The Path Forward for Fission Power Systems

Historical Perspective

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Path Forward

- The path forward is the path backward
  - By this I mean that we have now or have had in the past essentially all of the reactor system technology information that we would need for a wide range of new fission power systems.
  - By avoiding the pitfalls associated with developing new or advanced technologies, we could affordably design, build, test and fly a fission power system once the mission planners defined requirements.

Technology Issues

- Reactor material technologies are well known in three temperature ranges:
  - High Temperature ~900 K -- Stainless Steel, NaK or Na coolant (LMR)
  - Higher Temperature ~1350 K – Refractory alloys, Li coolant (SNAP 50, SP-100)
  - Very High Temperature >2000 K – Tungsten cermet, gas coolant (GE-710, ANL rocket program)
- Physics of reactors, both static and transient, is a very well understood science, for all reactor systems under consideration
- Principal challenges lie in areas of system integration, power conversion, heat rejection, and system dynamics and these are non-nuclear issues

System Qualification and Testing Issues

- System lifetime radiation issues can be resolved by in-pile testing at the component level.
- System operation and non-nuclear lifetime issues can be resolved by conventional component and system thermal vacuum testing.
- Design-specific reactor physics operating parameters can be determined by zero power hot and cold criticality testing.
- No full power nuclear power operating tests would be required to adequately qualify and accept fission power flight system hardware for a wide range of power levels and designs.
- This would be a key facility and cost driver for any contemplated program, and the issue needs to be further amplified.

Full Power Reactor Testing Issues

- Key Question to be asked: What will be learned from the test that cannot be determined in any other fashion?
- I categorically rule out the question of "unknown-unknowns," because that is an open-ended excuse for endless testing without any specific objective.
- Two testing principles were impressed upon me in school and I have found no reason to challenge them.
  - If you don't know what you are testing for, it would be only luck if you found something.
  - A bad test is worse than no test, because you can't believe the results.

Example of zero power critical testing at temperature

- SNAPTRAN 1 AND 2 TESTS
  - SNAP 2/10A reactor core with no NaK coolant or external power producing loops
  - Drum drives modified to allow fast reactivity insertion/removal
  - External heated enclosure and internal heating with once-through heated nitrogen
  - Many transient tests; documentation available

Hardware

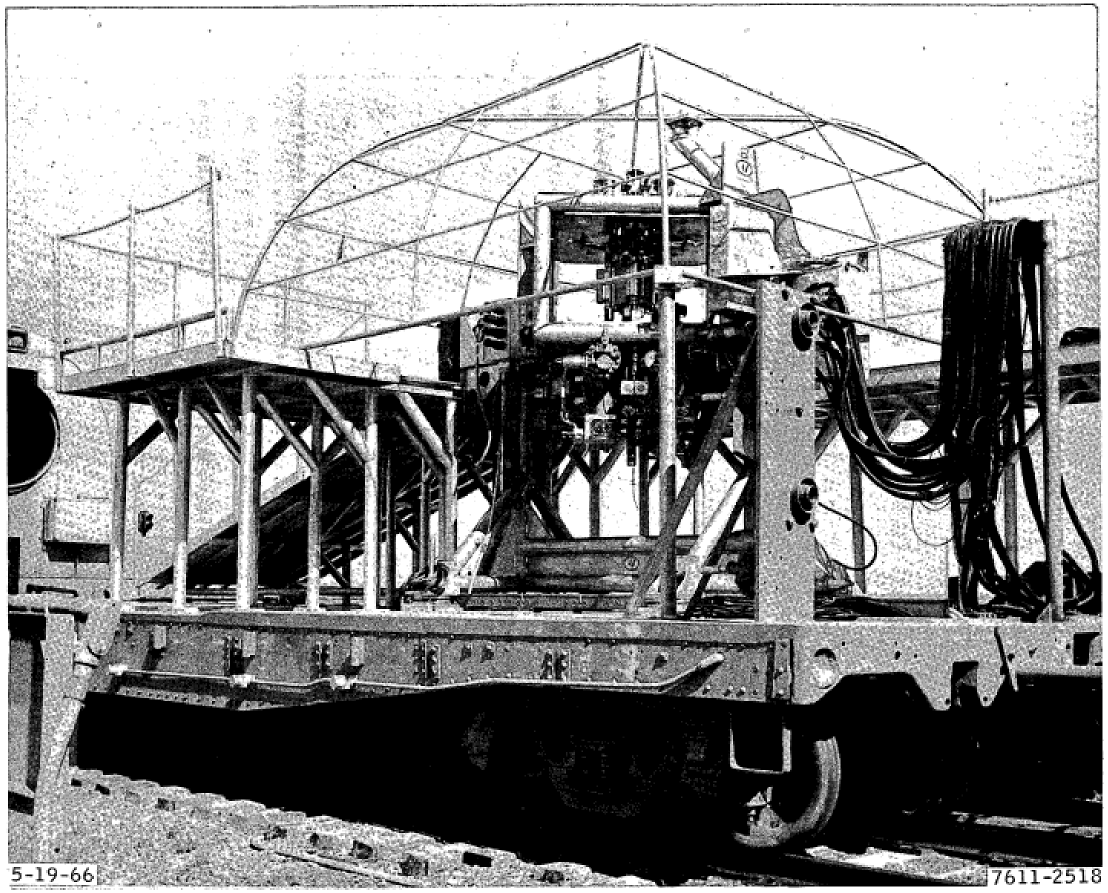
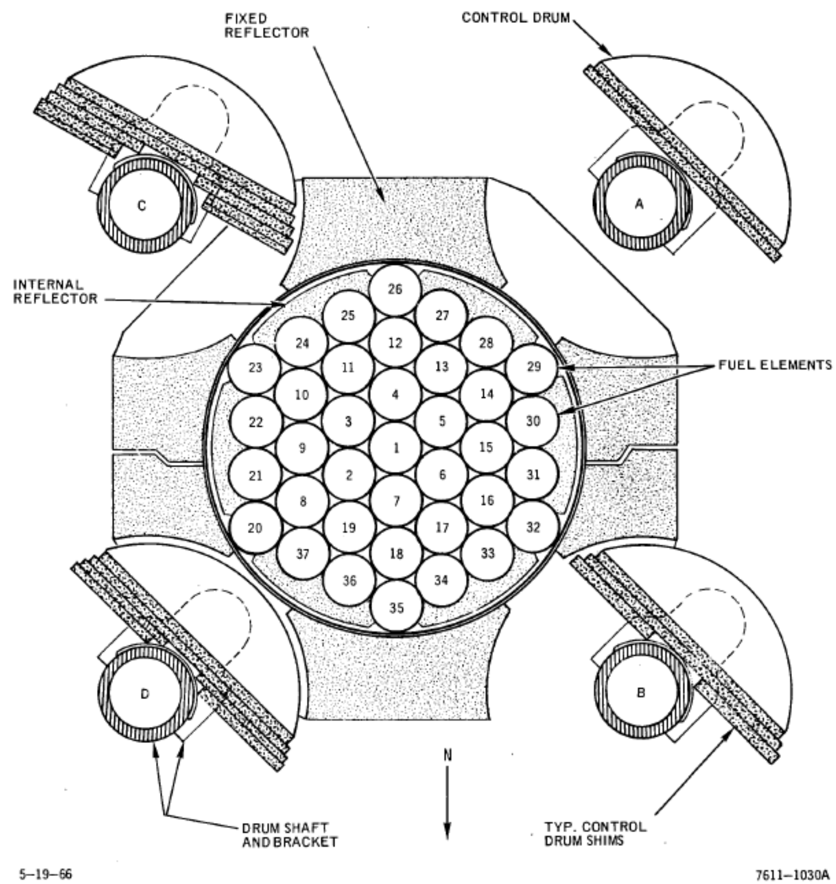


Figure 2. SNAPTRAN-1 Reactor on Test Dolly at IET Facility

Core

(Small, high leakage, Be reflected)



Experiments

- Loading to critical
- Hot critical experiments
- Drum worths and calibration
- Hot and cold transients
  - Varying start temperatures
  - Temperature coefficients obtained

Applicable Data Exists and Does Not Need to be Recreated