100 - 500 kWe NEP Systems

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100 - 500 kWe NEP Systems

• Use 2.4 MWt SP-100 reactor / dynamic power conversion
• Enhancing to 100 kWe thermoelectric SP-100
• Serve as interim step between 100 kWe and multimegawatt NEP
• New NEP mission/performance regime
System/Technology Assumptions

- **SP-100 Reactor**
  - fast spectrum, lithium-cooled, pin type
  - 2.4 MWt
  - 1375 K out
  - 7 yr life

- **Dynamic Power Conversion**
  - 1100 K Brayton
  - 1300 K Brayton
  - 1300 K Rankine
  - 1 to 4 100-125 kWe "modular" power conversion loops
  - 2000 V to load

- **Heat Rejection**
  - 10 kg/kWe (SP-100 program)

- **Krypton Ion Thrusters**
  - 50-100 cm
  - 3000-7000 sec Isp
  - 50-150 kWe/thruster
  - 6 kg/kWe

**Electrical Output Power of Modular Dynamic Power Conversion Systems**

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<th>Conversion Loops</th>
<th>Low Temperature Brayton Cycle 100 kWe Loops</th>
<th>High Temperature Brayton Cycle 125 kWe Loops</th>
<th>Rankine Cycle 125 kWe Loops</th>
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**Lewis Research Center**
Advanced Space Analysis Office
KRYPTON ION THRUSTER MASS SCALING
(500 kWc)

Thruster and PPU Specific Mass (kg/kWe)

- 50 cm thruster
- 100 cm thruster
- 150 cm thruster

Specific mass chosen for study

NEP System Specific Mass
for Rankine and Brayton Power Conversion
(2.4 MWt SP-100 reactor, Ion thrusters, 1 to 4 power conversion loops)

Specific Mass (kg/kWe)

- 1100 K Brayton
- 1300 K Brayton
- 1300 K Rankine

Power Level (kWe)
500 kWe SP-100/K-Rankine/Ion NEP Vehicle

250 kWe SP-100/K-Rankine/Ion NEP Vehicle
NEP MISSIONS

- Lunar Cargo
  - Scenario:
    - Depart LEO (400 km)
    - Spiral to Moon, Capture at Moon
    - Spiral down to Low Lunar Orbit (LLO)
    - Return Empty
  - Payload:
    - 40 MT to lunar surface
    - 39.5 MT lunar lander
  - Trip Time:
    - Round trip time < 1 year
    - Trip Time = Reactor, thruster operating time
  - Reference Cargo Vehicle:
    - Cryogenic LOX/LH2
    - Isp: 468 seconds
    - IMLEO: 267 MT
    - Trip Time: 3 days

EARLY TRACK NEP LUNAR CARGO MISSION PERFORMANCE
RESULTS

• 1350 K Rankine, Brayton provide system beneficial to SEI objectives

• Lunar Cargo:
  - 1350 K power systems at 1-1.5 MWe allow 90-130 MT savings over chemical vehicle (up to 50% reduction)
  - Round trip times: 250 days - 1 Year

• Mars Cargo:
  - 1350 K power systems at 1-1.5 MWe allow mass performance comparable to advanced NTP systems
  - Trip Time: 500 days - 2 Years

CONCLUSIONS

• Early Track NEP provides the option for "faster, cheaper" implementation of advanced propulsion for SEI

• Other areas of application:
  - Space Science - significant augmentation to exploration of outer planets and beyond
  - Precursors - Early Track NEP to Mars for robust mapping, sample return, subsurface probing

• Technology Developments Required:
  - Dynamic Power Conversion
  - Scaled Krypton Ion Thrusters
    - MPD Thrusters may also be an option
  - System integration