China Nuclear Power Development Program

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上海核工程研究设计院
SHANGHAI NUCLEAR ENGINEERING RESEARCH & DESIGN INSTITUTE

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1 Current status of Chinese NPPs

- Currently, China has 15 NPP units in operation and 26 new units under construction, about 40% units under construction in the world.
- Nuclear safety and reliability are the first priority issues for nuclear power industry, especially after Fukushima accident.
- Implementation of full life cycle ageing management, which more emphasizes EQ as one of the AM activities in design, construction, fabrication and commissioning stages, is of great significance for nuclear power development in a safe, reliable, profitable and sustainable way, especially in China.

1 Current status of Chinese NPPs

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NPPs		Owner	Type	Power (MWe)	Time of FCD	Time of get into grid
Qinshan-1		CNNC	PWR	310	1985-03-21	1991-12-15
Daya Bay	Unit1	CGNPC	PWR	984	1987-08-07	1993-08-31
	Unit2	CGNPC		984	1988-04-07	1994-02-07
Qinshan-2	Unit1	CNNC	PWR	650	1996-06-02	2002-02-06
	Unit2	CNNC		650	1997-04-01	2004-03-11
	Unit3	CNNC		650	2006-04-28	2010-08-01
	Unit4	CNNC		650	2007-01-24	2011-11-25
LingAo	Unit1	CGNPC	PWR	990	1997-05-15	2002-02-26
	Unit2	CGNPC		990	1997-11-28	2002-09-14
	Unit3	CGNPC		990	2005-12-15	2010-07-15
	Unit4	CGNPC		990	2006-06-15	2011-08-25
Qinshan-3	Unit1	CNNC	CANDU	720	1998-06-08	2002-11-19
	Unit2	CNNC		720	1998-09-25	2003-06-12
Tianwan	Unit1	CNNC	WWER	1060	1999-09-20	2006-05-12
	Unit2	CNNC		1060	2000-09-20	2007-05-14

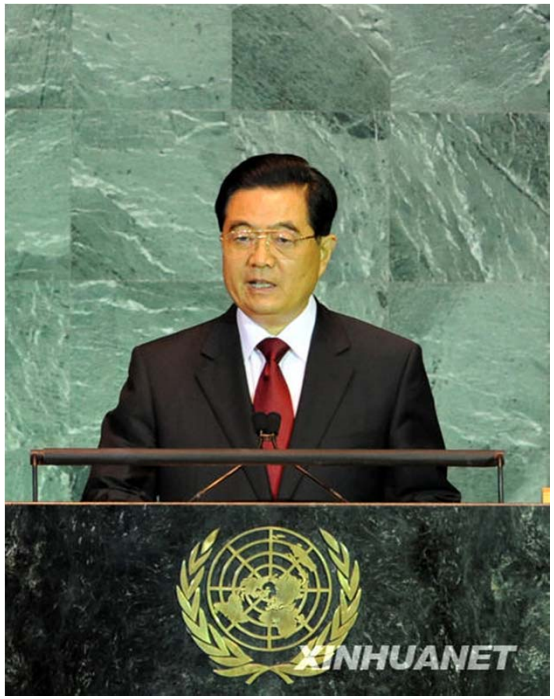
1 Current status of Chinese NPPs

Project Name	Owner	Type	Power（MWe）	Date of FCD	Date of get into grid (1st unit)
Hongyanhe	CGNPC/CPI	PWR(CPR1000)	1080×4	2007-04	2012-03
Ningde	CGNPC	PWR(CPR 1000)	1080×4	2008-02	2012-12
Fuqing	CNNC	PWR(CNP1000)	1080×2	2008-11	2013-07
Fangjiashan	CNNC	PWR(CNP1000)	1080×2	2008-12	2013-10
Yangjiang	CGNPC	PWR(CPR1000)	1080×6	2008-12	2013-10
Sanmen	CNNC	PWR(AP1000)	1250×2	2009-04	2013-10
Haiyang	CPI	PWR(AP1000)	1250×2	2009-09	2014-04
Taishan	CGNPC	PWR(EPR)	1750×2	2009-10	2013-12
Total			27, 940 / 26		

1 Current status of Chinese NPPs

1 Current status of Chinese NPPs

- **In Sept. 22, 2009, Chinese President Hu Jintao declared in UN Climate Summit on :**
  - **Develop actively reproducible and nuclear power；**
  - **By the year 2020, the rate of non-fossil energy will reach as high as 15%；**
- **In China, the percentage of coal energy is as high as ~82% and nuclear power is only ~2%. Currently, non fossil energy percentage is only 8%.**
- **The development of China is constrained largely by resource, environment, industrial safety and transportation capability.**



Conclusion: nuclear power is indispensible and irreplaceable for economic development in China!

2 China NPP development strategy after Fukushima accident

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TMI
Failure of Equi and HFE

- Great slowed down nuclear power develop.
- Uncertainty in safety review
- Regulations and standards upgraded
- Nuclear safety enhanced GII+

Chernobyl
Problem of Safety culture

- Enhance safety culture &training
  Application of PSA\HFE
- SA preventive & mitigation measures EOP

Fukushima
BDBA & SA

- Cautious plan & stringent safety approach and mitigation countermeasures forced
- GIII + passive technology preferred and intrinsic safety features such as LRF<10-7~-8

2 China NPP development strategy after Fukushima accident

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2.1 Quick response from central government of China

State Council Executive Conference reaffirmed Safety First during the nuclear power development and set forth four national resolutions on March 16, 2011 as follows:

1. Start safety evaluation on all operating nuclear facilities immediately.
2. Enhance the safety management of all operating nuclear facilities.
3. Conduct a comprehensive review based on advanced standards and technology to all the NPPs under construction.
4. Suspend approval of new NP projects until the Nuclear Safety Plan is in place.

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2.2 Immediately start comprehensive safety inspection activities

1. National Nuclear Safety Administration (NNSA), National Energy Administration (NEA) and China Earthquake Administration (CEA) organized and implemented comprehensive nuclear safety inspections for all operating and constructing nuclear power facilities.

2. Owners and utilities of operating and constructing NPPs performed self-review and response to the requirements of NNSA.

3. Inspection scope and contents were based on Chinese conditions taking account of the lessons learned from Fukushima accidents and the relevant international safety assessment. 12 inspection fields are listed in 2.3

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2.3 Safety Inspection Fields

No.	Category	Inspection Field
1	External events	Adequacy review of external events evaluated during the site selection process
2		Evaluation on capability of flood protection and flood control of nuclear power plants
3		Evaluation on seismic resistance capacity of nuclear power plants
4		Inspection on fire protection system of nuclear power plant
5		Prevention and mitigation measures against accident resulting from a variety of extreme natural events combined
6	Severe accident	Station Black Out accident analysis and evaluation, availability and emergency plan for additional power supply after losing the emergency power supply
7.		Evaluation on its reliability of prevention and mitigation countermeasures against SA

2 China development strategy after Fukushima accident

2.3 Safety Inspection Fields

No.	Category	Inspection Field
8	Emergency management	Plan of dealing with mass disturbances event
9		Effectiveness of environmental monitoring system and emergency response system
10	Project management and design	Quality assurance plan of construction, installation, pre-operation test
11		Evaluation on the project management and process control of nuclear power plants under construction
12		Other Potential weakness

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2.4 General Results of Safety Evaluation

1 **Based on the current effective nuclear safety regulations and guidelines, all NPPs in China are safe and reliable.**

- ✓ **The Chinese site conditions are better than that of Japan. The design basis flood of costal sites are all considered the tsunami factor. Only one site is forced to take measures to resist the external flood due to updating site data.**
- ✓ **Basically NPPs under operation and construction are already with or will consider severe accident management.**

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2.4 General Results of Safety Evaluation

2 The challenge of the extreme natural hazards such as beyond design basis earthquake and tsunami would possibly result into great safety impacts. So plant flood control design basis shall be reviewed with new standards.

- ✓ Present nuclear power plants are all located in regions of lower earthquake frequency.
- ✓ Seas near sites are shallow with long continental shelter and with low earthquake strength (below 6.5) i.e. very low big tsunami possibility.
- ✓ Initial draft results show that Chinese coastal tsunami flood produced by earthquake from remote ocean is much less than storm surges considered in design basis flood combination events, and has no impact to hydrological safety report of coastal nuclear power plants.

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2.5 Results of Safety Evaluation for AP1000 under Fukushima accident:

Although Fukushima accident is not possible to occur in Chinese AP1000 sites at Sanmen and Haiyang, the evaluation was made by Westinghouse and SNERDI respectively to demonstrate AP1000 can keep safe in Fukushima conditions:

- No fuel damage would occur in the reactor core or in the spent fuel pool.
- Containment integrity can be maintained.
- No unacceptable radiological material releases would occur.
- No off site assistance is required within 72 hours.

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2.6 Safety enhancement requirements on Operating NPP

- Check water seals for ducts, doors and windows, penetrations, pipes, etc to prevent safety-related buildings and equipment of nuclear power plants being flooded.
- Add the movable power supplies, movable pumps and corresponding interfaces to maintain safety-related function under station blackout event.
- Perform seismic PSA and seismic margin analysis.
- Establish and implement the severe accident management guideline (SAMG)

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2.6 Safety enhancement requirements on operating NPP

- Evaluate the survivability and availability of equipments for mitigation and the probability of hydrogen explosion and make improvement if necessary, etc.
- Perform flood protection engineering project for Qinshan-1 site based on evaluation of potential flood event.
- Finish the review and evaluation of earthquake and Tsunami, and make upgrade or improvement if necessary.
- Establish an integrated, coordinated, emergency response preparedness for multi units sites.

2 China NPP development strategy after Fukushima accident

2.7 Safety requirements on new NPP application for construction permit

- The site selection and design shall be based on the updating or advanced national safety guides/regulations and IAEA safety guide.
- Choose the type of reactor with more proven and advanced technology providing inherent safety.
- Control the scale and the speed of nuclear power plants construction for the time being.

2.7 Safety requirements of new NPP application for construction permit

- Ensure the gaseous and liquid effluents have no unacceptable impacts on the environment and the public when the nuclear reactors are under normal operation or accident conditions.
- The possibility of significant release of radioactive material shall be truly eliminated for new plants constructed after 2015 through design.

3 Progress of AP and CAP in China

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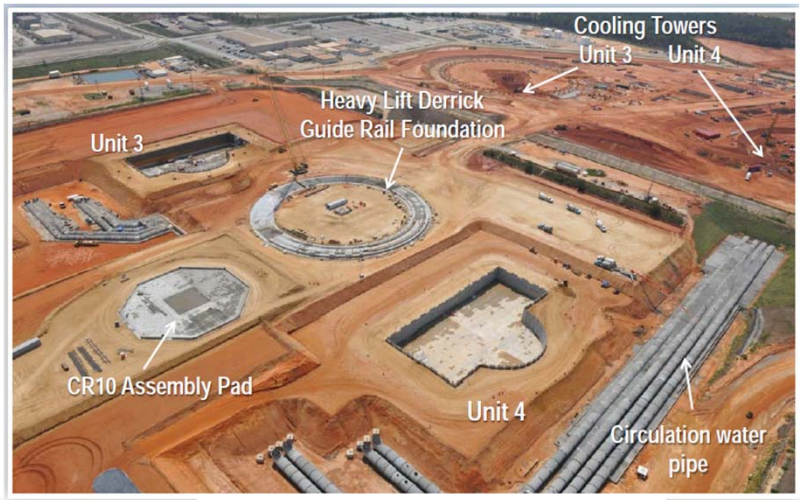
Chinese reliance-support AP1000 Project

Sanmen 1&2

Haiyang 1

Haiyang 2



Vogtle 3&4

VC Summer 2&3

3 Progress of AP and CAP in China

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Birds-view of Sanmen Site on Feb. 16th, 2012

S

The top head of CV will be on position in this year, and the NPP will connect to grid at the end of 2013.

3 Progress of AP and CAP in China

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General Parameter	AP/CAP1000	CAP1400
Nominal core power MWt	3400	4040
Anticipated electric power MWe	~1250	~1500
Reactor coolant average temp ℃	300.9	304.0
Reactor coolant operating pressure MPa	15.5	15.5
Number of fuel assemblies	157	193
Fuel assemblies type	AP1000 type	AP1000 type or new development type
Average linear power, W/cm	187	181
Steam generator type	△125	SNP SG
SG outlet steam pressure，MPa	5.61	6.02
Steam flow per loop，kg/s	944	1122
RCP design flow，m^3/h	17886	21640
DNBR margin	>15%	>15%

Accordingly, main components such as RPV, SG, Steel Containment, RCP, will modified in some way.

3 Progress of AP and CAP in China

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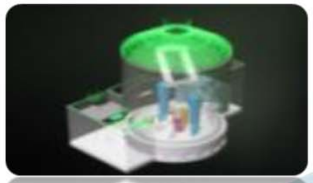
CAP1400 Mile Stones

2010年12月31日

- 概念设计通过审查
- Dec 31,2010
- Concept designed passed review



2011年12月31日

- 完成初步设计
- Dec 31, 2011
- Preliminary design complete

2013年4月30日

- 浇注第一罐混凝土
- Apr 30, 2013
- FCD

2017年12月31日

- 并网发电
- Dec 31, 2017
- Connection to Grid

4 Conclusions

- Although Fukushima Dachi-1 accident has considerable impact to world nuclear power development, as well as to China, nuclear power is still an indispensable to support China economic development. China will continue develop NPPs in a more sustainable and safer way.

- Lessons learned from Fukushima accident tell us that **SAFETY** should be in first priority. More new NPP types with more strict safety requirement will appear sooner or later, that means new and updated EQ requirements codes and standards, and criteria should be prepared.

Are we ready?

Thank you!