HTR reactors within Polish strategy of nuclear energy development - Cooperation with Japan -

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**High Temperature Engineering Test Reactor (HTTR)**

**HTTR**
Graphite-moderated and helium-cooled

**Major specification**

- **Thermal power**: 30 MW
- **Fuel**: Coated fuel particle / Prismatic block type
- **Core material**: Graphite
- **Coolant**: Helium
- **Inlet temperature**: 395°C
- **Outlet temperature**: 950°C
- **Pressure**: 4 MPa

**First criticality**: 1998
**Full power operation**: 2001
**50 days continuous 950°C operation**: 2010
**Loss of forced cooling test at 9MW**: 2010
History of HTTR R&D

The first HTGR built in Japan
Thermal power: 30MWth
Reactor outlet coolant temperature: 950 °C

1969
Conceptual design

1979
Experimental very high-temperature gas-cooled reactor for multipurpose

1984
Basic design
System integrity design

1985
Detail design

1997
Construction
Application and permission of construction

2001
Reactor thermal power (30MW), Reactor outlet coolant temperature 850 °C

2002
Safety demonstration test (Control rods withdrawal test)

2004
Reactor outlet coolant temperature 950 °C

2007
850°C/30 days operation

2010
Start of Loss of Forced cooling test
950°C/50 days operation

No CR reactivity control. No core cooling. Reactor is kept stable naturally with only physical phenomena.
Japanese Technologies for HTTR

- **HTTR’s design, construction and operational experiments** (MHI, Toshiba/IHI, Hitachi, Fuji Electric, KHI and etc.)
  Design optimization based on extensive technical database

- **Primary coolant system (MHI)**
  Construction of efficient transport and cooling system for very high temperature heat (950°C)
  Concentric hot gas duct
  Primary pressurized water cooler

- **He/He intermediate heat exchanger (IHX) (Toshiba/IHI)**
  Developed new heat (950°C) resistance material to enable extraction of heat and making of derivative equipment based on such material

- **Reactor pressure vessel (Hitachi)**
  Developed new material having high resistance to very high temperature and pressure and construct new pressure vessel using such material

- **Fuel (Nuclear Fuel Industries)**
  Advanced technology to coat uranium fuel using ceramics with high radioactivity retaining performance

- **Reactor internals (Fuji Electric)**
  Graphite material IG-110 (Toyo Tanso)
  High strength
  High heat conduction
  Irradiation-resistance
Technical development of HTGR is stated in the following policies approved by the Cabinet.

- **“Strategic Energy Plan”** approved by the Cabinet on **April 11, 2014**
  - Under international cooperation, government of Japan facilitates R&D of nuclear technologies that serve the safety improvement of nuclear use, such as high-temperature gas-cooled reactors which are expected to be utilized in various industries including hydrogen production and which has inherent safety.

- **“Growth Strategy 2017”** approved by the Cabinet on **June 9, 2017**.
  - Calls for future R&D concerning the HTGR development to be promoted using JAEA’s HTGR test reactor and through international cooperation.

- **“Strategic Roadmap of hydrogen and fuel cell”** issued by the committee in the METI on **June 23, 2014**.

**METI**: Ministry of Economy, Trade and Industry
MEXT established a committee including MEXT, METI, JAEA, industries and universities to discuss roadmap and conceptual design for the first demonstration plant.

- Specification of commercial HTGR, R&D plan, introduction scenario are being discussed.

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<th>Industry</th>
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<td>Toshiba Corporation</td>
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<td>Fuji Electric Co., Ltd.</td>
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<td>Mitsubishi Heavy Industries, Ltd.</td>
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<td>Honda R&amp;D Co., Ltd.</td>
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| Fuel/Graphite manufactures | Nuclear Fuel Industries, Ltd. |
|---------------------------| Toyo Tanso Co., Ltd. |
| Trading company/Think tank | Marubeni Utility Services, Ltd. |
|                           | Canon Institute for Global Studies |
| Government | Ministry of Education, Culture, Sports, Science and Technology (MEXT) |
|            | Japan Atomic Energy Agency (JAEE) |

Cooperation with Poland

Action Plan: May 2017
for the Implementation of the Strategic Partnership between the
Government of Japan and the Government of the Republic of Poland
for the years 2017-2020

encouraging cooperation toward research and development of high temperature
gas-cooled reactor technologies between the Japan Atomic Energy Agency (JAEA)
and National Centre for Nuclear Research of Poland (NCBJ);

Ministry of Foreign Affairs of Poland

Action plan (May 2017)

Ministry of Foreign Affairs of Japan

NATIONAL CENTRE FOR NUCLEAR RESEARCH ŚWIERK

MOC on R&D (May 2017)

JAEA
Overview of current HTGR R&Ds

(1) Reactor technology
- HTTR
- Reactor outlet coolant temperature 950°C at 30 MWe (April 2004)
- 950°C / 50 days operation (March 2010)
- Advanced fuel development
- HTTR tests for HTGR safety enhancement
- Safety review by NRA is underway

(2) Heat application technologies
- Completion of basic technologies related to hydrogen production facility and gas turbine power generation
- Establishment of operation control technology and facility reliability for IS process
- 31 hrs. hydrogen production with 0.02m³/h (October 2016)

(3) Commercial HTGR design
- Design study of commercial HTGR systems
- Core design of plutonium burning HTGR
- Establishment of safety design philosophy and international standardization for commercial HTGRs

(4) HTTR-GT/H₂ test
- Coupling to HTTR
- Licensing demonstration
- Plant performance test
- Integrated demonstration of HTGR heat application system technologies
**Objective of HTTR-GT/H₂ test**

- Demonstration of system technologies for HTGR helium gas turbine power generation and H₂ production
- Establishment of safety standard and design consideration for coupling between reactor and heat application system
- Improvement of cost evaluation reliability

**Plant cycle schematic**

- Reactor
- HTTR
- Secondary heat exchanger
- Isolation valves
- Intermediate heat exchanger (IHX)
- Reactor
- IHX
- Gas turbine
- Precooler
- Recuperator
- Generator

**HTTR-GT/H₂ test facility (Planned)**
Thank you for your attention.

JAEA is willing to cooperate Polish HTGR program with Japanese mature technologies!

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