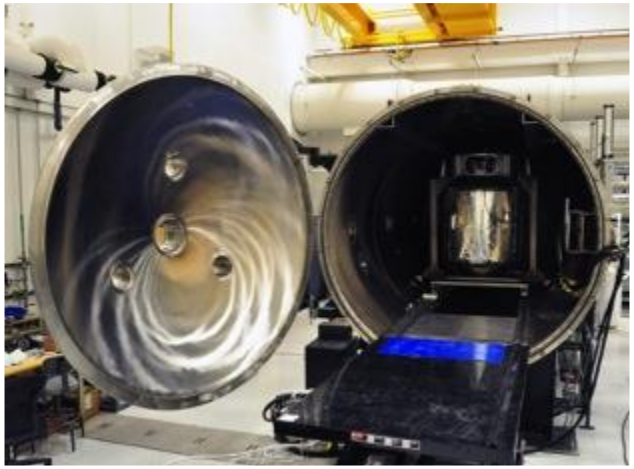


YETISPACE

Engineering for Extreme Environments

Company Capabilities

Summer 2017

Table of Contents

Corporate Overview

- Yetispace was founded by an engineer in 2006 in Huntsville, Alabama.
- Corporate office and laboratories are located 4 miles from Redstone Arsenal and Marshall Space Flight Center.

STAFF

- Yetispace staff members are cross-functional. Engineers and technicians are trained in many different areas allowing flexibility and versatility.
- Offices, fabrication and assembly areas, and test facilities are collocated, enabling seamless integration of team members from project conception to final delivery.

CORPORATE PROFILE

- Small business classification
- DUNS: 621507958
- Cage Code: 62A03
- NAICS Codes:
  - 336419: Space Vehicle Parts
  - 541330: Engineering Services
  - 541380: Testing Laboratories
  - 541715: Research and Development

Core Competencies

ENGINEERING

- Cryogenic Fluid Management
- High Power Systems
- Pressure Systems
- Insulation Systems
- Fluid and Thermodynamic Systems
- Aerodynamics
- Mechanical Design
- Propulsion Systems
- Systems Engineering
- Industrial Design
- General Engineering Design and Analysis
- Ground Support Tooling and Equipment Design

FABRICATION

- Pressure Systems
- Cryogenic Systems
- High Power Systems
- Prototype Design and Build
- Insulation Fabrication and Installation
- Test Facility Design and Build
- Metals, Wood, Composites, Soft Goods
- Special Test Equipment
- Data Acquisition Software/ Hardware Integration
- Ground Support Tooling and Equipment
- Instrumentation Design and Installation

TESTING

- Cryogenic Testing
- Thermal/Insulation Testing
- High Temperature Testing
- Hardware Testing and Data Analysis
- Instrumentation
- Test Facility Operation
- Data Collection and Analysis

The Yetispace Way

Yetispace believes in producing the simplest, smartest solution first, often by using fundamental pencil-and-paper analyses. This approach gets at the heart of the issue quickly, saving the customer time, money, and many sleepless nights.

MISSION

To advance propulsion systems and components for extreme temperature and pressure environments.

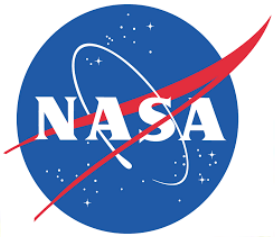
CORE VALUES

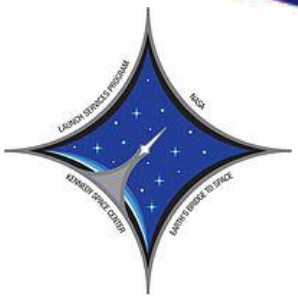
- Classical Engineering
- Independent Thinking
- Creative Solutions
- Decisive Action
- Accountability
- High Quality
- Customer Satisfaction

PRODUCE THE SMARTEST, SIMPLEST SOLUTION FIRST

Partners and Clients

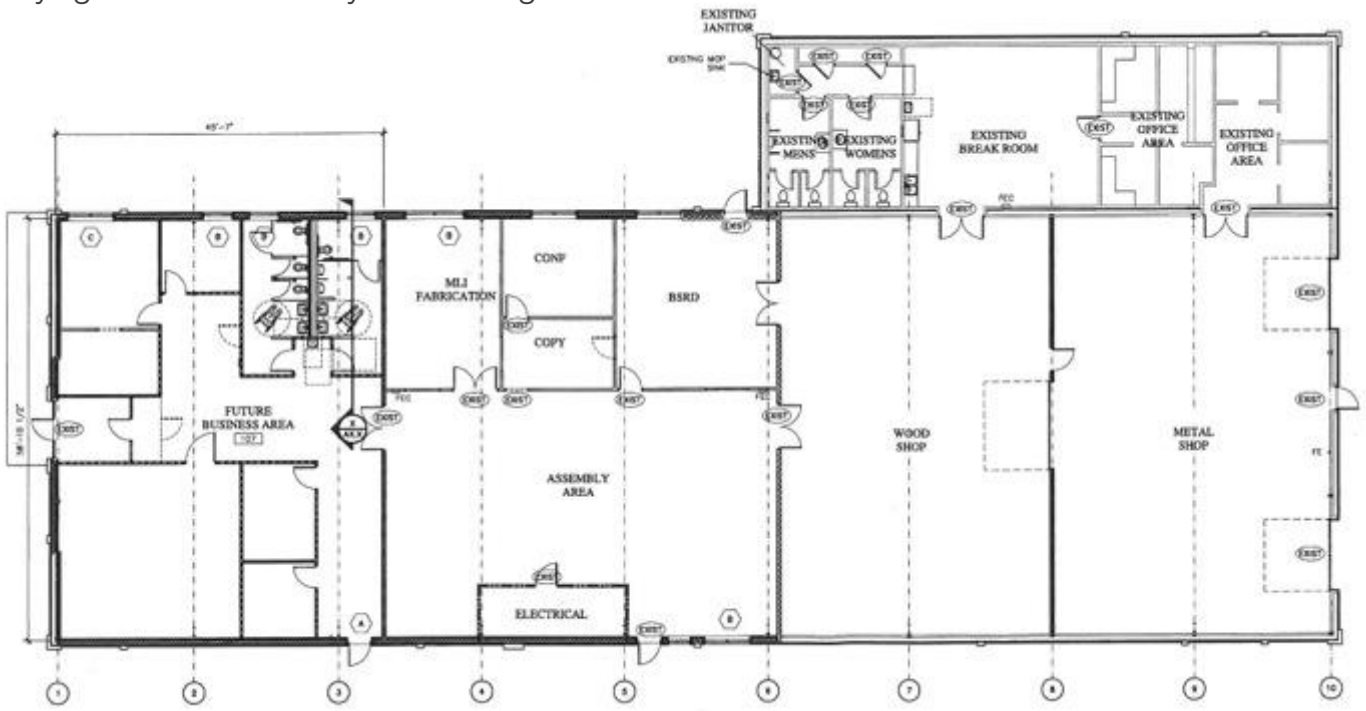
- a.i. solutions
- Analytical Mechanics Associates
- ASRC Federal Analytical Services
- ATK Aerospace
- Davidson Technologies
- Essex Industries
- Moon Express
- NASA Engineering and Safety Center
- NASA Glenn Research Center
- NASA Kennedy Space Center
- NASA Marshall Space Flight Center
- Teledyne Brown Engineering
- United Launch Alliance





Yetispace Facilities

- 13,000 square-foot corporate facility
- Machine Shop
  - Welding (stainless and carbon steel), tubing fabrication, Bridgeport mill
- Wood Shop
  - Tank and propulsion system mock-ups, fabrication jigs, shipping crates, etc.
- General Fabrication Laboratory
  - Spray-on foam insulation application, valve modifications, etc.
- Multilayer Insulation Fabrication Laboratory
  - Cryogenic insulation system design and build



Yetispace Overview

ENGINEERING

FABRICATION

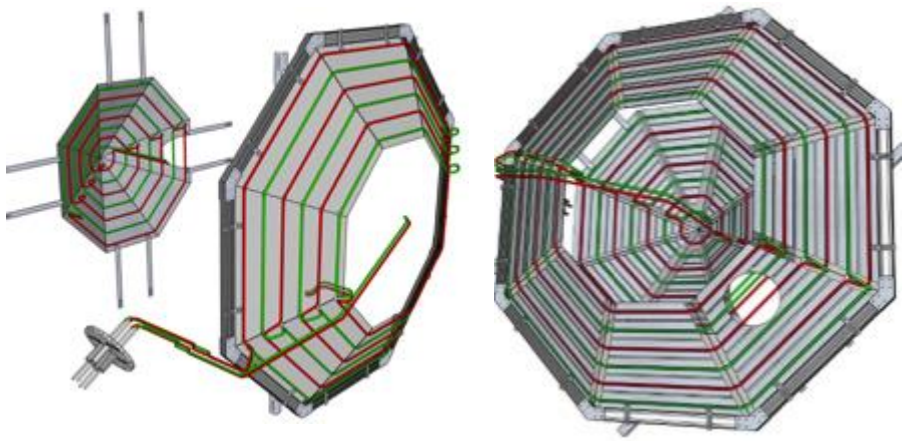
TESTING

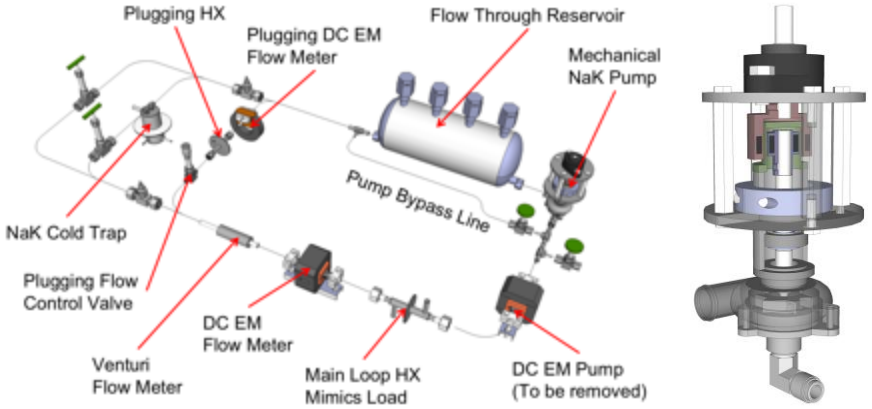
ADMINISTRATION

Mechanical Design

for Extreme Environments

- Propellant Systems
- High Temperature Systems
- Power Systems
- Propulsion Systems
- Valves and Actuators





YETISPACE

Mechanical Design: Propellant Systems

NAICS Code: 336419
541330
541380
541715

CAPABILITIES

- Propellant System Design
- System Analysis
- Assembly
- Operation
- Test
- Data Analysis
- Program Management
- Supply Chain Management
- Cryogenic Fluid Transfers
- Cryogenic Fluid Storage
- Propellant Handling

SELECTED WORK

Cryogenic Orbital Test Bed (CRYOTE1)

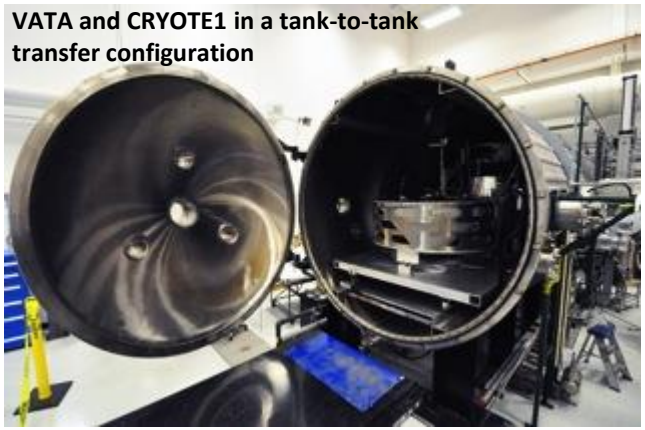
Yetispace utilized a sub-scale titanium sphere tank to measure thermal performance and test a thermodynamic vent system.

Cryogenic Orbital Test Bed (CRYOTE3)

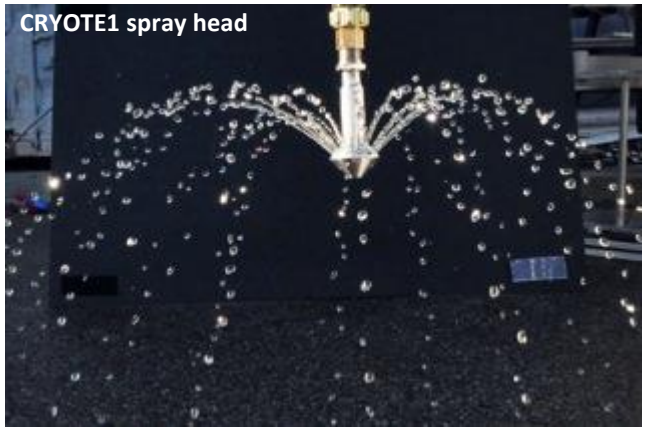
Yetispace designed a test program to measure thermal stratification in a flight-scale/weight tank.

Vibro-Acoustic Test Article (VATA)

Yetispace performed thermal and structural tests of a multilayer insulation/Broad Area Cooling shield assembly under launch acoustic loads.



VATA and CRYOTE1 in a tank-to-tank transfer configuration



CRYOTE1 spray head

Solid Propellant Void Evaluation Tool

NAICS Code: 336419
541330
541380
541715

Mechanical Design: High Temperature Systems

CAPABILITIES

- Pump Design and Build
- Furnace Design and Build
- Supply Chain Management
- Facility Design and Build
- Test Operations

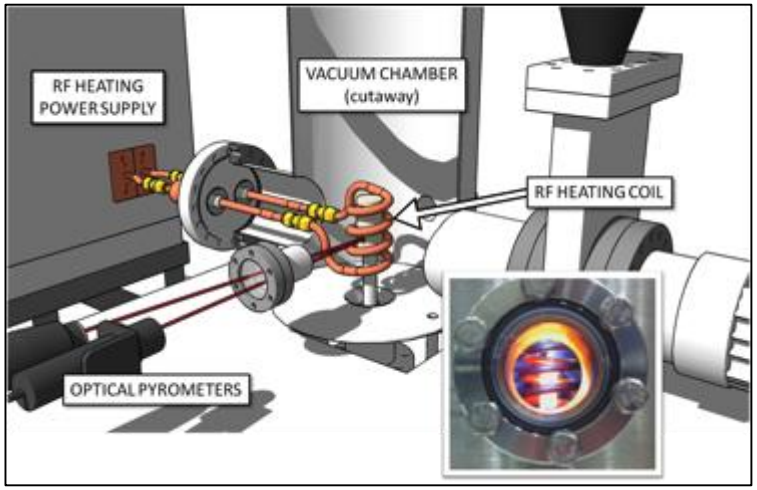
SELECTED WORK

Compact Fuel Element Environment Test (CFEET)

Yetispace designed and built a small test bed to heat fuel element samples via noncontact RF heating. Fuel samples were exposed to hydrogen in order to assist in optimal material and manufacturing selection without employing fissile material.

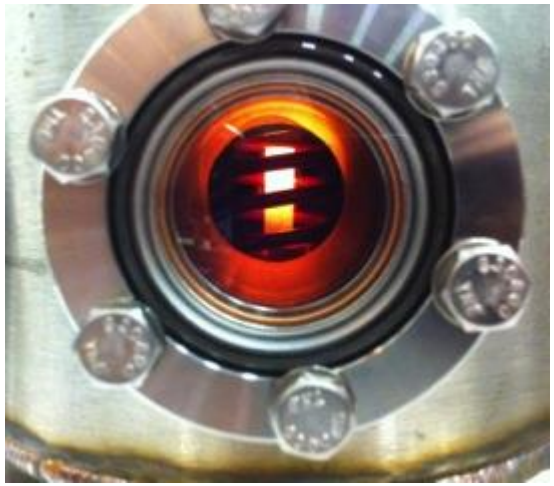
NaK Feasibility Test Loop

Yetispace designed, built, and operated a test loop that is able to non-invasively measure contamination levels and demonstrate purification by way of cold-trapping.



CFEET Model


Vacuum Chamber Setup


View into Sight Glass During Heating Test

Mechanical Design: Power Systems

NAICS Code: 336419
541330
541380
541715

CAPABILITIES

- AC Power System Design
- DC Power System Design
- Radio Frequency Power System Design
- Power System Fabrication
- Power System Test
- AC/DC Power Distribution

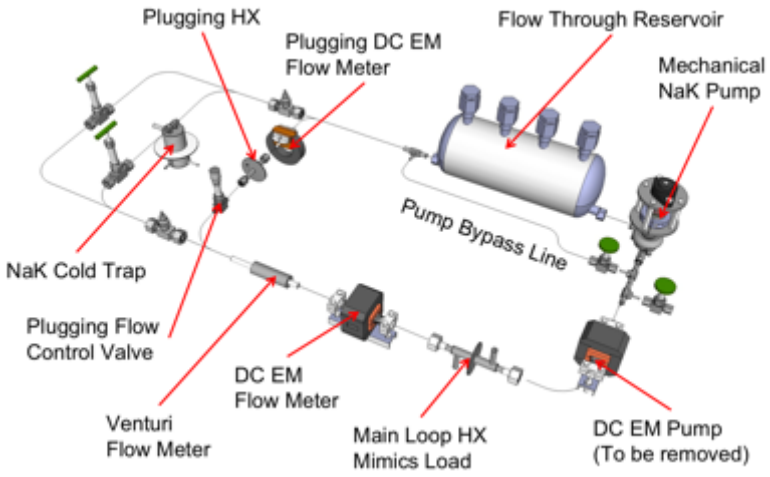
SELECTED WORK

NaK Feasibility Test Loop

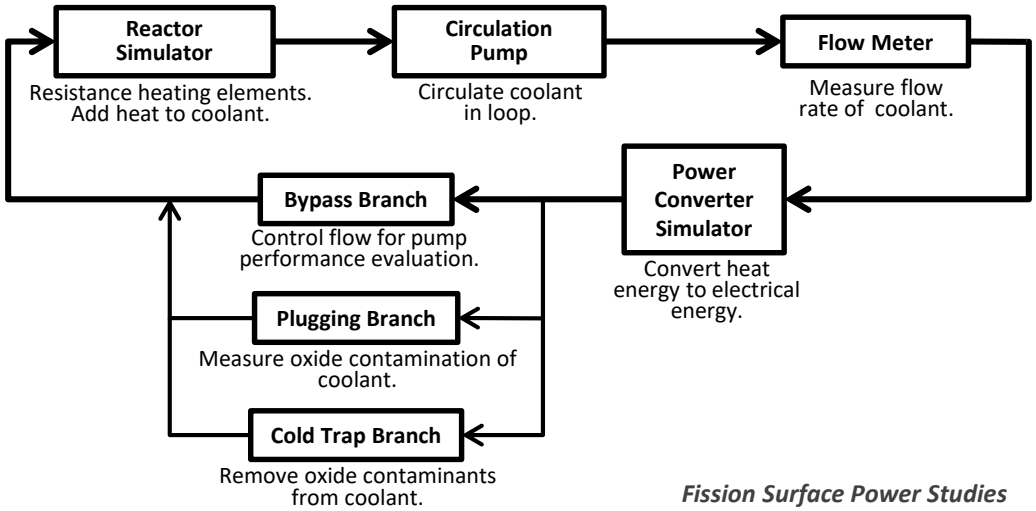
Yetispace designed a high-temperature liquid metal NaK coolant loop to simulate heat transfer in a prototypical fission reactor to electrical power conversion system.

Compact Fuel Element Environment Test (CFEET)

Yetispace utilized radio frequency power to generate controlled non-contact high temperature heating.



NaK Feasibility Test Loop Reactor Simulator Model



Fission Surface Power Studies

Mechanical Design: Propulsion Systems

NAICS Code: 336419
541330
541380
541715

CAPABILITIES

- Propulsion System Design
- Liquid Injector Design
- Solid Rocket Motor Design
- System Analysis
- Program Management
- Supply Chain Management
- Assembly
- Operation
- Testing and Analysis

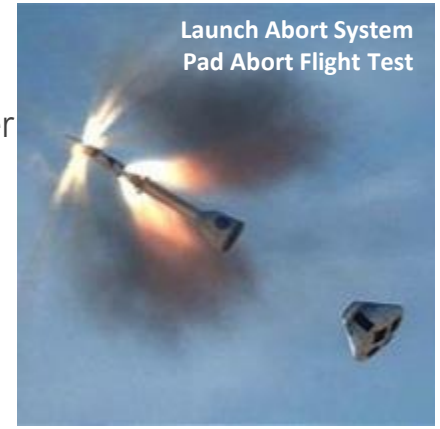
SELECTED WORK

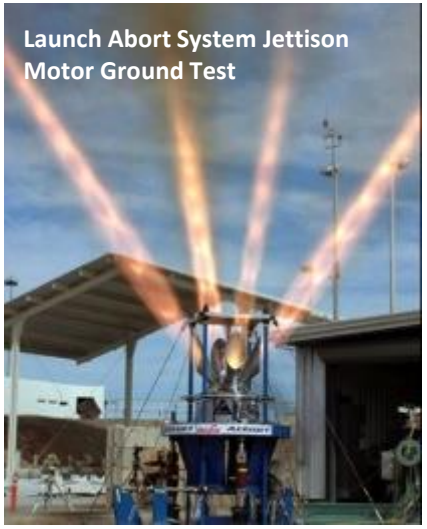
Doctoral Research

Noah Rhys studied injector sprays for his PhD research and as a researcher at the University of Alabama in Huntsville.

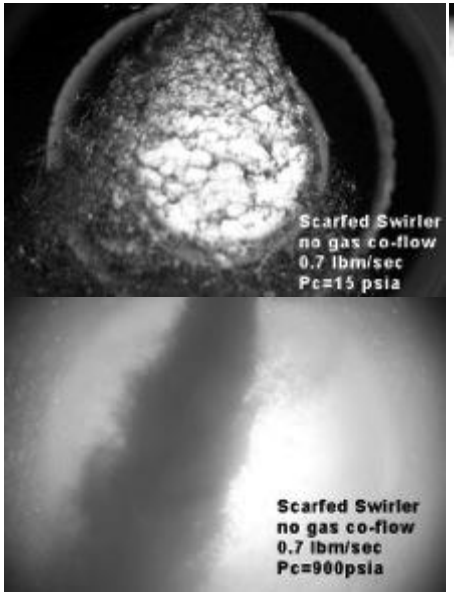
Orion Launch Abort System Jettison Motor

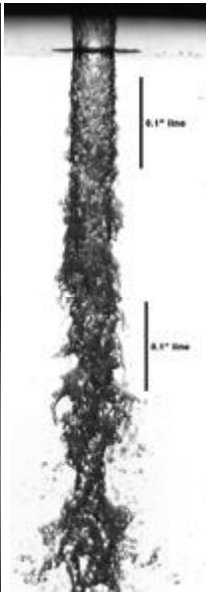
Yetispace led the Orion Launch Abort System Jettison Motor team. This motor was successfully flown on the Orion test flight in December 2014.






High Pressure Spray Lab





Mechanical Design: Valves and Actuators

NAICS Code: 336419
541330
541715

CAPABILITIES

- Modify, Design, Repair and Rebuild Valves and Actuators

SELECTED WORK

Solid Rocket Motor Cold Flow Variable Area Valve

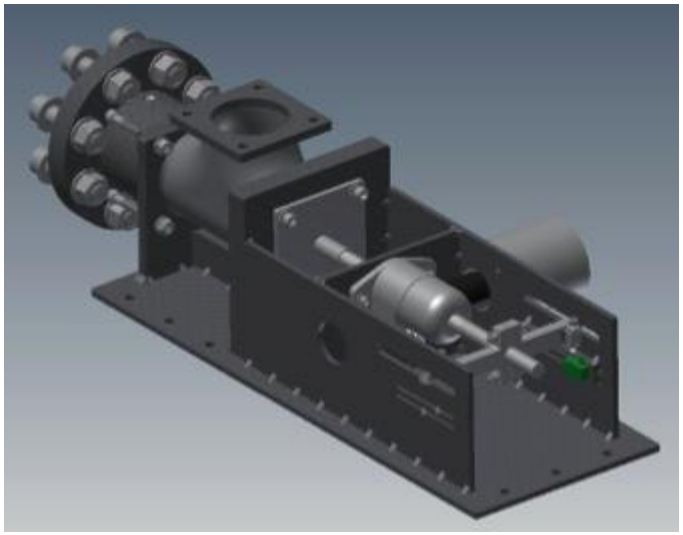
Yetispace designed, analyzed, and built a variable area valve to function as the throat of a customer supplied flow test article.

Stepper Motor Controlled Cryo Valve

Yetispace utilized off-the-shelf hardware to design and build a valve that would not impose high heat loads on a cryogenic system.

Stepper Motor
Controlled Cryo Valve

Stepper Motor
Controlled Cryo Valve

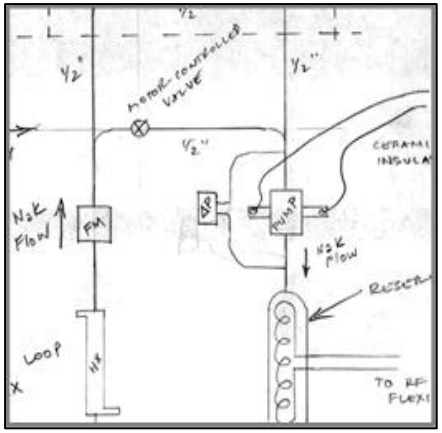


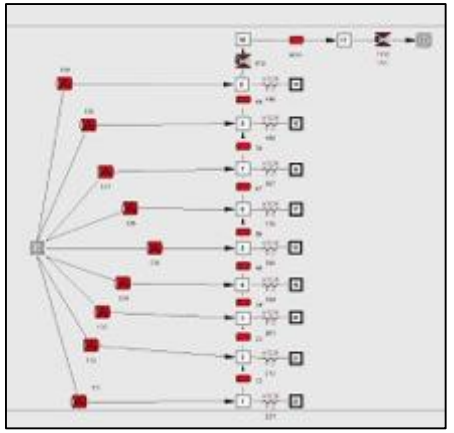
Solid Rocket Motor Cold
Flow Variable Area Valve

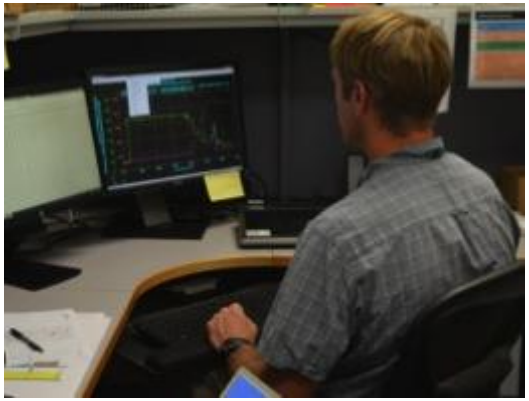
Analysis

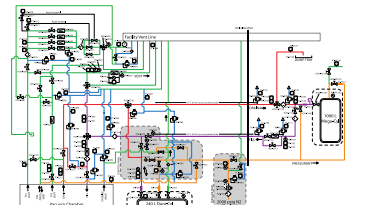
of Extreme Environments

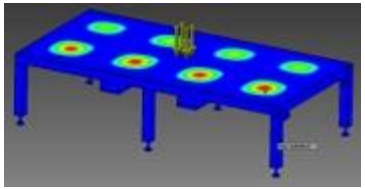
- High-Pressure Systems
- Generalized Fluid System Simulation Program (GFSSP)
- Heat Transfer

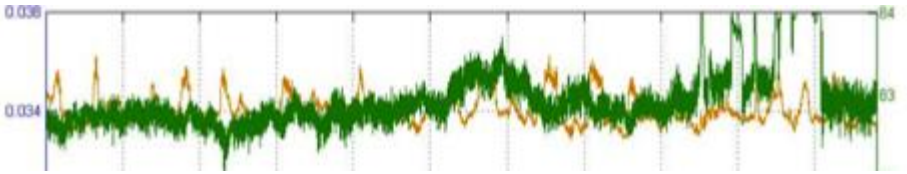


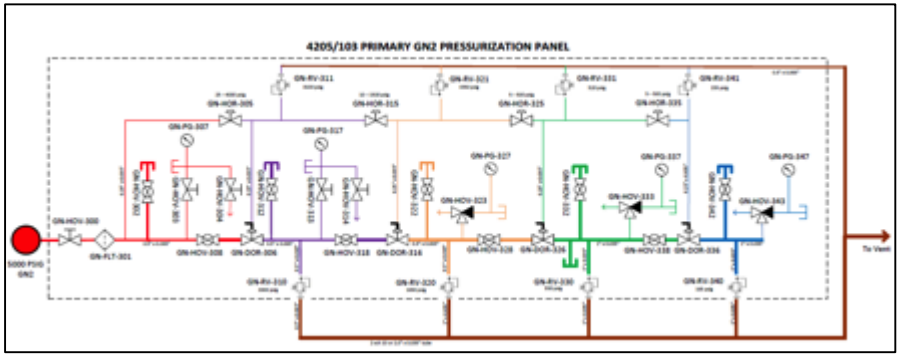












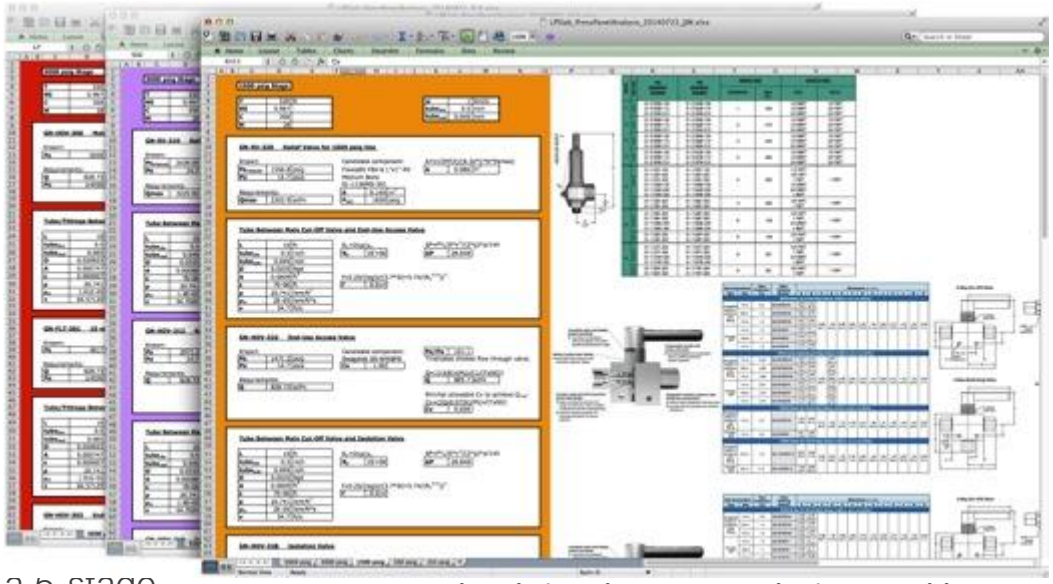
YETISPACE

NAICS Code: 336419
541330
541715

Analysis: High-Pressure Systems

CAPABILITIES

- Flow Calculations
- Spec Components and Lines
- Supply Chain Management
- System Build
- System Repair
- System Modification

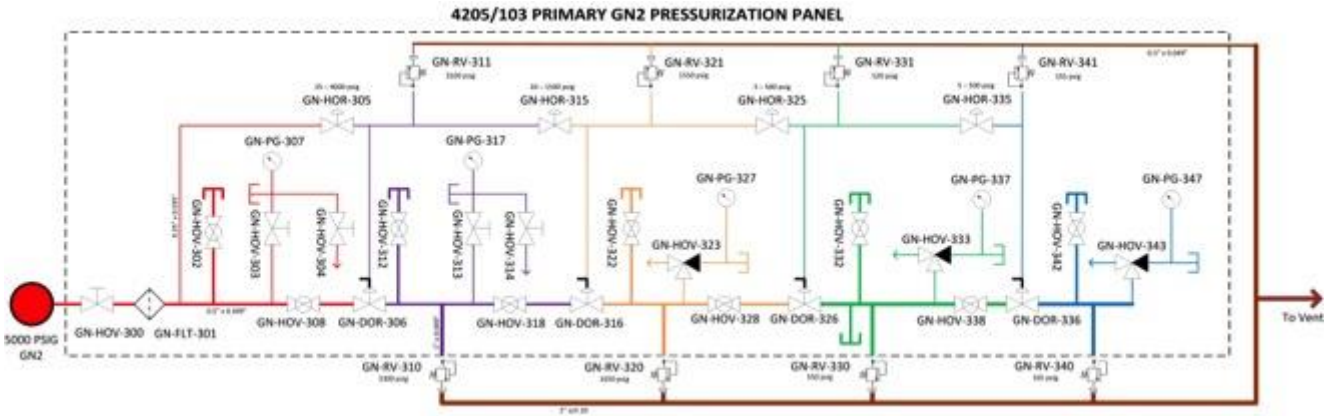


LPS Pressure Panel Analysis and Component Selection Spreadsheets

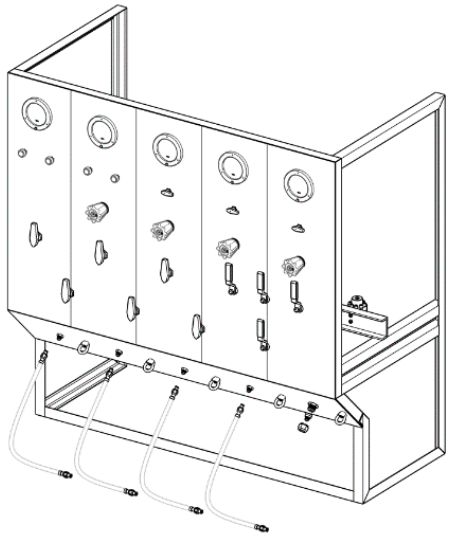
SELECTED WORK

Liquid Propulsion System (LPS)

Yetispace designed, analyzed, and built a 5-stage pressure panel for an engine component lab.



LPS Pressure Panel Schematic



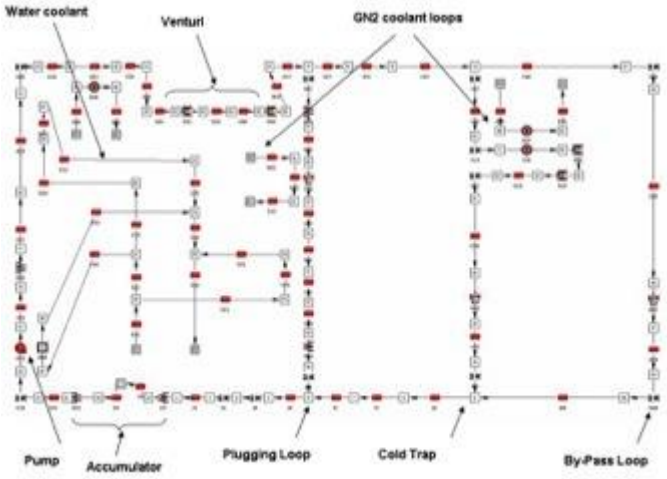
LPS Pressure Panel Layout

Analysis: GFSSP

OVERVIEW

General Fluid Systems Simulation Program (GFSSP)

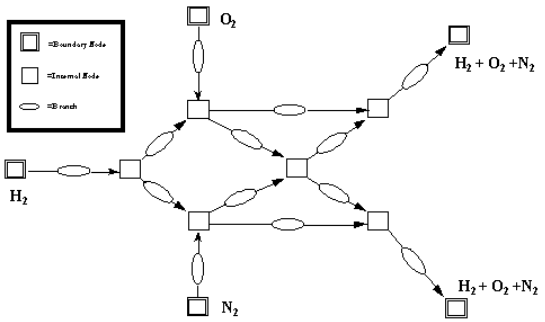
GFSSP is a general-purpose computer program for analyzing steady state and time-dependent flowrate, pressure, temperature, and concentrations in a complex flow network. It was developed at the NASA Marshall Space Flight Center (MSFC).

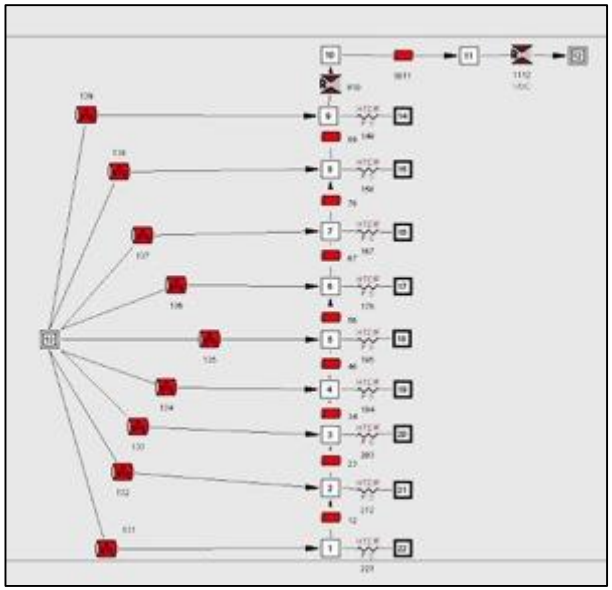


SELECTED WORK

Exploration Systems Test Facility at NASA/MSFC

Yetispace added cryogenic tank self-pressurization functionality to the GFSSP software and routinely uses GFSSP to analyze fluid systems.





NAICS Code: 336419
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541380
541715

Analysis: Heat Transfer

CAPABILITIES

- LabVIEW Operations
- Cryogenic Test Heat Leak
- Data Analysis

SELECTED WORK

Kilopower Reactor Simulator

Yetispace performed a thermal analysis on a heater simulator and setup then suggested design changes to provide adequate cooling to the system.

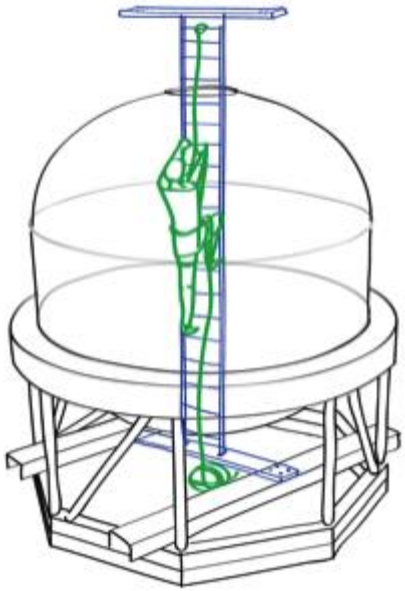
Vibro-Acoustic Test Article (VATA) Series

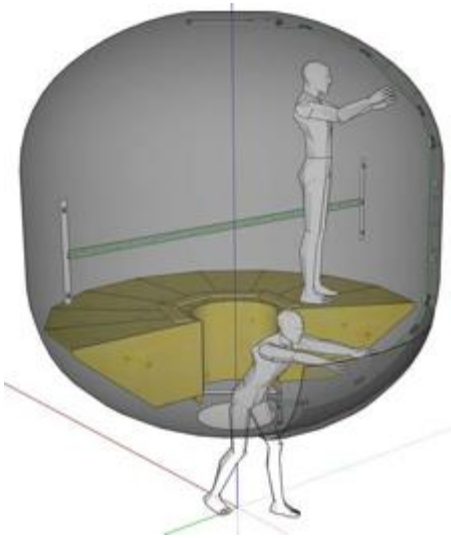
Yetispace evaluated the steady state heat leak on approximately 15 different thermal tests and configurations.

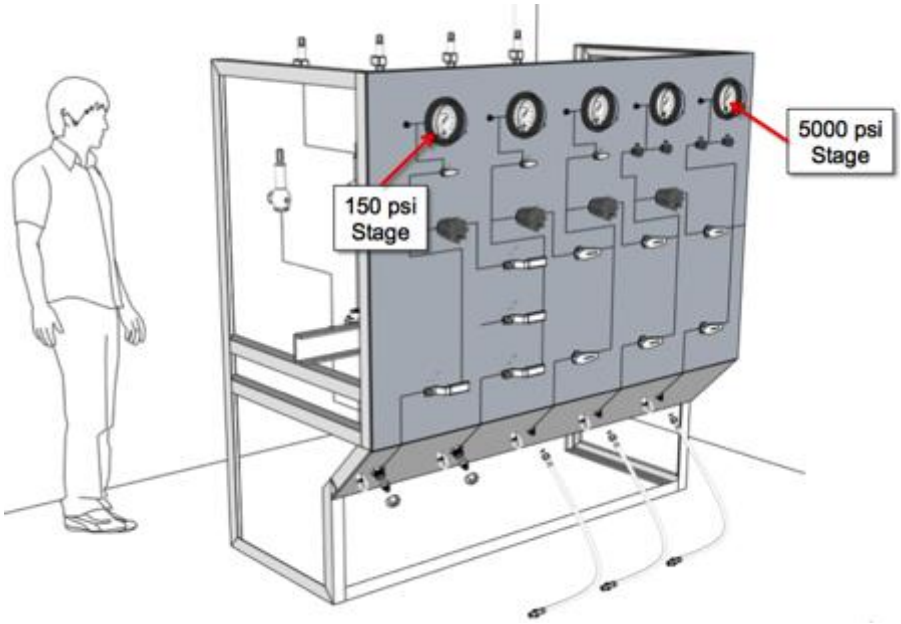
Industrial Design

for Extreme Environments

- Design Research
- Human Factors
- Concept Generation
- Interface Design
- Design for Manufacturing







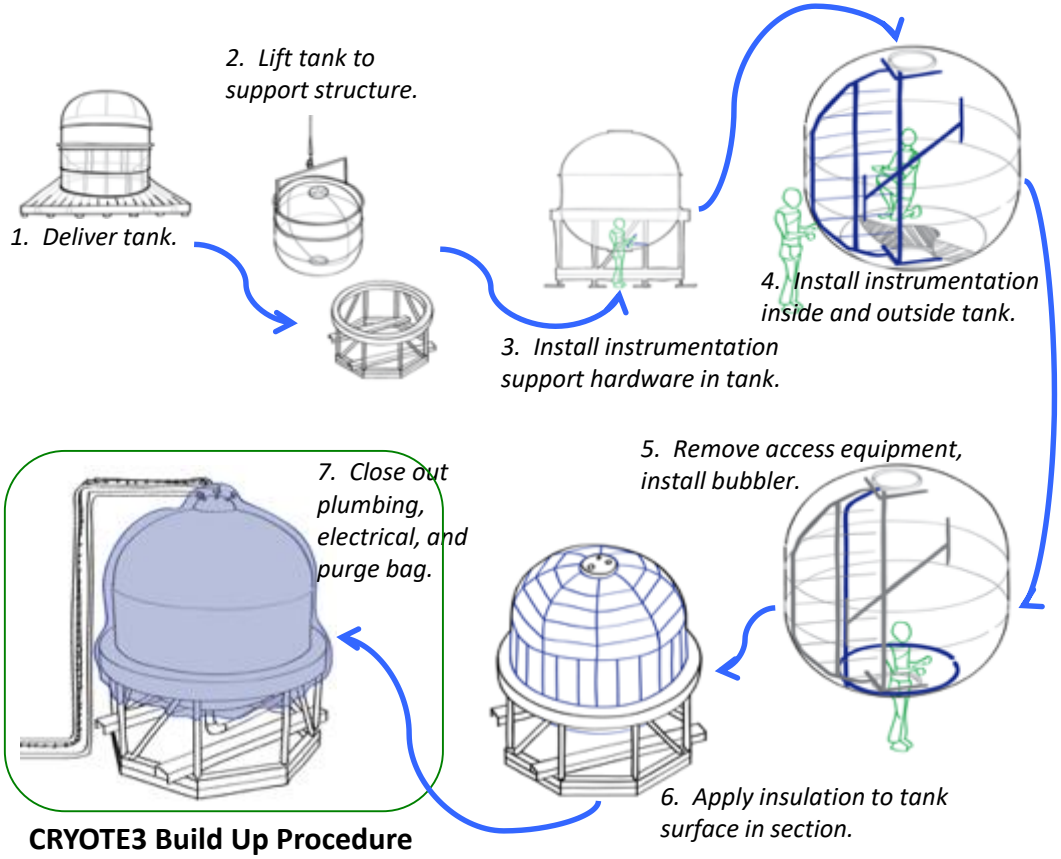
YETISPACE

Industrial Design

NAICS Code: 336419
541330
541715

CAPABILITIES

- Design Research
- User Research and Testing
- Human Factors
- Concept Generation and Development
- Interface Design
- Design for Manufacturing
- Task Breakdowns
  - Fabrication
  - Installation
  - Transportation



CRYOTE3 Build Up Procedure

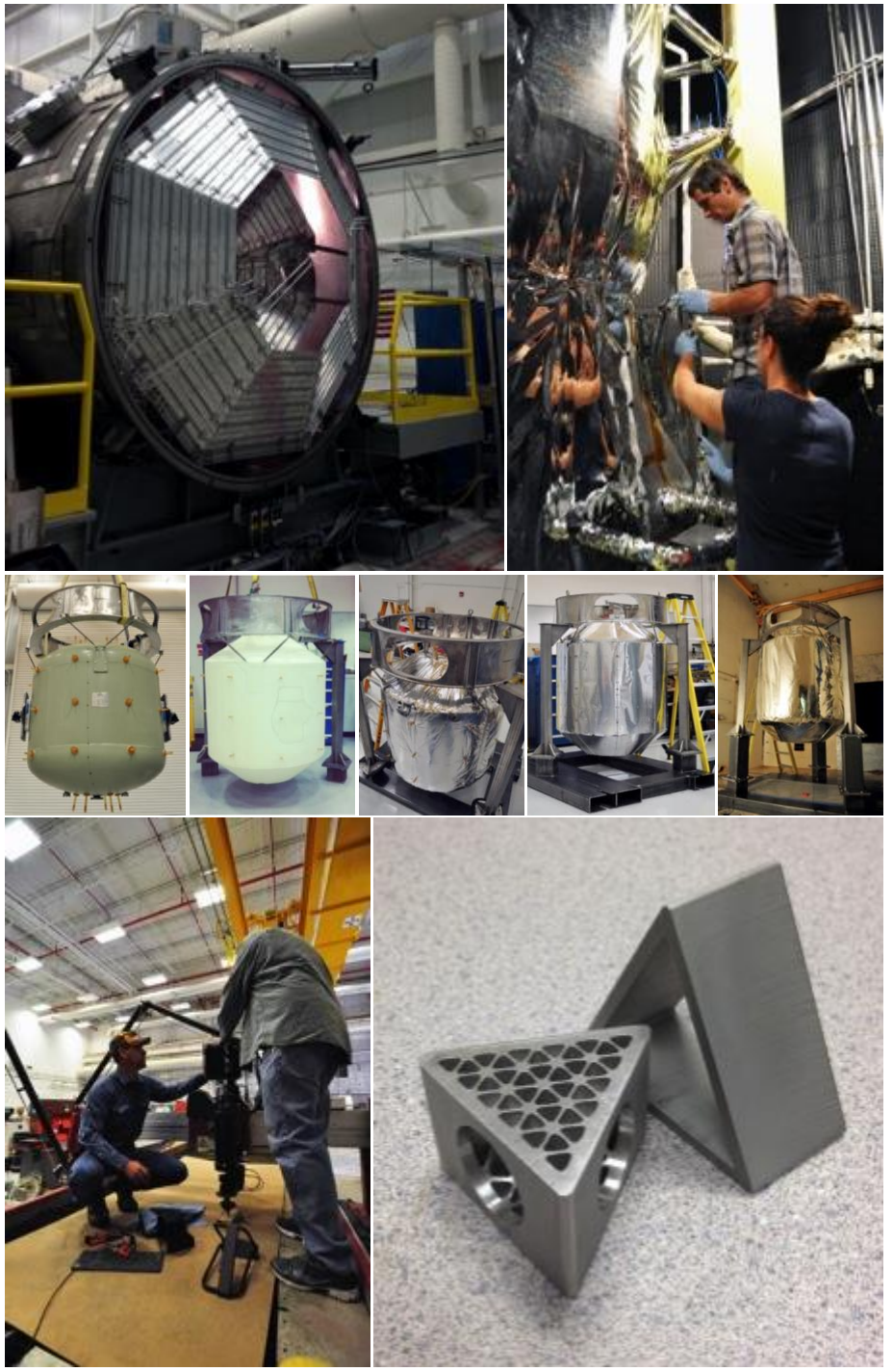
Human Factors Assessment Using Mock-Up

Manufacturing and Fabrication

for Extreme Environments

- Metals
- Waterjet
- Tubing Systems
- Wood
- Soft Goods
- Cryogenic Insulation Systems
- Valves and Actuators

YETISPACE



Manufacturing and Fabrication: Metals

NAICS Code: 336419
541330
541715







CAPABILITIES

- Welding (MIG, TIG, stick and orbital tube)
- Sheet Metal Fabrication
- High-Tolerance, Precision, and Complex Components
- Manual Mill, Lathe, and Grinding Operations
- Automated Waterjet and Tube Bending Operations
- Mechanical Assembly and Integration
- Quality
  - Yetispace adheres to the highest quality standards.
  - ASME certification for carbon steel, high pressure pipe.
  - Additional formal certifications are pursued as needed.


NAICS Code: 336419
541715

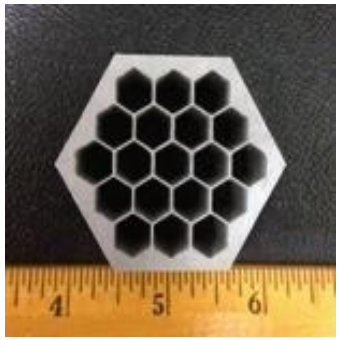
Manufacturing and Fabrication: Waterjet

OVERVIEW

- Yetispace technicians can design and produce parts based on customer needs.
- Our technicians are trained to operate, maintain, and rebuild OMAX Maxiem Waterjet machines.

WATERJET CAPABILITIES

- Turbine Blades
- Specialty Gears, Widgets, Components
- Prototypes
- Test Specimen
- Etched Parts
- Exotic Materials
- Thick Materials Cut to Precision



Manufacturing and Fabrication: Tubing Systems

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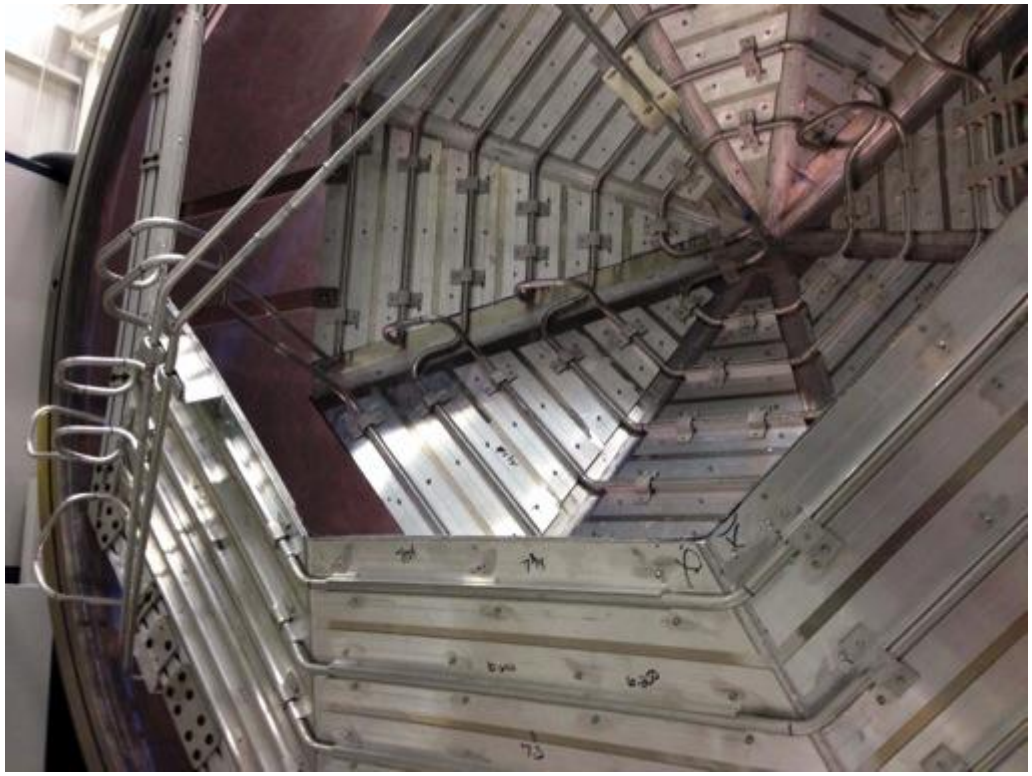
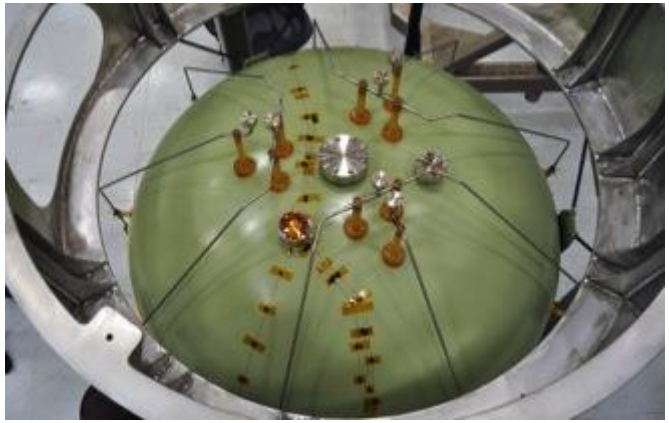




CAPABILITIES

- Flow Calculations
- Spec Components and Lines
- Supply Chain Management
- Precision Tube Bending
- Tube Welding
- System Build
- Helium Leak Test
- Hydrostat Pressure Testing
- System Operation

SELECTED WORK

Iodine Beam Stop

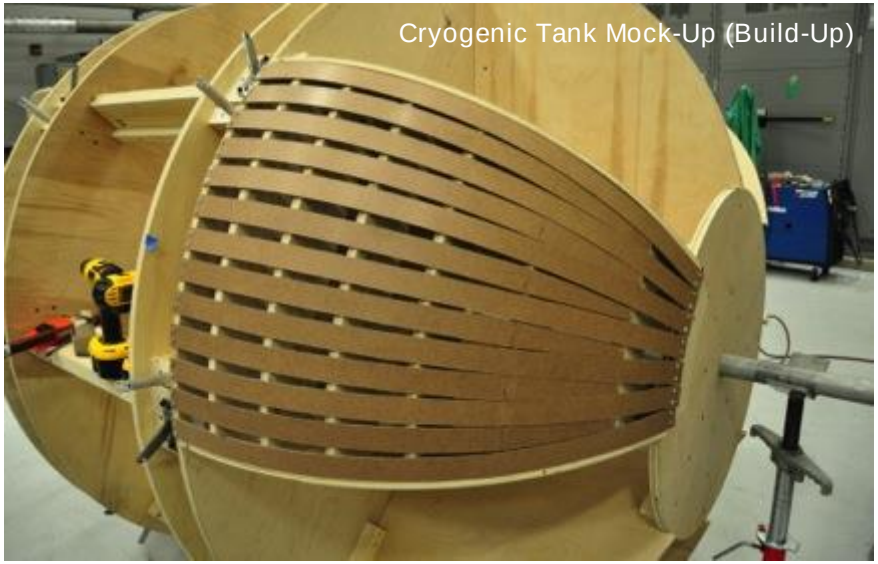
Yetispace designed and manufactured a refrigerant cooled shield to protect a vacuum chamber wall during thruster testing.

Broad Area Cooling (BAC) Shield

Yetispace manufactured a cryogen cooled shield to actively cool a cryogenic tank surface area and penetrations.

NAICS Code: 336419
541715

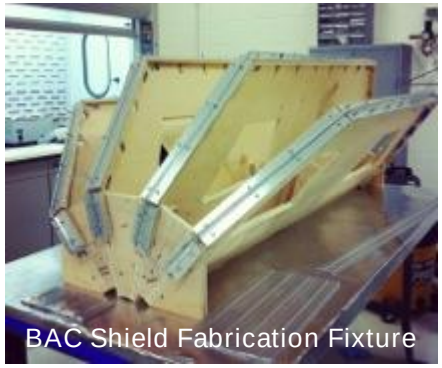
Manufacturing and Fabrication: Wood


Cryogenic Tank Mock-Up (Build-Up)

CAPABILITIES

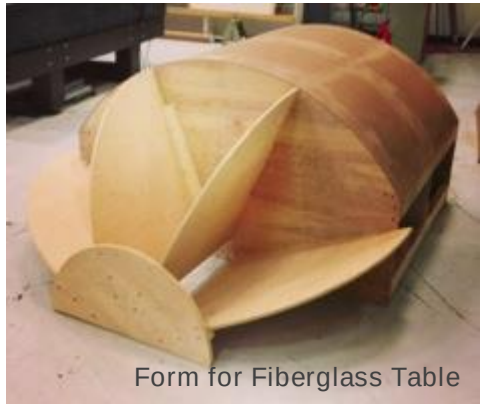
- General Carpentry and Fine Woodworking
- Manual Saw, Mill, Lathe, and Sanding Operations
- Table-Top CNC Machine Operations
- High-Tolerance, Precision, and Complex Products
- Prototype and Mockup Fabrication
- Assembly and Integration


MLI Layup Fixture


BAC Shield Fabrication Fixture


Crate for MLI Storage and Transportation

Waterjet-Cut Wood Example


Form for Fiberglass Table

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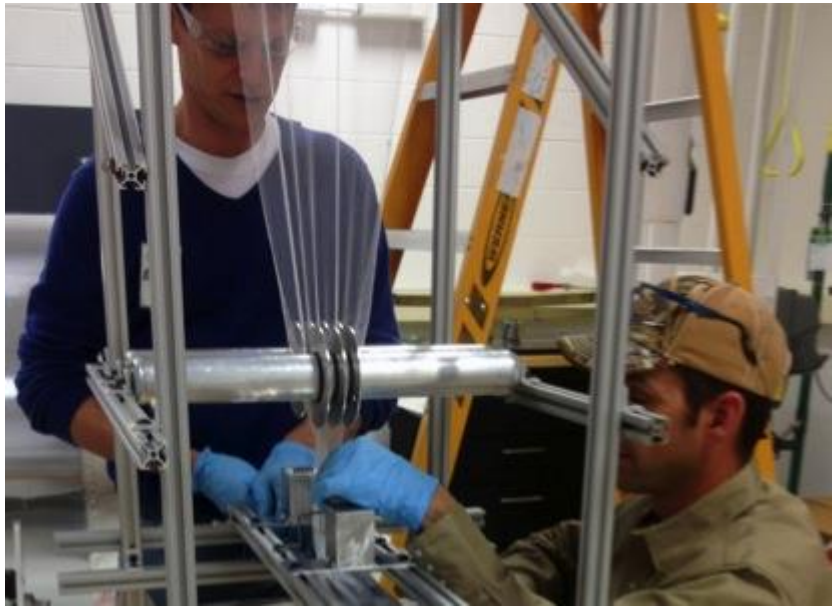
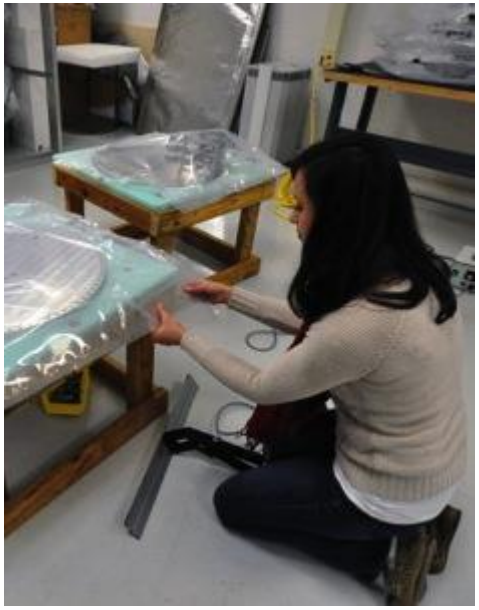
Manufacturing and Fabrication: Soft Goods

CAPABILITIES

- Prototypes, Mockups, and Models
- Industrial Sewing and Hand Stitching
- Fiberglass, Concrete and Other Composites
- Adhesive Selection and Application
- Pour, Spray, and Premade Foam Work
- Mold-Forming, Casting, and Finishing
- Adhesives
- Packaging





Fabrication: Cryogenic Insulation Systems

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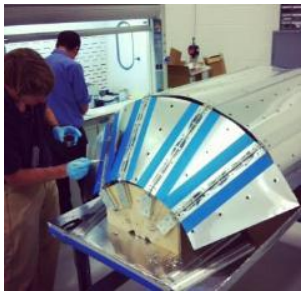




CAPABILITIES

- Multilayer Insulation
  - Thermal/Fabrication/Installation Design
  - Material Selection and Specification
  - Thermal and Rapid Pump-Down Testing
  - Semi-Automated Bumper Strip Folding Tool
- Foam Insulation
  - Thermal Design
  - Application and Trimming
  - Material Selection and Specification
  - Thermal Testing
- Aerogel
  - Thermal/Fabrication/Installation Design
  - Material Selection and Specification
  - Thermal Testing
- Active Cooling
  - Broad Area Cooling
    - Thermal Analysis Design,
    - Pressure Drop Analysis
    - Tube/ Foil Fabrication, Orbital Tube Welding
    - Thermal Testing
  - Vapor Cooling
    - Thermal Analysis Design, Pressure Drop Analysis
    - Fabrication for Shield and Structural Cooling
    - Thermal Testing

Manufacturing: Valves and Actuators

NAICS Code: 336419
541330
541380
541715

CAPABILITIES

- Design Valves and Actuators
- Build Valves and Actuators
- Repair Valves and Actuators
- Test Valves and Actuators
- Modify existing Valves and Actuators

SELECTED WORK

Solid Rocket Motor Cold Flow Variable Area Valve

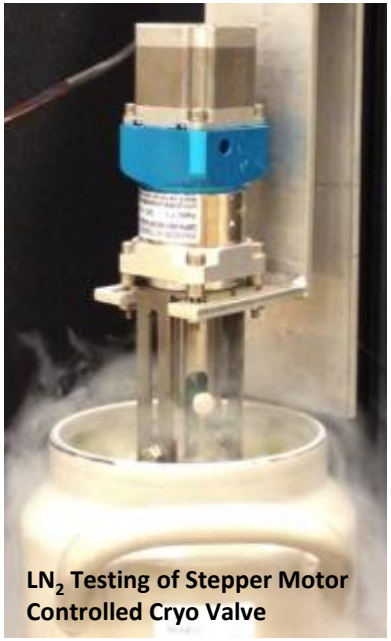
Yetispace designed, analyzed, and built a variable area valve to function as the throat of a customer supplied flow test article.

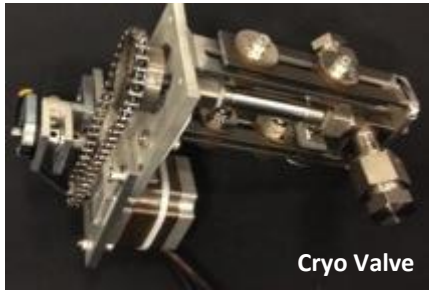
Stepper Motor Controlled Cryo Valve

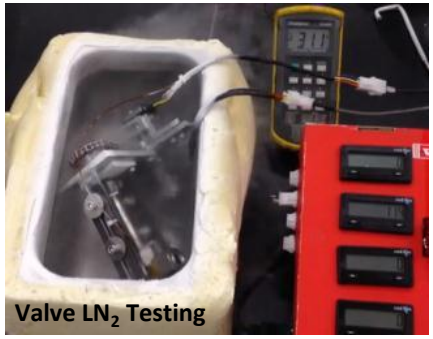
Yetispace utilized off-the-shelf hardware to design and build a valve that would not impose a high heat load in cryogenic applications.


Solid Rocket Motor Cold Flow Variable Area Valve


Stepper Motor Controlled Cryo Valve


LN_2 Testing of Stepper Motor Controlled Cryo Valve


Cryo Valve


Valve LN_2 Testing

Facility Design and Build

for Extreme Environments

- General Facility Designs and Build-Outs
- Cryogenic Test Facility Design and Build-Out
- LabVIEW
- Laboratory Equipment

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General Facility Designs and Build-Outs

CAPABILITIES

- Design Layout
- Work Station Design
- Platform Design and Build
- Compressed Air Systems
- Multistage Pressure Regulation Panels
- Facility Operation
- Supply Chain Management

SELECTED WORK

Multilayer Insulation Fabrication Lab

Yetispace retrofitted an existing NASA laboratory into a Controlled Work Area for the fabrication of Multilayer Insulation (MLI) blankets.

Engine Component Lab

Yetispace designed, analyzed, and built work platforms and a multistage pressure regulation panel for a laboratory at NASA.


Multistage Pressure Regulation Panel


Engine Work Platform


Controlled Work Area

Facility Design and Build: Cryogenic Test Facility

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CAPABILITIES

- Design Layout
- Facility Build
- Supply Chain Management
- Facility Operation

SELECTED WORK

MSFC Exploration Systems Test Facility

- 9-ft by 20-ft vacuum chamber
- Vacuum Systems
  - Pumps: 1 roughing (Kinney-CB7230), 2 turbos (Osaku TMG2400M), 2 cryos (SHI AD-22)
  - Operations: pump down, leak check, maintenance
  - Capability: 10^{-8} torr
  - Dycor System 200 Residual Gas Analyzer
- Fluid Systems
  - Liquid Nitrogen: 150 psig, ~4 gpm
  - Gaseous Nitrogen: 5000 psig, ~3 lbm/sec
  - Missile Grade Air: 3000 psig, ~2 lbm/sec
- Data Acquisition System
  - LabVIEW, 98 channels to vacuum chamber
  - Instrumentation: Pressure, Temperature, Flow Rate, and Mass
- Power Supply
  - 240 kW DC power (16 supplies @ 150 V, 100 Amps)

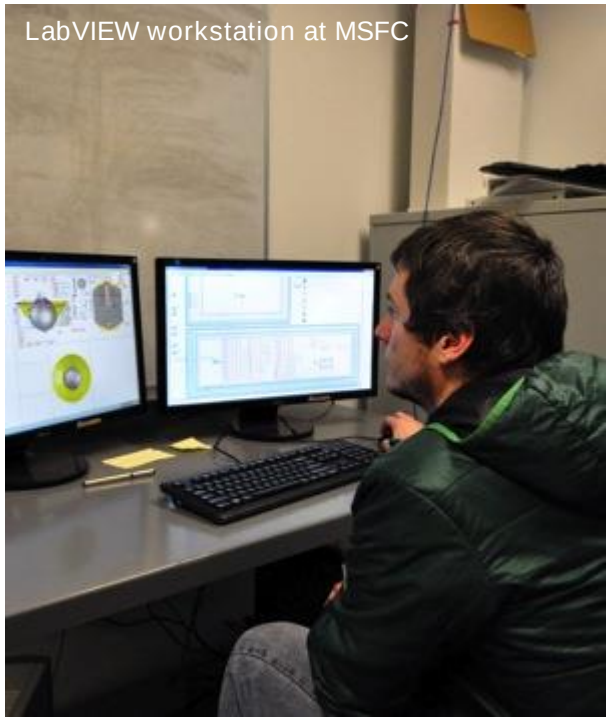

MSFC Exploration Systems Test Facility (ESTF)


MSFC ESTF 9' x 20' vacuum chamber

Facility Design and Build: LabVIEW

CAPABILITIES

- Software/Hardware Interface
- Dataflow Programming
- Graphical Programming
- Parallel Programming
- LabVIEW Operation
- Test Program Automation


LabVIEW workstation at MSFC

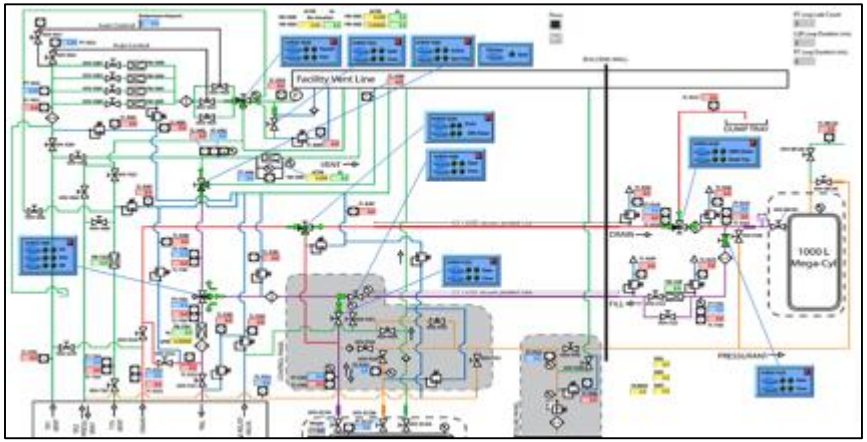
SELECTED WORK

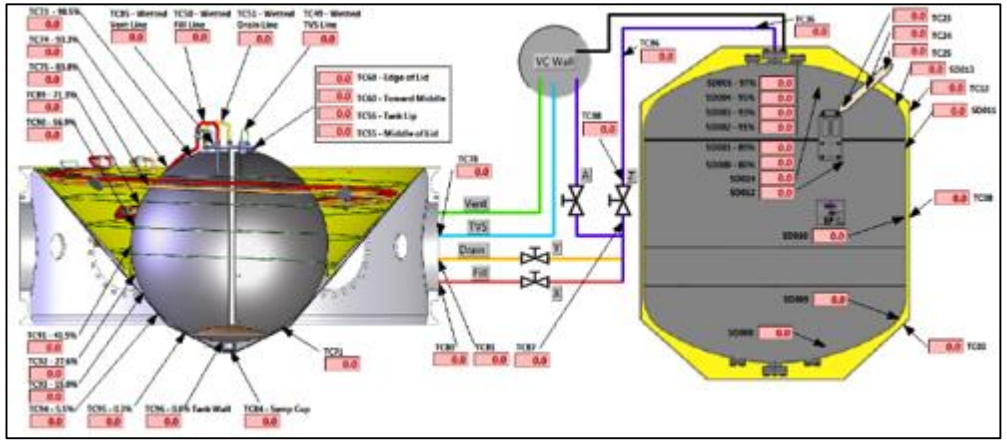
Moon Express

Yetispace developed several LabVIEW programs to automate a Moon Express test program. The programs included integrated data acquisition, controls, data analysis, and decision making.

Marshall Space Flight Center

Yetispace supports and updates the latest LabVIEW programs to for various test operations in the Propulsion Research and Development Laboratory (PRDL).


LabVIEW ESTF Schematic


VATA to CRYOTE Transfer Schematic

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Facility Design and Build: Lab Equipment

CAPABILITIES

- Commissioning Equipment

EXAMPLES

- Mass Spectrometry
- Streak Cameras
- Residual Gas Analyzers
- Vacuum Leak Checking Hardware
- Neutron Detectors

PAST PERFORMANCE

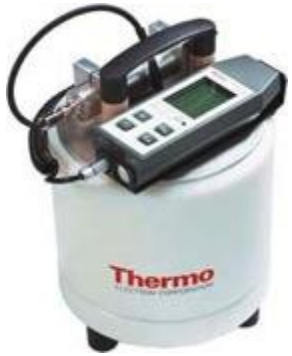
Pulsed Fission Fusion (PuFF)

Yetispace commissioned a Hamamatsu streak camera to capture a Z-pinch plasma.

Exploration Systems Test Facility

Yetispace set up a residual gas analyzer to use during cryogen testing.

Helium Leak Checker



Neutron Detector

Mass Spectrometry

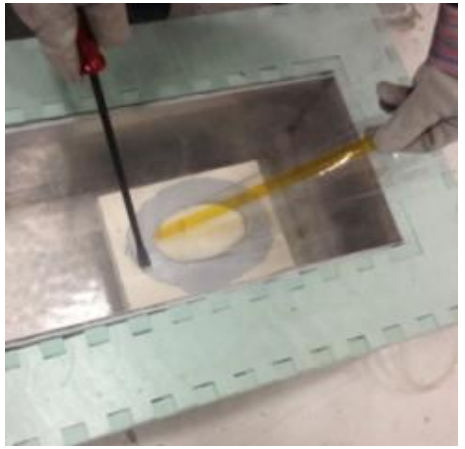
Streak Camera

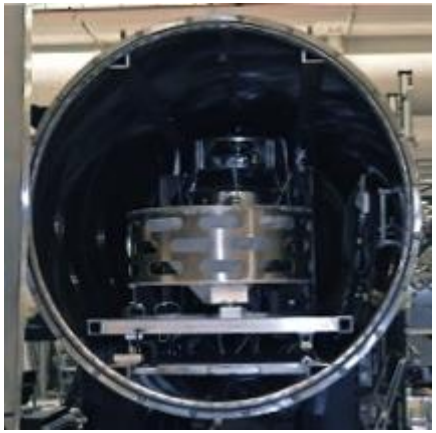
Residual Gas Analyzer

Test Operations

in Extreme Environments

- Low Pressure/ Vacuum Testing
- Low Temperature
- High Temperature





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Test Operations: Low Pressure/Vacuum Testing

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CAPABILITIES

- Vacuum Chamber Design and Operation
- Large – Spacecraft Systems
- Small – Components
- Roughing Pumps
- Turbo and Cryo-pumps
- Back Fill with Inert Gas
- Altitude Simulation
- Modification of Existing Vacuum Test Equipment

SELECTED WORK

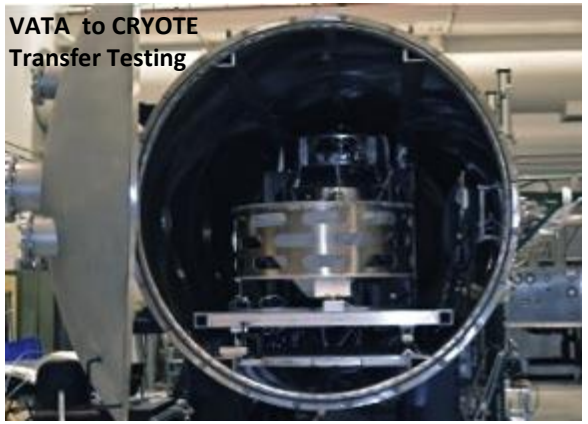
Vibro-Acoustic Test Article (VATA) Series: Yetispace evaluated the thermal performance of passive and active thermal control system configurations using low-cost LN_2 thermal/vacuum testing.

CRYOTE Test Series: Yetispace utilized a sub-scale titanium sphere tank to measure thermal performance and test a thermodynamic vent system.

VATA to CRYOTE Transfer Series: Yetispace demonstrated in-space cryogenic propellant storage and transfer from VATA to CRYOTE via No-Vent Fill.


Exploration System Test Facility


VATA Testing


VATA to CRYOTE Transfer Testing

Test Operations: Low Temperature Testing

NAICS Code: 541330
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541715

CAPABILITIES

- Test Facility Design and Build
- System Analysis
- Supply Chain Management
- Program Management
- Test Design and Conduction
- Data Analysis
- Cryogenic Fluid Transfers

SELECTED WORK

Vibro-Acoustic Test Article (VATA)

Yetispace performed a thermal and structural test of a multilayer insulation (MLI)/Broad Area Cooling (BAC) shield assembly under launch acoustic loads.

Cryogenic Orbital Test Bed (CRYOTE1)

Yetispace utilized a sub-scale titanium sphere tank to measure thermal performance and test a thermodynamic vent system.

Cryogenic Orbital Test Bed (CRYOTE3)

Yetispace designed a test program to measure thermal stratification in a flight-scale/ weight tank.

Stepper Motor Controlled Valves

Yetispace utilized off-the-shelf hardware to design and build a valve that would not impose high heat loads on a cryogenic system.

Stepper Motor Controlled Valve Testing in LN2

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Test Operations: High Temperature Testing

CAPABILITIES

- Pump Design, Build, Operation
- Furnace Design, Build, Operation
- Supply Chain Management
- Facility Design, Build, Operation
- Data Analysis
- Program Management

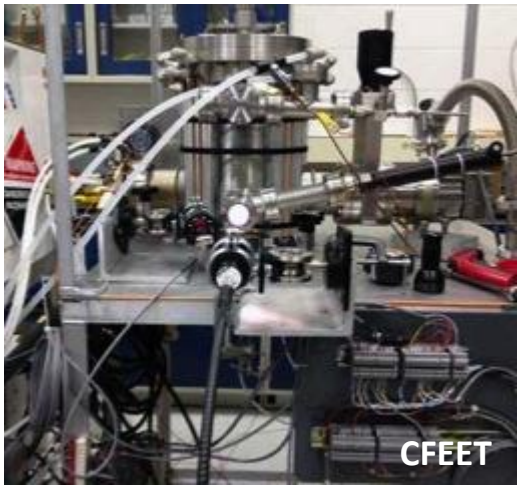
SELECTED WORK

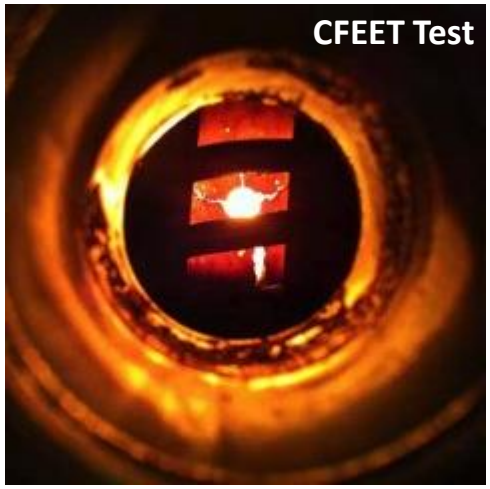
Compact Fuel Element Environment Test (CFEET)

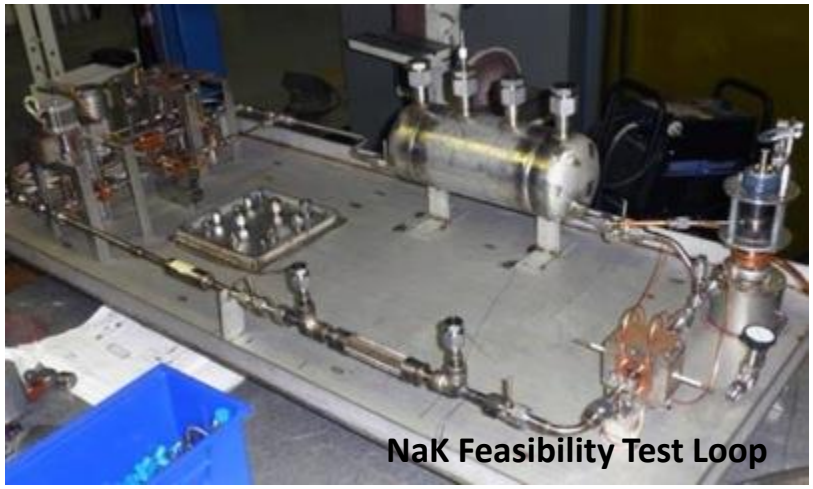
Yetispace designed, built, and operated a small test bed to heat fuel element samples via noncontact RF heating. The samples were exposed to hydrogen to assist in optimal material and manufacturing selection without employing fissile material.

NaK Feasibility Test Loop

Yetispace designed, built, and operated a test loop that non-invasively measured contamination levels and demonstrated purification by way of cold-trapping.


CFEET


CFEET Test


NaK Feasibility Test Loop

Program Management

for Extreme Environments

- Leadership
- Planning
- Coordination
- Systems Engineering
- Scheduling
- Budgeting
- Consulting

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Yetispace served as the Launch Abort System Jettison Motor Team Lead

Technical Communication

for Extreme Environments

- Technical Writing and Editing
- Graphic Design
- Sketching
- Presentations

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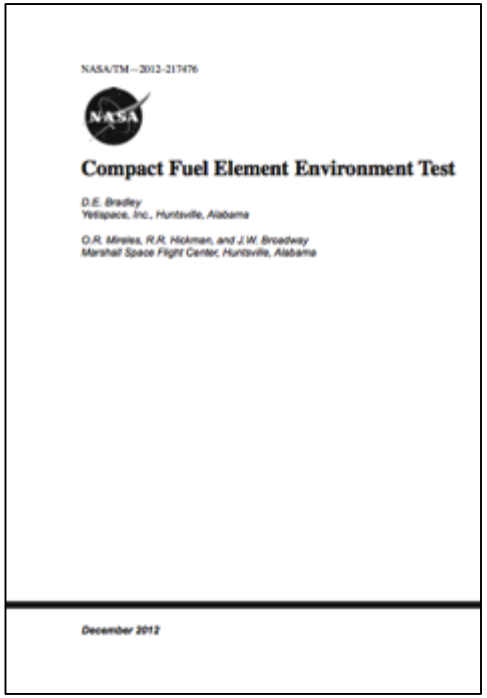

NASA/TM—2012-217476

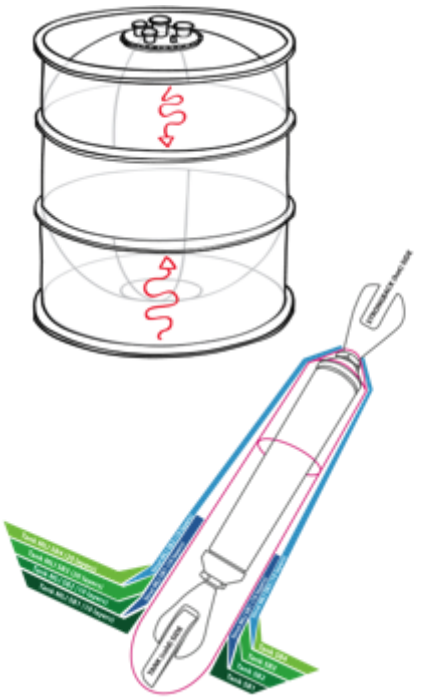
NASA

Compact Fuel Element Environment Test

D.E. Bradley
Yetispace, Inc., Huntsville, Alabama

O.R. Mireles, R.R. Hickman, and J.W. Broadway
Marshall Space Flight Center, Huntsville, Alabama

December 2012



Contact Information

Noah O. Rhys, PhD
President
Yetispace, Inc.
7902 Logan Drive
Huntsville, AL 35802
phone: 256.520.5014
email: noah@yetispace.com

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