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Introduction of China’s Localization And Nuclear Supply Chain

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Ⅰ. Overview of China’s Nuclear Power Development

Ⅱ. China’s Gen-III Nuclear Power Localization Practice

Ⅲ. China’s Gen-III Nuclear Power Supply Chain
1. Progress of China’s Nuclear Power

- China’s nuclear power industry started from 1970
- More than 40 years of continuous development

1970—1991
Chinese Design/Built
- Qinshan phase I/II
- Chinese designed/built/operation
- Export to Pakistan 4 units

1987—2013
Generation II localization
- Introduction of France M310
- Introduction of Canada CANDU
- Introduction of Russia VVER

2005—Till now
Generation III localization
- Introduction of US AP1000
- CAP1400
- HPR1000
- Introduction of France EPR
Achievement of China’s Nuclear Power Industry

- Complete nuclear industry, R&D facilities/capability
- Complete design, manufacturing, construction, maintenance & operations of G-III nuclear power plants
- Complete supply chain capability for 10 sets per year
- Lifetime support for operation of nuclear power plant
I Overview of China’s Nuclear Power Development

2. Distribution of China’s NPP

In operation: 36 units, 33.5 Gwe;
Under construction: 21 units, 23.5 Gwe;
Site preparation: 38 units.
3. China’s G III NPP Development Program

Introduction of AP1000 + National Funding Program

- Complete technology transfer from Westinghouse
- Construction of 4 AP1000 units in Sanmen and Haiyang
- Independent development of CAP1400
I Overview of China’s Nuclear Power Development

3.1 Design, R&D System

Qualifications

Shanghai Jiaotong University

Tsinghua University

Dalian Technology University
1 Overview of China’s Nuclear Power Development

3.2 Integrated Equipment Manufacturing System

EQ Center

- Center Introduction
- System Establishment
- Technical Capabilities
- Qualification Practices
- Foreign Exchange

RV (SEC)
SG (HEC)
RV (CFHI)
SG (SEC)
Pressurizer (SEC)
Residue heat exchanger (Dongfang)
Zirconium (SNPTC)
SNPEMC is the first AP1000 CV, structure & equipment module manufacturer.

Original Landscape

10 months

Standard Design, Shop Fabrication, Part Transport, Integrated Set

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I Overview of China’s Nuclear Power Development

3.4 Project Construction and Management, Commissioning

NPP Project Management

IMS System
- Carrier of project management experience
- Supporter of global collaboration in NP projects
- deliver digital plants to owner.

Physical

Deliver two plants to owner

Digital
I Overview of China’s Nuclear Power Development

3.5 Lifetime Service and Fuel Supply

SNPSC US Training

R&D Test Base

US Training

NDT

Refueling

Lifecycle Assessment Aging Management

Performance Test Equipment Inspection

Maintenance

Training

6 Main Business Sections

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I Overview of China’s Nuclear Power Development

3.6 AP1000 Project--Sanmen

Ready for Fuel Loading
I Overview of China’s Nuclear Power Development

3.6 AP1000 Project--Haiyang

Ready for Fuel Loading
I Overview of China’s Nuclear Power Development

3.7 CAP1400--Large Scale Passive PWR Technology

- Improvement based on experiences of China’s nuclear power, including construction of Sanmen and Haiyang
- Meeting the world’s highest nuclear safety standards
- Independent developed by SNPTC

采用模块化施工，建造周期可由60个月缩短为48个月。
Modular construction has shortened construction period from 60 months to 48 months.

单机组输出功率1500 MWe，年发电量114亿千瓦时。
Output power is 1500 MWe, and each unit’s annual power generation reaches 11.4 billion kilowatt-hour.

电站整体和主要设备寿命由40年提高至60年。
Life of plant and main equipment extended from 40 years to 60 years.

采用非能动安全系统，严重事故概率降低100倍，事故后无需操纵员干预的时间由半小时增至72小时。
Passive safety system lowers severe accident probability by 100 times. Post-accident no-operator intervention time has been extended to 72 hours from 30 minutes.

Nuclear-grade valves decreased by 50%.

Annual power generation per unit: 11.4 billion kWh.

Construction period: 48 Months.
I Overview of China’s Nuclear Power Development
3.7 CAP1400– project at Shidaowan

CAP1400 demonstration project is ready for FCD
Ⅰ. Overview of China’s Nuclear Power Development

Ⅱ. China’s Gen-III Nuclear Power Localization Practice

Ⅲ. China’s Gen-III Nuclear Power Supply Chain
2.1 Organization of Localization

- **Government**
  - Set up localization target
  - Approving self-reliance projects (Sanmen and Haiyang)
  - Funding R&D

- **SNPTC (Leading Entity)**
  - Organizing and management
  - Execution of Technology Transfer
  - Selection of research institutes and suppliers
  - Foster Manufacturers
  - Construction of self-reliance projects

- **Manufacturers**
  - Participation in technology transfer
  - Carrying out R&D for manufacturing
  - Equipment supply for self-reliance project
## Ⅱ. China’s Gen-III Nuclear Power Localization

### 2.2 Government

<table>
<thead>
<tr>
<th>Planning</th>
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<tbody>
<tr>
<td>• National Nuclear Power Program</td>
</tr>
<tr>
<td>• Safety requirement</td>
</tr>
<tr>
<td>• Localization target</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Projects (with clear localization target)</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Approval of 4 AP1000 units in Sanmen and Haiyang</td>
</tr>
<tr>
<td>• Following project of G III NPP planned</td>
</tr>
<tr>
<td>• Approval of CAP1400 project</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Funding</th>
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</thead>
<tbody>
<tr>
<td>• Funding to support National Programs fro G III NPP development</td>
</tr>
</tbody>
</table>

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II. China’s Gen-III Nuclear Power Localization

2.3 SNPTC

- Overall organization of development of Gen-III nuclear power
- Introducing AP1000 technology and transferring to manufacturer
- Establishing platform for technology introduction, and R&D
- Establishing supply chain for Gen-III nuclear power
- Coordination for R&D units, manufacturing and construction
II. China’s Gen-III Nuclear Power Localization

2.3 SNPTC

1) Technology Transfer

USG
DOE
DOC
NRC

CNG
NEA
MOFCOM
CAEA

Licensor （WEC Cons.）

SNPTC （Licensee on behalf of State）

15 Groups (70 Organizations) （Domestic Sharing）
1) Technology Transfer Management

- Integrated Project Management
- Enhance Intercultural Communication
- One Interface between Licensors & Sub-licensors
- 3-Level Coordinating Mechanism: SNPTC-Westinghouse
  - Annually—Executive level, Quarterly—Management level, Monthly—Working level
- “5431” Quantitative Objectives Management
  - 4 Steps (RRAP): Reception/Review/Acceptance/Payment
  - 3 Analysis Reports: Monthly Progress Data/Quarterly Review/Risk Analysis
  - 1 Tool (S/C): Schedule & Cost Control System.
2. China’s Gen-III Nuclear Power Localization

2.3 SNPTC

2) Selection of Suppliers

- Established supplier qualification procedures
- To assist supplier to establish Nuclear quality assurance system
- To assist supplier to obtain ASME qualification
- Organize suppliers to share experience feedback
- Strictly following the nuclear standards and regulations
- HAF 604 required for foreign suppliers
II. China’s Gen-III Nuclear Power Localization

2.3 SNPTC

3) Supplier Qualification

**Audit**

- Annual audit to be conducted for critical equipment supplier, with special audit if necessary.

**Inspection**

- Inspection subject to the equipment safety classification, importance and supplier’s capability.

**Evaluation**

- The quality, technical delivery, site service ability will be evaluated and documented during the contract execution.

**Qualification Management**

- Supplier need to be prequalified every three years to keep on the Qualified Supplier List
Ⅱ. China’s Gen-III Nuclear Power Localization

2.3 SNPTC

3) Supplier Qualification

159 AP/CAP qualified suppliers, 90% of which are local companies
Ⅱ. China’s Gen-III Nuclear Power Localization

2.3 SNPTC

4) Foster Manufacturers

Symposium held in Feb., 2012

Symposium held in May., 2014

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2.3 SNPTC

5) To improve quality assurance system of suppliers

- To Enhance Nuclear Safety Culture
  - Nuclear Safety Culture has been publicized & educated
  - Advanced Human Performance Tools have been promoted

- TO improve QA System
  - Based on NQA-1 & HAF, Inspections performed periodically
  - Important criterion for qualified suppliers evaluation
Ⅱ. China’s Gen-III Nuclear Power Localization

2.3 SNPTC

6 ) To improve Quality Control

- Documents Review
- Manufacturing Quality Plan
- Surveillance & Witness
- Quality Inspection
- Testing & Final Quality Inspection
Ⅱ. China’s Gen-III Nuclear Power Localization

2.4 Manufacturers

1) New Manufacturing Bases Established

Nansha (Guangzhou), Lingang (Shanghai), Qin Huangdao (Hebei), and Mian Huadao (Dalian)
## Ⅱ. China’s Gen-III Nuclear Power Localization

### 2.4 Manufacturers

#### 2) Localization step by step

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Sanmen Unit 1</th>
<th>Haiyang Unit 1</th>
<th>Sanmen Unit 2</th>
<th>Haiyang Unit 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reactor Coolant Pump</td>
<td>EMD</td>
<td>EMD</td>
<td>EMD</td>
<td>EMD</td>
</tr>
<tr>
<td>Squib Valve</td>
<td>SPX</td>
<td>SPX</td>
<td>SPX</td>
<td>SPX</td>
</tr>
<tr>
<td>Reactor Pressure Vessel</td>
<td>Doosan</td>
<td>Doosan</td>
<td>CHFI</td>
<td>SEC</td>
</tr>
<tr>
<td>Steam Generator</td>
<td>Doosan</td>
<td>Doosan</td>
<td>HEC/ENSA</td>
<td>SEC</td>
</tr>
<tr>
<td>Reactor Internals</td>
<td>Doosan</td>
<td>Newington</td>
<td>SEC</td>
<td>SEC</td>
</tr>
<tr>
<td>Control Rod Drive Mechanism</td>
<td>Newington</td>
<td>Newington</td>
<td>SEC</td>
<td>SEC</td>
</tr>
<tr>
<td>Integrated Head Package</td>
<td>PCC</td>
<td>PCC</td>
<td>SDNPC</td>
<td>SDNPC</td>
</tr>
<tr>
<td>Polar Crane</td>
<td>PaR</td>
<td>TYHI</td>
<td>DHI</td>
<td>TYHI</td>
</tr>
<tr>
<td>Refueling Machine</td>
<td>Westinghouse</td>
<td>DHI</td>
<td>SEC</td>
<td>DHI</td>
</tr>
<tr>
<td>RCL Pipe</td>
<td>CSIS</td>
<td>CNE</td>
<td>CNE</td>
<td>CSIS</td>
</tr>
</tbody>
</table>

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2.4 Manufacturers

Localization portion gradually increased

- Sanmen 1#: 31.50%
- Haiyang 1#: 44.40%
- Sanmen 2#: 71.80%
- Haiyang 2#: 72.00%
- CAP1400: 85.00%
- Next CAP1000 project: 88.00%

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II. China’s Gen-III Nuclear Power Localization

Roadmap of Localization

Learning
• Organizing TT and learning existing advanced technology
• Learning from international advanced enterprises to upgrade Hardware

Practicing
• Supply for nuclear projects & forge qualified work teams
• Be subject to oversight and inspection by EPC Contractor

Upgrading
• Joint R&D & improving tech capacity
• Breakthroughs one by one
Ⅰ. Overview of China’s Nuclear Power Development

Ⅱ. China’s Gen-III Nuclear Power Localization Good Practice

Ⅲ. China’s Gen-III Nuclear Power Supply Chain
Ⅲ. China’s Gen-III Nuclear Power Supply Chain

3.1 Overview

- Established high level and integrated Gen-III NPP supply chain through 40 years of continuous NPP Construction
- Accumulated rich localization experience
Ⅲ. China’s Gen-III Nuclear Power Supply Chain

3.2 Supply Chain Upgrading

Before 2007, “Made in China supply chain 2.0”: over 20 years of continuous NPP constructions, mainly for Gen-II NPP

After 2007, “Made in China supply chain 3.0”: localization promotion for the Gen-III technology

‘Made in China’ 2.0
- Incomplete supply chain
- Key equipment lifetime, 40 years
- Tech. Specification for Gen-II
- QA system
- Localization rate, 70%
- Annual capacity, 4 units

‘Made in China’ 3.0
- Complete supply chain
- Key equipment lifetime, 60 years
- Tech. Specification for Gen-III
- Manufacturing capability promoted
- Nuclear safety culture promoted
- Localization rate, 85%
- Annual capacity, 8-10 units

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Ⅲ. China’s Gen-III Nuclear Power Supply Chain

3.3 Main Manufactures

1) Large Forgings

- China First Heavy Industry
- Shanghai Electric Heavy Industry
- China National Erzhong Group
Ⅲ. China’s Gen-III Nuclear Power Supply Chain

3.3 Main Manufactures

2) NI & CI Main Equipment

Harbin Electric

China First Heavy Industry

Shanghai Electric

Dongfang Electric
Ⅲ. China’s Gen-III Nuclear Power Supply Chain

3.3 Main Manufactures

3) Pump, Valves, Piping

- Jilin Sino-Italy Nuclear Piping
- Dalian Dagao
- Dalian Baoyuan Nuclear Equipment
- Sufa Valves
- Shanghai Aporo Pumps
Ⅲ. China’s Gen-III Nuclear Power Supply Chain

4) I&C/Simulator

- NuPAC, NuCON
- Reactor Protection and Control System: NNSA and NRC certified
III. China’s Gen-III Nuclear Power Supply Chain

3.4 Summary of Supply Chain in China

- Strong nuclear safety culture
- Internationally recognized codes and standards
- Proven technology and process
- World-Class facilities
- Large amount of skilled personnel & experienced engineers
- Sufficient capacities for 10 sets of AP/CAP NPP per year
All equipment, including localized has been installed and commissioned. RPV, SG, RVI, PRHR, RCL, PRZ, ACC, CMT, IHP, CRDM, etc.
3.6 CAP1400 Equipment

- All long lead materials & equipment have been ordered
- Main equipment are under manufacturing smoothly
III. China’s Gen-III Nuclear Power Supply Chain

3.6 CAP1400 Equipment
Ⅲ. China’s Gen-III Nuclear Power Supply Chain

3.6 CAP1400 Equipment
Ⅲ. China’s Gen-III Nuclear Power Supply Chain

3.6 CAP1400 Equipment

Turbine, Generator, MSR

Turbine Test Blade Assembly
Dynamic Frequency Test
Aero Dynamical Test

Generator Rotor Forging Accepted、262t
Generator Stator
MSR
China formed an integrated Gen-III nuclear power supply chain with sufficient capability to provide 10 sets of AP/CAP NPP per year.

SNPTC accumulates rich localization experience and is willing to share with international partners.
謝謝！
THANK YOU！