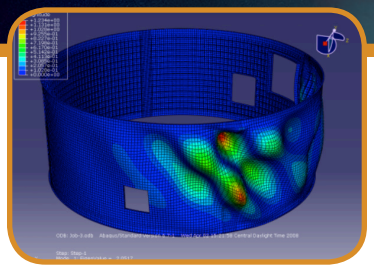
National Aeronautics and Space Administration

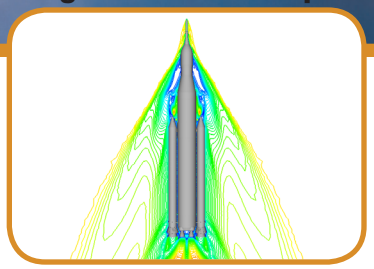
Marshall Space Flight Center
Structural Design and Analysis

Engineering Solutions for Space Science and Exploration

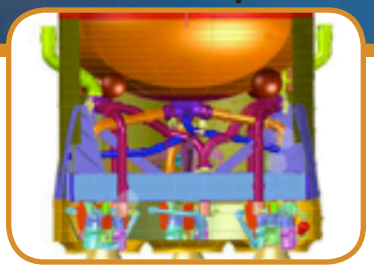


Buckling Analysis

Design of the Multi-Purpose Crew Vehicle Stage Adapter



Mach Distribution During Booster Separation



Compartment Thermal Environment

The Structural Design and Analysis Disciplines provide support to customers with structural design, analysis and definition of induced environments. These disciplines are responsible for assuring the structural integrity of spacecraft and launch vehicle primary structures, subsystems, mechanisms and components as well as to ensure designs for this hardware meet structural requirements and performance goals. MSFC has extensive experience with analysis and assessment of launch vehicles, spacecraft and systems in all phases of development and operation. Structural Design and Analysis is comprised of multiple discipline areas.

Dynamics, Loads and Strength provides dynamic loads development and stress analysis support to customers ranging from the Nation's largest launch vehicle to component development efforts. MSFC has experience in structural modeling, vehicle coupled loads analysis, vibroacoustics analysis, and strength analysis to support the design process as well as forensic analysis for anomaly and failure investigation. Advances in "state of the art" modeling, analysis and test methodologies, design practices, tools and standards are also supported. Discipline experts in this area work closely with structural and dynamic test as well as materials and processes organizations.

Aerosciences provides launch vehicle ascent as well as stage re-entry aerodynamics and induced environments. The Aerosciences discipline at MSFC emphasizes development of aerodynamic and aerothermodynamics design environments for applications that range from subsonic to hypersonic flight regimes. Experience includes complex multi-phase, fully reacting, computational fluid dynamics analyses to engineering codes with an emphasis on applying the appropriate level of fidelity to each problem. MSFC has code developers for several industry standard aerodynamic heating and plume flow field codes. Extensive aerodynamics and induced environments test experience resides in-house, including serving as primary test engineers for the 14" tri-sonic wind tunnel. This discipline area also conducts applied research in areas such as plume/soil interactions. Recent customers have included the Space Launch System and numerous commercial companies.

Structural and Mechanical Design provides structural and mechanical design, assembly design, pyrotechnic system design, and penetration analysis for various tasks related to launch vehicle and spacecraft engineering and development. MSFC has proficiency in structural/mechanical design tools, processes, and legacy projects. Team members have extensive background in aerospace metallic and composite systems. The discipline experts have developed propellant tanks and dry bay structures of varying sizes for in-house and commercial customers.

Thermal Analysis and Control provides analytical predictions to support the thermal control/protection system design process through specialized computational tools for modeling steady state and transient multi-mode heat transfer and fluid flow in terrestrial, ascent, orbital and inter-planetary environments. The discipline is responsible for the thermal management and protection of spacecraft, vehicles, payloads and related hardware through all prescribed mission phases including pre-launch, ascent, orbit and Earth departure. This typically entails the development and implementation of a thermal control and/or protection system through participation in a well established formulation, design and verification process including requirements definition, preliminary and critical design, qualification/acceptance testing and ultimately, operational certification and mission support. Extensive use is also made of interdisciplinary tools to import, manipulate, and mesh CAD geometries for eventual thermal model development. MSFC also supports thermal development and qualification testing with planning, real-time support and data reduction/model correlation.

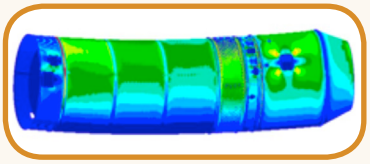
Capabilities

Dynamics, Loads and Strength

Cryotank Analysis

Expertise includes:

- Finite Element Modeling Analysis
- Structural Sizing and Strength Analysis
- Fracture and Fatigue Life Prediction
- Stability Analysis
- Static and Dynamic Test Definition
- Shock and Vibroacoustic Environment Definition
- Slosh Analysis and Baffle Design
- Integrated Coupled Loads Analysis
- Tools: NASTRAN, PATRAN, Abaqus, FEMAP, PANDA, Hypersizer, FLAGRO, LS DYNA, Matlab, and BOSOR



Integrated Structural Analysis

Structural and Mechanical Design

Composite Cryotank Technology Development

Expertise includes:

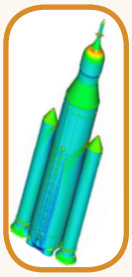
- Mechanism Design
- Composite Design
- Vehicle Component Design and Integration
- Pyrotechnics
- Hypervelocity and Launch Debris Impact Analysis
- Tools: Pro/E, SpaceClaim Hypersizer, Matlab, LS DYNA, and Hydrocodes

Pyroshock Characterization of Composite Materials

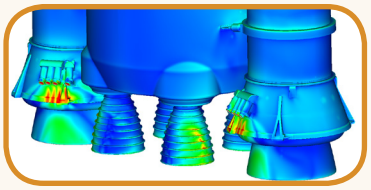
Aerosciences

Expertise includes:

- Aerodynamics Databases and Loads
- Aeroacoustic and Compartment Venting Environments
- Aerodynamic Heating, Plume Flow Field Characterization, Impingement, Radiation and Convective Heating Environments
- Tools: Loci-CHEM, Miniver, RAMP, GRAD, RMC, PLIMP, and CHCHVENT



Ascent Aerodynamic Heating

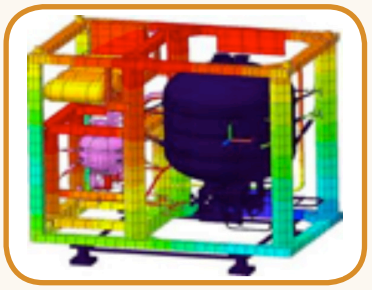


BSM Plume Induced Heating During Booster Separation

Thermal Analysis and Control

Expertise includes:

- Thermal Design and Analysis for Ground, Ascent, Orbital, and Re-Entry Environments
- Thermal Protection Sizing for Insulators and Ablatives
- Ice Formation Prediction
- MLI, Heaters and Active Thermal Control Design and Analysis including Heat Pipes, Heater/Thermostats, Forced Convection, Cold Plates/Pumped Loop
- Tools: Thermal Desktop, SURFICE, SINDA/FLUINT, SINDA/G, COMSOL, and Spaceclaim



Cryogenic Propellant Storage and Transfer (CPST)

For more information, please visit www.nasa.gov/centers/marshall/about/business.html

National Aeronautics and Space Administration

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

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