Nuclear Rockets - Fission

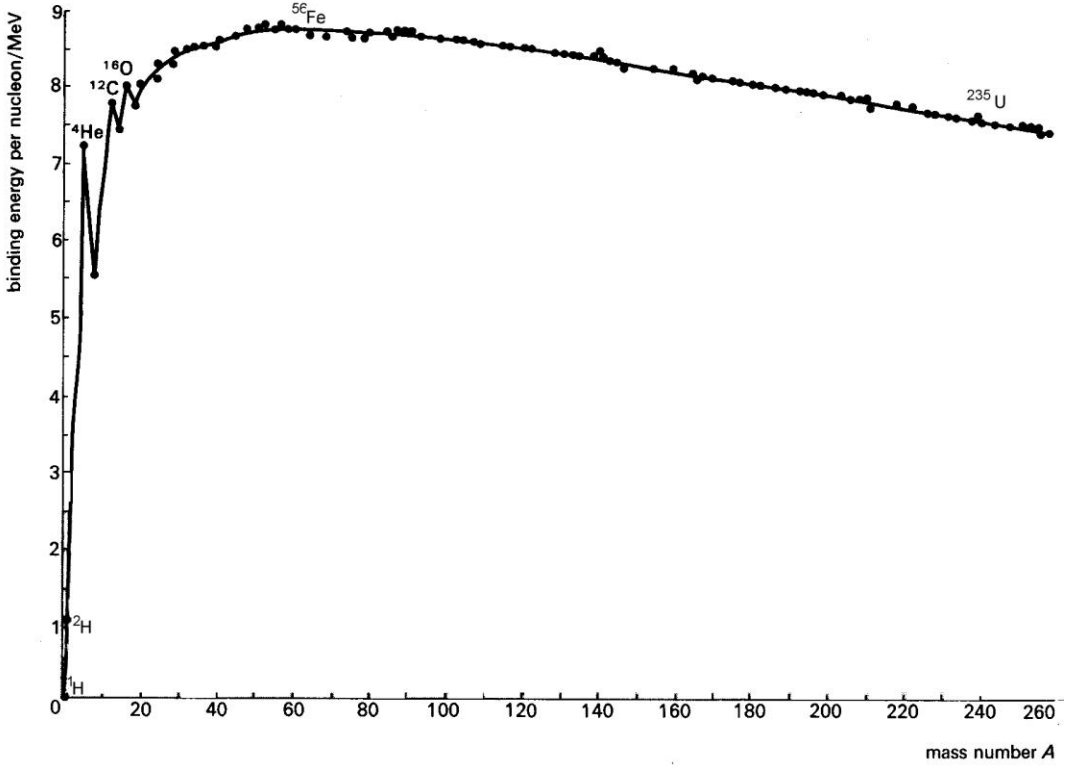
Energy Densities

- To visualise the effectiveness of propellants a useful measure is the specific energy or available energy per unit mass:

- Chemical: order of 10 MJ/kg

- Nuclear Fission:
  100,000 GJ/kg from
  U to 2Sn

- Nuclear Fusion:
  700 000 GJ/kg
  4H to He



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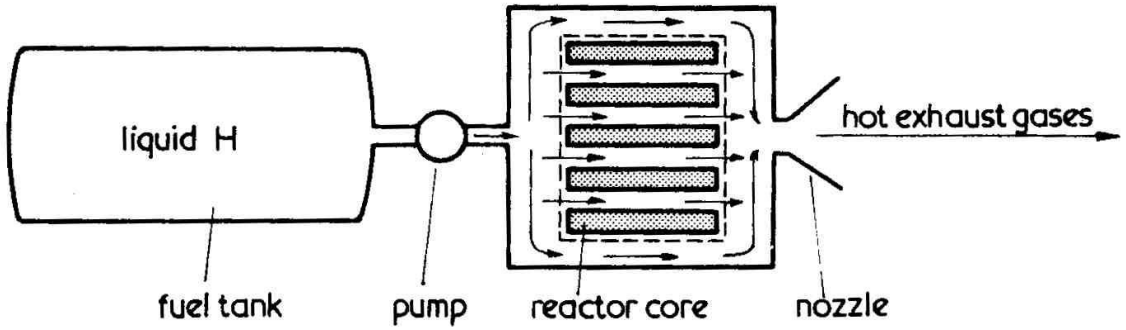
Nuclear Rockets - Fission

- Heat is exchanged between the solid reaction core and a gaseous working fluid such as water or hydrogen.
- Proven and tested, first in 1959 in the USA (Project NERVA), and yielded specific impulses in the range 1000-2000 s.

- The relatively low working temperature, limited by the structural strength of the reactor core is a disadvantage. It is worsened by hot hydrogen corrosion of the reactor core. This can be alleviated using a helium heat exchange loop. at the cost of greater complexity and mass.



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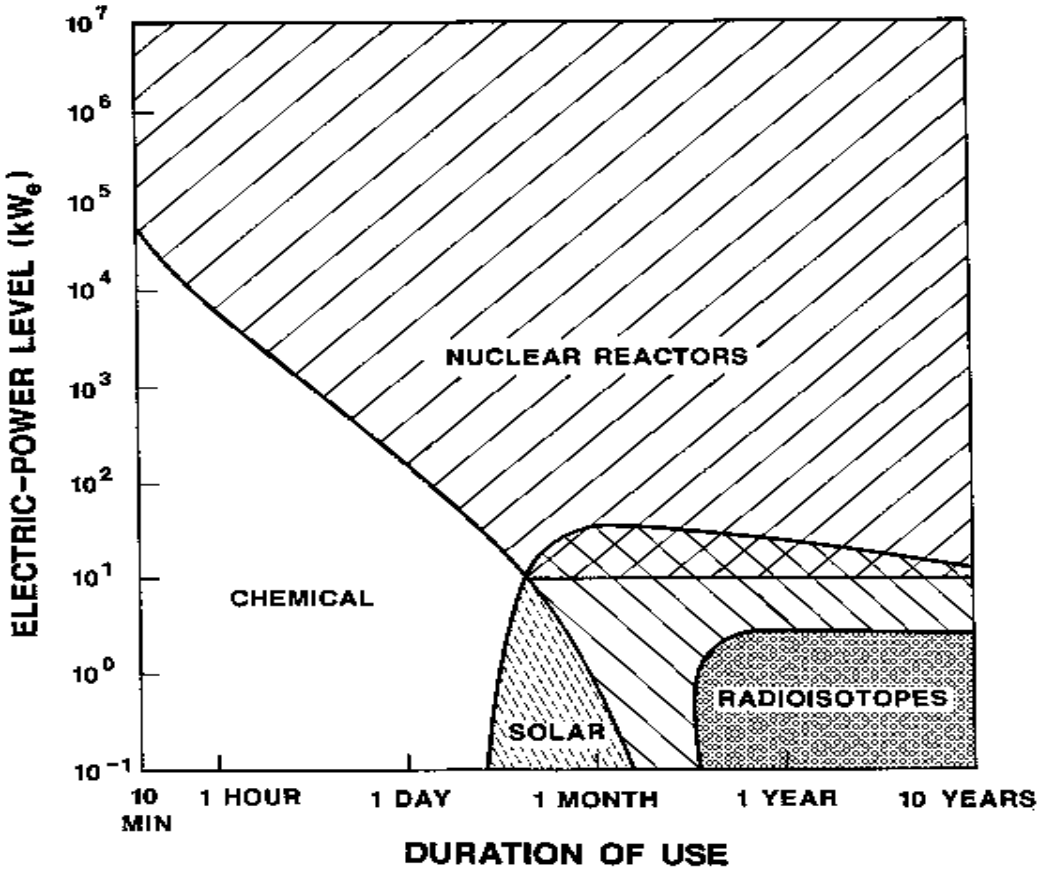
Why Use Nuclear Power in Space

Nuclear Power is Necessary for Human Exploration of Space



- Reacting 1kg of Uranium 235 through fission can yield 500,000 times the energy produced by the decay of 1kg of Plutonium 238 for 10 years.

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Nuclear Electric Fission Rockets

- Nuclear fission produces energy in the form of heat which is then transformed to electricity through thermodynamic or thermoelectric conversion.
- The electric output then drives an arc jet or ion engine.
- Operation on the Russian TOPAZ 10kW reactor satellite for reconnaissance missions.

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TOPAZ Reactor Configuration

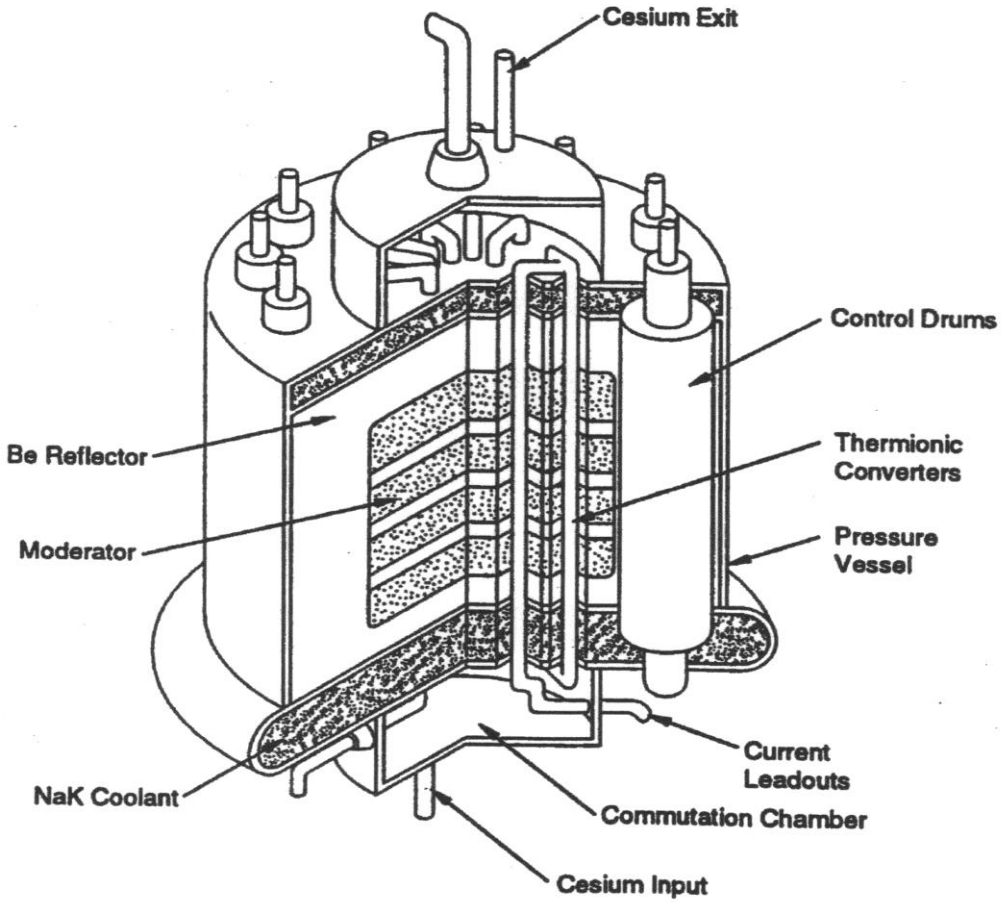

FIGURE 17. Configuration of the TOPAZ I Reactor (Bennett 1989).

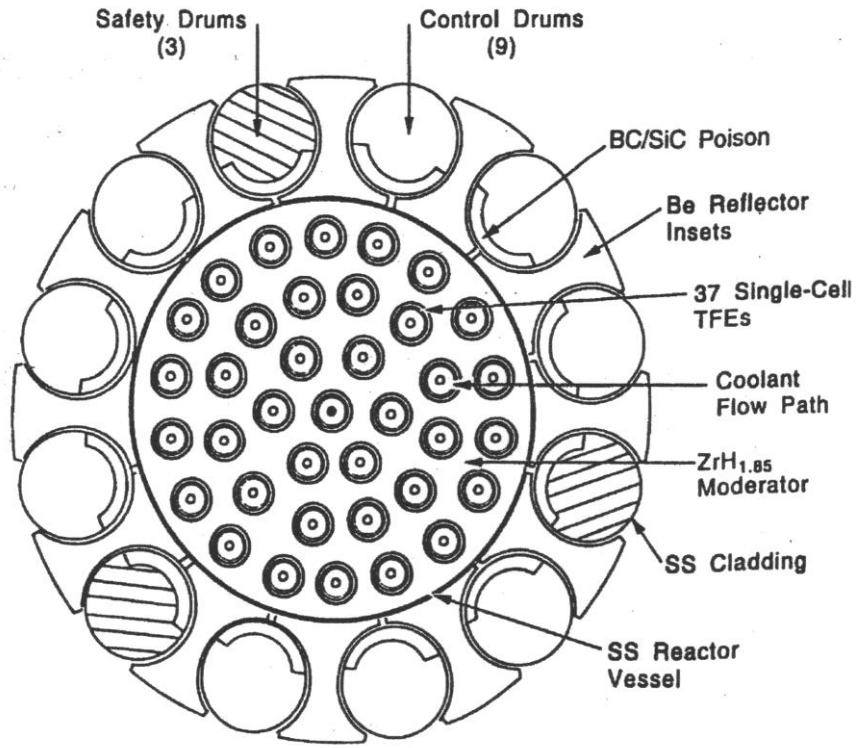

Figure 2. Top View of the TOPAZ II Reactor.

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TOPAZ Overall Configuration

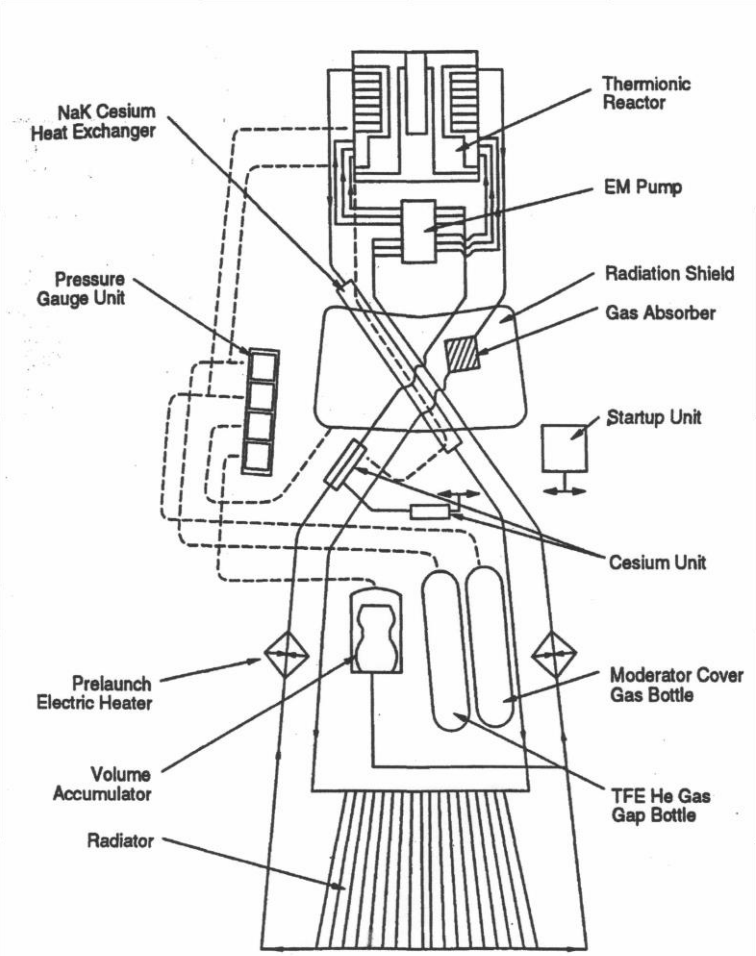

FIGURE 18. TOPAZ II Schematic (Topaz CoDR 1992).

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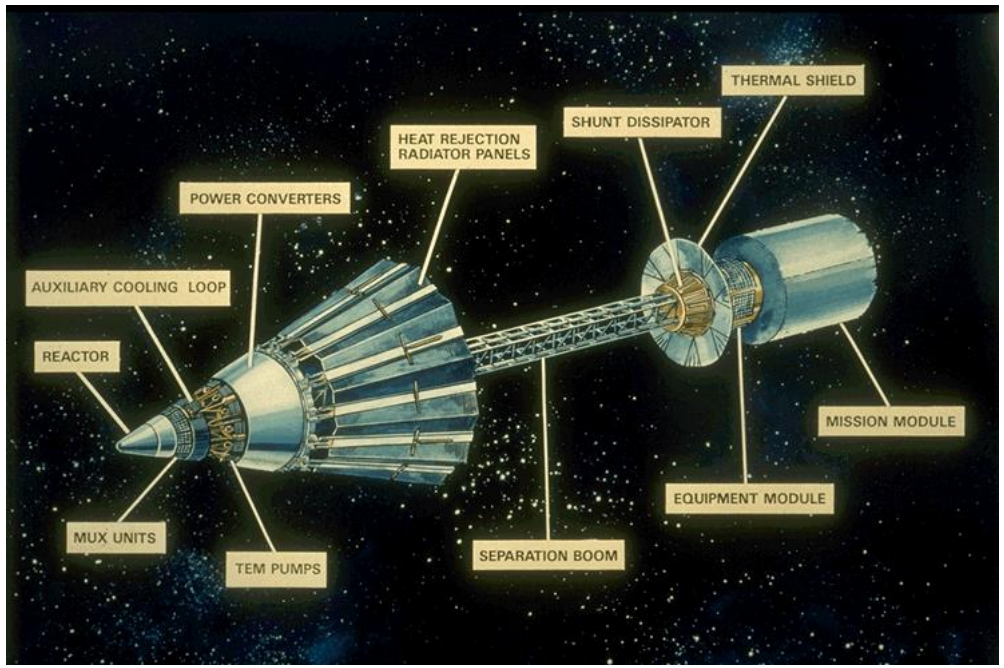
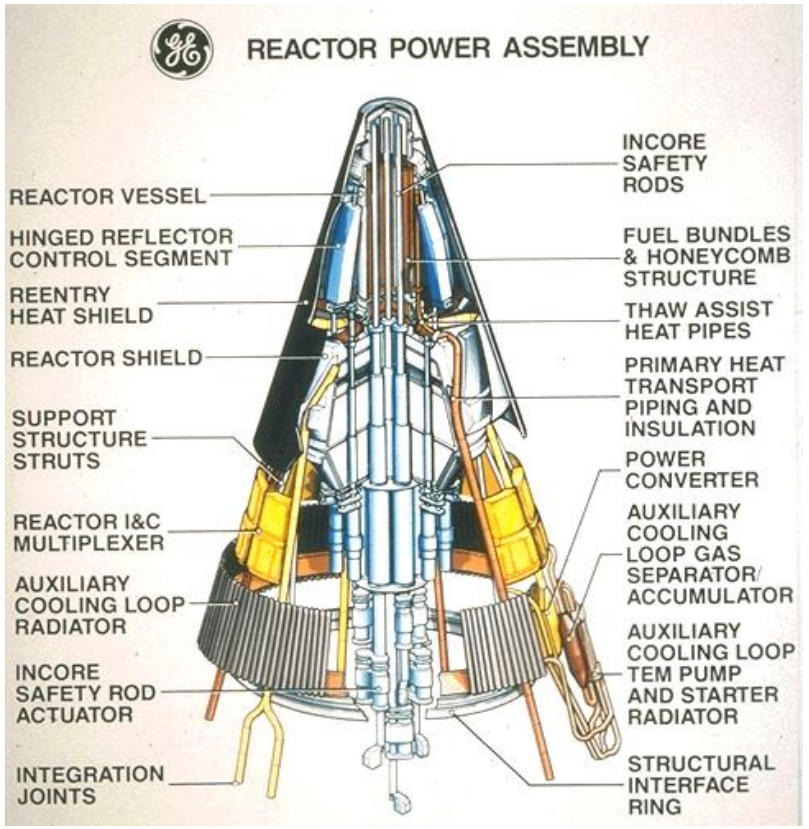
Nuclear Fission Rockets – USP100

- Similar to TOPAZ but more powerful with 100kW output.

- Electrical output powers multiple redundant arcjet thrusters.





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