible occurrences must be considered when developing such mid-term plan, like advances in decommissioning technology, changes in national laws, regulations and policies, current situations in nuclear facility, decommissioning resources assurance, and commissioning costs, etc. The impacts of any possible event or accident occurring during operation of nuclear facility on decommissioning must be reflected in the mid-term plans.

G.6.2 Operation of Spent Fuel Storage Facilities at Research Reactors

G-50 The principled requirements for spent fuel assembly management is specified in the HAF202, to which supplementary explanations are made in HAD202/01 and *Core management and fuel handling for research reactors* (HAD202/07), thus detailing the safety requirements for research reactor core management and spent fuel handling, and providing guidance an recommendations on these issues.

G-51 The operators of research reactors are responsible for and arrange for all activities covered by the reactor core management and the onsite fuel management. In order to ensure the safety of spent fuel assembly handling and storage, the operators prepared technical specifications in relation to the safety of spent fuel management facility operation, which specified the operating limits and conditions of reactors along with their spent fuel storage facilities. For instance, k_{eff} limit is developed to maintain sub-criticality of spent fuel; storage pool water level limits are developed to ensure radiation exposure reduction and residual heat removal; and storage water quality limits are developed to prevent fuel cladding degradation. Additionally, the accident treatment procedures were established to cope with the possible occurrence of accident during spent fuel handling.

G-52 In practical operation and handling, with developed operational procedures strictly implemented, and necessary measures taken, the system will have enough available redundancy, so that operating limits and conditions are not exceeded. Spent fuels withdrawn from reactor core are generally put on fuel racks in core to wait for decay of short-lived radionuclides, and are subsequently sent to storage pool. For handling of spent fuel, materials movement over spent fuel storage racks is strictly controlled to avoid materials downfall leading to damage to fuel assemblies. And safety interlocks were installed on handling equipment to prevent fuel assemblies from downfall during lifting. Underwater cameras were used for periodic inspection of spent fuel assemblies to eliminate hidden dangers in a timely manner. Safety oversight was enhanced to determine whether or not pool water meet the

standards required; and pool water was monitored and sampled at regular intervals for determining radionuclides in water and their activity concentrations so as to ensure the quality of water of pool meet the standards required. Measures to ensure normal operation of ventilation system were taken to make airborne concentrations within the range of the operating limits and conditions. A comprehensive set of record regime was established to document the details of spent fuel assemblies and ensure the accuracy and traceability of related information.

G-53 Any events occurring at research reactors should be reported and treated in accordance with relevant provisions. After treatment, written reports should be submitted to higher authorities and regulatory bodies.

G-54 Analyses of data collected during the operation of spent fuel storage facility indicates that, in order to reduce the exposure of workers to radiation, necessary modifications to spent fuel storage facility may be conducted where appropriate. Modifications that are significant to safety must be reported to the MEE/NNSA for review and approval. Such modifications must be in compliance with the procedures of safety analysis, design, construction and commissioning.

G-55 During operating lifetime of a research reactor, the operator and reactor management organizations must prepare its decommissioning plan abiding strictly by the decommissioning requirements for reactor along with spent fuel management facility.

G.6.3 Operation of Away- from-reactor Spent Fuel Storage Facilities

G-56 The HAF301 puts forth the principled requirements for the operation and management of civilian nuclear fuel cycle facilities, along with away-from-reactor spent fuel storage facilities. The *Operation of spent fuel storage installation* (HAD301/03) defines the safety requirements and recommendations on away-from-reactor spent fuel storage facilities.

G-57 Away-from-reactor spent fuel storage facilities are in consistent with design requirements and safety requirements. The operators established the scheme for safe operation of spent fuel storage facilities, including operating procedures, commissioning plan, QA program, training plan, radiation protection program, emergency preparedness, environmental release control of radioactive materials.

G-58 Operating limits and conditions are defined, including sub-criticality maintenance, radiation safety, and residual heat removal, etc. For instance, any spent fuel bundle to be transferred into basket will be required to have cooled for 5 years in spent fuel pool before being transported to interim spent fuel dry

storage facility.

G-59 The operation, maintenance, monitoring, inspection and testing of spent fuel away-from-reactor storage facility is proceeding in line with the plans, provisions, procedures and requirements that have been already approved. The above plans, provisions, procedures and requirements are comprised of those in relation to spent fuel storage, storage module, storage drum, fuel basket serial number, fuel basket inspection, basket loading, drying and welding, transportation and lifting, gamma-rays continuous monitoring, radiation protection in module storage area, storage drum routine inspection and oversight, storage module, storage drum, fuel basket and shielded workbox inspection and maintenance, equipment maintenance, testing and acceptance.

G-60 Spent fuel away-from-reactor storage facility can gain all of engineering and technical supports related to safety during its lifetime.

G-61 Any event or accident deviating from operating conditions should be reported, as specified, to the relevant regulatory bodies with respect to its nature, extent, consequence and remedial measure.

G-62 Operating data of spent fuel away-from-reactor storage facility are gathered in relation to gamma radiation monitoring in onsite environment, radiation monitoring at storage module and workplace. Also, air sampling for storage drum and heat conductivity monitoring in interior of module are conducted in attempt to verify design and provide experience feedback for the subsequent module manufacturing.

G-63 Decommissioning plan shall be reviewed and updated on an as-needed basis, during operation of away-from-reactor spent fuel storage facility, with advance in decommissioning technology, possible occurrence of event, revision of laws, regulations and policy, and variation in facility operating experience and costs, etc.

G.7 Spent Fuel Disposal (Article 10)

If, pursuant to its own legislative and regulatory framework, a Contracting Party has designated spent fuel for disposal, the disposal of such spent fuel shall be in accordance with the obligations of Chapter 3 relating to the disposal of radioactive waste.

G-64 China’s spent fuel management policy is to implement the reprocessing of spent fuel and to extract and recover uranium and plutonium, so as to achieve maximum use of resources. With economic and technical factors taken into account, however, the likelihood for direct disposal of a few types of spent fuel shall be not excluded in future. No spent fuel is designated to propose to undergo direct disposal at present.

H. SAFETY OF RADIOACTIVE WASTE MANAGEMENT

(Articles 11 to 17)

H.1 General Safety Requirement (Article 11)

Each Contracting Party shall take the appropriate steps to ensure that at all stages of radioactive waste management individuals, society and the environment are adequately protected against radiological and other hazards.

In so doing, each Contracting Party shall take the appropriate steps to:

(i) ensure that criticality and removal of residual heat generated during radioactive waste management are adequately addressed;

(ii) ensure that the generation of radioactive waste is kept to the minimum practicable;

(iii) take into account interdependencies among the different steps in radioactive waste management;

(iv) provide for effective protection of individuals, society and the environment, by applying at the national level suitable protective methods as approved by the regulatory body, in the framework of its national legislation which has due regard to internationally endorsed criteria and standards;

(v) take into account the biological, chemical and other hazards that may be associated with radioactive waste management;

(vi) strive to avoid actions that impose reasonably predictable impacts on future generations greater than those permitted for the current generation;

(vii) aim to avoid imposing undue burdens on future generations.

H-1 In China, a systematic set of policy and strategy, along with a complete set of laws and regulations and standards, on radioactive waste management has been established and a wide range of measures envisaged for implementing the safety of radioactive waste management, so as to achieve the goals of protecting individuals, society and the environment against radiological and other hazards.

H-2 Appropriate steps have been taken to ensure the residual heat produced during radioactive waste management can be removed well. Under GB14500-2002 and the *Regulations for designing storage building of high level radioactive liquid waste* (GB11929-2011), and for the design of liquid HLW storage tank, all reasonable and practical approaches should be taken to ensure criticality safety. The storage tanks are in-built with cooling systems with a full standby capability, and are equipped with multiple and diverse instrumentations to measure important process parameters such as temperature and liquid level. In the event of cooling water supply failure, the independent emergency cooling

system in the tanks shall ensure that the temperature in storage tank remains below 60℃.

H-3 China's laws and regulations require that the quantity of radioactive wastes generated should be kept at the levels that are as low as reasonably achievable (ALARA). Under the LPCRP, any nuclear facility operator and nuclear technology utility should adopt advanced technologies and equipment, and should reasonably select and utilize raw materials, in such a way that the amount of radioactive wastes is minimized. Under GB14500-2002, the generation of waste shall be controlled in all nuclear activities to keep the radioactivity and volume of waste as low as actually achievable. Under GB6249-2011 and HAD401/08-2016, the operator of a nuclear facility under design, construction, operation, and decommissioning shall, with respect to radioactive waste minimization, implement source control, recycle and reuse, clearance, optimization of waste treatment, and enhanced management, and cost-benefit analysis, so that the amount (volume and activity) of solid radioactive waste can be controlled at as low as reasonably achievable.

H-4 In the process of waste management, optimization shall be applied to the overall control of gaseous, liquid and solid wastes, as a whole, from generation to disposal of them, so as to obtain the best technical, economic, and social effects, and to be beneficial for sustainable development. The regulations, standards, guides that have been issued take account of the interdependency between several different steps to manage radioactive waste, for example, from their generation, collection, classification, treatment and conditioning to their storage, disposal and release and even to their recycle and reuse, as shown in Figure 4.

H-5 A legal framework comprised of national laws, administrative regulations, departmental rules (national standards), management guides and reference legal instruments governing radioactive waste management has been established and maintained in China. Implementation of these instruments can provide the protection of individuals, society and the environment. These documents were developed and issued after stringent review by relevant authorities including regulatory control department. These set out the management requirements (such as radioactive waste management licensing system, and disposal facility closure system) and technical requirements (such as discharge limits, dose limits, and safety provisions for near-surface disposal) for every step in radioactive waste management, and criteria for protection of the public, the workers and the environment in respect of several main links in waste management, which are basically consistent with internationally endorsed

standards and criteria. The MEE/NNSA, alongside with the competent authorities of nuclear facilities, shall conduct regulatory control and supervisory monitoring of compliance of such facilities with standards.

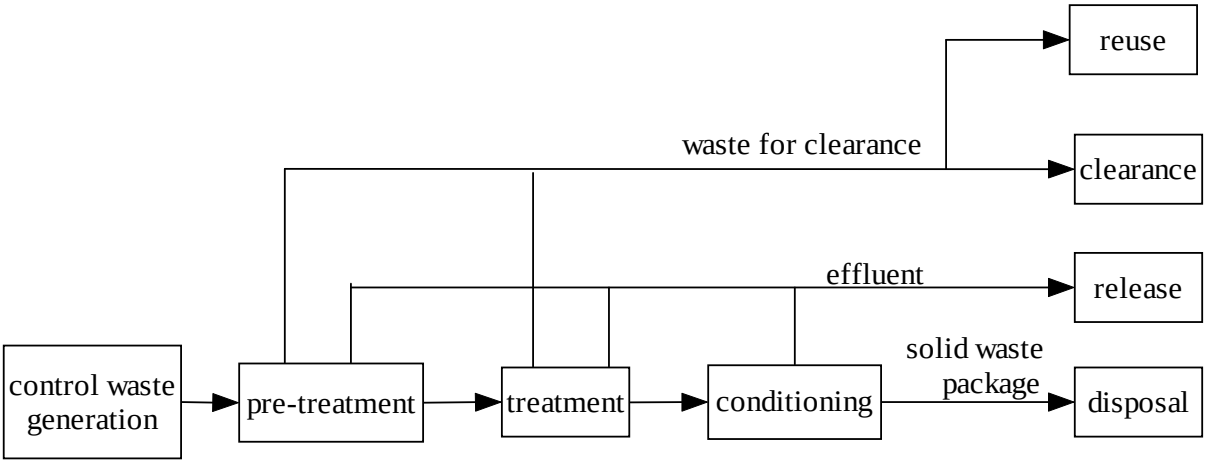

Figure 4 Basic Steps towards Radioactive Waste Management

H-6 China has taken full consideration of biological, chemical and other hazards that are likely attributable to the management of radioactive wastes. Under the announcement of *Radioactive Waste Classification*, GB9132-2018 and GB14500-2002, when developing the classification system of radioactive wastes, account was taken of potential chemical, biological and other hazards. Wastes received and disposed have enough chemical, biological, thermal and radioactive stability and will not produce toxic gases. Radioactive waste treatment systems are equipped with fire protection and explosion-proof device in such a way as to ensure that radioactive waste and other hazardous waste released to the environment are below regulatory limits.

H-7 In its laws, regulations and standards, China stipulated that efforts should be made to avoid the taking of actions that are expected to impose greater adverse impacts on the future generations than the current generation. Under the RSMRW, the solid radioactive waste generated in operating nuclear facilities, and the liquid radioactive waste that could not be discharged through purification shall be treated by turning into stabilized and standardized solid waste, and be timely delivered to the licensed solid radioactive waste disposal facility for disposal. The GB9132-2018 provides that when the disposal site is closed, a permanent mark shall be set up at the appropriate location to indicate the location of the waste burial and related matters; after the closure of the disposal site, active or passive institutional control shall be implemented in accordance with the institutional control program, and appropriate

environmental monitoring shall be retained and carried out according to the operating history and the situation of closure and stabilization. The long-term safety assessment after closure should determine the time range of long-term safety analysis and assessment after closure, cover the time when the maximum/peak dose or hazard occurs, evaluate the performance of the disposal system, and unintentional human intrusion activities, etc.

H-8 In developing its relevant laws, regulations and standards, China makes efforts to stick to the principle of avoiding undue burden on future generations. Under the RSRWM, radioactive waste management shall ensure no undue burden to be imposed on future generations. IPCUMFTDSFNPP was issued in July 12, 2010 in China (see F.2.2.1). A cost management approach for the decommissioning of nuclear facilities and the disposal of radioactive wastes is being developed. There have been three LILW disposal sites in operation in China. New ones are being planned and to be constructed according to needs of nuclear energy expansion in the country. The work on geological disposal of radioactive waste is also proceeding in an orderly way.

H.2 Existing Facilities and Past Practices (Article 12)

Each Contracting Party shall in due course take the appropriate steps to review:

(i) the safety of any radioactive waste management facility existing at the time the Convention enters into force for that Contracting Party and to ensure that, if necessary, all reasonably practicable improvements are made to upgrade the safety of such a facility;

(ii) the results of past practices in order to determine whether any intervention is needed for reasons of radiation protection bearing in mind that the reduction in detriment resulting from the reduction in dose should be sufficient to justify the harm and the costs, including the social costs, of the intervention.

H.2.1 Periodic Safety Review to Nuclear Facilities

H-9 Under HAD103/07 and HAD103/11, the 10-year periodic safety review has been conducted from 2014 to 2016 at China's operating NPPs, such as QNPP, QNPP-II, QNPP-III, Daya Bay NPP, Ling'ao NPP-I and Tianwan NPP covering solid radioactive waste management system review and radiation environmental impact assessment. During the process of solid radioactive waste management system review, the assessed were anti-seismic performance, shielding performance, operability, maintainability, heat removal measures, leakage prevention capability of waste resin storage tank; low level solid waste storage system safety, solidified forms storage system safety; stability of

cemented forms during long-term storage; retrievability of low level solid waste and solidified forms; and durability of container. The review results indicated that the assessed systems, as a whole, are consistent with the current safety basic requirements.

H-10 Under the HAD103/11, the first 10-year periodic safety review was conducted from 2013 to 2014 at CNNC Shaanxi Uranium Enrichment Co., Ltd. and CNNC Lanzhou Uranium Enrichment Co., Ltd., respectively. This review encompasses safety analysis; actual status of structure, system and parts; disaster analysis; and radiation environment impact assessment, etc. As has been stated by the review results, the technical modifications and specific actions taken in past many years have made relevant systems consistent with the specification requirements as a whole, like waste treatment system and radiation protection system.

H.2.2 Peer Review for Radioactive Waste Management

H-11 From May 27 to June 1, 2018, the China Nuclear Energy Association (CNEA) organized experts to conduct China's first peer review of radioactive waste management at the Nuclear Power Institute of China (NPIC).

H-12 In accordance with the work flow of peer review standards of the CNEA, and according to the customized special evaluation criteria, programs and guidelines, the evaluation expert group assessed the organization and management of radioactive waste related activities, the implementation of radioactive waste management and safety management of NPIC in the form of on-site inspection, activity observation, interview and document review. Through benchmarking with peer best practices, a number of observations, items to be improved and strengths that can be promoted in the industry are formed on the basis of all the facts confirmed.

H-13 From October 14 to 17, 2019, the CNEA organized experts to conduct a follow-up and return visit for the radioactive waste management peer review activities in the NPIC. The working methods of follow-up visits include: on-site inspection, activity observation, personnel interviews, access to documents and records, etc. For the corrective actions for items to be improved determined by the peer review, experts evaluate the effectiveness of these corrective actions by visiting the site, observing the on-site work activities, interviewing with the counterparts, verifying relevant procedures, documents and records completed, evaluating the effectiveness of corrective actions, and giving the concluding comments.

H-14 The results of the follow-up visit show that NPIC attaches importance

to the opinions put forward by the peer review of radioactive waste management organized by the CNEA in 2018. In response to the improvement items proposed by the peer review, a corrective action development discussion meeting was organized. More than 30 corrective actions were collated and developed. NIPC responded to the opinions of the peer review one by one. During the return visit, most corrective actions have been completed, other corrective actions are being implemented in an orderly manner.

H.2.3 Safety Inspection to Nuclear Facilities

H-15 MEE/NNSA and its regional branch stations conduct nuclear safety inspection on daily, routine and non-routine basis.

H-16 MEE/NNSA carries out its responsibility for routine nuclear safety inspection to nuclear facilities. This inspection, after to a NPP overhaul and prior to the first criticality, is focused on the management of radioactive waste generated both from previous fuel cycle and during overhaul. Regional branch stations have a responsibility for developing supervision plan and implementing daily and specific nuclear safety supervision and inspection.

H.3 Siting of Proposed Facilities (Article 13)

Each Contracting Party shall take the appropriate steps to ensure that procedures are established and implemented for a proposed radioactive waste management facility:

(i) to evaluate all relevant site-related factors likely to affect the safety of such a facility during its operating lifetime as well as that of a disposal facility after closure;

(ii) to evaluate the likely safety impact of such a facility on individuals, society and the environment, taking into account possible evolution of the site conditions of disposal facilities after closure;

(iii) to make information on the safety of such a facility available to members of the public;

(iv) to consult Contracting Parties in the vicinity of such a facility, insofar as they are likely to be affected by that facility, and provide them, upon their request, with general data relating to the facility to enable them to evaluate the likely safety impact of the facility upon their territory.

In so doing, each Contracting Party shall take the appropriate steps to ensure that such facilities shall not have unacceptable effects on other Contracting Parties by being sited in accordance with the general safety requirements of Article 11.

H.3.1 Siting of Facilities

H-17 China attaches high priority to the siting of radioactive waste

management facilities, with relevant regulations and standards being developed to guide the siting of different radioactive waste management facilities.

H.3.1.1 Siting of Nuclear Facility-affiliated Radioactive Waste Management Facility

H-18 A radioactive waste management facility, for a nuclear facility, shall be sited in compliance with the same requirements as shall be met in siting such a nuclear facility.

H-19 During the process of siting, account was taken of the requirements said above, such as geographical location, population distribution, natural resources (like mineral reserves, food, economic crops, aquatic products, etc.) industry, transportation, meteorology (like tropical cyclone, tornadoes, thunderstorms, etc.) hydrology, geology, earthquake and so on.

H-20 During the process of siting a facility, evaluation was made of annual individual dose equivalents and annual collective dose equivalents to workers of such a facility on different jobs, like operation, maintenance, waste handling and in-serve inspection, etc.; possible impacts of such a facility on the ambient environment in normal and accidental conditions were evaluated to demonstrate the acceptability of site conditions and safety facility.

H-21 No impact could be created on any other Contracting Party from China's existing nuclear facility-affiliated radioactive waste management facilities.

H.3.1.2 Siting of Radioactive Waste Storage Facility associated with Nuclear Technology Application

H-22 The site-related factors were evaluated, as required by the *Technical Requirements on Siting, Design and Construction of Nuclear Technology Application Radioactive Waste Storage Facility* (TRSDCNTARTSF) and the GB14500-2002, the natural conditions and socioeconomic conditions at the site were evaluated during the siting of nuclear technology applications' radioactive waste storage facility. The results are:

(1) Natural conditions at site are relatively flat topography, small slope, relatively simple geological structure, low seismic intensity, deep underground water level, far from the surface water; stable geological conditions (there is no debris flow, landslide, quicksand, karst cave surface phenomenon), poor permeability of rock, enough bearing capacity of foundation soil, and good meteorological conditions (like temperature, humidity, content of corrosive components in air, etc.), the site of the storage facility shall be located in an area

which is not threatened by flood, tide or waterlogging.

(2) The area where the site is located should not be located in a densely populated urban area, and the socioeconomic conditions around the site are characterized with no facility, having impacts on waste safety, likely to produce and store flammable and explosive and dangerous articles, no mineral area of important development value, no scenic tourist area, no natural reserves, no drinking water sources, or no economic development zone, and there being convenient transportation and convenient water and power supply.

H-23 The impacts of such a facility on individuals, the society and the public were evaluated. Under TRSDCNTARTSF, the potential impacts on such facilities from the external and natural events and possible impacts on individuals and the environment from the releases of radioactive and hazardous materials were evaluated during siting to ensure providing adequate isolation and robust confinement of the public and the environment from radioactive waste, as required by the relevant regulatory bodies, meeting the requirements of safe operation and management, and facilitating future expansion, transformation and decommissioning.

H-24 No impact could be created on any other Contracting Party from China's existing radioactive waste storage facilities associated with nuclear technology application.

H.3.1.3 Siting of Solid Radioactive Waste Disposal Facilities

H-25 Under the GB14500-2002, GB9132-2018, *Siting of Radioactive Waste Near-surface Disposal Facility* (HAD401/05) and *Siting of High Level Radioactive Waste Geological Facility* (HAD401/06), the site-related factors were evaluated during the siting of solid radioactive waste disposal facility, involving earthquake, regional stability, geological structure and lithology, engineering geology, hydrogeology, geochemistry, surface action, meteorological conditions, mineral resources, natural and cultural resources, population density, surface water and drinking water, urban, airports, and the distance away from the inflammable and explosive dangerous goods warehouse etc.

H-26 The impacts of such facilities on individual, the society and the public were evaluated, with account taken of the post-closure evolution of the site condition. Under GB9132-2018 and GB14500-2002, analyses were made, in the process of siting, of amounts and probability of migration of radionuclides into human environment, associated mechanisms, pathway, and velocity of radionuclide into human body, together with estimating initially the individual

dose equivalent and collective dose equivalent under normal conditions, natural and artificial events, and also preliminarily analyzing and evaluating the environmental impacts of disposal facilities during construction, operation and post closure, and the possible impacts of the surrounding environment on disposal facilities.

H-27 Under the RSRWM, other relevant standards and guides, the siting for the Beilong, Northwest, and Feifengshan disposal sites were completed in full compliance with the requirements of planned siting, regional survey, site characterization and site determination. Sufficient investigation and demonstration were conducted of around-the-site geological structure, hydrogeology as well as other natural and socioeconomic conditions. The above LILW disposal sites have already entered the operation phase, which were identified during regional screening survey based on the local conditions of natural environmental conditions, population, economy, and communications, etc. Gathering and comparison of data lead to candidate areas to be determined. On the basis of field reconnaissance on these candidate sites, suitable sites were recommended, the site characterization was conducted at several candidate sites. Subsequently, the environmental impact assessment statements and the safety analysis reports for siting phase were developed. At last, these sites were approved by the MEE/NNSA based on the provided scrutiny and advice. In addition, the siting for radioactive waste disposal facilities being carried out in Liaoning, Guangxi, Fujian and other nuclear power concentrated provinces has also strictly complied with the siting requirements.

H-28 CAEA took the lead in efforts to site for HLW disposal repository is focused on the candidate Beishan site located in Gansu province following the initial comparison between the pre-selected granite regions, such as in East China, South China, Southwest China, Inner Mongolia and Xinjiang. Emphases were on geology, hydrogeology, seismic geology and socioeconomic conditions. Bore drilling activities were partly conducted to obtain the in-depth samples of rock core and water and other relevant information, thus developing the preliminary approach to evaluation of granite site, and determining the site for underground laboratories. In the next few years, the research and development of HLW geological disposal will be further strengthened, laboratory research and development tasks in various disciplines (preliminary) will be completed; the feasibility study of the underground laboratory will be completed; and the safety review of the construction of the underground laboratory will be completed. On the basis of the preliminary investigation of clay rock pre-selection, the CAEA organized a supplementary survey on the key clay rock

pre-selection for HLW geological disposal repositories s in Inner Mongolia, Gansu and Qinghai, completed the target task in the planning and siting stage, determined the pre-selection sites for clay rock disposal repository, and recommended two sites to carry out preliminary investigation, which opens the stage of regional investigation for clay rock disposal repository.

H-29 No impact could be created on any other Contracting Party from China's existing LILW disposal sites.

H.3.2 Public Communication and Information Publicity

H-30 The LNS, which was implemented in 2018, established a special chapter on "Information Disclosure and Public Participation", which provides for the disclosure and public participation of nuclear safety-related information. As provided in the *Measures for the Public Participation in Environmental Impact Assessment* implemented in 2019, prior to submitting the environmental impact statement to the MEE/NNSA, the constructors of construction projects, including radioactive waste management facility projects, should disclose the full text of environmental impact report to be submitted for approval, and public participation statement through network platform. After accepting the environmental impact report, the full text of the environmental impact report, public participation statement, and the ways and means of public opinions shall be disclosed by MEE/NNSA through its website or other means. Before making a decision on the approval of the environmental impact report, information including the general situation of construction projects, major environmental impacts and environmental protection strategies and measures shall be disclosed to the public. Within 7 working days from the date making a decision on approval of the environmental impact report, the full text of the approval decision shall be announced to the public.

H-31 The building of information publicity channel is underway. The major platforms are the MEE/NNSA's information website and CAEA's and NEA's websites. Additional channels include China Environmental Status Bulletin, China Environmental Yearbook, NNSA's Annual Report, Annual Report on Radiation Environment Quality, China Environmental Paper, radio and television, network website, as well as other media and channels.

H.4 Design and Construction of Facilities (Article 14)

Each Contracting Party shall take the appropriate steps to ensure that:

(i) the design and construction of a radioactive waste management facility provide for suitable measures to limit possible radiological impacts on individuals, society and the environment, including those from discharges or uncontrolled

releases;

(ii) at the design stage, conceptual plans and, as necessary, technical provisions for the decommissioning of a radioactive waste management facility other than a disposal facility are taken into account;

(iii) at the design stage, technical provisions for the closure of a disposal facility are prepared;

(iv) the technologies incorporated in the design and construction of a radioactive waste management facility are supported by experience, testing or analysis.

H-32 A wide spectrum of legal instruments on radioactive waste management have been issued in China, such as GB14500-2002, GB6249-2011, and GB9132-2018, *Design of Radioactive Waste Management System for Nuclear Power Plant* (HAD401/02), TRSDCNTARTSF and GB/T19597-2004. These are intended to govern the design and construction of nuclear facility-affiliated radioactive waste management facilities, the waste storage facility for nuclear technology application and the LILW repository.

H.4.1 Design and Construction of Nuclear Facility-affiliated Radioactive Waste Management Facilities

H-33 To limit possible radiological impacts to individuals, the society and the environment, the following measures were mainly considered and taken in the design and construction of radioactive waste management system compatible with nuclear facilities in accordance with HAD401/02:

(1) radioactive waste management systems are separated from those of non-radioactive waste management system;

(2) zone division has been made of radioactive waste management facility and comprehensive measures taken, based on radiation level and contamination extent, covering appropriate radiation shielding and radiation monitoring meters;

(3) the technological processes of classification, collection and treatment of radioactive waste were designed according to the origin and nature of them, including well-designed waste treatment technology (filtration, adsorption and washing, flocculation sedimentation, centrifugal separation, evaporation, ion-exchange, membrane processing, super-compression, solidification) and well-installed waste gas treatment system, and ventilation system in radioactive work zone, for which gas flow direction, a certain amount of negative pressure and/or air changes are maintained and electric-gas interlocks are installed.

(4) suitable materials are selected in line with operational conditions and consideration is taken of corrosion, decontamination and radiation effects;

(5) for the systems that need to be maintained and examined after decontamination, their inner surface is designed smooth and to have washing or cleaning connectors.

(6) sampling points are designed to set at appropriate part of system, using as short sampling pipeline as possible and installing concurrently-used-with-system pipelines for frequent sampling activities; continuous monitoring is carried out of gaseous and liquid radioactive effluents prior to release; the monitored items may be gross alpha and gross beta radioactivity and concentrations of radionuclides in terms of source terms within facility; flow measuring equipment is set to control release of effluents; as activity concentrations in effluent are in excess of relevant limits or once discharge valves to control effluents fail to obtain driven power, the effluent discharge will be stopped automatically.

(7) for the design and layout of buildings, additional loading that could be created during or after its decommissioning is considered, with account taken of several factors, such as the place and space required for decommissioning;

(8) the necessary precautionary measures are considered in attempt to reduce the impacts potentially from the major risks discovered in safety analysis, such as earthquake, floods, air crash, natural and artificial events; these measures include main system equipment, fittings, supports, and ability of equipment to endure the impact from the operating basis earthquake; and

(9) functions to detect explosive gas, automatically control and alarm, and prevent explosion are designed to avoid the potential of explosion.

H-34 Conceptual plan is considered for the decommissioning of radioactive waste management facilities except for disposal facilities. Under HAF102-2016, GB/T19597-2004 and the *Provisions on the Safety Management of Civilian Nuclear Facility Decommissioning* under development, the operator of a nuclear facility shall take into account of future decommissioning in its design phase and develop preliminary decommissioning plans. Such plans should incorporate the considerations of basic safety concerns, expected decommissioning strategy, safety and feasibility of technology currently available or to be developed in the course of decommissioning practices, decommissioned waste management, decommissioning costs and financing means, and guarantee institutions.

H-35 The technical specifications, as incorporated in the design and construction documents of radioactive waste management facilities, all cited the relevant national standards and nuclear safety laws and regulations that have been issued and in effect. These specifications have also drawn on the experiences of operation and management experience gained over the past.

H-36 Prior to granting construction license, the NNSA organized review and evaluation of the environmental impact assessment report, the preliminary safety report and the QA program submitted by the operators for license application in construction phases. In the process of nuclear facility construction, the MEE/NNSA and its regional branches dispatch nuclear safety inspectors or groups of inspectors to the fabrication and construction fields for implementation of the following oversight missions:

(1) reviewing whether the safety data submitted is consistent with the reality;

(2) supervising whether the construction process is consistent with the approved design requirements; and

(3) supervising whether the management process is consistent with the approved QA program etc.

H-37 The radioactive waste treatment facilities for the concurrent use by multiple nuclear units on-site were designed using well-proven technologies at both the newly built Sanmen NPP and Haiyang NPP. As an additional one to nuclear islands' waste treatment systems, such facility can treat all sorts of wastes that are generated, but can't be directly treated, by all on-site nuclear islands, thus avoiding unnecessary duplication of equipment at multiple units. Radioactive waste treatment facility on site is divided into three zones, waste processing building, laundry and interim storage facility. Its functions are to treat solid radioactive waste and chemical waste liquid, wash work clothes and shoes for reuse, and provide interim storage of waste packages. The design of radiation protection associated follows the ALARA principles. The facility employs compaction and extra-compression technologies to achieve volume reduction and waste minimization. In addition, the treated liquid waste is going to be discharged after sample measurement and continuous monitoring.

H.4.2 Design and Construction of Radioactive Waste Temporary Storage Facility for Nuclear Technology Application

H-38 To limit possible radiological impacts to individuals, the society and the environment, the following measures were mainly considered and taken in the design and construction of radioactive waste temporary storage facility facilities for application of nuclear technologies in accordance with the TRSDCNTARTSF:

(1) the entire area of the facility is divided into storage area, office area and isolation zone, with a certain distance span existing between storage area and office area to a certain degree. Isolation zone should be around the temporary storage facility;

(2) the plane design of facilities reasonably arranges the flow of personnel and route of logistics to avoid cross-contamination; the flow of personnel follows the principle from low radiation area to high radiation area;

(3) process design should meet the requirements for the systems, equipment, instruments and handling devices required for the acceptance, transfer, storage, retrievability, transportation, waste treatment and disposal, decontamination and removal activities conducted during the operation, maintenance and decommissioning of such a temporary storage facility; specific measures include categorization of wastes and disused sealed sources, arranging and storing in groups, and reserving a certain distance between groups, disused sealed sources with high activity or high surface dose rate are stored in pits with shielded lids, disused sealed sources with low activity or short half-life are stored in iron cabinets on the ground, and radioactive waste should be separated and stored on the ground;

(4) the facility is installed with proper ventilation equipment to direct the proper airflow and to ensure adequate number of ventilation changes;

(5) necessary radiation monitoring means and meters are provided such as potable dose rate meters, surface contamination monitors, potable air samplers to monitor the contamination level of workers, at workplaces and in air; and

(6) necessary personal dose meters and personal protective articles, such as protective clothes, gloves, shoes and masks are provided for workers involved in handling, lifting, inspection, storage and monitoring of radioactive waste;

H-39 Conceptual plan was considered, in phase of design, for radioactive waste storage facility associated with nuclear technology applications. Under the TRSDCNTARTSF:

(1) source term estimating for nuclear facilities to be decommissioned;

(2) goals of decommissioning and radiation measurement requirements at termination of decommissioning;

(3) proposed decommissioning plan (such as characterization, removal of radioactive materials and disused sealed sources, decontamination, demolition and termination radiation measurement) and the potentials for safety of decommissioning using available technologies;

(4) resources and conditions required for facility decommissioning and resulted waste management; and

(5) requirements for continued evaluation, elaboration and renewal of decommissioning plan in construction and operation phases.

H-40 technical measures available for decommissioning of waste temporary storage facility are employed during design, mainly including:

(1) the floor, wall and worktable surface that could to be likely contaminated is made of smooth and seamless materials from which contaminants are difficultly absorbed contaminants or from which contaminants are easily removed;

(2) buildings, equipment and pipelines are arranged to allow sufficient channel and space to enable operating workers and instruments used to access for decontamination and dismantling operation;

(3) equipment and pipeline are arranged to avoid radioactive material deposition in system and in local part, with further account being taken of possibility of in-situ decontamination; and

(4) due consideration are given to ventilation to prevent the potential contamination being spread in the course of operation, decommissioning, decontamination, and dismantling.

H-41 The principles followed in the design of radioactive waste storage facility associated with nuclear technology applications is to use the technology, process, equipment and instrumentations that have proven in practices to be safe, reliable and effective. All of the technical specifications incorporated in the facilities' design and construction documents cited the relevant national standards and nuclear safety laws and regulations that have been issued and in effect.

H.4.3 Design and Construction of LILW Disposal Site

H-42 To limit possible radiological impacts to individuals, the society and the environment, the following measures were mainly considered and taken, in accordance with the GB14500-2002 and GB9132-2018, in the design and construction of LILW disposal sites:

(1) multiple barriers, consisting of engineering barrier (waste forms, container, disposal structure, and backfilling materials) and natural barrier, are developed and provided;

(2) proper waterproof and drainage systems are set; the engineering barrier is set to prevent the infiltration of groundwater and surface water in such a way as to minimize the contact of waste with water; waterproof design is focused on preventing surface water and rainwater from infiltration into disposal units; permeability and absorbability of rocks, surface runoff and ground water table and other site characteristics are considered in design of site waterproof; the

design of drainage system can ensure the timely drainage of impounded water on the ground at site and in disposal units;

(3) in addition to drainage and waterproof, the design of disposal site also involves unit backfilling, overburden structure, surface treatment, and plantation; a buffer zone is established between the disposal unit and the boundary of the disposal site, and groundwater monitoring wells are set up in the upstream and downstream of the groundwater flow direction in the buffer zone;

(4) disposal units are arranged in line with the overall plan, including access, walkways, contaminated area and non-contaminated area;

(5) for disposal sites that receive high surface dose rate waste packages, equipment for long-distance or remote transfer and placement of waste packages shall be provided;

(6) waste acceptance zones are equipped with detection instrumentations for measuring dose rate, surface contamination, cargo certificate of vehicle and cask; inspection device for unloaded waste drum (box); radiation monitoring and warning systems; installations to treat damaged containers: devices for transportation equipment decontamination, and facility to treat waste generated from decontamination; and

(7) laboratories are established for conducting routine analysis of water, soils, air and plant samples; individual decontamination, individual and environmental monitoring, instrumentation and equipment maintenance, and equipment decontamination.

H-43 Under GB9132-2018, the LILW disposal facilities currently in operation have been provided in design phase with technical preparation measures to enable such facilities to be closed. These includes buffer areas between disposal unit and disposal site boundary, underwater monitoring wells set in an appropriate location in buffer areas, on-site laboratories for analysis of samples from water, soils, air, animal and plant. In so doing, the analysis of on-site and ambient environmental safety may become available. Additionally, in accordance with design requirements, the enough distance should be left between the top level of disposed waste and disposal facility overburden layer. If necessary, anti-intrusion barrier needs to be established where protection can be provided to an unintentional intruder within institutional controls period. Overburden layer shall be designed so as to control water seepage to as low as practically feasible and as to lead infiltrated or surface water to the outside of disposal unit and to protect them from erosion due to geological process and biological activities.

H-44 The degins of the Northwest, Beilong and Feifengshan LILW disposal

sites all meet the requirements of GB9132-2018. The disposal unit of the Northwest disposal site is a structure with concrete baseplate, which is backfilled with cement mortar between the waste drums stored in it and between the waste drums and the wall of the disposal unit, and the reinforced concrete roof is poured after the disposal unit is full. When the disposal site is closed, a final overburden of 2 m thick is laid on top of the disposal unit. The 8 disposal units of Beilong disposal site have been completed with the structure of all-above-ground grave mound. The disposal units are constructed with reinforced concrete structure, and space between waste drums would be backfilled with sand and cement grout. Each unit, when it is full, would be covered with reinforced cement cap. After closure, such site will be covered with 5 m thick final covering layer. In order to reduce entry of rainwater into disposal unit, drainage ditches are designed around the disposal facility with each unit being installed with mobile active water shed. Below the unit bottom, a drainage collecting system was established. The disposal unit of Feifengshan disposal site is a mount-type reinforced cement structure on the ground, which is backfilled with cement mortar between waste packages. When the disposal unit is full, it will be poured with reinforced cement to form the top plate. A 20-ton numerical control crane with mobile rain shelter is used to remotely put waste drums in place. An underground pipe gallery is arranged in the middle part of the bottom of the disposal unit, which is used to receive rain water and dialysis water. Off-site flood interception ditches and on-site drainage ditches are set around the disposal site, which are used to export rain water. After closure, a 5 m thick covering layer composed of 6 layers of different materials will be laid.

H.5 Assessment of Safety of Facilities (Article 15)

Each Contracting Party shall take the appropriate steps to ensure that:

(i) before construction of a radioactive waste management facility, a systematic safety assessment and an environmental assessment appropriate to the hazard presented by the facility and covering its operating lifetime shall be carried out;

(ii) in addition, before construction of a disposal facility, a systematic safety assessment and an environmental assessment for the period following closure shall be carried out and the results evaluated against the criteria established by the regulatory body;

(iii) before the operation of a radioactive waste management facility, updated and detailed versions of the safety assessment and of the environmental assessment shall be prepared when deemed necessary to complement the

assessments referred to in paragraph (i).

H-45 Under the LNS, LPCRP and HAF001, proper safety analyses and environmental assessments were completed before the construction of the current radioactive waste management facilities.

H-46 Under the GB14500-2002, GB11929-2011, *Requirements on Safety Analysis Report for Solid LILW Interim Storage* (EJ532-1990), TRSDCNTARTSF and GB9132-2018, the safety analyses and environmental assessments were completed to some extent before the construction of the current radioactive waste management facilities, here considering possible accident spectrum during the operation of facility (like ventilation system failure, waste lifting malfunction, waste transfer incident, container leakage, earthquake, floods, sandstorm, fire, mis-operation, and inadvertent intrusion); defining the model, parameter, assumption and rationale envisioned in the analyses and assessments, analyzing possible environmental and human impacts under normal and abnormal conditions; calculating maximum annual effective dose equivalent, annual average effective dose equivalent and annual collective dose equivalent in assessed area under the accidental condition; comparing with performance criteria established; drawing on the conclusions on safety analysis and environmental impacts of concern; making clear the problems existing in current facilities and the countermeasures to be taken to improve safety quality.

H-47 Before construction of a disposal facility, a systematic safety assessment and an environmental assessment for the period following closure were carried out. Under the GB9132-2018, focuses were on predication, analysis and assessment of possible environmental impacts of the existing disposal sites during their construction, operation and post-closure phases and the potential for surrounding environment impact on disposal sites, etc. The assessment results of the existing disposal sites show that the disposal site was chosen in a closed environment with low population and good regional stability. Natural disaster such as typhoon, flooding and earthquake would not lead to destructive threat to the disposal site. Local geological media, with low permeation rate and strong adsorption onto radionuclides, is in line with national requirements on LILW disposal. In the normal conditions after closure of the disposal site, the release of radionuclides through groundwater may result in annual maximum individual dose to the public far below the national limits. Even in the case of inadvertent intrusion after closure of disposal site, the dose to the intruder will below the national limits. Therefore, the disposal sites will not lead to any unacceptable impacts on the environment.

H-48 As has been already pointed out by the GB14500-2002, the

environmental impact assessment should be revised and updated according to the relevant national or departmental provisions and requirements and then submitted to the regulatory bodies.

H.6 Operation of Facilities (Article 16)

Each Contracting Party shall take the appropriate steps to ensure that:

(i) the licence to operate a radioactive waste management facility is based upon appropriate assessments as specified in Article 15 and is conditional on the completion of a commissioning programme demonstrating that the facility, as constructed, is consistent with design and safety requirements;

(ii) operational limits and conditions, derived from tests, operational experience and the assessments as specified in Article 15 are defined and revised as necessary;

(iii) operation, maintenance, monitoring, inspection and testing of a radioactive waste management facility are conducted in accordance with established procedures. For a disposal facility the results thus obtained shall be used to verify and to review the validity of assumptions made and to update the assessments as specified in Article 15 for the period after closure;

(iv) engineering and technical support in all safety-related fields are available throughout the operating lifetime of a radioactive waste management facility;

(v) procedures for characterization and segregation of radioactive waste are applied;

(vi) incidents significant to safety are reported in a timely manner by the holder of the licence to the regulatory body; programmes to collect and analyse relevant operating experience are established and that the results are acted upon, where appropriate;

(vii) decommissioning plans for a radioactive waste management facility other than a disposal facility are prepared and updated, as necessary, using information obtained during the operating lifetime of that facility, and are reviewed by the regulatory body;

(viii) plans for the closure of a disposal facility are prepared and updated, as necessary, using information obtained during the operating lifetime of that facility and are reviewed by the regulatory body.

H-49 Under the LPCRP, the radioactive waste management facility, associated with a nuclear facility, should be constructed simultaneously with the main project in their design, construction and operation. According to the requirements of completion acceptance system of environmental protection, after completion of the main project, the application report for trial operation

shall be submitted to the MEE/NNSA. No trial operation can be started without approval. After completion of trial operation, the checking and acceptance after completion for environmental protecting facilities shall be performed by the MEE/NNSA. After being qualified, these facilities can be put into operation.

H.6.1 Operation of Nuclear Facility-affiliated Radioactive Waste Management Facilities

H-50 Under the LPCRP, HAF001 and MMLSRWSD, before operation of a nuclear facility, its operator should submit the written application for nuclear facility operation to the MEE/NNSA, together with the final safety analysis report and other related documents. The MEE/NNSA shall review these documents and grant operation licenses to the qualified. The existing radioactive waste treatment and storage facilities equipped for NPPs, research reactors and nuclear fuel cycle facilities are only responsible for treatment and storage of wastes generated by the facilities themselves, therefore there being no need for obtaining license.

H-51 Operational limits and conditions were set by the operators of all nuclear facilities for radioactive waste management facilities under HAF103, HAD103/01, HAF202, HAD202/01 and HAF301, together with other documents relating to NPPs' radioactive waste treatment systems, including evaporation and concentration limits, continuous workload of immobilization or solidification process, alarming limits and detectable limits of radiation monitoring meters (including effluent monitoring). These limits and conditions are reviewed and updated in keeping with experience gained and technological progress.

H-52 Under HAF103, HAF202, HAF301, HAD103/06, and HAD202/01, the operators of all nuclear facilities prepared operational program, maintenance program, environmental monitoring program, oversight program, and waste management program, etc. According to these programs, additional operating procedures are prepared covering system process, main equipment, valve manipulation, and preset operation; besides, the maintenance plans and procedures for radioactive waste management facility are prepared, along with radioactive effluence controlling and monitoring procedures. And non-radioactive simulation test and inspection procedures on engineering scale are prepared including operating model and parameters related to radioactive waste management system and equipment. The operators of nuclear facilities all follow strictly the above programs and procedures.

H-53 Under the HAD103/06, the maintenance workers are allowed to take turns to attend training, on a regular basis, held by construction contractors or

equipment manufacturers during the entire operational lifetime of a nuclear facility's radioactive waste management facility; professional advices are available from the external expert institutions with respect to operational experiences of the facility, failure and malfunction analysis; the QA-related review can be performed independently by qualified external experts; consultations about radioactive effluent release and on-field waste treatment may be obtained from professional institutions. In similarity, the engineering and technology support in safety-related field is also available to the operators for the entire operating period of the radioactive waste management facilities built for other nuclear facilities.

H-54 The operators of NPPs classify usually radioactive wastes generated at NPPs into process waste, technical waste and other types of waste according to their origin. Furthermore, according to physical behavior, the operators classify process wastes into evaporated residual liquid, waste resins, sediment and filter core, etc.; classify technical wastes into compressible and incompressible waste and combustible and incombustible waste. The operators developed radioactive waste segregation procedures to characterize all classes of wastes.

H-55 As provided by the LNS, relevant departments of the State Council shall establish a nuclear safety experience feedback system. Under the MMEFONPP, the operators of NPPs employ the analytical methods recommended by MEE/NNSA to investigate and study operating events, if occurred, and report to MEE/NNSA. The operators submit periodically to MEE/NNSA the lists and abstracts of internal events, together with the reports deemed necessary. As required by MEE/NNSA, they also prepare and effectively implement the program or management procedures of experience feedback for their own respective NPPs.

H-56 Under the GB/T19597-2004, after a period of operation of a nuclear facility, the operator of such a facility shall prepare the mid-term decommissioning plan, which should provide a detailed description of how to treat radioactively contaminated or exposed structures, systems and components during its radioactive waste management facility maintenance, in order to develop the decommissioning plan of the radioactive waste management facility. Under the *Provisions on the Safety Management of Civilian Nuclear Facility Decommissioning* that is currently under development, the operator of a nuclear facility since operation should make revision of its decommissioning plan at a 10 year interval. When a decommissioning plan is in need of substantial revision in response to a major change, event or accident taking place at a nuclear facility, a timely revision to this plan is necessary.

H.6.2 Operation of Radioactive Waste Temporary Storage Facility associated with Nuclear Technology Application

H-57 Under the MMLSRWSD, the operators of all radioactive waste storage facilities associated with nuclear technology application have obtained the operation licenses.

H-58 Operational conditions are set for the radioactive waste storage facilities associated with nuclear technology applications, such as surface dose rate limits of disused sealed source storage containers and of variable locations at such facilities, and number of ventilations change in different areas, etc.

H-59 A full range of management operational procedures have been established and implemented strictly by the operators of radioactive waste storage facilities associated with nuclear technology applications, such as those for equipment operation and operation procedures, for acceptance, inspection and validation of disused sealed sources, for packaging and conditioning of disused sealed sources, for workers' body surface contamination inspection and decontamination, for vehicle and tools contamination inspection and decontamination, and for operational monitoring plan and radiation environmental monitoring plan, and requirements for the safety prevention system of radioactive waste temporary storage facility periodic equipment inspection and testing, etc.

H-60 Radioactive waste temporary storage facilities associated with nuclear technology application can be provided with engineering and technical assistance and support in all areas related to safety during their entire operating lifetime.

H-61 Procedures for radioactive waste characterization and segregation are prepared by the operators of radioactive waste temporary storage facilities associated with nuclear technology application.

H-62 A safety-related accident, if occurred, shall be reported timely to the relevant regulatory bodies under the RSRWM, which points out that the operator of a radioactive waste temporary storage facility shall identify causes, take protective measures and report to the provincial ecological environment departments, autonomous regions or centrally governed municipalities where such a facility is located when discovering potential safety hazards and environmental radioactivity in excess of relevant national limits; a radiation accident, if occurred, should be reported to the relevant departments by law, and emergency response should be activated.

H-63 Under the TRSDCNTARTSF, the decommissioning plan proposed for an operational nuclear technology application facility continue to undergo the

evaluation, elaboration and updating during its operation.

H.6.3 Operation of LILW Disposal Facility

H-64 The MEE/NNSA granted operation licenses to the Northwest and Beilong disposal sites in 2011 and to the Feifengshan disposal site in 2016, specifying the category of waste, radionuclides inventory, waste disposal activity and licensed period.

H-65 Under the GB9132-2018, all the above three disposal sites specify the limits of radionuclide content, surface radiation level, and surface contamination limits of waste packages to be disposed of; mechanical stability, leaching resistance, free liquid, chemical composition, thermal and radiation stability, anti-ignitability, anti-microbial destructivity of waste forms; and requirements for the package container and loaded rate.

H-66 Under the RSRWM and GB9132-2018, the Northwest, Beilong and Feifengshan disposal sites developed and strictly implemented operational procedures for waste disposal, involving QA program, procedures of operation and manipulation, radiation protection program, environmental monitoring plan, accident emergency plan, and procedures for periodic equipment testing, etc. In consistent with disposal site surveillance and management requirements, operational monitoring plan and environmental radiation monitoring plan, in addition to facility safety inspection, the radiation monitoring was conducted for groundwater, surface water, rocks and soils, plant, and air in the surrounding environment. Monitoring and inspection data were recorded truthfully. Every year, the summary report of the previous year is reported to the MEE/NNSA before March 31. Monitoring results indicate that no significant variations were found in the environmental situation at the three sites above, before and/or after waste acceptance.

H-67 Radioactive waste disposal facilities can obtain engineering and technical support in all areas related to safety during their entire operating lifetime.

H-68 Procedures for radioactive waste characterization and segregation are prepared by the operators of radioactive waste disposal facilities.

H-69 If the disposal facility operator discovers the hidden safety risk, or radionuclides in the surrounding environment exceeds the national standard, the cause shall be immediately found out and preventive measures shall be taken accordingly, and it shall be reported to the competent ecology and environment department and nuclear industry department of the State Council. If a radiation accident is constituted, a report shall be made in accordance with relevant provisions, and emergency response shall be carried out.

H.7 Institutional Measure after Closure (Article 17)

Each Contracting Party shall take the appropriate steps to ensure that after closure of a disposal facility:

(i) records of the location, design and inventory of that facility required by the regulatory body are preserved;

(ii) active or passive institutional controls such as monitoring or access restrictions are carried out, if required; and

(iii) if, during any period of active institutional control, an unplanned release of radioactive materials into the environment is detected, intervention measures are implemented, if necessary.

H-70 In China, there has not yet been any activity or practice related to the closure of a disposal facility. However, the relevant requirements can be found in existing relevant laws, regulations and standards.

H-71 For record keeping, the operator of solid radioactive waste disposal facility shall, under the LNS and RSRWM, establish archives for solid radioactive waste disposal to accurately and completely record issues concerning disposal activities such as the origin, quantity, characteristics, and emplacement of solid radioactive wastes. The archives on solid radioactive waste disposal shall be preserved permanently.

H-72 Under the RSRWM, a solid radioactive waste disposal facility shall be closed complying with relevant laws and regulations, and subsequently permanent marks should be set up in the designated areas. After closure of a disposal facility, the operator of such a facility shall carry out institutional control according to the approved institutional control program.

H-73 Under the *Regulations on Radioactive Waste Safety* (HAF401), GB9132-2018 and HAD401/09, after the disposal site is closed, organized institutional control shall be carried out, which can be either active (monitoring, supervision and facility maintenance) or passive (restricting land use, setting up permanent site signs). According to the operation history of the disposal site and the situation of closure and stabilization, the appropriate environmental monitoring functions should be retained to ensure that the early alarm can be given before the radionuclides in the disposal site are released to the outside of the site boundary.

H-74 Under the HAF401, organized institutional controls shall be carried out after the closure of disposal site, so that necessary remedial actions can be implemented.

I. TRANSBOUNDARY MOVEMENT (Article 27)

1. Each Contracting Party involved in transboundary movement shall take the appropriate steps to ensure that such movement is undertaken in a manner consistent with the provisions of this Convention and relevant binding international instruments.

In so doing:

(i) a Contracting Party which is a State of origin shall take the appropriate steps to ensure that transboundary movement is authorized and takes place only with the prior notification and consent of the State of destination;

(ii) transboundary movement through States of transit shall be subject to those international obligations which are relevant to the particular modes of transport utilized;

(iii) a Contracting Party which is a State of destination shall consent to a transboundary movement only if it has the administrative and technical capacity, as well as the regulatory structure, needed to manage the spent fuel or the radioactive waste in a manner consistent with this Convention;

(iv) a Contracting Party which is a State of origin shall authorize a transboundary movement only if it can satisfy itself in accordance with the consent of the State of destination that the requirements of subparagraph (iii) are met prior to transboundary movement;

(v) a Contracting Party which is a State of origin shall take the appropriate steps to permit re-entry into its territory, if a transboundary movement is not or cannot be completed in conformity with this Article, unless an alternative safe arrangement can be made.

2. A Contracting Party shall not licence the shipment of its spent fuel or radioactive waste to a destination south of latitude 60 degrees south for storage or disposal.

3. Nothing in this Convention prejudices or affects:

(i) the exercise, by ships and aircraft of all States, of maritime, river and air navigation rights and freedoms, as provided for in international law;

(ii) rights of a Contracting Party to which radioactive waste is exported for processing to return, or provide for the return of, the radioactive waste and other products after treatment to the State of origin;

(iii) the right of a Contracting Party to export its spent fuel for reprocessing;

(iv) rights of a Contracting Party to which spent fuel is exported for reprocessing to return, or provide for the return of, radioactive waste and other

products resulting from reprocessing operations to the State of origin.

I-1 At the time of joining the Joint Convention, China has expressed its comprehension of transboundary movement from a Contracting Party as referred in Articles 2 (u) and 27 of the Joint Convention. Namely, prior to consenting to the transboundary movement from another Contracting Party, a Contracting Party as a State of destination should confirm, to the State of transit, that the State of origin has authorized such a transboundary movement.

I-2 Under Article 47 of the LPCRP, both radioactive waste and goods contaminated with radioactivity are prohibited from being imported to, or moved through, China's territory. However, radioactive waste and goods contaminated with radioactivity which is generated from the products exported from the People's Republic of China can be returned to the country's territory by law, if they are required under relevant regulations to return for treatment and disposal at home. Article 16 of RSPRRD requires the competent foreign trade authority of the State Council, in conjunction with the competent ecology and environment department of the State Council, the General Administration of Customs, the administration of quality supervision, inspection, and quarantine of the State Council, and the competent authority of radioisotopes producers, to develop and issue both the catalog of limited radioisotopes for imported and exported and the catalog of prohibited radioisotopes for import and export. The radioisotopes that are listed in the catalog of limited radioisotopes for import and export cannot be imported unless they have been reviewed and approved by the competent ecology and environment department of the State Council, have been granted import license by the foreign trade competent authority of the State Council, in accordance with relevant national foreign trade regulations. The radioisotopes other than the above-specified can be imported after implementing relevant national foreign trade regulations.

I-3 Under the *Regulations for the Safe Transport of Radioactive Material* (GB11806-2019), international transport of radioactive materials shall be subject to the regulations on the international transport of radioactive materials that are issued by State of transit and/or State of destination. Some types of consigned goods shall be subject to permission from each of such States. The overall safety level during transportation shall be sufficient to meet all applicable requirements.

I-4 China takes the appropriate steps to ensure that transboundary movements are undertaken in a manner consistent with the provisions of the Joint Convention and relevant binding international instruments. As a State of

origin, China requires the involved State of destination to confirm that such a transboundary movement has been authorized by China, and wants the involved consigner to have obtained the prior notification of such a State of destination. China shall legally approve and regulate any transboundary movement of radioactive waste within its boundary. China, as a State of destination, affirm to have the administrative and technical capacity, together with the regulatory system needed to manage spent fuel and radioactive waste in a manner consistent with the Joint Convention and shall examine and approve any transportation activities in territory on radioactive waste in a manner consistent with this Convention.

I-5 In August 2017 and December 2018, China successively shipped high-enriched uranium spent fuels from two miniature neutron source reactors in Ghana and Nigeria back to China for storage, respectively.

I-6 As of December 31, 2019, China has never shipped spent fuels or radioactive wastes to any destination south of latitude 60 degrees south for storage or disposal.

J. DISUSED RADIOACTIVE SOURCES (Article 28)

Each Contracting Party shall, in the framework of its national law, take the appropriate steps to ensure that the possession, remanufacturing or disposal of disused sealed sources takes place in a safe manner.

A Contracting Party shall allow for reentry into its territory of disused sealed sources if, in the framework of its national law, it has accepted that they be returned to a manufacturer qualified to receive and possess the disused sealed sources.

J-1 Radioactive sources are widely used in industry, agriculture, medical treatment, scientific research, teaching, and other fields, which are in various types, large quantity, and wide distribution. In recent years, with the rapid growth of China's economy, the number of radioactive sources in use is growing rapidly. At the same time, the number of disused sealed sources is also growing.

J-2 According to the statistics of the National Radiation Safety Management System for the Application of Nuclear Technology, as of December 31, 2019, China has more than 77,000 nuclear technology application organizations and more than 140,000 radioactive sources in use. About 170,000 disused sealed sources are stored in 31 provincial and urban radioactive waste temporary storage facilities and national disused sealed source centralized temporary storage facility.

J.1 Requirements for the Management of Disused Sealed Sources

J-3 China aims to emphasize and enhance the safety of radioactive source management during their entire lifetime. The supervision and management system of radioactive sources is established in line with the IAEA *Code of Conduct for the Safety and Security of Radioactive Sources*, and its supplementary *Guidance on the Import and Export of Radioactive Sources* and *Guidance on the Management of Disused Radioactive Sources*, which defines the management requirements for the production, sales, use, transfer, import and export, storage, and disposal of radioactive sources. The whole process of dynamic tracking and management of radioactive sources is achieved through the national network information system (the National Radiation Safety Management System for the Application of Nuclear Technology).

J-4 The LPCRP provides that "organizations that produce radioactive sources shall recover and utilize the disused sealed sources in accordance with the provisions of the competent ecology environment department of the State Council; organizations that use radioactive sources shall, in accordance with the

provisions of the competent ecology and environment department of the State Council, return the disused sealed sources to the organizations that produce these sources or send them to organizations specializing in the storage and disposal of solid radioactive wastes."

J-5 The RSPRRD (Decree No. 449 of the State Council) puts forward more specific requirements, that category I, II or III radioactive sources shall be returned to their original exporters or producers. If they, in fact cannot be returned, they shall be sent to qualified radioactive waste storage organizations; category IV or V radioactive sources shall be sent to qualified radioactive waste storage organizations after packaging and conditioning. In addition, in view of the problem that the orphan sources are easy to flow into scrap metal smelting enterprises, which may cause metal pollution, Decree No. 449 of the State Council requires metal smelting enterprises to take monitoring measures, accordingly.

J-6 The MMSLRRD explicitly requires that organizations importing category I, II or III radioactive sources need to submit to the MEE a copy of the commitment document from the original exporters to recover the radioactive sources from the end-users.

J-7 The MMSPRRD includes more specific regulations on the management of disused sealed sources and the radiation monitoring of smelting waste metal. Organizations which category I, II or III radioactive sources shall, in accordance with relevant contract provisions, return the disused sealed sources to the producers or to the original exporters within 3 months after the radioactive sources have been idle or disused. If they are, in fact, impossible to return, they shall be sent to qualified organizations for the centralized storage of radioactive wastes. Organizations which use category IV or V radioactive sources shall, in accordance with the provisions of the MEE, send the radioactive sources after packaging and conditioning to qualified organizations for the centralized storage of radioactive wastes, within 3 months after the radioactive sources have been idle or disused.

J.2 Recovery of Exported Radioactive Sources

J-8 Abiding by the IAEA *Code of Conduct for the Safety and Security of Radioactive Sources* and its supplementary *Guidance on the Import and Export of Radioactive Sources*, China promises to recover the radioactive sources exported from China.

J-9 Under the RSPRRD and MMSLRRD, the MEE shall exercise relevant procedures according to relevant laws, international conventions and agreements that are contracted or signed by the Chinese government.

Radioactive source exporters shall apply for the license for radioactive source export from the MEE, along with copies of effective agreement signed between the exporter and the importer, and certificate of foreign importers. There is an entry in the licensing application form on whether or not such sources shall be returned to the exporter.

J.3 Practices for the Management of Disused Sealed Sources

J-10 The disused sealed sources in China mainly come from the application of nuclear technology in industry, medical treatment, and other fields. In the process of application of nuclear technology, radioactive sources in use will no longer be used, and become disused sealed sources, when their safe lifetimes have passed, or when they have no effect of use due to decay and other reasons. Disused sealed sources that are produced by applications such as gamma irradiation device, industrial flaw detection machine, bone mineral density measurement instrument, teletherapy equipment, after-loading therapy equipment, gamma knife treatment, blood irradiator, surface applicator, instrument and equipment calibration source, etc., are mainly treated with the following three methods at present:

(1) returning to the manufacturers for storage;

(2) recovery and recycle by the manufacturers; and

(3) delivering to the urban radioactive waste temporary storage facilities by the users.

J.3.1 Returning to the Manufacturers

(1) Import and export of medical category III Ir-192 radioactive sources

J-11 The medical category III Ir-192 radioactive sources used in China are mainly imported from abroad. The half-life of the Ir-192 radioactive source is short. And the radioactive source for the after-loading therapy equipment needs to be replaced after about one and a half years. Therefore, the import and export frequency is rather high. In order to save the cost for transport of radioactive sources and reduce the burden on enterprises, while ensuring the safety is ensured, China implements import and export licensing at the same time for the replacement of medical Ir-192 radioactive sources, i.e., to grant a license for the import of new radioactive sources when the disused sources have not yet returned to the country of origin. In this way, the transport container carrying the new sources can be used to transport the disused sources back to the country of origin, so as to save the cost.

(2) Centralized return of category I Co-60 radioactive sources

J-12 The problem with the return of Co-60 sources for industrial irradiation is that the number of disused sealed sources produced in a single organization is

small, which makes the cost of transport relatively high. In order to solve this problem, China has tried the mode of centralized return, i.e., to collect the sources from several organizations, and then to return the sources will be centralized and returned to the original manufacturers. In 2013, Beijing Sanqiang Nuclear Radiation Engineering Technology Co., Ltd. cooperated with Nordion of Canada to complete the centralized return of 170 Nordion Co-60 sources from 9 Chinese organizations.

J.3.2 Recovery and Recycle of Disused Radioactive Sources

J-13 The Article 33 of the MMSPRRD (Decree No. 18 of MEE) provides that radioactive sources, which have been transferred to the storage facility or returned to the original manufacturers but still have useful value, may be transferred and recycled after going through relevant formalities in accordance with provisions of the RSPRRD accordingly.

J-14 The competent authorities of the Chinese government have been actively promoting the recycle of disused sealed sources, in order to recycle the valuable radioactive sources, to promote resource conservation, and to minimize radioactive wastes. At present, great progress has been made in the investigation of this work. The MEE has approved three radioactive source manufacturers to carry out the recovery and recycle of Cs-137, Co-60, Am-241/Be (Pu-238/Be) and other radioactive sources, reprocessing these sources, and reusing them as new ones when meeting relevant safety standards.

J.3.3 Disposal of Disused Radioactive Sources

J-15 In 2019, the MEE/NNSA approved the disposal of 18 000 Ir-192 and Se-75 detection sources from two organizations, and carried out near-surface disposal of some disused sealed sources with low radioactivity levels. The activity of these sources has decayed to a level less than 10^5 Bq. However, because the radioactivity levels of Ni-63 and Co-60 in their raw materials cannot be ignored, they can only be recovered by the manufacturers for long-term storage. The MEE/NNSA organized a review of the disposal plan for this batch of disused sealed sources, and approved that they will be delivered to the Northwest disposal site after assessing the safety of disposal.

J-16 In 2019, the MEE/NNSA organized a study on the disposal strategy of disused sealed sources and reception criteria for near-surface disposal, in order to promote the safe disposal of disused sources with low activity levels. On the basis of combing and analyzing the disused sources accumulated in the national disused sealed source storage, the MEE/NNSA organized a study on the safety requirements and reception criteria for the near-surface disposal of disused sources, and the technical opinion study on the near-surface disposal of disused

sources, and planned to formulate relevant management requirements. In addition, the MEE/NNSA also plans to carry out a feasibility study on the near-surface disposal of Co-60 and Cs-137 sources to solve the problem of disposal of some disused sealed sources.

J.3.4 Operation of Urban Radioactive Waste Temporary Storage Facility

J-17 China operates 31 radioactive waste temporary storage facilities and 1 national centralized disused sealed sources temporary storage facility to provide storage service for the disused sealed sources.

J-18 In order to ensure the safety of disused sealed sources, the former MEP carried out a national nuclear and radiation safety inspection and comprehensive surveillance in 2015, focusing on the comprehensive inspection of the safety and security of urban radioactive waste temporary storage facilities; and issued the HAD802/01 in 2017. Provincial and urban radioactive waste temporary storage facilities are being upgraded successively in accordance with the requirements of this document. Technical standards such as the safe operation and management of urban radioactive waste temporary storage facilities, and the collection and storage of radioactive wastes (disused sealed sources) are also being formulated.

J-19 To encourage the delivery and storage of disused sources, the Chinese government issued relevant provisions in 2017, which provide that provincial and urban radioactive waste temporary storage facilities will implement a free storage policy for category IV or V radioactive sources that are no longer used by organizations of nuclear technology application.

K. GENERAL EFFORTS TO IMPROVE SAFETY

K.1 Measures Taken to Suggestions and Challenges Identified at the Last Review Meeting

K-1 Specific to the five challenges and one suggestion identified the last Review Meeting, China has taken many measures to response to these challenges and suggestions.

K.1.1 Progress in The HLW Disposal Program Including the Finalization of The URL

K-2 According to the *Guidelines on the Research and Development Plan for the Geological Disposal of HLW* jointly issued by the CAEA, the MST and the former SEPA in 2006, China has systematically promoted the research and development of geological disposal of HLW, including underground laboratories, as detailed in B.5.

K-3 Since the last Review Meeting, the State Council of the People's Republic of China approved the TFP2025VNSRPC in February 2017, which called for speeding up the study on the disposal of HLW. During the 13th Five-year Plan period, the siting and site investigation for HLW geological disposal facilities will be promoted. Studies on engineering barriers, disposal processes, geochemistry, and safety assessment will be carried out. The screening for 2 or 3 key candidate sites will be completed. The safety objectives and principles of HLW geological disposal will be clarified. The technical safety criteria for the selection of HLW geological disposal facilities in China will be studied. The CAEA issued the *Guidelines for the Application of Scientific Research Projects on Nuclear Facility Decommissioning and Radioactive Waste Treatment (2018-2020)* in March 2018. The guidelines define the research objectives of HLW geological disposal at this stage, i.e. to master the key technologies for the design and construction of underground laboratories, to study the suitability of candidate sites and other granite sites at Beishan pre-selected areas in Gansu Province, to screen and evaluate clay rock candidate sites, to carry out in-depth research on geological disposal engineering, geochemistry and safety assessment, and to initially form a technical system for the research and development of HLW geological disposal in China. The guidelines also define the scope of research at this stage, i.e. to study the key technologies for the design and construction of underground laboratories; to study the suitability of candidate sites and other granite sites at Beishan pre-selected areas in Gansu Province, to select and evaluate clay rock candidate sites, to study the deep borehole disposal techniques, to study the engineering characteristics of fractured rock mass under the condition of disposal repository,

to study the engineering performance of buffer backfilling materials and additives, to study the evolution of engineering barrier performance, to study the big data integration of disposal system and large-scale scientific calculation methods, to study the release and migration behavior of key nuclides under simulated disposal conditions, to evaluate the long-term chemical stability of vitrification form and ceramic solidification form of high-level liquid wastes, and to study the safety assessment technology of geological disposal. At present, related research projects are being implemented.

K-4 Since the last Review Meeting, in line with the above guidelines, China National Nuclear Corporation (CNNC), relevant scientific research institutes and universities prepared a project proposal for the underground laboratory. The proposal was submitted to the competent authorities and was approved in May 2019. The construction target of the approved underground laboratory is to build an international advanced underground laboratory for HLW geological disposal in the Xinchang area of Beishan, Gansu Province, with an aim to fill the gap that there is no on-site underground research and development platform and related equipment for HLW disposal in China, to significantly improve the capability and level in the research and development of HLW disposal technology and assessment of site suitability, and to meet the urgent needs of China in this regard. Besides, the approval clearly defines the contents of construction, i.e. the underground laboratory and auxiliary systems, underground on-site test and research platform and facilities, ground experimental and supporting facilities on site, and other off-site engineering. The construction period of the project is 84 months, and the construction of auxiliary facilities, such as water transmission, electricity transmission and roads, is scheduled to start in 2020, and the shaft excavation work is expected to start in 2022. In December 2019, the CAEA approved the establishment of the chief commander and chief designer system of the underground laboratory.

K-5 Since the last Review Meeting, CNNC organized to prepare the proposals for 9 research projects related to the underground laboratory in August 2019, i.e. the study on the mechanical excavation equipment for the disposal pit of HLW repository, the long-term monitoring and impact study for the site environment of the underground laboratory, the preliminary study on the roadway structure layout and disposal concept for the demonstration disposal in the underground laboratory, the study on the in-situ test and installation technology of buffer material under the condition of underground laboratory, the study on the mechanical properties and long-term stability of deep surrounding rock of the underground laboratory, the study on the key technologies for deep

rock mass excavation, the study on the deep geological environment of the underground laboratory, the study on the hydrogeological characteristics of the underground laboratory, and the study on the release and migration behaviors of radio-nuclides under deep surrounding rock conditions. The above research projects will be carried out synchronously and managed uniformly with the underground laboratory project.

K.1.2 Completion Of The LILW Disposal Site Selection to Timely Attend the Needs of the Nuclear Program

K-6 China attaches importance to the whole process of radioactive waste management, and has been committed to building capacity for radioactive waste management commensurate with the development of nuclear technology, include gradually building and providing adequate capacity for the disposal of LILW.

K-7 Since the last Review Meeting, China issued the LNS. The LNS clearly requires that the competent authorities of nuclear industry of the State Council shall, in conjunction with relevant departments of the State Council and the people's governments of provinces, autonomous regions and centrally-governed municipalities, develop a siting plan for the disposal of LILW, and organize its implementation subject to the approval by the State Council; the construction of the solid radioactive waste disposal sites shall be commensurate with the expansion of nuclear power.

K-8 Since the last Review Meeting, the former MEP/NNSA, the NDRC, the MOF, the NEA and the CAEA jointly issued the TFP2025VNSRPC. The plan clearly provides that the *Plan for LILW Disposal Sites* should be issued and implemented, and the siting and construction for 5 such disposal sites should be carried out, so as to form a reasonable layout for the disposal of LILW.

K-9 Since the last Review Meeting, nuclear power groups concerned have accelerated the pace for siting and construction of LILW disposal sites. The CNNC is speeding up the preliminary work for the disposal sites in Liaoning, Zhejiang and Fujian Provinces. The CGN has prepared and submitted the project proposal and is carrying out a feasibility study for the LILW disposal site in Fangchenggang, Guangxi Province. In addition, academic organizations such as the CNEA have carried out the policy study on the disposal of LILW from NPPs, solving the challenges faced by the siting for LILW disposal.

K.1.3 Enhancement ff Regulator's Role in Communication to the Public of the Disposal Program

K-10 The MEE/NNSA has always attached great importance to public communication for nuclear-related projects, gradually improved relevant departmental regulations in this regard, and strengthened its role in

nuclear-related projects.

K-11 Since the last Review Meeting, China has issued laws and regulations involving the public communication for nuclear-related projects, further clarifying and strengthening the requirements and role of nuclear safety supervision and administration agencies in this work. The LNS, which came into force in 2018, has set up a special chapter on “Information Disclosure and Public Participation”. It clearly requires that citizens, legal persons and other organizations have the right to report to the nuclear safety supervision and administration department of the State Council or other relevant departments about the existence of nuclear safety risks or violations of nuclear safety laws and administrative regulations. The MEE/NNSA issued the *Methods for Public Participation in Environmental Impact Assessment* and supporting documents in 2018, which took into effect on January 1, 2019. Moreover, the preparation for the *Methods for Disclosure of Nuclear Safety Information* is being promoted; the *Program for the Disclosure of Nuclear and Radiation Safety Supervision Information* will be issued, the *Guidelines on the Public Communication for Nuclear and Radiation Safety* will be revised. As a result, the public communication for nuclear and radiation projects was strengthened through system construction.

K-12 Since the last Review Meeting, the former MEP/NNSA, the NDRC, the MOF, the NEA and the CAEA jointly issued the TFP2025VNSRPC, with “strengthening public communication and promoting public participation” as one of the safeguard measures to ensure the achievement of the targets and tasks of the plan. The plan clearly defines that “four-in-one” mode of public communication in nuclear safety shall be promoted. To facilitate this work, the government-led public communication system will be improved. The basic knowledge of nuclear safety will be incorporated into the education and training system to introduce nuclear and radiation knowledge into communities, primary and secondary schools, and cadre training courses. Relying on enterprises, 10 national popular science and education bases on nuclear and radiation safety will be built. The publicity function of network platform and news media, and the communication with media will be strengthened. Information disclosure plans and guidelines will be improved to strengthen the construction of information disclosure platforms. Enterprises shall disclose project construction information at different stages under law, and the government will actively disclose the information on licensing, supervision and law enforcement, environmental monitoring, incidents, and accidents, etc., and strengthen the interpretation of public information. The right of the public to participate in the

construction of nuclear facilities under law will be guaranteed.

K-13 Since the last Review Meeting, a joint meeting mechanism for the risk prevention of “not in my backyard” (NIMBY) issues in nuclear-related projects, and a linkage mechanism for the publicity of popular science have been set up. The former MEP, the MIIT and other governmental bodies have set up a joint meeting mechanism for the risk prevention of NIMBY issues related to environmental protection projects, and set up a coordination group for handling NIMBY issues related to nuclear projects. The coordination group is responsible for regularly carrying out NIMBY situation analysis and response, etc. Sudden and serious NIMBY issues, will be jointly dealt with by relevant members of the coordination group, nuclear power groups and relevant organizations.

K-14 The MEE/NNSA guides and urges all technical support organizations, local ecology and environment departments and enterprises to make many practical and effective achievements in public science popularization for different target groups, vigorously disseminates nuclear scientific knowledge and state-of-the-art technologies, enhances the scientific, authoritative and long-term effectiveness of nuclear science popularization, and helps the general public to improve their scientific quality, and to enhance their understanding and confidence in nuclear science and technology, nuclear safety and nuclear emergency management, and strives to promote the safe and efficient development and peaceful use of nuclear energy in China.

K-15 Since the last Review Meeting, the MEE/NNSA carried out a number of public communication activities in nuclear-related projects. The publicity and implementation of the LNS was carried out; the green nuclear power science popularization program and question bank were developed, including developing and revising the encyclopedia entries in the field of nuclear and radiation safety to form entry materials of about 760000 words; the green nuclear power science textbooks were developed; the construction for nuclear power science popularization field was strengthened; featured science popularization activities were held, and activities for popularizing science into communities and campuses were carried out extensively by taking advantage of important events, such as the “4·15” National Security Education Day, “6·5” Environment Day, “8·7” Nuclear Industry Public Open Day (or Week). More than 200,000 professionals in nuclear industry and students from hundreds of universities, and primary and secondary schools participated in the publicity activities. The popular science and publicity activities featuring in nuclear and radiation safety were carried out under its guidance, such as the “Light of Charm” Cup National Nuclear Power Popularization and Knowledge

Competition for High School Students, the National Extracurricular "Nuclear + X" Creative Competition for College Students, Nuclear Safety College Student Debate Competition, Nuclear Energy Public Communication Conference, which increasingly strengthen the influence in the public and society. Media publicity and book promotion activities were carried out; and the publicity and science popularization in nuclear-related provinces were strengthened.

K.1.4 Complete and Put in Force Specific Regulatory Requirements for Decommissioning

K-16 China attaches great importance to the safety of the decommissioning management of nuclear facilities and actively formulates relevant laws and regulations, including regulatory requirements for decommissioning of nuclear facilities.

K-17 In addition to the legal requirements on the decommissioning of nuclear facilities specified in the LNS, the MEE/NNSA organized to develop a series of nuclear safety guides, such as the *Safety Assessment for the Decommissioning of Nuclear Facilities*, the *Decommissioning of Nuclear Fuel Cycle Facilities*, the *Decommissioning of Nuclear Technology Application Facilities*, the *Decommissioning of Nuclear Power Plants and Research Reactors*, so as to refine the technical requirements for the decommissioning of nuclear facilities. The MEE/NNSA is also formulating the *Provisions on the Safety Management of Civilian Nuclear Facility Decommissioning* to clarify the management procedures and requirements for the decommissioning of nuclear facilities.

K-18 The *Provisions on the Safety Management of Civilian Nuclear Facility Decommissioning* is applicable to the decommissioning management of NPPs, research reactors, and other nuclear fuel cycle facilities, covering the main areas such as the categorization of decommissioning activities, decommissioning strategies, and final state of decommissioning, involving the decommissioning plan and investigation, decommissioning technology selection, decommissioning process, waste management, records and reports. The *Provisions on the Safety Management of Civilian Nuclear Facility Decommissioning* stipulates in detail the licensing system and regulatory requirements for the decommissioning of nuclear facilities. China has approved the decommissioning plan for the reactor 101, and the MEE/NNSA plans to improve the regulatory procedures during the decommissioning of the reactor 101.

K-19 In accordance with the authorization of the LNS, the MOF, together with relevant governmental departments, is formulating the *Interim Measures*

for the Management of Expenses for Nuclear Facility Decommissioning and Radioactive Waste Disposal. At present, the investigation has been completed and the first draft has been formed. The measures consider to establish a regular evaluation mechanism for the cost evaluation for the decommissioning of nuclear facilities, including the self-evaluation of nuclear facility operators, and the evaluation and examination of decommissioning cost management by regulatory bodies, and to establish a pricing mechanism for radioactive waste disposal.

K.1.5 Decommissioning Technology to be Developed in Depth Taking into Account Technical, Economic and Social Considerations

K-20 China attaches great importance to the technical research and accumulation for nuclear facility decommissioning, and actively considers the best and feasible decommissioning technology, including technical, economic and social factors, for the decommissioning of civilian nuclear facilities.

K-21 Since the last Review Meeting, the CAEA issued the *Guidelines for the Application of Scientific Research Projects on Nuclear Facility Decommissioning and Radioactive Waste Treatment* (2018-2020) in March 2018. The guidelines define the research objectives and contents for decommissioning technologies at this stage. In the research direction of reactor decommissioning technology, the proposed research contents include the conditioning and treatment technology of damaged high-burnup spent fuel assembly; pipeline system plugging technology and material, and the engineering application of technologies such as disassembly and removal of shielded concrete, cutting of parts and components of nuclear facilities, remote cutting under irradiation environment, high pressure water cutting, plasma cutting, underwater laser cutting, decontamination of pressure vessels, metal melting. In the research direction of other decommissioning technologies, the research contents include engineering applications of decommissioning technologies for the air duct and chimney of radioactive plant building, and the . In the direction of the engineering application of decommissioning technology and development of special equipment, the research contents include the digestion, absorption and secondary development of key instruments and equipment for decommissioning, and the development of special equipment for decommissioning, such as radiation monitoring, disassembly and decontamination.

K-22 Since the last Review Meeting, the CNNC, relevant scientific research institutes and universities prepared project proposals and submitted for approval in line with the above guidelines. The CAEA organized reviews and approved

relevant scientific research projects in the directions of reactor decommissioning technologies, other nuclear facility decommissioning technologies, engineering application of decommissioning technologies, and development of special equipment. At present, a number of R&D projects such as the decommissioning technique for radioactive process pipe ditch and the stripping technique for contaminated equipment are being implemented as planned.

K-23 Since the last Review Meeting, the technical, economic and social factors have been fully taken into account when selecting specific decommissioning techniques to be developed. For example, for the cutting technique of large-scale equipment decommissioned from reactor, the state-of-the-art underwater laser cutting technique to be developed has both economic and engineering application value, and the successful R&D of this technique can solve the difficult problem of underwater cutting for large and high-level radioactive components, reduce the exposure dose of workers, and save the cost of decommissioning. For the decontamination and recycling technique of scrap metal produced in the process of decommissioning, the special metal smelting technique to be developed focus on the recycling of scrap metal, the recovery and recycle of resources, and reduction of economic cost, while reducing the amount of waste. Besides, the relevant policy and standard study to be carried out is to clarify the standards and scopes of scrap metal recycle, and fully consider the social impact of radioactive scrap metal recycling.

K.1.6 To Develop a Mechanism to Make Regular Assessment of Cost Estimates Associated with the Long Term Liabilities for the Radioactive Waste Disposal Program and the Decommissioning Program

K-24 China recognizes the importance of adequate financial resources for the safety of spent fuel management and radioactive waste management. The LPCRP, which came into force in 2003, stipulates that the accrued expenses for the decommissioning of nuclear facilities and the disposal of radioactive wastes shall be earmarked and included in the investment estimate or production cost.

K-25 Since the last Review Meeting, China promulgated the LNS. It is clearly stipulated that the accrued expenses for the decommissioning of nuclear facilities and the disposal of radioactive wastes shall be specially earmarked and included in the estimated investment and production cost by nuclear facility operators.

K-26 Since the last Review Meeting, the MOF, together with relevant governmental departments, launched the formulation of the *Interim Measures*

for the Management of Expenses for Nuclear Facility Decommissioning and Radioactive Waste Disposal. So far, the research work has been completed and the first draft has been formed. These measures are applicable to the accrued calculation, management and use of decommissioning and disposal costs of civilian nuclear facilities (except spent fuel reprocessing and radioactive waste disposal facilities), as well as the collection and management of disposal fees for LILW. The measures require that commercial nuclear facility operators shall self-evaluate the suitability of decommissioning costs every five years, and adjust the standards for the accrued expenses according to the evaluation results; the MEE/NNSA evaluates and reviews the management of decommissioning fees by commercial nuclear facility operators every 10 years, and nuclear facility operators shall adjust the standards of decommissioning fees in accordance with the evaluation and audit opinions of the NEE/NNSA. Nuclear facility operators shall be responsible for the accrued calculation and management of disposal fees, which may be used when delivering to waste disposal facilities for disposing of solid radioactive wastes.

K-27 Since the last Review Meeting, the MEE/NNSA launched the special project “Study on Regular Evaluation for the Decommissioning Costs of Nuclear Facilities” to conduct in-depth studies on decommissioning cost evaluation techniques and regular evaluation methods to provide support for China’s implementation of a regular evaluation mechanism for nuclear facility decommissioning cost.

K.2 Existing Safety Issues, Faced Challenges and Proposed Actions of the Current Stage

K.2.1 Selection of Low- and Intermediate-level Solid Waste Disposal Site

K-28 The selection and construction of LILW disposal site needs to be further accelerated.

K-29 The siting process will be advanced by enhancing the multi-agency coordination between CAEA, NEA and MEE/NNSA, making local governments and relevant national nuclear power groups clearly responsible for their own functions, expediting development of radioactive waste treatment and disposal fund extraction and management methods, and establishing trans-regional fund disposition compensation mechanism.

K-30 As required by the OTFPNESDPRC and the TFP2025VNSRPC, the siting plan shall be studied and developed so as to expedite the siting process on the basis of NPP geographical distribution and of current progress of siting.

K.2.2 Geological Disposal of High-level Radioactive Wastes

K-31 China still needs to attach importance to and strengthen the construction of underground laboratories for geological disposal of HLW.

K-32 China will speed up the formulation of guides and technical documents related to the HLW geological disposal, such as the *Safety Requirements for Radioactive Waste Geological Disposal Facilities* and the *Systematic Analysis for the Whole Process of Radioactive Waste Disposal Safety*.

K-33 China will speed up studies on the disposal of HLW. The construction of underground laboratory for geological disposal of HLW shall be started, and studies on key technologies of design and construction of underground laboratory shall be carried out. Siting for HLW geological disposal repository, studies on the suitability of candidate sites and other granite sites in key zones of Beishan pre-selection area in Gansu Province, and selection and evaluation of clay rock candidate sites shall be carried out. The studies on deep drilling disposal technique, engineering characteristics of fractured rock mass under the condition of disposal repository, engineering performance of buffer backfilling materials and additives, engineering barrier performance evolution, and big data integration and large-scale scientific calculation methods for the disposal system shall be carried out. Studies on the release and migration behavior of key nuclides under simulated disposal conditions, long-term chemical stability assessment of glass and ceramic solidified bodies of high-level liquid waste, and safety assessment technology of geological disposal shall be carried out.

K-34 International cooperation related to the underground laboratory for HLW geological disposal will continue to be carried out. Cooperation with the IAEA in the field of HLW geological disposal will continue to be strengthened, such as related technical cooperation (IAEA-TC) projects. Cooperation with relevant foreign organizations and scientific research institutes in HLW geological disposal will be further strengthened, and research projects in this regard will be actively taken part in and jointly carried out.

K.2.3 Near-surface Disposal of Disused Sealed Sources

K-35 China needs to start and speed up the near-surface disposal of disused sealed sources.

K-36 China will conduct in-depth studies on the safety requirements, guidelines for disposal and reception, and other relevant requirements and standards for near-surface disposal of disused sealed sources. According to the safety requirements, and disposal and reception criteria for near-surface disposal of LILW, considering the characteristics of small volume and

concentrated activity of disused sealed sources, the grouping of disused sealed sources for disposal purpose, the activity limit of near-surface disposal of disused sealed sources, the conditioning requirements for disused sealed sources for disposal purpose, the safety and storage management requirements for waste packages conditioned and formed, and the requirements for disposal process will be studied.

K-37 China will launch the second phase construction project of the northwest disposal site, considering the construction of preparation facilities for near-surface disposal of disused sealed sources. In order to realize the multi-functions such as conditioning, detection, transfer, temporary storage before disposal required for the near-surface disposal of disused sealed sources, a complete, safe and reliable conditioning facility will be built, with reference to the layout and configuration of radioactive source production facilities and radioactive waste conditioning facilities.

K.3 Policy, Practice and Plan in Response to IRRS Mission to China

K-38 China recognizes the importance of international peer review in the areas of nuclear and radiation safety, including the safety of spent fuel management and the safety of radioactive waste management. China welcomes the IRRS mission for exchange with us. As pointed out clearly in the *Policy Statement on Nuclear Safety Culture* (PSNSC) issued in 2014, China pursues the international peer review and encourages the Third Party review activity in developing nuclear safety culture and practice, learning from successful experience, and identifying potential weakness and problems for correction and improvement.

K-39 In order to further improve nuclear and radiation safety regulation in China, an IAEA international team of senior safety experts conducted a follow-up IRRS mission, at the request of China, to the country's nuclear and radiation safety regulatory system from August 28 to September 8, 2016. Emphasis was on reviewing the implementation of recommendations and suggestions as raised in the 2010 IRRS mission report. This follow-up IRRS mission included two additional parts, namely "nuclear safety modification after Fukushima accident" and "radiation environmental monitoring". It has shown that significant progress has been achieved in nuclear and radiation safety regulation in the country, featuring continued increase in regulatory resources, sustained enhancement of independency, authority and effectiveness in regulatory capability.

K.4 Measures to Strength the Openness and Transparency of JC Fulfillment

K-40 China attaches great importance to and strengthen the openness and transparency of various activities taken during JC fulfillment as a whole. For this purpose, a National Report Writing Group (NRWG) and a National Report Review Committee (NRRC) were established. The NRRC consisted of experts from multiple agencies and organizations, such as the MEE/NNSA, the CAEA, the MFA, the MPS, the NHC, the NEA, national nuclear power groups, operators of some nuclear facilities and relevant research institutions. In the process of developing National Report, the NRWG gathered information/data from the NRRC's subsidiary organizations. After completion of the draft National Report, the NRRC conducted review of the draft and made recommendations and suggestions to revise it, followed by NRWG's once-again revision to the draft so as to form final National Report based on the proceeding recommendations and suggestions. In the process of answering the written questions asked by other Contracting Parties, the NRWG first gave the preliminary answers to the asked questions and then completed the revision to the written answers, preceded by NRRC's review of written answers, together with giving recommendations and suggestions. During the National Report compilation and question answering, the report contents and discussion process are all open and transparency to all of the agencies and organizations involved in these processes. Both the Chinese and English version of previous National Reports are available to the public on MEE/NNSA website (http://nnsa.mee.gov.cn/gjhz_9050/gjgybg/). Therefore, the text of National Report is open and transparent to the Public.

K-41 Furthermore, the information related to China's participation with Organizational Meetings, Review Meetings and Extraordinary Meetings of Contracting Parties was made available to the public on MEE/NNSA government website, CAEA website and Annual Reports of NNSA.

K.5 International Cooperation Measures

K-42 China will continue to pay attention to the role that the IAEA has played in providing a platform to promote international cooperation in respect of the safety of spent fuel and radioactive waste management. China actively participates in IAEA sponsored technical cooperation projects, international and regional training courses and meetings. In addition, China will continue to seriously implement the obligations under the Joint Convention, participate in research and development of international standards, carry out perspective study and discussion, and to promote international cooperation and exchange.

K-43 China will steadily push forward cooperation with the United States, France, Britain, Japan, Russia, Spain, the European Union countries and relevant regional organizations in aspect of the safety of spent fuel and radioactive waste management, including signing cooperative agreements or memorandums in this regard with other relevant countries. Besides, China will increase international peer review frequency, enhance information disclose of peer review, pay attention to emergency response and assistance, and strengthen bilateral and multilateral cooperation in the field of technology import and joint research.

K-44 China will actively participate in regional nuclear safety cooperation. This includes China-Japan-Korea Senior Officials Meeting on Nuclear Safety Supervision, Global Nuclear Safety and Security Network (GNSSN), Asian Nuclear Safety Network (ANSN) and Forum for Nuclear Cooperation in Asia (FNCA). Through these platforms, relevant member states would commonly share experiences and lessons learnt in respect of the safety of spent fuel management and the safety of radioactive waste management, and these platforms would promote member states to maintain and achieve a high level of safety in aspects of spent fuel management and radioactive waste management. Pursuant to “One Belt and One Road” initiative, China will make unremitting effort to achieve the goal of Joint Convention by extending capability construction, information feedback and experience exchange with the countries around the One Belt and One Road in the field of the safety of spent fuel management and the safety of radioactive waste management.

L. ANNEXES

L.1 List of Spent Fuel Management Facilities

L.1.1 Spent Fuel Storage Facilities at NPPs

No.	Facility	Affiliation	Design Capacity (tHM)	Time put into operation
1	Spent fuel pool 1#	Qinshan NPP	184	1991
2	Spent fuel pool 2#	Qinshan NPP	231	1991
3	Spent fuel pool 1#	Fangjiashan NPP	554	2014
4	Spent fuel pool 2#	Fangjiashan NPP	554	2015
5	Spent fuel pool 1#	Qinshan NPP Phase II	317	2002
6	Spent fuel pool 2#	Qinshan NPP Phase II	317	2004
7	Spent fuel pool 3#	Qinshan NPP Phase II	317	2010
8	Spent fuel pool 4#	Qinshan NPP Phase II	317	2011
9	Spent fuel pool 1#	Qinshan NPP Phase III	941	2002
10	Spent fuel pool 2#	Qinshan NPP Phase III	941	2003
11	Interim spent fuel dry storage facility	Qinshan NPP Phase III	8251	2009
12	Spent fuel pool 1#	Fuqing NPP	554	2014
13	Spent fuel pool 2#	Fuqing NPP	554	2015
14	Spent fuel pool 3#	Fuqing NPP	554	2016
15	Spent fuel pool 4#	Fuqing NPP	554	2017
16	Spent fuel pool 1#	Daya Bay NPP	427	1992
17	Spent fuel pool 2#	Daya Bay NPP	427	1993
18	Spent fuel pool 1#	Ling'ao NPP Phase I	554	2001
19	Spent fuel pool 2#	Ling'ao NPP Phase I	554	2002
20	Spent fuel pool 1#	Ling'ao NPP Phase II	554	2010
21	Spent fuel pool 2#	Ling'ao NPP Phase II	554	2010
22	Spent fuel pool 1#	Tianwan NPP	316	2007
23	Spent fuel pool 2#	Tianwan NPP	316	2007
24	Spent fuel pool 3#	Tianwan NPP	320	2018
25	Spent fuel pool 4#	Tianwan NPP	326	2018
26	Interim spent fueldry storage facility	Tianwan NPP	132	2019
27	Spent fuel pool 1#	Hainan Changjiang NPP	317	2015
28	Spent fuel pool 2#	Hainan Changjiang NPP	317	2016
29	Spent fuel pool 1#	Hongyanhe NPP	554	2012
30	Spent fuel pool 2#	Hongyanhe NPP	554	2013
31	Spent fuel pool 3#	Hongyanhe NPP	554	2014
32	Spent fuel pool 4#	Hongyanhe NPP	554	2015

No.	Facility	Affiliation	Design Capacity (tHM)	Time put into operation
33	Spent fuel pool 1#	Ningde g NPP	554	2012
34	Spent fuel pool 2#	Ningde g NPP	554	2013
35	Spent fuel pool 3#	Ningde NPP	554	2014
36	Spent fuel pool 4#	Ningde NPP	554	2015
37	Spent fuel pool 1#	Yangjiang NPP	554	2013
38	Spent fuel pool 2#	Yangjiang NPP	554	2014
39	Spent fuel pool 3#	Yangjiang NPP	554	2015
40	Spent fuel pool 4#	Yangjiang NPP	554	2016
41	Spent fuel pool 5#	Yangjiang NPP	554	2017
42	Spent fuel pool 6#	Yangjiang NPP	554	2019
43	Spent fuel pool 1#	Fangchenggang NPP	554	2016
44	Spent fuel pool 2#	Fangchenggang NPP	554	2016
45	Spent fuel pool 1#	Haiyang NPP	474	2018
46	Spent fuel pool 2#	Haiyang NPP	474	2018
47	Spent fuel pool 1#	Taishan NPP	641	2018
48	Spent fuel pool 2#	Tiaishan NPP	641	2019
49	Spent fuel pool 1#	Sanmen NPP	386	2018
50	Spent fuel pool 2#	Sanmen NPP	386	2018

Note：As of December 31, 2019.

L.1.2 Spent Fuel Storage Facilities at Research Reactors

No.	Facility	Operator	Location
1	Spent fuel pool of CIAE	China Institute of Atomic Energy	Beijing
2	Spent fuel pool of Tsinghua University	Tsinghua University	Beijing
3	Spent fuel pool of NPIC	Nuclear Power Institute of China	Sichuan Province

Note：As of December 31, 2019.

L.2 Inventory of Spent Fuel

L.2.1 Inventory of Spent Fuel at NPPs

No.	Facility	NPP	Existing Fuel(tHM)
1	Spent fuel pool 1#	Qinshan NPP	130.0
2	Spent fuel pool 2#	Qinshan NPP	96.1
3	Spent fuel pool 1#	Fangjiashan NPP	110.3
4	Spent fuel pool 2#	Fangjiashan NPP	110.3

No.	Facility	NPP	Existing Fuel(tHM)
5	Spent fuel pool 1#	Qinshan NPP Phase II	235.7
6	Spent fuel pool 2#	Qinshan NPP Phase II	214.6
7	Spent fuel pool 3#	Qinshan NPP Phase II	128.7
8	Spent fuel pool 4#	Qinshan NPP Phase II	150.7
9	Spent fuel pool 1#	Qinshan NPP Phase III	644.7
10	Spent fuel pool 2#	Qinshan NPP Phase III	635.3
11	Interim spent fuel dry storage facility	Qinshan NPP Phase III	1959.7
12	Spent fuel pool 1#	Fuqing NPP	112.6
13	Spent fuel pool 2#	Fuqing NPP	79.0
14	Spent fuel pool 3#	Fuqing NPP	49.6
15	Spent fuel pool 4#	Fuqing NPP	47.8
16	Spent fuel pool 1#	Daya Bay NPP	308.8
17	Spent fuel pool 2#	Daya Bay NPP	259.2
18	Spent fuel pool 1#	Ling'ao NPP Phase I	371.3
19	Spent fuel pool 2#	Ling'ao NPP Phase I	348.3
20	Spent fuel pool 1#	Ling'ao NPP Phase II	238.9
21	Spent fuel pool 2#	Ling'ao NPP Phase II	268.3
22	Spent fuel pool 1#	Tianwan NPP	222.7
23	Spent fuel pool 2#	Tianwan NPP	200.0
24	Spent fuel pool 3#	Tianwan NPP	100.0
25	Spent fuel pool 4#	Tianwan NPP	24.4
26	Interim spent fuel dry storage facility	Tianwan NPP	26.7
27	Spent fuel pool 3#	Hainan Changjiang NPP	47.8
28	Spent fuel pool 4#	Hainan Changjiang NPP	33.1
29	Spent fuel pool 1#	Hongyanhe NPP	145.2
30	Spent fuel pool 2#	Hongyanhe NPP	99.3
31	Spent fuel pool 3#	Hongyanhe NPP	97.4
32	Spent fuel pool 4#	Hongyanhe NPP	47.8

No.	Facility	NPP	Existing Fuel(tHM)
33	Spent fuel pool 1#	Ningde g NPP	121.3
34	Spent fuel pool 2#	Ningde g NPP	115.8
35	Spent fuel pool 3#	Ningde NPP	91.9
36	Spent fuel pool 4#	Ningde NPP	64.3
37	Spent fuel pool 1#	Yangjiang NPP	128.7
38	Spent fuel pool 2#	Yangjiang NPP	93.7
39	Spent fuel pool 3#	Yangjiang NPP	66.2
40	Spent fuel pool 4#	Yangjiang NPP	60.7
41	Spent fuel pool 5#	Yangjiang NPP	31.2
42	Spent fuel pool 6#	Yangjiang NPP	0.0
43	Spent fuel pool 1#	Fangchenggang NPP	64.3
44	Spent fuel pool 2#	Fangchenggang NPP	64.3
45	Spent fuel pool 1#	Haiyang NPP	0.0
46	Spent fuel pool 2#	Haiyang NPP	0.0
47	Spent fuel pool 1#	Taishan NPP	0.0
48	Spent fuel pool 2#	Tiaishan NPP	0.0
49	Spent fuel pool 1#	Sanmen NPP	34.6
50	Spent fuel pool 2#	Sanmen NPP	0.0
Amount of wet storage at reactor			6494.9
Amount of interim dry storage facility			1986.4
Total			8481.3

Note：As of December 31, 2019.

L.2.2 Inventory of Spent Fuel at Research Reactors

No.	Facility	Operator	Existing Spent Fuel(tU)
1	Spent fuel pool of CIAE	China Institute of Atomic Energy	3.06 E-01
2	Spent fuel pool of Tsinghua University	Tsinghua University	0
3	Spent fuel pool of NPIC	Nuclear Power Institute of China	3.57 E-01

Note：As of December 31,2019.

L.3 List of Radioactive Waste Management Facilities

L.3.1 Radioactive Waste Treatment and Storage Facilities at NPPs

No.	Facility	Affiliation	Time put into operation
1	21# LILW storeroom	Qinshan NPP	1991
2	22# solidification workshop	Qinshan NPP	1991
3	24# solid waste storeroom	Qinshan NPP	1991
4	9 TES cementation system	Fangjiashan NPP	2014
5	Waste treatment auxiliary workshop (QS)	Fangjiashan NPP	2014
6	Waste storeroom (QT)	Fangjiashan NPP	2014
7	Radioactive oil temporary storeroom (QR)	Fangjiashan NPP	2014
8	9TES cementation system	Qinshan NPP Phase II	2002
9	8TES cementation system	Qinshan NPP Phase II	2002
10	Solid waste temporary storeroom (QT)	Qinshan NPP Phase II	2002
11	New solid waste temporary storeroom (5QT)	Qinshan NPP Phase II	2011
12	Radioactive oil temporary storeroom (5QT2)	Qinshan NPP Phase II	2002
13	Waste temporary storeroom	Qinshan NPP Phase III	2002
14	Solid waste temporary storeroom (QT)	Fuqing NPP	2014
15	Waste treatment auxiliary workshop (QS)	Fuqing NPP	2014
16	Radioactive oil temporary storeroom (QR)	Fuqing NPP	2014
17	Solid waste treatment system (TES)	Fuqing NPP	2014
18	11UKT technical waste storeroom	Tianwan NPP	2007
19	21UKT technical waste storeroom	Tianwan NPP	2007
20	91UKT cement solidified waste storeroom	Tianwan NPP	2007
21	31UKT radioactive waste storeroom	Tianwan NPP	2018
22	41UKT radioactive waste storeroom	Tianwan NPP	2018
23	T1UKT radioactive waste storeroom	Tianwan NPP	2018
24	T2UKT waste neutron flux and temperature measurement channel temporary storeroom	Tianwan NPP	2018
25	QT plant building	Tianwan NPP	Not in operation
26	QR plant building	Tianwan NPP	Not in operation
27	1# solid radioactive waste treatment system (1KPA)	Tianwan NPP	2007

No.	Facility	Affiliation	Time put into operation
28	2# solid radioactive waste treatment system (2KPA)	Tianwan NPP	2007
29	1# liquid radioactive waste cementation system (1KPC)	Tianwan NPP	2007
30	2# liquid radioactive waste cementation system (2KPC)	Tianwan NPP	2007
31	Degradable waste treatment system (2KPW)	Tianwan NPP	Not in operation
32	Radioactive waste treatment center (T4UKT)	Tianwan NPP	2018
33	Solid waste treatment system of Unit 5 and 6 (TES)	Tianwan NPP	Not in operation
34	Compaction and packing device of QS plant building	Changjiang NPP	2015
35	Temporary storeroom of solid radioactive waste in QT plant building	Changjiang NPP	2015
36	NX plant building (part of TES)	Changjiang NPP	2015
37	TES system (NX)	Daya Bay NPP	1994
38	TES system (DQS)	Daya Bay NPP	1994
39	Solid radioactive waste storeroom (DQT)	Daya Bay NPP	1994
40	TES system (NX)	Ling'ao NPP Phase I	2002
41	TES system (LQS)	Ling'ao NPP Phase I	2002
42	TES system (NX)	Ling'ao NPP Phase II	2013
43	Solid radioactive waste storeroom (KQT)	Ling'ao NPP Phase II	2011
44	TES solidified system of 8NX plant building	Hongyanhe NPP	2014
45	TES solidified system of 9NX plant building	Hongyanhe NPP	2012
46	HQS plant building	Hongyanhe NPP	2014
47	HQT plant building	Hongyanhe NPP	2014
48	Cement solidification facility (9TES1&9TES3)	Ningde NPP	2013
49	Cement solidification facility (8TES1&8TES3)	Ningde NPP	2014
50	Sorting and compression facility (0TES2) QS plant building	Ningde NPP	2013
51	Temporary storeroom (QT)	Ningde NPP	2013
52	Waste oil storeroom (QR)	Ningde NPP	2013
53	9TES system	Yangjiang NPP	2013
54	8TES system	Yangjiang NPP	2015
55	7TES system	Yangjiang NPP	2018

No.	Facility	Affiliation	Time put into operation
56	0QS plant building	Yangjiang NPP	2013
57	0QT plant building	Yangjiang NPP	2014
58	0QR plant building	Yangjiang NPP	2014
59	0QV plant building	Yangjiang NPP	2013
60	Radioactive waste treatment system TES (NX)	Fangchenggang NPP	2015
61	Radioactive waste treatment system TES (QS)	Fangchenggang NPP	2015
62	Solid radioactive waste storeroom (QT)	Fangchenggang NPP	2016
63	Site radioactive waste treatment facility (SRTF)	Haiyang NPP	2018
64	9HQS plant building (solid radioactive waste storeroom)	Taishan NPP	2018
65	9HQB plant building (solid radioactive waste storeroom)	Taishan NPP	2017
66	9HQR plant building (solid radioactive waste storeroom)	Taishan NPP	2018
67	9HQV plant building (solid radioactive waste storeroom)	Taishan NPP	2018
68	1/2HNX plant building (nuclear auxiliary building)	Taishan NPP	2017
69	Site radioactive waste treatment facility (SRTF)	Sanmen NPP	2018

Note：As of December 31, 2019.

L.3.2 Radioactive Waste Treatment and Storage Facilities at Research Reactors

No.	Facility	Operator
1	Liquid waste temporary storage room	CIAE
2	Liquid waste treatment system	CIAE
3	Solid waste temporary storage room	CIAE
4	Solid waste conditioning facility	CIAE
5	Liquid waste treatment system	Tsinghua University
6	Cement solidification system	Tsinghua University
7	Compressor	Tsinghua University
8	Temporary waste storeroom	Tsinghua University
9	Liquid waste treatment workshop	NPIC
10	Cement Solidification workshop	NPIC

No.	Facility	Operator
11	Temporary waste storeroom	NPIC
11-1	Temporary storage section	NPIC
11-2	Conditioning section	NPIC
11-3	Compressing section	NPIC

Note：As of December 31, 2019.

L.3.3 Radioactive Waste Treatment and Storage Facilities at Nuclear Fuel Cycle Facilities

No.	Facility	Operator
1	Liquid waste pool	Shaanxi Uranium Enrichment Plant
2	Liquid waste treatment facility	Shaanxi Uranium Enrichment Plant
3	Solid waste temporary storage room	Shaanxi Uranium Enrichment Plant
4	Ventilation system	Shaanxi Uranium Enrichment Plant
5	Liquid waste treatment facility	Gansu Uranium Enrichment Plant
6	Solid waste temporary storage room	Gansu Uranium Enrichment Plant
7	Ventilation system	Gansu Uranium Enrichment Plant
8	Liquid waste treatment facility	Northern China Nuclear Fuel Assembly Plant
9	Temporary storeroom for waste containing uranium	Northern China Nuclear Fuel Assembly Plant
10	Ventilation center	Northern China Nuclear Fuel Assembly Plant
11	Liquid waste treatment facility	China Jianzhong Nuclear Fuel Co., Ltd.
12	Bearing uranium waste temporary storeroom	China Jianzhong Nuclear Fuel Co., Ltd.
13	Waste treatment and conditioning facility	China Jianzhong Nuclear Fuel Co., Ltd.
14	Ventilation center	China Jianzhong Nuclear Fuel Co., Ltd.

Note：As of December 31, 2019.

L.3.4 Radioactive Waste Storage Facilities

No.	Facility	Location	Status
1	Low-level waste storage facility of Gansu Dongfang Ruilong Environmental Control Co., Ltd.	Gansu	in operation

Note：As of December 31, 2019.

L.3.5 Radioactive Waste Storage Facilities for the Application of Nuclear Technology

No.	Facility	Location	Design capacity (m^3)	Time put into operation
1	Anhui Radioactive Waste Storage Facility	Anhui	800	2007
2	Beijing Radioactive Waste Storage Facility	Beijing	2453	2009
3	Fujian Radioactive Waste Storage Facility	Fujian	600	2010
4	Gansu Radioactive Waste Storage Facility	Gansu	800	2009
5	Guangdong Radioactive Waste Storage Facility	Guangdong	600	2001
6	Guangxi Radioactive Waste Storage Facility	Guangxi	800	2013
7	Guizhou Radioactive Waste Storage Facility	Guizhou	600	2010
8	Hainan Radioactive Waste Storage Facility	Hainan	400	2010
9	Hebei Radioactive Waste Storage Facility	Hebei	800	2011
10	Henan Radioactive Waste Storage Facility	Henan	800	2008
11	Heilongjiang Radioactive Waste Storage Facility	Heilongjiang	800	2009
12	Hubei Radioactive Waste Storage Facility	Hubei	500	2000
13	Henna Radioactive Waste Storage Facility	Hunan	800	2003
14	Jilin Radioactive Waste Storage Facility	Jilin	1200	1998
15	Jiangsu Radioactive Waste Storage Facility	Jiangsu	1200	2010
16	Jiangxi Radioactive Waste Storage Facility	Jiangxi	600	2012
17	Liaoning Radioactive Waste Storage Facility	Liaoning	666	2012
18	Inner Mongolia Radioactive Waste Storage Facility	Inner Mongolia	800	2009
19	Ningxia Radioactive Waste Storage Facility	Ningxia	400	2009
20	Qinghai Radioactive Waste Storage Facility	Qinghai	400	2012
21	Shandong Radioactive Waste Storage Facility	Shandong	1650	2005
22	Shanxi Radioactive Waste Storage Facility	Shanxi	800	1990
23	Shaanxi Radioactive Waste Storage Facility	Shaanxi	800	2012
24	Shanghai Radioactive Waste Storage Facility	Shanghai	1785	1989

25	Sichuan Radioactive Waste Storage Facility	Sichuan	940	2016
26	Tianjin Radioactive Waste Storage Facility	Tianjin	800	2004
27	Tibet Radioactive Waste Storage Facility	Tibet	200	2010
28	Xinjiang Radioactive Waste Storage Facility	Xinjiang	600	2008
29	Yunnan Radioactive Waste Storage Facility	Yunnan	800	2010
30	Zhejiang Radioactive Waste Storage Facility	Zhejiang	800	2009
31	Chongqing Radioactive Waste Storage Facility	Chongqing	100	Renting
32	National Centralized Disused Sealed Sources Storage Facility	Gansu	2600	2007

Note：As of December 31, 2019.

L.3.6 Radioactive Waste Disposal Facilities

No.	Facility	Location	Status
1	Northwestern China LILW Disposal Site	Gansu	In operation
2	Guangdong Beilong LILW Disposal Site	Guangdong	In operation
3	Feifengshan LILW Disposal Site	Sichuan	In operation

Note：As of December 31, 2019.

L.4 Inventory of Radioactive Wastes

L.4.1 Inventory of Conditioned Radioactive Wastes in NPPs

(m^3)

No.	NPP Name	Radioactive Waste Volume					
		Concentration	Spent ion exchange resin	Sludge	Water filter	Technical waste	Total
1	Qinshan NPP	1371.6	0.0	0.0	99.4	778.9	2249.9
2	Qinshan NPP Phase II	394.4	466.8	0.0	128.9	2342.0	3332.1
3	Qinshan I NPPPhase II	0.0	0.0	0.0	0.0	0.0	0.0
4	Daya Bay NPP	108.0	370.0	14.0	83.7	1441.8	2017.5
5	Ling'ao NPP Phase I	106.0	416.0	4.0	138.1	618.6	1282.7
6	Ling'ao NPPPhase II	70.4	122.8	0.0	38.4	346.0	577.6
7	Tianwan NPP	475.4	1086.4	0.0	0.0	653.6	2215.4
8	Hongyanhe NPP	24.8	97.2	0.0	73.2	726.0	921.2
9	Ningde NPP	67.2	90.8	0.0	66.4	426.0	650.4

No.	NPP Name	Radioactive Waste Volume					
		Concentration	Spent ion exchange resin	Sludge	Water filter	Technical waste	Total
10	Yangjiang NPP	72.8	69.6	0.0	27.4	65.2	235.0
11	Fuqing NPP	102.4	77.2	8.8	0.0	457.6	646
12	Fangjiashan NPP	66.4	33.6	0.0	17.4	206.6	324
13	Changjiang NPP	36.0	20.8	0.0	2.0	112.0	170.8
14	Fangchenggang NPP	8.0	40.4	0.0	14.8	2.4	65.6
15	Haiyang NPP	0.0	0.0	0.0	0.0	1.0	1.0
16	Taishan NPP	0.0	0.0	0.0	0.0	0.0	0.0
17	Sanmen NPP	0.0	0.0	0.0	0.1	0.0	0.1
Total		2903.4	2891.6	26.8	689.8	8177.7	14689.3

Note：As of December 31, 2019.

L.4.2 Inventory of Conditioned Radioactive Wastes in Research Reactors and Nuclear Fuel Cycle Facilities

(m^3)

No.	Type	Radioactive Waste Volume				
		Intermediate level liquid waste	Intermediate level solid waste	Low level liquid waste	Low level solid waste	Total
		Waste Package	Waste Package	Waste Package	Waste Package	Waste Package
1	Research Reactors	0.0	16.6	365.0	4297.2	4678.8
2	Uranium Enrichment Facilities	0.0	0.0	0.0	35.0	35.0
3	Fuel Fabrication Facilities	0.0	0.0	0.0	112.1	112.1
Total		0.0	16.6	365.0	4444.3	4825.9

Note：As of December 31, 2019.

L.4.3 Inventory of Disused Sealed Sources in Nuclear Technology Application Radioactive Waste Temporary Storage Facilities

No.	Province	Disused Radioactive Source
1	Anhui	1691
2	Beijing	9700
3	Fujian	1053
4	Gansu	1572

No.	Province	Disused Radioactive Source
5	Guangdong	8935
6	Guangxi	992
7	Guizhou	1083
8	Hainan	304
9	Hebei	1338
10	Henan	3794
11	Heilongjiang	1557
12	Hubei	1579
13	Hunan	1739
14	Jilin	1205
15	Jiangsu	2969
16	Jiangxi	905
17	Liaoning	1630
18	Inner Mongolia	2444
19	Ningxia	428
20	Qinghai	271
21	Shandong	3113
22	Shanxi	2103
23	Shaanxi	1264
24	Shanghai	1618
25	Sichuan	1607
26	Tianjin	1207
27	Tibet	0
28	Xinjiang	344
29	Yunnan	1621
30	Zhejiang	3399
31	Chongqing	109
32	National centralized temporary storage facility for disused sealed sources	105248
Total		166822

Note：As of December 31, 2019.

L.4.4 Inventory of Waste Received by Disposal Sites

No.	Disposal Site	Waste Received (m^3)	Total Activity (Bq)
1	Northwest LILW Disposal Site	22422.47	6.38 E+14
2	Guangdong Beilong LILW Disposal Site	2526.44	7.95E+13
3	Feifengshan LILW Disposal Site	19767.92	1.31 E+15
Total		44716.83	2.03 E+15

Note：As of December 31, 2019.

L.4.5 Inventory of Waste Received by Storage Facilities

No.	Storage Facility	Waste Received (m^3)	Total Activity (Bq)
1	Low-level waste storage facility of Gansu Dongfang Ruilong Environmental Control Co., Ltd.	208	2.78 E+10

Note：As of December 31, 2019.

L.5 Relevant Laws, Regulations, Rules, Guidelines and Standards

L.5.1 Relevant Laws

Title	Issued by	Entry into force
The Law of the People's Republic of China on Environmental Protection	The Standing Committee of the National People's Congress	Revised, 2015
The Law of the People's Republic of China on Prevention and Control of Water Pollution	The Standing Committee of the National People's Congress	Revised, 2017
The Law of the People's Republic of China on Prevention and Control of Air Pollution	The Standing Committee of the National People's Congress	Revised, 2018
The Law of the People's Republic of China on Marine Environment Protection	The Standing Committee of the National People's Congress	Revised, 2017
The Law of the People's Republic of China on Safety of Operation	The Standing Committee of the National People's Congress	Revised, 2014
The Law of the People's Republic of China on Environmental Impact Assessment	The Standing Committee of the National People's Congress	Revised, 2018
The Law of the People's Republic of China on Prevention and Control of Radioactive Pollution	The Standing Committee of the National People's Congress	2003
The Law of the People's Republic of China on Prevention and Control of Solid Waste Pollution	The Standing Committee of the National People's Congress	Revised, 2016

Title	Issued by	Entry into force
The Law of the People's Republic of China on Prevention and Control of Occupational Disease	The Standing Committee of the National People's Congress	Revised, 2018
The Law of the People's Republic of China on Nuclear Safety	The Standing Committee of the National People's Congress	2018

L.5.2 Relevant Administrative Regulations

Title	Issued by	Entry into force
Regulations of the People's Republic of China on the Safety Supervision and Management of Civilian Nuclear Installations, HAF001	The State Council	1986
Regulations of the People's Republic of China on Nuclear Material Control	The State Council	1987
Regulations of the People's Republic of China on Emergency Management of Nuclear Accident at Nuclear Power Plants	The State Council	1993
Regulations of the People's Republic of China on Nuclear Export Control	The State Council	Revised, 2006
Regulations of the People's Republic of China on Control of Nuclear Dual-use Items and Related Technologies Export	The State Council	Revised, 2007
Regulations on Safety and Protection of Radioisotope and Ray-emitting Devices	The State Council	Revised, 2019
Regulations on the Supervision and Management of Civilian Nuclear Safety Equipment	The State Council	2008
Regulations on the Safe Transportation of Radioactive Materials	The State Council	2010
Regulations on the Safe Management of Dangerous Chemical Materials	The State Council	Revised, 2013
Regulations on the Safety of Radioactive Waste Management	The State Council	2012

L.5.3 Relevant Rules and Provisions

Title	Issued by	Entry into force
1 Generic Series		
Annex 1 of the detailed rules (i) of the People's Republic of China on regulating civilian nuclear facility safety - granting and management procedures of NPP operator license	NNSA	1993
Detailed rules (ii) of the People's Republic of China on regulation of civilian nuclear facility safety – regulation of nuclear facility safety	NNSA	1995
Annex 1 of the detailed rules (ii) of the People's Republic of China on regulation of civilian nuclear facility safety – reporting system of NPP operators	NNSA	1995

Title	Issued by	Entry into force
Annex 2 of the detailed rules (ii) of the People's Republic of China on regulation of civilian nuclear facility safety – reporting system of research reactor operators	NNSA	1995
Annex 3 of the detailed rules (ii) of the People's Republic of China on regulation of civilian nuclear facility safety – reporting system of nuclear fuel cycle facilities	NNSA	1995
Detailed rules (i) for regulations on NPP accident emergency management – emergency preparedness and response of NPP operators	NNSA	1998
Regulations on NPP quality assurance safety	NNSA	1991
Temporary regulations on road transport of NPP spent fuel	CAEA, MPS, MOT and MOH	2003
Regulatory procedures on transfer and transboundary movement of nuclear products (trial)	NNSA	2000
Certificate management methods for regulatory inspection staff of nuclear and radiation safety	MEP/NNSA	2014
Safety licensing procedures for nuclear power plants, research reactors and nuclear fuel cycle facilities	MEE	2019
2 Nuclear Power Plant Series		
Regulations on Nuclear Power Plant siting safety, HAF 101	NNSA	1991
Regulations on Nuclear Power Plant design safety	NNSA	Revised, 2016
Regulations on NPP operation safety, HAF103	NNSA	2004
Annex 1 of the regulations on NPP operation safety – management of NPP during refueling, modification, and accidental shutdown	NNSA	1994
Methods for management of experience feedback at operational nuclear power plants	NNSA	2012
General Technical Requirements for Modification Action of Nuclear Power Plants after Fukushima Daiichi Nuclear Power Station Accident (trial)	NNSA	2012
3 Research Reactor Series		
Regulations on research reactor design safety	NNSA	1995
Regulations on research reactor operation safety	NNSA	1995
4 Nuclear Fuel Cycle Installation Series		
Regulations on civilian nuclear fuel cycle safety	NNSA	1993
5 Spent Fuel and Radioactive Waste Management Series		
Assumptions on the potential accident at spent fuel reprocessing plant	NNSA	1995
Design safety guidelines on spent fuel reprocessing plant	NNSA	1995
Regulations on radioactive waste safety	NNSA	1997

Title	Issued by	Entry into force
Rules for categorization of radioactive sources	SEPA	2005
Technical requirements on siting, design and construction of nuclear technology application radioactive waste storage facility (Trial)	SEPA	2004
Provisions on decommissioning management of nuclear facilities and radioactive waste	CAEA	2010
Interim procedures on collection, utilization and management of the funds for treatment and disposal of spent fuel from nuclear power plants	MOF, NDRC, CAEA	2010
Projects management methods of the funds for treatment and disposal of spent fuel from nuclear power plants	CAEA	2014
Management measures for the licensing of solid radioactive waste storage and disposal	MEP	2014
Classification of radioactive wastes	MEE, MIIT, CAEA	2018
6 Emergency Series		
Regulations on transboundary emergency management for radiation impacts of nuclear accident	CAEA	2002
Intervention principles and levels for the public protection in an event of a nuclear emergency	NNSA, SEPA	1991
Derived intervention levels for the public protection in the event of a nuclear emergency	NNSA, SEPA	1991
Emergency preparedness and response for radioactive sources and radiation technology applications	CAEA, MOH	2003
Regulations on management of special revenue for NPP accident emergency preparedness	MOF, CAEA	2007
Decision-making on protection measures and rehabilitation against serious accident in later stage	CAEA	2000
Emergency preparedness and response on radioactive materials transport accident	CAEA	2000
Regulations on the management of nuclear emergency exercises	NNAECC	2015
Management methods on nuclear emergency training	NNAECC	2015
Management Methods for Nuclear Accident Information Release	NNAECC	2015
Management methods for national nuclear emergency on-shift network operation	NNAERO	2015
Management methods on nuclear accident emergency reporting	NNAECC	2016
Management methods on national nuclear emergency technical support center and rescue team	NNAECC	2016
Code of building national radiation monitoring technical support team for on-site nuclear emergency rescue	NNAECC	2016
Code of national air radiation monitoring team for nuclear emergency rescue	NNAECC	2016
Code of building national maritime radiation monitoring technical support center for nuclear emergency and national maritime radiation monitoring team for nuclear emergency rescue	NNAECC	2016

Title	Issued by	Entry into force
Code of building national radiation protection technical support team for on-site nuclear emergency rescue	NNAECC	2016
Code of building national medical rescue team for nuclear emergency	NNAECC	2016
Summarized Principles on Developing Nuclear Emergency Assistance Program	NNAERO	2016
7 Nuclear Series		
Detailed rules for the regulations of the People's Republic of China on regulating nuclear materials	NNSA, NEA, CAEA	1990
8 Civilian Nuclear Safety Equipment Regulatory Management Series		
Regulations on oversight of design, manufacture, installation and non-destructive detection of civilian nuclear safety equipment	SEPA	2007
Regulations on qualification management of non-destructive detection staff of civilian nuclear safety equipment	SEPA	2007
Regulations on qualification management of welding workers of civilian nuclear safety equipment	SEPA	2007
Regulatory provisions on import of civil nuclear safety equipment	SEPA	2008
9 Radioactive article transportation management series		
Management methods for licensing radioactive article transportation safety	MEE	Revised, 2019
Management methods for oversight of radioactive article transportation safety	MEP	2016
10 Radioisotopes and Ray-emitting Devices Regulatory Series		
Measures for the Management of Safety Licensing of Radioisotope and Radiation Devices	MEE	Revised, 2019
Management measures on safety and protection against radioisotope and ray-emitting devices	MEP	2011
11 Others		
Regulations on management of special revenue for NPP accident emergency Preparedness	MOH	2007
Measures for public participation in environmental protection	MEP	2015
Measures for public participation in environmental impact assessment	MEE	2019

L.5.4 Relevant Guidelines

Title	Issued by	Entry into force
1 Generic Series		
Emergency preparedness and response for nuclear power plant, HAD 002/01	NNSA	Revised, 2019
Emergency preparedness by local government for nuclear power plant, HAD 002/02	NNSA, SEPA, MOH	1990

Title	Issued by	Entry into force
Intervention principle and level for the public radiation protection in an event of nuclear emergency, HAD 002/03	NNSA,SEPA	1991
Derived intervention principle for the public radiation protection in an event of nuclear emergency, HAD 002/04	NNSA,SEPA	1991
Medical emergency preparedness and response in an event of nuclear accident, HAD 002/05	NNSA, MOH	1992
Emergency preparedness and response by research reactor operators, HAD 002/06	NNSA	Revised, 2019
Emergency planning for operators of civilian nuclear facilities, HAD 002/07	NNSA	Revised, 2019
Quality assurance program for NPPs, HAD003/01	NNSA	1988
Quality assurance organization of NPPs, HAD003/02	NNSA	1989
Quality assurance for items serve and procurement for NPPs, HAD003/03	NNSA	1986
Quality assurance record system for NPPs, HAD003/04	NNSA	1986
Oversight and inspection of quality assurance for NPPs,HAD003/05	NNSA	1988
Quality assurance for design of NPPs, HAD003/06	NNSA	1986
Quality assurance during construction of NPPs, HAD003/07	NNSA	1987
Quality assurance during items manufacture for NPPs,HAD003/08	NNSA	1986
Quality assurance during commissioning and operation of NPPs, HAD003/09	NNSA	1988
Quality assurance during procurement, design and construction of nuclear fuel elements, HAD003/10	NNSA	1989
2 Nuclear Power Plant Series		
Seismic issues in design of siting NPPs, HAD101/01	NNSA, NEA	1994
Atmospheric dispersion problems in siting NPPs, HAD101/02	NNSA	1987
Population distribution problems in siting and assessment of NPPs, HAD101/03	NNSA	1987
External human-made event in siting NPPs, HAD101/04	NNSA	1989
Hydrological dispersion problems of radioactive materials in siting NPPs, HAD101/05	NNSA	1991
Relevance of NPPs siting to hydrology, HAD101/06	NNSA	1991
Site survey of NPPS, HAD101/07	NNSA	1989
Determination of design basis flooding for costal NPP site, HAD101/08	NNSA	1989
Determination of design basis flooding for costal NPP site,	NNSA	1990

Title	Issued by	Entry into force
HAD101/09		
Extreme meteorological event related to NPP siting, HAD101/10	NNSA	1991
Design basis tropical cyclone for NPPs, HAD101/11	NNSA	1991
Issues relating to safety of NPP base, HAD101/12	NNSA	1990
Safety principle of NPPs design, HAD102/01	NNSA	1989
Design and evaluation of anti-earthquake design for NPPs, HAD102/02	NNSA	1996
Safety function and graded components for BWRs, PWRs and pressurized tube reactors, HAD102/03	NNSA	1986
Flying object and secondary effect protection inside NPPs, HAD102/04	NNSA	1986
External human-made event relating to design of NPPs, HAD102/05	NNSA	1989
Design of NPP reactor containment system, HAD102/06	NNSA	1990
Design of NPP reactor core safety, HAD102/07	NNSA	1989
NPP reactor cooling system and related systems, HAD102/08	NNSA	1989
Final heal well of NPPs and directly related heat conduction system, HAD102/09	NNSA	1987
NPP protection system and related facilities, HAD102/10	NNSA	1988
Fire protection at NPPs, HAD102/11	NNSA	1996
Radiation protection design for NPPs, HAD102/12	NNSA	1990
NPP emergency power system, HAD102/13	NNSA	1996
NPP safety related instrument and control system, HAD102/14	NNSA	1988
Design of handling and storage system at NPPs, HAD102/15	NNSA	2007
Computer-based system software of safety significance for nuclear power plant, HAD102/16	NNSA	2004
Safety analysis and verification for nuclear power plant, HAD102/17	NNSA	2006
OL&C and operational procedure for nuclear power plant, HAD103/01	NNSA	2005
NPP commissioning procedures, HAD103/02	NNSA	1987
Management of core and fuel at NPPs, HAD103/03	NNSA	1989
Radiation protection during operation of NPP, HAD103/04	NNSA	1990
Staffing, recruitment, training and delegation at NPPs, HAD103/05	NNSA	2013

Title	Issued by	Entry into force
Organization and operational management of operators of NPPs, HAD103/06	NNSA	2006
In-commissioning examination of NPPs, HAD103/07	NNSA	1988
Repair and maintenance of NPPs, HAD103/08	NNSA	1993
Oversight of important safety items at NPPs, HAD103/09	NNSA	1993
Fire protection for NPPs, HAD103/10	NNSA	2005
Periodic safety review for NPPs, HAD103/11	NNSA	2006
Aging management for NPPs, HAD103/12	NNSA	2012
3 Research Reactor Series		
Format and contents of research reactor safety analysis report, HAD201/01	NNSA	1996
Research reactor operation management, HAD202/01	NNSA	1989
Management of criticality installation operation and experiment, HAD202/02	NNSA	1989
Regular safety review of research reactors, HAD202/02	MEP/NNSA	2017
Application and modification of research reactor, HAD202/03	NNSA	1996
Safety management of research reactors after long-term shutdown, HAD202/03	MEP/NNSA	2017
Decommissioning of research reactor and criticality installation, HAD202/04	NNSA	1992
Commissioning of research reactor, HAD202/05	NNSA	2010
Research reactor maintenance, regular testing and inspection, HAD202/06	NNSA	2010
Core management and fuel handling for research reactors, HAD202/07	NNSA	2012
4 Nuclear Fuel Cycle Installation Series		
Format and content of safety analysis report of uranium fuel fabrication installation, HAD301/01	NNSA	1991
Design of spent fuel storage installation, HAD301/02	NNSA	1998
Operation of spent fuel storage installation, HAD301/03	NNSA	1998
Safety assessment of spent fuel storage installation, HAD301/04	NNSA	1998
5 Radioactive Waste Management Series		
Management of radioactive effluents and waste arising from nuclear power plant, HAD401/01	NNSA	1990
Design of radioactive waste management system for nuclear power plant, HAD401/02	NNSA	1997

Title	Issued by	Entry into force
Design and operation of radioactive waste incineration installation, HAD401/03	NNSA	1997
Siting of radioactive waste near-surface disposal facility, HAD401/05	NNSA	1998
Siting of high level radioactive waste geological facility, HAD401/06	NNSA	2013
Decommissioning of gamma-ray irradiation installations, HAD401/07	NNSA	2013
Radioactive Waste Minimization at Nuclear Facilities HAD401/08	NNSA	2016
Monitoring and inspection of radioactive waste disposal facilities, HAD401/09	MEE/NNSA	2019
6 Nuclear Materials Regulation Series		
Nuclear fuel balance budget for low enriched uranium conversion and element fabrication plant, HAD501/01	NNSA	2008
Physical protection for nuclear installations, HAD501/02	MEE/NNSA	2018
Alarming system against intrusion to nuclear facility, HAD501/03	NNSA	2005
Access control of nuclear facility, HAD501/04	NNSA	2008
Physical protection of nuclear materials transportation, HAD501/05	NNSA	2008
Format and content of safety analysis report of physical protection and nuclear materials accountancy and control, HAD501/06	NNSA	2008
Nuclear materials accountability for nuclear power plant, HAD501/07	NNSA	2008
7 Civilian Nuclear Safety Equipment Regulatory Management Series		
Civilian Nuclear safety simulated machinery and equipment parts production（trial）, HAD601/01	NNSA	2013
Technical requirements on civilian nuclear safety equipment installation and license applicant（trial）, HAD601/02-2013	NNSA	2013
8 Radioactive Article Transport Management Series		
Standard format and content of safety assessment (analysis) report of radioactive article transportation container design, HAD701/01	NNSA	2010
Standard format and content of nuclear and radiation safety analysis report of radioactive article transportation, HAD701/02	NNSA	2014
9 Supervision and management of radioisotopes and radiation devices series		

Title	Issued by	Entry into force
Requirements for the safety protection system of urban radioactive waste temporary storage facilities, HAD802/01	MEP/NNSA	2017

L.5.5 Relevant Standards

Title	Issued by	Entry into force
1 Generic Series		
Basic standards for protection against ionizing radiation and for the safety of radiation sources, GB18871-2002	AQSIQ	2002
Regulation of radiation protection for handling non-sealed radioactive material, GB 11930-2010	AQSIQ, SAC	2011
Glossary of nuclear science and technology terms—Part 3:Nuclear fuel and nuclear fuel cycle, GB/T 4960.3-2010	AQSIQ, SAC	2011
Glossary of terms: Nuclear science and technology -Radiation protection and safety of radiation sources, GB/T 4960.5-1996	NTSB	1996
Glossary of nuclear science and technology terms—Part 7:Nuclear materials control and safeguards, GB/T 4960.7-2010	AQSIQ, SAC	2011
Glossary of term: nuclear science and technology - Part 8: Radioactive waste management, GB/T 4960.8-2008	AQSIQ, SAC	2008
Regulations for the safe transport of radioactive material, GB 11806-2019	MEE, SAMR	2019
Quality assurance for packaging used in transport of radioactive material, GB/T 15219-2009	AQSIQ, SAC	2009
Activity Concentration of Radionuclides in Materials Exempted from Radiation Protection, GB 27742-2011	AQSIQ, SAC	2012
2 Nuclear Power Plant Series		
Regulations for environmental radiation protection of nuclear power plant, GB 6249-2011	MEP,AQSIQ	2011
Safety design rule for spent fuel dissolving system of nuclear fuel reprocessing plant, EJ/T 1142-2002	CAEA	2003
Design criteria for pressurized water reactor spent fuel storage facilities at nuclear power plant, EJ/T883-2006	CAEA	2007
Design criteria for spent fuel storage pool away from reactor, EJ/T878-2011	CAEA	2011
3 Radioactive waste Management Series		
3.1 Fundamental Document		
Regulations for radioactive waste management, GB 14500-2002	AQSIQ	2003
3.2 Generation, Pre-treatment, Treatment and Discharge		
Authorized limits for normalized releases of radioactive effluents from nuclear fuel cycle, GB 13695-1992	NTSB	1993
The general regulation for environmental radiological assessment, GB 11215-1989	SEPA	1990
General requirements of quality assurance program for effluent and environmental radioactivity monitoring at nuclear	SEPA	1990

Title	Issued by	Entry into force
facilities, GB 11216-1989		
Graphical signs for environmental protection--Discharge outlet(source), GB 155621.1-1995	SEPA	1997
Radiological protection management for medical radioactive waste, GBZ 133-2009	MOH	2009
Radioactive source term of PWR nuclear power plant for operational states, GB/T 13976-2008	AQSIQ, SAC	2009
Decontamination of radioactively contaminated surfaces - Part 1: Method for testing and assessing the ease of decontamination, GB/T 14057.1-2008	AQSIQ, SAC	2009
Decontamination of radioactively contaminated surface—Part 2:Testing method of decontamination agents for textiles, GB/T 14057.2-2011	AQSIQ, SAC	2011
Characterization of radioactive waste forms and packages, EJ 1186-2005	COSTIND	2005
Technical regulations on LILW volume reduction system, EJ/T 795-1993	CNNC	1994
3.3 Waste Conditioning		
Standard test method for leachability of low and intermediate level solidified radioactive waste forms, GB/T 7023-2011	AQSIQ, SAC	2012
Standard of safety for low- and intermediate-level solid radioactive wastes packages, GB 12711-2018	MEE, SAMR	2018
Performance requirements for low and intermediate level radioactive waste form-Cemented waste form, GB 14569.1-2011	MEP, AQSIQ	2011
Characteristic requirements for solidified waste of low-and intermediate-level radioactive waste--Bitumen solidified waste, GB 14569.3-1995	NTSB	1996
High integrity container of low- and intermediate-level radioactive waste — ductile iron container, GB 36900.1-2018	MEE, SAMR	2019
High integrity container of low- and intermediate-level radioactive waste — concrete container, GB 36900.2-2018	MEE, SAMR	2019
High integrity container of low- and intermediate-level radioactive waste — cross-linked high-density polyethylene container, GB 36900.3-2018	MEE, SAMR	2019
Packaging container for low - and intermediate - level radioactive solid wastes steel drum, EJ 1042-2014	COSTIND	2014
Container for low-and intermediate - level radioactive solid wastes Steel box, EJ 1076-2014	COSTIND	2014
Concrete container for low-and intermediate-level radioactive solid wastes, EJ/T 914-2000	COSTIND	2000
3.4 Waste Storage		
Regulations for interim storage of low-and intermediate-level radioactive solid wastes, GB 11928-1989	NTSB	1990
Regulations for designing storage building of high level radioactive liquid waste, GB 11929-2011	AQSIQ, SAC	2012
Technical rules for interim storage of low and inter-mediate level solid radioactive waste from nuclear power plant, GB	NTSB	1993

Title	Issued by	Entry into force
14589-1993		
Requirements on safety analysis report for solid LILW interim storage, EJ/T 532-1990	CNNC	1990
3.5 Waste Disposal		
Safety provisions for near-surface disposal of solid low and intermediate-level radioactive wastes, GB9132-2018	MEE, SAMR	2019
Regulations for disposal of solid low-and intermediate level radioactive wastes in rock cavities, GB 13600-1992	NTSB	1993
Graphical signs for environmental protection solid waste storage (disposal) site, GB 15562.2-1995	SEPA	1995
General requirements for environmental radiation monitoring of near-surface disposal sites for low- and intermediate-level radioactive wastes, GB/ T 15950-1995	SEPA, NTSB	1996
Regulations for design of near-surface disposal facilities for low- and intermediate-level radioactive wastes - disposal in rock caverns, EJ/T 1109.1-2000	COSTIND	2000
Regulations for design of near-surface disposal facilities for low- and intermediate-level radioactive wastes - disposal except in rock caverns, EJ/T 1109.2-2000	COSTIND	2002
Environmental protection regulation guidelines for nuclear facilities. Standard format and content of environmental impact reports for shallow ground disposal of solid radioactive waste, HJ/T 5.2-1993	SEPA	1993
Siting of near surface disposal facilities of low-and intermediate-level radioactive wastes, HJ/T 23-1998	SEPA	1998
Landfill disposal for very low level radioactive waste, GB/T 28178-2011	AQSIQ, SAC	2012
Activity measurements of solid materials considered for recycling re-use, or disposal as non-radioactive waste, GB/T 17947-2008	AQSIQ, SAC	2009
3.6 Nuclear Facility Decommissioning and Environmental Reclamation		
Technical regulations for environmental management of reactor decommissioning, GB 14588-2009	AQSIQ	2009
Clearance Levels for Recycling and Reuse of Steel, Aluminum, Nickel and Copper from Nuclear facilities, GB 17567-2009	AQSIQ, SAC	2009
Safety requirements for decommissioning of nuclear facilities, GB/T 19597-2004	AQSIQ, SAC	2005
Provisions of decommissioning nuclear fuel reprocessing radiation protection, EJ 588-1991	CNNC	1992
Technical guidelines on decontamination during reactor decommissioning, EJ/T 941-1995	CNNC	1995
Standard format and content for the decommissioning environmental impact report of uranium processing and fuel fabrication facilities, EJ/T 1037-1996	CNNC	1997
Interim regulation for acceptable levels of residual radionuclides in soil of site considered for release, HJ 53-2000	SEPA	2000

Title	Issued by	Entry into force
3.7 Management of Radioactive waste from Uranium Mining and Milling		
Regulations for safe management of radioactive wastes from the mining and milling of uranium and thorium ores, GB 14585-1993	SEPA, NTSB	1994
Technical regulations of the environmental management of decommissioning of uranium mining and milling facilities, GB 14586-1993	SEPA, NTSB	1994
Regulation for radiation environmental monitoring in uranium mine and mill, GB 23726-2009	MEP, AQSIQ	2010
Regulations for radiation and environment protection in uranium mining and milling, GB 23727-2009	AQSIQ, SAC	2010
Regulation for radiation environmental impact assessment in uranium mine and mill, GB/T 23728-2009	MEP, AQSIQ	2009
Regulations on radiation protection technique for uranium heap leaching and in-suit leach mining, EJ 1007-1996	CNNC	1996
Regulations for uranium mine and processing plant site selection, EJ/T 1171-2004	CAEA	2004

L.6 NPP Occupational Exposure

NPP name \ Item Unit / Year		Annual average individual effective dose (mSv)	Annual maximum individual effective dose (mSv)	Annual collective effective dose (Man.Sv)	Normalized collective effective dose (man·mSv/GWh)
Qinshan NPP	2017	2.90E-02	2.14E+00	4.20E-02	1.50E-02
	2018	2.72E-01	5.69E+00	7.64E-01	4.70E-01
	2019	1.42E-01	4.25E+00	3.17E-01	1.21E-01
Daya Bay NPP	2017	2.42E-01	6.76E+00	7.12E-01	4.33E-02
	2018	2.60E-01	5.11E+00	7.53E-01	4.57E-02
	2019	2.99E-01	9.14E+00	9.60E-01	5.93E-02
Qinshan NPP Phase II	2017	2.51E-01	7.64E+00	9.41E-01	4.70E-02
	2018	2.95E-01	9.73E+00	1.15E+00	5.50E-02
	2019	3.02E-01	7.00E+00	1.10E+00	5.20E-02
Ling'ao NPP Phase I	2017	3.01E-01	6.61E+00	9.17E-01	5.95E-02
	2018	5.17E-01	1.03E+01	1.62E+00	1.09E-01
	2019	4.25E-01	6.94E+00	1.31E+00	8.73E-02
Ling'ao NPP Phase II	2017	3.32E-01	7.67E+00	1.20E+00	7.42E-02
	2018	2.23E-01	5.25E+00	6.28E-01	3.67E-02

NPP name \ Item Unit / Year		Annual average individual effective dose (mSv)	Annual maximum individual effective dose (mSv)	Annual collective effective dose (Man.Sv)	Normalized collective effective dose (man·mSv/GWh)
	2019	2.98E-01	5.81E+00	8.26E-01	5.01E-02
Qinshan NPP Phase III	2017	3.03E-01	6.03E+00	7.02E-01	6.40E-02
	2018	3.55E-01	6.80E+00	8.55E-01	7.60E-02
	2019	2.79E-01	6.32E+00	6.87E-01	5.90E-02
Tianwan NPP	2017	1.26E-01	2.14E+00	3.26E-01	1.89E-05
	2018	1.07E-01	3.07E+00	6.00E-01	2.60E-05
	2019	2.49E-01	5.32E+00	1.26E+00	3.83E-05
Hongyanhe NPP	2017	4.86E-01	7.80E+00	1.70E+00	7.20E-02
	2018	4.36E-01	7.60E+00	1.53E+00	5.10E-02
	2019	5.63E-01	8.79E+00	2.14E+00	6.90E-02
Ningde NPP	2017	5.14E-01	8.62E+00	1.97E+00	6.40E-02
	2018	3.69E-01	8.00E+00	1.45E+00	4.30E-02
	2019	4.20E-01	8.74E+00	1.48E+00	4.70E-02
Yangjiang NPP	2017	2.57E-01	7.89E+00	9.76E-01	3.26E-05
	2018	2.65E-01	8.11E+00	1.47E+00	4.19E-05
	2019	5.07E-01	1.18E+01	2.57E+00	5.84E-05
Fangjiashan NPP	2017	3.52E-01	8.50E+00	1.17E+00	7.30E-02
	2018	3.40E-02	9.84E-01	7.40E-02	4.00E-03
	2019	2.79E-01	6.02E+00	8.36E-01	4.90E-02
Fuqing NPP	2017	3.62E-01	8.01E+00	1.60E+00	6.40E-02
	2018	3.69E-01	1.00E+01	1.78E+00	5.80E-02
	2019	2.04E-01	6.61E+00	7.71E-01	2.80E-02
Changjiang NPP	2017	3.19E-01	5.89E+00	8.49E-01	1.14E-04
	2018	2.23E-01	4.34E+00	5.55E-01	7.19E-05
	2019	1.67E-01	5.92E+00	3.82E-01	3.93E-05
Fangchenggang NPP	2017	4.31E-01	8.03E+00	1.38E+00	1.09E-04
	2018	1.35E-01	3.59E+00	2.98E-01	1.90E-05
	2019	2.45E-01	4.10E+00	4.93E-01	2.90E-05
Taishan NPP	2017	—	—	—	—
	2018	6.80E-03	2.88E-01	1.40E-02	4.00E-03
	2019	1.41E-02	1.01E+00	5.43E-02	2.94E-03
Haiyang NPP	2017	—	—	—	—
	2018	3.30E-03	2.32E-01	8.05E-03	2.08E-06

NPP name \ Item Unit / Year		Annual average individual effective dose (mSv)	Annual maximum individual effective dose (mSv)	Annual collective effective dose (Man.Sv)	Normalized collective effective dose (man·mSv/GWh)
	2019	7.80E-03	6.12E-01	1.03E-02	4.95E-04
Sanmen NPP	2017	1.00E-03	2.30E-02	4.63E-04	—
	2018	5.00E-03	2.46E-01	9.04E-03	1.40E-04
	2019	1.22E-01	3.45E+00	3.98E-01	3.70E-05

L.7 NPP Radioactive Effluents

Percent of Radioactive Effluents to the Discharge Limits (%)

(From 2017 to 2019)

NPP name \ Category / Year		Gaseous Effluents			Liquid Effluents	
		Noble gas	Halogen	Aerosol	Tritium	Other Nuclides
Qinshan NNP	2017	0.026	0.002	0.001	0.764	0.112
	2018	0.031	0.003	0.001	0.602	0.098
	2019	0.012	0.003	0.001	0.000	0.165
Daya Bay NNP	2017	0.156	0.035	0.113	18.178	0.170
	2018	0.161	0.048	0.105	17.422	0.139
	2019	0.171	0.036	0.099	17.689	0.092
Qinshan NNP Phase II	2017	0.027	0.009	0.007	8.296	0.256
	2018	0.027	0.013	0.006	10.995	0.195
	2019	0.024	0.007	0.005	9.938	0.282
Ling’ao NNP Phase I	2017	0.171	0.088	0.123	21.289	0.141
	2018	0.166	0.031	0.131	14.800	0.100
	2019	0.149	0.026	0.121	15.867	0.088
Ling’ao NNP Phase II	2017	0.116	0.021	0.113	22.889	0.157
	2018	0.236	0.157	0.101	25.422	0.109
	2019	0.109	0.036	0.095	20.800	0.087
Qinshan NNP Phase III	2017	0.100	0.002	0.002	15.423	1.264
	2018	0.081	0.001	0.001	10.361	1.208

NPP name \ Category / Year		Gaseous Effluents			Liquid Effluents	
		Noble gas	Halogen	Aerosol	Tritium	Other Nuclides
	2019	0.065	0.001	0.002	15.423	1.094
Tianwan NNP (Unit 1 & 2)	2017	8.598	1.712	0.617	45.455	12.662
	2018	2.582	0.458	0.831	57.424	3.203
	2019	3.250	0.375	13.417	41.970	1.797
Tianwan NNP (Unit 3 & 4)	2017	0.250	0.112	0.248	0.003	0.858
	2018	2.910	0.507	1.067	18.333	1.838
	2019	4.797	1.299	8.583	37.121	2.351
Hongyanhe NNP	2017	0.147	0.105	0.110	42.540	0.218
	2018	0.208	0.315	0.124	65.952	0.205
	2019	0.195	0.216	0.096	69.286	0.191
Ningde NNP	2017	0.510	0.095	0.083	46.392	0.386
	2018	0.303	0.076	0.079	61.915	0.298
	2019	0.282	0.063	0.082	55.801	0.242
Yangjiang NNP	2017	0.297	0.142	0.176	43.295	0.381
	2018	0.236	0.107	0.134	33.902	0.286
	2019	0.302	0.289	0.196	41.000	0.550
Fangjiashan NPP	2017	0.042	0.014	0.003	4.167	0.333
	2018	0.030	0.015	0.004	7.376	0.161
	2019	0.029	0.024	0.005	6.505	0.415
Fuqing NPP (Unit 1 & 2)	2017	1.109	2.500	2.718	20.505	1.558
	2018	0.366	0.786	1.046	43.030	1.617
	2019	0.331	0.975	1.191	46.263	1.108
Fuqing NPP (Unit 3 & 4)	2017	2.927	4.424	3.092	14.242	1.120
	2018	1.533	4.144	4.618	26.667	0.973
	2019	0.514	0.419	0.763	33.131	1.810
Changjiang NPP	2017	1.683	10.533	16.789	31.694	2.891
	2018	1.545	2.744	15.229	30.601	2.854
	2019	1.490	1.133	4.018	23.497	3.839
Fangchenggang NPP	2017	0.39	0.09	0.18	31.09	0.78
	2018	0.35	0.08	0.13	42.34	0.43

NPP name \ Category / Year		Gaseous Effluents			Liquid Effluents	
		Noble gas	Halogen	Aerosol	Tritium	Other Nuclides
	2019	0.29	0.09	0.12	62.29	0.30
Haiyang NPP	2017	—	—	—	—	—
	2018	2.441	0.007	0.017	7.829	0.328
	2019	6.483	0.075	0.063	58.685	0.781
Taishan NPP	2017	—	—	—	—	—
	2018	0.540	0.195	0.424	2.179	0.705
	2019	1.590	0.729	1.244	14.061	3.022
Sanmen NPP	2017	—	—	—	—	—
	2018	1.566	0.414	0.329	3.362	0.451
	2019	1.897	1.710	4.125	13.475	3.559

Notes:

1. The release amount of radioactive effluents is dependent on power of nuclear units.

2. For each NNP, the Discharge Limits of radioactive Effluents are respectively approved by NNSA.

L.8 References

L.8.1 Documents

No.	References
1	The seventh national report of the People's Republic of China to the Convention on Nuclear Safety, 2016.
2	The eighth national report of the People's Republic of China to the Convention on Nuclear Safety, 2019.
3	13th Five-year Plan and 2025 Vision for Nuclear Safety and Radioactive Pollution and Control, 2017
4	The Guidelines for the Application of Scientific Research Projects on Nuclear Facility Decommissioning and Radioactive waste Treatment (2018-2020), 2018
5	The Outline of Thirteenth Five-Year Plan of National Economic and Social Development of the People's Republic of China, 2016
6	Nuclear Safety in China, 2019
7	Annual report of nuclear safety, MEP/NNSA, 2017
8	Annual report of nuclear safety, MEE/NNSA, 2018

L.8.2 Websites

More Information can be available at the following websites:

No.	Agency Name	Website
1	MEE	www.mee.gov.cn

2	CAEA	www.caea.gov.cn
3	NHC	www.nhc.gov.cn
4	NEA	www.nea.gov.cn
5	MPS	www.mps.gov.cn
6	CNNC	www. cnnc.com.cn
7	CGN	www.cgnpc.com.cn
8	SPIC	www.spic.com.cn

L.9 Abbreviation

No.	Abbreviation	Full name
1	ALARA	As Low As Reasonably Achievable
2	AQSIQ	Administration of Quality Supervision, Inspection and Quarantine
3	Beilong Disposal Site	Guangdong Beilong LILW Disposal Site
4	BSS	Basic Safety Standard
5	CAEA	China Atomic Energy Authority
6	CGN	China General Nuclear Power Group
7	CIAE	China Institute of Atomic Energy
8	CNNC	China National Nuclear Corporation
9	CSDCNTARSF	Criteria on Siting, Design and Construction of Nuclear Technology Application radioactive waste Storage Facility
10	CWGJCI	Chinese Working Group for Joint Convention Implementation
11	EPDNFO	Emergency Preparedness and Response of Nuclear Fuel Cycle Facility Operators
12	EPRNPO	Emergency Preparedness and Response of NPP Operators
13	EU	European Union
14	HIC	High Integrity Containers
15	HLW	High level waste
16	IAEA	International Atomic Energy Agency
17	ICRP	International Commission on Radiological Protection
18	ILW	Intermediate level waste
19	IPCUMFTDSFNPP	Interim Procedures on Collection, Utilization and Management of the Funds for Treatment and Disposal of Spent Fuel at Nuclear Power Plants
20	Joint Convention	The Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive waste Management
21	LDEE	The Law of People's Republic of China on Dealing with Emergency Event
22	LILW	Low and intermediate level waste

No.	Abbreviation	Full name
23	LLW	Low level waste
24	LNS	Law of the People's Republic of China on Nuclear Safety
25	LPCOD	Law of the People's Republic of China on Prevention and Control of Occupational Disease
26	LPCRP	Law of the People's Republic of China on Prevention and Control of Radioactive Pollution
27	MEE	Ministry of Ecology and Environment
28	MEP	Ministry of Environmental Protection, P. R. of China
29	MFA	Ministry of Foreign Affairs
30	MIIT	Ministry of Industry and Information Technology
31	MLRRIS	Methods for Licensing of Radioisotopes and Ray-generating Installations Safety
32	MMEFONPP	Management Methods for Experience Feedback about Operational NPPs
33	MMLSDSRW	Management Measures for Licensing the Storage and Disposal of Solid Radioactive waste
34	MMSPRRI	Management Measures on Safety and Protection against Radioisotope and Ray-generating Installation
35	MoF	Ministry of Finance
36	MoH	Ministry of Health
37	MoT	Ministry of Transport
38	MPS	Ministry of Public Security
39	MST	Ministry of Science and Technology
40	NDRC	National Development and Reform Commission
41	NEA	National Energy Administration
42	NHC	National Health Commission
43	NHFPC	National Health and Family Planning Commission
44	NIMBY	Not In My Back Yard
45	NNAECC	National Nuclear Accident Emergency Coordination Committee
46	NNAEO	National Nuclear Accident Emergency
47	NNEP	National Nuclear Emergency Planning
48	NNSA	National Nuclear Safety Administration
49	NORM	Naturally Occurring Radioactive Materials
50	Northwestern Disposal Site	Northwestern China LILW Disposal Site
51	NPCSC	National People's Congress Standing Committee
52	NPIC	Nuclear Power Institute of China
53	NPPs	Nuclear Power Plants

No.	Abbreviation	Full name
54	OTFPNESDPRC	the Outline of Thirteenth Five-Year Plan for National Economic and Social Development of the People's Republic of China
55	QA	Quality Assurance
56	RNAEMN	Regulations on Nuclear Accident Emergency Management at Nuclear Power Plant
57	RRSSFDSSN	Regulatory Requirements for the Safety of Spent Fuel Dry Storage System at NPPs (Trial)
58	RSPRRD	Regulations on Safety and Protection of Radioisotope and Ray-generating Devices
59	RSRWM	Regulations on Safety of Radioactive waste Management
60	SAMG	Serious Accident Management Guides
61	SFDSS	spent fuel dry storage system
62	SLPNPPRRNFCF	Safety licensing procedures for nuclear power plants, research reactors and nuclear fuel cycle facilities
63	SRTF	Site Radioactive Treatment Facility
64	TFP2025VNSRPC	13^{th} Five-year Plan and 2025 Vision for Nuclear Safety and Radioactive Pollution and Control
65	TRRQNSE	Temporary Regulations on Registration qualifications for Nuclear Safety Engineer
66	TRSDCNTARWSF	Technical requirements on siting, design and construction of nuclear technology application radioactive waste storage facility
67	VLLW	Very low level waste
68	VSLW	Very short lived waste,

Appendix: Name List for Preparing and Reviewing the National Report for the Seventh Review Meeting

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Part 2

A Introduction

A.1 Overview

Hong Kong Special Administrative Region (HKSAR) does not produce spent fuel. There are also no facilities related to spent fuel management. Hence, the articles under Chapter 2 of the *Joint Convention* concerning the safety of spent fuel management are not applicable to HKSAR.

To realise and maintain a high standard of radiation protection so as to safeguard the health of the public and workers as well as the safety of the society and environment, HKSAR has established a proper and effective radiation protection system and regulatory regime to manage the use of radioactive substances and to deal with the resultant wastes. In HKSAR, radioactive substances are primarily used in medical services, industry, education and scientific research, etc. All radioactive wastes arising from such uses belong to the class of low level or low to intermediate level radioactive wastes.

The management of radioactive substances in HKSAR is founded on the basis of international principles of radiation protection, with legislation and a licensing system as the regulatory instruments. A permanent statutory regulatory authority is established as the policy formulation and law enforcement agency. The entire system is complemented by collaboration amongst the various professional bodies that provide advice and services on radiation protection and practical radiation protection technology and instrumentations. In formulating and reviewing the policies on radiation protection, the regulatory authority has made extensive reference to national and international standards and recommendations to facilitate the application and development of radiation technology.

A.2 Waste Facility

In addition, a purpose-built Low-level Radioactive Waste Storage Facility ("Storage Facility") was commissioned in HKSAR in mid-2005. It is a crucial facility to enable a holistic and effective management of radioactive wastes in conformance to the high standard of management culture on radiation safety.

B Policies and Practices

B.1 Definition of Radioactive Wastes

The *Radiation Ordinance* (Cap. 303 of the Laws of Hong Kong) (please refer to Appendix I.2 Reference[1]) and the associated licensing system form the legal basis for the control of radioactive substances and radioactive wastes in HKSAR. The Hong Kong Radiation Board ("the Board") is established as the regulatory authority under the Radiation Ordinance.

As defined in the *Radiation Ordinance*, all disused radioactive substances or wastes contaminated by radioactive substances should be regarded as radioactive wastes. Any person who works and undertake activities involving radioactive substances (including radioactive wastes) are required to be covered by a valid licence issued by the Board.

Any premises where radioactive substances are handled are subject to radiation safety assessment and on-site inspection of the Board to ensure that legal requirements and conditions of licence are fully met before a licence is granted. The Board will also conduct review assessment at such premises during the licence period and before the renewal of licence to ensure that requirements on radiation safety are effectively maintained.

B.2 Criteria for the Categorization of Radioactive Wastes

Radioactive wastes produced in HKSAR are classified into the following basic categories according to their properties –

i) solid waste;
ii) liquid waste;
iii) gaseous waste; and
iv) exempt waste.

Solid radioactive waste mainly includes disused sealed sources and solid wastes contaminated by radioactive substances, etc. Sealed sources are used primarily in medical and industrial sectors. Sealed sources in medical applications include the higher activity Category 1 and Category 2 sources under the *Categorization of Radioactive Sources* of the International Atomic Energy Agency (IAEA), such as caesium-137 in blood irradiator systems and cobalt-60 in gamma knife radiosurgery system, as well as Category 3 or lower category sources that are used in brachytherapy and calibration of radiation detectors. Sealed sources for industrial applications include Category 2 and Category 3 sources such as iridium-192 and cobalt-60, etc., that are used in non-destructive testing, as well as sealed sources of lower categories that are used in quality inspection instruments, such as americium-241/beryllium neutron sources in the measurement of moisture and density in concrete, strontium-90 and thallium-201 β-sources in the measurement of material thicknesses as well as nickel-63 β-sources in electron capture devices.

Sealed sources for scientific research and educational purposes primarily belong to the lower radioactivity Category 5. Radioactive substances used in other products include americium-241 in lightning conductors and smoke detectors as well as tritium in luminous watches and directional signs, etc.

Liquid radioactive waste mainly refers to disused liquid or solution containing radioactive substances. Liquid radioactive substances include radio-pharmaceuticals used in nuclear medicine for the treatment and diagnosis of diseases, such as iodine-131, technetium-99m, thallium-201, strontium-90, fluorine-18, and phosphorus-32; as well as radioactive compounds used in clinical tests and scientific research, such as iodine-125, phosphorus-32, carbon-14 and uranium-238, etc.

Gaseous radioactive waste mainly refers to waste radioactive gases, vaporised radioactive liquid and radioactive aerosols, such as krypton-85 and technetium-99m vapour, etc.

Exempt waste refers to waste that is exempted from regulatory control in accordance with exemption principles.

C Radioactive Waste Management Policies and its Practices

C.1 Radioactive Waste Management Policies

The fundamental principle of HKSAR's radioactive waste management policy is to minimise the waste arising at source. The Board adopts the following management policies commensurate with the properties and categories of radioactive wastes –

i) Sealed sources: the licensed user is required to return disused sealed sources to their original manufacturer. With prior approval from the Board, the licenced user could also return disused sealed sources to alternative suppliers or manufacturers of the same type of sealed sources outside Hong Kong. In case that there are justifiable reasons proving that the foregoing measures are impracticable, the licensed user may seek approval from the Board for transferring the waste sources to the Storage Facility;

ii) Solid contaminated wastes: the licensed user is required to store such wastes to allow for radioactive decay for a period of time as specified in the conditions of licence, after which the wastes should be disposed of as exempt wastes. Subject to the conditions of licence, some wastes that present biological hazards may be disposed of by incineration. Subject to the approval of the Board, wastes exceeding the permitted discharge level after delay storage may be transferred to the Storage Facility;

iii) Liquid wastes: the licensed user is required to store such wastes to allow for radioactive decay for a period as specified in the conditions of licence, after which the wastes should be disposed of as exempt liquid wastes. Subject to the approval of the Board, wastes exceeding the permitted discharge level after delay storage may be solidified and transferred to the Storage Facility for suitable processing and storage; and

iv) Gaseous wastes: the licensed user is required to collect such wastes or discharge them through a purpose-designed exhaust system according to the principles specified in the conditions of licence.

C.2 Discharge of Effluents

The permitted discharge level of different wastes is determined with reference to the Annual Limit on Intake of the individual radionuclide. The user concerned should record in detail the date on which the waste is produced, its activity, storage duration and the date of discharge. Any disposal of wastes exceeding the limit permitted by the licence shall only be carried out after satisfactory assessment of the impact on the public and environment caused by the proposed disposal method in conjunction with the radioactivity and the radiation

level of such wastes and subject to the approval of the Board.

D Safety of Radioactive Waste Management (Articles 11-17 of the Joint Convention)

D.1 Safety Management Practices of the Storage Facility

As stated in paragraph C.1, the basic principle for the management of radioactive wastes of HKSAR is to proactively minimise the quantity of wastes at the source of waste arising. This is further complemented by the formulation and implementation of relevant disposal policies and regulations commensurate with the properties of various categories of wastes so as to minimize the risks caused by such wastes on humans, society and the environment.

The Storage Facility, with a designed storage capacity of 140m^3, has been commissioned in HKSAR since mid-2005. Presently the total volume of waste in store is about 79m^3. It is estimated that the storage capacity will meet the waste storage requirement of HKSAR in the coming 100 years. Apart from this facility, HKSAR does not have any other proposed radioactive waste facilities.

The siting and planning of the Storage Facility were studied and examined in detail by the Environmental Protection Department ("EPD") of the HKSAR Government, which included risk and environmental assessment. The Storage Facility was designed and constructed under the supervision of independent professional consultants according to high standards and advanced technology in radiation safety design specified by EPD. Having satisfactorily passed the Board's in-depth licensing assessments to confirm that legal requirements and terms of licence are met, the Storage Facility is now operated by EPD's contractor.

The Storage Facility is located at Siu A Chau, a small remote island located at the southwest of Lantau, which is far away from residential areas. Its core design comprises a central waste storage vault, a waste processing area equipped with glove boxes and fume cupboard, a radiation laboratory which provides various radioactivity analysis and measurement equipment, a continuous radiological surveillance system which monitors the gaseous discharge as well as the radiation level inside and outside the facility and a central control room for overall management of the facility, etc. The Storage Facility is also equipped with an all round weather-proof security surveillance system, which is directly connected to a 24-hour monitoring centre located at the urban area through a dedicated data network. The safe operation of the Storage Facility is therefore stringently ensured.

The radiation levels inside and outside the Storage Facility are continuously monitored and controlled to be within the range specified by the licence and in accordance with the operation manual, with due regard to the principle of optimisation of radiological protection. The contractor is also required to conduct regular analysis and assessment on the impact of the Storage Facility to its surrounding environment, so as to ensure that high standards of radiation

protection are effectively maintained. Radioactive wastes generated during the operation of the Storage Facility are required to be properly disposed of in accordance with the methods and discharge limits approved under the relevant policies of the Board.

D.2 Inventory of Wastes

At present, the majority of the low-level radioactive wastes produced in HKSAR, including those arising from medical, industrial and educational origins, has already been transferred to the Storage Facility. An inventory list of these wastes is given in Appendix I.1.

E Legislative and Regulatory Framework (Articles 18-20 of the Joint Convention)

E.1 Regulatory Framework

The *Radiation Ordinance* establishes the Board as the statutory authority to exercise the powers conferred by the *Ordinance*, which include granting of licence and imposing conditions of licence. Section 3 of the *Radiation Ordinance* provides that the Board shall consist of three ex-officio members (the Director of Health being the *ex-officio* Chairman) and such persons not exceeding 10 in number as the Chief Executive may appoint from time to time. Under section 13 of the *Radiation Ordinance* and subject to the approval of the Legislative Council, the Board may by regulation provide for a series of matters related to radiation safety that comes under the jurisdiction of the *Ordinance*. In addition, the Board may from time to time appoint persons by name or office to be inspectors to exercise the powers of inspection stipulated under section 16 of the *Ordinance*.

The Board has established an effective licensing system according to the regulatory framework. It has also formulated policies and corresponding conditions of licence in accordance with principles and requirements of radiation protection for different practices involving the use of radioactive substances. Any person who is engaged in work or activity relating to radioactive substances or wastes should obtain a valid licence issued by the Board. During the evaluation of licence application, appropriate and comprehensive radiation safety assessment will be conducted on the applicant, premises and equipment, etc. to confirm the compliance of the requirements stipulated in relevant legislations and licence conditions.

E.2 Licensing System

Licence applicants are required to submit detailed technical specifications of the radioactive source or irradiating apparatus, the applicable safety standards, certification and record of safety tests, radiation safety design of the premises and equipment, etc. to facilitate the assessment of the Board. All radioactive substance licences will have specific prescriptions about the concerned radioactive nuclides and the approved purposes of use and activity limits. Inspectors of the Board, as part of the assessments of the application, will conduct on-site inspection of the concerned premises. The inspection assessment will cover the following aspects –

i) radiation level surveys;
ii) radiological protection facilities and equipment;
iii) effective operation of monitoring equipment;
iv) contamination control facilities and procedures;

v) records of purchase and storage of radioactive substances;
vi) records of disposal of radioactive wastes;
vii) inventory list and safety management of sealed sources;
viii) radiation monitoring programme and working instructions;
ix) appointment of supervising persons;
x) health surveillance of radiation workers; and
xi) contingency plan, etc.

The licensee is required to report any changes in the licence particulars to the Board for approval and updating and to submit regular reports on testing of sealed sources and radiation monitoring equipment, as well as sale and purchase records of sealed sources, etc. Inspectors of the Board will conduct on-site audit visit at the premises to ensure that radiological safety is effectively maintained. The Board will proactively initiate investigation into any suspected irregularities and, if such irregularities are substantiated, the parties concerned could be prosecuted or warned according to the provisions of the *Ordinance* and licence conditions. Review and follow-up on the improvement measures will also be conducted.

E.3 Radioactive Sources Information Management

To facilitate the effective implementation of the *Code of Conduct on the Safety and Security of Radioactive Sources* issued by the IAEA, the Board has set up a comprehensive information management system to maintain the register of sealed sources in HKSAR. The licensing system has been accredited with *ISO 9001:2000 Quality Management System* certification since 2004 and successfully upgraded to conform to the *ISO 9001:2008* quality management standards in 2009 and subsequently to the latest *ISO 9001:2015* quality management standards in early 2018, which reflects the quality of the management system and the commitment to continual improvement. The entire licensing system and the associated radioactive sources database information system have been successfully converted to a fully electronic work flow system in 2010 to enhance the information analysis and data handling capability and to facilitate a “cradle to grave” lifecycle management of radioactive sources. The electronic work flow system is successfully upgraded in 2020 with enhanced performance and capacity.

E.4 Emergency Response

In the event of radiological incidents, inspectors of the Board will, depending on the nature and category of the incident and in accordance with established emergency procedures, take appropriate response actions in collaboration with relevant departments such as the Security Bureau, Fire Services Department and the Police, etc. The response actions will consist of evaluating the risks of the radiation hazards, carrying out emergency countermeasures including decontamination, as well as managing radioactive wastes arising from the incident, so as to limit the impact arising from possible radiation exposure and

contamination on individuals, society and the environment.

F General Safety Provisions (Articles 21-26 of the Joint Convention)

F.1 Responsibility of the licence holder (Article 21 of the Joint Convention)

According to the *Radiation Ordinance*, the licensees who are authorized to handle radioactive substances are required to manage and dispose of their radioactive wastes properly in accordance with the requirements stipulated in the Radiation *Ordinance* and the relevant conditions of licence. Such requirements include method of storage, radiation level at the storage site, method of waste management, record of waste discharge and safety standards of transportation, etc. Inspectors of the Board will regularly inspect the premises at which radioactive substances are used to ensure that requirements of the law and conditions of licence are met. The licensees are liable for contraventions to the *Radiation Ordinance*, and may be subject to the prescribed penalties upon conviction by the court.

F.2 Human and Financial Resources (Article 22 of the Joint Convention)

Any licensee who is engaged in work involving the handling of radioactive substances is required to employ qualified supervising persons who have received proper training on radiation protection to supervise the work. The approved supervising persons are listed in the licence.

The Storage Facility is the property of and fully funded by the HKSAR Government. Hence, human and financial resources required for the operation of the Storage Facility, including staff training and management, can be reliably maintained. Every staff working at the Storage Facility has completed proper training and professional assessments as required by the work.

F.3 Quality Assurance (Article 23 of the Joint Convention)

The contractor of the Storage Facility is required, according to the conditions of licence, to set up and maintain an effective quality management system, so as to ensure the safety and security of radioactive substances.

The Storage Facility is operated and managed in accordance with I*SO 14000 Environmental Management Standards*, which reflects the Government's commitment to management quality and environmental protection.

F.4 Operational Radiation Protection (Article 24 of the Joint Convention)

The conditions of licence of the Storage Facility require the radiation level inside and outside the facility to be controlled within the specified range commensurate with the principle of optimisation. Under normal operation of the Storage Facility, the radiation exposure of workers and the public are required to be controlled within the relevant dose limits applicable to occupational exposure and public exposure stipulated in the *Radiation Ordinance*, i.e. no more than 20mSv and 1mSv in any one year respectively.

The Storage Facility is equipped with high standard radiation safety design: the structure of the storage vault provides shielding of radiation and prevents the release of radioactive substances from the Facility. The specially designed wastewater treatment system and high performance air filtration system can effectively reduce the discharge of liquid and gaseous radioactive substances. Data from the continuous radiation monitoring systems inside and outside the Storage Facility are directly transferred to a 24-hour monitoring centre located in the urban area through dedicated network to ensure that these radiation levels are controlled within the regulatory requirements. Furthermore, environmental monitoring with the collection of relevant environmental samples for radiation monitoring and radioactivity analysis is conducted regularly to ensure that the operation of the Storage Facility will not result in any adverse impact on the environment.

F.5 Facility Emergency Preparedness (Article 25 of the Joint Convention)

The contractor of the Storage Facility has, as required by the Board, set up corresponding contingency plans and mechanisms for the various foreseeable emergency scenarios. Under such mechanisms, the contractor should carry out appropriate response measures jointly with relevant government departments for the various emergency scenarios, so as to safeguard the safety of workers and the public as well as protecting the environment. The contractor is required to conduct regular exercises to test the contingency plans under the supervision of the EPD.

F.6 Decommissioning (Article 26 of Joint Convention)

At the planning stage of the Storage Facility, the HKSAR Government has given serious considerations to its decommissioning requirements. As there remains a long period of time to go before decommissioning of the Storage Facility takes effect, the HKSAR Government will formulate detailed plans, provide the funds and take charge of the decommissioning work at an appropriate time.

G Transboundary Movement (Article 27 of the Joint Convention)

G.1 Import and Export Control

HKSAR does not produce any sealed sources or radioactive substances and, therefore, the transboundary movement of radioactive substances, in general, is confined to transhipment operations, import of radioactive substances for local use and return of disused sealed sources to their places of origin. According to the existing regulations, any import of radioactive substances into HKSAR is required to be covered by a valid import licence issued under the *Import (Radiation) (Prohibition) Regulations* (Cap. 60K of the Laws of Hong Kong) (please refer to Appendix I.2 Reference[2]) and a radioactive substance licence issued by the Board under the *Radiation Ordinance*. The assessment of import licence application will include a comprehensive evaluation of the export and transport approvals for the particular radioactive substances or sealed sources, their categories and properties, radioactivity, safety tests, the radiation safety of the proposed stowage or storage sites, etc. The licensee is required to regularly submit their records of import and sale activities to the Board for auditing.

G.2 Transport Management

The transportation of radioactive substances in HKSAR should comply with the *Regulations for the Safe Transport of Radioactive Material* and the *Guidance on the Import and Export of Radioactive Sources* issued by the IAEA and is required to be covered by a valid licence and conveyance permit issued by the Board. The transportation should be conducted under the personal supervision of the approved supervising persons prescribed by the licence. The licensee is required to submit to the Board the reports and records of the transportation activities after they have been completed.

H Disused Sealed Sources (Article 28 of the Joint Convention)

H.1 Disused Sealed Sources

As stated in paragraph G.1, HKSAR does not produce any sealed sources or radioactive substances. Therefore, article 28 “Disused sealed sources” of the *Joint Convention* does not apply to HKSAR.

I Appendices

I.1 Inventory of wastes stored in the Storage Facility

Low-level Radioactive Waste Storage Facility of Hong Kong

List of Major Isotopes in Store

Isotope	Total Activity (MBq)	Weight (kg)	Major Sources of Wastes
Caesium-137	6.2×10^5	9.6×10^2	Medical radiation sources
Radium-226	7.1×10^4	1.0×10^4	Lightning conductor heads, luminous watch dials and hands, medical radiation sources
Cobalt-60	4.7×10^4	6.2×10^2	Radioactive check sources
Promethium-147	4.0×10^4	8.3×10^3	Luminous watch dials and hands
Strontium-90	3.1×10^4	3.9×10^2	Medical radiation sources
Gadolinium-153	1.1×10^4	1.0	Medical radiation sources
Americium-241	7.2×10^3	5.0×10^2	Radioactive check sources, smoke detectors
Thorium-232	1.2×10^3	8.0×10^3	Rayon mantles for kerosene lanterns

Total volume of waste in store = $79m^3$ (as at July 2020)

I.2 References

1. Radiation Ordinance (Cap. 303 of the Laws of Hong Kong)
2. Import (Radiation) (Prohibition) Regulations (Cap. 60K of the Laws of Hong Kong)
3. INTERNATIONAL ATOMIC ENERGY AGENCY, Guidance on the Import and Export of Radioactive Sources, IAEA, Vienna (2012)
4. INTERNATIONAL ATOMIC ENERGY AGENCY, Code of Conduct on the Safety and

Security of Radioactive Sources, IAEA, Vienna (2004)
5. INTERNATIONAL ATOMIC ENERGY AGENCY, Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, INFCIRC/546, Vienna (1997)
6. INTERNATIONAL ATOMIC ENERGY AGENCY, Categorization of Radioactive Sources, IAEA Safety Standards Series No. RS-G-1.9, IAEA, Vienna (2005)
7. INTERNATIONAL ATOMIC ENERGY AGENCY, Radiation Protection & Safety of Radiation Sources: International Basic Safety Standards, IAEA Safety Standards Series No.GSR Part 3, IAEA, Vienna (2014)
8. INTERNATIONAL ATOMIC ENERGY AGENCY, Regulations for the Safe Transport of Radioactive Material, 2018 Edition, Specific Safety Requirements No. SSR-6 (Rev. 1), IAEA, Vienna (2018)
9. INTERNATIONAL ATOMIC ENERGY AGENCY, IAEA Safety Glossary, 2018 Edition, IAEA, Vienna (2019)