

File:  
Pebble Bed  
Reactor

# **PEOPLE'S REPUBLIC OF CHINA**

## **Pebble Bed Reactor Program**

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- Tsinghua University  
Institute for Nuclear Energy Technology  
Contact: Prof. Xue Dazhi

Part of High Technology Program Funded  
by Ministry of Education

- 550 Staff & 200 Graduate Students
- 2 MW Pool Reactor
- 5 MW District Heating Reactor
- 10 MWt HTGR

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### **HTGR Program**

- HTRE 10 MWt
  - 1992 - Site Agreement
  - 1993 - PSAR
  - 1994 - CP
  - 1998 - FSAR
  - ~Nov. 2000 - Fuel Load License
  - 2001 - Revised FSAR
  - 2001 - OL
  
- HR - 200 MWt
  - 1993 - Site Agreement
  - 1994 - PSAR
  - 1996 - CP
    - FSAR
    - Fuel Load License
    - Revised FSAR
    - OL

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### Reactor Design:

- Reactor Thermal Power 10 MWt
- Core Diameter 1.8 m
- Core Height 1.97 m
- Average Power Density 2 MW/m<sup>3</sup>
- He Coolant (Forced Circulation-Down Flow)
- He Temperature (Normal Operation)
  - Inlet: 250 - 300 °C
  - Outlet: 700 - 900 °C
- He Pressure ~80 bar (~1200 psig)
- One Steam Generator/Heat Exchanger
- Single Loop with a Concentric Hot-Leg and Cold-Leg Configuration
- Passive Residual Heat Removal

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Fuel:

- 6 cm-diameter "Pebbles" or "Balls"
- 5 cm-diameter of  $\text{UO}_2$  Fuel Particles  
0.5 cm-thickness Graphite Layer
- Fuel Details not Provided
- Appears Very Similar to Modular  
Pebble Bed Reactor (MPBR)...German  
Design
- 27,000 Fuel Balls in Reactor Core  
Average
- Burnup Target - 80,000 MWD/MT
- Fuel Enrichment 17%  $\text{U}^{235}$   
(200 MWt Design Expected to Have  
Lower Enrichment)

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HTRE - Fuel Handling:

- 125 Balls Cycled Each Day
- 100 Recycled, 25 Added, 25 Discharged
- Balls Pass 5 Times Through the Core Before Being Discharged
- Fuel Separator Based on Balls Rolling Smoothly on Drum (Damaged Balls Discharged)
- Balls Also Checked for Burnup Before Recycling
- "Dummy Balls" Graphite Only are Used for Initial Fuel Loading

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Fuel Facility Supporting HTR (Pebble Bed Reactor Design)

- INET (Tsinghua University)
- Capacity - 125 kg U/yr
- FSAR - 1997 ("Special Case")
- OL - 1998
- 5000-6000 Fuel Pebbles (balls) On-site

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### **Safety Systems:**

- Control Rods in Graphite Reflector Region
- Digital Reactor Protection System
- Backup Shutdown System - Small Boron Balls Over Reactor Moderator Region
- Natural Circulation Cooling
- Liner Cooling System for Decay Heat Removal
- Containment Function
  - Fuel Barriers
  - Confinement Building



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### **Preliminary Thoughts on Pebble Bed Reactor Issues**

- Fuel Design & Performance (Needs to be Tested Under Fluence & High Temp & Mechanical Load)
- Component Performance at High Temperature
- Fuel Handling Mechanical Equipment (Chinese Built Full Scale Mockup and Tested "Dummy" Balls)
- Reactivity Control Based on Ability to Calculate Need to Explore Criticality (i.e., Limit Excess Reactivity to 1% <Greater or Less)
- Potential for Natural Circulation Flow Blockage
- Maintainability of Components (Ability or Inability to Offload Fuel)

## Cross section of the HTR primary circuit

