



Safety Lessons from Space Reactor Development for Micro Reactors

ARPA-E Micro Reactor Workshop

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Regulations and Requirements

- No “Code of Federal Regulations” specific to space reactor development
- Presidential Directive/NCS-25 outlines process for approval of space reactor launch by Office of Science and Technology Policy in President’s office
 - Risk based approach to safety (DOE performs analysis)
 - Precedence of previous space reactor projects indicates that there exist some “general design criteria” like requirements for space reactors.
 - Main GDC like requirement “Reactor shall not go critical during a launch accident”
 - Translation – Reactor falling into water or wet sand should have a vanishingly small probability of going critical

How does this impact design?

- Presumed accident is reactor (core and reflector or just the core) falling into water (moderator) or being buried in wet sand (moderator and reflector)
- Design must accommodate this accident by using core geometry (length to diameter ratio) or poisons (extra rods) to prevent this accident
- Criticality calculations are performed with a Monte Carlo radiation transport code.
 - Critical is measured in k_{eff}
 - A k_{eff} of 1 is critical, less than 1 is sub-critical

Example Accident Criticality Results

Reactor State

As launched, immersed in sand (pure 64% SiO₂)

As launched, immersed in water

As launched, Immersed in wet-sand

Fuel only (no rod) bare

Fuel only (no rod) immersed in sand

Fuel only (no rod) immersed in water

Fuel only (no rod) immersed in wet-sand

k-eff

0.9939

0.9936

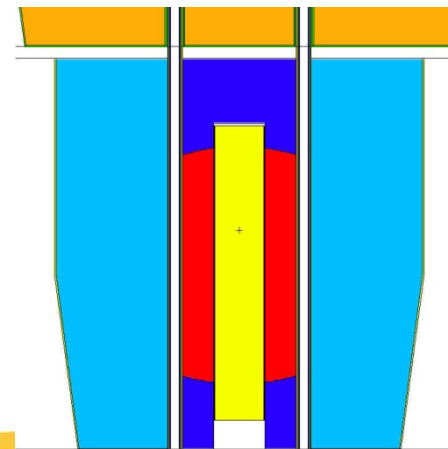
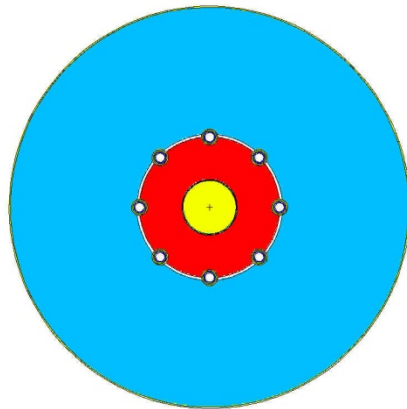
0.9938

0.6141

0.8533

0.9794

0.9649



Application to Micro-Reactors

- If your reactor concept is portable (either by truck or plane) then the accident involving the reactor falling into water during transport must be considered.
- Issue can be designed away!
 - Might require use of a poison rod that must be removed prior to reactor startup
 - Must consider fresh reactor and used reactor if both configurations are transported