

Marshall Space Flight Center

Propulsion Structural, Thermal and Fluid Analysis

Engineering Solutions for Space Science and Exploration

Propulsion Structural, Thermal and Fluid Analysis Division

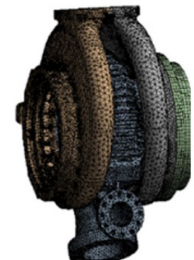
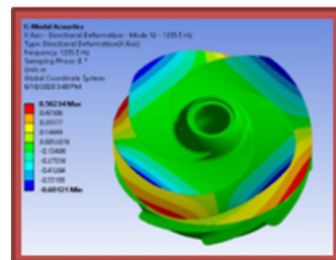
Propulsion systems technical expertise is provided by engagement throughout the entire life cycle. The division provides value added products that result in growing deep technical discipline lines needed at NASA, Other Government Agencies, Industry, and Universities. The division provides expertise in the areas of integrated analysis, problem resolution, testing, and data reduction for multiple propulsion systems (e.g. solids, liquids, nuclear, etc.), components (turbomachinery, valves, line, ducts, combustion devices, etc.), flight vehicles and landers. To meet the challenging needs continually requested by our customers, team members are constantly developing new tools, techniques, test facilities/rigs, and relevant one-of-a-kind data to ensure safe and reliable space flight.

The Propulsion Structures and Design Branch is responsible for all aspects of structural and dynamic analysis of propulsion hardware as well as detailed design of propulsion systems elements. The branch specializes in dynamics, strength, and life assessments of components under extreme operating environments of space vehicle propulsion systems. It provides analysis support for design and development of non-propulsion hardware.

Propulsion Structures and Design Branch Capabilities

- Structural Dynamics Analysis
 - Component dynamics, loads, and environments analysis
 - High-frequency dynamic response assessments
 - Fluid-structure interaction
- Strength, Fatigue, and Fracture Analysis
 - Thermal-structural and nonlinear assessments
 - Analysis of high-temperature ablative nozzles
 - Analysis of viscoelastic solid propellant, liner, and insulation
 - Analysis of composites
- Rotordynamic Analysis

- Linear and nonlinear stability assessments of rotating machinery
- Bearing and seal design, analysis, and testing
- High speed Vibration Data Analysis: Engine Testing, Rotating Machinery, High Speed Data Acquisition and Health Management
- Vibroacoustic and Shock Analysis: Design and Test Criteria and Test Support
- Detailed Design: Conceptual, System Integration and Drawing Release



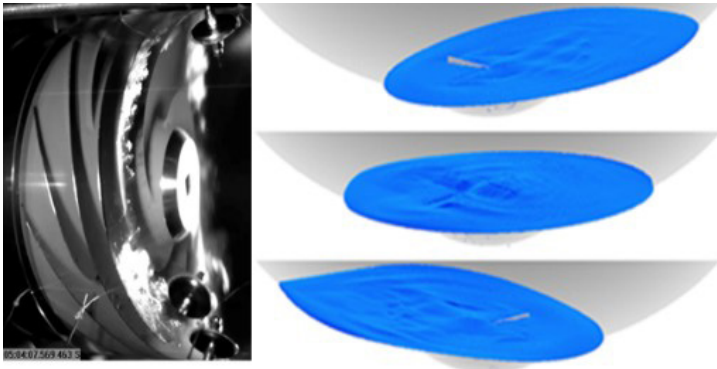
Stress Dynamics and Design of Impeller and Housing

The Fluid Dynamics Branch is responsible for all aspects of the discipline of fluid dynamics applied to propulsion or propulsion-induced loads and environments. This work begins with design trades and parametric studies, and continues through development, risk assessment, anomaly investigation and resolution, and failure investigations. The branch is discipline-centric, and utilizes methods including system stability analysis, lump parameter modeling, finite element modeling, Computational Fluid Dynamics (CFD), cold flow testing, and signal processing.

Fluid Dynamics Branch Capabilities

- Acoustics
 - Internal acoustics
 - Lift-off/separation environments
- Multi-phase Flows
 - Sound suppression
 - Cavitation dynamics
 - Slosh dynamics and Cryogenic Fluid Management

- Combustion Dynamics: Injectors, Chambers, and Combustion Stability
- Computational Fluid Dynamics
 - Algorithm development and validation
 - Loads and environment predictions.
- Cold Flow Testing with Air and Water:
 - Turbines, pumps, nozzles, Feed- lines, etc., with dynamic data acquisition
- Coupled Propulsion System Dynamics:
- Flow Dynamics
- High-Speed Data Acquisition, Analysis, and Signal Processing: End-to-End
- Dynamic System Identification: Damping and Characterization
- Plume Surface Interaction Modeling

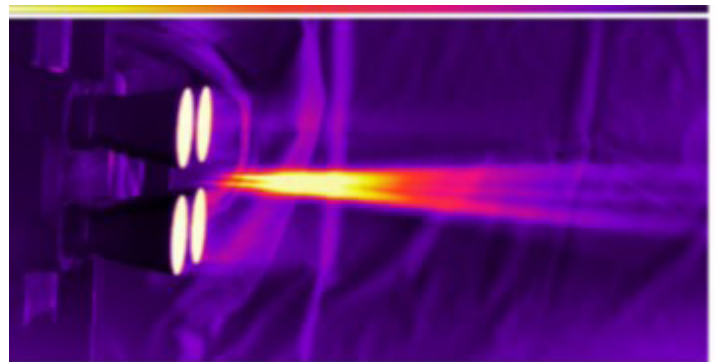


Inducer Cavitation Testing and Modeling

The Thermal Analysis Branch is responsible for all thermal and thermal fluid aspects of propulsion systems and hardware as well as non-propulsion activity such as Infrared Thermography. The branch specializes in assessing the thermal environments and conditions and mitigating issues resulting from these extreme operating environments, including large thermal transients that exist on space vehicle propulsion systems.

Thermal Analysis Branch Capabilities

- Thermal and thermal structural analysis
 - Complex integrated conjugate systems and component analysis
 - Testing/instrumentation support
- Thermal fluid analysis including characterization of environments.
 - NASA software “General Fluid Systems Simulation Program (GFSSP)”
 - Thermal Desktop with SINDA/FLUINT
 - Joint analysis (thermal and joint pressurization)
 - Film cooling – propellant boil off – propellant conditioning
- Thermo-chemical analysis and testing
 - Composite ablative modeling
 - Routines to account for “burn-back”
- Thermal characterization of materials/environment for test
- Infrared thermography



Infrared Thermography From a Space Launch System Scale Model Test

National Aeronautics and Space Administration

Marshall Space Flight Center
Huntsville, AL 35812
www.nasa.gov/center/marshall

www.nasa.gov/

MSFC-02-2025-G-657270 (23)

Doing Business With MSFC

