

Safety Review Progress and Status of AP1000 in China

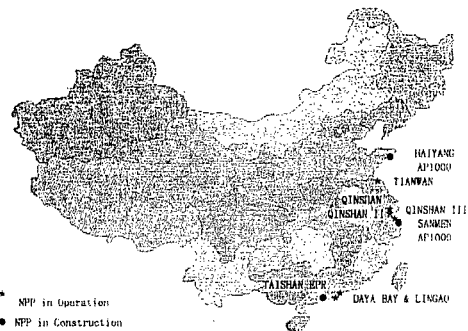
National Nuclear Safety Administration
February 9, 2009, Washington D.C.

Safety Review Progress and Status of AP1000 in China

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Background

- P.R.China and the U.S.A. signed a Frame Contract about import four AP1000 units on July 24, 2007 in Beijing, two units are assigned as Sanmen NPP unit 1&2, another two units are assigned as Haiyang NPP unit 1&2.
- The first engineering project of AP1000 in the world was started on December 31, 2007.
- Sanmen NPP submitted a CP application for its unit 1&2 to NNSA on February 25, 2008, with all supporting documents, including PSAR. Sanmen NPP expects that they can start construction (First Pour of Concrete) in March, 2009, and connect to the grid in September, 2013.
- Haiyang NPP submitted a CP application for its unit 1&2 to NNSA on May 26, 2008, with all supporting documents, including PSAR. Haiyang NPP expects that they can start construction (First Pour of Concrete) in September, 2009, and connect to the grid in March, 2014.



E/19

(B)

Format and Content of PSAR

- PSAR of Sanmen NPP and Haiyang NPP are based on Tier 2 of AP1000 DCD Revision 16, with some plant specific information.
- The format and content of PSAR shall comply with RG1.70 and SRP.

Review Team

- 182 technical persons are involved in the review team for AP1000 PSAR in China, they are from Nuclear and Radiation Safety Center (NSC), Nuclear Power Research and Design Institute of China (NPIC), Beijing Nuclear Safety Review Center (subpart of Beijing Institute of Nuclear Engineering, BINE), Mechanical Equipment Reliability Center, Suzhou Nuclear Safety Center.
- NSC takes the overall technical responsibility of the nuclear safety review project, organizes and cooperates with other organization to carry out the review project.
 - Mr. Tang Bo is the technical principle of the review project.
 - Mr. Chai Guohan is the project manager.
 - All the chief Reviewer of each chapter (except QA) of PSAR are from NSC.
- Review Team for AP1000 PSAR

Review Target

- Familiar with the design of AP1000, obtain all of the technical supporting documents.
- Ensure that the review scope and depth of CP application of AP1000 in China are equivalent to that of COL application of AP1000 in the USA.
- Ensure that the Scope and Depth of Nuclear Safety Regulation to AP1000 in China are equivalent to that in the USA.
- Confirm the design of AP1000 are conformance with Chinese Nuclear Safety Requirements.

Review Progress and Status

	PSAR of Sanmen NPP			PSAR of Haiyang NPP	
	Initial Time Schedule	Time Schedule Addressed	Actual Progress	Initial Time Schedule	Actual Progress
Receive CP Application with PSAR			2006.2.27		2006.3.28
Send Out Form Factors F.A.I	2006.3.31		2006.3.31		NA
Receive Response to Form Review F.A.I			2006.4.21		NA
Send Out First Batch of F.A.I	2006.3.30		2006.4.30	2006.10.31	2006.10.21
Receive Response to First Batch of F.A.I	2006.4.30	2006.7.25	2006.7.25	2006.10.1	2006.11.25
First Review Meeting, Action Sheet	2006.7.15	2006.6.11	2006.6.11-12	2006.11.15	2006.10.6-7
Receive Response to Action Sheet of First Review Meeting	2006.9.15	2006.9.15	2006.9.16	2006.1.15	2006.1.15
Send Out Second Batch of F.A.I	2006.9.15	2006.10.15	2006.10.17	2006.1.16	
Receive Response to Second Batch of F.A.I	2006.10.15	2006.11.14	2006.11.17	2006.1.16	
Second Review Meeting, Action Sheet	2006.10.30	2006.10.1	2006.10.1-2	2006.1.17	
Receive Response to Action Sheet of Second Review Meeting	2006.11.30	2006.1.5	2006.1.5	2006.1.1	
Determine the Review Topics	2006.12.15	2006.1.20	2006.1.23	2006.1.20	
Topical Review Meeting	2006.12.30	2006.2.1	2006.2.3-4	2006.1.18	
Consultant Meeting of Nuclear Safety and Radiation Advisory Committee	2006.1.15	2006.2.16		2006.1.15	
Issue CP	2006.3.10	2006.3.10		2006.5.10	

Statistical Data of the Review

- Sanmen NPP
 - ~ There are 1572 questions in The First Batch of RAIs.
 - ~ 663 Action Sheets are generated during the first review meeting.
 - ~ There are 698 questions in The Second Batch of RAIs.
 - ~ 269 Action Sheets are generated during the second review meeting.
 - ~ Several review topics have been chosen.
- Haiyang NPP
 - ~ There are 856 questions in The First Batch of RAIs.
 - ~ 276 Action Sheets are generated during the first review meeting.

Technical Cooperation with NRC

- NRC has performed the Regulatory Review for the Design Certification of AP900 and AP1000 about 16 years. Design Certification of AP900 and AP1000 have been issued separately by NRC, and NRC is performing the Regulatory Review of AP1000 DC amendment Application and several COL Applications for AP1000 in the U.S.A. right now.
- The first four units of AP1000 will be built and operated in China, the experience of safety review, construction, commission, and operation of AP1000 in China is very important to both countries.
- Cooperation actions till now:
 - Training workshop on AP1000 technology from August 5 to 16, 2007.
 - Consultant to NRC about the First Batch of RAIs for PSAR of Sanmen NPP (sent to NRC in July, 2008).
 - Workshop on NRC Regulatory Review for the AP1000 design from October 20 to 31, 2008.
 - A lot of documents related to the regulatory review of AP1000 in the U.S.A. have been provided by NRC, includes:
 - NUREG-1512 "USER related to the certification of AP900 standard design".
 - RAIs and its Response during review of AP1000 DCD Revision 15 (in 2002 and 2003).
 - NUREG-1763 "USER related to the certification of AP1000 standard design".
 - RAIs and its Response during review of AP1000 DCD Revision 15
 - Related to TR.
 - Related to each subsection of SRP.
 - Consultation meeting of nuclear safety review on AP1000 NPP from February 8 to 14, 2009.
- Cooperation on the computer codes is expected.

Achievement of the Review

- Most of the targets have been achieved.
- Review conclusion will be formed, it will support the final decision on issue of CP.

Shortcoming and Disadvantage


- The efficiency of the safety review is affected due to the language problem, all of the review documents are in English;
- Some review questions has no actual progress after several Q&A rounds due to poor communication between the Reviewer and the Designer, and due to the limited number of WEC experts attended the review meeting.
- The review time is not sufficient, the Reviewer don't have enough time to read all of the review documents carefully.
- Audit calculation has not been performed due to lack of tools.

Preliminary Review Comments


- Most of the review questions have been closed. Some open questions need a technical position of NNSA.
- There is not any big issue which could affect the issue of CP to Sanmen NPP on schedule from the view point of nuclear safety review.
- There maybe some uncertainties during construction, equipment manufacture, commission due to lack of experience, so risk of investment (such as delay of construction and/or operation, non-conformance of important equipment, etc) maybe exist.

Following Review Plan


- Sanmen NPP
 - Compile the technical position (Exception of Regulatory requirement and guidance, and National Standards) for the Review of AP1000 in China.
 - Consult meeting of Nuclear Safety and Radiation Advisory Commission to discuss about the technical position above.
 - Complete the Report for consult meeting of Nuclear Safety and Radiation Advisory Commission.
 - Consult meeting of Nuclear Safety and Radiation Advisory Commission to discuss about the CP of Sanmen NPP.
 - Compile Safety Evaluation Report for PSAR of Sanmen NPP.
- Haiyang NPP
 - Send out second batch of RAI.
 - Second review meeting.
 - And so on.
- Follow up the NRC's regulatory review of Application of AP1000 DC amendment and Application of COL for AP1000 in USA. Keep the design of Sanmen NPP and Haiyang NPP the same as that will be built in USA as extensive as possible. Safety Review on any important design modification in the future.
- Some topics need to be reviewed after CP but before FSAR, so as to minimize the press of safety review of FSAR.
- Establish some key conditions for Audit calculation of AP1000, so as to perform audit calculation on some key design and analyses in the future.


 中华人民共和国国家核安全局 *Safety first Quality first*
 National Nuclear Safety Administration


Organization of the China regulatory body & overview of the Chinese NPP regulatory framework




National Nuclear Safety Administration, P. R. China



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- ② Construction of safety infrastructure
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- ④ Evolution of the roles of NNSA
- ⑤ Safety requirements and practices




① Nuclear power plants in China

NPPs in Operation	Unit code	Reactor type	Rated power (MWe)	Date of FCD	Date of commercial operation
Qinsan	CN-1	PWR	310	1985/03/21	1994/04/01
Daya Bay	Unit 1	CN-2 (CPY)	2 × 984	1987/08/07	1994/02/01
	Unit 2	CN-3 (CPY)		1988/04/07	1994/05/06
Qinsan Phase II	Unit 1	CN-4 (CNP650)	2 × 650	1996/06/02	2002/04/15
	Unit 2	CN-5 (CNP650)		1997/04/01	2004/05/03
Lingao	Unit 1	CN-6 (CPY)	2 × 990	1997/05/15	2002/05/28
	Unit 2	CN-7 (CPY)		1997/11/28	2003/01/08
Qinsan Phase III	Unit 1	CN-8 (PHWR (CANDU))	2 × 700	1998/06/08	2002/12/31
	Unit 2	CN-9 (PHWR (CANDU))		1998/09/25	2003/07/24
Tianwan	Unit 1	CN-10 (VVER)	2 × 1060	1999/10/20	
	Unit 2	CN-11 (VVER)		2000/09/20	




NPPs in Construction	Reactor type	Rated power (MWe)	Date of FCD
Lingao	Unit 3 (CPR1000)	2 × 1080	2005/12/15
	Unit 4 (CPR1000)		2006/06/15
Qinsan Phase II	Unit 3 (CNP650)	2 × 650	2006/04/28
	Unit 4 (CNP650)		2007/01/28
Hongyanhe	Unit 1 (CPR1000)	2 × 1080	2007/08/18
	Unit 2 (CPR1000)		2008/03/28
Ningde	Unit 1 (CPR1000)	2 × 1080	2008/02/18
	Unit 2 (CPR1000)		

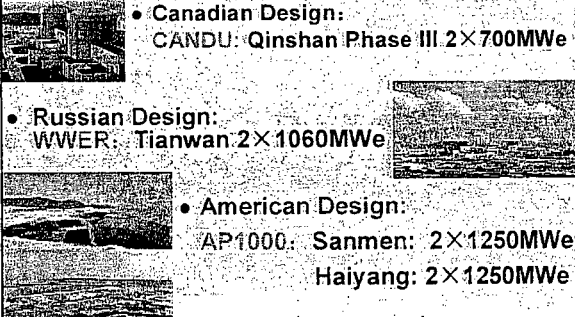
NPPs in Safety Review	Reactor type	Rated power (MWe)	Expected date of FCD
Fujing	Unit 1	PWR (M310)	2008/10
	Unit 2		2009
Hongyanhe	Unit 3	PWR (CPR1000)	2008/11
	Unit 4		2009
Yangjiang	Unit 1	PWR (CPR1000)	2008/12
	Unit 2		2009
Fangjinsan	Unit 1	PWR (M310)	2009
	Unit 2		2009
Sanmen	Unit 1	PWR (AP1000)	2013
	Unit 2		2013
Haiyang	Unit 1	PWR (AP1000)	2013
	Unit 2		2014
Taishan	Unit 1	PWR (EPR)	2009/09
	Unit 2		2010

Nuclear power plants in China

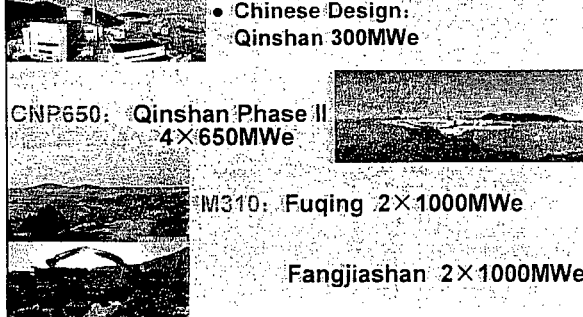
- French Design:
 - CPY: Daya Bay 2×980MWe
 - Lingao 2×980MWe
 - EPR: Taishan 2×1750MWe





- Canadian Design:
 - CANDU: Qinshan Phase III 2×700MWe
- Russian Design:
 - VVER: Tianwan 2×1060MWe
- American Design:
 - AP1000: Sanmen: 2×1250MWe
 - Haiyang: 2×1250MWe



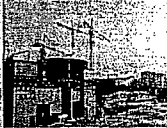
- Chinese Design:
 - Qinshan 300MWe
 - CNP650: Qinshan Phase II 4×650MWe
 - M310: Fujing 2×1000MWe
 - Fangjiashan 2×1000MWe



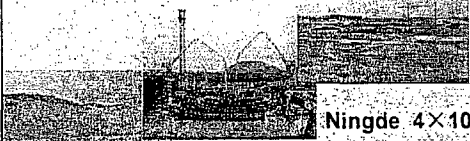



CPR1000:
Lingao 3&4 2×1080MWe

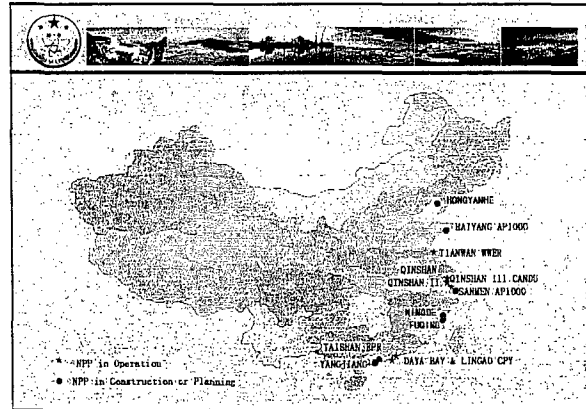

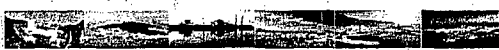
Hongyanhe 4×1080MWe



Ningde 4×1080MWe





Yangjiang 6×1080MWe

② Construction of safety infrastructure

- Foundation of NNSA
 - NNSA was founded in 1984
 - Independent from Nuclear Industry
 - Defining the Principle: *Safety first, Quality first*
 - Promoting the safety culture
 - Government reform in 1998: NNSA was combined into SEPA (now the MEP - Ministry of Environmental Protection)
 - Totally more than 300 staff for the whole system

- Working areas
 - Nuclear installations: NPPs, Research reactors, Fuel recycle, Radwaste...
 - Radioactive isotopes and devices
 - Uranium (Thorium) and radioactive associated mine
 - Nuclear equipment
 - Electromagnetic protection...



- Responsibilities defined by law and regulations

- Law & policy-making on nuclear safety and radiation protection.
- Safety review and license management.
- Safety inspection in the installations.
- Nuclear and radiation accidents investigation and treatment.



- Nuclear accident emergency preparedness and response:
 - on site: emergency response plan review and inspection.
 - off site: cooperating with national competent authority.
- Nuclear safety study
- Nuclear safety international cooperation
- Radiation environmental monitoring
- Electromagnetic environment management





- Licensing on radioactive isotope and devices
- Uranium (Thorium) and radioactive associated mine management
- Radwaste management
- Supervision on nuclear equipment design, manufacture, installation and NDT activities.
- Welding worker certificate
- Foreign nuclear equipment companies registration and equipment import checkout...





- Licensing Process

- Siting
- CP
- First fuel loading
- OP
- Decommissioning
- Reactor operator
- Radioactive sources
- Nuclear Equipment...

• Nuclear safety legal framework

- IAEA safety standards are used as reference
- Good practice for newcomers in nuclear industry
- Keeping the high and universal level of safety
- Legal basis for licensing process
- 5-level framework:
 - Laws
 - Regulations
 - Departmental rules
 - Safety guides
 - Technical documents

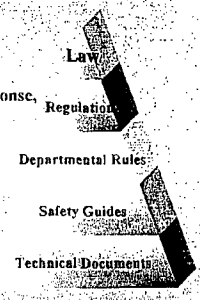


1 Law
 Law on Prevention and Remedy of Radioactive Contamination (2003)

5 Regulations
 Nuclear installations, emergency response, nuclear materials, sources, equipment

More than 20
 Sub-documents under regulations
 HAF series (Safety Requirements)

More than 70 (HAD series)

More than 180







■ Laws

- Issued by the Congress (mandatory)
- Setting up the administrative permissions
- "Nuclear Energy Act" or "Nuclear Safety Law" is to be established.

■ Regulations

- Issued by the State Council (mandatory)
- Setting up administrative scope, principles, organizations and its' functions etc.





■ Departmental Rules

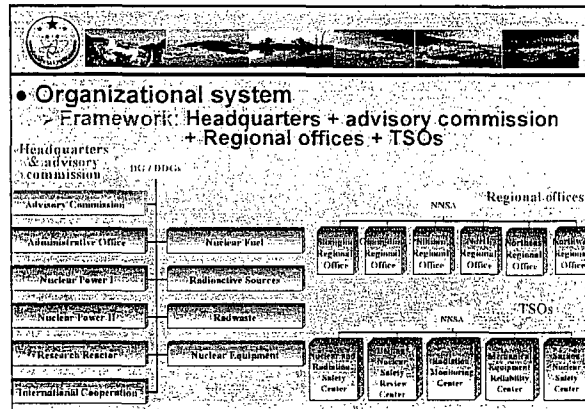

- Issued by Governmental organizations (mandatory)
- Implemental rules: Defining the implemental methods based on the Regulations.
- Safety requirements: Setting up nuclear safety objectives and basic requirements.

■ Safety Guides


- Issued by the Governmental organizations (recommendatory)
- Recommending the methods or procedures to satisfy the safety requirements.




- **Technical documents**
 - Issued by the Governmental organizations (referential)
 - Similar to IAEA TECDOC






- **NNSA Headquarters**
 - 9 divisions and 42 staff in the headquarters
 - Annual project budget about 90,000,000 RMB
- **Advisory commission**
 - more than 100 senior experts (including academicians)
 - 4 professional groups: 1) nuclear reactor and system, 2) fuel recycle, radwaste and siting, 3) radiation and emergency response, 4) I&C and mechanical equipment




- **Regional offices**
 - 6 regional offices and totally more than 100 staff
 - performing inspection to nuclear installations and radioactive sources in the areas
 - special function for North Regional Office: performing safety review and inspection on nuclear equipment related activities.
- **TSOs**
 - 5 main TSOs providing technical support to NNSA in safety review and inspection



- **Nuclear and Radiation Safety Center (NSC)**
 - NSC was found in 1989
 - belonging to MEP too
 - the most important TSO to NNSA 
 - 14 divisions, 170 staff
 - annual project budget: about 20,000,000 RMB
 - providing comprehensive technical support to NNSA.



- **NSC's functions**
 - Providing technical support on safety review and inspection (nuclear installations, radwaste, decommissioning, nuclear material, transport, nuclear equipment...)
 - Performing environmental impact evaluation
 - Evaluating nuclear installations events.
 - Providing technical support on emergency preparedness and response (Accident emergency response technical center).



- Providing technical support to law-making, electromagnetic environment management, nuclear technology applications...
- Performing international cooperation and nuclear safety studies.



- **Training**
 - *Regular training:*
 - Annual Inspector training course
 - Staff exchange within the system, or with the utilities
 - Through IAEA, OECD and bilateral agreements (USA, France, Canada, Japan...)
 - *Imported Project Training*
 - Getting support from vendor countries (USA, France, Canada) for batch training (1 year, 1/2 year)
 - Getting support from buyer for technical training course on imported project (2 weeks)



- **Capacity building**

- ✓ Computer (Cyber-180/830 from UNDP),
- ✓ Software (from vendor countries, e.g. ASN/IRSN)
- ✓ Safety studies,
- ✓ Inspection mode and procedures,
- ✓ Databanks,
- ✓ Event reporting system,
- ✓ Experience feedback system,
- ✓ Emergency response system,
- ✓ Radiation environmental monitoring network..



- **Working modes**

- ✓ Safety Review
 - Technical review
 - Advisory Commission review and consultation
 - Issuing license
- ✓ Inspection
 - routine inspections performed by regional offices
 - Comprehensive or special inspections organized by NNSA



3 **NPP review and approval process**

- National nuclear power development middle-long term plan (2005-2020), or national nuclear power development five-year plan
- Approval document from NRDC for earlier stage preparedness
- Approval documents from related governmental organizations, For MEP(NNSA): approval documents for EIR (sitting stage) and site safety analysis report
- NRDC organizing advisory company to evaluate the application documents
- State Council meeting for project approval



- MEP(NNSA) reviewing PSAR, EIR (design stage), QA program (design stage) for CP
- MEP(NNSA) reviewing FSAR, EIR (operational stage), QA program (operational stage), Emergency Plan for first fuel loading permit
- After 1 year trial operation, NNSA issuing OP



④ Evolution of the roles of NNSA

- At beginning:
 - Not involved in the decision for national nuclear developing program (including the decision for importing NPP).
 - Only responsible for the safety review and inspection of the NPP thereafter.
 - Remediation measures may cost a lot due to the different safety requirements between buyer country and vender country.
- At present:
 - Actively participating in the national decision process on any nuclear power related issues.



- For importing project, NNSA requires the Chinese buyer company:
 - ✓ To reflect national safety requirements in the commercial contract.
 - ✓ To set up corresponding items in contract convenient for the safety review, equipment inspection, share of software, personal training etc..
- Sending observers to the commercial negotiation or inform the Chinese buyer company in advance the corresponding requirements.
- Organizing comprehensive review of more than 100 sites
- More and more support from the Government





⑤ Safety requirements and practices



- For Importing NPPs
 - Safety review principles: Prior to review, some principles should be clearly defined by discussion with the utilities. Especially the codes and standards which must be followed
 - Codes and standards: Requirements from related Chinese laws, regulations, departmental rules must be satisfied. Technical standards from vendor country may be adopted. (e.g. RCC, RSEM...).
 - Joint review or consultation: Seeking for help from nuclear safety authority of vendor country (e.g. ASN/IRSN)

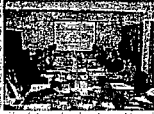





- Inspection experience exchange: GRO (regional office of NNSA in Guangdong) and regional office of ASN in Lyon signed a agreement and exchange inspectors and experience periodically.
- Training: holding training course and sending staff to vendor country for training (ASN/IRSN).
 - To bring up technical and management staff.
 - To master the review techniques and skill.
 - To get familiar with vendor country's safety codes and standards...
 - Try to get support from utility and vendor country's nuclear safety authority for above mentioned activities.
- Share computer codes with utilities: some computer codes important to safety review should be shared between NNSA and utilities. If necessary, NNSA will purchase additional computer codes for independent checking calculation during the safety review.




- Equipment inspection: communicating in advance with utility, setting up some items in the commercial contract for NNSA performing inspection to the equipment manufactured in foreign countries.
- International third-party cooperation: IAEA, OECD, and other related nuclear safety authorities for independent consultation
 - IAEA Pre-OSART/OSART
 - Daya Bay: 1996.10, Lingao: 2002.11, Tianwan: 2004.11, Qinshan III: 2005.03
 - IAEA expert consultation
 - CFER design safety review in 1998, follow-up in 2001
 - OECD MDEP

- For exported NPPs (Chashma)
 - China is a responsible country and has the obligation to help Pakistan to ensure the safety of CHASNUPP-1&2.
 - Nuclear safety cooperation agreement between NNSA and PNRA. A steering committee periodically exchanges information and reviews the implementation of the planned activities.
 
 - At the request from PNRA, NSC has provided services on training, SAR review consultation, equipment inspection consultation etc. since 1992.
 

- SRO (regional office of NNSA in Shanghai) provides services on commissioning inspection, training of inspectors.
- Peer review to TSO of PNRA: At the request from PNRA and its TSO, NNSA/NSC sent an expert team to Pakistan to perform a peer review based on IAEA safety standards and Chinese practices in 2006.

**Thank you
for your attention!**