INL/CON-22-67358-Revision-0

DRPS Poster for MFC SAC

June 2022

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Changing the World's Energy Future

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Final Edge of Poster

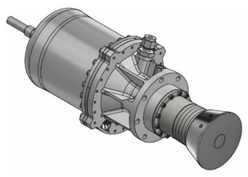
Space Nuclear Power & Isotope Technologies

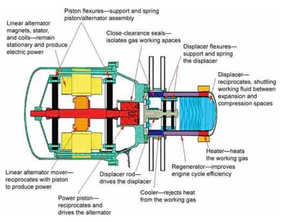
Path to a Dynamic Radioisotope Power System

The goal is to develop a power system for space applications that is three times more efficient than the systems currently in service.

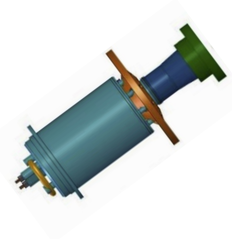
2017

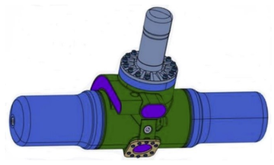
NASA initiated the Dynamic Radioisotope Power System (DRPS) development program in 2017 to evaluate potential dynamic conversion technologies and mature at least one technology toward flight development. The goal was to have a reliable system with >20% efficiency.



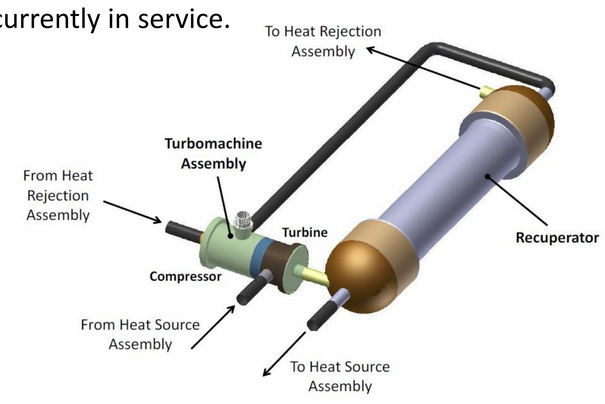


Stirlings





Thermal Acoustic



Brayton

2018

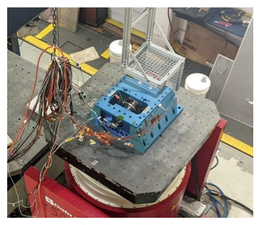
2019

NASA Development Program

Two Stirling cycle based designs have progressed toward testing at NASA Glenn Research Center. Two Sunpower SRSC convertors have exceeded 4500 hours of operation. One of the AMSC FISC convertors has exceeded 3600 hours of operation. Individual convertor efficiency estimated to be >25%.

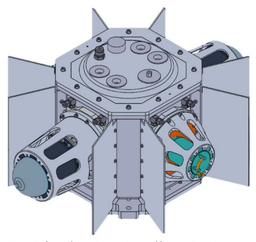
2020

NASA's test plan includes testing the convertors in various near flight-like conditions to help determine the performance and ability to service a 17-year mission.



Vibration testing

Steady-state performance test arrangement

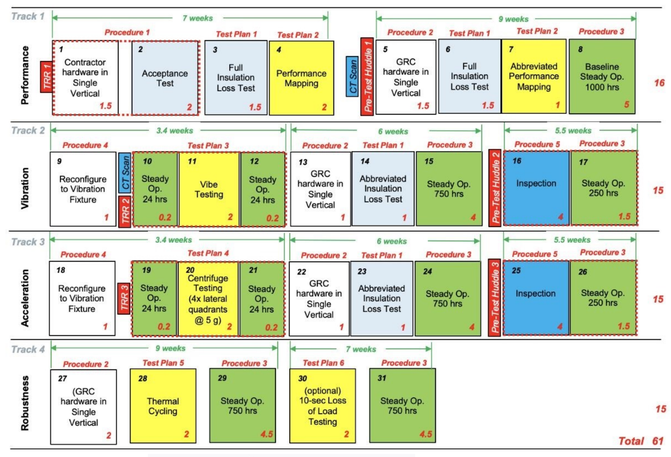


Test bed setup to allow testing of multiple convertors together

Some of the design and process improvements include:

- Heater head material
- Regenerator material and form
- Centering spring form
- Piston centering and optimization
- Magnet form

Baseline Test Plan



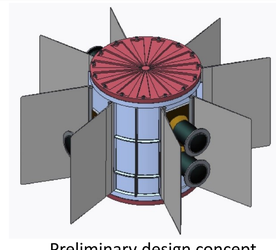
2021

2022

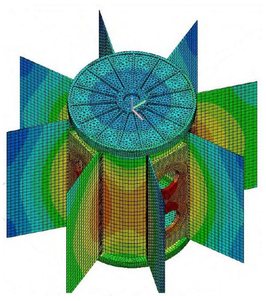
INL Phase 1 Contract - Design

In 2021, INL entered a contract with Aerojet Rocketdyne to design a DRPS for a 20-month Lunar mission and 17-year life. Testing of a prototype benchtop system is planned to begin in 2023 with delivery of a protoflight unit in 2028.

Trade studies have been completed to down-select the convertor manufacturer, the number of convertors, and the basic generator design. Initial analyses of the generator design have begun. Controller design has begun.



Preliminary design concept

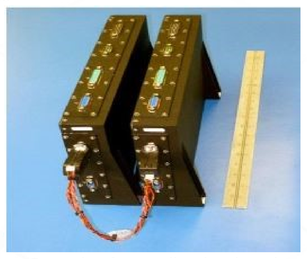


Preliminary thermal analysis

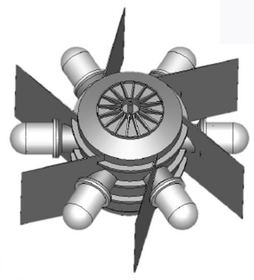
2023

A significant effort of a DRPS design is the controller. The controller functions include:

- Control Stirling convertor for power output
- Convert AC power to DC power
- Synchronize convertors to minimize vibration
- Shut down a convertor if it's opposing partner fails
- Monitor spacecraft power and connect/disconnect as needed
- Provide redundancy in case of failure



Example of controller developed at APL.



Preliminary design concept

2024

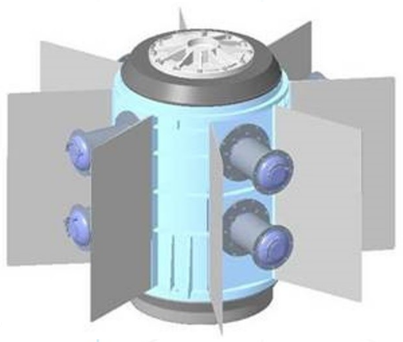
INL Phase 2 Contract – Brassboard Testing

Phase 2 includes building a brassboard, or laboratory unit, to demonstrate the design in relevant environments. This is where the attributes and interfaces of the convertors, generator and controller come together in simulated hardware.

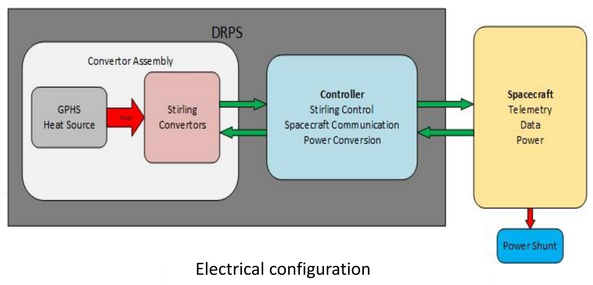
Stirling convertors and simulators will be used to test the controller to demonstrate the ability to monitor and control multiple convertors at the same time.

2025

2026



2022 DRPS configuration
1500 W thermal input
8 convertors
330 W electrical output
22% efficient



Electrical configuration

2027

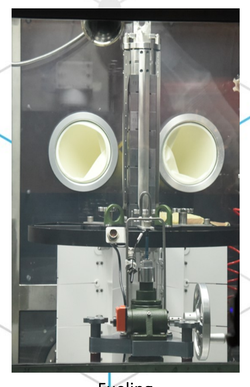
INL Phase 3 Contract – Simulators & Protoflight Build

During Phase 3, the subcontractor will build and test simulators for mass, thermal properties, and dynamic properties. A protoflight unit will also be fabricated and shipped to INL.

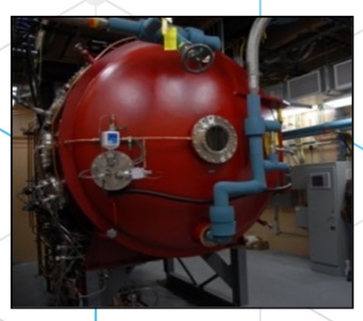
If a DRPS is selected for a future NASA mission, INL has the capabilities and infrastructure to support fueling and testing to ensure the generator meets performance objectives. INL also provides the transportation of the generator and supports launch facility operations.

2028

2029



Fueling



Vacuum Testing

Vibration Testing

Transportation in the 9904 shipping cask

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Final Edge of Poster