



清華大學

核能与新能源技术研究院

Institute of Nuclear and New Energy Technology (INET), Tsinghua University

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



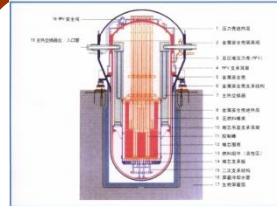
**Pool type
reactor
district
heating test**

1983



**Vessel type
NHR test
reactor
(NHR-5)**

1989



**NHR200-I
Regulatory
reviewed,
Construction
permit
approved**

1996



**NHR200-II
Design &
Verification
tests
completed**

2016



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*

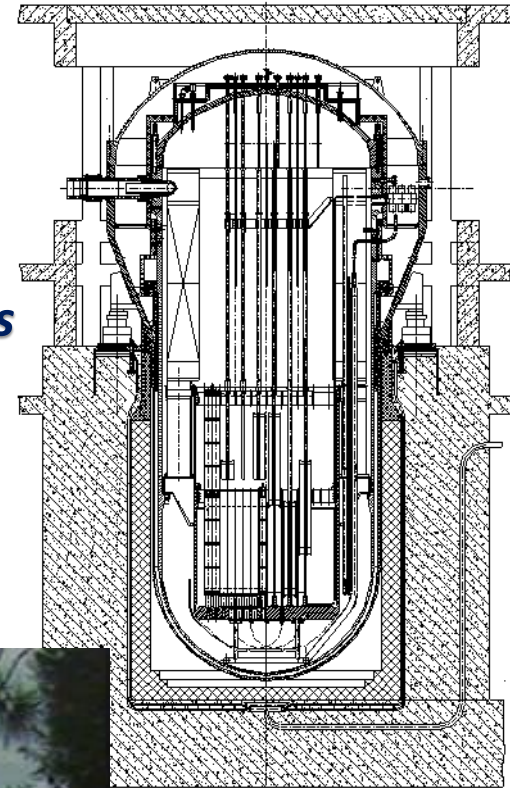
◆ *Full power natural circulation*

◆ *Completely integrated*

◆ *Passive safety systems*

◆ *Internal CRDM*

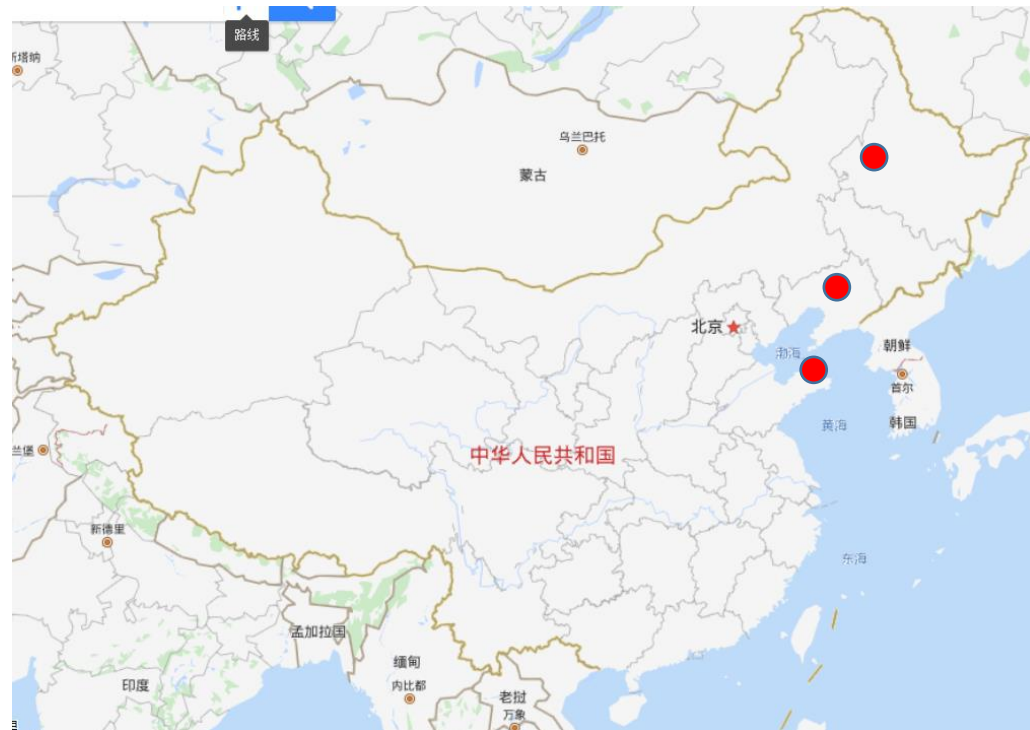
◆ *.....*



Roadmap of NHR in China

➤ NHR200-I

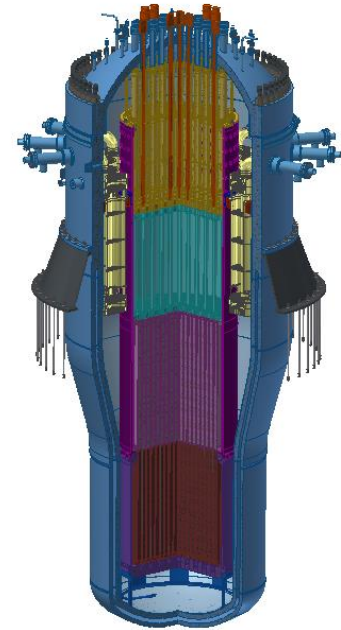
- ❑ *Inherited all the merits of NHR 5MWt , 130 °C water*
- ❑ *The research and design started in 1991*
- ❑ *Construction permit approved by NNSA in 1996, Daqing*
- ❑ *Shenyang nuclear heating project established, 2001*
- ❑ *Yantai nuclear seawater desalination project established, 2003*



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*



District heating/cooling



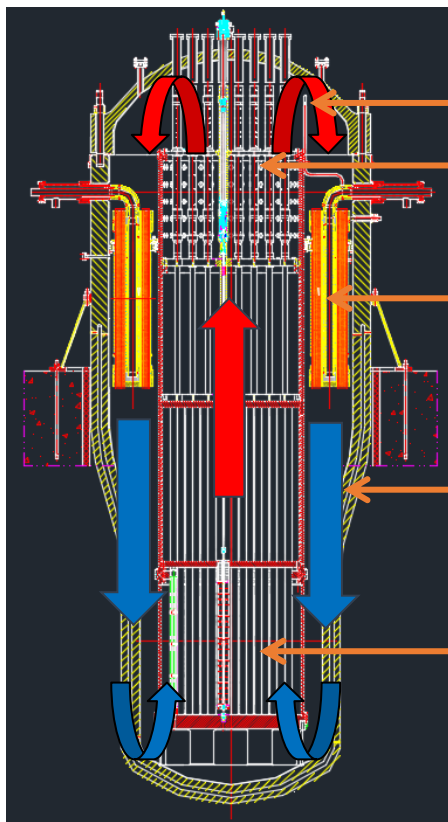
Seawater desalination



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
- ✗



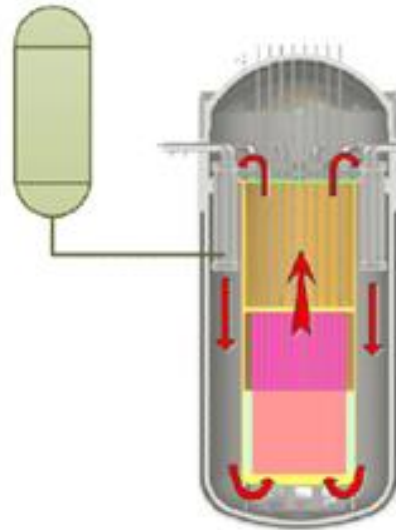
Key features

➤ *Passive safety*

❑ *Passive decay heat removal*

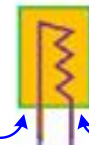
❑ *Passive boron injection*

Boric acid injection system

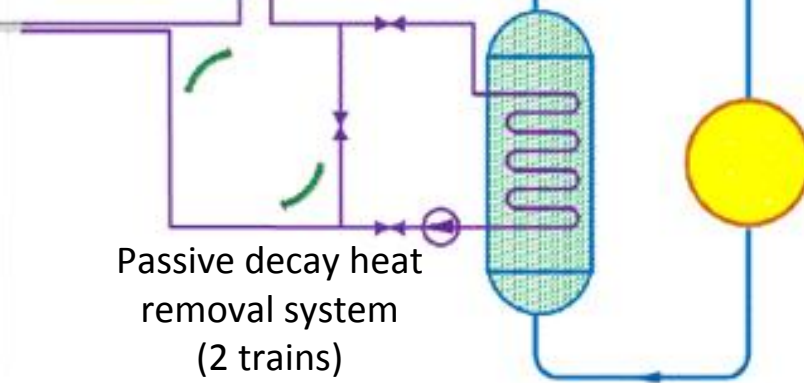


Primary loop

Air cooler



Passive decay heat removal system (2 trains)



Intermediate loop

Second loop

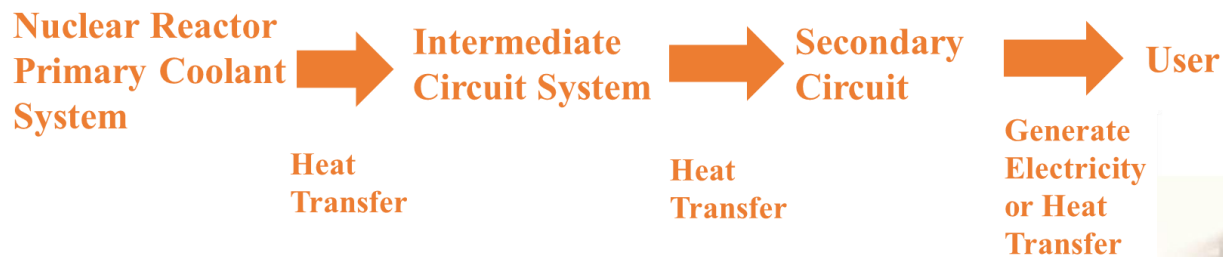
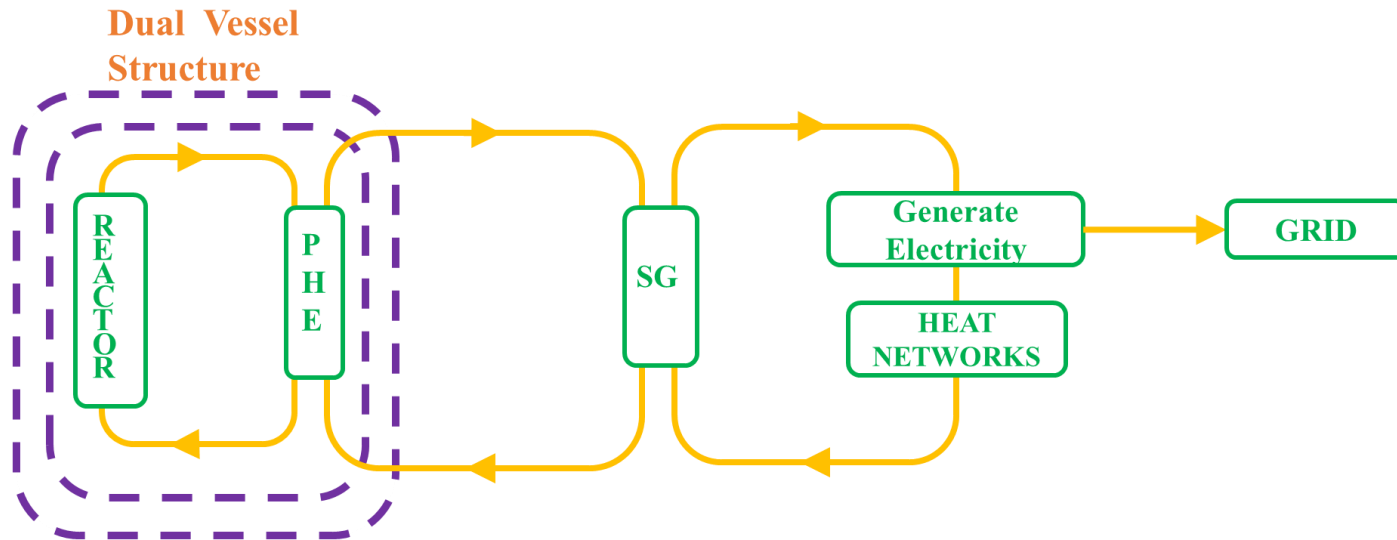


Key features

➤ Multiple layers of isolation

□ 3 loops

□ $P_{intermediate} > P_{primary}$



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*



Thanks

