IAEA technical meeting
MHI's R&D project on Microreactor Technology and Development Plan

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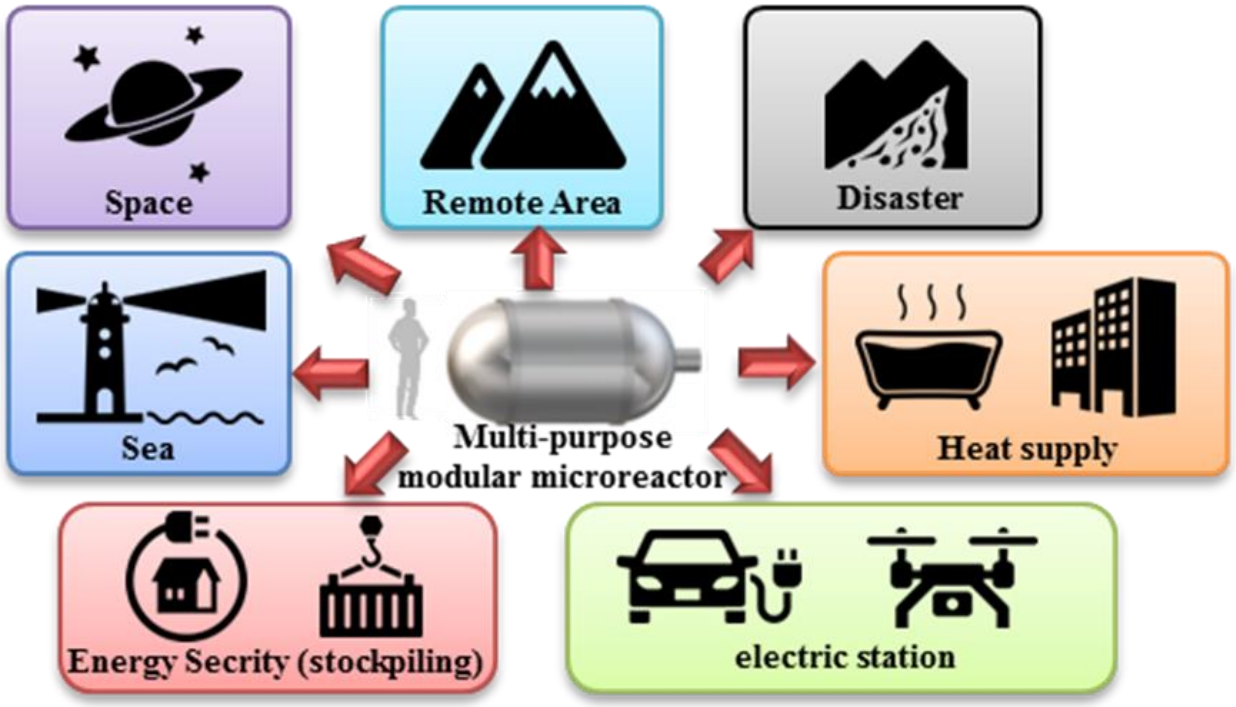
1. Mitsubishi Multi-Purpose Modular Microreactor

- MHI is developing a multi-purpose modular micro reactor as power/heat sources.
- With its portability and its inherent safety, the microreactor can provide new values different from existing nuclear power plants.

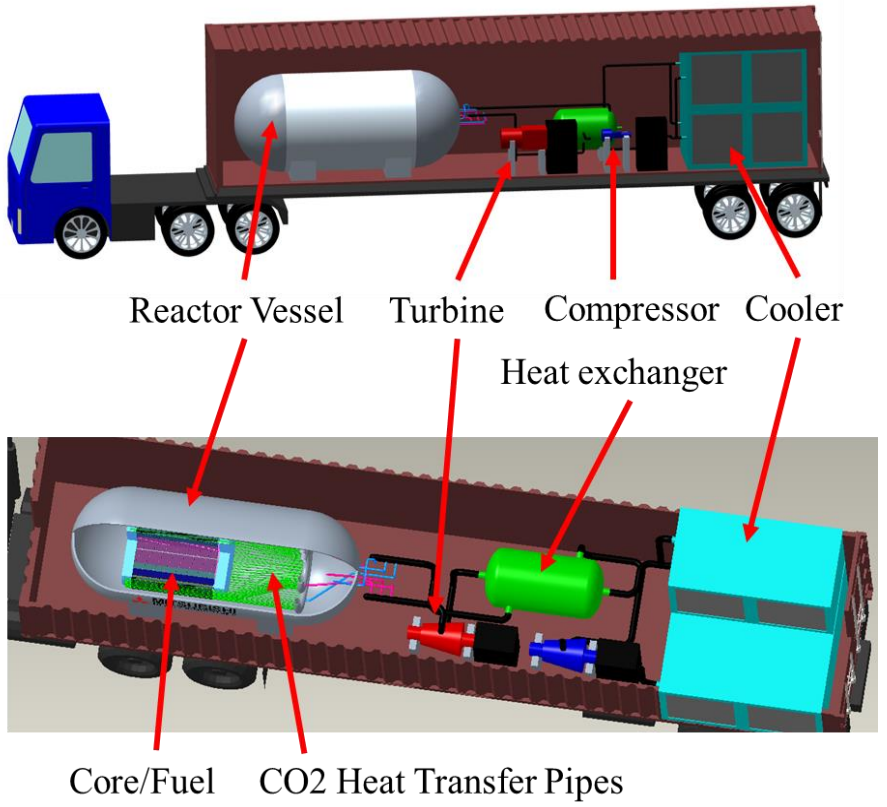


2.Mitsubishi Microreactor Outline(1)

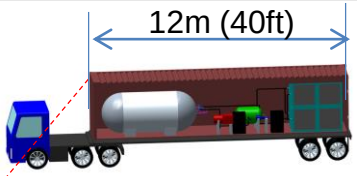
- **The maximum thermal output is 1MWt per module and total power demand is satisfied flexibly combining multiple units.**
- **Based on “all-solid-state core” concept, the reactor uses a highly thermal conductive graphite-based material that remove heat from core without liquid coolant.**
- **Transport inside 40ft standard cargo container by conventional transport systems**

Conceptual Specifications of the Microreactor

Item	Value
Fuel/Core	HALEU Neutron Spectrum: Epithermal neutron
Core structure	Layer structure with Graphite type material (lighter weight)
Thermal Output	～1MWt
Electric Output	～0.5MWt
Operation/Control	Automated
Safety System	Full passive
Size	Inside Standard 40ft freight container



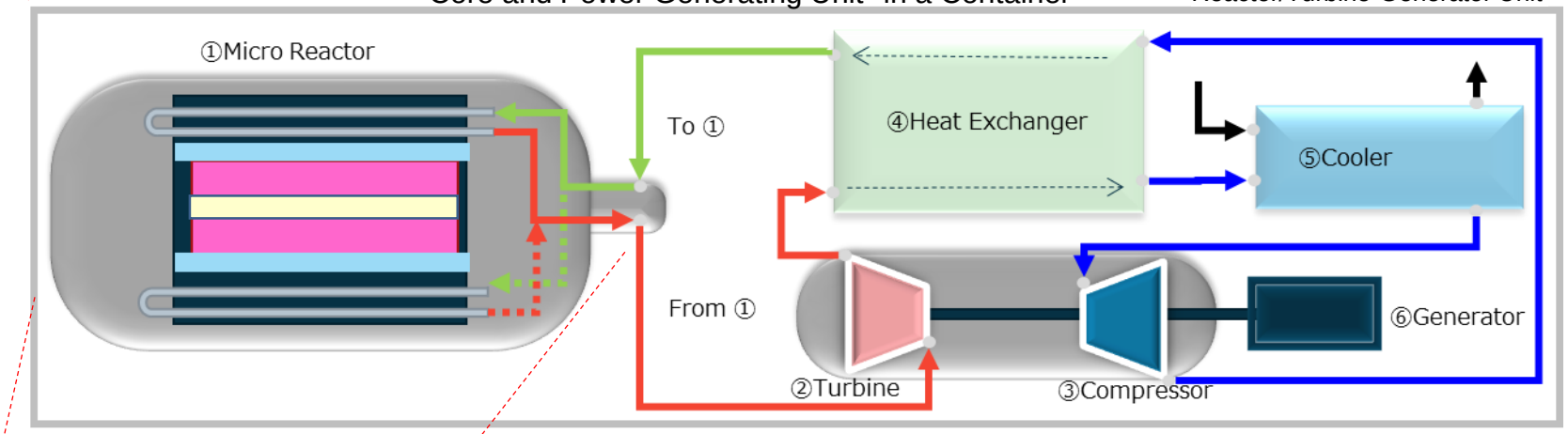
2.Mitsubishi Microreactor Outline(2)



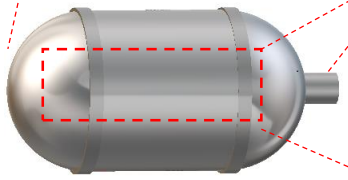
※Supercritical CO_2 gas turbine under investigation

Core and Power Generating Unit* in a Container

Reactor/Turbine-Generator Unit

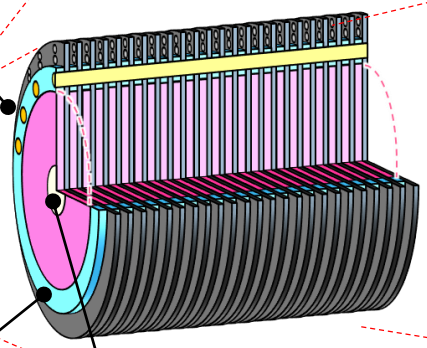


A. Reactor System

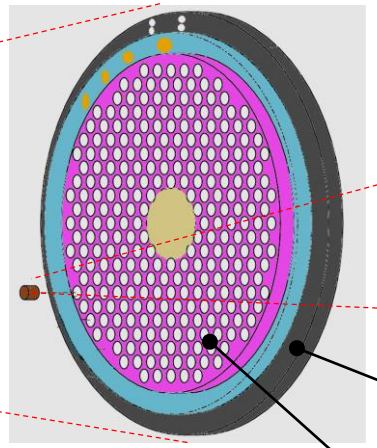


Reactor vessel

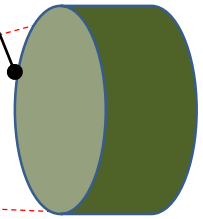
B. Core Structure



C. Carbide-Fuel-Plate



D. Fuel Element

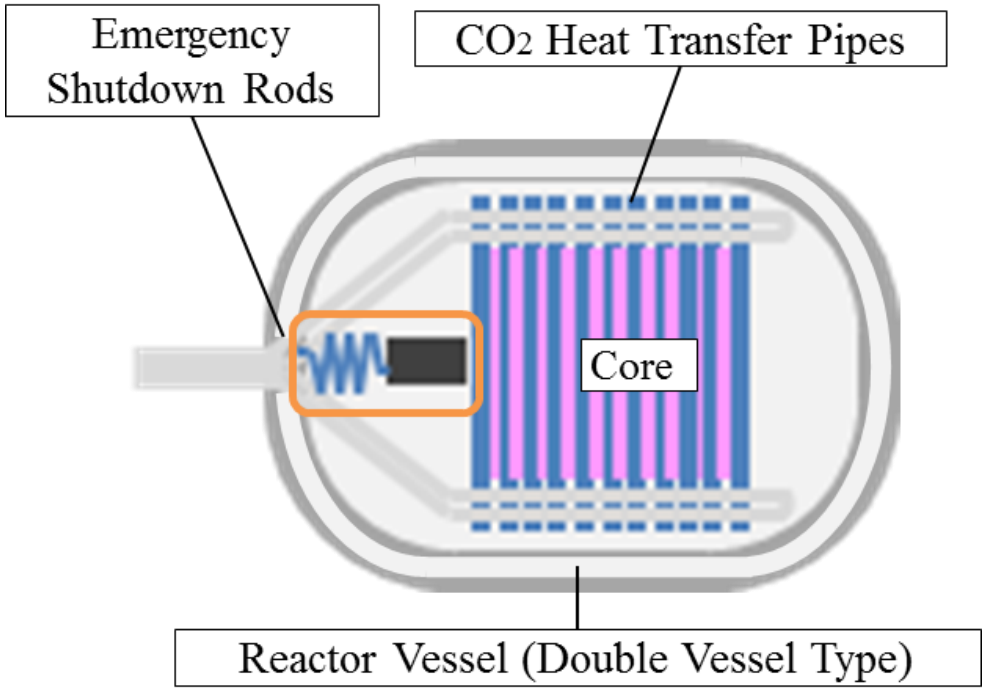


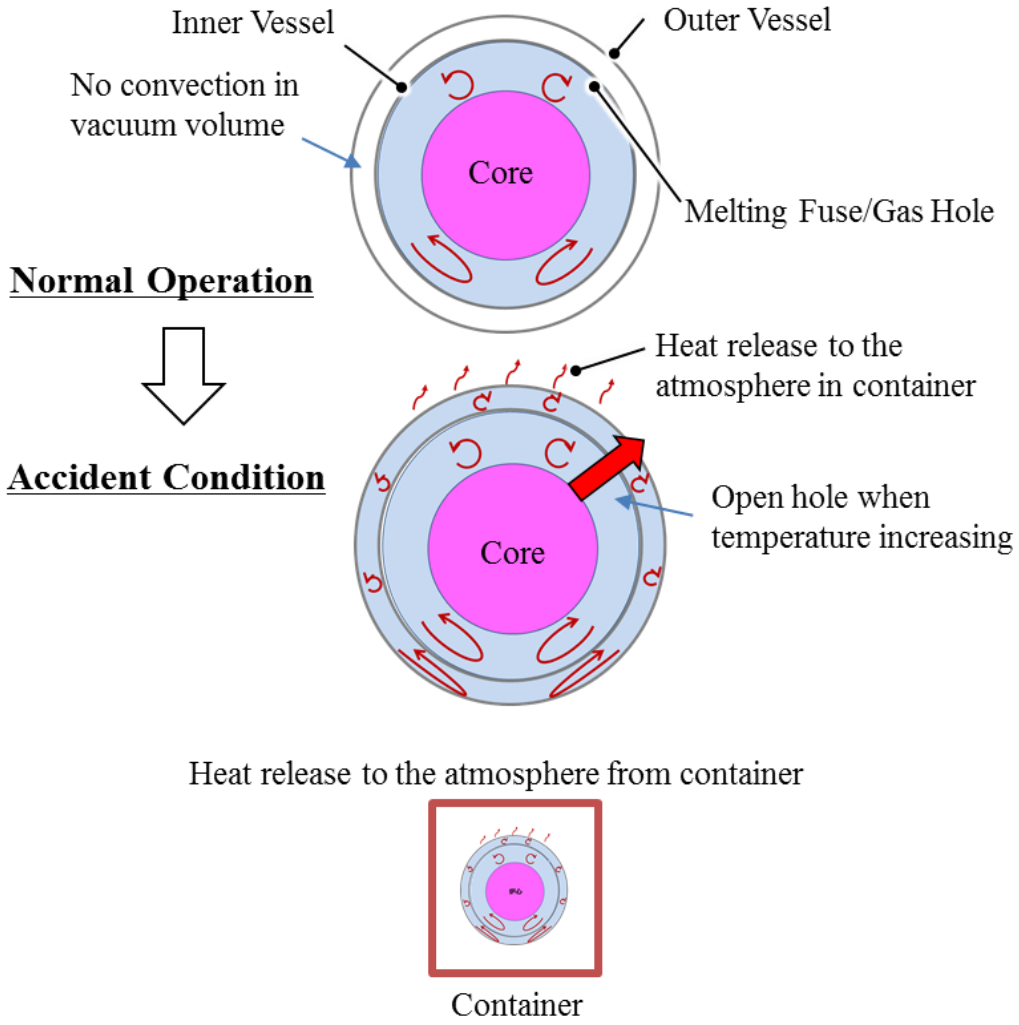
3. Safety Concept(1)

- **Passive safety concept is fully adopted for safety measures.**
- **The safety measures are accomplished without any power source, water source and operator action.**

Safety measures	safety concept
Shutdown	**Passive shutdown** to prevent accident conditions
Core Cooling	**Passive core cooling** by **natural heat transfer** without power source, water source, and operator action to prevent core damage
Containment	Three **physical barriers** for contain fission products, fuel cladding, reactor vessel, container.

3. Safety Concept(2)





4. Nuclear Security Concept

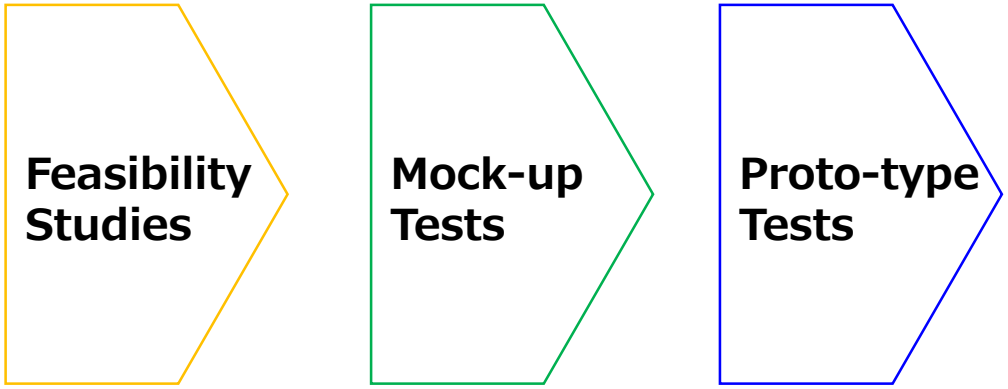
- **Nuclear security is more important topic to prevent external accesses intended for sabotage and nuclear fuel extraction because microreactors can be used in remote areas with fewer operators or no operators.**
- **A concept is under investigation with defense in depth approach as below. The concept is also to be discussed internationally.**

Defense in depth in nuclear security	Conceptual Measures
Level 1: detect and prevention of plans to external access to reactor	• Monitoring by National/International organizations
Level 2： prevention of external access	• Monitoring, detection, warning with cameras, IR sensors, GPS, etc.,
Level 3： prevention of sabotage and nuclear fuel extraction	• Block /Delay sabotage by sealed and solid structure • Prevent nuclear fuel extraction by internal and/or radioactive condition and/or high temperature
Level 4： Mitigation and control	• Accident mitigation with passive safety systems
Level 5: Evacuation	• Identify evacuation area • Notify necessary information to evacuate

5. Development Schedule

- Technology readiness levels (TRLs) of the microreactor is between TRL 2 and 3.
- The long-term development schedule is on-going to step up the TRLs.
- Mock-up test is planned to be performed from 2023 to 2025 to verify cooling function. The tests do not use nuclear fuels.
- After the tests, proto-type test is planned to be performed from 2026 to 2030 to verify various features of the microreactor such as long-term operation, start-up/shutdown, safety system functions.

Microreactor Development Schedule



6. Summary

1. The multi-purpose modular microreactor fundamentally enhance nuclear safety, reliability and opportunity of nuclear energy for zero-carbon energy.
2. “All-solid-state core” concept and full passive safety concept realizes sufficient safety in the operation environment for the microreactors.
3. Nuclear Security is important for microreactor operation and transport. International discussion is needed to build framework on the microreactor nuclear security.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