The Development of NHR200-II

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Outline

- About INET
- Roadmap of Nuclear Heating Reactor (NHR)
- Key features
- Recent progress of NHR-II projects
- Key factors affecting SMR deployment
About INET

A leading research institute in China

- Established in Tsinghua University, 1960
- Largest R&D institution in the system of China’s higher education
- Multidisciplinary research center, mainly on nuclear energy
- Three nuclear reactors
  - experimental shielding reactor, 1964
  - 5MW nuclear heating reactor (NHR-5), 1989
  - 10MW high temperature gas-cooled reactor (HTR-10), 2000
Roadmap of NHR in China

1983
Pool type reactor
district heating test

1989
Vessel type NHR test reactor (NHR-5)

1996
NHR200-I Regulatory reviewed, Construction permit approved

2016
NHR200-II Design & Verification tests completed
Roadmap of NHR in China

5MWt test Reactor

- Constructed in 1989
- District heating tests completed in 1992
  - Supply heat to INET campus for 3 winter seasons
  - Heating availability > 99%

- Advanced characteristics
  - Full power natural circulation
  - Completely integrated
  - Passive safety systems
  - Internal CRDM
  - .......
Roadmap of NHR in China

NHR200-I

- Inherited all the merits of NHR 5MWt, 130 °C water
- The research and design started in 1991
- Construction permit approved by NNSA in 1996, Daqing
- Shenyang nuclear heating project established, 2001
- Yantai nuclear seawater desalination project established, 2003
Roadmap of NHR in China

**NHR200-II**

- Inherited all the merits of NHR 5MWt
- Main parameters improved, 201 °C saturated steam
- The general design completed in 2006
- All the design and verification tests completed in 2016

**Roadmap of NHR in China**

- District heating/cooling
- Seawater desalination
- Industrial steam
Key features

- Completely integrated, without primary pipe
- Full power natural circulation, without main pump

- Self stabilization of pressure by Nitrogen and Steam
- In-vessel hydraulic type control rod driven mechanism (INET property)
- Main heat exchanger
- Double layer Pressure Vessel
- Reactor core

- Large LOCA
- Control Rod ejection
- Main pump failure
- Vessel rupture
- ......
Key features

- Passive safety
  - Passive decay heat removal
  - Passive boron injection

Diagram:
- Boric acid injection system
- Air cooler
- Passive decay heat removal system (2 trains)
- Primary loop
- Intermediate loop
- Second loop
Key features

- **Multiple layers of isolation**
  - 3 loops
  - $P_{\text{intermediate}} > P_{\text{primary}}$
Key features

- **Limited EPZ (Emergency Planning Zone)**
  - Core being covered in all the DBA and important BDBAs
  - EPZ = Exclusion area, no public sheltering or evacuation
Recent progress of NHR-II projects

- The demonstration project in Hebei Province
  - Alleviating the escalating air pollution in north China
  - District heating: ~130 °C hot water
  - Industrial steam: board processing
Recent progress of NHR-II projects

➢ The demonstration project

- 2016.5, Project Proposal submitted
- 2018.1, Feasibility study permitted by National Energy Administration
- 2018.11, Most investigation and research work for feasibility study completed
- 2019.4, Environment impact report (plant siting phase) submitted to NNSA
Recent progress of NHR-II projects

- **Clean energy project in Guizhou, Southwest China**
  - Manganese ore processing
  - ~¥175/ton, economically acceptable
  - 2018.9 Prefeasibility study completed
  - 2018.11 Project Proposal submitted
Key factors affecting SMR deployment

- **Safety**
  - REGULATORY REVIEW PRINCIPLES OF SMALL PWR’s SAFETY (TRIAL VERSION)
    - NNSA, the regulatory position document, issued in 2016
    - Practically elimination of large release

- **Economy**
  - Electric: coal, PWR
  - Non-electric: Natural gas, coal

- **Construction time**
  - Longer than local governor term

- **Public acceptability**

[https://www.guancha.cn/society/2013_07_13_157900.shtml](https://www.guancha.cn/society/2013_07_13_157900.shtml)
Thanks