Gas Turbine - Modular Helium Reactor Safety Approach

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General Atomics

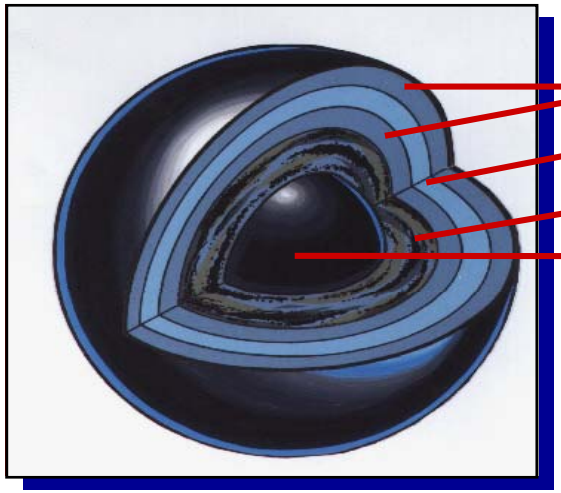
GENERAL ATOMICS

Modular Gas-Reactor Safety Approach Differs From Earlier Reactor Designs

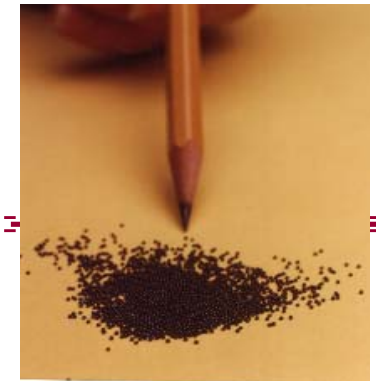
- GT-MHR safety emphasizes
  - Keeping radionuclides at source during all accidents
  - Minimizing reliance on active/complex engineered systems
- Passive safety design is based on reoptimized application of established HTGR technology
  - High temperature fuel and core
  - Single phase, chemically & neutronically inert coolant
  - Specially tailored core power and geometry

Conservative, robust design with defense-in-depth remain foundations of safety

Key to GT-MHR Safety
Multiple Ceramic Fuel Coatings



TRISO Coated fuel particles (left) are formed into fuel compacts (center) and inserted into graphite fuel elements (right).



PARTICLES

COMPACTS

FUEL ELEMENTS

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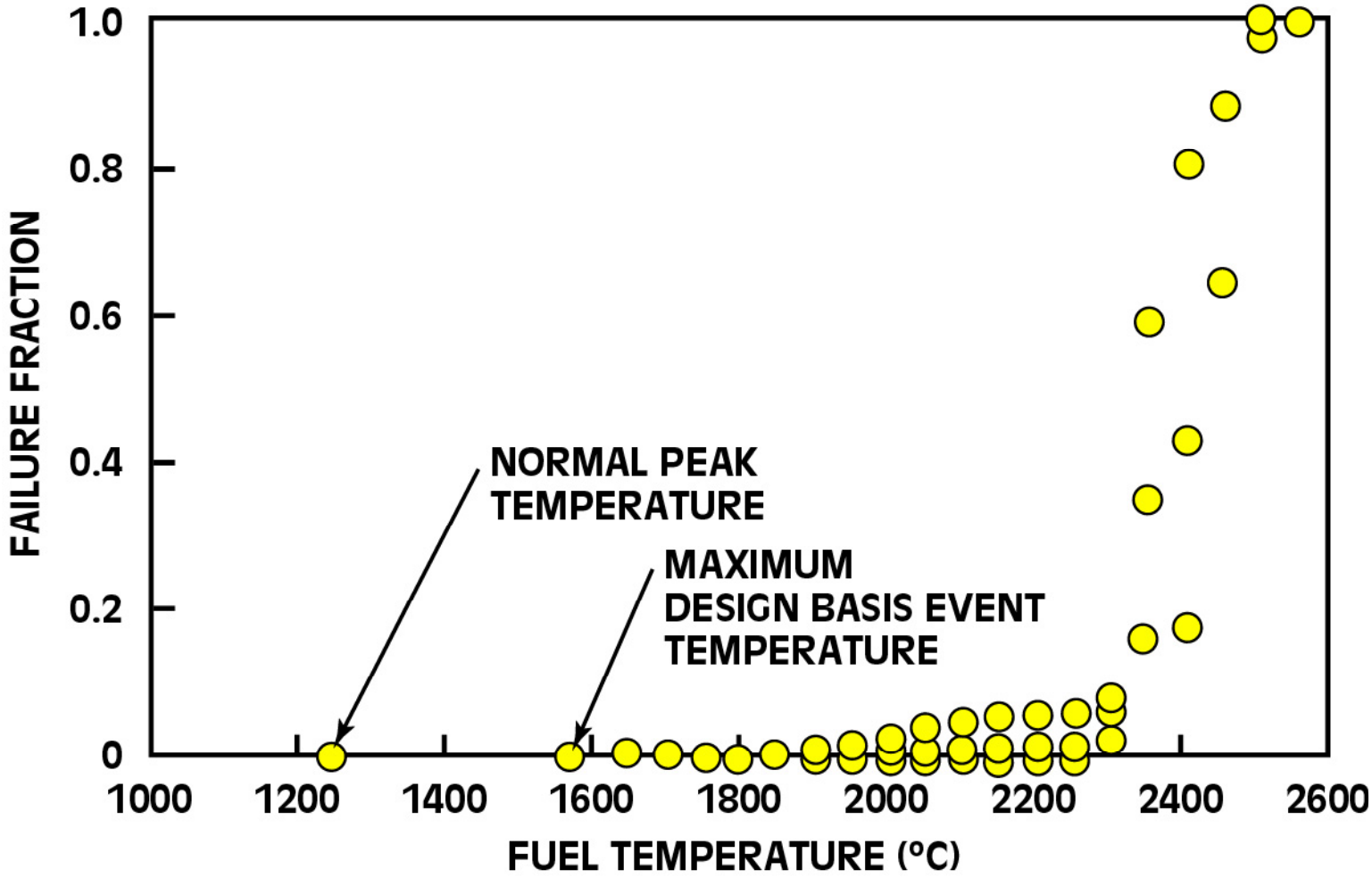
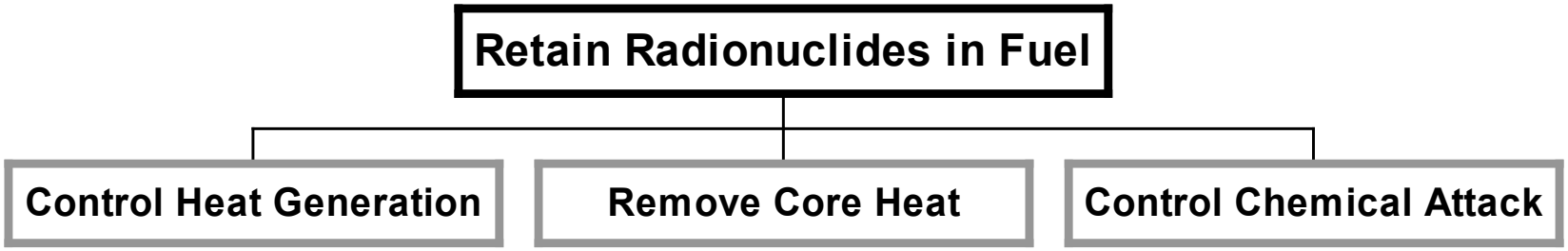
Coated Particles Remain Intact Even at Very High Temperatures



Safety Focused on Assured Fuel Particle Integrity



- **Fission (heat generation) shut down assured by**
  - *Large negative temperature coefficient*
  - *Large temperature margins*

  ] *Passive Shutdown*
- **Heat removal assured by**
  - *Low power density & module thermal rating*
  - *Annular core and high L/D ratio*

  ] *Passive Cooling*
- **Chemical attack limited by**
  - Absence of high pressure water sources
  - Nuclear graphite, core geometry, and limited air availability

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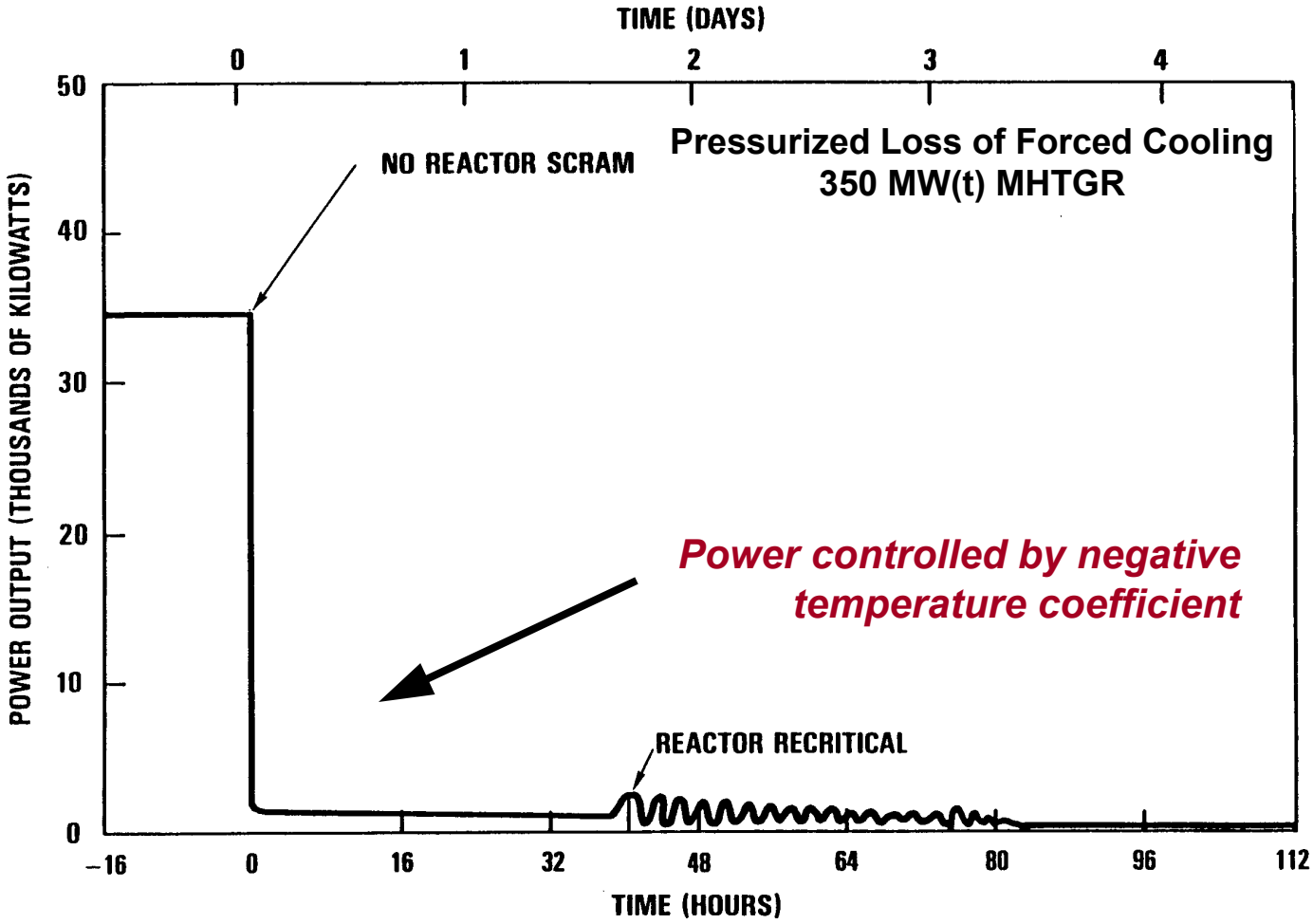
Multiple Means Available to Control Heat Generation

- Control rods capable of terminating fission
- Reserve shutdown system provides independent and diverse means of terminating fission
- Large negative temperature coefficient and large core temperature margins can provide passive shutdown for anticipated transient without scram

Heat Generation Stops During Loss of Cooling Without Rod Motion



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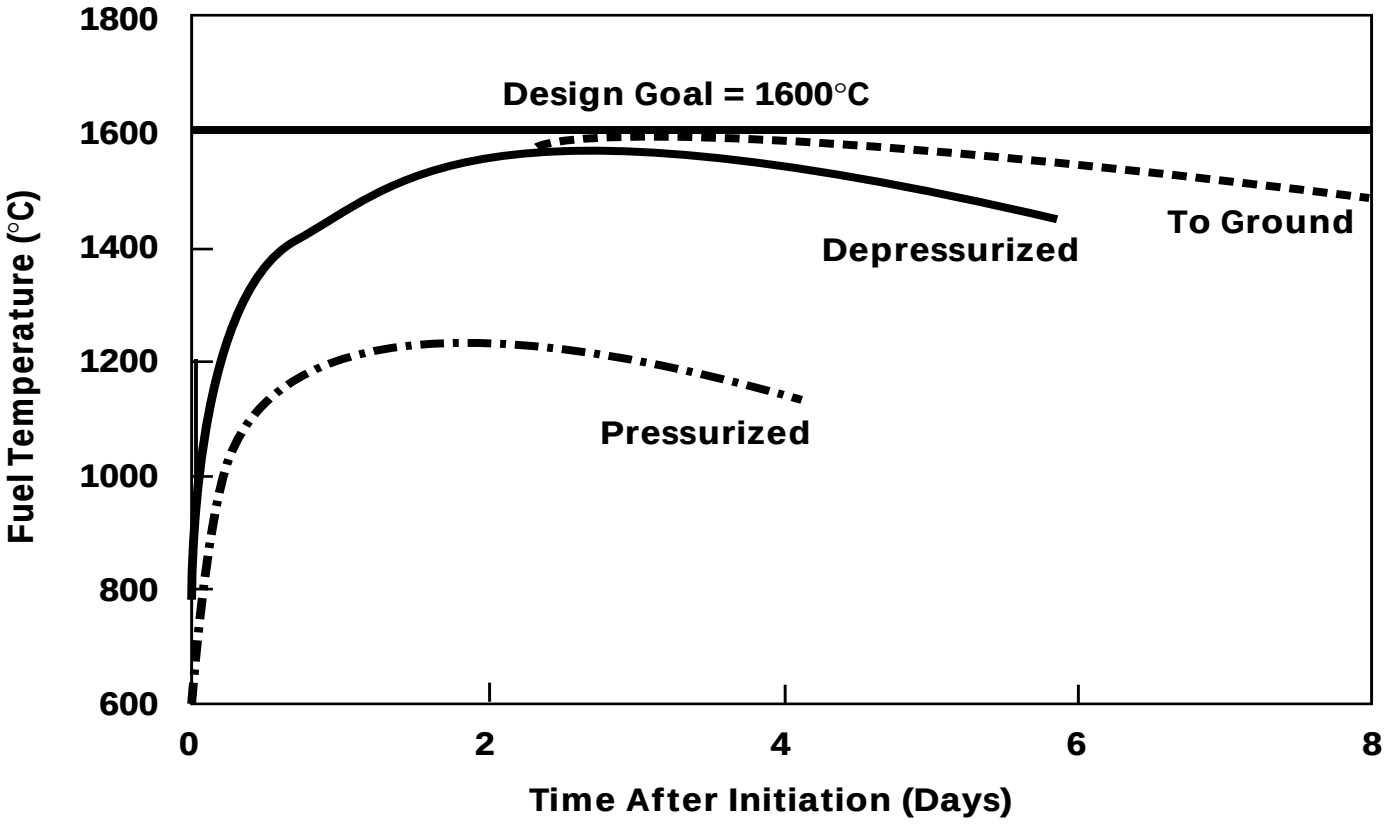
Multiple Means Available to Remove Core Heat

- Power conversion loop provides normal heat rejection
  - Normal operation
  - Preferred mode of shutdown cooling
  - Operates with pressurized or depressurized coolant
- Shutdown cooling system offers alternative means of forced circulation heat removal
- Passive heat rejection to Reactor Cavity Cooling assures safety for all events
- Passive heat rejection to the surroundings limits maximum consequences

FUEL TEMPERATURES REMAIN BELOW DESIGN LIMITS DURING LOSS OF COOLING EVENTS

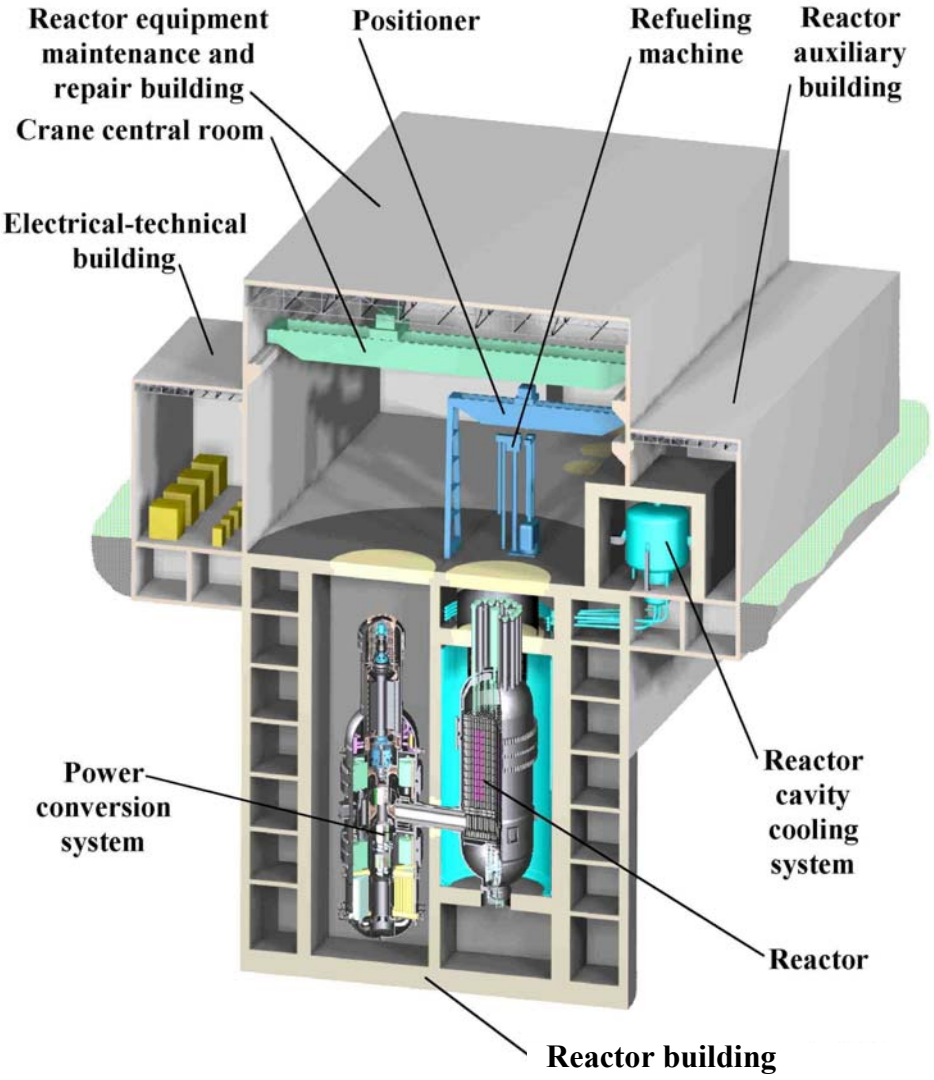


passive design ensures fuel remains below 1600°C

Inherent and Passive Features Control Air Attack

- Non-reacting coolant (helium)
- Embedded ceramic coated particles
- Air ingress limited (requires failure of Class 1 vessels)
- Below grade, closed reactor silo (isolation)
- Air flow rate limited by core flow area (L/D > 700)
- Slow oxidation rate (nuclear grade graphite)

Below-Grade Siting Augments Enhanced Safety



- Reduced seismic response
- Effective heat sink using surrounding earth
- Robust structure
  - Additional containment of accident releases
  - Limited vulnerability of core and key safety features to surface events
  - Limits oxidant ingress

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GT-MHR Optimization of Established Gas Reactor Features Provides

- Enhanced, easily understood safety
- Assured accomplishment of safety functions with simple, passive features
- Limited consequences, even for beyond design basis accidents

Cost of passive features offset by design simplicity and modularity