PEOPLE'S REPUBLIC OF CHINA

A. National Framework for management of radioactive waste and spent fuel

A.1 Overview of National Policy

Spent fuel management policy in China is to implement the reprocessing of spent fuel and to recover uranium and plutonium materials, so as to achieve maximum use of resources, to reduce the generation of high level radioactive waste and to ensure the safety of spent fuel management and the public safety, and to lower the risks to the future generations.

Radioactive waste management policy in China is to implement management and disposal of radioactive wastes according to their classification. Both gaseous and liquid radioactive wastes shall be treated and released on the up-to-standard basis. Solid LLW-ILW shall be disposed of in regional near-surface disposal facilities. Solid HLW shall be disposed of in a centralized deep geological disposal repository.

A.2 National Regulatory Bodies

The major regulatory bodies in China which are engaged to the safety of spent fuel management and the safety of radioactive waste management are the Ministry of Environmental Protection / National Nuclear Safety Administration (MEP/NNSA), the Ministry of Public Security (MPS) and the National Health and Family Planning Commission (NHFPC)（the former Ministry of Health） etc.

The MEP/NNSA is an independent regulatory body for regulating nuclear and radiation safety. Regarding to the safety of spent fuel management and the safety of radioactive waste management, MEP/NNSA is responsible for the regulation of spent fuel and radioactive waste upon their nuclear safety, radiation safety and environmental radiation relating to their storage, transport, treatment and disposal and for the regulation of radioactive pollution prevention.

The MPS is responsible for the approval of on-road transport of spent fuel and HLW.

The NHFPC is, in regard to spent fuel and radioactive waste management, responsible for organizing the radiological injury diagnosis and treatment and responsible for medical emergency related to nuclear and radiation accidents.

A.3 National Implementation Bodies

The governmental authorities for nuclear power development and promotion in China are China Atomic Energy Authority (CAEA) and National Energy Administration (NEA).

The main responsibilities of the CAEA are proposing and developing the policies, development program or plan, decrees and industry standards concerning spent fuel and radioactive waste management, organizing demonstration of major projects and their review and approval, overseeing and coordinating the implementation of the projects, taking the responsibility of national nuclear accident emergency administration, organizing to convene the National Nuclear Accident Emergency Coordination Committee (NNAECC), regulating nuclear material, and undertaking nuclear facility decommissioning and radioactive waste management.

The responsibilities of the NEA are proposing and developing the rules and technical standards on nuclear power, proposing and developing the development program of nuclear power and its safety, reviewing and approving nuclear power projects; and organizing the emergency arrangement in the event of nuclear accident at NPPs.

B. National legal and regulatory framework

B.1 Primary Legislations and General Regulations

The laws already in effect applicable to the purposes of spent fuel and radioactive waste management are:

Law on Prevention and Control of Radioactive Pollution (LPCRP), promulgated in 2003, which stipulates: the MEP/NNSA shall implement overall regulatory control of radioactive pollution prevention and control; both the licensing and the environmental impact systems are attempted for the siting, construction, operation, and decommissioning of all kind of nuclear facilities including spent fuel and radioactive waste management facilities; those which are dedicated solely to storage and disposal of solid radioactive waste should implement a license for operators.

Law on Road Traffic Safety, revised in 2011, in which the MPS is stipulated to be responsible for the supervision of road transportation safety of hazardous materials

including radioactive materials. For the spent fuel and radioactive wastes in specific, the MPS shall be in charge of the approval granting for the road transportation of spent fuel and HLW.

Law on Occupational Disease Prevention and Treatment, revised in 2011, in which the NHFPC is stipulated to be responsible for organizing the radiological injuries' diagnosis and treatment related to spent fuel and radioactive wastes, and responsible for medical emergency related to nuclear and radiation accidents.

B.2 Rules Governing Specific Activities or Facilities

The Regulations that have already been in effect applicable to the management of spent fuel and management of radioactive waste are:

Regulations on Safety Control of Civilian Nuclear Installations, issued by the State Council in 1986, the NNSA has independent regulatory authority and implement overall regulation over the safety of all civilian nuclear facilities. Nuclear facility safety licensing system is adopted in China. Spent fuel management facility and radioactive waste treatment and disposal facility are as nuclear facilities. So the NNSA is responsible for reviewing, approving and granting the safety license for those kinds of facilities.

Regulations on Nuclear Material Control, issued by the State Council in 1987, in which the NNSA is prescribed to be in charge of the safety regulation of nuclear materials, before a nuclear material license issued by the CAEA, it should be ratified by the NNSA.

Regulations on Safety of Radioactive Waste Management, issued by the State Council in 2012, which stipulates that radioactive wastes are managed in accordance with classification; those which are dedicated solely to storage and disposal of solid radioactive waste should implement license for the operators and MEP takes charge of reviewing and granting the license.

National Emergency Plan (revised), issued by the State Council in 2013, which stipulates that CAEA is taking the responsibility of national nuclear accident emergency administration, organizing to convene the NNAECC and being responsible for studying developing and implementing national nuclear accident emergency plan.

The codes that have been in effect applicable to such purpose set forth the safety requirements for the management of spent fuel and radioactive waste, such as Codes

on NPP siting safety, design safety and operation safety respectively, Code on civil nuclear fuel cycle facility safety, Regulating measures for qualification certification for the storage and disposal of solid radioactive waste etc. issued by MEP/NNSA.

Reporting system on accident emergency at NPPs, Decision-making on protection measures and rehabilitation against serious accident in later stage, Emergency preparedness and response for accident of radioactive materials transport, and Provisions on decommissioning and remediation management of nuclear facilities and radioactive waste etc. issued by CAEA.

Temporary code on road transport of NPP spent fuel, issued associated by CAEA, MPS, Ministry of Transportation (MOT) and Ministry of Health (MOH).

Temporary management methods on collection and utilization of the funds for spent fuel management on nuclear power plants, issued associated by the Ministry of Finance (MOF), National Development and Reform Commission (NDRC) and CAEA, the funds cover the transport, AFR storage, reprocessing of spent fuel and their waste disposal arising from reprocessing plant operations, 2.6 cent RMB/KWh is deposed into a dedicated account.

C. Radioactive waste management, decommissioning and spent fuel strategy and current practices & technologies

C.1 Strategy and Practices on Spent Fuel Management

Spent fuel generated from NPPs and research reactors are mainly stored AR in a wet-storage way. Part of them was transported to storage pool of spent fuel reprocessing pilot plant by road transport means. CANDU spent fuel is partly stored in dry interim storage facility.

Spent fuel reprocessing pilot plant is commissioning. The research on the overall scheme design is finished for a large-sized commercial spent fuel reprocessing plant.

C.2 Strategy and Practices on Radioactive Waste Management

Both gaseous and liquid radioactive wastes generated from nuclear facilities have being treated and released on the up-to-standard basis. Solid LILWs are partly interim stored and partly has been disposed. Two solid LILW disposal sites had been operated. Screening survey has being conducted for HLW geological disposal repository. And early-

phase preparatory work of Underground Research Laboratory (URL) construction is in progress.

The decommissioning for two mini-reactors, some radioactive chemical experimental laboratories and radiation devices has been completed.

C.3 Current Issues at National Level

The total amount of spent fuel arising from NPPs is gradually increased with the rapid expansion of number of operational nuclear reactors. It is not well matching of related programs, between nuclear development program and program of spent fuel storage, transportation and reprocessing, is gradually emerged.

Except a guide for siting of high level radioactive waste geological disposal facility (HAD401/06) was issued, no other technical standards or guides on designing, construction, operating and safety assessment of geological disposal facility are developed and issued.

Existing solid LILW disposal sites in operation define the acceptance limits of LL-ILW. And the final disposal route of LL-ILW is still not determined, such waste can only be stored now.

C.4 Research and Development

China initiated research efforts on major special project "large-scale advanced PWR and high temperature gas cooled reactor NPPs”. CAEA is responsible for the research of the sub-project of SF reprocessing. Vitrification-related research efforts were initiated for liquid HLW arising from spent fuel reprocessing of NPPs. The study on deep geological disposal of HLW is being initiated in respect of engineering, geology, chemistry and safety.

The revision of National Standards to Regulations on Near Surface Disposal of Solid LIIW (GB 9132) and Regulations on Categorization of Radioactive Waste (GB 9133) have been launched by MEP, taking into account of properties and disposal methodologies of long lived radioactive waste. The prophase study of intermediate-depth disposal of LL-ILW is in process.

C.5 Financing of Radioactive Waste Management and Spent Fuel Management

Under the Interim Procedures on Collection, Utilization and Management of the Funds for Treatment and Disposal of Spent Fuel at Nuclear Power Plants (IPCUMFTDSFNPP), spent fuel management fund was built. The said funds are intended for utilization in the related transport, AFR storage, reprocessing of spent fuel, treatment and disposal of HLW generated from such reprocessing.

Under the Law on Prevention and Control of Radioactive Pollution and Regulations on Safety of Radioactive Waste Management, the operators of nuclear facilities and nuclear technology applications shall bear the costs for treatment, storage and disposal of their wastes.

Under the State Council's Reply on Nuclear Accident Damage Compensation Liability, China has established insurance regime for nuclear incident liability during the operation of NPPs or prior to spent fuel storage, transport and reprocessing.

MEP is developing the Regulation on Facility Decommissioning Safety. According to the Law on Prevention and Control of Radioactive Pollution, the operators of nuclear facilities shall bear and predicate the costs to decommission, and such costs shall be listed in the cost estimates or production costs.

D. RADIOACTIVE WASTE CLASSIFICATION, QUANTITIES (INVENTORY) OF WASTE AND SPENT FUEL

The current Chinese radioactive waste categorization standards were developed on the basis of the equivalent adoption of the *Classification of Radioactive Waste* (111-G-1.1) developed by IAEA in 1994. According to their activity level, wastes are classified into exempt waste, low-level radioactive waste, immediate-level radioactive waste and high level radioactive waste.

The solid LILWs generated by the end of 2013 arising from nuclear power reactors, research reactors, uranium enrichment, fuel manufacturing and nuclear technology applications had been stored largely at the site where they were generated, as shown in Table 1, consisting of 10076.1 m^3 unconditioned and 11456.8 m^3 conditioned low-level waste; 1913.2 m^3 conditioned and 958.9 m^3 conditioned intermediate- level waste.

By the end of 2013, a total of 10947.9 m^3 solid LILWs had been disposed of, as shown in Table 2, of which 13.6％ volume was from NPPs and other 86.4％from research reactors, nuclear technology applications and nuclear facilities decommissioning.

By the end of 2013, there were 3196.9 MTHM of spent fuel stored in pools at reactor, 766.6 MTHM (from CANDU reactors) in away-from-reactor dry storage and 394.2 MTHM sent to spent fuel reprocessing pilot plant in away-from-reactor wet storage for nuclear power reactor operation. Among those from research reactors, there were 0.6 MTHM in spent fuel pools at reactor and 2.8 MTHM sent to spent fuel reprocessing pilot plant in away-from-reactor wet storage, as shown in Table 3 and 4.

The translation matrix of Chinese and IAEA radioactive waste classifications are shown in Table 5.

Table 1 radioactive waste in storage

Route Waste Class	Processed(type) /Unprocessed	Total Current Volume (m^3)	Estimated disposal Volume (m^3)	Distribution (%)							Planned Disposal Route
				RO	FFE	RP	NA	DF	DC/ RE	ND	
Total	Unconditioned	11989.3	19559.4	60.7	38.9	-	0.4	-	-	0.0	Near-surface disposal
	Conditioned	12415.7	12415.7	95.1	0.9	-	4.0	-	-	0.0	
LLW	Unconditioned	10076.1	15733.0	53.2	46.3	-	0.5	-	-	0.0	Near-surface disposal
	Conditioned	11456.8	11456.8	94.7	1.0	-	4.3	-	-	0.0	
ILW	Unconditioned	1913.2	3826.4	100.0	0.0	-	0.0	-	-	0.0	Large portions near-surface disposal, small amounts in intermediate depth disposal
	Conditioned	958.9	958.9	99.9	0.0	-	0.1	-	-	0.0	

Waste origin type codes:

RO – reactor operations

FFE – fuel fabrication & enrichment

RP – reprocessing

NA – nuclear applications

DF– defense

DC/RE – decommissioning & remediation

ND – Undetermined

Table 2 radioactive waste disposed

Waste Class	Processed(not)	Total Volume (m^3)	Distribution (%)							Disposal Route Used
			RO	FFE	RP	NA	DF	DC/RE	ND	
Total of all classes	YES	10947.9	13.6	-	-	-	-	-	86.4	NSD
LILW	YES	10947.9	13.6	-	-	-	-	-	86.4	NSD
HLW	YES	0.0	0.0	-	-	-	-	-	0.0	DGD

(Note: Abbreviations as in Table 1)

Table 3 spent fuel in storage (MTHM)

Type	**Current amount (NPP)**	**Current amount (Research Reactors)**
Total spent fuel storage	4367.7	3.4
Wet storage (AR)	3196.9	0.6
Wet storage (AFR)	394.2	2.8
Dry storage (AR)	0.0	0.0
Dry storage (AFR)	776.6	0.0
Total spent fuel held in storage for other countries (amounts also included above)	0.0	0.0

AR = “at reactor site”, including fuel pools at NPP

AFR = “away from reactor site”

Table 4 amounts of spent fuel sent for reprocessing (MTHM)

Type	NPP	Research Reactor
Total amount spent fuel sent to reprocessing in China	394.2	2.8
Total amount spent fuel sent to reprocessing in another country	0.0	0.0
Total amount of spent fuel received from another country for reprocessing and recycling	0.0	0.0
Total amount of spent fuel (MTHM) or radioactive waste (m^3) returned to country of origin for storage/disposal	0.0/0.0	0.0/0.0

Table 5 translation matrix between Chinese and IAEA classifications

National Waste Classification Name	VLLW	LLW	ILW	HLW
LLW	20%	80%	0	0
ILW	0	80%	20%	0
HLW	0	0	0	100%

E. THE CAPACITIES AND STATUS OF PROCESSING, STORAGE AND DISPOSAL FACILITIES FOR WASTE AND SPENT FUEL

By the end of 2013, there are 25 spent fuel storage facilities in operation, 27 spent fuel storage facilities under construction and 19 be planned for construction.

By the end of 2013, one spent fuel reprocessing pilot plant is commissioning, and one large-sized commercial SF reprocessing plant is under planning.

By the end of 2013, there are 33 and 55 radioactive waste treatment and storage facilities respectively in operation, 26 and 23 radioactive waste treatment and storage facilities respectively under construction, and 19 and 17 respectively be planned for construction including one liquid HLW vitrification facility and one solid HLW storage facility.

By the end of 2013, there are 2 solid LILW disposal sites in operation, and an additional one solid LILW disposal site under construction. It is currently planned to construct another 2 solid LILW disposal sites and one deep geological repository for HLW.

Tables 6 and 7 give the current status and quantities of spent fuel and radioactive waste management facilities.

Table 6 summary of management facilities of spent fuel and radioactive waste

Type	Planned	Construction	Commissioning	In Operation	Shut-down	Decommissioning	Other	Total
Spent fuel storage	19	27	0	25	0	0	0	71
Spent fuel reprocessing And recycling	1	0	1	0	0	0	0	2
Spent fuel conditioning	-	-	-	-	-	-	-	-
Spent fuel disposal	-	-	-	-	-	-	-	-
Waste processing:	19	26	2	33	0	0	0	80
LILW processing	18	26	2	33	0	0	0	79
HLW processing	1	0	0	0	0	0	0	1
Waste storage:	17	23	1	55	0	0	0	96
LILW storage	16	23	1	55	0	0	0	95
HLW storage	1	0	0	0	0	0	0	1
Waste disposal	3	1	0	2	0	0	0	6
LILW disposal	2	1	0	2	0	0	0	5
HLW	1	0	0	0	0	0	0	1

Table 7 summary of major sources of waste

Type	Planned	Construction	Commissioning	Operation	Shutdown	Decommissioning	Other	Total
Research reactors	0	0	0	13	0	0	0	13
Nuclear power reactors	18	27	0	19	0	0	0	64
Spent fuel reprocessing and recycling	1	0	1	0	0	0	0	2
Fuel fabrication/ enrichment	0	0	0	4	0	0	0	4

* Note: research reactors with medium or high power from RRDB

Note: "Planned"means it has been identified in a national report, strategy, or formal plan. It includes: Planned, Under Study-Assessment, Siting-Design phases

F. Trends and future prospects (volumes of waste and spent fuel arising, waste and spent fuel management facilities)

By 2030, the total spent fuel stored will be expected to 29900 MTHM, including at-reactor wet storage of 15400 MTHM, away-from-reactor dry storage of 4100 MTHM and at-reprocessing-plant wet storage of 10400 MTHM, additionally with storage of 31000 m^3 solid LILW and disposal of 70400 m^3.

By 2050, the total spent fuel stored will be expected to 76900 MTHM, including at-reactor wet storage of 28400 MTHM, away-from-reactor dry storage of 7900 MTHM and at-reprocessing-plant wet storage of 40600 MTHM. And the reprocessed spent fuel will be expected to reach 16000 MTHM. Additionally the total storage of solid LILWs will be expected to 55200 m^3, storage of 8000 m^3 solid HLW and α radioactive waste, and disposal of 264100 m^3 solid LILW.

Table 8 shows the projection of spent fuel and radioactive waste.

Table 8 the projected amounts of spent fuel and radioactive waste

Type	**Current amount**	**Estimated current Amount when prepared for disposal***	**Current Disposal Capacity**	**Total forecast at 2030**		**Total forecast at 2050**	
Spent fuel storage	4371.1 MTHM	-	-	29900 MTHM	-	76900 MTHM	-
Wet storage (AR)	3197.5 MTHM	-	-	15400 MTHM	-	28400 MTHM	-
Wet storage (AFR)	397.0 MTHM	-	-	10400 MTHM	-	40600 MTHM	-
Dry storage (AR)	0.0 MTHM	-	-	0 MTHM	-	0 MTHM	-
Dry storage (AFR)	776.6 MTHM	-	-	4100 MTHM	-	7900 MTHM	-
Total amount spent fuel sent to reprocessing and recycling	397.0 MTHM	-	-	10400 MTHM	-	56600 MTHM	-
Total amount spent fuel disposed	- MTHM	- MTHM	- MTHM	- MTHM	-	MTHM	-
Waste in storage	24405.0（m^3）	31975.0（m^3）	-	31000（m^3）	-	63200（m^3）	-
LILW	24405.0（m^3）	31975.0（m^3）	-	31000（m^3）	-	55200（m^3）	-
HLW	0.0（m^3）	0.0（m^3）	-	0.0（m^3）	-	8000（m^3）	-
Waste disposal	10947.9（m^3）	-	140000（m^3）	70400（m^3）	-	264100（m^3）	-
LILW	10947.9（m^3）	-	140000（m^3）	70400（m^3）	-	264100（m^3）	-
HLW	0.0（m^3）	-	0.0（m^3）	0.0（m^3）	-	0.0（m^3）	-

AR = “at reactor site”

AFR = “away from reactor site”

* calculated equivalent amount when waste has been conditioned and packaged for disposal as per table of conversion factors given.

Sources of data, assumptions (especially for future waste forecasts) and references

Data sources quoted in the report are:

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3	MEP announcement on review and approval of environmental impact report http://hps.mep.gov.cn/jsxm/pzxmgg/
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4	Twelfth-Five Year Plan on Energy Expansion, the State Council, 2013
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6	Zhang Zhiyin, Yan Cangsheng, Huang Laixi, Maximization of Radioactive Waste from NPPs, Beijing Atomic Press, 2013
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2014-02-28