

## I. Introduction and Motivation

### A. Motivation

### B. Scope of Work

## II. Background and Literature Review

### A. Previous Space Reactor Work

1. RTGs
2. SP-100
3. INL paper
4. Kilopower
5. Nuclear Thermal Propulsion

### B. Cermet Fuel Work

1. INL paper
2. NASA testing

## III. Reactor Physics Parameter Sweeps

### A. Parameters

1. Thermal Power
2. Core Radius
3. Enrichment
4. Fuel Fraction
5. Core Aspect Ratio

### B. Results

### C. Statistical Analysis of Results

## IV. Mass Modeling Methods

### A. Initial Reactor Design Choices

### B. Thermal Hydraulic Analysis Methods

1. Core Geometry
2. Flow Properties
  - a. Temperature
  - b. Pressure
  - c. Thermal Conductivity
  - d. Viscosity
  - e. Specific Heat
3. Fuel Properties
  - a. Thermal Conductivity

- b. Density
    - c. Maximum Temperature
  - 4. Flow Analysis
    - a. Mass Flux
    - b. Reynold's Number
    - c. Nusselt Number
    - d. Heat Transfer Coefficient
  - 5. 1D Heat Transfer
    - a. Plane Wall Conduction Approximation
    - b. Radius of Conduction
    - c. 1D Resistance Network
    - d. Max Q at Centerline
    - e. Flux Shape Scaling of Thermal Power
  - 6. Fuel Fraction Iteration Scheme
- C. Critical Radius Requirements
  - 1. Critical Radius Search with MCNP6
  - 2. Results
    - a. CO<sub>2</sub>-UW Cermet
    - b. CO<sub>2</sub>-UO<sub>2</sub>
    - c. H<sub>2</sub>O-UW Cermet
    - d. CO<sub>2</sub>-UW Cermet
- D. Mass Modeling Iterations
  - 1. Reflector Design
  - 2. Core Aspect Ratio
  - 3. Martian Regolith Reactivity Impact
- E. Mass Modeling Results
- V. Coupling With Power Cycle Optimization
  - A. Coupling Scheme
  - B. Optimal Reactor Design
- VI. Full-Core Concept Model
  - A. Modeling Methods
    - 1. Neutron Transport
    - 2. Depletion
    - 3. Data
  - B. Fuel Design
  - C. Cooling
  - D. Reactivity Control

E. Depletion

F. Shielding

G. Safety Analysis

H. Reactor Dynamics Analysis

VII. Summary and Future Work