Development and Construction of ACP100

Reporter：Qu Yong

2023.09.05

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01 Characteristics of ACP100

Brief Project Introduction

ACP100, also called “Linglong 1”, is a significant innovation in the development of reactor technology. Due to its high safety, environmental-friendly, and site-flexibility, it can be applicatted to multi-missions, such as power generation, steam and heat supply, and seawater desalination.

Layout: Single-reactor, Semi-underground

Rated Power: 125 MWe

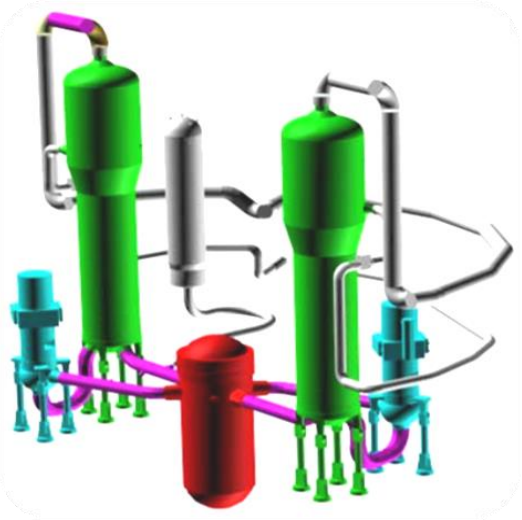
Design Life: 60 years

Refueling Cycle: 24 months

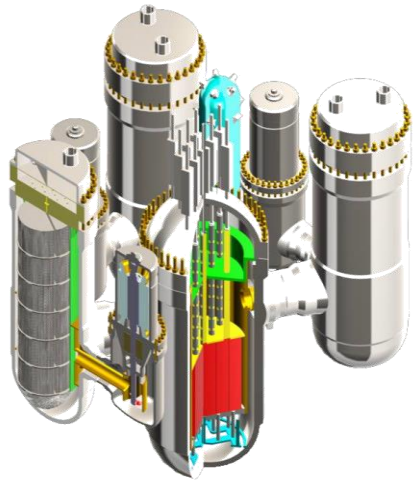
Construction Period: 55 months

Brief Project Introduction

Fully independently designed integrated small pressurized light water reactor



Traditional Reactor



Improved Compact Layout Reactor

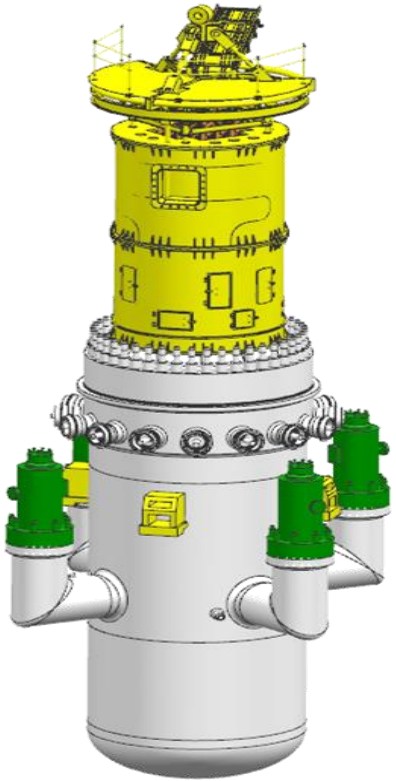
“Linglong 1”

Integrated Reactor

Technology Features

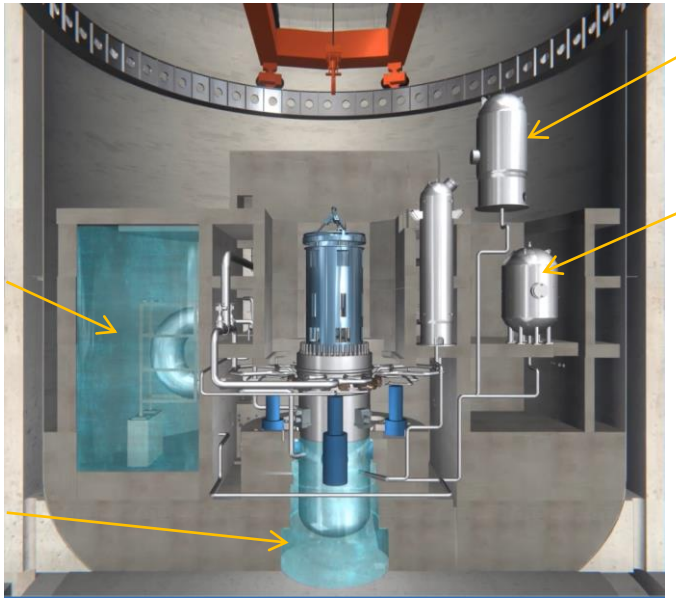
① Integrated Reactor

- The Steam Generators are integrated with the Reactor Pressure Vessel;
- The L-shaped Reactor Coolant Pump Casing, functioning both pump inlet and outlet flow channels and support of RCP motor, is machined from forgings, directly welded to the RPV cylinder and delivered together with the RPV;
- Top structure of the reactor is also integrated head package design;
- Integrated reactor reduces the possibility of accidents and mitigates their consequences, results in slower accident progress and more response time.



② Passive Core Cooling System

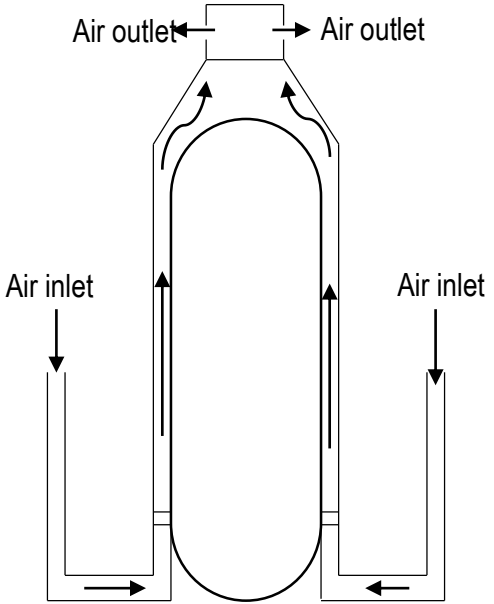
- Emergency make-up and boration of the reactor coolant system;
- Safety injection;
- Post accident pH control;
- Cavity injection cooling.



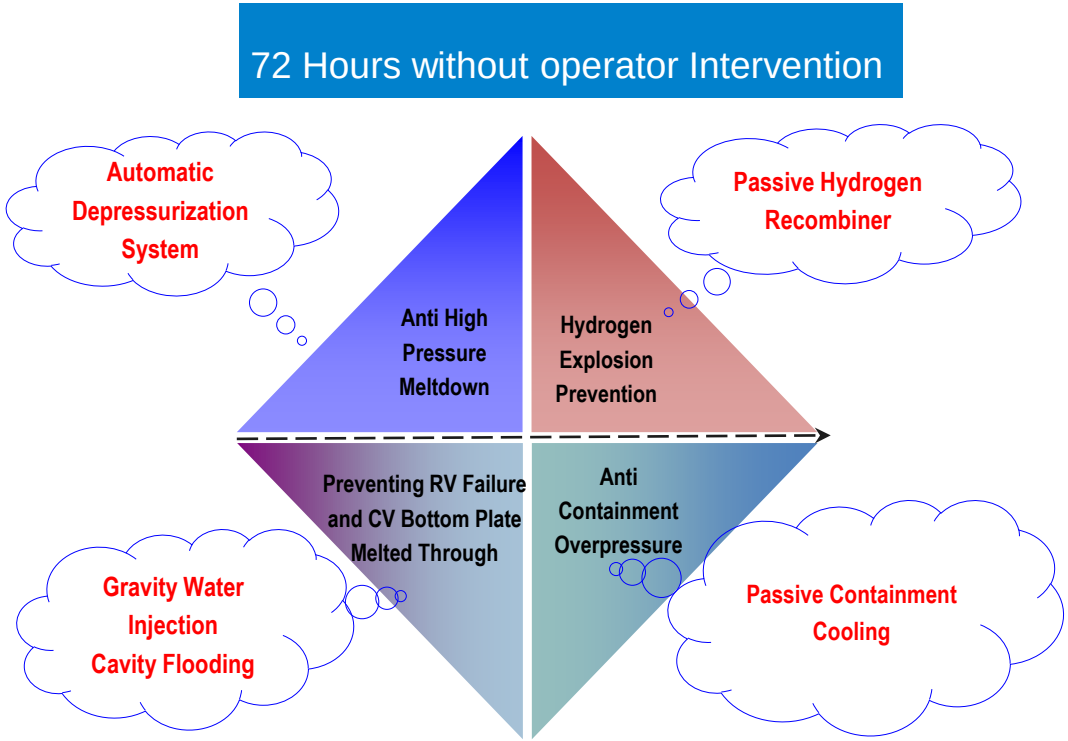
③ Passive Containment Air Cooling System

The inner steel containment vessel is under pressure and used as a heat transfer surface, the outer concrete containment structure organizes an air flow channel.

- The inner surface of the steel shell is heated by steam condensation.
- Heat is transferred to the outer surface of the steel shell.
- The outer surface is cooled by natural air circulation.



Safety Features



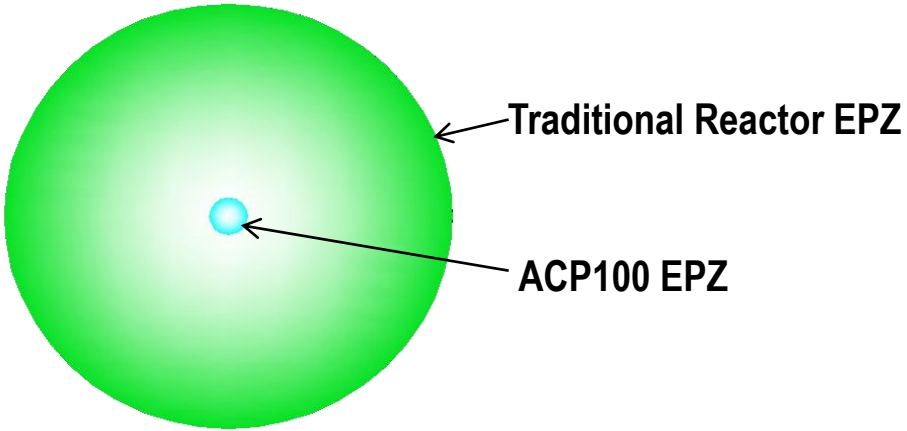
Safety Indicators of PSA	
	Linglong 1
CDF	~10^{-7}
LRF	~10^{-8}

IAEA believes that the design of ACP100 is an small pressurized water reactor that adopts passive safety features and is expected to handle extreme environmental conditions and multiple failures, ensuring the actual elimination of early or large-scale radioactive releases.

Safety Features

Technically, Linglong 1 can eliminate off-site emergency plan and flexibly deploy near cities/industrial areas:

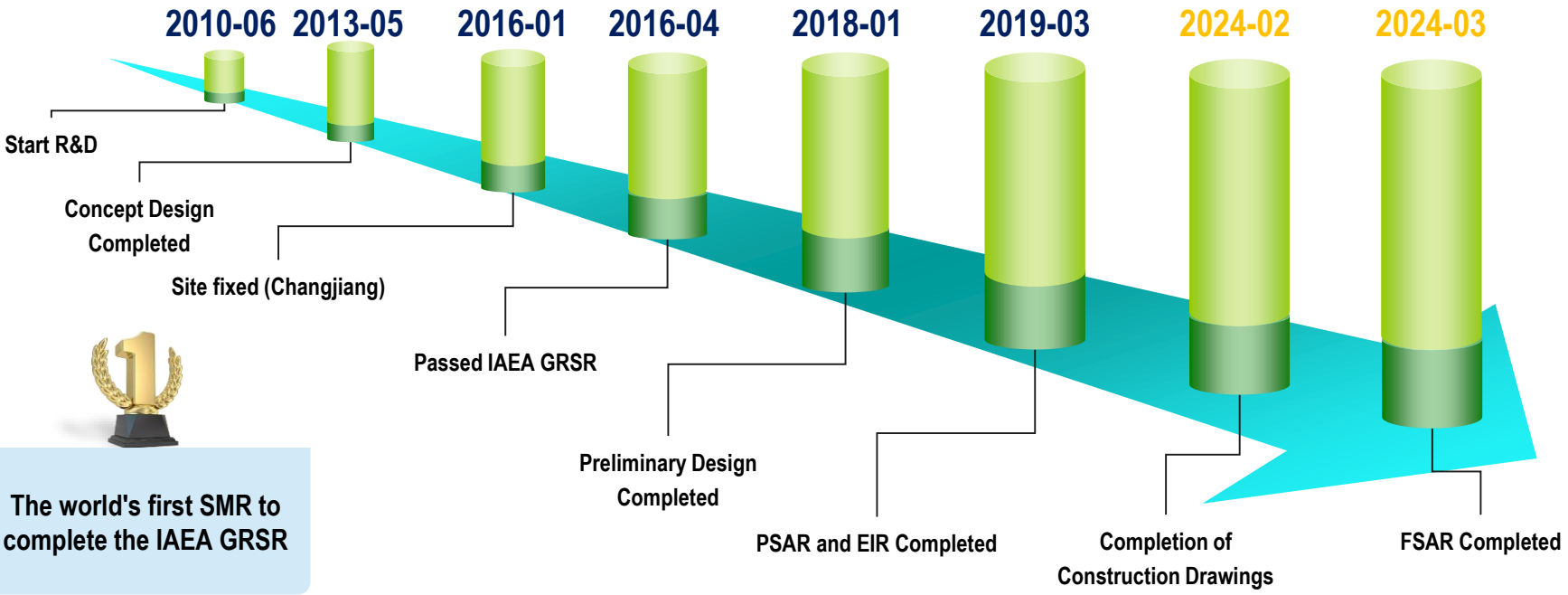
	ACP100	Traditional Reactor
EAB (Exclusion area boundary)	100m	500m
LPZ (limited planning zone)	800m	5Km
EPZ (emergency planning zone)	500m	5Km



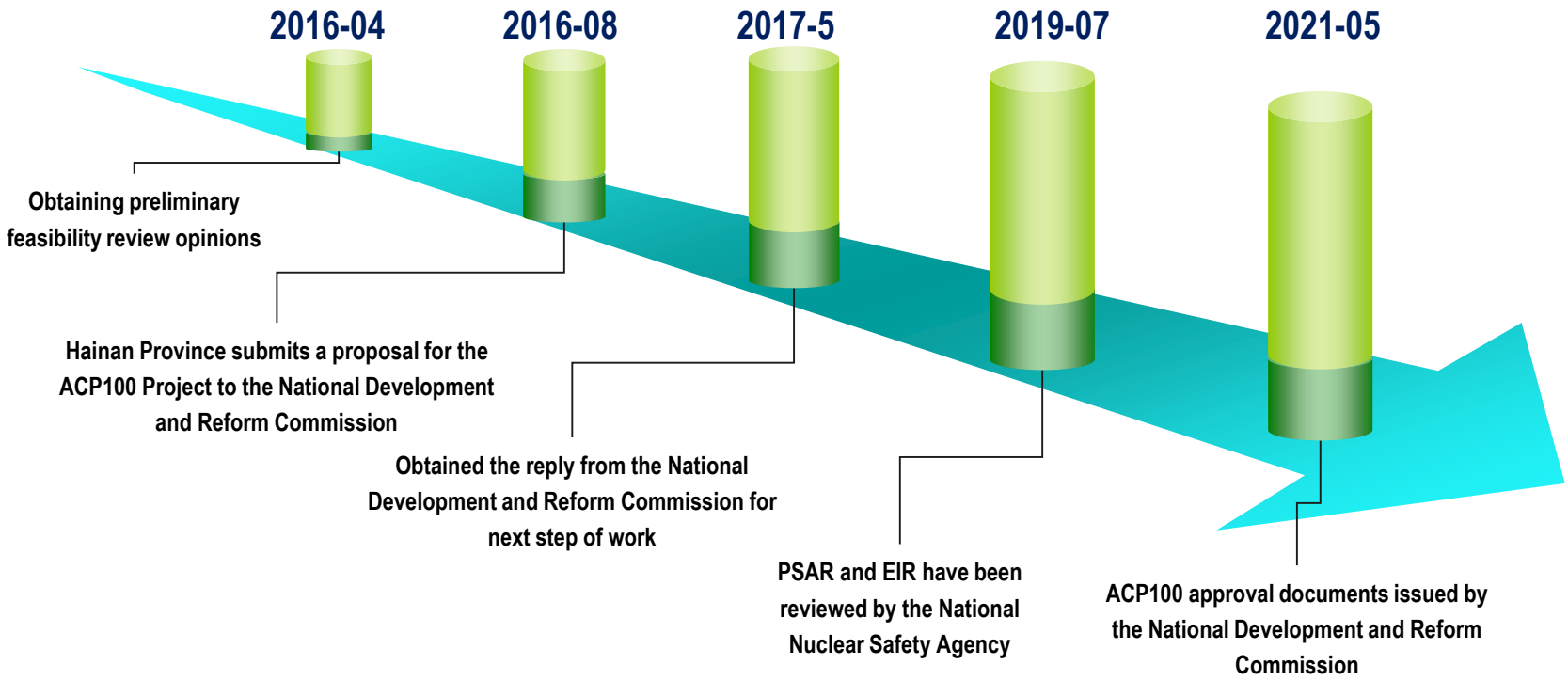
02

Preliminary Work Management of ACP100

Milestones of Development and Design

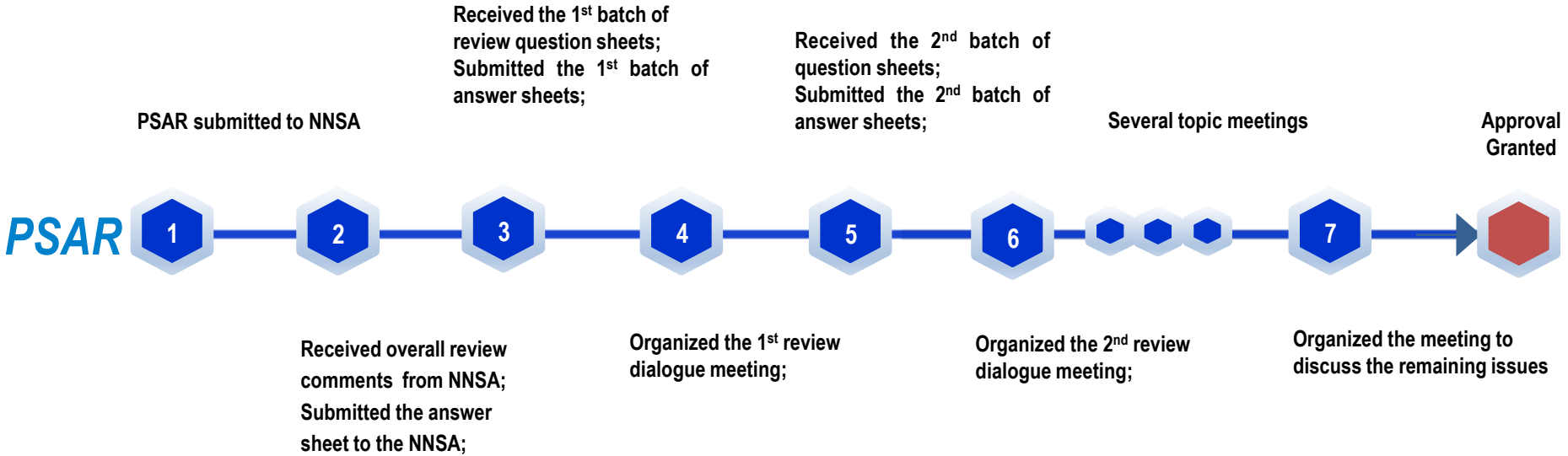


Milestones of Project Application



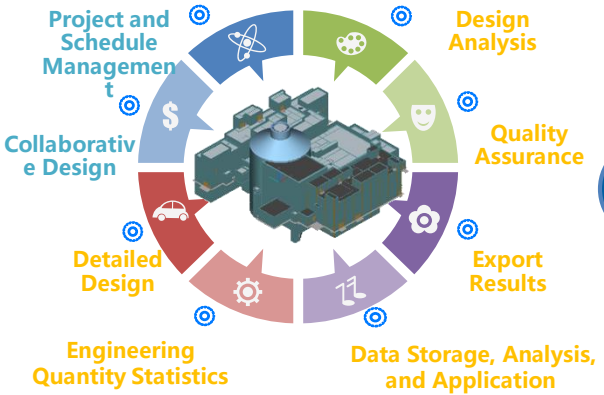
License Application Process

TYPICAL SAFETY REVIEW PROCESS

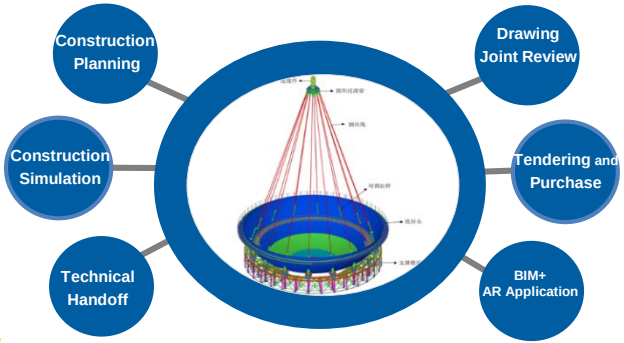


ACP100 Digital Design and Construction

Engineering Design BIM Application



Construction BIM Application



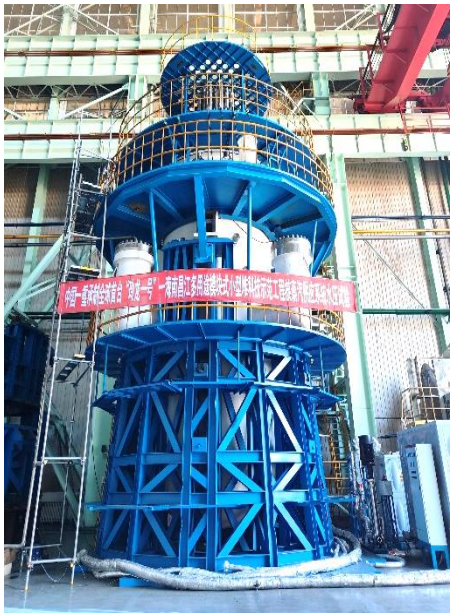
Digital Monitoring of Construction Site Safety

03 Project Progress

RPV Module of the Reactor

The RPV module of the "Linglong 1" reactor, known as the "Linglong Heart", integrates reactor pressure vessel, SGs, and RCP casing. It is the most challenging and representative "factory prefabricated, modular manufactured" main equipment.

Integrated design dose not only improve the safety and reliability of nuclear power plants, but also greatly shortens the construction period.



Hydrostatic testing of pressure vessels

The RPV module of the reactor arrived at the site on July 26th, 2023 and was hoisted into the RPV cavity on August 10th, 2023.

Reactor Coolant Pump

The RCP is one of the key equipment in primary circuit of ACP100.
In July 2021, the RCP manufacture started. At present, the assembly of four stators, the final assembly of three rotors, and the initial assembly of the fourth rotor have been completed. The guide vanes, impellers, heads, etc. are curently being processed.

Pump Base Processing

Rotor Dynamic Balance

Guide Vane Processing

Heat Exchanger for Passive Residual Heat Removal

The manufacturing of the Heat Exchanger for passive residual heat removal system is near to be completed，and will be delivered to site on September 10th, 2023.

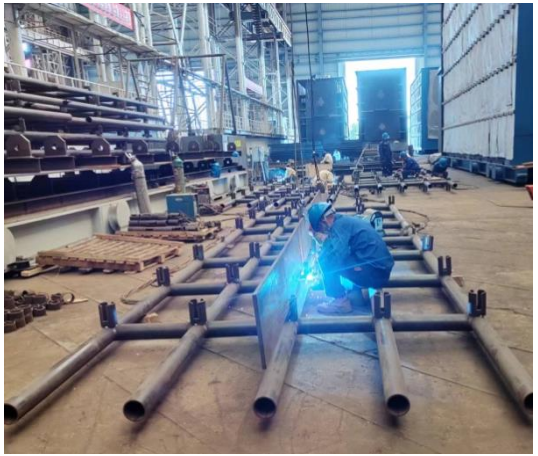
Welding of Tube Bundle Components

Assembly and Welding of Tube Bundle Components and Heads

Steam Turbine & Generator

The manufacturing of the turbine generator has started, and currently the upper and lower halves of the high-pressure cylinder have been processed, and the low-pressure outer cylinder is being assembled and welded; The processing of the stator core ring has been completed, and the generator shaft has been jointly inspected.

Machining of the Lower Half of the High-pressure Outer Cylinder



Assembly Welding of Condenser Frame

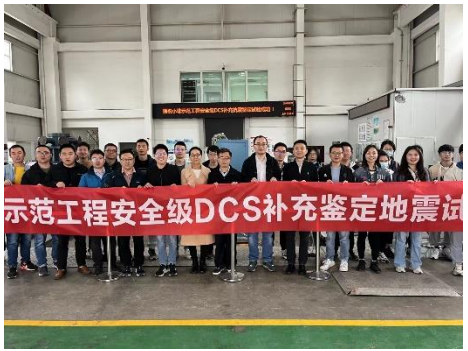
The Lower Half of the Stator Frame is Merged with the Inner Frame

DCS

Overall: The quality and progress is under control, and it is expected to arrive on February 29th, 2024;
Safety-related DCS: The cabinet assembly has been completed, and the software V&V is underway. Factory testing is expected to begin before September 15th, 2023;
Non-safety-related DCS: The cabinet assembly has been completed, and factory testing is currently underway. Factory testing is expected to be completed by December 30th, 2023;

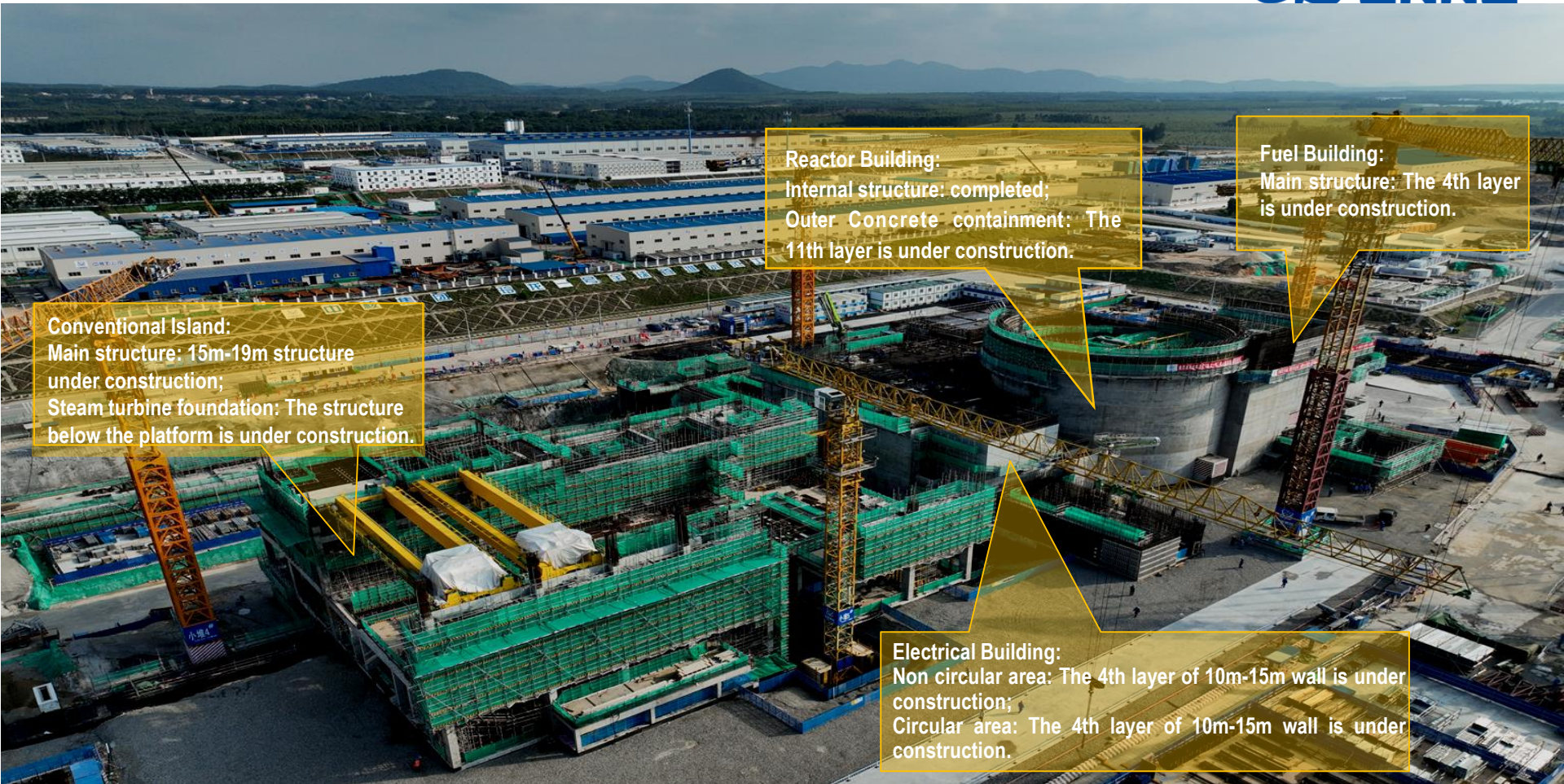
Non-safety related DCS Factory Testing

Safety-related DCS Cabinet Assembly Completed



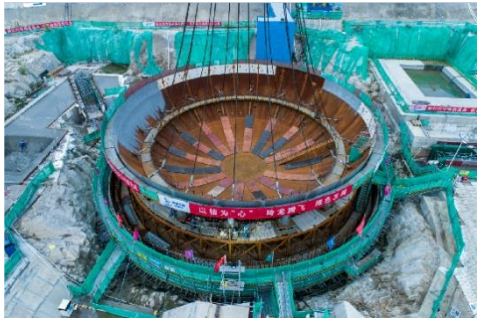
Completion of Supplementary qualification test for Safety-related DCS

Current Construction Progress



Current Construction Progress

ACP100 FCD
July 13, 2021



CV Bottom Head Positioned
October 24, 2021

Hoisting of the Lower Cylinder of the Containment Vessel
February 26, 2022

Hoisting of the Pressurizer
July 6, 2023

the RPV Module Positioned
August 10, 2023

Hoisting of the main beam of the Polar Crane
August 16, 2023

04

Experience and Foresight

Experience and Foresight

Owner-operator's Deep Participation to Promote Project Progress

Organizing the owner company's relevant departments to participate in project earlier, organizing special design reviews for ACP100, reserving technical strength and project management experience is beneficial to the project promotion.

Digital Design Based on 3D-Models

The application of 3D-models digital design in ACP100 improve design efficiency and accuracy, reduce design defects, and provide possibility for BIM application in progress civil work and installation.

International Safety Review of Design

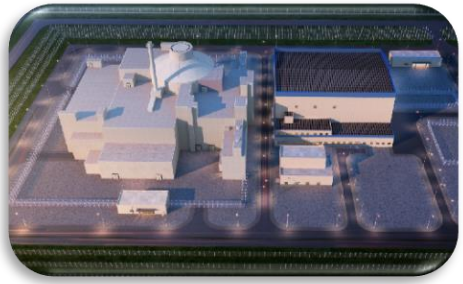
In 2016, ACP100 passed GRSR by IAEA , ensuring it meets international nuclear safety codes and standards. This greatly enhanced the confidence of the designer and owner-operator.

Pay more attention to FOAK and Key Equipment

For FOAK and key equipment, it is necessary to carry out equipment R&D before the project starts, match the equipment R&D period with the engineering plan items to eliminate engineering and technical risks.

Experience and Foresight

Based on experiences of Linglong 1 construction and the Hainan Free Trade Port policy, HNPC will create a platform to provide project management, talent cultivation and technical service, promoting the international development and application of SMRs, and supporting global carbon emission reduction.



Codes and Standards

Project Management

Equipment Procurement

Engineering Construction

Training Center

Technical Service

Effective Global Deployment of Safe and Secure Advanced Nuclear Reactors

NUCLEAR HARMONIZATION & STANDARDIZATION INITIATIVE

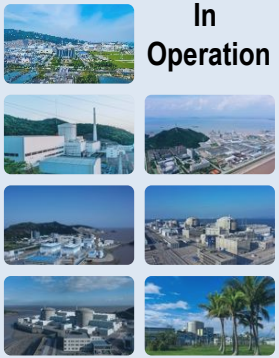
Experience and Foresight

CNNC

China National Nuclear Corporation

A closed nuclear industry chain with excellent design and construction capabilities.

In Operation



Under Construction

25 Units in Operation
23.75 GWe Installed Capacity

246 Reactor-Years
Operating experience

WANO Index Performance

98.58 Average Score (2020-2022)

15 (2020) **19** (2021) **18** (2022)
Full Score Units

Reactor Type

- CNP 300
- CNP 600
- CNP 1000
- HPR 1000
- SMR
- CANDU 6
- VVER 1000
- VVER 1200
- AP 1000

All nuclear power units built in recent years have been put into operation on schedule and on budget.

CNNC's efforts in the field of SMRs will provide a good option for all owner-operators.

THANKS FOR YOUR TIME!

Reporter：Qu Yong　　2023.09.05