Gas Turbine - Modular Helium Reactor Safety Approach

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GENERAL ATOMICS

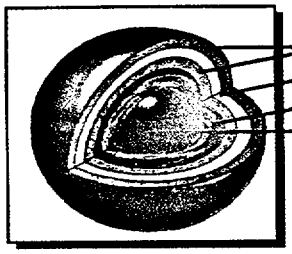
Modular Gas-Reactor Safety Approach Differs From Earlier Reactor Designs

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

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

GENERAL ATOMICS

Key to GT-MHR Safety
Multiple Ceramic Fuel Coatings



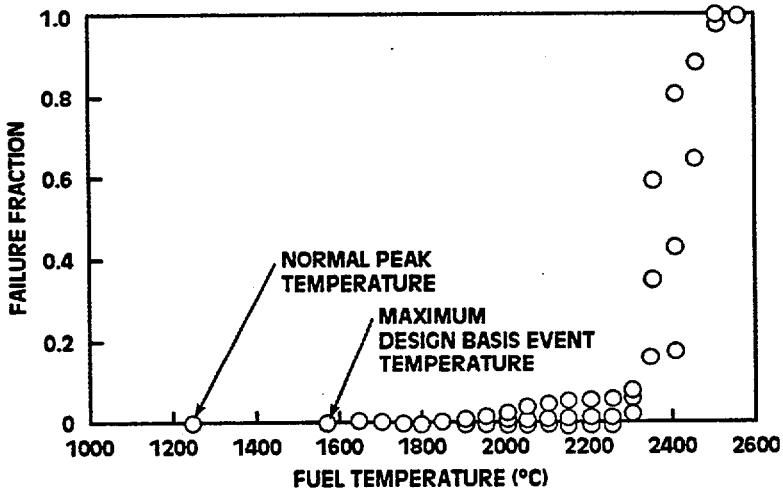
TRISO Coated fuel particles (left) are formed into fuel rods (center) and inserted into graphite fuel elements (right).

PARTICLES COMPACTS FUEL ELEMENTS

GENERAL ATOMICS

L-029(5)
4-14-94

Coated Particles Remain Intact
Even at Very High Temperatures



GENERAL ATOMICS

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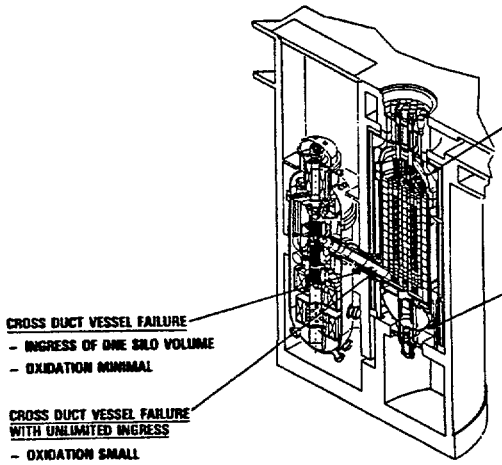
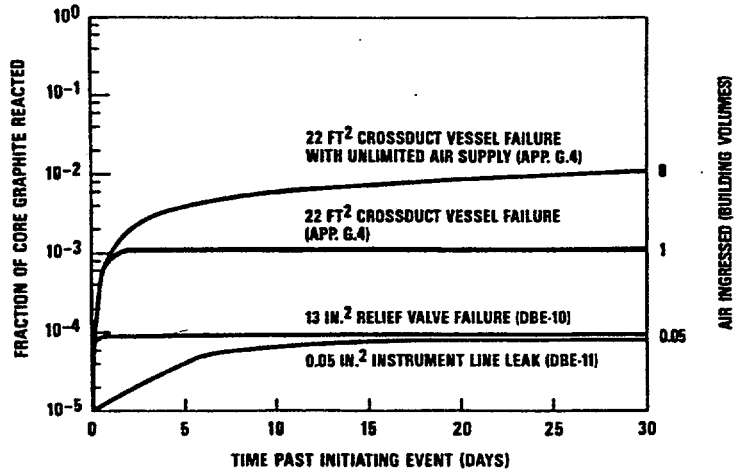
7-28-94
W-9

Graphite Oxidation Limited by Available Air



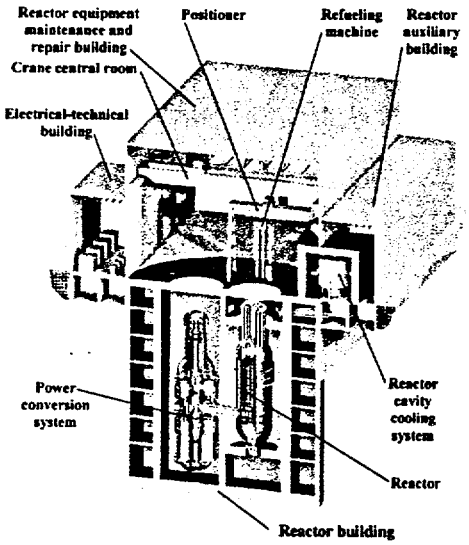
GENERAL ATOMICS

Mass Transfer, Core Temperature, & Graphite Purity Limit Oxidation Rate



GENERAL ATOMICS

Below-Grade Siting Augments Enhanced Safety



- Reduced seismic response
- Earth provides ultimate heat sink
- Robust structure
  - Additional holdup of accident releases
  - Reduces vulnerability of core and key safety features to surface events
  - Controls oxidant ingress

GENERAL ATOMICS

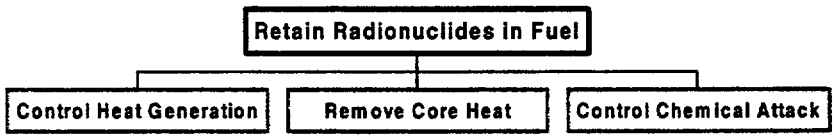
GT-MHR Optimization of Established Gas Reactor Features Provides

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

SAR intended to provide full demonstration of safety

GENERAL ATOMICS

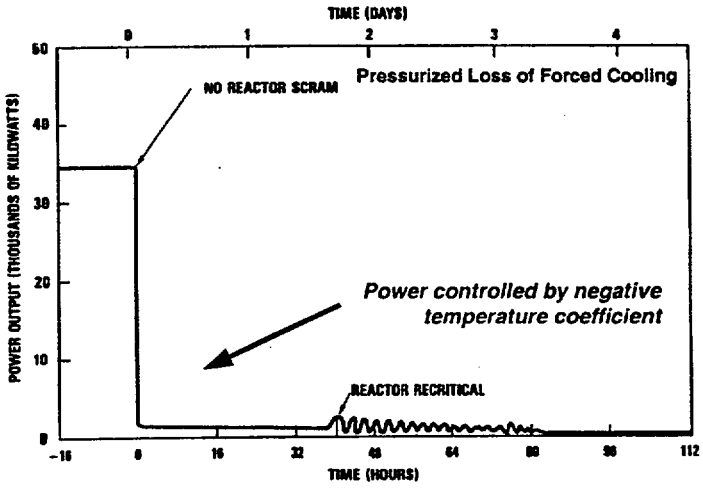
Safety Focused on Assured Fuel Particle Integrity



- Fission (heat generation) shut down without rod motion
- Heat removal assured by reactor design
  - *Low power density*
  - *Low thermal rating per module*
  - *Annular core and high L/D ratio*
- Chemical attack limited by design & materials
  - No high pressure water source in gas-turbine plant
  - Nuclear graphite, geometry, and limited air control potential oxidation

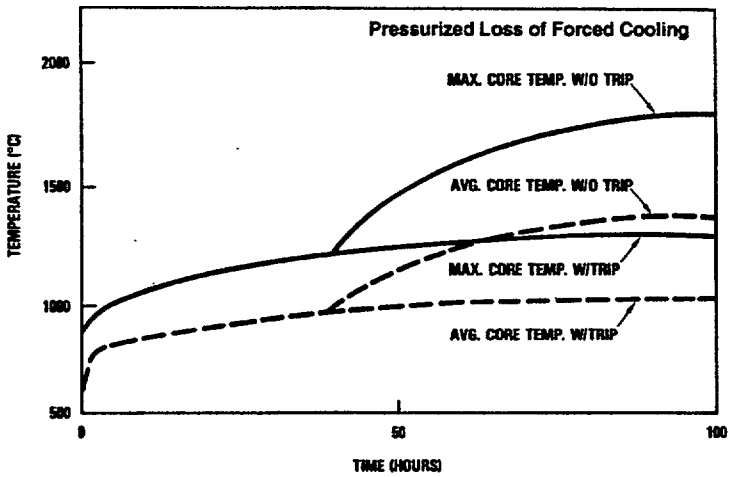
GENERAL ATOMICS

Heat Generation Stops During Loss of Cooling Without Rod Motion



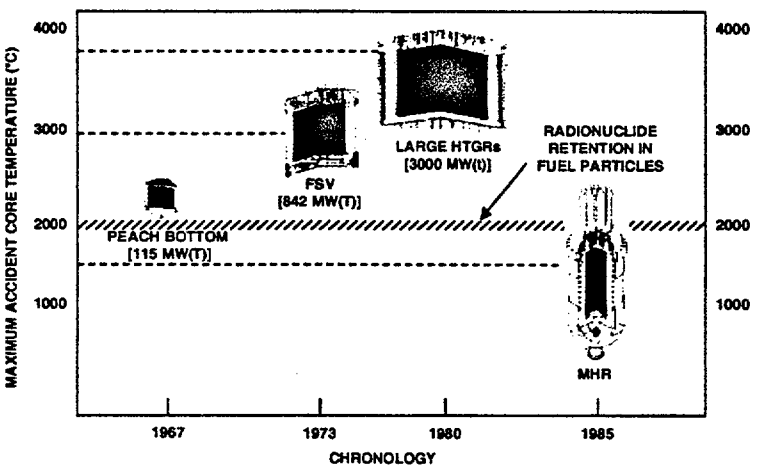
GENERAL ATOMICS

Core Temperatures Maintained at Safe Levels With and Without Reactor Trip



GENERAL ATOMICS

Passive Heat Removal Changes Reactor Design Philosophy



SIZED AND CONFIGURED TO WITHSTAND EVEN A SEVERE ACCIDENT

GENERAL ATOMICS

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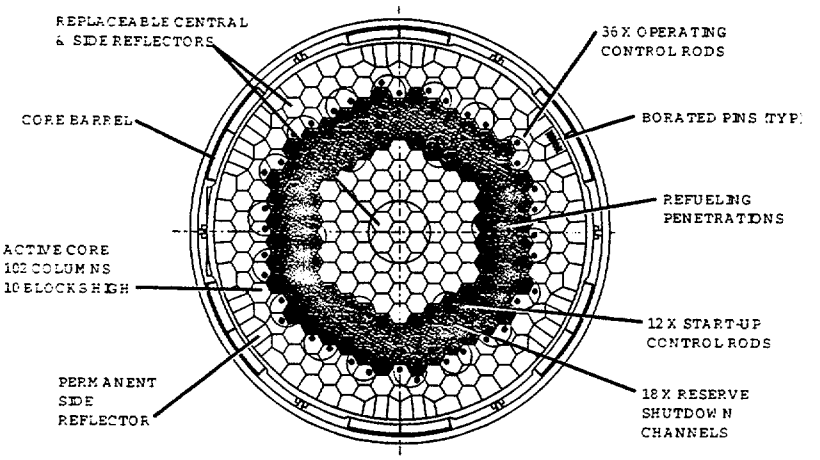
1-12-96

ANNULAR CORE LIMITS FUEL TEMPERATURE DURING ACCIDENTS



ANNULAR CORE USES EXISTING TECHNOLOGY

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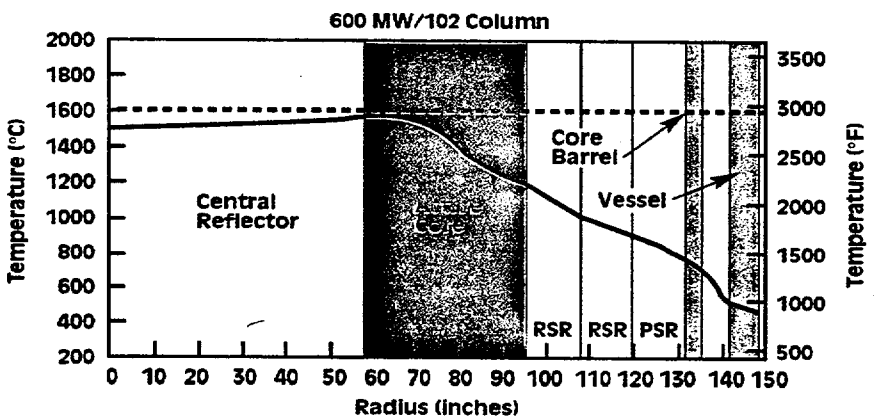
6-9-95

Temperature Gradient Provides Driving Force for Residual Heat Removal

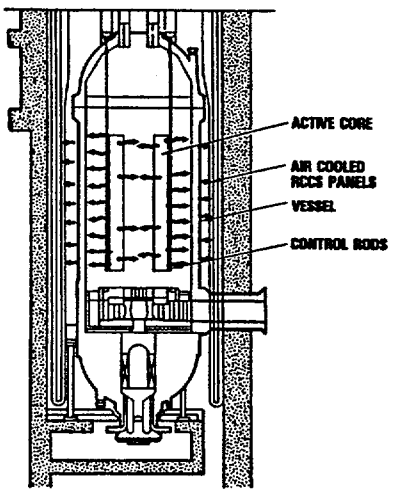


GENERAL ATOMICS

Heat Removed Passively Without Circulation or Coolant

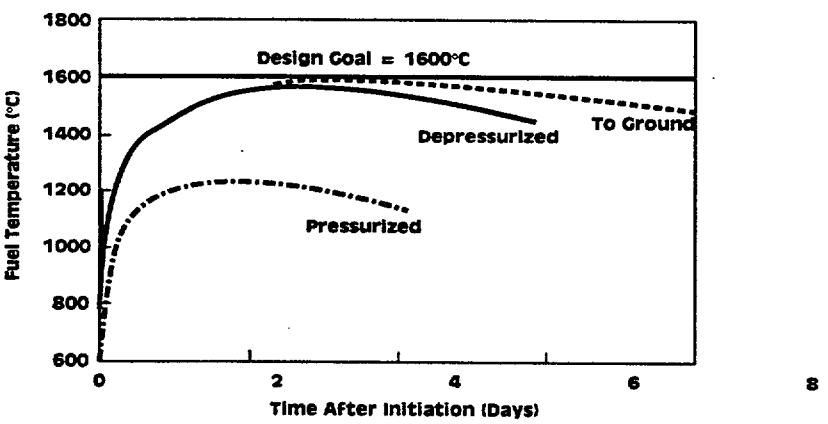
HEAT REMOVED BY:

- CORE CONDUCTION
- CORE INTERNAL RADIATION
- VESSEL RADIATION
- RCCS CONVECTION



GENERAL ATOMICS

FUEL TEMPERATURES REMAIN BELOW DESIGN LIMITS DURING LOSS OF COOLING EVENTS



passive design ensures fuel remains below 1600°C

GENERAL ATOMICS

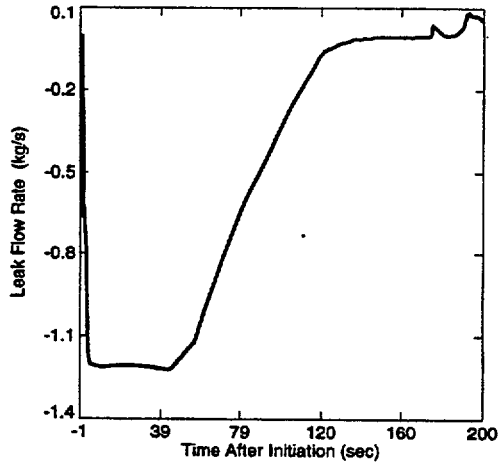
L-340(3)
11-16-94

Risk From Water Ingress Significantly Reduced in GT-MHR

- No steam generators therefore no high pressure steam source
- Precooler and intercooler water pressure below primary coolant operating pressure
- Low water pressure in heat exchangers greatly reduces potential for water ingress during normal operation
- Liquid water transport to core under depressurized conditions as unlikely as in steam cycle system

GENERAL ATOMICS

Leakage is Out of Primary Coolant System Following Tube Break



GENERAL ATOMICS

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)

GENERAL ATOMICS

Low Potential for Graphite Fires

- Test results successfully compared favorably to computer code (AIP) predictions
- Extremely low probability of burning graphite
  - requires temperatures above those during operation or accidents, and
  - requires large quantities of air
- MHTGR analyses show introduction of air results in limited, decay heat driven oxidation

GENERAL ATOMICS