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INTEGRATED REGULATORY REVIEW SERVICE (IRRS)

FOLLOW-UP MISSION

TO

CHINA

Beijing, China

28August to 8 September 2016

DEPARTMENT OF NUCLEAR SAFETY AND SECURITY

Integrated Regulatory Review Service

IAEA IRRS

NNSA

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Mission date:	*28 August to 8 September 2016*
Regulatory body:	*Ministry of Environmental Protection (MEP), National Nuclear Safety Administration (NNSA)*
Location:	*Beijing, China*
Regulated facilities and activities in the scope:	*Nuclear power plants, research reactors, fuel cycle facilities, medical industrial and research facilities, waste facilities, decommissioning and remediation, environmental monitoring.*
Organized by:	*International Atomic Energy Agency (IAEA)*

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

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EXECUTIVE SUMMARY

In July 2010, at the request of the government of the People's Republic of China, an international team of seventeen senior safety experts, from fifteen Member States, visited the MEP (NNSA) to conduct an Integrated Regulatory Review Service (IRRS) mission to review the Chinese nuclear regulatory framework and its effectiveness. The purpose of the initial IRRS mission was to review the regulatory framework for nuclear and radiological safety in China and the effectiveness of regulatory functions implemented by the MEP (NNSA).

At the request of the government of the People's Republic of China, an international team of thirteen senior safety experts met the representatives of the MEP (NNSA) from 29 August to 8 September 2016 to conduct a follow-up IRRS mission. The mission took place at the Grand Metro Park Yuantong Hotel in Beijing, China. The purpose of the follow-up mission was to review the national regulatory framework for nuclear and radiological safety in China, and specifically, the measures undertaken following the recommendations and suggestions of the 2010 IRRS mission. The review compared the Chinese regulatory framework for safety against IAEA safety standards as the international benchmark for safety.

The IRRS team carried out the review in the following areas: responsibilities and functions of the government, global nuclear safety regime, responsibilities and functions of the regulatory body; the management system of the regulatory body, the activities of the regulatory body including the authorization, review and assessment, inspection and enforcement processes, regulations and guides, management systems and emergency preparedness and response. The IRRS team also reviewed the area of environmental monitoring which was not reviewed during the 2010 IRRS mission. The follow-up mission was also used to exchange information and experience between the IRRS team members and the Chinese counterparts on two policy issues regarding China's development of the *Nuclear Safety Act* and on China's international cooperation with countries importing nuclear power technology from China.

As recommended by the IAEA Nuclear Safety Action Plan, special attention was given to regulatory implications to the Chinese framework for safety in relation to the lessons learned from the TEPCO Fukushima Daiichi accident.

The MEP (NNSA) performed a self-assessment of the status of implementation of the findings of the 2010 IRRS mission and provided its results and the supporting documentation to the team as advance reference material for the mission. During the mission, the IRRS team performed a systematic review of all topics by reviewing the advance reference material and by conducting interviews with management and staff from the MEP (NNSA). A meeting with the MEP Vice-Minister and NNSA Administrator, Mr Li Ganjie, and other senior managers was also organized. The mission included observations of regulatory activities at the Fuqing NPP, Fujian Fuqing Nuclear Power Co. Ltd, and the Beijing Hongyisifang Radiation Technology Co. LTD and included interviews and discussions with licensee management and staff to help assess the effectiveness of the system.

All through the mission, the IRRS team received excellent support and cooperation from the MEP (NNSA) who demonstrated extensive openness and transparency.

China's nuclear power programme has grown significantly since the IRRS mission in 2010. At that time, China had 10 units in operation. In 2016, 32 units are in operation and 24 under construction. By 2020, China intends to have approximately 90 units either already operating or under construction.

The IRRS team was recognizant of the Chinese President's declaration of a political commitment to nuclear safety. The Chinese Government has approved and implemented a Nuclear Safety Plan, increased the human and financial resources and strengthened the capacity building of the MEP (NNSA).

The MEP (NNSA) has carried out extensive work in developing and updating their regulations and guides to be in line with the IAEA Safety Standards. It has optimized and improved its organizational and management systems. Within its mandate, the MEP (NNSA) implemented in an independent and effective manner its regulatory activities such as authorization, review and assessment, inspection and enforcement. The IRRS team commended the MEP (NNSA) for these improvements that have contributed to enhancing nuclear safety at the national level and determines that the MEP (NNSA) is an effective and credible regulatory body.

The IRRS Team considers that the MEP (NNSA), as the leading organization, in cooperation with other governmental agencies, has acted promptly and effectively after the TEPCO Fukushima Daiichi accident in the interest of nuclear safety and the protection of the public and environment.

The IRRS team concluded that the recommendations and suggestions from the 2010 IRRS mission have been taken into account and that significant progress has been made in many areas and many improvements were carried out following the implementation of the recommendations and suggestions.

During this follow-up mission, the IRRS team determined that:

- 30 out of 39 recommendations and 32 of 40 suggestions made by the 2010 IRRS mission had been effectively addressed and therefore could be considered closed;
- 3 out of 39 recommendations and 6 out of 40 suggestions made by the 2010 IRRS mission could be considered closed on the basis of progress made and confidence in their effective completion.
- 6 out of 39 recommendations and 2 out of 40 suggestions made by the 2010 IRRS mission remain open.

The IRRS team made the following conclusions:

- The Government of the People's Republic of China should continue its progress in promulgating the *Nuclear Safety Act* (NSA) to embed in the law, the MEP (NNSA) as an independent regulatory body separated from other entities having responsibilities or interest that could unduly influence its decision-making.
- The NSA should be consistent with common international concepts, the IAEA Safety Fundamentals in particular, to unequivocally state the independence of the regulatory body, its transparency and that the prime responsibility for safety lies with the nuclear operators.
- In promulgating other nuclear laws such as the *Atomic Energy Act* (AEA), the Government of the People's Republic of China should ensure that the AEA will not conflict nor restrict the powers of the MEP (NNSA) as embedded in the NSA.
- Radioactive waste management should be addressed by the nuclear waste producers in parallel to the expansion of the nuclear program in China with an emphasis on the new nuclear power plants that will come into operation in 2020 and beyond. This should be reflected in a national policy and strategy for radioactive waste management.

- The MEP (NNSA) has established a monitoring system for the supervision of nuclear and radiological facilities and for environmental quality monitoring in accordance with the IAEA Safety Standards.

The good practices identified by the IRRS team were:

- The extensive use of social software and networking by the MEP (NNSA) in daily business for sharing information and regulatory experiences; raising questions and comments; and as a discussion forum in order to enhance the effectiveness of regulatory activities is considered as a good practice.
- The MEP (NNSA) Nuclear and Radiation Safety Centre in Beijing have established a mechanism in the form of software for the regulator to independently and very quickly assess the practicability and effectiveness of detailed evacuation proposals. This mechanism is beneficial in the MEP (NNSA) roles of both reviewing regional authority off-site emergency plans and, in the event of an emergency, the implementation of specific evacuation actions.

The IRRS team raised three specific recommendations to the MEP (NNSA):

- The MEP (NNSA) should establish a specific process and guidelines for the content and review of applications for extending or renewing NPP operating licenses.
- The MEP (NNSA) should establish legal requirements for financial provisions for the decommissioning of facilities other than NPPs or FCFs, that are subject to decommissioning requirements.
- The MEP (NNSA) should further develop legal requirements to have a waste minimization plan as part of the application for licences other than for nuclear installations

The findings by the IRRS team of 2010 that remain open can be found in Appendix IV.

Due to the unparalleled expansion of its nuclear programme and the six-year period that has passed between the 2010 initial mission and the 2016 follow-up mission, the IRRS team encourages China to host a full scope IRRS mission in accordance with IAEA guidelines.

The new IRRS team findings are summarized in Appendix V.

An IAEA press release was issued at the end of the mission and a joint MEP (NNSA) and IAEA press conference was organized.

I. INTRODUCTION

In July 2010, at the request of the government of the People's Republic of China, an international team of seventeen senior safety experts, from fifteen Member States, visited the MEP (NNSA) to conduct an Integrated Regulatory Review Service (IRRS) mission to review the Chinese nuclear regulatory framework and its effectiveness. The purpose of the initial IRRS mission was to review the regulatory framework for nuclear and radiological safety in the China and the effectiveness of regulatory functions implemented by the MEP (NNSA).

At the request of the government of the People's Republic of China, an international team of thirteen senior safety experts met the representatives of the MEP (NNSA) from 29 August to 8 September 2016 to conduct a follow-up IRRS mission. The mission took place at the Grand Metro Park Yuantong Hotel in Beijing, China. The purpose of the follow-up mission was to review the national regulatory framework for nuclear and radiological safety in China, and specifically, the measures undertaken following the recommendations and suggestions of the 2010 IRRS mission. The review compared the Chinese regulatory framework for safety against IAEA safety standards as the international benchmark for safety.

The IRRS Review Team carried out the review in the following areas: responsibilities and functions of the government, global nuclear safety regime; responsibilities and functions of the regulatory body; the management system of the regulatory body, the activities of the regulatory body including the authorization, review and assessment, inspection and enforcement processes, regulations and guides, management systems and emergency preparedness and response. The IRRS team also reviewed the area environmental monitoring which was not reviewed during the 2010 IRRS mission. The follow-up mission was also used to exchange information and experience between the IRRS Team members and the Chinese counterparts on two policy issues regarding China's development of a Nuclear Safety Act and on China's international cooperation with countries importing nuclear power technology from China.

As recommended by the IAEA *Nuclear Safety Action Plan*, special attention was given to regulatory implications to the China framework for safety in relation to the lessons learned from the TEPCO Fukushima Daiichi accident.

The MEP (NNSA) performed a self-assessment of the status of implementation of the findings of the 2010 IRRS mission and provided its results and the supporting documentation to the team as advance reference material for the mission. During the mission, the IRRS Team performed a systematic review of all topics by reviewing the advance reference material and by conducting interviews with management and staff from the MEP (NNSA). A meeting with the MEP (NNSA) Administrator and other senior management was also organized. The mission included observations of regulatory activities at the Fuqing NPP, Fujian Fuqing Nuclear Power Co. Ltd, and the Beijing Hongyisifang Radiation Technology Co. LTD and included interviews and discussions with licensee management and staff to help assess the effectiveness of the system.

All through the mission, the IRRS Team received excellent support and cooperation from the MEP (NNSA) who demonstrated extensive openness and transparency.

The IRRS exit meeting was held on Thursday 8 September 2016. The presentation of the results of the mission was made by IRRS team leader Mr Ramzi Jammal at the exit meeting and were followed by the remarks by Mr Li Ganjie, Vice-Minister of MEP and Administrator of NNSA. Closing remarks were made by Mr Greg Rzentkowski, Director, Division of Nuclear Installation Safety.

A joint MEP (NNSA) and IAEA press conference was held and an IAEA press release was issued at the end of the mission.

II. OBJECTIVE AND SCOPE

The purpose of this IRRS mission was to review the regulatory framework for nuclear and radiological safety in the People's Republic of China and the effectiveness of regulatory functions, specifically the measures undertaken following the recommendations and suggestions of the 2010 IRRS mission. The IRRS review scope was expanded from the scope of the 2010 IRRS mission to include the area of environmental monitoring and regulatory implications to the Chinese framework for safety in relation to the lessons learned from the TEPCO Fukushima Daiichi accident. The review was carried out by comparison against IAEA safety standards as the international benchmark for safety.

It is expected that the IRRS mission will facilitate regulatory improvements in China and other Member States from the knowledge gained and experiences shared by the MEP (NNSA) and IRRS reviewers and through the evaluation of the effectiveness of the Chinese nuclear regulatory framework and its good practices.

III. BASIS FOR REVIEW

A) Preparatory work and IAEA Review Team

At the request of the Government of the People's Republic of China, a preparatory meeting for the Integrated Regulatory Review Service (IRRS) follow-up mission was conducted on 22 and 23 February 2016 in Beijing, China.

The preparatory meeting was carried out by the appointed Team Leader, Mr Ramzi Jammal, Deputy Team Leader, Mr Mika Markkanen and the IAEA representatives, Mr Tim Kobetz and Mr Ahmad Al-Khatibeh.

The IRRS mission preparatory team had discussions regarding the progress made by the MEP (NNSA) in addressing measures undertaken following the recommendations and suggestions of the 2010 IRRS mission. The Chinese team was led by the Chief Engineer on Nuclear Safety of MEP and Vice Administrator of NNSA, Mr Liu Hua. The Chinese participants provided the IRRS mission preparatory team with an overview on the progress made in response to the 2010 IRRS mission recommendations and suggestions.

This was followed by a discussion on the tentative work plan for the implementation of the IRRS in China in August and September 2016.

The proposed IRRS team composition (senior regulators from Member States to be involved in the review) was discussed and the size of the IRRS team was tentatively confirmed. Logistics, including meeting and work space, counterparts and liaison officer identification, lodging and transportation arrangements were also addressed.

The Chinese Liaison Officer for the preparatory meeting and the IRRS mission was Mr Shen Gang, Director of the Division for Nuclear Safety International Cooperation.

The MEP (NNSA) provided the IAEA and the IRRS review team with the advance reference material for the review in July 2016. In preparation for the mission, the IRRS team members conducted a review of the advance reference material and provided their initial review comments to the IAEA Team Coordinator prior to the commencement of the IRRS mission.

B) Reference for the review

The most relevant IAEA safety standards and the *Code of Conduct on the Safety and Security of Radioactive Sources* were used as review criteria. A more complete list of IAEA publications used as references for this mission is given in Appendix VII.

C) Conduct of the review

An initial IRRS team meeting was conducted on Sunday, 28 August 2016, in Beijing by the IRRS Team Leader and the IRRS IAEA Team Coordinator to discuss the general overview, the focus areas and specific issues of the mission, to clarify the basis for the review and the background, context and objectives of the IRRS and to agree on the methodology for the review and the evaluation among all reviewers. They also presented the agenda for the mission.

The Chinese Liaison Officer was present at the initial IRRS team meeting, in accordance with the IRRS guidelines, and presented logistical arrangements planned for the mission.

The reviewers also reported their first impressions of the advance reference material.

The IRRS entrance meeting was held on Monday, 29 August 2016, with the participation of senior management and staff of the MEP (NNSA). Opening remarks were made by Mr Li Ganjie, Vice Minister of MEP and Administrator of NNSA, and Mr Ramzi Jammal, IRRS Team Leader. Mr Liu Hua, Chief Engineer on Nuclear Safety of MEP and Vice Administrator of NNSA, gave an overview of the major regulatory changes in nuclear safety since 2010 and presented the status of progress made regarding previous IRRS findings.

During the mission, a review was conducted for all the review areas with the objective of providing China and the MEP (NNSA) with recommendations and suggestions for improvement as well as identifying good practices. The review was conducted through meetings, interviews and discussions.

The IRRS team performed its activities based on the mission programme given in Appendix II.

The IRRS exit meeting was held on Thursday 8 September 2016. The presentation of the results of the mission was made by the IRRS Team Leader, Mr Ramzi Jammal at the exit meeting and were followed by the remarksby Mr Li Ganjie. Closing remarks were made by Mr Greg Rzentkowski, Director, Division of Nuclear Installation Safety.

A joint MEP (NNSA) and IAEA press conference was held and an IAEA press release was issued at the end of the mission.

1. RESPONSIBILITIES AND FUNCTIONS OF THE GOVERNMENT

1.1. NATIONAL POLICY AND STRATEGY

2010 MISSION RECOMMENDATIONS, SUGGESTIONS	
R1	**Recommendation:** The government/MEP (NNSA) should compile one document as soon as practicable, in which an expanded nuclear policy and strategy for safety that covers compliance with the ten safety principles as given in IAEA Safety Fundamentals (SF-1) should be included, taking account the current and future challenges faced by the government, regulatory body and the industry.
S1	**Suggestion:** The MEP (NNSA) should consider enhancing the application of the graded approach in the implementation of the national policy and strategy for safety.

Changes since the initial IRRS mission

Recommendation 1: The Government of China promulgated the "*12th Five-Year - Plan and Prospective Targets of 2020 on Nuclear Safety and Radioactive Pollution Prevention and Control*" (Nuclear Safety Plan), which includes the basic principles and objectives of nuclear safety regulation.

The Nuclear Safety Plan is a well-structured strategic document. The first section includes an overview of the current situation in the nuclear field in China. The following section includes a clear reference to the fundamental policy of "Safety first, quality first". It underlines the following guiding principles:

- Complying with regulations and standards;
- Relying on scientific and technological progress;
- Effective management;
- Continuous improvements;
- Elimination of potential hazards;
- Continuous enhancement of nuclear safety as well as the radioactive pollution prevention and control;
- Ensuring nuclear safety, environmental safety and the public health; and
- Ensuring the safe and sustainable development of nuclear energy and technology application in China.

It also includes a description of the five basic safety principles:

- Prevention first, Defence in Depth;
- Actively promoting solutions for legacy problems;
- Relying on science and technology, make continuous improvements;
- Insisting on governing by rule of law, implementing strict regulation and enforcement; and
- Openness and transparency.

The plan also describes specific arrangements regarding measures to strengthen the technological support to nuclear safety, including emergency preparedness and regulation. Furthermore, the Nuclear Safety Plan specifies measures to improve the nuclear safety regulatory framework, the governmental framework, the financing of projects and the improvement of experience feedback. This essentially comprise a comprehensive set of nuclear safety assurance measures.

The Nuclear Safety Plan includes nine key tasks to implement the above mentioned objectives covering all major areas and current challenges in China. It also describes in detail five key projects: improvement of nuclear safety, management of radioactive pollution, technological research and development, accident prevention and mitigation and regulation building.

The commitment of the Government of China to the highest level of nuclear safety was also part of the Chinese statement at the 2014 Nuclear Security Summit in The Hague, emphasizing its decision to include nuclear safety as an essential component of its national security system.

China has also clearly stated at the level of national safety policy and strategy its commitment to enhance nuclear safety. The *State Security Law of the People's Republic of China*, Article 31 states: "the State persists in peaceful use of nuclear energy and nuclear technology, strengthening international cooperation, preventing nuclear proliferation and improving its mechanisms; strengthening regulatory oversight and protection of nuclear facilities, materials, nuclear activities, and disposal of nuclear wastes; reinforcing the construction of nuclear accident emergency response system and its capability; preventing, controlling and eliminating harm caused by nuclear accidents to citizens' lives and health and to the environment; and continuously enhancing ability to effectively respond to and prevent from nuclear threats and attacks."

The IRRS team identified in the Nuclear Safety Plan all the basic elements required by the GSR-Part 1 Requirement 1, which includes the fundamental safety objectives, binding international legal instruments, description of the governmental, legal and regulatory framework for safety and elaboration on provisions for human and financial resources and for research and development. The document also considers social and economic development in China and promotes strong leadership and management for safety, including safety culture.

The IRRS team also verified that all the fundamental safety principles from the IAEA document Safety Fundamentals SF-1 are included in the Nuclear Safety Plan or in any other legally binding documents. Although not all ten principles are explicitly included into the Nuclear Safety Plan, most of them are implicitly referenced. The first principle about the prime responsibility of the person or organization responsible for facilities and activities that give rise to radiation risks is an example of a principle not explicitly included in the Nuclear Safety Plan. However, this is explicitly included as Article 4 of the draft Nuclear Safety Act to be adopted in the near future by the National People's Congress of China (see also Recommendation 6). It is also referenced in Article 7 of the document "*Regulations on the Safety Regulation for Civilian Nuclear Installations of People's Republic of China* (HAF-001)" from 1986. Similarly, the fourth principle about the justification of facilities and activities is not explicitly mentioned in the Nuclear Safety Plan, but is stated in the document GB18871 from 2002, which represents the Chinese Basic Safety Standards. The only fundamental safety principle that is not explicitly quoted anywhere in the Chinese legal framework is the seventh principle about the protection of future generations. Nevertheless, IRRS team is of the opinion that, the objective of this principle is reflected in the China's comprehensive legal framework, which evidently demonstrates the intention to protect the people and the environment today and in the future. Therefore, the IRRS team determines that this principle is implicitly taken into consideration.

Suggestion 1: The MEP (NNSA) has adopted a graded approach based on the radiation risk level of different nuclear facilities such as nuclear power plants, research reactors, nuclear fuel cycle facilities, radioactive sources and radioactive waste management facilities.

In September 2013, MEP (NNSA) issued the *Measures on Research Reactor Safety Classification* and classified research reactors into three classes (I, II and III) based on their safety features and the consequences of a radioactive material release.

The MEP (NNSA) is also formulating the *Classification Principle and Basic Requirements on Civilian Nuclear Fuel Cycle Facilities*, which divides the facilities into four classes for the different types of nuclear fuel cycle facilities based on the consequences of a potential accident (such as uranium purification, uranium conversion, uranium enrichment, nuclear fuel element manufacturing, off-site spent fuel storage and spent fuel reprocessing etc.).

In 2005, the MEP (NNSA) had already issued *Measures on Radioactive Sources Classification*. It divides radioactive sources into five categories based on their potential hazards to human health and the environment. The lower limit activity value of the Category 5 source is the exempt activity of the radionuclides. The 2014 amendments to the *Regulations on the Safety and Protection of Radioisotopes and Radiation Devices* stipulate that licenses for the organizations that produce radioisotopes, sell or use Category 1 radioactive sources and sell Category 1 radiation emitting devices shall be approved by the competent department of the MEP (NNSA). Licenses for other organizations engaged in radiation work are approved and issued by competent departments of environmental protection under governments at the provincial level.

The MEP (NNSA) also adopted a graded approach towards the licensing of the transport containers for radioactive materials and divide radioactive materials into three classes based on the characteristics of radioactive materials and their degree of potential hazard to human health and the environment.

The graded approach used by the MEP (NNSA) is also extensively described and prescribed in section 5, chapter 2 of the *Integrated Management System Manual for Nuclear and Radiation Safety Regulation*.

Status of the finding in the initial mission

Recommendation 1 (R1) is closed as the Nuclear Safety Plan contains all the necessary elements of the policy and strategy on nuclear safety.

Suggestion 1 (S1) is closed as a graded approach is appropriately applied at different levels of activities of the MEP (NNSA).

1.2. ESTABLISHMENT OF A FRAMEWORK FOR SAFETY

2010 MISSION RECOMMENDATIONS, SUGGESTIONS	
R2	**Recommendation:** The government should expedite the promulgations of nuclear laws such as Atomic Energy Act and Nuclear Safety Act, consolidating and updating the nuclear safety infrastructure in China in such a way that it complies with GSR Part 1 requirements taking account of the rapid development of the nuclear power programme. Efforts should be made to complete the promulgations process within a reasonable time frame.

2010 MISSION RECOMMENDATIONS, SUGGESTIONS	
S2	**Suggestion:** The regulatory authorities should ensure that in the implementation of regulations covering the Basic Safety Standard there is no gaps or unnecessary overlaps in assessment, inspection and enforcement.
S3	**Suggestion:** The government should adequately strengthen institutions to respond to the development of the nuclear laws and associated regulations.

Changes since the initial IRRS mission

Recommendation 2: The Government of China is committed to promulgating high level nuclear laws through the following three Acts: *Law on the Prevention and Control of Radioactive Pollution, Nuclear Safety Act and Atomic Energy Act*. In 2012, the *Nuclear Safety Act* was included in the legislative plan of the 12th National Peoples' Congress (NPC). In 2013, the MEP (NNSA) prepared the first draft of the *Nuclear Safety Act* and submitted it to the NPC Environmental and Resources Protection Committee (ERPC) as proposal. The ERPC drafted new NSA on the proposal of the MEP (NNSA), which was reviewed in October 2015 during its 18th Session. It is expected that the Standing Committee of the NPC will perform the first review by the end of 2016. The second and third reviews will be completed in 2017.

The IRRS team was informed that the *Atomic Energy Act* is being drafted by the China Atomic Energy Agency (CAEA). It focuses on aspects related to the development and promotion of the nuclear industry, including nuclear liability. To avoid overlaps or contradictions, the MEP (NNSA) has been reviewing the draft of the *Atomic Energy Act* and has had discussion with CAEA on this matter. A satisfactory draft should be agreed upon before it is submitted to the NPC for approval. At the time of the mission, it was not clear to the IRRS team when this might happen, but it was expected that the *Nuclear Safety Act* would be adopted by the NPC earlier than the *Atomic Energy Act*.

The IRRS team recommended that nuclear safety related issues should be covered only by the *Nuclear Safety Act*, while the *Atomic Energy Act* should concentrate on all other nuclear issues. Any overlaps should be avoided.

The IRRS team had the opportunity to see the draft *Nuclear Safety Act* as it was submitted by the MEP (NNSA) in 2013 to the NPC. The draft has been slightly modified since then, but the latest version could not be provided to the IRRS team as it is not public yet. However, the IRRS team was assured that the following three principles are still included in the draft *Nuclear Safety Act*: the independence of the regulatory body, transparency and prime responsibility of safety that lies with the operator.

The IRRS team encourages the government to expedite the promulgations of nuclear laws such as *Atomic Energy Act* and *Nuclear Safety Act* in such a way that it complies with the IAEA Safety Standards, The *Nuclear Safety Act* should be consistent with common international concepts, and fully reflect China's accumulated good practices and successful experience in nuclear safety regulation. The *Nuclear Safety Act* should embed in law the independence and transparency of the MEP (NNSA), and assigns the prime responsibility for nuclear safety to the organization responsible for the facilities or activities.

Based on the available draft version, the IRRS team believes that the *Nuclear Safety Act* will reasonably consolidate and update the nuclear safety infrastructure in China in such a way that it

will comply with GSR Part 1 requirements taking into account also the rapid development of the nuclear power programme.

However, as the *Nuclear Safety Act* is not yet adopted by the NPC and it is not known when exactly it will be adopted, this recommendation cannot be closed.

Suggestion 2: The IRRS team has carefully studied the observations of the IRRS mission in 2010 that have led to suggestion S2 and recommendation R7. In 2010, the IRRS team was concerned that there may exist gaps or unnecessary overlaps in the regulatory control in the area of occupational exposure control as there might be conflicting understanding of roles as to what the responsibilities of MEP (NNSA) and National Health and Family Planning Commission (NHFPC), formerly as Ministry of Health (MoH), are with respect to enforcing Basic Safety Standards requirements.

During the mission, the IRRS team had the opportunity to see also the notification of the common position of the NHFPC and the MEP (NNSA) from 2016 about the radiation monitoring in the medical area dividing and defining roles of each authority.

However, the IRRS team did not see enough evidence that would prove there are no issues that have a potential of duplication and/or conflicts between the roles of different authorities as listed on pages 20 and 21 of the 2010 China IRRS report. On the contrary, during the site visit to the irradiation facility, the team members were informed that, the other authority, State Administration of Work Safety (SAWS), also recently took some of the previous responsibilities from MOH that are overlapping with responsibilities of the MEP (NNSA) and that there is no coordination between the MEP (NNSA) and SAWS regarding the supervision of licensees. Additionally, the SAWS has assigned the Centre of the Disease Control (CDC) to make the annual evaluation of the site. It is not clear how SAWS will respond to the findings of CDC evaluations, how the evaluation results will be communicated to MEP (NNSA) and if there will be any coordinated response of the MEP (NNSA) and the SAWS to inspection findings no matter which regulatory body conducts them.

The IRRS team is of the opinion that there is an overlap regarding the control of occupational exposure, therefore S2 remains open.

Suggestion 3: The MEP (NNSA) has instituted the Department of Policies, Laws and Regulations, which bears the responsibility of establishing and improving relevant laws and administrative regulations that form the basic legal system. The Division of policy and technology in the Department I of Nuclear and Radiation Safety Regulation of the MEP (NNSA) is responsible for organizing and coordinating the drafting of nuclear and radiation safety related laws, administrative regulations and departmental rules, regulatory requirements and guidelines.

The Nuclear and Radiation Safety Centre (NSC) is the technical support organization of the MEP (NNSA), and is responsible for providing technical support for nuclear safety regulation and researches on the civil nuclear facilities and nuclear safety regulatory policies and regulations. There is a division of policy and regulation research inside the NSC that is responsible for carrying out the research on nuclear and radiation safety policies, regulations, guides and related management and technical documents, and undertaking support of the drafting and reviewing of nuclear and radiation safety regulations and standards.

The IRRS team has observed that as the overall number of MEP (NNSA) staff has increased, the number of staff in the above mentioned Departments and Divisions has also significantly increased in recent years (4 the Division of policy and technology in the Department I of the MEP (NNSA) and 7 in the division of policy and regulation research in the NSC).

Status of the finding in the initial mission

Recommendation 2 (R2) is open as the *Nuclear Safety Act* is not yet adopted by the National People's Congress.

Suggestion 2 (S2) is open as there is not enough evidence about improvements.

Suggestion 3 (S3) is closed as institutions were significantly strengthened.

1.3. ESTABLISHMENT OF A REGULATORY BODY

2010 MISSION RECOMMENDATIONS, SUGGESTIONS	
R3	**Recommendation:** In effectively responding to the increasing safety challenges of rapid development of nuclear power, the government should strengthen the NNSA as a real integrated regulatory Authority (Administration or Agency) within the MEP with a Vice Minister as its Administrator and Head mainly focused on safety regulation, so as to enable the MEP (NNSA) to mobilize and use management resources in more efficient and intensive way.
R4	**Recommendation:** The Government should allocate adequate financial and human resources, of the appropriate competencies, for developing and maintaining the regulatory infrastructure in China commensurate with the current and the rapid development of its nuclear power programme.
R5	**Recommendation:** The Government should provide MEP (NNSA) with sufficient flexibility, to ensure that the regulatory body can attract and retain the suitably qualified and experienced regulatory staff that it will require.

Changes since the initial IRRS mission

Recommendation 3: After the 2010 IRRS Mission and especially after the Fukushima Accident, the Government of China strengthened the nuclear safety regulatory capacity building. Inside the MEP (NNSA), the nuclear safety department has been expanded into three different departments: Department I, II and III of Nuclear and Radiation Safety Regulation. One of the MEP Vice Ministers serves as the NNSA Administrator and the Chief Engineer on nuclear safety is designated to assist the Administrator. The Chief Engineer on nuclear safety and the three heads of the aforementioned departments are designated as Vice-Administrators. Other departments within the MEP (NNSA) such as the Department of Human Resources Management and Institutional Arrangement, the Department of Planning and Finance, the Department of Policies, Laws and Regulations, the Department of Science, Technology and Standards, the Department of International Cooperation, and the Department of Publicity and Education, provide support functions. In particular, Department I focuses on overall coordination, emergency preparedness and response, radiation environmental monitoring and nuclear safety equipment, Department II focuses on nuclear power plants and research reactors, Department III focuses on nuclear fuel cycle, radioactive waste management and nuclear technology utilization and uranium mining. The six Regional Offices, which are also reporting to the NNSA Administrator, conduct regulatory control in their regions. The Nuclear and Radiation Safety Centre (NSC) and other TSOs provide specific technical support on safety review and inspection.

The organizational structure of the MEP (NNSA) and lines of reporting are clearly prescribed in the *Integrated Management System Manual* and seem to be well established and functional. The

MEP (NNSA) is in a position to effectively and efficiently perform all functions of the nuclear safety regulatory body.

Recommendation 4: The Government of China has enhanced resource input, and the MEP (NNSA) has continuously strengthened its organization structure and put great resources into nuclear safety regulation since 2010. Staff of the Regional Office has increased from 100 to 331, in the NSC from 162 to 600. The department that specializes in nuclear safety has expanded and been divided into three departments, the staff of which increased from 59 to 85. In addition to human resource, the budget for nuclear and radiation safety regulation has quadrupled from RMB 11 million in 2010 to RMB 45 million in 2016.

The Government of China has been increasing capacity building investments into nuclear and radiation safety regulation and constantly improving the regulation level through: the construction of the National Nuclear and Radiation Safety Regulatory Technology R&D Base, building nuclear and radiation safety regulation technology support platform, comprehensively strengthening review and licensing, inspection and enforcement, radiation monitoring, emergency preparedness, experience feedback, R&D, public communication and international cooperation. In February 2013, the R&D base proposal made a breakthrough and was approved by the National Development and Reform Commission (NDRC) with a construction area of 92967 m^2 and total fund of RMB 748.86 million. Construction of the R&D base has begun at the end of 2015.

Recommendation 5: The Government of China has taken a series of measures to attract and retain talents. The IRRS team has been informed that the salaries of public servants in general have been steadily increasing since 2010 while in state owned companies like nuclear power plants have been even decreasing. Currently, the salary difference between the public servants and the similar positions in the industry was narrowed down. This is reflected also by the great interest demonstrated for employment at the MEP (NNSA). When the MEP (NNSA) opens a new position, it might get hundreds of applications.

The Government of China has been continuously improving the employee welfare. China has a unified wage system for the government employees that takes into consideration both employee position and rank. The principle "distribution according to work" is carried out in the wage system so as to embody such factors as responsibilities, capabilities, achievements and seniority, maintaining a reasonable wage difference between different positions and ranks. A mechanism for normal wage growth of civil servants is also established. In addition, China has established an insurance system so as to ensure that a government employee may enjoy assistance and compensation under retirement, illness, occupational injury, childbirth or unemployment. The MEP (NNSA) also adopts a working-hour system; a government employee who works for extra hours beyond the legal workdays will have corresponding deferred holidays.

Status of the finding in the initial mission

Recommendation 3 (R3) is closed as the MEP (NNSA) is able to perform all necessary regulatory functions.

Recommendation 4 (R4) is closed as the MEP (NNSA) has adequate resources available.

Recommendation 5 (R5) is closed as the MEP (NNSA) has enough flexibility to attract talented individuals to join its staff.

1.4. INDEPENDENCE OF THE REGULATORY BODY

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

1.5. PRIME RESPONSIBILITY FOR SAFETY

2010 MISSION RECOMMENDATIONS, SUGGESTIONS	
R6	**Recommendation:** Although the current regulations assign the prime responsibility for nuclear safety to the organization responsible for the facilities or activities, this requirement should also be clearly defined in the new laws to be promulgated.

Changes since the initial IRRS mission

Recommendation 6: Article 4 of the draft *Nuclear Safety Act*, referred to under the Recommendation 2 above, clearly states that the organization that operates the nuclear units or holds the nuclear materials should hold prime responsibility for their safety. It also states that any organization that provides equipment, construction or service with respect to nuclear installation siting, designing, construction, commissioning, operation, decommissioning and utilization of nuclear materials should hold responsibilities for their own actions.

This recommendation can be closed on the basis of progress made and confidence as the prime responsibility for safety lies with the utility and the independence of regulatory body are addressed in the draft NSA,. This recommendation is also addressed under the requirement of R2.

Status of the finding in the initial mission

Recommendation 6 (R6) is closed on the basis of progress made and confidence in effective completion as the prime responsibility for safety resting with the utility and the independence of the regulatory body are addressed in the draft NSA. The recommendation is addressed in R2, which remains open.

1.6. COMPLIANCE WITH REGULATIONS AND RESPONSIBILITY FOR SAFETY

2010 MISSION RECOMMENDATIONS, SUGGESTIONS	
S4	**Suggestion:** The new *Nuclear Safety Act* should include a clear commitment for the maintenance of the prime responsibility for safety in line with GSR Part 1 Requirement 6.

Changes since the initial IRRS mission

Suggestion 4: As mentioned in the comment on Recommendation 6, Article 4 of the draft *Nuclear Safety Act*, referred to in the recommendation R2 above which clearly states that the operator that operates the nuclear units or holds the nuclear materials shall hold prime responsibility for their safety.

Status of the finding in the initial mission

Suggestion 4 (S4) is closed on the basis of progress made and confidence in effective completion as the prime responsibility for safety resting with the utility is addressed in the draft NSA. The suggestion is addressed in R2, which remains open.

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

2010 MISSION RECOMMENDATIONS, SUGGESTIONS	
R7	**Recommendation:** The regulatory authorities should establish mechanisms for the effective coordination of the regulatory functions on occupational radiation protection, including ALARA applications, amongst MOH, provincial DoH, MEP and provincial EPB to ensure complete and clear coverage and coordination.

Changes since the initial IRRS mission

Recommendation 7: The observations from the 2010 IRRS mission leading to this recommendation were the same or similar to the observations for the suggestion S2 (see above). In addition to what is described above in responding to this recommendation, the MEP (NNSA) has explained, that since 2010 many activities were carried out such as: a comprehensive examination of national radiation safety in 2012, radiation source focused inspection in 2013 and special campaign promoting nuclear safety culture publicity in 2014. The MEP (NNSA) has also been continuously promoting coordination and communication between the MEP and the NHFPC (formerly as MoH), both at the state and provincial levels and on ALARA application in occupational radiation protection. As per medical exposure, national health authorities focus on quality assurance and dose control, i.e. the treatment per se; while the MEP (NNSA) focuses on the protection of the environment and the public, as well as occupational exposure. In 2016, the MEP (NNSA) held meetings with the national health authorities and reached a consensus on the establishment of a more effective coordination mechanism.

The MEP (NNSA) has also established the national radiation safety experience feedback and exchange system and been holding experience exchange workshops every year since 2006. These workshops provided guidance for the provincial environmental protection departments to efficiently carry out their regulatory duties.

The IRRS Team believes that, based on the information presented, there is no actual evidence proving any potential duplication, gaps and/or conflicts between the roles of different authorities as mentioned in the 2010 China IRRS report are avoided and this recommendation cannot be closed. The only exception could be the issue related to potential overlap when approving environmental impact assessment for medical facilities. Article 8 of the *Regulation on Safety and Protection of Radioisotopes and Radiation-emitting Devices* from 2005 is clearly stating that for the medical facilities, the MEP (NNSA) should issue its licence first and only then the NHFPC issues the licence for diagnostic and therapeutic technique with radioactive sources and medical radiation.

Status of the finding in the initial mission

Recommendation 7 (R7) is open as no mechanisms are established to ensure effective coordination between different authorities on occupational radiation protection.

1.8.PROVISION FOR THE DECOMMISSIONING OF FACILITIES AND THE MANAGEMENT OF RADIOACTIVE WASTE AND OF SPENT FUEL

2010 MISSION RECOMMENDATIONS, SUGGESTIONS	
R8	**Recommendation:** The government should establish a comprehensive national policy and strategy for the management of radioactive waste and spent nuclear fuel.
S5	**Suggestion:** The government should establish one agency responsible for the implementation of the national strategy for disposal of radioactive waste.
S6	**Suggestion:** When regulations or the law on prevention and control of radioactive pollution are amended, it should be made explicit that storage facilities for radioactive waste are defined as nuclear installations.

Changes since the initial IRRS mission

Recommendation 8: The IRRS team has been provided with explanations about the new waste management related developments in China after 2010:

- New legally binding documents (the *Regulation on the Safety Management of Radioactive Waste* from 2011 and later *Administrative Measures of Licenses for Storage and Disposal of Radioactive Solid Waste).*
- Drafted standards (the *Requirements on the Safety Regulation for Radioactive Waste* and the *Requirements on Decommissioning Safety*, national standards *Radioactive Waste Classification* (GB9133) and *Requirements on Near Surface Disposal of Radioactive Waste* (GB9132)).
- Regulations to be drafted (requirements on very low-level radioactive waste disposal, requirements on radioactive waste clearance, measures on raising and using funds of nuclear facilities and uranium mining facilities decommissioning, measures for long-term supervision and management of uranium mine decommissioning, management system for radioactive source recycling and reuse and measures on the collection and management of radioactive waste disposal fees).

The management of the low and intermediate level waste in China is entrusted to the utilities operating nuclear power plants, fuel cycle facilities and research reactors. The management of disused radioactive sources is borne by the provinces. They are responsible also for the construction and operation of the disposal facilities. Relevant radioactive waste management facilities should, however, be designed, constructed and operated according to the same standards.

For the spent fuel, China committed itself to the closed cycle strategy. China will reprocess the spent fuel as to reduce radioactive waste, ensure safety management of spent fuel and reduce long-term radiation risks to future generations. The *Administrative Measures of the Project of Nuclear Power Plant Spent Fuel Treatment and Disposal Fund* have been issued and the appropriate waste management fund has been established.

CAEA has formulated and promulgated *2013-2030 Plan on the Transportation, Storage and Reprocess of Nuclear Power Plant Spent Fuel*. The MEP (NNSA) has formulated and

promulgated the *Requirements for Nuclear Safety Regulation on Nuclear Power Plant Spent Fuel Dry Storage System* (For Trial Implementation).

China has also set up the funds for management of spent fuel from NPPs available for the transportation, storage and reprocessing of spent fuel and the disposal of high-level waste.

Elements of the national strategy are included in the National Safety Plan but mainly by mentioning short term plans until 2020. There is also the sentence "Implement a unified strategy in distributing the capacity to treat and dispose radioactive waste across the country, and promote the understanding by local governments and nuclear power-related businesses of their abilities to store, treat and dispose radioactive waste." However, there is no such unified radioactive waste management national strategy clearly written in one document or a set of reasonably interrelated documents.

The IRRS team has recognized that there are firm plans related to radioactive waste and spent fuel management set in China for the relatively short-term, i.e. five years or next decades and for selected kinds of waste streams. However, there is no clearly written analysis describing the current and future radioactive waste inventories and complete list of different waste streams as well as long-term policies and strategies that would cover periods longer in the future, actually forever. For example, who would take over the monitoring of the radioactive waste disposal repository once it is closed or if its operator ceases to exist? The structure and content of such national policy and strategy is described in the IAEA document NW-G-1.1 Policies and Strategies for Radioactive Waste Management from 2009.

Suggestion 5: The IRRS-FU Team was explained that the CAEA is the competent authority for formulating and implementing the national strategy (which is, however, not written in a single or several documents – see recommendation R8) for the management of radioactive waste. While the utilities operating nuclear power plants are responsible for the disposal of the radioactive waste originating from their facilities, the CAEA organizes the preparation of the siting plan for radioactive waste disposal; it organizes and carries out the engineering and safety technology research, underground experiments, siting and construction of deep geological disposal facilities for high-level radioactive waste and radioactive waste containing significant amounts of alpha nuclides; it participates in the formulation of rules and measures to levy and manage the decommissioning fund and radioactive waste disposal fee for nuclear facilities; it participates in the establishment of the national information system for the radioactive waste management. China National Nuclear Corporation (CNNC), however, is mainly responsible for the construction of all kinds of radioactive waste disposal facilities. CNNC's responsibilities include R&D, construction relating to the radioactive waste and spent fuel management.

China has not decided to establish one and only national agency, which would be responsible for the implementation of all aspects of the radioactive waste management. The Chinese legal and regulatory framework, however, is requesting, that "the operator of the disposal facility for the radioactive waste shall be responsible for its safety…" as it is required by the SSR-5 Requirement 3, which was the basis for the Suggestion 5. Therefore, the IRRS team believes this suggestion can be closed.

Suggestion 6: The IRRS team was informed that the *Regulation on Safety Management of Radioactive Waste* which was issued in 2011 describes the safety requirements and licensing procedure of waste management facilities, which is equivalent with those for nuclear installations. Article 10 of this regulation defines the scope of radioactive waste storage facilities. Thus, practically the storage facilities are regulated as nuclear installation.

Status of the finding in the initial mission

Recommendation 8 (R8) is open as China has no comprehensive national long term strategy on radioactive waste and spent fuel management.

Suggestion 5 (S5) is closed as the operator of the disposal facility is expected to be responsible for the safety of the facility until it is transferred to the provincial government.

Suggestion 6 (S6) is closed on the basis of issuing the new regulation and its implementation.

1.9.COMPETENCE FOR SAFETY

2010 MISSION RECOMMENDATIONS, SUGGESTIONS	
S7	**Suggestion:** The government should develop the national human resources development plan as an integral part of the five years national nuclear power programme strategic plan.
S8	**Suggestion:** The MEP (NNSA) may consider expanding the system of recommendations for training organizations to all professional areas relevant to nuclear safety.

Changes since the initial IRRS mission

Suggestion 7: The IRRS team has been explained that according to the requirements of the *National Medium and Long-Term Plan for Human Resource Development* (2010-2020) and the requirements of initializing human resource planning in key areas mandated by Central Coordination Group on Human Resource, MEP (NNSA) took the lead in the preparation and issuance of the *Medium and Long-Term Plan for Human Resource Development for Ecological and Environmental Protection* (2010-2020), and set forward the objectives and tasks for the fostering and training of nuclear and radiation safety regulation personnel.

The Nuclear Safety Plan is addressing human resource development in the chapter "To speed up talent cultivation, and promote balanced flow" as one of the 8 assurance measures to increase the level of nuclear and radiation safety, and clearly defines the requirements and priorities regarding nuclear and radiation safety regulation personnel fostering and training.

Human resource development of MEP (NNSA) is also addressed in detail by *Integrated Management System Manual* in chapter 4.3.

Suggestion 8: In recent years, the MEP (NNSA) has recommended groups of university research institutes and enterprises with strong faculty and professional management teams, superior basic training conditions, outstanding training performance as the specialized training organizations for certain professional areas important for radiation safety. These are: Tsinghua University to offer the Master of nuclear and nuclear technology engineering program, the Nuclear Industry Graduate Department to offer the nuclear safety "initial training", CGN University to offer nuclear power training program and Nuclear Industry Non-destructive Testing Centre to offer special training course for non-destructive testing personnel. These training programs/courses have been carried out on a regular basis and have trained a large number of nuclear and radiation safety regulation personnel

Status of the finding in the initial mission

Suggestion 7 (S7) is closed as the human resources development plan is in place.

Suggestion 8 (S8) is closed as the MEP (NNSA) has expanded its system of recommendations for training organisations to all relevant nuclear safety areas.

Policy issue discussion 1

Nuclear Safety Act Development

The government of China is committed to improving the quality of life in China. In this regard one of their top priorities is to address air pollution problems in the country by converting from fossil fuel energy to nuclear energy. The government has concluded that it is essential to implement a comprehensive and effective *Nuclear Safety Act* for the safe, secure and peaceful uses of nuclear technology. They are in the process of enacting the *Nuclear Safety Act* to do so. The MEP (NNSA) requested this policy discussion to gain the experiences by the IRRS team in implementing and following similar laws in their countries.

The MEP (NNSA) noted that a fast growing economy, environmental protection challenges, strong state commitment for safety and growing public focus on life quality create the basis for development of the *Nuclear Safety Act*. Development of the Act is supported by new governmental policy of openness and transparency and promulgated in *2015 Environmental Protection Act of Peoples' Republic of China*. The draft Act covers all nuclear safety issues. Mining and radiation sources activities are excluded from the scope. The following highlights of the draft act were presented: independent supervision, operators' prime responsibility; disclosure of nuclear safety information; public involvement; safety culture. Several steps are left before the act approval: three rounds of readings by the Standing Committee of NPC with Public Solicitations that follows the first and potentially the second readings. If all the procedures will go smoothly, the MEP (NNSA) expects promulgation of the *Nuclear Safety Act* by early 2017.

The following challenges in the development of the *Nuclear Safety Act* were shared by Chinese counterparts: fundamental character of the Act that requires to be very clear and concise in reflecting of the 30 years national experience in nuclear safety; clear division of responsibilities of different governmental departments; limiting the scope of the act to the civilian facilities only; integrations of 3S – safety, security, safeguards; emergency planning at the provincial level; protection of information versus new policy of broad disclosure of safety information.

Team members welcomed the development of the Act and mentioned that it takes into account IAEA Fundamental Safety Principles. They shared the information on the appropriateness of 3S integration, regulation of safety & security and safeguards by one regulatory body; balance in disclosure of information and protection of security information.

Flexibility of the Act for the regulation of new nuclear technologies such as transportable reactor facilities was discussed. Chinese counterparts confirmed that the Act is flexible because it implements universal fundamental safety principles.

Special attention was paid to the public confidence establishment as the draft act proposes to enhance public communication on safety issues. It was stressed that the goal of public relations is not to "protect" nuclear power use but provide clear information on risks and how the risks are controlled. Building of public trust in national regulatory body was emphasized. The IRRS team stressed that only practical regulatory actions (including strong enforcement actions) can create the real trust.

2. GLOBAL NUCLEAR SAFETY REGIME

2.1. INTERNATIONAL OBLIGATIONS AND ARRANGEMENTS FOR COOPERATION

2010 MISSION RECOMMENDATIONS, SUGGESTIONS	
R9	**Recommendation:** MEP (NNSA) should be provided with adequate resources and flexibility for international cooperation, especially taking into account the nature of some of the new designs of nuclear power plants which originate from abroad.
S9	**Suggestion:** MEP (NNSA) should have its own line of communication/interaction with the IAEA.

Changes since the initial IRRS mission

Recommendation 9: The MEP (NNSA) has increased the resources in the area of international cooperation. These efforts have enhanced its ability to provide information on technologies originating in China and obtaining information on with designs from other Member States. Examples include MEP (NNSA) strengthening its cooperation with US, France and Russia on safety regulation and review of AP1000, EPR and VVER nuclear power plants. The MEP (NNSA) conducts an annual steering committee meeting and various technical exchange meetings, including the exchange of inspection personnel between China-US and China-France to observe the construction and commissioning inspections of the AP1000 and EPRs under construction. China also participates in OECD/NEA Multinational Design Evaluation Programme (MDEP) activities associated with the AP1000, EPR, VVER Design Specific Working Groups and MDEP's Vendor Inspection Cooperation Working Group (VICWG), Codes and Standards Working Group (CSWG) and Digital I&C Working Group (DICWG).

The MEP (NNSA) has secured financial support from foreign programs including those from IAEA and EU. For example, in the China-Europe Programme of "strengthening the capabilities of China's national nuclear regulatory body and its TSOs" implemented in 2014, EU provided two million Euros of financial support and will further invest three million Euros for the second-phase cooperation.

The MEP (NNSA) has developed international cooperation information system and periodic internal communication mechanism to disseminate information regarding international cooperation throughout the MEP (NNSA).

Suggestion 9: The official liaison between the Chinese government and the IAEA is the Chinese Permanent Mission in Vienna. The CAEA, which advocates for the nuclear industry in China, is the lead governmental organization at the Permanent Mission. The MEP (NNSA) has established its own direct line of communication with IAEA on nuclear safety within the Permanent Mission where there are staff specially assigned by the MEP (NNSA) for nuclear safety and keeping close contact with the MEP (NNSA) in China. This is similar to practices of other Member States. There is no indication that this arrangement has inhibited the direct communications between the IAEA and the MEP (NNSA) on nuclear safety issues.

Status of the finding in the initial mission

Recommendation 9 (R9) is closed as the MEP (NNSA) has significantly increased its participation and coordination of international cooperation activities.

Suggestion 9 (S9) is closed. Although the current arrangement is not optimal, in that CAEA is the lead organization at the Permanent Mission, there is no evidence that this arrangement has interfered with the direct line of communication between IAEA and the MEP (NNSA).

2.2. SHARING OF OPERATING EXPERIENCE AND REGULATORY EXPERIENCE

2010 MISSION RECOMMENDATIONS, SUGGESTIONS	
R10	**Recommendation:** MEP (NNSA) should take over the role of national coordinator of the IRS and the ANSN.

Changes since the initial IRRS mission

Recommendation 10: Subsequent to the IRRS Mission in 2010, the MEP (NNSA) expressed its desire to IAEA to include MEP (NNSA) staff to serve as IRS country coordinator. In the interim, the MEP (NNSA) requested the ability to upload China's nuclear power plant operating events to the IRS system and share them with international peers, as well as refer to information of operating incidents of other countries in the system. The IAEA has granted MEP(NNSA) access to upload incidents directly into the IRS and, in August 2016, IAEA notified MEP(NNSA) that they were invited to participate in the October 2016 "Technical Meeting to Exchanges Experience on Recent Events in Nuclear Power Plants" and the "Meeting of the Technical Committee of the International Reporting System for Operating Experience Nation Coordinators."

With regard to the participation in ANSN (Asian Nuclear Safety Network), The Director, Division of Nuclear Safety International Cooperation, MEP (NNSA) has become a member of ANSN steering committee and is responsible for the coordination between China and the IAEA on ANSN-related work.

Status of the finding in the initial mission

Recommendation 10 (R10) is closed as the MEP (NNSA) has taken appropriate actions to become an active member of the IRS and ANSN.

Policy issue discussion 2

International Cooperation with the Regulators of Embarking Countries Importing Chinese Nuclear Power Technology

China's first NPP began operation in 1991 and by 2020 they plan to have about 90 units either in operation or under construction. To support this rapid expansion China has been developing its own nuclear power technology. China is also starting to export this technology to countries embarking on nuclear power programmes. The government of China is strongly committed to assisting countries strengthen their regulatory framework in the implementation of this technology. To be able to better assist regulatory bodies of embarking countries that intend to use this technology MEP (NNSA) requested a policy discussion on the best methods to support these regulatory bodies.

Currently, MEP (NNSA) has bilateral agreements with the regulatory bodies from 18 member states, among which many are countries intending to use Chinese technology. China plans to assist relevant countries to enhance their capacity in safety regulation, relying on the National Research and Development Base for Nuclear and Radiation Safety Regulatory Technology which should be ready in 2018. They also provide support to Member States through the

Regulatory Cooperation Forum (RCF), Asian Nuclear Safety Network (ANSN), the IAEA Global Nuclear Safety and Security Network (GNSSN) and the OECD/NEA Multinational Design Evaluation Programme (MDEP).

The IRRS team emphasized the need for the MEP (NNSA) to communicate, in a timely and frank manner, with Member States to share information on any safety issues associated with the design, manufacture, construction and operation of the Chinese and other nuclear power technologies. The MEP (NNSA) should promote the same nuclear safety principles as applied in China to embarking countries where applicable and notify them of any potential nuclear safety related problems with the use of these technologies. The MEP (NNSA) should also notify the Chinese exporting companies about the potential problems.

The IRRS team suggested several areas, that experience had demonstrated where embarking countries require significant assistance. These include developing regulations, conducting review and assessment and authorization activities, and conducting vendor and construction inspections including the application of and applying appropriate enforcement actions.

The IRRS team encouraged the MEP (NNSA) to continue its support of the RCF and other international organizations and work with the IAEA Office of Technical Cooperation to host scientific visits and fellowship for embarking countries which will use both Chinese technology and other nuclear power technologies.

3. RESPONSIBILITIES AND FUNCTIONS OF THE REGULATORY BODY

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

2010 MISSION RECOMMENDATIONS, SUGGESTIONS	
R11	**Recommendation:** In the circumstances of MEP (NNSA) becoming a real integrated body, to maximize regulatory effectiveness it should be organized with a clearer and more efficient line management structure where responsibilities are well defined and understood by everybody involved, ensuring that regional offices report to one coordinating body within the NNSA.

Changes since the initial IRRS mission

Recommendation 11: Since the 2010 mission, the Chinese government has strengthened the MEP (NNSA) by significantly increasing its human and financial resources and establishing a new organizational structure.

The MEP (NNSA) has published in August 2016 a comprehensive *Integrated Management System (IMS) Manual* for Nuclear and Radiation Safety Regulation. The IMS describes in detail the MEP (NNSA)'s organizational structure, such as management responsibilities and authorities, support and guarantee for the purpose of human and financial resources planning, process implementation for ongoing improvements. The IMS also outlines the internal and external interface management and coordination, internal and external communication channels and reporting system.

Chapter 3.5 "Organizations and responsibilities" of the IMS Manual describes the regulatory organizational structure of the MEP (NNSA). The nuclear and radiation safety regulator consists of the headquarter, six regional offices and two TSOs, the Nuclear and Radiation Safety Centre and the Technical Centre of Radiation Environment Monitoring. At the time of the 2010 IRRS mission, there was a single department responsible for all nuclear and safety regulation. Currently this department has been expanded to three departments: the Department of Nuclear Facility Safety Regulation, the Department of Nuclear Power Safety Regulation, the Department of Radiation Source Safety Regulation. The IRRS team concludes that this is an improvement since 2010.

Since 2010, the MEP (NNSA) increased its nuclear and radiation safety regulatory staff to more than 1000.

The MEP (NNSA) continues to share general management support services such as Administrative Systems, Human Resources, Planning and Financial Services, etc., with other Departments within the MEP.

Substantial work has been performed and significant progress has been made in relation to coordination and flow of information between regional offices, TSOs and headquarter. Chapter 5.2.4 of the IMS entitled "Communication and information disclosure" describes systematically the communication and disclosure of information to be carried out by the nuclear and radiation safety personnel in order to enhance the effectiveness and transparency of the regulator. They also report and coordinate interfaces according to the specified requirements.

Status of the finding in the initial mission

Recommendation 11 (R11) is closed as the Chinese Government has strengthened MEP (NNSA) through increasing human and financial resources and the MEP (NNSA) made changes in the organizational structure and internal and external communication and coordination to enhance the effectiveness of the regulator.

3.2. EFFECTIVE INDEPENDENCE

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

3.3. STAFFING AND COMPETENCE OF THE REGULATORY BODY

2010 MISSION RECOMMENDATIONS, SUGGESTIONS	
R12	**Recommendation:** MEP (NNSA) should develop and implement an integrated human resource management programme, in particular technical competence including knowledge management and systematic approach to training, commensurate with the needs to fulfil their regulatory responsibilities taking into account the current and the rapid nuclear power development programme of China. The ability for MEP (NNSA) to address this recommendation would be facilitated by the government addressing recommendations 4 and 5.

Changes since the initial IRRS mission

Recommendation 12: To address this recommendation, the MEP (NNSA) has taken a number of initiatives to strengthen the knowledge management. New organizational unit "Personnel Qualification Division" has been established for organizing the personnel training and knowledge management development.

The nuclear and radiation safety regulatory personnel training plans and training material have been drawn up and annual training plan published. As evidence, the counterpart presented annual training plans for 2015 and 2016 to the team. All the units of the nuclear and radiation safety regulatory system send personnel to participate in various training courses according to their own requirements for human resource and profession development. The personnel qualification training includes primary training, intermediate training and on-the-job training of which the main contents are nuclear and radiation safety regulatory law enforcement, radiation environmental monitoring management and technology, and the special subject training focused on important position personnel and the key professional work such as the simulator training, non-destructive testing, civil nuclear safety equipment regulation and quality assurance. The IRRS team was informed that more than 1000 employees, including junior, middle and senior level have so far been trained based on these programmes.

Sharing personnel experience, as an important element of the knowledge management, has been improved. To share the information online databases have been developed, including the MEP (NNSA) knowledge management system, nuclear power plants' experience feedback system, national nuclear technology utilization radiation safety management system and personnel qualification system.

The counterpart informed the IRRS team that the centralized knowledge management information platform and public information database is planned in the near future, which will integrate existing relevant systems and data resources.

Status of the finding in the initial mission

Recommendation 12 (R12) is closed as the MEP (NNSA) has established an integrated human resource management programme to fulfil their regulatory responsibilities.

New observation from the follow-up mission

Information and regulatory experience sharing is done through the networking. In order to share the experience and enhance the effectiveness, the MEP (NNSA) set groups of many special areas on social software (QQ and WeChat). For example, in the area of nuclear technology utilization, there are 5 groups on QQ network, including one director group, two junior inspector groups and two system manager groups. There are similar groups on the WeChat network. The number of all members of groups is more than 1000. Work topics can be discussed in groups, and members can ask questions about their work in the groups and can answer any question that they are interested in sharing their experience. At the time of the mission, there are about 1000 messages a day in an observed group.

FOLLOW UP MISSION RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
Observation: *In order to share the regulatory experience and enhance the regulatory effectiveness, MEP set up groups of different special areas using social software (QQ & WeChat), for example: in the area of nuclear technology utilization, there are 5 groups on QQ network, including one director group, two junior inspector groups, two system manager groups, with more than 1000 users.*	
(1)	**BASIS: GSR Part 1 Requirement 15 states that** *"The regulatory body shall make arrangements for analysis to be carried out to identify lessons to be learned from operating experience and regulatory experience, including experience in other States, and for the dissemination of the lessons learned and for their use by authorized parties, the regulatory body and other relevant authorities."*
GPF1	**Good Practice: The extensive use of social software and networking by MEP (NNSA) in daily business for sharing information and regulatory experiences, raising questions and comments and as a discussion forum in order to enhance the effectiveness of regulatory activities is considered as a good practice.**

3.4. LIAISON WITH ADVISORY BODIES AND SUPPORT ORGANIZATIONS

2010 MISSION RECOMMENDATIONS, SUGGESTIONS	
R13	**Recommendation:** MEP (NNSA) should make formal arrangement with Technical Support Organizations that they are using to ensure that there is no conflict of interest. Also the potential for conflict of interest within the subcontractors used by the TSOs should be periodically assessed by NNSA.

Changes since the initial IRRS mission

Recommendation 13: In cases where services are required from external organizations, the MEP (NNSA) has established a mechanism to avoid potential conflict of interest with respect to the selection of the appropriate suppliers and external TSOs. This mechanism for selection of appropriate suppliers and external TSOs is described in detail in section 4.8 of the IMS "Suppliers and external TSOs" that makes reference to the procedure *Procurement Control and Contract Management* (NNSA/HQ-00-ZG-AP-015).

It was explained to the IRRS team how the process is implemented. The members of the external TSO team must provide the MEP (NNSA) with a declaration of no conflict of interest and they are not to engage in any work which could raise concerns about potential conflicts of interest while they are providing services to the MEP (NNSA). These requirements are clearly defined in the contract. The MEP (NNSA) conducts internal verification to verify conformity with its own internal process. In addition, the compliance with the IMS process is independently audited by the National Audit Office of China.

The IRRS team recognized the improvements made in the capabilities of the Nuclear and Radiation Safety Centre since the 2010 IRRS mission that reduced the reliance on external TSO services.

Status of the finding in the initial mission

Recommendation 13 (R13) is closed as the MEP (NNSA) established a mechanism to avoid potential conflict of interest for work performed by external organizations.

3.5. LIAISON BETWEEN THE REGULATORY BODY AND AUTHORIZED PARTIES

2010 MISSION RECOMMENDATIONS, SUGGESTIONS	
S10	**Suggestion:** The MEP (NNSA) should continue regulatory liaison arrangements with authorized facilities.

Changes since the initial IRRS mission

Suggestion 10: The MEP (NNSA) recognized communication with authorised parties as an important tool to enhance effectiveness and transparency of the regulations. To improve and formalize process, detailed requirements are established in chapter 5.2.4 "Communication and information disclosure" of IMS Manual. Based on this document the departments and organizations of the MEP (NNSA) are required to establish appropriate internal and external communication processes among different departments and organizations, strengthen regulation information disclosure, and establish different levels of vertical and horizontal connections.

The MEP (NNSA) has expanded the way it liaises with other licensees, similar to NPPs, such as arranging annual coordinating conferences and topical dialogue meetings.

Status of the finding in the initial mission

Suggestion 10 (S10) is closed as the MEP (NNSA) established mechanisms for maintaining open, appropriate and transparent communication with authorised parties.

3.6. STABILITY AND CONSISTENCY OF REGULATORY CONTROL

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

3.7. SAFETY RELATED RECORDS

2010 MISSION RECOMMENDATIONS, SUGGESTIONS	
R14	**Recommendation:** The authorities involved in the regulatory body should enhance their information management to ensure proper information recording, analysing and dissemination to the relevant stakeholders (including the international organization) in a timely manner.
S11	**Suggestion:** MEP (NNSA) should consider strengthening its arrangements for document management, record keeping and long-term retrievable storage in accordance with the management system.

Changes since the initial IRRS mission

Recommendation 14: The MEP (NNSA) has established the National Nuclear Technology Utilization Radiation Safety Management System, to ensure a complete record and timely update of all specified information about nuclear technology utilisation.

The MEP (NNSA) issued the *Notice of Issuing and Distributing the Requirements on Administrating National Nuclear Technology Utilization Radiation Safety Management System* (No. [2012]83, MEP) in 2012. It requires that relevant data about radiation practices is recorded, and updated accurately, completely and timely. Provincial Environmental Protection Bureaus and licensees have access to the system, however, some important authorities such as the National Health and Family Planning Commission (NHFPC) and the Ministry of Public Security do not have direct access. The IRRS team was informed by the MEP (NNSA) that the nuclear technology information inside the system will be shared with the health sector and police sector in the future.

Currently, the MEP (NNSA) regularly informs the NHFPC, the Ministry of Public Security and Provincial Environmental Protection Bureaus of its regulatory decisions relating to import/export approvals and licensing of radioisotopes. The IRRS team was presented with such documents of the last three years.

Suggestion 11: In order to strengthen the management of archives and to establish the database named "National Nuclear Technology Utilization Radiation Safety Management System", the MEP (NNSA) issued *Rules for Administration of Environmental Protection Documents* (Order No. 13, NNSA) based on The Archives Law of the People's Republic of China, which describes how the archives management duties, the entire process for the archives, information records preservation, and the archives utilization should be conducted.

The IRRS team was informed that all units of the MEP (NNSA) have set up special offices for the management of archives, equipped with staff and related archives management facilities.

Meanwhile, MEP (NNSA) also paid attention to the promotion of information technology, such as, the development and operation of the digital library, with the historical archives collection and the emergence of digital archives.

Status of the finding in the initial mission

Recommendation 14 (R14) is closed on the basis of progress made and confidence in the effective completion of the process to share nuclear technology information inside the system with the relevant authorities.

Suggestion 11 (S11) is closed as the MEP (NNSA) has strengthened the archives and document management information resources.

3.8. COMMUNICATION AND CONSULTATION WITH INTERESTED PARTIES

2010 MISSION RECOMMENDATIONS, SUGGESTIONS	
S12	**Suggestion:** MEP (NNSA) should consider holding meetings with the residents and representatives of the public of the areas around the operating facilities to explain their work and decisions.

Changes since the initial IRRS mission

Suggestion 12: The MEP (NNSA) has given high importance to public communication and has taken a number of initiatives, especially after the Fukushima nuclear accident.

To promote public communication, the MEP (NNSA) issued *Administrative Measures of Nuclear and Radiation Safety Regulatory Information Publicity* (NNSA/HQ-00-ZG-AP-004-02). Additionally, the MEP (NNSA) drafted programmes and rules to specify public communication in more detail, such as, *Work Scheme of Nuclear and Radiation Safety Public Communication* and *Scheme of Nuclear and Radiation Safety Regulatory Information Publicity*.

The IRRS team was informed that the MEP (NNSA) has built a communication system with the local governments, nuclear power corporations, and licensees to promote an effective communication platform between the government, licensees and the public. For a specific nuclear facility project, further communication between the local government and the public is organized, to strengthen the public involvement during project construction. For example, public communication pilot programmes were conducted in Xudapu and Lufeng nuclear power plant sites in 2013 and 2014, respectively.

In 2015, in an effort to enhance public communication with the surrounding residents, the MEP (NNSA) held a national nuclear power "public open day", in which an operating nuclear power plant was chosen as a pilot to hold a public communication meeting with the surrounding residents' delegates, explaining to them the work and decisions made by the MEP (NNSA).

For the convenience of the public, MEP (NNSA) has set up a special "Administrator Mailbox" to facilitate public communication, accessible through its official website and app.

Status of the finding in the initial mission

Suggestion 12 (S12) is closed as the MEP (NNSA) has taken many initiatives to improve the public communications and organized meetings with the public to explain their work and decisions.

4. MANAGEMENT SYSTEM OF THE REGULATORY BODY

4.1. MANAGEMENT SYSTEM

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

4.2. MANAGEMENT RESPONSIBILITY

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

4.3. RESOURCE MANAGEMENT

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

4.4. PROCESS IMPLEMENTATION

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

4.5. MEASUREMENT, ASSESSMENT AND IMPROVEMENT

2010 MISSION RECOMMENDATIONS, SUGGESTIONS	
R15	**Recommendation:** MEP (NNSA) should establish and implement an integrated management system in conformance with IAEA SS GS-R-3.

Changes since the initial IRRS mission

Recommendation 15: The MEP (NNSA) has established its *Integrated Management System Manual for Nuclear and Radiation Safety Regulation* based on the requirements of IAEA safety standards. The manual is applicable to the MEP (NNSA) headquarter, the regional offices, and its technical support organizations. The manual addresses the scope of MEP (NNSA) regulatory activities, safety culture, graded approach, documentation system, management responsibilities (including commitment, mission, vision, core values, safety goals, policies, organization structure, interface and communication arrangements), stakeholders satisfaction, resource management, information and knowledge management, international cooperation, management of research and development activities, process implementation (including general management processes and core regulatory processes), assessments and improvements.

The manual refers to a number of procedures, programs, plans, and instructions. The counterparts explained the implementation mechanism and also showed certain documents in this regard. The team also reviewed one self-assessment report required to be generated under the IMS on semi-annual basis for the implementation of IMS for the first half of 2016.

Status of the finding in the initial mission

Recommendation 15 (R15) is closed as the MEP (NNSA) has established and is implementing its integrated management system manual based on IAEA safety standards.

5. AUTHORIZATION

5.1. NUCLEAR POWER PLANTS

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

New observation from the follow-up mission

The IRRS team was informed that Qinshan Phase one NPP will reach the end of its original 30-year licence in 2021, and Daya Bay units 1 and 2, will reach the end of their original 40-year licences in 2033. In 2015, the MEP (NNSA) issued the *Technical Policy for Operation Licence Extension (OLE)* which outlines the regulatory requirements for licence extension and the IRRS team was informed that it is discussed in the draft *Nuclear Safety Act*.

The MEP (NNSA) stated that they have conducted numerous discussions with the licensee regarding the content of the licence extension application and the MEP (NNSA) review schedule. A separate document, *Implementing Programme for Operating Licence Extension of Qinshan 320MWe Unit* (QM-OLE-TGAM-0000), provides a detailed plan for the Qinshan NPP to submit an application for a licence extension/renewal and for the MEP (NNSA) to review the application.

The MEP (NNSA) is developing a five-year plan to complete the development of the guidance for the review of applications. The MEP (NNSA) is considering basing their review on the USNRC *Generic Aging Lessons Learned (GALL) Report*. To date, the MEP (NNSA) has completed drafting several documents to implement the Technical Policy Statement, e.g. *Safety Guide of Ageing Management of NPP* (2012).

The MEP (NNSA) should continue to develop regulations, and implement review procedures and provide guidance on the content of the application. This will provide guidance and clarity to licensees to submit a complete application for extending or renewing the operating license and allow for the MEP (NNSA) to perform a timely evaluation of the submitted applications.

FOLLOW UP MISSION RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
Observation: *The MEP (NNSA) has developed the "Technical Policy for Operation Licence Extension (OLE)" for renewing the licences of NPPs and a plan for extending/renewing the Qinshan NPP operating licence; however, regulations and a formal process and guidelines have not been established.*	
(1)	**BASIS: GSR Part 1 - Requirement 24 para 4.34 states that** *"The regulatory body shall issue guidance on the format and content of the documents to be submitted by the applicant in support of an application for an authorization. The applicant shall be required to submit or to make available to the regulatory body, in accordance with agreed timelines, all necessary safety related information as specified in advance or as requested in the authorization process."*
(2)	**BASIS: GSR Part 1 - Requirement 24 para 4.37 states that** *"Any subsequent amendment, renewal, suspension or revocation of the authorization for a facility or an activity shall be undertaken in accordance with a clearly specified and established procedure and shall make provisions for the timely submission of applications for the renewal or amendment of the authorization."*

FOLLOW UP MISSION RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
(3)	**BASIS: NS-G-2.12 para 6.1 states that** *"To facilitate long term operation of a nuclear power plant, the operating organization should demonstrate, and the regulatory body should oversee, that the safety of the nuclear power plant is acceptable when compared with current safety standards. This section presents recommendations on an in-depth review of ageing management in connection with the long term operation of a nuclear power plant."*
RF1	**Recommendation: The MEP (NNSA) should establish a specific process and guidelines for the content and review of applications for extending or renewing NPP operating licences.**

5.2. RESEARCH REACTORS

2010 MISSION RECOMMENDATIONS, SUGGESTIONS	
R16	**Recommendation:** MEP (NNSA) should make explicit requirements in revising the relevant code to ensure that applications submitted by the licensee that contain safety analyses results shall be verified by experts independent from those that were involved in the preparation of the application, reflecting existing practices.
S13	**Suggestion:** Acknowledging that MEP (NNSA) regulates all research reactors as in operational status, it should consider elaboration of regulations on the design and maintenance requirements related to the extended shutdown state of research reactors and critical assemblies.

Changes since the initial IRRS mission

Recommendation 16: There is no standard review plan for research reactor applications. To review an application for a research reactor, the MEP (NNSA) adopts the review standard for nuclear power plants *Safety Requirements on the Nuclear Power Plant Design (HAF102)*, issued in 2004, as a reference. HAF102, stipulates that a safety assessment report submitted by the licensee to the MEP (NNSA) includes an independent evaluation. However, there are no procedures or guidance that specifically state that HAF102 should be used for the review of research reactors.

The MEP (NNSA) has not yet updated the requirements or codes per the recommendation. The MEP (NNSA) stated that the intent to update the requirements and codes was pending on the issuance of IAEA Safety Standard SSR-4 *Safety of Research Reactors*, which will replace NS-R-4 *Safety of Research Reactors*. The intended update is included as part of the five-year plan to update several regulations and guides but is listed as a Category II update noting that it should be updated between 2016 and 2020.

Suggestion 13: At the time of the IRRS Mission in 2010, a research reactor in long-term shutdown was still considered as operational and regulated as such. The concept of "long-term shutdown" was promoted in the IAEA NS-R-4. To address this recommendation the MEP (NNSA) drafted the *Management Guidelines for Long-term Shutdown of Research Reactors* in 2014, and issued it in August 2016.

Status of the finding in the initial mission

Recommendation 16 (R16) is open as the MEP (NNSA) has not yet drafted the requirement for independent verification of the safety analysis which supports licence applications for research reactors.

Suggestion 13 (S13) is closed. The MEP (NNSA) has issued *Management Guidelines for Long-term Shutdown of Research Reactors* in August 2016.

5.3. FUEL CYCLE FACILITIES

2010 MISSION RECOMMENDATIONS, SUGGESTIONS	
S14	**Suggestion:** MEP (NNSA) should consider applying a graded approach in a carefully balanced manner to regulatory control over the various fuel cycle facilities, and this control should be commensurate with the potential hazard the facilities represent.
S15	**Suggestion:** With the increase in need for nuclear fuel cycle facilities in the future, MEP (NNSA) should consider whether it needs more formal means to achieve confidence in contractor qualifications having influence on the safe operation of fuel cycle facilities.
S16	**Suggestion:** MEP (NNSA) should consider the elaboration of a procedure/programme for systematic supervision of the qualification and training of fuel cycle facility personnel.

Changes since the initial IRRS mission

Suggestion 14: The IRRS team observed that substantial work has been performed in reply to this suggestion. The MEP (NNSA) has developed a documented requirement entitled *Classification Principles and Basic Requirements for Civilian Nuclear Fuel Cycle Facilities* meant to supplement HAF301 *Safety Regulations on Civil Nuclear Fuel Cycle Facilities*. This document will be used as a basis for elaboration of safety requirements of fuel cycle facilities and contains requirements for categorizing the fuel cycle facilities according to their safety significance and risk level as follows:

1) potential off-site radiation risk and accident consequences (e.g. spent fuel reprocessing facilities);
2) highly critical on-site hazard and potential significant radiation risk and accident consequences (e.g. spent fuel storage facilities, MOX fuel manufacturing facilities);
3) critical on-site hazard and potential significant radiation risk and accident consequences (e.g. uranium enrichment facility, fuel (other than MOX or natural uranium) manufacturing facilities);
4) moderate on-site radiation risks and accident consequences (e.g. natural uranium purification/conversion facilities, natural uranium fuel manufacturing facilities).

The document *Classification Principles and Basic Requirements for Civilian Nuclear Fuel Cycle Facilities* is based on IAEA-TECDOC-1347 (Nuclear fuel cycle facilities design considerations of external events) and on DOE-STD-1027 (Hazard rating and accident analysis) and reflects the relevant requirements of NS-R-5. It has been released after closure of ARM, in June 2016.

In the authorization of FCFs a generic licensing procedure is applied to differentiate the risk categories based on the *Classification Principles*. However, no regulatory requirement addresses explicitly a graded approach to authorization of FCFs, while the respective regulatory guidance is still under development and is expected to be ready by 2020 or later.

Suggestion 15: The document *Regulation on the Supervision and Management of Civilian Nuclear Safety Equipment* (State Council Order No. 500) specifies the requirements for the nuclear safety of facilities, their systems and system components, and for equipment important for nuclear safety. This document also applies to nuclear fuel cycle facilities. Among others this regulation requires that contractors taking part in design, manufacturing, installation, non-destructive testing, welding and maintenance of FCFs obtain licenses from the MEP (NNSA); have given qualification and given length of practice in the work to be performed. The MEP (NNSA) has the right to supervise the manufacturing process and the qualification of the personnel at the contractor.

At the same time, the licensee can also determine the vendor's qualification and confirm the ability of contractors.

The document *Nuclear Power Plant Quality Assurance Safety Regulations* (HAF003) formulates requirements on contractors having roles in procurement or manufacturing of safety related equipment. These requirements pertain to all details of the quality systems of the contractor.

A *Catalogue of Civil Nuclear Safety Equipment* has just been published and is to be applied to the first commercial reprocessing plant in China (being in the site selection phase).

A document similar to the Catalogue is under preparation for FCFs other than reprocessing plants.

Suggestion 16: The *Self-Assessment Summary Report* states that MEP (NNSA) supervises the qualification and training of the staff of nuclear fuel cycle facilities mainly from the aspect of their quality assurance programs and procedures.

During the follow-up mission the IRRS team was informed that, on one hand all regional offices have specific inspection programmes including parts on inspection of staff qualification and training, on the other hand generic inspection programs for fuel reprocessing plants (not existing yet in China) and for uranium enrichment facilities including items on personnel training have been presented. The IRRS team was also informed that similar programmes exist also for other FCFs, yet no specific regulatory procedures are available for such activities.

Even though no MEP (NNSA) level dedicated qualification and training supervision programme exists, there is a quality control code containing specific requirements on supervision of qualification and training for NPP personnel. The code states that it can be applied also to other nuclear facilities. This code, however, sets obligations to the licensees and does not address regulatory supervision.

Registration of workers is required in order to work in certain critical positions (e.g. those related to radiation protection, quality control and nuclear safety management; a minimum of four persons need to be employed in each FCF in these categories). Registration is done jointly by MEP (NNSA) and the Ministry of Human Resources and Social Security.

The IRRS team notes that the MEP (NNSA) has in place supervision of qualification and training of FCF staff based on training procedures and inspection plans, although no respective general regulatory process or procedure is in place. The MEP (NNSA) is encouraged to make this a regular and required practice by establishing and implementing the respective regulatory procedure/process.

Status of the finding in the initial mission

Suggestion 14 (S14) is closed on the basis of progress made and confidence in effective completion as the general basis for application of graded approach in authorization has been established and the respective regulatory guidance is planned to be developed.

Suggestion 15 (S15) is closed on the basis of progress made and confidence in effective completion as the requirements on supervision of subcontractors have been established for certain types of FCFs and are foreseen for other types.

Suggestion 16 (S16) is closed as in practice supervision of qualification and training of FCF staff is performed based on training procedures and inspection plans, although no respective general regulatory process or procedure is in place.

5.4. INDUSTRIAL, MEDICAL AND RESEARCH FACILITIES

2010 MISSION RECOMMENDATIONS, SUGGESTIONS	
S17	**Suggestion:** The MEP (NNSA) should consider ensuring that the provisions of the Guidance on Import and Export of Radioactive Sources are fully followed, as far as practicable.
R17	**Recommendation:** The regulatory body should establish requirements for financial provisions for the safe management of disused sources.
S18	**Suggestion:** The regulatory body should consider enhancing the implementation of the graded approach by adjusting the authorization process according to the category of the sources.

Changes since the initial IRRS mission

Suggestion 17: When approving the export and import of Category 1 and 2 radioactive sealed sources, the MEP (NNSA) applies the *Guidance on Import and Export of Radioactive Sources Supplementing the Code of Conduct on the Safety and Security of Radioactive Sources*. The MEP (NNSA) has established forms for consent request from China to the importing state on import of Category 1 radioactive sources and China's consent to the exporting state (consent granted or not granted). The forms for consent were approved in 2012 by the MEP (NNSA) (Forms). Using the forms ensures that the provisions of the Guidance are followed.

Notification of the state of import prior to the specific shipment of Category 1 and 2 radioactive sealed sources is done by the Chinese exporting companies and an example of notification of the importing facility with a copy to the regulatory body of the importing state was provided.

The MEP (NNSA) demonstrated to the IRRS team:

- An example of a request for consent of the importing state and the MEP (NNSA)'s answer to the request for consent for Category 1 radioactive source shipment;
- A draft agreement between the MEP (NNSA) and the Canadian regulatory body requires compliance with the provisions of the *Guidance on Import and Export of Radioactive Sources Supplementing the Code of Conduct on the Safety and Security of Radioactive Sources* for Canada-China export-import operations.

Recommendation 17: The MEP (NNSA) has not established requirements for financial provisions for the safe management of disused sources.

The IRRS team was informed that safe and secure management of the sources at the end of their life cycle is mainly provided by the following measures:

- Implementation of the requirement of the Article 32 of the *Regulation on Safety and Protection of Radioisotopes and Radiation-emitting Devices* (Decree No. 449 of the State Council of the People's Republic of China, 2005): "Where a unit producing or importing radioactive sources sells radioactive sources of Category 1, 2 or 3 to another unit to use, it shall sign an agreement with the unit using radioactive sources on returning the disused sources. The unit using radioactive sources shall return the disused sources to the original producer or exporter in accordance with the agreement. If it is truly impossible to return the disused sources to the original producer or exporter, they shall be sent to a centralized storage unit of radioactive wastes with relevant qualification for storage. A unit using radioactive sources shall, in accordance with provisions of the competent environmental protection department of the State Council, pack the disused sources of Category 4 or 5 and send them to a centralized storage unit of radioactive wastes with relevant qualification for storage.",
- The current practice is to provide provincial public finance support and central financial support in special circumstances (like bankrupt company) for the transfer of the disused radioactive sources to the radioactive waste storage facility. However, no legal provisions are in place to support this current practice.

Suggestion 18: The MEP (NNSA) licensing process for radiation sources consists of two steps. The first step is the review of applicant's environmental impact assessment. For this step different processes are established in accordance with Management Directory of Environmental Impact Assessment for Construction Project (MEP Order No.33, 2015). The processes are based on:

- A registration form (low risk facilities and activities such as the use of radioactive sources of Category 4 and 5, the manufacture, sale and use of Category 4 and 5 sources);
- An impact assessment form (medium risk facilities and activities such as the production of radiopharmaceutical for PET; sale of Category 1 – 3 radioactive sources; sell of unsealed radioactive materials; use of Category 1 radioactive sources for medical purposes; use of Category 2 radioactive sources; manufacture, sale and use of Category 2 and 3 radiation-emitting devices; class B and C work places for unsealed radioactive materials; experiments using radioactive tracer in open field), and
- An impact assessment report (for high risk facilities and activities such as radioisotope production (except radiopharmaceutical for PET), sale and use of Category 1 radiation generators; class A work places for unsealed radioactive materials).

The requirements for the preparation, the content and review of these submittals are graded according to the risk. The regulation *Radiation Environmental Protection Management Guidelines/Content and Format of Environmental Impact Assessment Document for Nuclear Technology Application Facilities* was revised in 2016 to include requirements on the registration form, the impact assessment form and the import assessment report.

Status of the finding in the initial mission

Suggestion 17 (S17) is closed as forms have been established to support the implementation of the provisions of the *Guidance on Import and Export of Radioactive Sources Supplementing the Code of Conduct on the Safety and Security of Radioactive Sources* and practical examples showed that the provisions are fully followed.

Recommendation 17 (R17) is closed as the requirements will be addressed in RF2 in Section 9.5.

Suggestion 18 (S18) is closed as a graded approach has been implemented for the environmental impact assessment which is the first step of licensing providing for the radiation safety assessment.

5.5. WASTE FACILITIES

2010 MISSION RECOMMENDATIONS, SUGGESTIONS	
R18	**Recommendation:** MEP (NNSA) should establish a formal legal requirement to have a waste minimization plan as part of the application for a license.
S19	**Suggestion:** MEP (NNSA) should encourage the operator of the Beilong Disposal Facility to apply for an operating licence for the facility, be that as a disposal facility or as a storage facility. The current temporary operating permit is not a sustainable situation.

Changes since the initial IRRS mission

Recommendation 18: During the 2010 IRRS Mission it has been stated that there had been substantial efforts to reduce the generation of RAW at NPPs and had been done already at the design stage of the plants. As part of licensing, operators of NPPs submit to MEP (NNSA) a plan for the minimization of RAW included in the overall waste management plan.

The minimization of the RW is required both as per article 39 of *Law of Prevention and Control of Radioactive Pollution* and in article 4 of the State Council Decree *Regulation on Safety Management of Radioactive Wastes* issued in 2011. In the State Council Decree (*Regulations on the Safety Regulation for Civilian Nuclear Installations of the People's Republic of China* HAF001)it was formally requested that SAR should be submitted by the operator of the nuclear installation to the regulatory body for applying licences in each stage of construction, first fuel loading and operation. The IRRS team was informed by the MEP (NNSA) that the regulation specifying the contents required in these reports is under development (*Regulation on the Content of SAR*). In the safety guide *Waste Minimization of the Nuclear Installation* (HAD 401/08)which is now a draft but will be issued before the end of this year, it is required that the SAR should include a section of RW minimization plan, and the format and content is also listed as the annex of HAD 401/08.

Suggestion 19: Due to the expansion of nuclear power it had been concluded during the 2010 IRRS Mission that the capacity of the Beilong Disposal Facility may not be sufficient and other disposal options would be considered. Thus, the Beilong Disposal Facility was authorized for trial operation only.

Two more LILW disposal facilities were licensed and are in operation (Northwest Disposal Facility, Feifeng Mountain Disposal Facility) and another five disposal facilities are under

development in China. It is expected that each of three existing nuclear power corporations will develop a disposal facility for the RAW from their NPPs and will operate and close them and perform institutional control of sites. Then the ownership of the site will be transferred to the provincial government.

Beilong Disposal Facility had applied for the license, and got it from NNSA in 2011 (NNSA file No. [2011] 12 and NNSA license No. 1107). The license was presented to the reviewer. It is valid for 10 years, limits the amount of disposed RAW to 70 vaults, each 7x17x17 m large and defines the maximal total activity of RAW to $5.4x10^{15}$Bq (for α nuclides up to $3.7x10^{5}$Bq). The disposal of disused sealed sources is forbidden. Annually, till 31 March the operator of Beilong Disposal Facility has to provide an annual report to NNSA.

In annex of the licence maximal activities for critical radionuclides (H-3, C-14, Co-60, Ni-63, Sr-90, Cs-137 and Pu-239) are listed. NNSA presented the EIA report submitted in March 2006 to the regulatory body as a support of the licensing of the operation of Beilong Disposal Facility. The report contains analysis of operational and long-term safety of the facility. The initial dose constraint for the public is 0.25mSv/y for normal operational scenario and 1.5mSv/y for accidental scenarios (multiple/single irradiation). The source term defined by the operator of the Daya Bay NPP (2x984MWe) corresponds to the maximal activities for critical radionuclides listed in the operating license. The safety assessment showed that the maximal dose rate for operational staff will not exceed 8.1mSv/y and for the public 10^{-7}Sv/y (from ^{60}Co in RAW). In a long term the critical radionuclide is ^{14}C (total dose rate to the public from drinking water reaches maximal value after 300 y and is $2.85x10^{-5}$Sv/y) and ^{3}H (total dose rate to the public from drinking water reaches maximal value after 100 y and is $4.99x10^{-6}$Sv/y). For the intrusion scenario the critical nuclide is ^{137}Cs (total dose rate to the public reaches maximal value after 100 y and is $7.9x10^{-5}$Sv/y).

Status of the finding in the initial mission

Recommendation 18 (R18) is closed as legal requirements for waste minimisation in nuclear installations have been established.

Suggestion 19 (S19) is closed as the NNSA provided clear evidence that the Beilong Disposal Facility is operated on the basis of a valid license.

New observation from the follow-up mission

A waste minimization requirement for facilities other than nuclear installations needs to be addressed by published law, regulation or guideline, since this does not currently exist. This will require installations other than NPPs, FCFs and Waste Facilities to submit as part of their licensing process a waste minimization plan.

FOLLOW UP MISSION RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
Observation: *According to IAEA Safety Standards, the licensees of facilities other than nuclear installations should provide a waste minimization plan as part of their applications for licenses. At the time of the IRRS follow-up mission this was not required as part of the licensing process.*	
(1)	**BASIS: GSR Part 5 Requirement 14 para 5.5 states that** *"The design of the facility, the arrangements for operational management and the systems and processes that are used have to be considered and justified in the safety case.*

FOLLOW UP MISSION RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
	This has to involve the identification of waste arising and the establishment of an optimal programme of waste management to minimize the amount of waste generated and to determine the design basis and operational basis for the treatment of effluents, the control of discharges and clearance procedures. The primary aim of the safety case is to ensure that the safety objectives and criteria set by the regulatory body are met."
(2)	**BASIS: SF1 Principle 7 states that** *"People and the environment, present and future, must be protected against radiation risks."*
RF2	**Recommendation: The MEP (NNSA) should further develop legal requirements to have a waste minimization plan as part of the application for a licence for facilities other than nuclear installations.**

6. REVIEW AND ASSESSMENT

6.1. NUCLEAR POWER PLANTS

2010 MISSION RECOMMENDATIONS, SUGGESTIONS	
R19	**Recommendation:** The headquarter MEP (NNSA) should assess its current and future needs for internal technical expertise considering especially its decision-making functions.
S20	**Suggestion:** NNSA should perform appropriate conformational analysis and verification for nuclear facilities accident analyses in the construction license phase, where possible acquiring adequate tools.
R20	**Recommendation:** In developing safety guides, regulations and Evaluation Principles MEP (NNSA) should ensure that there are no conflicts.
S21	**Suggestion:** The MEP (NNSA) should consider developing guidance concerning the use of PSA for key applications, and should consider starting to risk-inform its own regulatory functions to optimize regulatory activities and develop an implementation programme for that purpose.
S22	**Suggestion:** The MEP (NNSA) should consider ensuring that they have adequate capability to review human factors and safety culture related issues in the light of the nuclear industry expansion.

Changes since the initial IRRS mission

Recommendation 19: Since 2010, the MEP (NNSA) has restructured its organization and significantly increased its staff. At present, the headquarter staff, which consists of the nuclear and radiation safety supervisors, has grown their proposed staffing level to 85, the Regional Offices has grown to 331, and the Technical Support Organizations have grown to 600. The MEP (NNSA) performed a comparison with other foreign regulatory organization such as the US, France and the Republic of Korea, comparing staff to the number of power plants to determine the increase in the size of the staffing necessary in the MEP (NNSA). Recommendation 19 requested that the MEP (NNSA) assess the current and future needs for internal technical expertise. In the *Proposal on Infrastructure and Human Resource Demand of National Nuclear Safety Regulations System*, the IRRS team notes that the necessary technical disciplines staffing levels were not taken into consideration, but only looked at the proposed changes in overall staffing levels at Headquarters, Regional Offices, and Technical Support Organizations. However, there is a process for performing an analysis of the necessary technical disciplines that are needed for each Division and Department within the NSC which perform the specific technical reviews which lead to appropriate decision-making. The individual division heads determine their necessary staffing levels based on their projected workload using Review Team Arrangement templates for the various future tasks. The Division Heads then hold a joint meeting with the administrator of NSC to discuss their respective division staffing requests. During the meeting, and based on the allowed budget, the NSC decides the allocation of staff and the *Talent Introduction Plan and Implementation in Nuclear and Radiation Safety Centre* is issued yearly This includes all of the technical disciplines that the NSC needs and therefore, determines the recruitment which should occur to complete the staffing of the NSC.

Prior to being hired, the prospective staff must have a background in nuclear engineering, and pass a public service examination and an examination in their respective discipline. To ensure the proper level of knowledge, the MEP (NNSA) has developed an in-depth training program to ensure that the new staff has the necessary knowledge and skills required to perform the reviews that will be necessary as the nuclear program expands. This training provides the training framework for not only the technical staff but for the applicable supervisor level for both nuclear safety and radiation safety.

Suggestion 20: During its review of a license application, the MEP (NNSA) performs an independent review based on computer models and independent computations, using software different from the designer's, and then compares the outcomes with the designer's result to verify the acceptability of document. Independent calculations assist the reviewer in its evaluation and assessment of operational and new construction nuclear power plants, including the model analysis and verification of severe accidents.

The MEP (NNSA) has obtained several software systems developed by the USNRC, Westinghouse and Areva to perform independent confirmatory analysis and verification for the AP1000 and EPR designs, as well as conducting workshops on the use of this software. This includes software to verify: 1) Neutron Physics and Criticality Safety, 2) Thermal-hydraulic Analysis, 3) Severe accident analysis, 4) Computational fluid dynamics code, and 5) PSA. The MEP (NNSA) has used this software and other softwares to perform the independent calculations in the review of FSAR of Sanmen NPP and the PSAR of CAP1400 NPP, and is currently reviewing the HPR1000 NPPs.

Currently, the MEP (NNSA) has the necessary software for the AP1000 and EPR designs, however, they do not have the necessary software for any future or existing high temperature gas-cooled reactor, fast reactors or research reactors. NSC has been given a separate budget to develop the necessary codes for accident analysis, however, research is needed and this is part of the next five-year research plan, which is currently being developed for future designs.

Recommendation 20: In the various procedures, issued in 2015 and 2016, for the development and revision of safety guides, regulations or principles, such as *The Procedure for Department Rules Formulation on Nuclear and Radiation Safety*, Section 9.2, informs the writers that they should review the necessary aspects that need to be included in Section 5 of the package, to ensure that conflicts do not exist. These aspects include: 1) complying with existing Laws and Administrative Codes, 2) consistent with existing regulations, 3) comply with nuclear and radiation safety regulation responsibilities, 4) whether they include any administrative reviews, administrative penalty, administrative forcing, and administrative charge that are not authorized by regulations, 5) whether the legal rights of citizens, legal persons and other organizations are diminished or damaged or obligations are increased which result in potential administrative review or suits, 6) whether they enquire the comments and carry out sufficient coordination on significant issues, and 7) whether they comply with legislative technical requirements. After the formulation of these documents, these are submitted to the Nuclear and Radiation Safety Regulations Standards Review Committee, Professional Committee and General Committees (Collectively called, "Regulations and Standards Review Committee"). After being reviewed and approved by the Regulations and Standards Review Committee, these departmental rules, safety guidelines, technical documents and other regulations are enacted by the MEP (NNSA).

Suggestion 21: In Section 5.9 Safety Analysis' of HAF102, *Safety Requirements on the Safety of Nuclear Power Plant Design*, operating plants were to use probabilistic results in their safety analysis. In addition, in 2010, the MEP (NNSA) issued technology policy *Application of Probabilistic Safety Analysis Techniques in the Field of Nuclear Safety* (for Trial

Implementation)." Section 4 of this policy, defines the requirements for the use of a probabilistic safety analysis (PSA). In 2012, the MEP (NNSA) officially launched a pilot application for nuclear power plants. The MEP (NNSA) has risk-informed its regulatory process through the development of a database on the reliability of equipment, and issued the *Report of Equipment Reliability Data in China*. These documents were developed by the MEP (NNSA) through the collection and analysis of equipment reliability data of operational NPPs through the end of 2013, and the establishment of a data base of the equipment reliability.

As clarification, the initial IRRS Mission report stated in Section 6.1.4 that "Level 3 PSAs for internal and external events are required in HAF 102", however after reviewing the document, the IRRS team determined that only Level 2 PSAs are required.

Suggestion 22: In December 2014, the MEP (NNSA) along with the National Energy Administration, and the State Administration of Science, Technology and Industry for National Defence issued the *Policy Statement on Nuclear Safety Culture*, and in August 2016, the MEP (NNSA) issued the *Integrated Management System Manual for Nuclear and Radiation Safety Regulation*. Section 2.4 "Nuclear Safety Culture" of the Manual describes the basic position on safety culture and the eight characteristics of a good nuclear safety culture throughout the entire nuclear industry. Once promulgated, the *Nuclear Safety Act* will also contain provisions related to developing a nuclear safety culture. The MEP (NNSA) has created a specific division to study nuclear safety culture and to develop the necessary documents related to safety culture. In addition, NSC has established a staff of experts who oversee the safety culture program. Lastly, the MEP (NNSA) sends safety culture experts to the nuclear power plants to explain and train their staffs on nuclear safety culture.

In September 2014, the MEP (NNSA) began a one-year special program related to safety culture. This program was related to safety equipment, nuclear power and research reactors, nuclear fuel cycles and nuclear technology applications. The program had several phases including preparation, first implementation, second implementation, and summary stage. After this program, the MEP (NNSA) summarized the findings of the program and issued the results in various public outlets.

The IRRS team was informed that the licensees include a chapter in their SARs to consider the effects of human factors on the design basis of the nuclear power plant. The NSC has established a division to review and assess this chapter.

Status of the finding in the initial mission

Recommendation 19 (R19) is closed. The MEP (NNSA) has a process for determining the necessary staffing for their Departments.

Suggestion 20 (S20) is closed. The MEP (NNSA) has obtained numerous software systems and has performed independent confirmatory analysis and verification.

Recommendation 20 (R20) is closed as the MEP (NNSA) has in place various levels of control to ensure that, during the development or revision of various safety guides, regulations or principles, conflicts are prevented.

Suggestion 21 (S21) is closed based on the MEP (NNSA) issued guidance related to the use of PSAs.

Suggestion 22 (S22) is closed based on the various documents issued and the organization structure which has been established to provide the capability to review human factors and safety culture.

6.2. RESEARCH REACTORS

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

6.3. FUEL CYCLE FACILITIES

2010 MISSION RECOMMENDATIONS, SUGGESTIONS	
R21	**Recommendation:** MEP (NNSA) should require the updating of the SAR of fuel cycle facilities on a regular basis as well as following important modifications that have an effect on the safety of the installation.
R22	**Recommendation:** MEP (NNSA) should make the necessary steps to provide adequate resources in order to make it able to perform all the assessment and review work necessary to support the MEP (NNSA)'s regulatory supervision of fuel cycle facilities, especially for spent fuel facilities. Analyses provided by organizations outside of the regulatory body should be ensured to be independent of the nuclear operators.
S23	**Suggestion:** MEP (NNSA) should consider setting requirements on the frequency of the periodic safety review of fuel cycle facilities and the issuance of regulatory guidance on periodic safety reviews for fuel cycle facilities.

Changes since the initial IRRS mission

Recommendation 21: In 2015 MEP (NNSA) developed a document entitled *Administrative Measures of Licences for Civilian Nuclear Fuel Cycle Facilities*, which requires that nuclear fuel cycle facilities should conduct periodic safety reviews and each facility should update its Safety Analysis Report timely. Another document, entitled *Classification Principles and Basic Requirements for Civilian Nuclear Fuel Cycle Facilities*, published in 2016, states that the SAR should be updated whenever significant changes, having impact on safety, have been introduced. A regulatory guidance entitled *Contents and Format of SAR of Fuel Cycle Facilities* has been published in 1991.

Recommendation 22: In recent years, with the rapid development of China's nuclear power programme, the Nuclear and Radiation Safety Centre (NSC), as an internal technical support organization of the MEP (NNSA), has been substantially extended and strengthened. This includes extension of its technical expertise. Newly acquired competences include criticality safety calculations, shielding calculations, and seismic analysis. MEP (NNSA) management believes that the future development of NSC could render it competent to undertake all types of safety review tasks related to fuel cycle facilities.

Although no institutional guarantees exist on avoiding conflicts of interest if external organizations are involved in review and assessment activities, for the reasons above, this is not considered a real issue. With the establishment of the new R&D centre, the technical capabilities of NSC staff will be further extended and there will be less demand for external contributors.

Suggestion 23: MEP (NNSA) has carried out periodic safety reviews of several nuclear fuel cycle facilities in recent years based on requirements set by the document *Period Safety Review of Nuclear Power Plants*. Specifically, PSRs were conducted in two FCFs in the last three years (uranium enrichment facilities) and PSRs of two fuel manufacturing facilities were performed in the last six years. Development of a document specific to fuel cycle facilities has been initiated.

Finalization of this document has been suspended because there are few FCFs requiring PSRs in the near future as they have been built less than 12 years ago while the responsible experts are overwhelmed with the development of FCF guidelines.

In the draft document the required frequency of PSRs of fuel cycle facilities is once every ten years. According to the self-assessment report the completion of this draft is expected after 2020. In the discussions the IRRS team was informed that the deadline was changed to before 2020.

Status of the finding in the initial mission

Recommendation 21 (R21) is closed as the basic requirement on updating SAR has been established, and the respective regulatory guidance is in existence.

Recommendation 22 (R22) is closed as the internal capability of the TSO has increased and the conflict of interest is adequately addressed in the IMS.

Suggestion 23 (S23) is closed on the basis of progress made and confidence in effective completion as a draft document setting the frequency of the PSR of fuel cycle facilities has been developed, however the finalization of the draft was postponed to some date before 2020.

6.4. INDUSTRIAL, MEDICAL AND RESEARCH FACILITIES

2010 MISSION RECOMMENDATIONS, SUGGESTIONS	
S24	**Suggestion:** The MEP (NNSA) should consider to establish procedures for formal recognition of external experts in the field of radiation protection.

Changes since the initial IRRS mission

Suggestion 24: The MEP (NNSA) established Nuclear Safety and Environmental Experts Committee that is regulated by the MEP (NNSA) document *Measures for the Organization and Administration of Nuclear Safety and Environmental Experts Committee* ("Measures for Committee").

Members of this Committee are recognized by the MEP (NNSA) as external experts in different areas including radiation protection. The list of the experts is approved by the Minister on the basis of the Committee proposal. Committee prepares its proposal on the basis of: recommendation of the organization where the candidate expert is employed; its qualification as senior and higher title that is proved by the certification in the candidate's organization; criteria that are listed in the article 6(2) of the "Measures for Committee" (senior professional title, more than 15 years of experience, high attainments in nuclear and radiation safety). The IRRS team received a list of recognised external experts, which is publically available. Names and organizations of the experts are indicated in the list; area of expertise is not indicated.

Status of the finding in the initial mission

Suggestion 24 (S24) is closed as the MEP (NNSA) has established a formal procedure for the recognition of the external experts.

6.5. WASTE FACILITIES

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

7. INSPECTION

7.1. NUCLEAR POWER PLANTS

2010 MISSION RECOMMENDATIONS, SUGGESTIONS	
S25	**Suggestion:** MEP (NNSA) should enhance its training programme for inspectors and experts; the enhancement would provide knowledge and experience in all areas of safety, security, radiation protection and the environment that inspectors oversee during the lifecycle of the plant.
R23	**Recommendation:** MEP (NNSA) should enhance the process of review, analysis and sharing of operating experiences. This includes sharing of experience amongst the regions. This process should include appropriate means of sharing information amongst the regulatory body and operating organizations. The regulatory body should consider the development of a database to facilitate management of follow up actions, trending, accessing to information as part of overall knowledge management.
S26	**Suggestion:** MEP (NNSA) should formalize a mentoring programme to build expert knowledge and skills of inspectors in order to aid the inspectors in areas which are not covered by procedures. This mentoring programme should extend beyond the initial inspector certification training programme.
S27	**Suggestion:** MEP (NNSA) should look for ways to enhance the sharing of detailed inspection procedures and their application amongst the regional offices, especially for new construction inspections. Detailed inspection procedures would provide guidance on what to inspect from the significance perspective to inspectors without detailed technical expertise.
S28	**Suggestion:** MEP (NNSA) inspectors should consider extending the scope of review of NPPs to include how the licensee manages technical processes and programmes in detail.
S29	**Suggestion:** MEP (NNSA) should consider developing a database of inspection findings, to be shared within the entire NNSA.
S30	**Suggestion:** MEP (NNSA) should continuously improve and implement the programme of safety performance indicators for utilities and ensure that staffs are trained in their use.
S31	**Suggestion:** MEP (NNSA) should consider optimizing the practice of rotating resident inspectors among sites to allow sufficient time at one site in order to stabilize the experience level but not too long to suffer regulatory capture.
S32	**Suggestion:** MEP (NNSA) should consider using technical support organizations consistently to contribute to the development of site specific inspection guides.
R24	**Recommendation:** MEP (NNSA) should strengthen the auditing programme in foreign factories for quality assurance of equipment to be used in Chinese NPPs.

2010 MISSION RECOMMENDATIONS, SUGGESTIONS	
S33	**Suggestion:** MEP (NNSA) should consider enhancing the sharing of major lessons learned from manufacturing experience with others.

Changes since the initial IRRS mission

Suggestion 25: The MEP (NNSA) has enhanced its training programmes for inspectors and technical experts. This features an entry level training programme, centralized in Head Office, followed by specific training programmes to inspectors and experts, portions of which are centralized and portions of the training being delegated to regional offices. Staff become certified inspectors upon successful completion of the training. Staff follow continuous training, and in particular, inspectors must renew their certification. The MEP (NNSA) has also presented documents as evidence of entry level, continuous and regular training activities (forums, seminars), which also serve to enhance communications between work groups. Responsibilities for inspection duties are distributed and work methods are established in a way that encourages communications and knowledge transfer among technical experts from regional offices and inspectors at site. Interviews with the operator's staff showed that NPP licensees encourage discussions between their own experts and regulatory staff on station engineered features and work methods. This is recognized by the IRRS team as a positive contributor to transparency, knowledge management and collaborative relationship with licensees.

The MEP (NNSA) uses their own NPP generic full-scale simulator to enhance the training of their inspectors and technical experts.

The MEP (NNSA) demonstrated clear expectations for training of their technical staff and has a dedicated training administration group that plans, delivers and oversees delivery of an annual training plan. The MEP (NNSA) maintains records of seminar and forum activities. The MEP (NNSA) also maintains updated personnel records, which the IRRS team sampled, that maintain qualification status of the inspectors. Training activities are evaluated as prescribed by the IMS expectations.

Operational experience records are used to enhance the training programme. The MEP (NNSA) also encourages staff to pursue higher education towards post graduate university degrees and has undertaken collaboration with specific institutions towards that objective.

Recommendation 23: The MEP (NNSA) has designed and implemented a software platform for the purpose of sharing operating experience. This platform is accessible by all agency staff and integrates, among others, the related areas of operational experience, reports of licensee unusual operating events, power plants safety performance indicators and inspection reports findings. So far, users have a capacity to trend some of the parameters as well. The platform is also partly accessible to licensees.

Suggestion 26: The MEP (NNSA) has greatly improved their work methods which lead to enhanced discussions between technical experts and inspectors at the NPP level, regional offices and among regional offices as well. This is supported by a management process for mentoring that encourage the sharing and communication of relevant operational knowledge throughout the year. This enhancement increases confidence in the quality and completeness of MEP (NNSA) staff assessments and evaluation of their licensees.

Suggestion 27: The MEP (NNSA) have demonstrated and implemented management processes with the objective of sharing procedures among sites and regional offices on a regular basis.

These processes increase the efficiency of resources for recurrent inspection such as commissioning activities for nuclear power plants and plants under construction.

Suggestion 28: The MEP (NNSA) has demonstrated their current scope of inspections and a baseline set of inspections to identify minimum inspection coverage. MEP (NNSA) regional office staff also presented the index of technical programme inspections conducted on a need basis, at a specific site. These inspections are covered by teams of technical experts and site inspectors from the site and regional office. Staff of the regional office demonstrated to the IRRS team that the MEP (NNSA) also conducts inspections as needed to cover in more details licensee programmes or processes.

The IRRS team saw evidence of adequate inspection guides and related criteria that support the conduct of inspections, inspection reports, and record keeping. These inspections are conducted and cover the lifecycle of the NPP visited, that is, construction, commissioning and operations.

Following the 2015 chemical explosion in Tianjin, China, the MEP (NNSA) completed special inspections of their nuclear sites. These inspections included the review of safety culture. MEP (NNSA) presented samples of their follow-up findings related to these inspections. MEP (NNSA) inspectors had the adequate training to address cross-functional issues including safety culture.

Suggestion 29: Following the 2010 mission, the MEP **(**NNSA) developed an inspection database. MEP (NNSA) staff demonstrated to the IRRS team that the inspection database is kept up-to-date with respect to the status of important findings. The category search in the database is currently limited. MEP (NNSA) staff has indicated to the IRRS team that improvements were being planned to enhance the search capabilities. This enhancement could lead to improved regulatory oversight. The IRRS team is of the opinion that all findings should be entered in the inspection database until their closure, and entries not being limited to important findings.

Suggestion 30: The MEP (NNSA) has developed and implemented a safety performance indicator programme for NPPs. This programme is captured in the operational feedback software platform and associated database. The database features trending capability, and the demonstration of its capacity showed it had a relatively user-friendly interface. The system was up to date when observed by the IRRS team. The MEP (NNSA) uses similar indicators as USNRC. The MEP (NNSA) has also indicated their interest in modernizing the set of indicators. The MEP (NNSA) presented evidence of a high level, undated draft procedure which shows how staff analyse and respond to the performance indicator data submitted by the licensee and how this analysis affects the regulatory oversight of licensees. They also indicated that this oversight was similar to the oversight undertaken by the USNRC. Despite interviews with inspectors, the IRRS team could not confirm the application of detailed procedures.

Suggestion 31: The MEP (NNSA) has established a management expectation on inspector to optimize the length of stay at a particular site. For the site visited, the IRRS team observed that the maximum site residence time for inspectors is five years.

Suggestion 32: The IRRS team has observed that TSOs contribute to the establishment of appropriate inspection guides. Moreover, mechanisms and management processes are in place to ensure that these guides are made available for similar usage at different stages of the lifecycle at NPP locations across the country. The IRRS team recognizes that this is a significant improvement since the initial IRRS mission in 2010.

Recommendation 24: The Government of China and the MEP (NNSA) have strengthened the auditing programme in foreign factories towards quality assurance of equipment to be used in Chinese NPPs. The MEP (NNSA) has a management process and resources that organize

auditing functions and a registration process for suppliers to the Chinese industry. China has also set up foreign offices to closely monitor the suppliers. The MEP (NNSA) has established a programme of inspection and reporting and communicates to stakeholders the results of the audits, and also ensures closure of findings through a proper QA auditing process.

Suggestion 33: The MEP (NNSA) has demonstrated the process and tools used to communicate lessons-learned using their software platform. This system follows findings until closure and it links findings from previous inspections. The MEP (NNSA) has also implemented a management process for regularly sharing findings from their suppliers among the community of suppliers and stakeholders of the supply chain including the regulator.

Status of the finding in the initial mission

Suggestion 25 (S25) is closed on the basis of achieving the objective of training and knowledge transfer.

Recommendation 23 (R23) is closed on the basis that the MEP (NNSA) has implemented knowledge management platform and its accessibility.

Suggestion 26 (S26) is closed on the basis of implemented work methods that result in enhanced knowledge transfer among staff with different experience and knowledge levels.

Suggestion 27 (S27) is closed on the basis of implemented work methods, inspection procedures and managed processes that support the sharing of knowledge among staff.

Suggestion 28 (S28) is closed on the basis of implementation of an extension of the scope of review of NPPs which include how the licensee manages technical processes and programmes in detail.

Suggestion 29 (S29) is closed on the basis of the implementation of a software platform and database which reaches the objectives that were set in the suggestion. The NNSA could however take steps to increase efficiency to ease the follow up of inspection findings status.

Suggestion 30 (S30) is closed on the basis of the implementation of a safety performance indicator program for power reactors.

Suggestion 31 (S31) is closed on the basis of establishing a management expectation on maximum residence time for inspectors at a particular NPP.

Suggestion 32 (S32) is closed on the basis of the implementation of appropriate practices and a managed process to ensure that TSOs contribute to the establishment of appropriate inspection guides.

Recommendation 24 (R24) is closed as the NNSA has set up an appropriate auditing function, reporting follow up and closure mechanism for any findings related to these audits. NNSA uses their information software platform to make the auditing results information available to stakeholders.

Suggestion 33 (S33) is closed on the basis of sharing major lessons learned from manufacturing experience with others.

7.2. FUEL CYCLE FACILITIES

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

7.4. INDUSTRIAL, MEDICAL AND RESEARCH FACILITIES

2010 MISSION RECOMMENDATIONS, SUGGESTIONS	
S34	**Suggestion:** The regulatory body should ensure that the inspectors' competencies and inspection procedures are enhanced so that they recognize matters related to radiation safety and regulatory requirements if not included in their inspection checklists.
S35	**Suggestion:** The regulatory body should consider optimizing the implementation of the graded approach by adjusting the inspection frequencies and process according to the category of the sources.

Changes since the initial IRRS mission

Suggestion 34: Inspection procedures have been enhanced so that MEP (NNSA) Technical Procedures for Regulation and Inspection of Radiation Safety and Protection do not limit the inspectors to those items on the checklist, but allows them to use their experience and knowledge of radiation safety to inspect other matters as deemed necessary.

Inspectors' competencies in radiation protection are enhanced through training, workshops and networking.

Training is mainly provided through the participation in the Nuclear and Radiation Safety Training Courses. Since 2010, the frequency of the training courses was increased for providing more training opportunities. The MEP (NNSA) document *Measures for the Administration of Safety and Protection of Radioisotopes and Radiation Generators* (2011) establishes more detailed requirements for radiation safety inspector training and examination. The one week duration training course for 150 radiation safety inspectors is held by NNSA 3 times per year. Regional inspectors that have passed the training in NNSA subsequently train inspectors at the regional training events. The Training course programme was provided and it includes radiation safety inspection topics.

Seminars for regional inspectors are held on a yearly basis, which are attended by senior officers of the MEP (NNSA), regional offices and Provincial Environmental Protection Bureaus (EPB), to discuss regulatory activities and to exchange information pertaining to radiation safety inspection issues.

Inspection experience sharing is also done through networking. This networking is considered a good practice (see Section 3).

Suggestion 35: Article 42 of the Regulation HAF802-2011 *Measures for the Administration of Safety and Protection of Radioisotopes and Radiation Generators* stipulates that the frequencies of inspections for facilities and activities with radiation sources shall be determined based on radiation safety risks associated with the radiation sources.

This requirement is implemented for category 1 sealed radioactive sources licensed by the MEP (NNSA). Inspection frequencies for category 2-5 radioactive sealed sources may vary between the different administrative regions. The IRRS team was provided with examples of inspection frequencies for category 2-5 radioactive sources which are adjusted according to the category of radioactive sources.

Inspection processes are different for different types of practices. These are prescribed in the MEP Technical Procedures for Regulation and Inspection of Radiation Safety and Protection.

Site visit

The IRRS Team observed an inspection at the industrial irradiation facility Beijing Hongyisifang Radiation Technology Co., LTD. The inspection was conducted by four inspectors of the North-Regional Office of the MEP (NNSA). The IRRS team was informed that the overall scope and depth of the inspections is generally the same and that this particular inspection was the second of its kind this year.

The inspection started with an entrance meeting in which the licensee presented an overview of relevant radiation safety related actions taken since the last inspection and continued by a presentation showing the actions taken based on the findings of the previous inspection. Then two inspectors went on-site to each of the two irradiators. The IRRS Team followed one of the groups inspecting BFT II ^{60}Co irradiator.

The on-site aspects of the inspection were conducted following a very detailed check-list constituting a comprehensive set of tests on the various safety systems. The inspectors reviewed comprehensive sets of licensee's records including occupational exposure, training certificates, source inventories, water monitoring, as well as import and export of sources.

The IRRS team observed that the inspection was conducted in a systematic and professional manner. The inspectors used a web-based online software installed (electronic checklist) on a tablet computer to submit the inspection findings directly to the MEP (NNSA) data system. The IRRS team observed an open and professional relationship between the inspectors and the licensee.

During the site visit the IRRS team was informed that in addition to the MEP (NNSA) the facility is also regulated by the State Administration for Work Safety (SAWS). This authority had been transferred from the Ministry of Health, but the SAWS had not executed this authority until this year. The SAWS has assigned the Centre for Disease Control and Prevention (CDC) to make an annual evaluation of the site. The IRRS team was informed by the licensee that the evaluation covers various radiation safety related matters including occupational exposure control and related issues. The evaluation report is being sent by the CDC back to the facility itself and to the SAWS.

Status of the finding in the initial mission

Suggestion 34 (S34) is closed as the NNSA has enhanced inspectors' competence by means of training, experience exchange and networking and has revised its inspection procedures.

Suggestion 35 (S35) is closed as the inspection frequencies and processes have been adjusted according to the category of sources.

7.5. WASTE FACILITIES

2010 MISSION RECOMMENDATIONS, SUGGESTIONS	
R25	**Recommendation:** The regulatory body should ensure that due consideration is given to certain parameters and properties of waste which the operator does not appear to be reporting, namely: - a cumulative total of the nuclide specific inventory of the disposal facility, - important non-radiological properties of the waste.
R26	**Recommendation:** The regulatory body should require the operator to strengthen their programme for radiation protection monitoring of the controlled area at the Beilong disposal facility.

Changes since the initial IRRS mission

Recommendation 25: In 2010, the IRRS team observed records of the waste management facility and found that the facility operator did not:

1) maintain a cumulative total of the nuclide-specific inventory in the disposal vaults; and
2) specify on records of waste receipt many of the important non-radiological parameters for the waste (e.g. toxic metals).

Since 2010, the State Council of China adopted *Decree No.612 on Safety Management of RAW* (HAF004 2011) which requires that the operator of a storage facility collects and manages records on RAW in these facilities (quantities and other important parameters). These records have to be kept by the operator until the RAW is delivered to a disposal facility. A similar requirement is applicable for the operators of disposal facilities, and they have to retain all records for unlimited time.

The IRRS team was provided with records of three waste packages delivered to Beilong Disposal Facility, containing details such as package type, package and RAW weight and volume, surface dose rate and dose rate at 1 m distance from surface, surface contamination and content of radionuclides (absolute and relative values). Information on non-radiological parameters of RAW in package, such as content of lead or boron, is recorded for each RAW package, if applicable.

The operator of Beilong Disposal Facility provides an annual report on RAW management (operating license condition). For 2015 the report contained the inventory of critical radionuclides (e.g. ^{60}Co – 5,3 .10^{13}Bq, ^{63}Ni – 2,6 .10^{13}Bq, ^{137}Cs – 7,6 .10^{12}Bq).

Recommendation 26: According to the radiation protection plan (Radiation Protection Management of Beilong Site, GNPEP, No. B-IP-HPS-001, dated 7 July 2016) approved in the operating license, the Beilong Disposal Facility operating organization conducts monitoring of the staff working in the control zone. In chapter 4.4.2.2 of this plan procedures for leaving the control zone of the disposal facility are listed. Once contamination of staff is indicated decontamination is performed or, if needed, the staff is sent for specialized medical treatment. A photo of a personal monitor at Beilong site was provided by the MEP (NNSA).

Status of the finding in the initial mission

Recommendation 25 (R25) is closed as evidence has been provided regarding reporting of inventory of Beilong Disposal Facility and on the structure and content of records of single RAW packages.

Recommendation 26 (R26) is closed based on the review of the document Radiation Protection Management of Beilong Site and evidence of an installed contamination monitor.

8. ENFORCEMENT

8.1. NUCLEAR POWER PLANTS

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

8.2. INDUSTRIAL, MEDICAL AND RESEARCH FACILITIES

2010 MISSION RECOMMENDATIONS, SUGGESTIONS	
R27	**Recommendation:** Periodically the regulatory body should collect, analyse and disseminate information on non-compliances and enforcement actions, in particular to provide feedback to enhance the performance of the regulatory functions.
R28	**Recommendation:** Consideration should be given for the involvement of all authorities comprising the regulatory body in the completion of the enforcement guide.
S36	**Suggestion:** Consideration should be given to include risk-based grading in the implementation of the enforcement policy for radioactive sources.

Changes since the initial IRRS mission

Recommendation 27: The MEP (NNSA) collects and maintains records on non-compliances for activities and facilities with radiation sources in the database called National Radiation Safety Management System of Nuclear Technology Utilization (NRSMS). Records in the NRSMS are kept in the form of central and regional offices inspectors' reports. Today, the system includes about 70 000 reports. Non-compliances and enforcement action records of provincial EPB are kept by these bureaus. According to the NNSA request all provincial EPBs prepare and submit to the NNSA, yearly report with the analysis of non-compliances and enforcement actions. NNSA summarizes these reports and information from NRSMS and prepares the summary report. The 2015 summary report was provided to the IRRS team in Chinese. This report includes a list of the non-compliances and proposals of regulatory actions to resolve the non-compliances. The report and enforcement actions are analysed in the framework of preparation for the annual workshop for regulatory experience exchange (see Suggestion 34 information in Chapter 7.4). The most typical and/or important non compliances and appropriate enforcement actions are chosen from the summary report and are included into the workshop agenda. Minutes of the workshop establish measures/actions to improve regulatory effectiveness. These actions become obligatory for the implementation by all inspection offices. The 2015 minutes were provided as an example.

Nation-wide notifications on the typical cases of non-compliances, enforcement actions, lessons learned are issued by the MEP (NNSA) to relevant licensees and inspection offices. The IRRS team was provided an example of a notification sent to all gamma-radiography facilities and all inspection offices about the loss of a category 2 source. "Typical" enforcement cases are part of the Nuclear and Radiation Safety Training Course (see Suggestion 34 information in Chapter 7.4).

Therefore, the regulatory body does collect, analyse and disseminate information and provide feedback as recommended.

Recommendation 28: Implementation of this recommendation is part of the overall issue of coordination between MEP (NNSA) and other regulatory authorities addressed in Recommendation 7 which remains open.

Suggestion 36: The MEP (NNSA) has prepared the draft of *Environmental Administrative Enforcement Guideline of Nuclear Technology Application*. This draft establishes calculation of fines with risk-based grading. For example, if activities with radiation sources are executed without environmental assessment document approval or without the license, the magnitude of fines is calculated according to the category of radiation source in use. Another example is the violation of regulations requirements. For a radioactive source of category 1 and 2, or radiation-emitting devices of category 1, violator would receive a penalty in an amount of 30% from the maximum established in the regulation. For a radioactive source of category 3, or radiation-emitting devices of category 2, a penalty would be issued at 20% of the maximum. For radioactive source of category 4 and 5, or radiation-emitting devices of category 3 the penalty would be set at 10% of the maximum.

Status of the finding in the initial mission

Recommendation 27 (R27) is closed as the MEP (NNSA) collects, analyses and disseminates information on non-compliances and enforcement actions and enhances the performance of the regulatory functions using feedback.

Recommendation 28 (R28) is closed as it is covered by Recommendation 7 which remains open.

Suggestion 36 (S36) closed on the basis of progress made and confidence in the effective completion of draft *Environmental Administrative Enforcement Guideline of Nuclear Technology Application*, which is at the final stage of development and planned to be issued by the end of 2016.

9. REGULATIONS AND GUIDES

9.1. NUCLEAR POWER PLANTS

2010 MISSION RECOMMENDATIONS, SUGGESTIONS	
R29	**Recommendation:** The MEP (NNSA) should adopt a practice where all the regulations are reviewed on a regular basis.
S37	**Suggestion:** The MEP (NNSA) should allocate sufficient resources and funding to the development of regulations and guides.
R30	**Recommendation:** The MEP (NNSA) should follow a policy where, in the long run, the licensing of new nuclear power plants is based on existing regulations. The need to backfit operating plants to meet the regulations should be assessed first as new regulations are issued and then in connection with Periodic Safety Reviews. Backfitting concerning operating plants should be performed, based on these assessments, as found reasonably practicable.

Changes since the initial IRRS mission

Recommendation 29: The MEP (NNSA) reviews the regulations mainly based on the input from the field staff (involved in review and assessment or inspections), input from the industry and academia, development activities in nuclear industry and the condition of development and revision of international regulations and standards of nuclear safety. This practice is in line with the IAEA GSR Part 1 requirement 33 that "Regulations and guides shall be reviewed and revised as necessary to keep them up to date, with due consideration of relevant international safety standards and technical standards and of relevant experience gained."

The draft *13th Five Year Plan for the Development and Revision of Nuclear and Radiation Safety Laws and Regulations* (2016-2020) includes a list of documents (regulations, departmental rules and guides) that would be developed or revised. These documents are divided in three categories 1, 2 and 3 - category 1 documents are those which are expected to be completed and issued by 2020; category 2 documents are those that are expected to be completed to a large extent but may not be issued until after 2020; whereas category 3 documents are those that should be started but may not be issued until 2020. The list includes a total of 179 documents out of which 24 are in category 1, 90 are in category 2 and 65 are in category 3.

Suggestion 37: The MEP (NNSA) appears to allocate the necessary financial and human resources for the development of regulations and guides. The funds are allocated for research projects in support of the development of regulations and guides and related activities. At the time of the IRRS Follow-up Mission, the total amount of such projects ranged from RMB 200,000 to 700,000.

Recommendation 30: The MEP (NNSA) issues licences for the new nuclear power plants based on existing regulations as required under article 12(3) of HAF 001*Regulation on Safety Regulation of Civilian Nuclear Installations*, which states that "the facility filing application shall be in compliance with relevant laws and nuclear safety regulations of the State". The MEP (NNSA) carries out licensing for nuclear facilities and activities, and refuses to issue licenses to nuclear facilities and activities which do not meet nuclear safety regulations and standards.

Regarding a backfit to the operating nuclear power plants, the counterparts informed the IRRS team that when the MEP (NNSA) issues new regulations, the licensees of operating nuclear power plants are required to assess their plants against these new regulations. In the event the assessment identifies the need for modifications (such as structures, systems and components; operational limits and conditions; instructions and procedures; or a combination of these), the licensees are required to submit plans of their proposed modifications to the MEP (NNSA) for approval in accordance with *Safety Requirements on Operation Safety of Nuclear Power Plants Operation* (HAF-103). The MEP (NNSA) may require certain modifications from operating plants based on experience feedback or outcome of research activities. As an example, the counterparts provided the IRRS team with the document entitled "Notification regarding performing containment sump screen modification" issued to all operating plants for making modifications based on experience feedback.

Article 10.1 of HAF103 requires that "in the whole operating lifetime of a nuclear power plant, considering the operating experience and new important safety information from all relevant sources, the operating organization must conduct a systematic safety assessment again on the nuclear power plant according to management requirements". The MEP (NNSA) requires licensees to conduct a PSR in accordance with Article 10.1 to assure conformance with the safety standards specified by nuclear safety regulations.

Following the Fukushima Daiichi Nuclear Power Plant accident, the MEP (NNSA) issued in June 2012 the *General Technical Requirements on Improvement Actions of Nuclear Power Plants after the Fukushima Nuclear Accident*, requesting licensees to address lessons learned and experiences from the accident, which requires each nuclear power plant to divide improvement actions into short, medium and long-term accordingly for implementation.

Status of the finding in the initial mission

Recommendation 29 (R29) is closed as the MEP (NNSA) revises and updates the regulations and guides with due consideration of relevant international safety standards and relevant experience gained.

Suggestion 37 (S37) is closed as necessary resources appear to be provided for the development of regulations and guides.

Recommendation 30 (R30) is closed as the MEP (NNSA) assesses the need for a backfit based on new regulations during the periodic safety review and approves the proposed modifications.

9.2. RESEARCH REACTORS

2010 MISSION RECOMMENDATIONS, SUGGESTIONS	
R31	**Recommendation:** MEP (NNSA) should revise its regulations on research reactors and critical assemblies in order to formulate requirements in compliance with the IAEA safety requirements in NS-R-4 where they exist and as far as reasonably practicable.
S38	**Suggestion:** In order to facilitate the issuance and application of the Department Rule under revision MEP (NNSA) should initiate the elaboration of related regulatory guides without waiting for issuance of the IAEA guidance.

Changes since the initial IRRS mission

Recommendation 31: The MEP (NNSA) has begun addressing this recommendation by issuing documents to establish requirements in accordance with IAEA Specific Safety Requirements NS-R-4, *Safety of Research Reactors*. For example, the *Measures on Research Reactor Safety Classification* (For Trial Implementation) was issued in September 2013. However, the MEP (NNSA) stated that it will not begin the process of updating the governmental requirements until IAEA SSR-3, *Safety of Research Reactors* is issued by the IAEA replacing NS-R-4.

To address Recommendation 29, the MEP (NNSA) has developed a broader plan for the development and revision of regulations and standards (2016-2020) which will also be used to manage the update of requirements for research reactors with a proposed completion date of 2020.

In the next five years, the following three aspects of regulations of research reactors will be developed:

- In terms of site safety evaluation, the *Safety Requirements on Site Assessment of Research Reactors* and its supporting guide *Safety Assessment for the Site of Research Reactors*;
- In terms of design safety, the *Safety Requirements on Research Reactor Design*, and its supporting guides including *Radiation Protection Design and Operating Radiation Protection of Research Reactors*, *Requirements on the Quality Assurance of Safety Important Items of Research Reactors* and *Classification of Quality Assurance of Research Reactor Items*;
- In terms of operating safety, the *Safety Requirements on the Operation of Research Reactors*, and its supporting guides including the *Regular Safety Review for Research Reactors*, *Operating Limits and Conditions and Procedures for Research Reactors*, *Ageing Management for Research Reactors* and *Operating Organizations and Personnel Management for Research Reactors*.

Suggestion 38: Until the actions for Recommendation 31 have been completed, the MEP (NNSA) continues to issue these documents in draft format for trial use.

Status of the finding in the initial mission

Recommendation 31 (R31) is open due to the uncertainties associated with the MEP (NNSA) issuing new requirements and regulations.

Suggestion 38 (S38) is closed on the basis of progress made and confidence in the effective completion as the MEP (NNSA) has made progress in the development of draft documents to address this Suggestion.

9.3. FUEL CYCLE FACILITIES

2010 MISSION RECOMMENDATIONS, SUGGESTIONS	
R32	**Recommendation:** MEP (NNSA) should revise its regulations on fuel cycle facilities in order to formulate requirements in compliance with the IAEA safety requirements in NSR-5 where they exist and as far as are reasonably practicable.
S39	**Suggestion:** In order to facilitate the issuance and application of any such revision to regulations, MEP (NNSA) should initiate the elaboration of related regulatory guides.

Changes since the initial IRRS mission

Recommendation 32: In reply to the recommendation a high level regulatory document *Classification Principles and the Basic Safety Requirements for Civilian Nuclear Fuel Cycle Facilities* has been developed. Another document *Catalogue of Civil Nuclear Safety Equipment* has been revised whereas other documents are planned to be developed. These documents do not fully address the non-compliances underlying the Recommendation as discussed in the report of the 2010 IRRS mission.

The IAEA safety requirement NS-R-5 has been translated to Chinese and has been published as a nuclear industrial standard (a guidance and technical document). Furthermore, a working group has been set up for the revision/elaboration of the respective detailed regulatory requirements. The MEP (NNSA) has developed a five-year plan for the development and revision of nuclear and radiation safety regulations including HAF 301 *Safety Requirement for Nuclear Fuel Cycle Facilities*.

Suggestion 39: Besides the elaboration of the five-year plan mentioned in connection with Recommendation 32, no significant development has so far been reached for FCFs. Regulatory safety guides on uranium conversion, uranium enrichment, fuel manufacturing, evaluation principles of reprocessing facility, FCF siting safety analysis and various equipment qualifications are foreseen to be developed by 2020. More than 10 safety guides are planned to be developed after 2020.

Status of the finding in the initial mission

Recommendation 32 (R32) is open as the detailed regulations addressing the specific non-compliances are only foreseen in the coming years, some of them sometimes after 2020.

Suggestion 39 (S39) is open as, besides planning, no further effective progress was reached in the development of FCF-related regulatory guides.

9.4. INDUSTRIAL, MEDICAL AND RESEARCH FACILITIES

2010 MISSION RECOMMENDATIONS, SUGGESTIONS	
R33	**Recommendation:** MEP (NNSA) should finalize, approve and implement draft documents on *Implementation Rule for Safety and Protection management of radioisotopes and radiation-emitting devices*.
R34	**Recommendation:** MEP (NNSA) should finalize and implement the draft Rule related to radiation monitoring at scrap metal and smelting industry.

Changes since the initial IRRS mission

Recommendation 33: The MEP (NNSA) issued *Regulations on Safety and Protection of Radioisotopes and Radiation-emitting Devices* in April 2011. It applies to the safety of radiation sources.

Recommendation 34: The MEP (NNSA) issued *Regulations on Safety and Protection of Radioisotopes and Radiation-emitting Devices* in 2011. Articles 35-37 of this regulation prescribe requirements for radiation monitoring of scrap metal and recycling industry.

Status of the finding in the initial mission

Recommendation 33 (R33) is closed as the MEP (NNSA) has issued and is implementing *Regulations on Safety and Protection of Radioisotopes and Radiation-emitting Devices*.

Recommendation 34 (R34) is closed as the MEP (NNSA) has issued and is implementing *Regulations on Safety and Protection of Radioisotopes and Radiation-emitting Devices* that covers radiation monitoring at scrap metal and smelting industry.

9.5. WASTE FACILITIES

2010 MISSION RECOMMENDATIONS, SUGGESTIONS	
R35	**Recommendation:** MEP (NNSA) should develop regulations for decommissioning plans covering: • When decommissioning plans should be drawn up; • Scope and content of the plan; and • Periodic revision of the plan. The regulations should cover decommissioning plans for existing as well as for planned nuclear installations.
R36	**Recommendation:** For the Legislative plan for the period 2010-2015, MEP (NNSA) should assign suitable priority to the development of the regulations and rules for radioactive waste management. The proposed suite of guides for radioactive waste management to be produced in the same period should be re-evaluated in light of the current plans for the development of the IAEA safety standards.

Changes since the initial IRRS mission

Recommendation 35: Article 27 of the *Law on the Prevention and Control of Radioactive Pollution* requires all operators of nuclear installations to draw up decommissioning plans. NPPs in operation or under construction have decommissioning plans. However, many existing nuclear installations (i.e., installations other than NPPs) did not have such plans in 2010.

The Government of China and the MEP (NNSA) are currently developing departmental rules including the *Safety Management of Decommissioning of Nuclear and Radiation Facilities* and guides to regulate the decommissioning work. A draft of *Safety Management of Decommissioning of Nuclear and Radiation Facilities* has been provided to the IRRS team. It contains requirements on decommissioning specific for nuclear installations, uranium mining facilities, facilities using Category 1-3 sealed radioactive sources, Class A and B unsealed radioactive substances, and further requirements on NNSA inspections and enforcement.

The operator will need to submit the decommissioning plan first in the design stage of the nuclear facility covering the following:

- decommissioning strategy,
- decommissioning schedule,
- feasibility analysis,

- EIA report,
- safety analysis,
- RAW management,
- financial arrangements and
- organization of the decommissioning works.

Details on the content of these documents are not included in the requirements and will be a subject of detailed guidelines.

During the operation, the decommissioning plan will be updated within the framework of periodic review of safety case or in case of modifications of the facility or if major accident occurs. Once the nuclear installation is shut down the operator shall implement the decommissioning plan no later than 5 years after shutdown.

As an example, the SAR of Changjiang NPP (Units 1 and 2) was provided to the IRRS team. In chapter 20 of the SAR, information on the decommissioning strategy (immediate dismantling), decommissioning plan and implementation of requirements on facilitation of decommissioning at design and operational phases is included.

A decommissioning plan will be required for all facilities using radiation sources within the scope of the radiation safety licence. During the design of these facilities, the facilitation of decommissioning shall be considered (selection of used materials, layout of the facility, record keeping, etc.). The decommissioning strategy for these facilities is immediate dismantling. First the disused source(s) has to be removed from the facility and then, like in the case of NPPs, the operator shall implement the decommissioning plan no later than 5 years after shutdown. Prior to the beginning of decommissioning the operator shall submit to the MEP (NNSA) an EIA report, which has to be approved by the MEP (NNSA) and only then can decommissioning commence. As in the case of nuclear installations, guidelines on the content of EIA will be developed in the future.

During the discussion with the management of Beijing Hongyisifang Radiation Technology Co. Ltd., the IRRS team was informed that no decommissioning plan is required to be submitted to the regulatory body to obtain a radiation safety licence. MEP (NNSA) staff informed the IRRS team of a "Guideline on γ Radiation Irradiators Decommissioning" issued in 2013 and that this guideline will be applicable to this licensee for licence renewal in 2018.

Recommendation 36: The IRRS mission in 2010 stated, that there is no regulatory standard defining the format and content of a safety case for predisposal radioactive waste management facilities (e.g. RAW storage facilities).

Since then, the Government of China and NNSA gave the priority to the development and revision of regulations of RAW management within the framework of the development and revision of regulations of nuclear safety. In 2011, the State Council issued the *Regulation on the Safety Management for Radioactive Wastes*, which regulates activities of the processing, storage, and disposal of radioactive waste. In 2013, the MEP (NNSA) issued *Measures for the Administration of Licenses for Storage and Disposal of Radioactive Solid Waste*.

A guideline on the content and format of safety documentation has been presented to the IRRS team. The document *Content and Format of Environmental Impact Evaluation Document for Nuclear Technology Utilisation Facilities* (HJ 10.1-2016) provides details on content and format of EIA report for facilities producing, using or selling radionuclide sources or radiation emitting devices. This category of facilities covers also all provincial RAW storage facilities.

The MEP (NNSA) submitted to the IRRS team the *13th Five Year Plan for the Development and Revision of Nuclear and Radiation Safety Laws and Regulations* (2016-2020). The plan contains a list of regulatory documents which will be developed or revised. The Plan states that these documents should take into account experiences gained at the national level and consider international standards.

The IRRS team was informed that regarding RAW management and decommissioning, five requirements and 41 guidelines will be developed, as well as two guidelines on design of NPPs, RAW management systems and on the operation of RAW management systems in NPPs will be revised between 2016 and 2020.

Status of the finding in the initial mission

Recommendation 35 (R35) is closed on the basis of progress made and confidence in the effective completion of the development of Requirements for Decommissioning Safety and specific guidelines defining details on the scope and content of documentation building a decommissioning plan.

Recommendation 36 (R36) is closed as the *13th five year plan* contains details on development and revision of five requirements and 43 guidelines (41 new and two to be revised) related to RAW management and decommissioning.

New observation from the follow-up mission

Significant progress has been observed in the NNSA arrangements on decommissioning. However, the IRRS team has identified the need to further develop legal requirements for funding of decommissioning. So far, only NPPs and FCFs generate funds needed for their future decommissioning. According to the IAEA Safety Standards, the requirement on availability of adequate financial resources should cover the costs of safe decommissioning of management of the resulting RAW and is applicable not only to NPPs, research reactors and other nuclear fuel cycle facilities, including predisposal waste management facilities, but also to facilities for processing naturally occurring radioactive material (NORM), former military sites, and relevant medical facilities, industrial facilities, and research and development facilities.

FOLLOW UP MISSION RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
Observation: *During the site visit at Beijing Hongyisifang Radiation Technology Co., Ltd, the IRRS team was informed that there is no decommissioning fund available in China covering this type of facility (other than NPPs and FCFs) and it is up to the operators to create their own decommissioning funds on voluntary basis.*	
(1)	**BASIS: GSR Part 6 Requirement 9 states that** *"Responsibilities in respect of financial provisions for decommissioning shall be set out in national legislation. These provisions shall include establishing a mechanism to provide adequate financial resources and to ensure that they are available when necessary, for ensuring safe decommissioning."*
RF3	**Recommendation: The MEP (NNSA) should establish legal requirements for financial provisions for the decommissioning of facilities other than NPPs or FCFs that are subject to decommissioning requirements.**

10. EMERGENCY PREPAREDNESS AND RESPONSE

10.1. LEGAL BASIS

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

10.2. ASSESMENT OF THREATS

2010 MISSION RECOMMENDATIONS, SUGGESTIONS	
R37	**Recommendation:** MEP (NNSA), MII/CAEA and NEA should promote the elaboration and approval of a legal and regulatory framework for an assessment of the threats by categorizing facilities and practices in accordance with the IAEA safety standards.

Changes since the initial IRRS mission

Recommendation 37: The MEP (NNSA)'s self-assessment does not describe any specific changes since the initial mission but explains that the existing legal and regulatory framework in 2010 covers the five threat categories in IAEA GS-R-2. Specifically the national law Emergency Response Law of the People's Republic of China applies to all facilities, the HAF series of safety regulations and guides applies to NPPs, research reactors and civil nuclear fuel-cycle utilities (e.g. IAEA threat categories I and II), the Law of the People's Republic of China on Prevention and Control of Radioactive Pollution (2003) applies specifically to radiological facilities and nuclear technology utilisation organisations (e.g. IAEA threat category III), and the Regulation on Safety and Production of Radioisotopes and Radiation Emitting Devices (2005) applies to radiation sources (e.g. IAEA threat categories IV and V).

The Chinese Government and the MEP (NNSA) indicated to the IRRS team that the legal and regulatory framework described, whilst not directly referring to the IAEA threat categories, follows the principles of the categorizations by having separate emergency planning requirements for each threat category/ type of facility.

Since the initial mission of 2010, the Regulation on Nuclear Accidents Emergency Preparedness and Response (HAF002) was revised in 2014 and The Safety Guides for Emergency Preparedness and Response for NPP (HAD002/01) and the Safety Guides for Emergency Preparedness and Response for Fuel-Cycling Facilities (HAD002/07) were revised and drafted respectively in 2010. Similarly the National Nuclear Emergency Plan and the MEP Nuclear and Radiological Emergency Plans were both revised in 2013. Based on statements obtained by the IRRS team from the interviews it was demonstrated to the team that these documents continue to follow the principles of the IAEA threat categorizations.

Status of the finding in the initial mission

Recommendation 37 (R37) is closed as the legal and regulatory framework covers, in principle, the five threat categories in IAEA GS-R-2.

10.3. RESPONSIBILITY OF THE MEP (NNSA) EMERGENCY ORGANIZATION

2010 MISSION RECOMMENDATIONS, SUGGESTIONS	
S40	**Suggestion:** MEP (NNSA) should consider an improvement of existing training emergency preparedness programmes and education, namely for local/provincial environmental authorities (as first response organizations at the local/provincial level) to ensure that the personnel both at headquarters and at provinces have the comparable knowledge and skills.
R38	**Recommendation:** MEP (NNSA) should establish a quality assurance programme to ensure a high degree of availability and reliability of all the supplies, equipment, communication systems and facilities necessary to perform the assigned response functions, namely at the Nuclear and Radiation Accident Emergency Technical Centre.

Changes since the initial IRRS mission

Suggestion 40: The Government of China and the MEP (NNSA) have recognised that prior to 2010, their emergency preparedness training focus was on NPP operating personnel. The *Emergency Management Regulations for Nuclear Accidents at NPP* (HAF002, 1993, Article 17) states that provincial governments are responsible for training of these persons but the MEP (NNSA), through the TSO, take a coordinating and facilitating role. In accordance with Suggestion 40, courses have been enhanced for MEP (NNSA) nuclear emergency management personnel, NSC (TSO) personnel, administrative staff and technicians from provincial environmental protection departments, and for personnel involved in the expanded radiation monitoring station network.

Each year the MEP (NNSA), regional offices and TSOs organize technical training, emergency skills training, and emergency facility training. The enhanced courses introduced consistency and standardised existing emergency preparedness training programmes in order to ensure harmonised training and education, particularly for national and local/provincial staff.

In particular, the MEP (NNSA) currently organises two emergency management training courses every year for MEP (NNSA) and provincial EPB staff. Staff are recommended to attend annual refresher training.

The MEP (NNSA) TSO (Nuclear and Radiation Safety Centre) organises on a yearly basis three to five monitoring courses for provincial teams (there are 31 Provinces). Additional courses are provided for the staff responsible for the monitoring network. Refresher courses are carried out once or twice per year and additional lectures and seminars are provided on a case-by-case basis. The approved Provincial Emergency Plans require staff to attend appropriate training. Because the MEP (NNSA) funds provincial emergency planning (including emergency preparedness and monitoring network training) and receives annual summaries of progress from relevant provinces, the MEP (NNSA) are aware of the attendance rates and effectiveness of the training. The MEP (NNSA) also confirms training attendance and its effectiveness when reviewing provincial emergency plans following the two yearly updates to the MEP (NNSA) Radiological Emergency Plan.

The MEP (NNSA) has provided evidence that in 2015 and 2016 they have and plan to carry out/ coordinate around nine types of emergency planning and response half day duration training courses and that, depending upon the topic, these are each repeated up to five times per year.

Thousands of personnel have attended these training courses and the examination results are good.

The MEP (NNSA) informed the IRRS team of the concerns raised by provincial emergency personnel regarding the significant number of radiological training courses they are required to attend. In response to this feedback, the MEP (NNSA) has undertaken a top level review of the design of the overall training program and a more coordinated and efficient programme is planned for implementation during 2016-2017.

Recommendation 38: In May 2015 MEP (NNSA) published and commenced a quality assurance programme for ensuring the capability of the response of the MEP (NNSA) Nuclear and Radiation Accident Emergency Technical Centre in Beijing. In 2011 the MEP (NNSA) established a special section of emergency preparedness, staffed with around 20 persons, with the responsibilities of development and maintenance of emergency establishments in the Centre. These improvements to the resourcing of the Centre are in response to the findings of the IRRS mission in 2010, lessons from Fukushima, and correspond to the rapid development of the nuclear programme in China.

The IRRS team was informed by the MEP (NNSA) that it has approved the QA Programme of "Quality Assurance for Nuclear and Radiation Emergency Command Centre of MEP", dated May 2015, and that the Director of the Centre has overall responsibility for its effective implementation.

The QA Programme was reviewed during the follow-up mission with the assistance of a translator. The IRRS team is of the opinion that the programme is comprehensive.

During the follow-up mission the IRRS team visited the Centre, and Centre management provided appropriate examples of QA audits, their analysis, and conclusions carried out to date.

It was noted by the IRRS team that the MEP (NNSA) requires similar QA programmes for Operator's Emergency Centres at NPPs. The MEP (NNSA) confirms that the operator's QA arrangements are in place prior to first fuelling operations and the Regional Office NPP site inspector confirms continuing implementation during routine and non-routine inspections. Typically, Regional Office NPP site inspectors review emergency preparedness during inspections 2-3 times per year. These operator's QA arrangements and NPP site inspector actions were confirmed during an IRRS team visit to the Emergency Centre at Fuqing NPP. The IRRS team noted that the facility, equipment, procedures and its management appeared particularly good.

Status of the finding in the initial mission

Suggestion 40 (S40) is closed as appropriate improvements have been made to the training programme and its provision for local/provincial authorities.

Recommendation 38 (R38) is closed as an appropriate Quality Assurance Plan has been established.

10.4. RESPONSIBILITIES OF THE MOH EMERGENCY ORGANIZATION

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

10.5. RESPONSIBILITIES OF THE CHINESE ATOMIC ENERGY AUTHORITY

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

10.6. REGULATION OF LICENSEES EMERGENCY PREPAREDNESS

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

10.7. SYSTEM FOR PROTECTIVE ACTIONS TO REDUCE EXISTING OR UNREGULATED RADIATION RISKS

2010 MISSION RECOMMENDATIONS, SUGGESTIONS	
R39	**Recommendation:** MEP (NNSA) and MOH should ensure managing, controlling and recording the doses received by emergency workers for different types of response activities.

Changes since the initial IRRS mission

Recommendation 39: *Emergency Management Regulations for Nuclear Accidents at NPP*, HAF002, 1993, Article 24 requires that: "All emergency organisations on the accident scene should implement effective dose surveillance. All emergency response personnel and other personnel on the scene should act under the supervision and guidance of radiation protection personnel to prevent over-exposure as much as possible." During the initial mission, the IRRS team observed that the MEP (NNSA) regulated the requirements for the management, control and recording of doses received by emergency workers on-site, but didn't have procedures to actively manage adherence during an emergency. In addition, with regards to off-site emergency responders, the NHFPC (formerly as MoH) had no guidance in place for either regulating or supervising adherence to the requirements.

"Basic Safety Standard for Protection Against Ionising Radiation and for the Safety of Radiation Sources", National Standard GB18871-2002, which the IRRS team was informed as being almost identical to the IAEA BSS No. 115, existed in 2010, and remains in place. This requires all relevant organisations with a role in emergency to have an overall off-site emergency plan (Chapter 5.2.1.2) and be responsible for the radiation protection of their intervention staff according to the requirements of the regulator (Chapter 5.2.3.1). These organisations and the regulator, the relevant approving body of the emergency plan, are responsible for implementing the relevant regulations and the Standard (Chapter 10.5).

For on-site worker radiation doses, the MEP (NNSA) regulate compliance with the requirements both during normal operations and in the event of an emergency through approval and review of the on-site emergency plans prepared in accordance with their HAF guides (HAD 002/01-2010, HAD 002/02-2010, HAD 002/06). Further, in the event of an emergency, dose monitoring data could be used for grading the emergency and provide a reference for emergency measures. The MEP (NNSA)'s activities in this area were confirmed during interviews with NNSA staff and with site inspectors during a visit to Fuqing NPP. The National Health and Family Planning Commission (NHFPC), formerly the MoH transferring regulatory responsibility for radiation safety to MEP(NNSA) in 2010, has also distributed provisions for management of the emergency radiation exposures of operators for nuclear operating facilities; *The Provisions on Health Standards and Medical Supervision of Nuclear Power Plant Operators*.

MEP (NNSA) staff confirmed that NHFPC are responsible for the regulation to the management, control and recording of radiation doses for off-site responders. MEP (NNSA) has no involvement in the off-site arrangements. MEP (NNSA) informed the IRRS Team that all off-site responding organisations must have an emergency plan and be responsible for their personnel (National Standard GB18871-2002 referred to above). The responsibility for this lies with the

radiation protection team of the provincial government. The National Nuclear Accident Emergency Coordination Committee (NNAECC) approves provincial emergency plans and therefore the requirements for the management, control, and recording of radiation doses. The Provincial Committee for Public Health (supervised by and under NHFPC) is responsible for checking that management, control and recording of doses is performed. The IRRS team was not able to observe any evidence of requirements by NHFPC in relation to the management of off-site doses received by responders or the specific content of the provincial plans. However, as an example and by way of personal examination of the Guangdong and Hainan provinces Off-site Emergency Plans, the MEP (NNSA) counterpart was able to confirm directly and describe its contents in relation to the management, control and recording of doses.

Status of the finding in the initial mission

Recommendation 39 (R39) is closed as the MEP (NNSA) and the NHFPC (formerly as MoH) have ensured that provisions are in place for the management, control and recording of radiation doses received by emergency workers.

New observation from the follow-up mission

"Regulation on Nuclear Accidents Emergency Preparedness and Response" (HAF002, 1993) was redrafted by the MEP (NNSA) and other government departments in 2014 and the IRRS team was informed that the redraft includes many improvements, including significant strengthening of the availability of public information on emergency preparedness. Since the redraft adopts the legal framework and emergency response responsibilities in the intended Nuclear Safety Act (NSA), the intention is to submit the redrafted HAF002 to government for consideration, enactment and promulgation following enactment of the NSA.

The IRRS team was concerned that, given that it may take up to two years to enact the NSA and that the government process for subsequently promulgating a revision to HAF002 may take a further year or two, this revision and its improvements for public protection may not take effect for a number of years. Numerous statements in the Director General's Fukushima report (published 2015) and the MEP (NNSA) *12th Five-Year Plan* for 2020 regarding the need to improve public information on emergency preparedness also raised the concern amongst the IRRS team for the need to ensure that measures to improve public information on emergency preparedness were in place as soon as practicable.

However, the IRRS team was informed that the MEP (NNSA) has already taken steps to implement improvements for public information on emergency preparedness. In particular:

1) MEP (NNSA) Ministerial Notice No.115, *Strengthening the work about public communication and information disclosure of nuclear and radiation safety* was issued in 2012 to all provincial authorities and EPBs and applies to the MEP (NNSA) themselves. It includes details of MEP (NNSA)'s expected improvements for public information on emergency preparedness.
2) The MEP (NNSA) "Nuclear Emergency Plan" was revised in 2013 and contains a number of improvements for public information on emergency preparedness. MEP (NNSA) has also produced an internal procedure to implement the public information aspects of the revised plan and Ministerial Notice No.115.
3) NNAECC issued the management guide "Administrative measures of nuclear accident information publicity" (NNAECC document number 2) in 2016 which contains their

expectations for public information on emergency preparedness by MEP (NNSA), provincial authorities, and EPBs.

The IRRS team was informed that the redraft of HAF002 includes widening its scope to include radiation facilities, inclusion of explicit reference to organisations responsible for emergency planning, and inclusion of the improvements for public information on emergency preparedness contained in 1 – 3 above. The IRRS team accepted that improvements have been made and encouraged the MEP (NNSA) to expedite their plans to formalise these in a revised HAF002.

New observation from the follow-up mission

The MEP (NNSA) TSO operates the Nuclear and Radiation Safety Centre in Beijing and as part of this role they have developed a mechanism in the form of software to independently assess the practicability and effectiveness of evacuation within the emergency planning zones around NPPs. This is used to fulfil the MEP (NNSA)'s roles in both reviewing regional authority off-site emergency plans (pending NNAECC approval) and, in the event of an emergency, for very quickly advising the NNAECC. In particular, they have developed Emergency Evacuation Ability Assessment System software that contains population and road infrastructure data for all emergency planning zones. This is able to estimate the time required for various degrees of evacuation of any identified area (e.g., a particular village or part of a town) and the effects evacuation of other parts of the zone may have on that area. The ability of a regulator to review proposals on local evacuation decisions of this nature is considered an example of good practice.

FOLLOW UP MISSION RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
Observation: *The MEP (NNSA) TSO Nuclear and Radiation Safety Centre have developed a mechanism to independently assess the practicability and effectiveness of evacuation within the emergency planning zones around NPPs. This is used to fulfil the MEP (NNSA) roles in both reviewing regional authority off-site emergency plans (pending NNAECC approval) and, in the event of an emergency, for advising the NNAECC.*	
(1)	**BASIS: GSR Part 7 Requirement 9 states that** *"The government shall ensure that arrangements are in place to assess emergency conditions and to take urgent protective actions and other response actions effectively in a nuclear or radiological emergency."*
GPF2	**Good Practice: The MEP (NNSA) Nuclear and Radiation Safety Centre in Beijing have established a mechanism in the form of software for the regulator to independently and very quickly assess the practicability and effectiveness of detailed evacuation proposals. This mechanism is beneficial in the MEP (NNSA) roles of both reviewing regional authority off-site emergency plans and, in the event of an emergency, the implementation of specific evacuation actions.**

11. ADDITIONAL AREAS IN THE FOLLOW-UP MISSION

11.1. ENVIRONMENTAL MONITORING

Radiological environmental monitoring was added as a new review area for the IRRS Follow-up Mission. The IRRS team was informed that the MEP (NNSA) did not receive the list of questions that would support an efficient self-assessment. However, the MEP (NNSA) provided a chapter on environmental monitoring in their document "Self-assessment Report on China's Nuclear and Radiation Safety Regulation for IAEA IRRS Follow-up" issued by the MEP (NNSA) in June 2016.

The IRRS team decided to ask for detailed information and supporting documents during the interviews, taking the relevant sections in GRS Part 3 and in the Safety Guide No. RS-G-1.8 as a basis. Many documents, however, were not available in English. The IRRS team suggested translating key text passages into English to support the verbal information provided by the MEP (NNSA). The review of the module "Environmental Monitoring" is based on this partial verification of the information provided. Wherever acceptable evidence could not be provided, recommendations are given.

Observations

As stated in GSR Part 3, monitoring the discharges of a facility or installation and environmental monitoring are the bases for assessing doses to members of the public and an important element to demonstrate compliance with the dose limits for members of the public and the specific licensing requirements in planned exposure situations. In emergency exposure situations and existing exposure situations, e.g. in areas with residual radioactive material, it is the basis for assessing the radiological impact on the population, selecting suitable countermeasures and/or remediation measures and demonstrating their efficiency in dose reduction.

The IRRS team observed the following:

Regulatory requirements and responsibilities for monitoring

People's Republic of China Law on the Prevention and Control of Radioactive Pollution of 28 June 2003 ensures compliance with Requirement 32 of GSR Part 3. There are regulatory requirements for source and environmental monitoring in place. The responsibilities for monitoring of the operator, of the regulatory body and of other agencies are clearly defined and documented in most cases. Details are specified in the document "Integrated Management System Manual for Nuclear and Radiation Safety Regulation" of August 2016.

Monitoring networks

A monitoring network for the supervision of nuclear and radiological facilities and a network for environmental quality have been established by the MEP (NNSA). According to the Self-assessment Report, 42 nuclear and radiological facilities, including NPPs, research and test reactors, facilities of the nuclear fuel cycle, uranium mining and milling facilities and facilities for mining, processing and utilization of associated radioactive minerals, are fully equipped.

Monitoring programmes

The monitoring programmes are evaluated by the Nuclear and Radiation Safety Centre and approved by the MEP (NNSA) in accordance with the provisions of paragraph 3.135 (a) and (b) of GSR Part 3. The monitoring data of the licensees are verified against the results of an independent governmental monitoring programme. Both the licensees and two technical support organisations of the MEP (NNSA) are obliged to store the monitoring data. Monitoring data is made available in Annual Reports and on the internet.

The types of monitoring programmes, as well as their scale and extent, are commensurate with the source characteristics at the expected or current discharge rates, the radionuclide composition, the comparative significance of different exposure pathways, and the magnitudes of expected and potential doses to individuals. The document "Technical criteria for radiation environmental monitoring (HJ/T 61-2001)" provides guidance on environmental monitoring for different facilities but allows some flexibility (in Chinese, partially translated into English). The monitoring programme is established by the licensee, reviewed by the Nuclear and Radiation Safety Centre and approved by MEP (NNSA).

Independent governmental monitoring programme

The MEP (NNSA) conducts an independent monitoring programme. Two organisations, the Radiation Monitoring Technical Centre and the Nuclear and Radiation Safety Centre, support the governmental monitoring programme. A division and a technical supporting branch of the Environmental Protection Bureau (EPB) of the provincial government are responsible for governmental monitoring in the respective province.

The Nuclear and Radiation Safety Centre uses the independent governmental monitoring programme to verify the monitoring data provided by the licensees (nuclear facilities and Category 1 sources). For all other sources the corresponding EPB of the provincial government is responsible for verifying the monitoring data.

Technical requirements

The IRRS team was informed by the MEP (NNSA) that it established technical requirements for monitoring arrangements, including arrangements for emergency monitoring and quality assurance, and regularly reviews them. The requirements include the spatial distribution of monitoring/sampling points, the list of radionuclides to be monitored, the measurement methods to be used and the sampling frequency. Each applicant for a licence has to demonstrate the capability to perform environmental monitoring and, if appropriate, source monitoring as part of the environmental impact assessment report. Capability refers to the technical equipment and the staff.

Calculation of doses to members of the public

The licensee (based on discharge data) and the Radiation Monitoring Technical Centre (based on environmental monitoring data) independently calculate doses to members of the public (a) in the vicinity of NPPs and (b) in the vicinity of all other facilities that discharge relevant amounts of radionuclides. The document *Basic Standards for Protection Against Ionizing Radiation and for the Safety of Radiation Sources* (GB 18871-2002; in Chinese, partially translated into English) specifies the general guidelines for dose assessment, closely following the International BSS of 1996. A detailed calculation procedure to assess the dose to members of the public originating

from gaseous and liquid discharges is specified in Appendix 3 *Radiation Environment Status Evaluation Module Based on Monitoring Data of Radioactive Effluen*t of the document *Technical Specification of National Nuclear Bases and Nuclear Installations Environmental Status Survey and Evaluation Program* of 2015 (in Chinese, partially translated into English). The results of the dose assessment are reported to the MEP (NNSA) as numerical values and to the public in a qualitative way. The *People's Republic of China National Nuclear Safety Administration 2014 Annual Report* states, for example, that "the radiation doses to the public were much lower than regulatory limits". The IRRS Team was informed that Chinese citizens obtain the numerical values upon request. The IRRS Team encourages the MEP (NNSA) to publish the numerical values in the Annual Report, together with information on the regional exposure from natural sources. This open and transparent communication is expected to educate the public and enhance confidence in the Chinese regulatory authorities.

Storage of monitoring data

The MEP (NNSA) receives the monitoring data from the licensee and forwards them to the Radiation Monitoring Technical Centre and the Nuclear and Radiation Safety Centre. Both organisations as well as the licensee are obligated to store the monitoring data and related relevant information, e.g. meteorological data.

Publication of monitoring data

The results of the monitoring programmes, including data on the discharge of nuclear facilities and the calculated doses to members of the public, are published in several reports, including a comprehensive Annual Report in Chinese and English. This Annual Report and the results of the real-time monitoring stations for ambient dose rate can be accessed via a public NNSA website (http://nnsa.mep.gov.cn). The direct link to the real-time monitoring stations for ambient dose rate is http://data.rmtc.org.cn:8080/gis/PubIndex.html. The public NNSA website also provides policy documents, laws and technical standards.

Quality assurance

A quality assurance programme for environmental monitoring has been established by the MEP (NNSA). Laboratories responsible for environmental monitoring have to pass the accreditation requirements of the Chinese Metrology Accreditation (CMA). The quality requirements are laid down in the national document "Certification and Accreditation Administration of the People's Republic of China" and in Chapter 9 of the document *Technical criteria for radiation environmental monitoring* (HJ/T 61-2001) (in Chinese, partly translated into English). The latter document also contains quality standards for staff responsible for source monitoring and environmental monitoring. They need a certificate that documents their qualification and has to be renewed every five years. The requirements are specified in the document *Detailed Implementing Rules on Radiation Environmental Monitoring Personnel Certification Assessment* of 2015. The Radiation Monitoring Technical Centre established a regular training program for staff with mandatory exams every year. The official training plan has been approved by the MEP (NNSA). The IRRS team concludes that quality assurance is adequate.

Monitoring in emergency exposure situations

The Nuclear and Radiation Safety Centre is responsible for organising monitoring campaigns in emergency situations, which are carried out by the EPB of the provincial government, supported by the Nuclear and Radiation Safety Centre and the Radiation Monitoring Technical Centre. The responsibility is documented in the *National Nuclear Emergency Plan* of June 2013 (in Chinese) and a supporting document to the *12th five-year plan* (period 2011-2015; in Chinese). General requirements are specified in the *Basic Standards for Protection Against Ionizing Radiation and for the Safety of Radiation Sources* (GB 18871-2002) issued in October 2002 (in Chinese, partially translated into English), in the *National Nuclear Emergency Plan* of June 2013 (in Chinese) for nuclear facilities and in the *MEP (NNSA) Radiological Emergency Plan in 2013* for radioactive sources. Specific requirements, i.e. monitoring and sampling procedures, are issued by the EPB of the provincial government.

Monitoring of areas with residual radioactive material

The EPB of the provincial government, under the supervision of the MEP (NNSA) is responsible for environmental monitoring in areas with residual radioactive material in the late phase of an emergency (existing exposure situation). The responsibility is laid down in the *National Nuclear Emergency Plan* of June 2013. Details are specified in the *Basic Standards for Protection Against Ionizing Radiation and for the Safety of Radiation Sources* (GB 18871-2002) issued in October 2002 (in Chinese). The MEP (NNSA) is responsible for environmental monitoring in areas with residual radioactive material in the case of uranium mining and milling facilities and the EPB of the provincial government in the case of facilities for other mining, processing and utilization of associated radioactive minerals. The IRRS team was informed that the responsibility of the EPB includes all conventional mining activities, e.g. coal mining. General guidelines that are applicable to all mining activities, including conventional mining, are specified in the document *Regulations for Radiation Environment Protection in Uranium Mining and Milling* (GB 23727-2009; in Chinese, partially translated into English). The IRRS team was informed that the monitoring programme will be developed by the EPB of the local government on a case by case basis, in consideration of the technical specifications in the document *The Letter of Issuance of Monitoring Technical Specification Documents of the Current Situation Survey and Evaluation Program of Radiation Environment of National Nuclear Base and Nuclear Facility* (MEP Office Letter 2013 No. 100). These technical specifications also apply to all mining activities, including conventional mining. There is acceptable confidence that the monitoring of areas with residual radioactive material meets the requirements of GSR Part 3.

12. REGULATORY IMPLICATIONS OF THE TEPCO FUKUSHIMA DAI-ICHI ACCIDENT

12.1. IMMEDIATE ACTIONS TAKEN BY THE REGULATORY BODY

Immediate emergency response

Subsequent to the accident on March 11, 2011, the relevant local environmental departments entered into an emergency state under the coordination of MEP (NNSA), initiating a 24-hour emergency on-duty system. The accident's progress was closely tracked by collecting and analysing information, evaluating radioactive material diffusion, and regularly drafting reports to the Central Government. The MEP (NNSA) headquarters and the provincial offices, as well as NSC took part in these activities. The initial analysis showed no immediate potential effect on China from the accident. In response to the information gathered the Environmental Protection Bureaus, Radiological Environmental Monitoring Agencies and other emergency response forces of 31 provinces (municipalities) took prompt actions.

The MEP (NNSA) set up a special expert team to track and analyse the accident progress on an around-the-clock basis. They performed calculations simulating the accident scenario using the latest information to assess the progression of the release of radioactive materials and propose appropriate response actions, if needed. As the TEPCO Fukushima Daiichi nuclear plant gradually stabilized, MEP (NNSA) terminated the emergency state on May 22, 2011.

Environmental monitoring

The national environmental radiation monitoring network was activated and continuously monitored the diffusion of radioactive material on the territory of China. Monitoring information was published through the website of the MEP (NNSA) every day. During the period from March 15 to March 26, a wide range of information was published daily, such as monitoring methods and data submission including sample monitoring on round trip flights between China and Japan. The monitoring data is still available on the website.

Beginning on March 13, 2011, 47 radioactive environmental automatic monitoring stations in 43 cities across China collected real-time changes of γ-air-absorbed dose rate. Furthermore, 23 automatic monitoring stations at the Qinshan Nuclear Base in Zhejiang province, at the Daya Bay and Ling'ao nuclear power plants in Guangdong province, and at the Tianwan nuclear power plants in Jiangsu province provided similar monitored data. Any unexpected increase above environmental background level would be detected. Furthermore, from March 15 to April 8, 52 mobile monitoring spots were established in 20 coastal cities to monitor γ-air-absorbed dose rate. No radiation level above natural background has ever been detected by the monitoring stations above.

Beside the environmental radiation real-time γ-monitoring, sampling monitoring of gaseous iodine, of aerosols, of atmospheric fallout, of precipitation, and of surface soil were also carried out.

After the accident, MEP (NNSA) developed a set of specific environmental radiation monitoring programs to cope with the consequences of a severe accident likely to impact on the environment.

Immediate actions by the NPPs

Following the accident MEP (NNSA) immediately demanded the domestic nuclear power plants to take timely measures in order to enhancing safety management of nuclear facilities, strengthening supervision and inspection, as well as taking the necessary precautionary measures against potential hazards caused by tsunami waves. MEP (NNSA) requested its regional offices to strengthen supervision and inspection.

State Council Executive meting decisions

On March 16 the Prime Minister held a meeting of the State Council Executive to identify urgent actions in reply to the situation set by the accident. The State Council Executive identified the following actions:

1) Immediate comprehensive inspections are to be performed in all nuclear facilities
2) Safety management of operating nuclear installations shall be strengthened
3) Comprehensive safety review and inspection shall be conducted at NPPs under construction
4) Pay close attention to the preparation of nuclear safety plans. Adjust and improve medium-term and long-term plan for nuclear power development.

Comprehensive inspections

In compliance with the State Council decision MEP (NNSA), in collaboration with the National Energy Administration and the China Earthquake Administration, conducted a comprehensive safety inspection of civilian nuclear facilities, and assessed the safety margins of operating nuclear power plants against the threat of external events.

The purpose of the inspections was threefold: comparison of present status with the requirements at the time of construction, with the requirements by international standards and with the lessons learned from the accident.

The inspections were carried out from March to October 2011 with the participation of more than 300 experts.

An "Implementation Programme on the Comprehensive Safety Inspection of Civilian Nuclear Facilities" was prepared by MEP (NNSA) and NEA (National Energy Administration), approved by the State Council. A respective Guide was prepared by experts and issued by MEP (NNSA).

The Programme identified 11 focused areas as:

- external events taking into account in siting based on recent developments
- review and reassessment of the flood prevention design basis
- review and reassessment of the earthquake resistance design basis
- quality assurance of nuclear facilities
- fire protection of nuclear facilities
- prevention and mitigation of superposition of several extreme external events
- managing station blackout
- prevention and mitigation of severe accidents
- preparedness plan on social impact of incidents

- effectiveness of environmental monitoring and emergency preparedness systems
- protection of other vulnerable facilities

The inspections were preceded by a self-assessment by the facilities and evaluations of the results. The inspections resulted in improvement requirements and measures.

The main general conclusions of the inspections were:

- Both the operating nuclear power plants and those under construction meet China's existing nuclear safety regulations and the latest requirements of the relevant IAEA safety standards.
- The operating NPPs have full ability to respond to the design basis accidents and have the ability to prevent and mitigate severe accidents.
- Safety risks are controlled and the safety of operating nuclear power plants is guaranteed.
- In the design stage of the NPPs under construction prevention and mitigation of severe accidents were fully taken into account.
- Reactor types, other than power reactors, are effectively regulated by MEP (NNSA) and meet the requirements of existing safety regulations.
- Safety was demonstrated for the oldest nuclear installations which built before MEP (NNSA) supervision was in place.
- All civilian nuclear fuel cycle facilities meet appropriate requirements of nuclear safety regulations.
- External events such as flood and earthquake have been taken into account in siting of the nuclear facilities.
- There is a very low probability that extreme natural events occurred in the Fukushima nuclear accident could happen.

In addition to the general conclusions a number of specific issues have been identified by the inspections:

- Severe accident management guides are partially or fully missing in some of the NPPs.
- Protection against extreme flooding conditions at the Qinshan site is not fully adequate.
- Impact of earthquake and tsunami on the coastal NPPs had been considered in the siting process. The inspections concluded that the effects of tsunami triggered by earthquakes on coastal sites need further investigations and assessment. These effects are being assessed by NNSA jointly with China Earthquake Administration and State Oceanic Administration by investigating the consequences of a tsunami triggered by the Manila trench on the coastal NPP sites. The results suggest that oceanic tsunamis may not significantly influence the safety of the coastal NPPs
- Seismic resistance of the high flux experimental engineering reactor requires to be reinforced.
- Certain other issues that require further considerations were identified by the inspection. These included the evaluation of anti-flooding and confining measures, hydrogen concentration monitoring and elimination during severe accidents and probabilistic safety assessment of external events, as well as analysis of seismic safety margin evaluation.

In reaction to the specific issues revealed by the comprehensive inspections, MEP (NNSA) issued regulatory requirements on improvements separately for each operating NPP. Short-term action (in 2011), medium-term actions (by the end of 2013) and long-term actions were prepared.

Examples of typical specific requirements set for an NPP are those for the Qinshan NPP:

- Waterproof plugging of doors, windows, vents, cable penetrations, pipelines
- Temporary anti-flooding measures to protect important buildings
- Measures ensuring core and spent fuel pool cooling, etc. in case of station blackout
- Enhancing earthquake monitoring and recording
- Developing severe accident management guides (SAMG)
- Evaluation of equipment and systems to mitigate severe accidents or hydrogen explosion.
- Final anti-flooding measures
- Additional diesel generator
- Enhancement of fire protection
- Seismic PSA or seismic margin analysis
- Improvement of battery based power supply
- Possibility of filtered venting
- Possibility of multi-unit emergency

The first five requirements had to be performed in 2011, the others by the end of 2013.

Public communication

From March 12, 2011, MEP (NNSA) continuously updated information to the public by updating the official website of MEP (NNSA) entitled "Nuclear Safety Related Problems of Japan Earthquake". Experts appeared in the media (television, radio, newspapers and magazines) explaining the accident progress and presenting basic knowledge on nuclear safety.

During the of emergency response period , MEP (NNSA) issued 46 nuclear and radiation emergency instructions, completed 80 daily reports, published 121 news (containing 5 journalist interviews), 23 integrated information on radiation monitoring situation, 20 articles on nuclear and radiation science and 78 translated articles of reports by the Japan Atomic Safety Agency on the TEPCO Fukushima Daiichi nuclear accident. MEP (NNSA) also compiled and published a document entitled Ninety-nine Questions about Nuclear and Radiation Protection.

The MEP (NNSA) published on its official website the results of the comprehensive inspections of nuclear facilities in the documents entitled Report of Comprehensive Safety Inspection on National Civilian Nuclear Facilities and *12th Five-Year Plan and Prospective Targets of 2020 on Nuclear Safety and Radioactive Pollution Prevention and Control*. Public comments on the documents received from June 15 to 29, 2012.

By June 29, about 600 comments arrived to the reports from nuclear power groups, nuclear-related scientific research institutes and community groups, from citizens, and from experts in nuclear industry. Southern Weekend, an eminent weekly paper in China, interviewed many experts from the nuclear industry. NGOs such as United States Natural Resources Defence Council and Public Research Centres, Böll Foundation, Greenpeace, Friends of Nature and Darwin's Natural Learning have also had comments and suggestions. Most of the comments were related to the five-year Plan. In view of the public comments a new version of the Plan was issued, which is now available on the MEP (NNSA) website.

Preliminary lessons learned

As an immediate consequence of the comprehensive inspections and of the analysis of the accident progression MEP (NNSA) defined eight areas needing further progress:

- deepen the knowledge and understanding of nuclear safety practitioners in basic safety principles and rules;
- improve further the nuclear safety requirements and ensure their effective implementation;
- develop emergency response mechanism and capability;
- improve the capabilities, capacities and resources of operating organizations in management and technical issues;
- improve further the independence, authority and effectiveness of the nuclear safety regulatory body;
- strengthen further R&D of nuclear safety technology and promote sustainable improvement of nuclear safety level relying on scientific and technical innovation;
- enhance further the sharing of domestic and international experiences on nuclear safety;
- strengthen further the dissemination of information to the public.

Improvement measures directly related to the MEP (NNSA) include management improvements like development of safety codes and standards, enhancing emergency preparedness management, improvements in operational experience feedback and public communications and acceleration of the decision making process of NNSA. Future actions by NNSA were summarized in a Nuclear Safety Plan.

Partly due to the consequences of the accident (and partly because of the rapid development of the nuclear sector in China) substantial changes in MEP (NNSA) organization were decided and performed. As a consequence of this, NNSA Headquarter includes 85 staff in three departments (instead of 59 in the former one department), the staff of the regional offices was tripled, while that of NSC was increased about five times. The regular budget was substantially elevated.

CONCLUSION [1]

The IRRS Team considers that MEP (NNSA), in cooperation with other governmental agencies has acted promptly and effectively after the TEPCO Fukushima Daiichi accident in the interest of nuclear safety and the protection of the public and environment. The results of the comprehensive inspections held in the Chinese nuclear power plants represent a solid basis for taking into account the lessons learned from the accident. Implementation within three years of the short- and medium-term improvement actions required by MEP (NNSA) is considered exemplary.

12.2. TECHNICAL AND OTHER ISSUES CONSIDERED IN THE LIGHT OF THE ACCIDENT

Following the accident China addressed the lessons learned by focusing on two main areas: the assessment of safety margins on external events in the operating NPPs and the improvement of the nuclear safety regulatory regime.

Assessment of safety margins for operating NPPs

On February 16, 2012, MEP (NNSA) requested the operating NPPs to carry out comprehensive assessments of the plants' safety margin to events that exceed the design basis and to optimize and implement improvement measures. The assessments covered accident response, protection against and consequences of extreme external events, effectiveness of mitigation measures and possible weaknesses against cliff-edge effects. The purposes of the assessments were: to recheck the robustness and safety margins of nuclear power plants; to reconsider the appropriateness of accident management measures; and to determine whether the NPPs needed safety improvements in their facilities and procedures.

The external events safety margin assessments were performed by all operating nuclear power plants. A typical unit is selected to carry out the analysis for the same type of reactors at one site.

The assessment method was based on a deterministic approach, assuming that the lines of defence of NPPs lose their effectiveness successively during the evolution of the extreme external events, without considering their failure probability.

The specific contents of the preliminary assessments covered earthquakes (initiating events), floods (initiating events) and station blackout (with subsequent safety system failures). The purpose was to analyse whether the nuclear power plant in question was able to sustain its important safety features in beyond design basis conditions.

The NPPs assessed were: Qinshan (unit 1, CNP300), Qinshan II (unit 1-4, CNP600), Qinshan III (unit 1-2, CANDU600), Tianwan (unit 1-2, WWER-1000), Daya Bay (unit 1-2, M310), Ling'ao (unit 1-4, CPR1000).

The general conclusions of the assessments found that nuclear power plants in operation in mainland China have the ability to respond to external events beyond design basis, with the safety margin not less than the internationally accepted level of similar nuclear power plants. The seismic safety margin of nuclear power plants in operation is not less than 1.5 times of the design basis earthquake. Except Qinshan nuclear power plant, nuclear power plants in operation have sufficient beyond design basis flood safety margin, while Qinshan nuclear power plant, which is located on a wet site, can handle beyond design basis flood after safety improvement measures. For station blackout accidents, nuclear power plants have taken measures to keep at least 8 hours of battery power in case of loss of power.

Note that when assessing the case of SBO, no recovery off-site or emergency diesel power was assumed available, important parameter monitors and unit status control devices are operated by battery-powered devices. Thus the running time of batteries determines the time period when the personnel are able to monitor and control the main parameters of the units.

No additional measures were deemed necessary for protection against earthquakes. Flood protection needed the heightening of certain dykes and seawalls, erection of confinement facilities around buildings, sealing of openings and installation of bulkhead. For conservatism, the Daya Bay NPP, flood protection measures included the demolition of a water reservoir built for the construction phase and not in use anymore. For station blackout it was concluded that the NPPs generally met the requirements and can discharge residual heat, however, the worst case scenario, (i.e. SBO combined with loss of heat-sink) such as flooding superimposed blackout can lead to more severe consequences.

Improvement of nuclear safety regulatory regime

The comprehensive safety inspections have led to a number of potential improvements in the nuclear regulatory framework. These improvements mainly relate to enhancement of safety requirements regarding nuclear facilities.

One major group of improved requirements relate to engineering and technical conditions. They concern water tightness, mobile power supply, mobile pumps, seismic monitoring and recording equipment, and post-earthquake action plans. Specific requirements are formulated on road reconstructions and transport, physical protection and civil engineering some of them also pertain to research reactors, fuel cycle facilities and spent fuel reprocessing facilities.

The second large group of improved requirements concern documents and activities related to management of safety. Improvements and extensions are initiated in severe accident management guides; in emergency preparedness and response capabilities, including plans; in information dissemination by NPPs; in safety analysis of external events including cooperation with external partners. This package also contains requirements on acceleration of spent fuel transport from research reactors to decommission and radioactive waste management foreseen in after severe accidents.

The improvement of operating nuclear facilities is divided into short-term, medium-term and long-term research projects. The short and medium term projects have been completed in 2011 and 2013, respectively as also discussed in the previous section. Improvement projects for nuclear facilities under construction are divided into projects completed before initial loading and those completed during the *12th Five-Year Plan*.

A separate group of tasks emerging from the comprehensive inspection requires cooperation of MEP (NNSA) with other governmental departments or with enterprises. Typical such tasks are: enhancement of regional and national emergency preparedness and response; developing further Chinese nuclear safety legislation and regulation taking into account international requirements; control of population in the restricted area around NPPs; building earthquake and tsunami early warning mechanisms and developing the related information exchange.

Requirements on technical upgrading of NPPs

In order to standardize the common improvement actions of nuclear power plants in China, MEP (NNSA) created a document entitled *General Technical Requirements on the Improvement of Nuclear Power Plants after the Fukushima Nuclear Accident*. This document provides technical guidance regarding improvements in a number of areas, such as:

- anti-flooding capability of NPPs (based on design basis flood + 1000 years maximum rainfall);

- selection of emergency water supply equipment and layout of pipelines (requiring 6 hours residual heat removal before connection of mobile water supply, with two sets of portable equipment per sites);

- selection of portable power supply and interface setting (two sets of mobile power supply, one being able to drive low head safety injection pump or auxiliary feedwater pump); the mobile water supply and power supply devices are to be stored at places 5 m

higher than the design basis flood height and more than 100 m away from its use at seismically safe buildings;

- monitoring the temperatures and the water levels of spent fuel pools;
- improvement of hydrogen monitoring and control systems;
- increase seismic resistance and estimate habitability and functions of emergency control centre (the estimated maximum dose in severe accidents should not exceed 100 mSv/30 days);
- radiation environment monitoring and emergency improvement;
- response to external hazards.

The IRRS team considers the development of the document *General Technical Requirements on the Improvement of Nuclear Power Plants after the Fukushima Nuclear Accident* an important step in elimination of possible differences in the understanding of safety improvement strategy of the regulatory body and of the licensees. The document provides technical guidance for post-Fukushima improvement actions in NPPs.

Status of implementation of technical upgrading

The actual status of the improvements in the operating NPPs is summarized below:

- The short term improvement projects regarding waterproof plugging; establishment of mobile power supplies and mobile pumps; earthquake monitoring and anti-seismic response ability have been completed according to the requirements by General Technical Requirement document.
- Severe accident management guides (foreseen by medium term projects) have been revised or newly elaborated by all operating NPPs and, by assignment by NNSA, are being reviewed by China Nuclear Energy Association (a non-governmental organization comprising utilities, scientific research institutions, universities, etc. providing experts for this peer review) since 2013 and 2014.
- Other generally required medium term improvements, like hydrogen removal and analysis of the probability of external hazards have been completed in all NPPs.
- Specific activities were required at certain NPPs (e.g. detailed evaluation of earthquake and tsunami risk at Daya Bay, various improvements at Qinshan and at Tianwan), which have all been completed.

Special attention was paid to the NPPs under construction. The relevant requirements are similar to those related to the operating plants, i.e.

- Flood control and water tightness: all units with initial loads have performed the necessary control;

- Implementation of mobile power supply and mobile pumps: all NPPs under construction have completed implementation, the units with initial load have also performed the necessary other modifications, tests, and drills;

- In seismic monitoring, seismic resistance and maintaining habitability of emergency control room the required improvement programmes have been completed;

- In severe accident and hydrogen management issues all NPPs under constructions were requested to take the necessary steps. All units that have initial loads have completed SAMGs, and installed hydrogen monitoring and removal devices;

- Monitoring and water supply of spent fuel pools are available for the loaded units;

- Evaluation of the risks of earthquakes, tsunami and extreme external events have been performed;

- Similarly, all NPPs under construction have developed their emergency response capabilities, prepared their emergency preparedness and response plans and the related procedures and documents;

The research reactors for civil purposes have also been involved in the improvement actions stemming from the lessons learned from the TEPCO Fukushima Daiichi accident. Typical upgrading activities were as below:

- Protection against seismic events: the high flux engineering test reactor of Nuclear Power Institute of China (NPIC) was analysed and upgraded in 2012; the primary circuit siphon breaker transformation of the research reactors of the China Institute of Atomic Energy (CIAE) was completed by October 2013;

- The very low power miniature neutron source reactors (MNSR) and critical assemblies of CIAE and the 5 MW low temperature reactor of Tsinghua University have been provided with emergency power supplies;

- Mobile power supply has been provided to the high flux engineering test reactor;

- Implementation of emergency rescue equipment against natural disasters is underway.

In case of fuel cycle facilities of civil purposes, a number of improvement measures have been requested. The most relevant ones were as follows.

- In case of the old facilities analyses of their seismic resistance capabilities have been performed. Based on the results either seismic reinforcement has been performed, or decommissioning of the plant has been initiated;

- All operating FCFs have updated their emergency preparedness and response plans;

- Various specific actions have been initiated and partially completed in some of the plants.

The IRRS Self-Assessment report states that the implementation of improvements after the Fukushima nuclear accident is proceeding well in the various nuclear facilities in China. It meets

the time requirements and basically corresponds to the relevant regulations of *General Technical Requirements*. The document emphasizes the improvements in four aspects:

- ability of withstanding external natural events;
- preventing and mitigating severe accidents;
- emergency preparedness and response;
- informing general public.

The last aspect of the improvements above can be illustrated by the required steps in informing public prior to taking a decision on the construction of a new NPP:

1) The public is informed through several channels on the plans via information bulletin of standardized contents
2) A questionnaire is released to the public and at least 300 responses are expected
3) An information symposium is organized with the participation of the representatives of the affected public (at least 30 participants are expected to take part)
4) A public hearing is organized

Supervision of technical upgrades

NNSA held regular targeted supervisions in September 2011, 2012 and 2013 to review the status of the technical upgrades. The upgrading items related to the lessons learned from the accident were further inspected by the regional offices in 2012-2014. Since then, completion of the respective work related to the NPPs in commissioning is confirmed during the inspections of the first fuel load. Re-evaluation of the upgraded status is planned to be performed sometimes in 2017 or later.

CONCLUSION [2]

The IRRS Team considers that the technical issues identified, analysed and implemented by the MEP (NNSA) and by the nuclear facilities in the light of the TEPCO Fukushima Daiichi accident were adequate and fairly complete. The fact that nuclear installations other than NPPs were also included into the identification and improvement processes is considered exemplary. The leading role demonstrated by the MEP (NNSA) in initiating and supervising the technical improvements is recognised by the IRRS Team.

The MEP (NNSA) is encouraged to continue its efforts in developing further and completing its regulatory standards and guides by also taking into account the lessons learned from the accident.

12.3. PLANS FOR UPCOMING ACTIONS TO FURTHER ADDRESS THE REGULATORY IMPLICATIONS OF THE ACCIDENT

The improvement projects during the *12th Five-Year Plan* include analysis and evaluation of the reliability of safety-grade digital control systems, carrying out Level 2 PSA safety analysis for external event and improving radioactive waste treatment system projects. At present, all NPPs are conducting the relevant analysis and assessment work according to their working plans. Most Level 2 PSA and the PSA for external events developments have already been completed.

Long term actions related to the implications of the accident include further development of the emergency preparedness and response ability of the Chinese NPPs, improving public information activities, enhancement of operational experience feedback and taking advantage of the latest results of research and technical development.

In developing emergency preparedness of the plant it is notable that all operating nuclear power plants have established communication channels with local meteorological, oceanographic and seismological departments, completed their emergency preparedness and response plans and tested them with exercises.

Major users and operators have formed cooperating groups for joint emergency actions if needed. Three major emergency support bases have been formed at various areas of China for common use.

Analysing and evaluating the reliability of safety-grade digital control systems: each NPP under construction analysed and evaluated the reliability from the aspects of design, verification and failure analysis, determines the weaknesses and are implementing the corresponding improvements

Special attention is paid to collection and feedback of operation experience in China as well as in foreign countries and to following the latest research and development results.

The long term research projects of civilian research reactors mainly include providing emergency rescue teams with equipment against natural disasters such as landslides for NPIC or constructing standby channels for plant sites.

In case of fuel cycle facilities long-term improvement projects concerning depleted uranium hexafluoride treatment plan are focused to strengthen the safety management of storage of depleted uranium hexafluoride.

CNNC has completed the first draft of the treatment plan, initiated a research on safe management and disposal technology of depleted uranium hexafluoride and evaluated the safe storage of the existing depleted uranium hexafluoride.

IRRS FOLLOW-UP MISSION TEAM

APPENDIX I - LIST OF PARTICIPANTS

INTERNATIONAL EXPERTS:		
JAMMAL Ramzi	Canadian Nuclear Safety Commission (CNSC)	ramzi.jammal@canada.ca
MARKKANEN Mika	Radiation and Nuclear Safety Authority (STUK)	Mika.Markkanen@stuk.fi
BLOOM Steven	United States Nuclear Regulatory Commission (USNRC)	Steven.Bloom@nrc.gov
BOSNJAK Jovica	Radiation Protection Center Public Health Institute (PHI)	jovica.bosnjak@phi.rs.ba
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RINFRET Francois	Canadian Nuclear Safety Commission (CNSC)	francois.rinfret@canada.ca
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STRITAR Andrej	Slovenian Nuclear Safety Administration (URSJV)	andrej.stritar@ursjv.si
THOMAS Gareth	Office for Nuclear Regulation (ONR)	Gareth.Thomas@onr.gov.uk
IAEA STAFF MEMBERS		
KOBETZ Tim	Division of Nuclear Installation Safety	t.kobetz@iaea.org
MAKAROVSKA Olga	Division of Nuclear Safety and Radiation Waste	o.makarovska@iaea.org
DANI Mario	Division of Nuclear Installation Safety	m.dani@iaea.org
LIAISON OFFICER		
SHEN Gang	National Nuclear Safety Administration (NNSA)	shen.gang@mep.gov.cn

APPENDIX II - MISSION PROGRAMME

<table>
<tr><th>Time</th><th>SAT
27 Aug</th><th>SUN
28 Aug</th><th>MON
29 Aug</th><th>TUE
30 Aug</th><th>WED
31 Aug</th><th>THU
1 Sept</th><th>FRI
2 Sept</th><th>SAT
3 Sept</th><th>SUN
4 Sept</th></tr>
<tr><td>9:00-10:00</td><td rowspan="10">Arrival of Team Members</td><td rowspan="3"></td><td></td><td rowspan="3">Interviews
Site Visits</td><td rowspan="3">Interviews
Site Visits</td><td rowspan="3">Interviews
TC/DTC writes introductory parts</td><td rowspan="3">TM write Report
TL and DTL review introductory part

Draft text to TL/DTL</td><td rowspan="3">• Discussing and improving Draft Report
• Cross-Reading
• TL, DTL, TC and DTC read everything</td><td rowspan="10">Free day, Social Tour</td></tr>
<tr><td>10:00-11:00</td><td rowspan="2">Entrance Meeting</td></tr>
<tr><td>11:00-12:00</td></tr>
<tr><td>12:00-13:00</td><td>Lunch with Host</td><td colspan="2">Lunch</td><td>Lunch</td><td>Lunch</td><td>Lunch</td><td>Lunch</td></tr>
<tr><td>13:00-14:00</td><td>Lunch</td><td rowspan="5">Interviews</td><td rowspan="5">Interviews + in-group discussions
Site Visits</td><td rowspan="4">Interviews + in-group discussion
Site Visits</td><td rowspan="5">Team finalize Findings and draft report
TC/DTC writes introductory parts</td><td colspan="2">Policy Discussions</td><td rowspan="5">Finalisation of the Draft Report</td></tr>
<tr><td>14:00-15:00</td><td rowspan="3">Initial Team Meeting:
• Welcome
• Meet host liaison officer
• Mission logistics
• Discussion of first impressions
• Closing</td><td rowspan="3">Secretariat edits the report
Preliminary Draft Report Ready</td><td rowspan="3">Cross-reading by TM</td></tr>
<tr><td>15:00-16:00</td></tr>
<tr><td>16:00-17:00</td><td>Written Preliminary findings delivered to TL/DTL</td></tr>
<tr><td>17:00-18:00</td><td>Daily Team Meeting</td><td>Daily Team Meeting</td><td>Daily Team Meeting: Discussion of findings</td><td>Daily Team Meeting</td><td>Daily Team Meeting</td><td>Submission of the Draft Report to the Host</td></tr>
<tr><td>18:00-20:00</td><td>Informal dinner</td><td>Dinner</td><td>Dinner</td><td>Dinner</td><td>Dinner</td><td>Dinner</td><td>Dinner</td><td>Dinner</td></tr>
<tr><td>20:00-24:00</td><td></td><td></td><td>Writing of the report</td><td>Writing of the report</td><td>Daily Team Meeting: Discussion of findings</td><td>Writing of the report</td><td>Team Read Draft</td><td>Free</td><td>Reading, Cross-reading of the Report</td></tr>
</table>

<table>
<tr><th></th><th>MON
5 Sept</th><th colspan="2">TUE
6 Sept</th><th colspan="2">WED
7 Sept</th><th>THU
8 Sept</th><th></th></tr>
<tr><td>9:00-10:00</td><td rowspan="2">Discussion of report conclusions with counterparts by module</td><td colspan="2" rowspan="2">Written comments provided by the Host

Team meeting to discuss and resolve Host comments</td><td colspan="2" rowspan="2">Common read through and finalisation of the Report by the Team</td><td>Submission of the Preliminary Report</td><td>9:00-10:00</td></tr>
<tr><td>10:00-12:00</td><td>Exit Meeting
Press Conference
Publication of Press Release</td><td>10:00-12:00</td></tr>
<tr><td>12:00-13:00</td><td>Lunch</td><td colspan="2">Lunch</td><td colspan="2">Lunch</td><td>Lunch</td><td>12:00-13:00</td></tr>
<tr><td>13:00-15:00</td><td rowspan="2">Individual discussions of report conclusions with counterparts</td><td rowspan="3">Discussion of the Report by the Team with Host Present</td><td rowspan="3">TC, DTC prepare Executive Summary and exit presentation and provides it to the Host</td><td>TL finalises Executive Summary and Exit Presentation</td><td>TC Drafts the Press Release</td><td rowspan="5">Departure</td><td>13:00-15:00</td></tr>
<tr><td>15:00-17:00</td><td>15:00-17:00</td></tr>
<tr><td>17:00-18:00</td><td>Daily Team Meeting</td><td colspan="2">Daily Team Meeting</td><td>17:00-18:00</td></tr>
<tr><td>18:00-20:00</td><td>Dinner</td><td colspan="2">Dinner</td><td colspan="2">Dinner</td><td>18:00-20:00</td></tr>
<tr><td>20:00-21:00</td><td rowspan="2">Secretariat updates Report</td><td colspan="2" rowspan="2">Secretariat finalises Report</td><td colspan="2" rowspan="2">Discussion of Executive Summary with the Host</td><td>20:00-21:00</td></tr>
<tr><td>21:00-24:00</td><td>21:00-24:00</td></tr>
</table>

APPENDIX III - MISSION COUNTERPARTS

	IRRS Experts	NNSA Lead Counterpart	NNSA Support Staff
1.	**RESPONSIBILITIES AND FUNCTIONS OF THE GOVERNMENT**		
	STRITAR Andrej	HU Liguang LI Bin	LIU Yi, WANG Lei, ZHU Lixin, YIN Dejian, LIU Wei, WANG Gang, WU Di, YU Yi
2.	**GLOBAL NUCLEAR SAFETY REGIME**		
	STRITAR Andrej KOBTZ Tim	SHEN Gang CHENG Jianxiu	FENG Yi, WEN Yujiao, FU Jie, LUAN Haiyan, YU Dan
3.	**RESPONSIBILITIES AND FUNCTIONS OF THE REGULATORY BODY**		
	MANSOOR Faizan BOSNJAK Jovica	LI Rujun YANG Haifeng	WANG Lei, DING Yihang, ZHU Lixin, LIU Wei, LI Xueqin, ZHANG Xiuzhi, WU Di, LIU Yingwei, ZHANG Qinghua, LI Bin, FU Jie, SONG Zurong, ZHAI Zhixin, LI Yixuan
4.	**MANAGEMENT SYSTEM OF THE REGULATORY BODY**		
	MANSOOR Faizan BOSNJAK Jovica	LI Rujun YANG Haifeng	LIU Liming, YIN Dejian, ZHANG Jingjing, ZHANG Qinghua, LI Bin, FU Jie, SONG Zurong, LI Yixuan, AN Hongzhen
5.	**AUTHORIZATION**		
	LIETAVA Peter	LUO Jianjun SONG Chenxiu	WANG Lei, ZHANG Lin, SONG Chenxiu, ZHU Pei, LIU Liming, WANG Gang, WU Di, ZHANG Xiuzhi

	IRRS Experts	NNSA Lead Counterpart	NNSA Support Staff
6.	**REVIEW AND ASSESSMENT**		
	BLOOM Steven	LI Jigen TAO Shusheng	ZHAO Guobin, LIU Liming, LIU Yi, FENG Youcai, ZHANG Xiuzhi, WANG Gang, WANG Ruixue, ZHOU Jingzhi
7.	**INSPECTION**		
	RINFRET Francois	YAN Tianwen LI Jingxi	ZHAO Guobin, LIU Yi, ZHOU Jingzhi, FU Qiang, DING Yihang, ZHU Pei, WANG Xiaotao, ZHANG Xiuzhi, ZHANG Jingjing, XUE Lei, XIAO Zhi
8.	**ENFORCEMENT**		
	RINFRET Francois	HOU Wei XU Xianhong	ZOU Bing, LI Xueqin, LV Ailin, WANG Xiaotao, Li Yan
9.	**REGULATIONS AND GUIDES**		
	MANSOOR Faizan BOSNJAK Jovica	HU Liguang LI Bin	LI Jingyun, WANG Ruixue, SONG Chenxiu, WU Di, ZHANG Xiuzhi, ZOU Bing
10.	**EMERGENCY PREPAREDNESS AND RESPONSE**		
	THOMAS Gareth	DING Zhibo YUE Huiguo	LI Xiaozhu, YAng Ling, HOU Jie

	IRRS Experts	NNSA Lead Counterpart	NNSA Support Staff
11.	**ENVIRONMENTAL MONITORING**		
	STEINER Martin	ZHANG Jiali	MA Lei, XIANG Yuanyi, HUANG Donghui, NIU Yunlong, LI Xiaozhu, YAng Ling, HOU Jie
12.	**REGULATORY IMPLICATIONS OF THE TEPCO FUKUSHIMA DAI-ICHI ACCIDENT**		
	LUX Ivan	HOU Wei TAO Shusheng	WANG Chongxiang, WEI Li, LIU Yigang, XIAO Zhi, PAN Rong, LI Chun, ZHANG Xiuzhi

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

Section	R/S	Recommendation/Suggestion
1.2.	**R2**	The government should expedite the promulgations of nuclear laws such as Atomic Energy Act and Nuclear Safety Act, consolidating and updating the nuclear safety infrastructure in China in such a way that it complies with GSR Part 1 requirements taking account of the rapid development of the nuclear power programme. Efforts should be made to complete the promulgations process within a reasonable time frame.
1.2.	**S2**	The regulatory authorities should ensure that in the implementation of regulations covering the Basic Safety Standard there is no gaps or unnecessary overlaps in assessment, inspection and enforcement.
1.7.	**R7**	The regulatory authorities should establish mechanisms for the effective coordination of the regulatory functions on occupational radiation protection, including ALARA applications, amongst MOH, provincial DoH, MEP and provincial EPB to ensure complete and clear coverage and coordination.
1.8.	**R8**	The government should establish a comprehensive national policy and strategy for the management of radioactive waste and spent nuclear fuel.
5.2.	**R16**	MEP (NNSA) should make explicit requirements in revising the relevant code to ensure that applications submitted by the licensee that contain safety analyses results shall be verified by experts independent from those that were involved in the preparation of the application, reflecting existing practices.
9.2.	**R31**	MEP (NNSA) should revise its regulations on research reactors and critical assemblies in order to formulate requirements in compliance with the IAEA safety requirements in NS-R-4 where they exist and as far as reasonably practicable.
9.3.	**R32**	MEP (NNSA) should revise its regulations on fuel cycle facilities in order to formulate requirements in compliance with the IAEA safety requirements in NSR-5 where they exist and as far as are reasonably practicable.
9.3.	**S39**	In order to facilitate the issuance and application of any such revision to regulations, MEP (NNSA) should initiate the elaboration of related regulatory guides.

APPENDIX V - RECOMMENDATIONS (RF), SUGGESTIONS (SF) AND GOOD PRACTICES (GPF) FROM THE 2016 IRRS FOLLOW UP MISSION

Section	RF/SF/GPF	Recommendation, Suggestion or Good Practice
3.3.	**GPF1**	The extensive use of social software and networking by MEP (NNSA) in daily business for sharing information and regulatory experiences, raising questions and comments and as a discussion forum in order to enhance the effectiveness of regulatory activities is considered as a good practice.
5.1.	**RF1**	The MEP (NNSA) should establish a specific process and guidelines for the content and review of applications for extending or renewing NPP operating licences.
5.5.	**RF2**	The MEP (NNSA) should further develop legal requirements to have a waste minimization plan as part of the application for a licence for facilities other than nuclear installations.
9.5.	**RF3**	The MEP (NNSA) should establish legal requirements for financial provisions for the decommissioning of facilities other than NPPs or FCFs that are subject to decommissioning requirements.
10.7.	**GPF2**	The MEP (NNSA) Nuclear and Radiation Safety Centre in Beijing have established a mechanism in the form of software for the regulator to independently and very quickly assess the practicability and effectiveness of detailed evacuation proposals. This mechanism is beneficial in the MEP (NNSA) roles of both reviewing regional authority off-site emergency plans and, in the event of an emergency, the implementation of specific evacuation actions.

APPENDIX VI - REFERENCE MATERIAL PROVIDED BY NNSA

1. State Security Law of the People's Republic of China
2. “12th Five-Year” Plan and Prospective Targets of 2020 on Nuclear Safety and Radioactive Pollution Prevention and Control (“Nuclear Safety Plan”)
3. People’s Republic of China Law on the Prevention and Control of Radioactive Pollution
4. Regulation on the Safety Regulation for Civilian Nuclear Installations of the People’s Republic of China
5. Integrated Management System Manual for Nuclear and Radiation Safety Regulation
6. The 13th National Five-Year Plan for National Economic and Social Development
7. China’s Nuclear Emergency Preparedness
8. Regulation on the Safety Management of Radioactive Waste
9. Measures for the Administration of Licenses for Storage and Disposal of Radioactive Solid Waste
10. Administrative Measures of the Project of Nuclear Power Plant Spent Fuel Treatment and Disposal Fund
11. Requirements on Nuclear Safety Regulation on Nuclear Power Plant Spent Fuel Dry Storage System (For Trial Implementation)
12. Measures on Research Reactor Safety Classification (For Trial Implementation)
13. Measures on Radioactive Sources Classification
14. Regulation on the Safety and Protection of Radioisotopes and Radiation-emitting Devices
15. Administrative Measures of Safety and Protection of Radioisotopes and Radiation-emitting Devices (Ministry Order No.18 of MEP, also HAF802-2011)
16. Administrative Measures of Diagnosis and Identification of Occupational Diseases (Ministry Order No.91 of MOH)
17. Requirements on Radiological Protection in Industrial X-ray Radiography (GBZ117)
18. Norms of Radiological Protection Training for the Medical Radiation Professionals (GBZT149)
19. Norms for Industrial X-ray Inspection Room Radiation Shielding (GBZT250)
20. National Medium and Long-Term Plan for Human Resource Development (2010-2020)

21. Medium and Long-Term Plan for Human Resource Development for Ecological and Environmental Protection (2010-2020)

22. Procedure for the Convention on Nuclear Safety

23. Procedure for Joint Convention

24. The Notice of Issuing and Distributing "The Requirements on Administrating National Nuclear Technology Utilization Radiation Safety Management System" (No.[2012]83, MEP)

25. Rules for Administration of Environmental Protection Documents (Order No. 13, NNSA)

26. MEP (NNSA) Work Scheme of Nuclear and Radiation Safety Public Communication

27. MEP (NNSA) Scheme of Nuclear and Radiation Safety Regulatory Information Publicity

28. Administrative Measures of Nuclear and Radiation Safety Regulatory Information Publicity

29. Nuclear Safety Culture Policy Statement

30. Safety Requirements on the Nuclear Power Plant Design (HAF102)

31. Principle and Basic Requirements of Classification for Civilian Nuclear Fuel Cycle Facilities

32. Regulation on the Supervision and Management of Civilian Nuclear Safety Equipment (State Council order No. 500)

33. Management Directory of Environmental Impact Assessment for Construction Projects(MEP Order No.33)

34. Measures for the Administration of Licenses for Safety of Radioisotopes and Radiation-emitting Devices (former National Environmental Protection Administration Order No. 31)

35. Regulation on Application and Issuance of Safety Licenses for Research Reactors (HAF001/03-2006)

36. Application and Issuance of Safety Licenses for Nuclear Power Plants

37. Application of Probabilistic Safety Analysis Techniques in the Field of Nuclear Safety (for Trial Implementation)

38. Administrative Measures of Licenses for Civilian Nuclear Fuel Cycle Facilities

39. Report of Equipment Reliability Data in China

40. On-site Inspection Guidance of Nuclear and Radiation Regulatory Department III

41. Measures for the Organization and Administration of Nuclear Safety and Environmental Experts Committee

42. Rules on Credentials Management of Nuclear and Radiation Safety Inspectors (MEP Order No.24)

43. MEP Technical Procedures for Regulation and Inspection of Radiation Safety and Protection (MEP NR [2012]17)

44. MEP Program for Regulation and Inspection of Radiation Safety and Protection

45. Notice on Division of Responsibilities between Regulatory Bodies for the Safety of Radioactive Sources (issued by the State Commission Office of Public Sectors Reform) (SCOPSR [2003] No. 17)

46. Five-year Plan for the Development and Revision of Nuclear and Radiation Safety Laws and Regulations (2010-2015)

47. Administrative Requirements on the Safety Regulation of Civilian Nuclear Facilities

48. Safety Requirements on Operation Safety of Nuclear Power Plants(HAF103)

49. General Technical Requirements on Improvement Actions of Nuclear Power Plants After Fukushima Nuclear Accident

50. Safety Requirements on the Site Assessment for Research Reactors

51. Safety Classification for Research Reactor Items

52. Regular Safety Review of Research Reactors

53. Operating Limits and Conditions and Procedures for Research Reactors

54. Aging Management of Research Reactors

55. Radiation Protection Design and Operating Radiation Protection for Research Reactors

56. Operating Organization and Operating Personnel Management of Research Reactors

57. Safety Management for Long-term Shutdown of Research Reactors

58. Classification Principles and the Basic Safety Requirements for Civilian Nuclear Fuel Cycle Facilities

59. Safety Guides for Emergency Preparedness and Response for NPPs

60. Safety Guides for Emergency Preparedness and Response for Fuel-Cycling Facilities

61. MEP (NNSA)Nuclear Emergency Plan in 2013

62. MEP (NNSA)Radiological Emergency Plan in 2013

63. General Requirements for the Buildup of Site Rapid Rescue Teams for Nuclear Accidents Emergency in NPP for Nuclear Group Corporations

64. Technical Requirements on the Buildup of Rapid Rescue Teams for Nuclear Accidents Emergency in NPP for Nuclear Group Corporations

65. Emergency Response Law of the People's Republic of China

66. MEP (NNSA) Quality Assurance Program for Nuclear and Radiation Emergency Command Center

67. Performance Requirements on Low and Intermediate Level Radioactive Waste Form －Cemented Waste Form

68. Technical Requirements on Discharge of Radioactive Liquid Effluents from Nuclear Power Plants,

69. Electromagnetic Environmental Monitoring Method for AC Electric Power Transmission and Distribution Projects

70. Standard for Construction of the Supervision Monitoring System for the Radiation Environment on Site of Nuclear Power Plants (trial)

71. Specific Technical Requirements on the Construction of the Supervision Monitoring System for the Radiation Environment on Site of Nuclear Power Plants (trial)

72. National Radiation Environmental Monitoring Scheme (Trial) (Huanban [2003] No. 56)

73. Technical Specification of Radiation Environmental Monitoring (HJ/T 61-2002)

74. National Radiation Environment Quality Report

75. Effects of the Fukushima Nuclear Accident on Mainland China

76. Monitoring Results of Radiological Environment in Mainland China during the Fukushima Accident

77. Specification for Data Transmission Protocol of Automatic Monitoring System for Radiation Environment

78. Distribution Scheme of Automatic Monitoring Data for National Radiation Environment Monitoring Network

79. Implementation Details of Automatic Monitoring Data Distribution for National Radiation Environment Monitoring Network (trial)

80. Emergency Plan of Unexpected Events for Distribution System of Automatic Monitoring Data for National Radiation Environment Monitoring Network

81. Nuclear Safety Act

82. Safety Requirements on Newly-built Nuclear Power Plants

83. Implementation Programme on the Comprehensive Safety Inspection on Civilian Nuclear Facilities

84. Guide of Implementation Programme on the Comprehensive Safety Inspection on Civilian Nuclear Facilities

85. Report of Comprehensive Safety Inspection on National Civilian Nuclear Facilities

86. Safety Requirements on Nuclear Power Plants' Siting

87. Notice on Carrying out Safety Margin Assessments on External Events of NPPs in Operation

88. General Technical Requirements on the Improvement Actions of Nuclear Power Plants after the Fukushima Nuclear Accident

89. Safety Requirements on Nuclear Power Plants Newly Built During the "12th Five-Year" Period

90. Nuclear Power Safety Plan (2011-2020)

91. Mid-and-long Term Nuclear Power Development Plan (2011-2020)

92. Regulation on Managing Transportation Safety of Radioactive Materials

93. Regulation on Environmental Radiation Protection of Nuclear Power Plants

94. Opinions of the State Council on Strengthening Major Environmental Protection Work

95. National Nuclear Emergency Plan

96. Regulation on Emergency Management of Nuclear Accidents at Nuclear Power Plants

97. Basic Standards on the Ionization Radiation Protection and Radioactive Source Safety

98. Regulation on Cross-border Emergency Management of Radioactive Impact due to Nuclear Accidents

99. Administrative Measures of Nuclear Accident Information Publicity

100. Emergency Action Development of Pressurized Water Reactors

101. Nuclear Emergency Drills at Operating Organizations of Nuclear Power Plants

102. Earthquake Problems in Nuclear Power Plants' Siting

103. External Human Events of Nuclear Power Plants' Siting

104. Habitability of Nuclear Power Plants' Emergency Facilities

105. Emergency Exposure Control for Nuclear Facilities

106. Volcanic Hazard to Site Evaluation of Nuclear Power Plants

107. Determination of Flood Design Basis for Riverfront Nuclear Power Plants' Siting

108. Determination of Flood Design Basis for Coastal Nuclear Power Plants' Siting

109. Extreme Weather Events in Nuclear Power Plants' Siting

110. Tropical Cyclone Design Basis for Nuclear Power Plants

111. Ninety-nine Questions about Nuclear and Radiation Protection

112. MEP (NNSA) Scheme of Nuclear and Radiation Safety Regulatory Information Publicity (for trial implementation)

113. Notice on Strengthening Information Publicity of Nuclear and Radiation Safety in Nuclear Power Plants

114. Notice on Strengthening the Work of Public Publicity and Information Disclosure of Nuclear and Radiation Safety

APPENDIX VII - IAEA REFERENCE MATERIAL USED FOR THE REVIEW

1.	**IAEA SAFETY STANDARDS SERIES No. SF-1** - Fundamental Safety Principles
2.	**IAEA SAFETY STANDARDS SERIES No. GSR PART 1** - Governmental, Legal and Regulatory Framework for Safety
3.	**IAEA SAFETY STANDARDS SERIES No. GSR PART 3** - Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards
4.	**IAEA SAFETY STANDARDS SERIES No. GS-R-2** - Preparedness and Response for a Nuclear or Radiological Emergency
5.	**IAEA SAFETY STANDARDS SERIES No. GS-R-3** - The Management System for Facilities and Activities
6.	**IAEA SAFETY STANDARDS SERIES No. NS-R-1** – Safety of Nuclear Power Plants: Design
7.	**IAEA SAFETY STANDARDS SERIES No. NS-R-2** – Safety of Nuclear Power Plants: Operation
8.	**IAEA SAFETY STANDARDS SERIES No. NS-R-4** - Safety of Research Reactors
9.	**IAEA SAFETY STANDARDS SERIES No. GS-G-1.1-** Organization and Staffing of the Regulatory Body for Nuclear Facilities
10.	**IAEA SAFETY STANDARDS SERIES No. GS-G-1.2** - Review and Assessment of Nuclear Facilities by the Regulatory Body
11.	**IAEA SAFETY STANDARDS SERIES No. GS-G-1.3-** Regulatory Inspection of Nuclear Facilities and Enforcement by the Regulatory Body
12.	**IAEA SAFETY STANDARDS SERIES No. GS-G-1.4** - Documentation for Use in Regulatory Nuclear Facilities
13.	**IAEA SAFETY STANDARDS SERIES No. GS-G-2.1** - Arrangements for Preparedness for a Nuclear or Radiological Emergency
14.	**IAEA SAFETY STANDARDS SERIES No.GS-G-3.1** - Application of the Management System for Facilities and Activities
15.	**IAEA SAFETY STANDARDS SERIES No. GS-G-3.2** - The Management System for Technical Services in Radiation Safety
16.	**IAEA SAFETY STANDARDS SERIES No. RS-G-1.3** - Assessment of Occupational Exposure Due to External Sources of Radiation
17.	**IAEA SAFETY STANDARDS SERIES No. RS-G-1.4** - Building Competence in Radiation Protection and the Safe Use of Radiation Sources
18.	**IAEA SAFETY STANDARDS SERIES No. NS-G-2.10** - Periodic Safety Review of Nuclear Power Plants Safety Guide
19.	**IAEA SAFETY STANDARDS SERIES No. NS-G-211** - A System for the Feedback of Experience from Events in Nuclear Installations Safety Guide
20.	**INTERNATIONAL ATOMIC ENERGY AGENCY** - Convention on Early Notification of a Nuclear Accident (1986) and Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency (1987), Legal Series No. 14, Vienna (1987).

APPENDIX VIII - NNSA ORGANIZATIONAL CHART