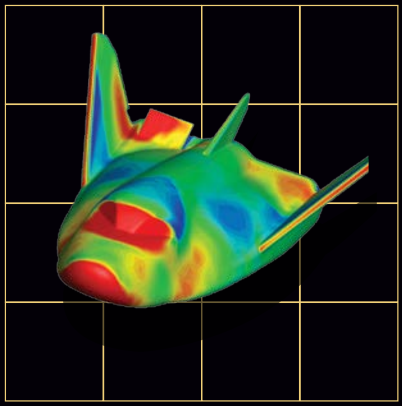
National Aeronautics and Space Administration

NESC

NASA ENGINEERING & SAFETY CENTER



2012 TECHNICAL UPDATE

www.nasa.gov

For general questions and requests for technical assistance visit us at:
nesc.nasa.gov

For anonymous requests write to:
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An online learning site for sharing technical expertise

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(Above) The NESC supported multiple assessments for the International Space Station.

(On the cover) Background: Measured velocity distribution in the wake of an 8%-scale model of the Orion crew module obtained in the ARC 11-Foot Transonic Wind Tunnel using particle imaging velocimetry. (Photos left to right) A CFD prediction of the HL-20 lifting body, an SLS model in the LaRC Unitary Plan Wind Tunnel, an Orion crew module in the ARC Unitary Plan Wind Tunnel.

The NESC Overview

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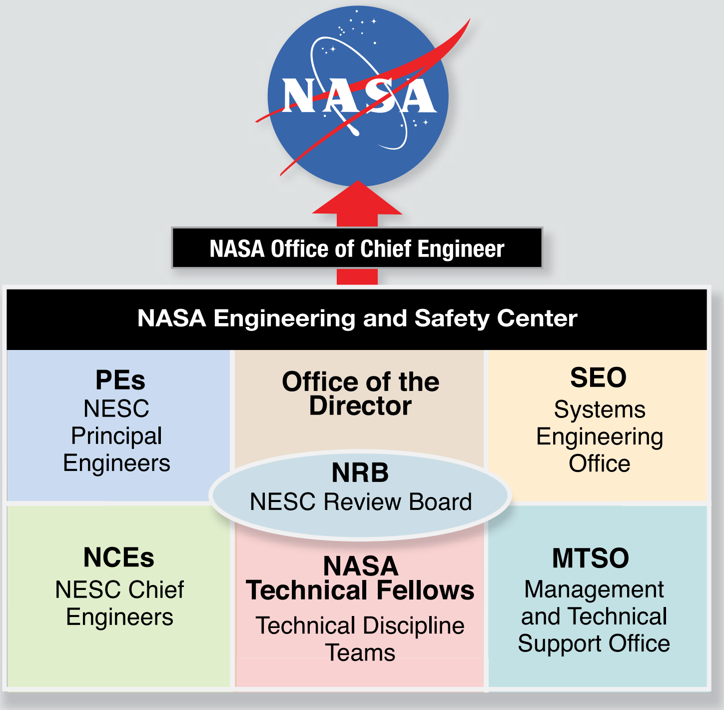
The NESC Model

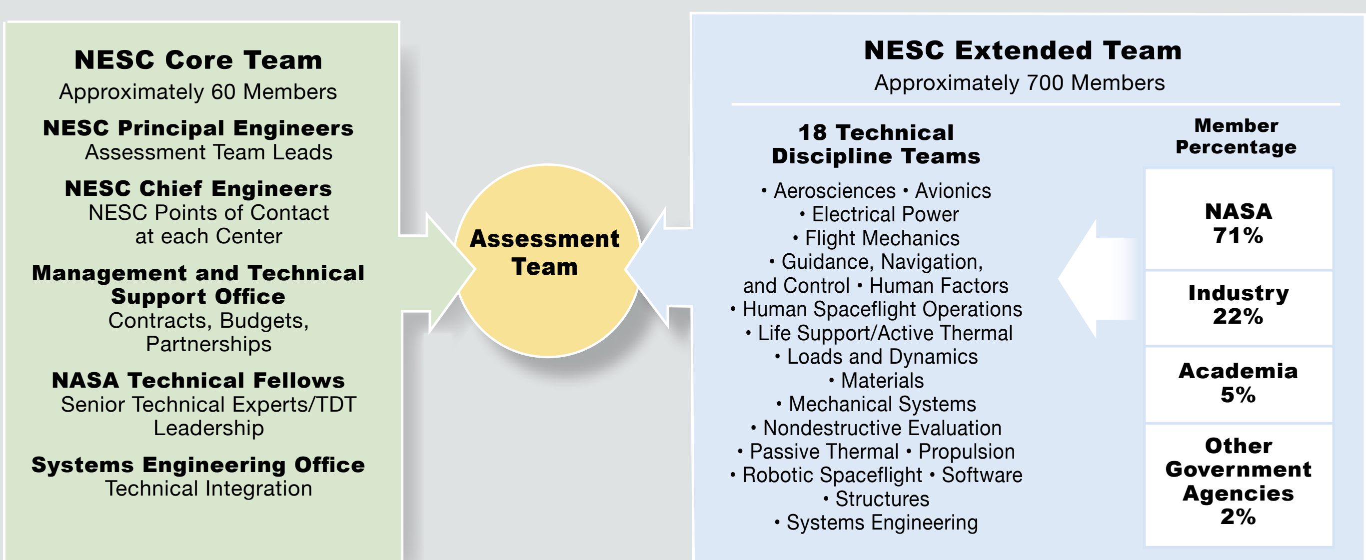


The NASA Engineering and Safety Center (NESC) employs the talent and diversity of NASA's workforce to ensure safety and mission success for NASA's high-risk programs. The NESC is guided by the philosophy that robust engineering is as essential in promoting safety as it is for mission success. Hundreds of scientists and engineers work on technical issues each year within the framework provided by the NESC. The NESC reports to the NASA Chief Engineer and is also closely affiliated with the Office of Safety and Mission Assurance. This arrangement allows independence, objectivity, and flexibility when working with other NASA organizations.

The NESC promotes safety through engineering excellence. This is realized by assembling science and engineering experts from across the country into "assessment teams," whose purpose is to address specific technical issues. The leadership and managerial support for each assessment are provided by the NESC Core Team. Core Team members work directly for the NESC. The NESC Extended Team is the collective engineering and scientific talent from 18 NESC Technical Discipline Teams (TDTs). Each TDT is centered around an engineering discipline, and most are led by a NASA Technical Fellow (the exceptions are the Robotic Spaceflight, Human Spaceflight Operations, and Systems Engineering TDTs, led by the NESC Chief Scientist, NESC Chief Astronaut, and the manager of the Systems Engineering Office respectively). TDT members come from all 10 NASA Centers as well as academia, industry, or other government agencies. When forming an assessment team, the assessment lead will draw the appropriate skill mix from the TDTs.

Those NASA employees who contribute their skills to TDTs and assessments also gain from their experience with the NESC. They acquire a broad NASA-wide perspective, problem-solving experience, and technical contacts they can use when they return to their home Centers. The NESC is also striving to ensure a productive and prepared workforce for NASA's future by integrating early-career engineers into NESC assessments.

The NESC Assessment Team Structure



This concept began with the Resident Engineer Program, where junior NASA employees were invited to join the NESC for 1-year detail assignments. This has evolved into a broader effort, where young engineers support individual assessments on a case-by-case basis.

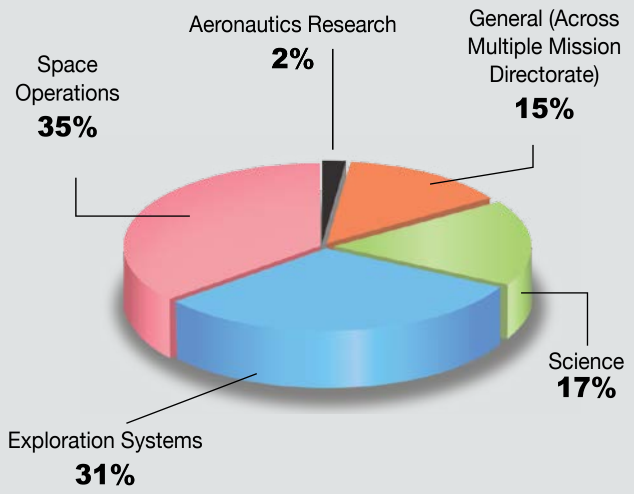
Another important feature of the NESC is the NESC Review Board (NRB). All decisions and items needing approval by the NESC are discussed by the NRB. The NRB members come from all areas of the NESC and represent all 10 NASA Centers and each of the TDT disciplines. The NRB is successful because people with different experience bases and technical backgrounds approach each issue from a different vantage point resulting in a more complete understanding of the problem and a robust decisionmaking process.

The NESC is guided by the philosophy that robust engineering is as essential in promoting safety as it is for mission success.

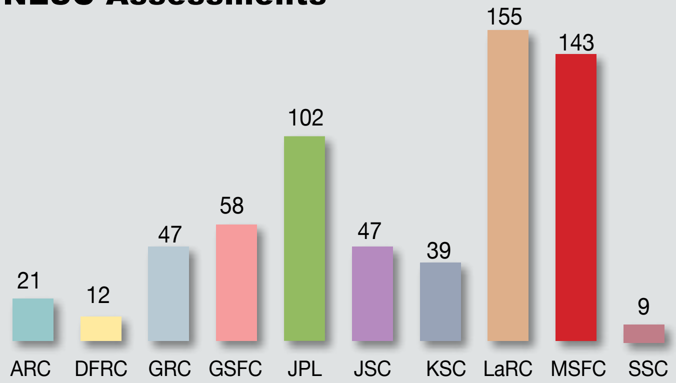
As NASA moves forward, reaching for new heights and revealing the unknown, the NESC contributes by providing a structure that facilitates interaction between Centers and between programs and delivers the highest level of expertise to where it is needed. Though the Space Shuttle era has ended, NASA's focus on human spaceflight remains strong, and the NESC continues to help build the foundation for the next generation of human exploration by performing assessments and contributing technical assistance to the NASA organizations and private companies developing new spacecraft.

The NESC is a resource available for anyone at NASA searching for an independent engineering assessment. NESC assessments have benefited all of the NASA mission directorates. For more information or to submit a request, contact your Center's NESC Chief Engineer or visit nesc.nasa.gov.

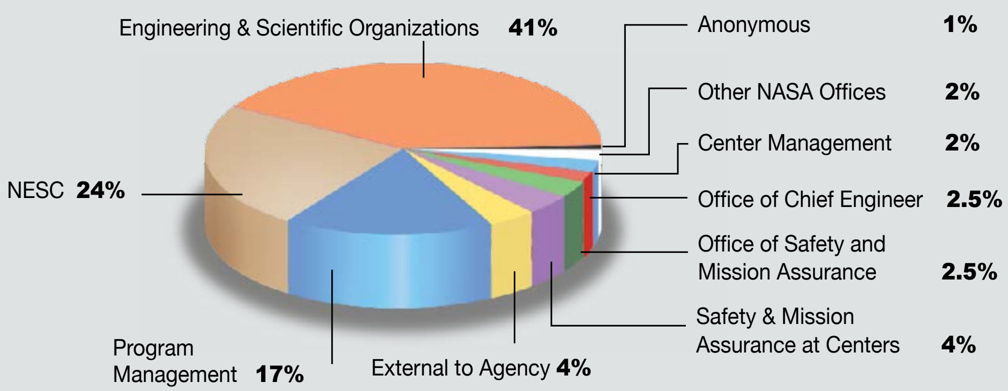
Accepted Requests: 495 Total



NASA Employees Supporting NESC Assessments



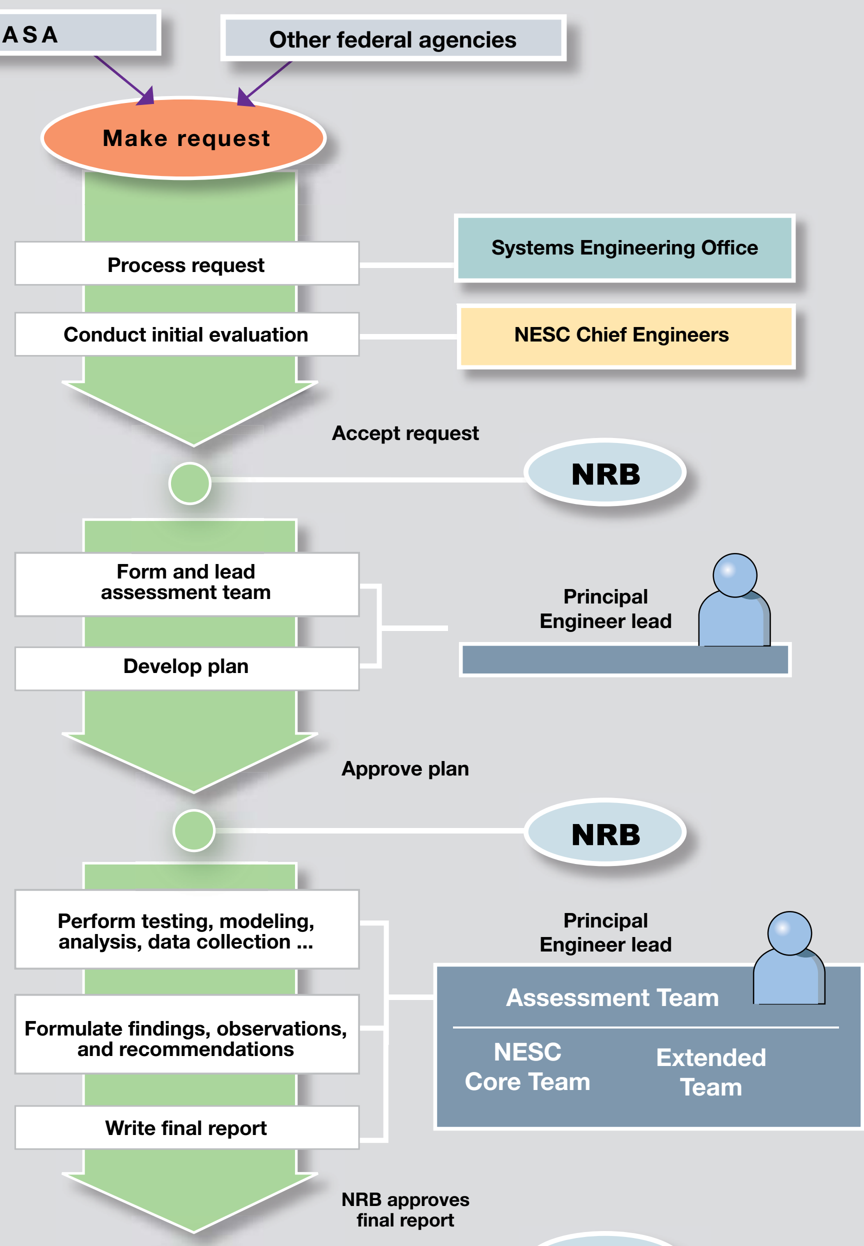
Sources of Accepted Requests: 495 Total



All statistics as of December 31, 2012

The Process of Finding Solutions to Difficult Problems

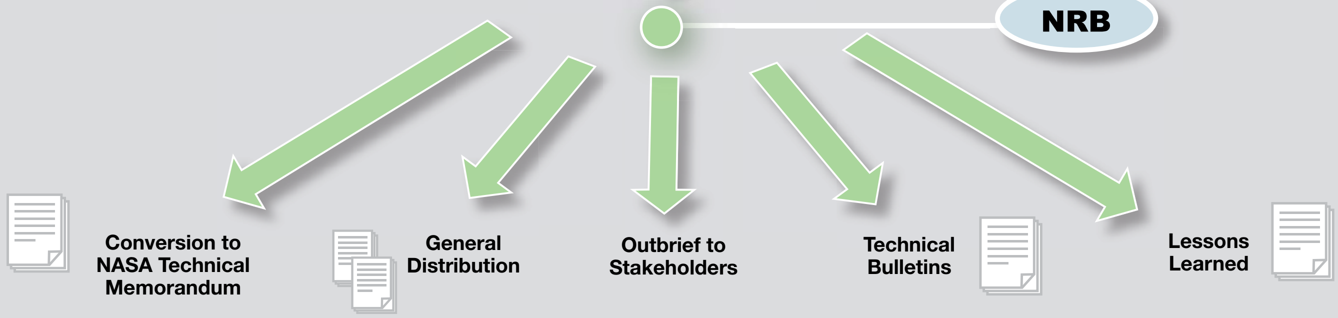
Assessments form the structure and define the process the NESC uses to respond to requests and arrive at solutions to technical issues. The length of time an assessment takes and the size of the assessment team vary. The process outlined below can be tailored to accommodate requirements for a given assessment.



1 The Systems Engineering Office screens each new request and assigns it to one of the NESC Chief Engineers for an initial evaluation. The NESC Review Board (NRB) then decides whether or not to proceed with the assessment.

2 A lead is assigned, usually from the Principal Engineers Office, to run the assessment. The team then develops the assessment plan, which is presented to the NRB for comments and approval.

3 The team proceeds with the technical portion of the assessment. This may entail testing, data analysis, literature searches, interviews, modeling—whatever has been specified in the plan and is necessary to meet the goals of the assessment. As the assessment draws to a close, the team formulates findings, observations, and recommendations and publishes them in a peer-reviewed final report, which is presented to the NRB for approval.



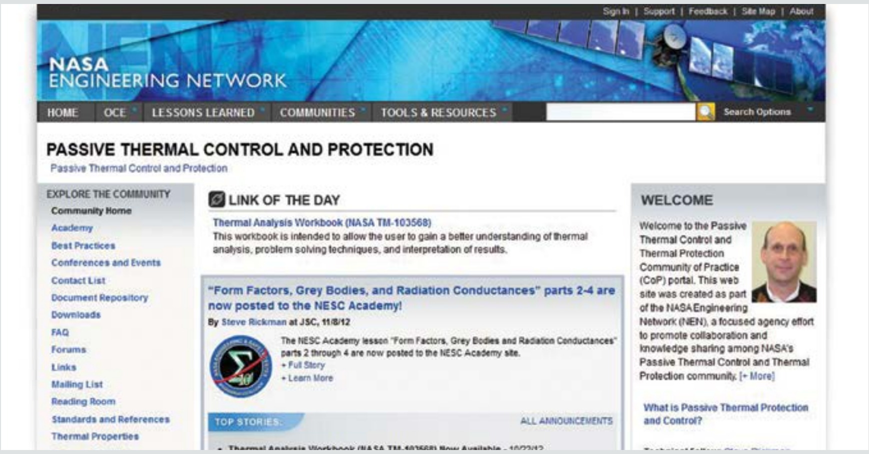
Additional NESC Contributions in Support of the NASA Mission

In addition to helping programs and projects solve the Agency's toughest technical problems, the NESC team also supports the NASA mission through participation in various activities that include discipline stewardship, technology evaluation, education, knowledge transfer, and outreach. Here are examples of NESC engagement in these areas.

Discipline Lessons Learned

As the stewards of their respective disciplines, NASA Technical Fellows are responsible for identifying, capturing, and disseminating engineering lessons learned and best practices. In 2012, multiple lessons learned were documented in NESC Technical Bulletins and/or posted on the appropriate Community of Practice (CoP) website, covering a wide range of engineering issues, including:

- Pressure Testing and Venting of Enclosed Volumes
- Use of Titanium for Tribological Applications
- Setting Human Factors Requirements for Induced Environments
- Structural Analyses and Margins of Safety
- Flying Through Instabilities
- Tin Whisker Risks to Spacecraft Electronic Components



Community of Practice page at nen.nesc.gov

Discipline CoP Workshops

NASA Technical Fellows organize and host CoP workshops and other technical interchange forums. In 2012, the following workshops/forums were held:

- The 2nd NASA Spaceflight Fault Management Workshop
- The Structures, Loads and Dynamics, and Mechanical Systems (SLaM) Workshop
- The In-Space Nondestructive Inspection Workshop
- The High Voltage Design Workshop
- Thermal and Fluids Analysis Workshop

Technology Roadmap Development Teams

NASA Technical Fellows are supporting the renewed emphasis on NASA innovation and technology development. Recently the NASA Office of the Chief Technologist (OCT) developed 14 Space Technology Roadmaps (STRs), which describe the time sequencing and interdependencies of high-priority advanced space technology research and development over the next 5 to 30 years. The NASA Technical Fellows were instrumental in the development of these STRs, each of which focuses on a particular technology area, including Communication and Navigation Systems; Materials/Structures/Mechanical Systems and Manufacturing; Thermal Management Systems; and Entry, Descent, and Landing Systems. The final versions of these roadmaps have been released to the public.

NEN Engineering Discipline CoP Enhancements

Each NASA Technical Fellow maintains a discipline-focused online CoP within the NASA Engineering Network (NEN) framework. These CoP sites are intended to provide an online resource for the next generation of NASA engineers seeking specific engineering knowledge or aid in addressing challenging engineering questions. NASA Technical Fellows routinely update the content of their CoP sites with noteworthy discipline information, lessons learned, and technical reports.

External Professional Society and Engineering Community Activities

Many members of the NESC team support professional societies and engineering communities outside of NASA as recognized experts in their disciplines. They have reviewed and edited over 40 articles for engineering and scientific journals, including the International Journal for Numerical Methods in Engineering; the International Journal of Fracture; Engineering Fracture Mechanics; the International Journal for Structural Health Monitoring; the Journal of Acoustic Emission; and the Journal for Materials Evaluation.

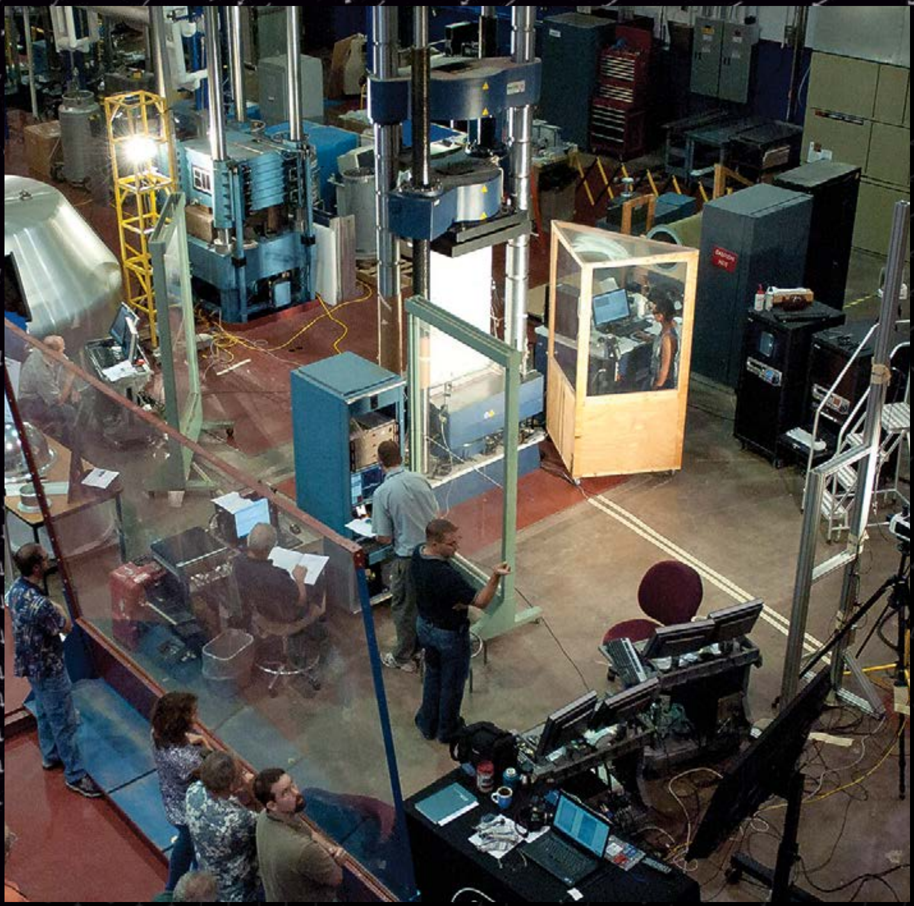
The NESC Academy Now Online

The NESC Academy has undergone a major upgrade and has greatly increased the number of discipline-specific videos and webcasts this year. Currently, there are 123 videos spanning 13 technical disciplines available for viewing by various audiences. The NASA Technical Fellows and their Technical Discipline Team members are included among the contributors and continued an effort to effectively capture engineering knowledge through the revitalized NESC Academy. They conducted over 16 NASA-wide technical webcasts and recorded numerous discipline-specific video tutorials. For example, the NASA Technical Fellows for Structures, Loads and Dynamics, and Mechanical Systems hosted monthly technical webcasts addressing such topics as "Large Space Vehicle Lift Off: Problems Definition and Assessment" and "Selection of Lubricants for Space Vehicles."

The NASA Technical Fellow for Guidance, Navigation, and Control (GNC) holds bimonthly tutorial-type webcasts covering the fundamental aspects of the GNC discipline, such as "Fundamentals of Spacecraft Attitude Control." All such webcasts are recorded and captured on the NESC Academy website for future viewing by NASA engineers. As an example of a video tutorial, the NASA Technical Fellow for Nondestructive Evaluation (NDE) created lessons on the "Probability of Detection for NDE" and on "Materials Durability," while the NASA Technical Fellow for Passive Thermal developed a four-part lesson on the topic of "Form Factors, Grey Bodies and Radiation Conductances."

All webcasts and lesson videos are available on the NESC Academy website. Another 88 videos are in work for release in the near future, so check out the NESC Academy regularly at nescacademy.nasa.gov.

The NESC staffed an exhibit at the Smithsonian Air & Space Museum during Hispanic Heritage Month in October. On hand to represent the NESC was (from left) Oscar Gonzalez, NASA Technical Fellow for Avionics; Terecita Mayorga, a technical representative from GSFC; and Michael Aguilar, NASA Technical Fellow for Software. The NESC team was part of the Meet the Engineers – "Latinos in STEM" exhibit with this year's theme of Hispanic Innovators in Air & Space.



Engineers from the NESC Shell Buckling Knockdown Factor Assessment prepare for a destructive test of a lightweight fluted-core composite panel (center) in the LaRC Structures and Materials Laboratory.

Technical Highlights

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A section of space shuttle external tank covered in photogrammetry targets being mounted in the shell buckling test fixture at MSFC.

Launch Vehicle Shell Buckling Knockdown Factor Development and Implementation

Introduction to Knockdown Factors

Over the past 4 years, Dr. Mark Hilburger has led an NESC assessment team that is intent on reducing the overall weight of launch vehicles. During launch vehicle design, an empirical design factor often referred to as a "knockdown factor" is used to account for unknown variability in the buckling load of thin-walled cylinder structures such as cryogenic tanks or interstages. Dr. Hilburger described the team's challenge: "Knockdown factors were developed during the Apollo era when results from buckling tests indicated loads much lower than those predicted by theory. Today our improved high-fidelity modeling and testing techniques are showing that historical knockdown factors may be too conservative for the design of modern aerospace-quality launch vehicle structures. Updating the knockdown factors could enable significant weight savings in launch vehicles and help mitigate some of their development and performance risks."

The NESC Shell Buckling Knockdown Factor (SBKF) Assessment was established to develop and validate new knockdown factors for future metallic and composite launch vehicle structures. The NESC has supported the design and fabrication of large-scale test capabilities and test articles. They also provide programmatic and technical support, peer reviews and advocacy.

Mark Hilburger and Marc Schultz review a test plan in LaRC's Structures and Materials Laboratory.

Current Status

Deputy Assessment Manager, Courtney Flugstad, stated, "This was a year of transition for SBKF… from testing efforts to a focus on the development and implementation of the first set of new knockdown factors for buckling-critical cylinders. We also transitioned from working knockdown factors for the Ares V vehicle to NASA's new heavy lift Space Launch System (SLS)." The team also completed the first update to the NASA Special Publication-8007 "Buckling of Thin-Walled Cylinders", 1968, which gave design recommendation for buckling of thin-walled circular cylinders on the SLS core stage design. "Industry continues to follow the SBKF progress closely and is very interested in using these knockdown factor updates," says Ms. Flugstad, adding, "We have had inquiries from several companies on when these factors will be available."

The SBKF Team conducted a host of design trade studies soon after the preliminary SLS vehicle configuration and loads were defined. The results of the trade studies were used to formulate a strategy for developing the new knockdown factors for high-payoff orthogrid- and isogrid-stiffened tanks and dry structure. Dr. Hilburger explained, "The aggressive SLS development schedule meant that SBKF would have to transition quickly from the Ares V vehicle to the new SLS configuration, and the trade studies enable them to make informed changes to their development plan and schedule. You can't hurry through the beginning stages of these development activities, you have to take time to fully understand the problem and engage the end user to understand their needs … detailed trade studies and planning are essential. The SBKF Team did a fantastic job switching gears and meeting the aggressive schedule … they understood that we might only get one chance to make an impact on the SLS design."

SKBF test day visitors (from left), Robert Lightfoot, NASA Associate Administrator; George Olden, MSFC; Courtney Flugstad, SBKF deputy, Clint Cragg, NESC Principal Engineer; Charles Bolden, NASA Administrator; Michael Roberts, MSFC; and Dr. Mark Hilburger, SBKF assessment lead.

Collaboration

The SBKF Team entered into a Space Act Agreement with Dynetics Inc., Huntsville, AL, to help with the development of an advanced booster concept for the SLS Program. Ms. Flugstad stated, "Dynetics came to us because they wanted to work with cutting-edge design technology so that they may develop a robust and cost-effective booster concept. They, like us, believe that the updated knockdown factors can help achieve this goal."

The SBKF Team continues their successful collaboration with the Boeing Corporation on a lightweight fluted-core composite structural concept. Dr. Hilburger outlined the work stating, "We are currently preparing for the testing of a 13-foot-diameter barrel that was manufactured by Boeing and was shipped to LaRC in August 2011." A partnership with the SLS Advanced Development Office (ADO) was established in the spring of 2012 and will provide the SBKF effort with a significant amount of funding in FY13 and FY14. SLS ADO is a technology development program for SLS that seeks to develop technologies that reduce cost and increase reliability in the areas of materials, propulsion, and spacecraft and vehicle systems. "ADO saw SBKF as a high-payoff activity that could provide near-term and long-term benefits to SLS cost, reliability, and performance," stated Dr. Hilburger.

Knockdown Factor Updates for SLS

The SBKF Team proposed a development and implementation strategy for the new knockdown factors for SLS. Boeing has implemented the preliminary knockdown factors in their core stage orthogrid designs and has reported several positive outcomes. "Boeing has indicated the potential for both mass and cost savings on the core stage liquid hydrogen tank by reducing material thickness requirements and a reduction in machining time … this is a really good initial outcome. We expect more of this in the future as we develop and implement more knockdown factor updates," stated Dr. Hilburger. A second knockdown factor update was released for review in September of 2012. "This update included new knockdown factors for orthogrid- and isogrid-stiffened cylinders with longitudinal weld lands. This update was an exciting step forward in that it would, for the first time, enable designers to explicitly account for the effects of the weld land feature in the preliminary design phase," he added.

A final technical hurdle is being addressed on the side of manufacturing. Dr. Hilburger explained, "This was in response to SLS requirements that the assumed worst-case, as-built geometry used in cylinder buckling simulations and knockdown factor calculations, be shown to bound the actual as-built cylinder geometry produced using existing design and manufacturing standards of practice for friction stir welded cylinders." To meet this requirement, a Manufacturing State-of-Practice assessment team, which is made up of manufacturing discipline experts from NASA and industry, was implemented. The team is studying state of practice for fabricating friction stir welded metallic cylinders for launch vehicles and are also obtaining full-scale launch vehicle barrel geometry measurements from several sources to establish a better understanding of the type of geometric variability to be expected in future SLS launch vehicle structures.

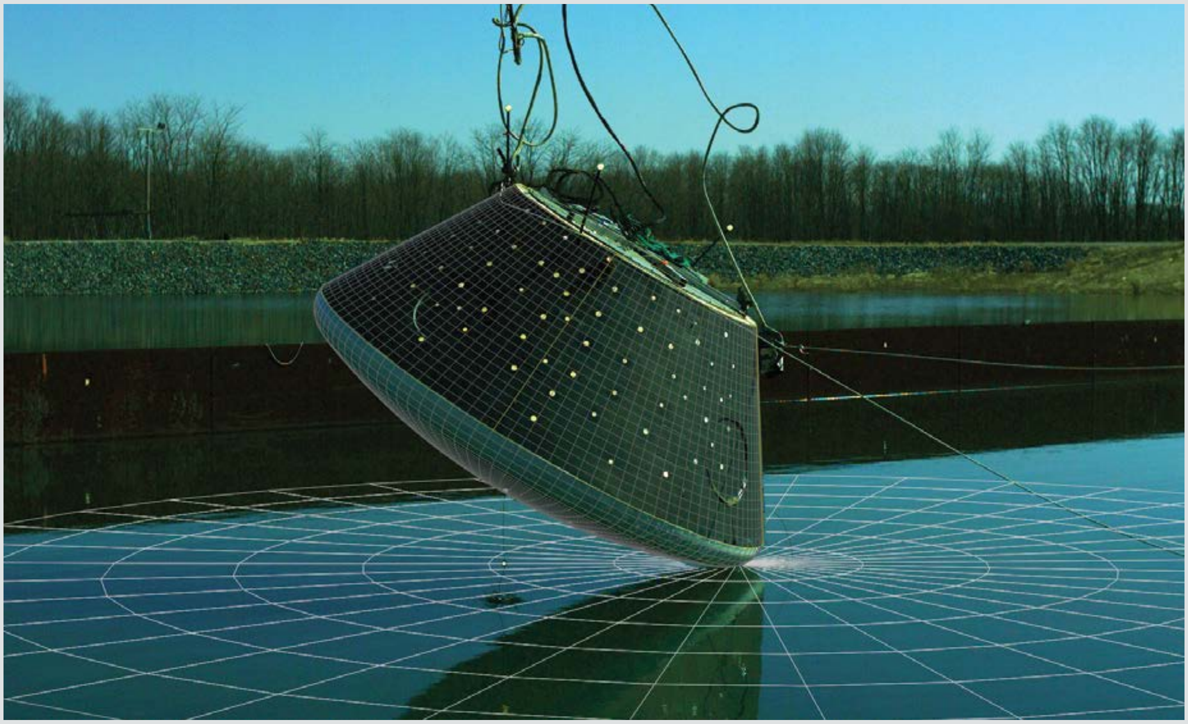
> *"Historical knockdown factors may be too conservative for the design of modern aerospace-quality launch vehicle structures. Updating the knockdown factors could enable significant weight savings in launch vehicles."*
>
> — Dr. Mark Hilburger

They are also conducting buckling analyses of selected preliminary SLS core stage barrel designs that include geometric imperfections.

It has been recently observed that weld lands can reduce the predicted buckling load in orthogrid-stiffened cylinders by as much as 30% when included in high-fidelity structural models. However, there were no guidelines available to account for this effect in the preliminary design phase in which such details are typically neglected. This reduced buckling load resulted in negative design margins and subsequent redesigns. "In the most recent update, a separate design knockdown factor has been derived for stiffened cylinders with weld lands that can be used in preliminary design cycles and should reduce the risk of developing unconservative designs. In addition, this factor can be adjusted or removed, as appropriate, when the structural models include the weld land detail so that double bookkeeping of design margin does not occur," stated Dr. Hilburger.

Looking Ahead to FY13

Three areas of work are planned in FY13. The SBKF Team has already supported the SLS Program Preliminary Design Review by providing documentation that gave the technical justification for using the new knockdown factors. Another knockdown factor update will be released and is planned to include factors that can account for cylinders with circumferential weld lands, nonuniform loading that can come about due to fit-up mismatch, and cylinders subjected to combined bending and compression loads. The SBKF Team will also resume buckling tests to complete the validation of the new knockdown factors being developed.



This image from a high-speed video shows how a crew module wireframe model was mathematically aligned to the known positions of the photogrammetry targets (white dots) at the proper scale. The water surface and orientation was modeled using the free-fall trajectory and attitude measured by photogrammetry at the instant of water contact.

New Photogrammetry Technique is Accurate and Adaptable

A new photogrammetry system has been developed to measure the position and orientation of two rigid bodies relative to one another. Mr. Kurt Severance, of the Flight Software System Branch at LaRC, was the principal developer of the new technique. Mr. Severance, along with Dr. Samuel Miller, formerly of LaRC, refined and implemented this technique for two significant NESC assessments. The system was first designed for the NESC's Max Launch Abort System (MLAS). MLAS included a full-scale Orion crew module (CM) outfitted with four inexpensive high-speed cameras designed to record the separation from its protective forward fairing. The four cameras employed low-cost, wide-angle lenses to capture nonoverlapping views of the protective fairing that contained numerous circular photogrammetric targets. Because conventional photogrammetry requires low-distortion lenses and overlapping camera views of the object of interest, a new algorithm was needed.

Mr. Severance summarized the technique as follows: "If all the targets are constrained to a single rigid body, then the constraint of overlapping camera views can be removed, and a representative set of equations can be developed. The solution to the equations is the one unique 6-degree-of-freedom orientation of the rigid object that produces the target patterns observed in all the cameras. Modern camera calibration techniques were employed, and a robust target-tracking algorithm was implemented to follow targets from frame to frame, even in the midst of significant flying debris. All these technologies were combined and implemented into a common platform using commercially available software development tools and runs on a workstation laptop, which could be used on site immediately after an experiment."

Kurt Severance is the principal developer of the PACER photogrammetry system.

The new photogrammetry system is called pose from an arbitrary camera rig (PACER). It provides maximum flexibility in choosing the number of cameras, the types of lenses, and the placement of those cameras in accessible locations for a flight experiment or ground test facility. Mr. Severance pointed out that "PACER was successfully used to determine the relative positions between the MLAS CM and fairing to within 1/2 of an inch even after 16 feet of separation. This capability was extended and applied to the NESC's Crew Module Water Landing Modeling Assessment (CMWLMA) tests in Phase I and Phase II. Displacements with millimeter accuracy and attitude within hundredths of a degree were obtained for the water entry tests." In this two-phase test, a full-size Orion CM was repeatedly dropped in the water at nominal and off-nominal splashdown velocities to collect trajectory, attitude, and other data that were then used to validate water

FEATURED ASSESSMENTS

"The drop video was helpful but the photogrammetric overlays made it magic ... I can't imagine doing without such a tool on future dynamic data collection projects. This has the potential to be an engineering analyst's best friend."

— T. K. Mattingly, former Apollo and Shuttle astronaut, and engineering consultant

(Above) Photogrammetry was used to directly measure the CM trajectory and attitude during water impact tests at the Aberdeen Test Center, Maryland.

(Left) Photogrammetry supported the critical separation event during the MLAS flight test by looking for recontact between the CM and the MLAS I fairing. Photogrammetry targets are visible on the fairing's interior.

impact modeling being performed by NASA and the Orion CM development contractor. The PACER system drove the trajectory and attitude measurement uncertainty well below a point to where it was not of concern to the analysts as it was an order of magnitude more accurate than the model outputs.

According to Mr. Daniel Yuchnovicz of the NESC, "The result was a precise trajectory characterization of the CM that served as the baseline or ground truth for all other trajectory measurements." Object velocities, accelerations, gravity direction, and maximum plunge depth were derived from the photogrammetry results. These solutions also made it possible to augment the original high-speed videos to clearly visualize vehicle shape and motion even when the CM was otherwise obscured by significant water dynamics.

Mr. T. K. Mattingly, former Apollo and Shuttle astronaut, was a consultant on the NESC CMWLMA Team. Referring to the augmented videos made possible by photogrammetry, he indicated, "The drop video was helpful but the photogrammetric overlays made it magic. Now we can visualize what's really happening and correlate our digits with reality. I can't imagine doing without such a tool on future dynamic data collection projects. This has the potential to be an engineering analyst's best friend."

Mr. Severance pointed out, "Lessons learned from using PACER during the CMWLMA have been applied to sub-scale and full-scale water entry tests of the Orion CM. In addition, the flexibility of PACER to scale from using a single camera up to multiple camera rigs was particularly useful in recent measurements of the take-off and landing trajectory of the V-22 tilt-rotor on an aircraft carrier." Mr. Thomas Jones, also at LaRC, led the CMWLMA photogrammetry hardware set-up and also led the V-22 photogrammetry study. Mr. Jones said, "Compared to conventional methods, PACER allowed us to greatly simplify our camera network configuration, allowing us to capture data and deliver results much more effectively than previously possible."

Thomas Jones, Head of the Advanced Sensing and Optical Measurement Branch at LaRC, developed the network of high-speed cameras used during CM water drop testing.

A NASA-sponsored patent application for the PACER system has been submitted. A company specializing in augmented reality has licensed the technology, and discussions are continuing with other companies. Dr. Miller demonstrated in his doctoral research how to extend the capabilities of PACER to low-cost nano-satellite applications, including star-based orientation, close-proximity docking, and full-sky imaging.

Qualification of Parachute Systems for High Altitude Deployment

During a nominal Orion crew module (CM) reentry descent, the spacecraft's reaction control system (RCS) will maintain CM attitude control until its capsule parachute assembly system (CPAS) drogue parachutes deploy at 25,000 feet. The CPAS drogues will deploy early if the CM's guidance, navigation, and control (GNC) system senses the onset of wind-induced aerodynamic instability within the contingency altitude range of 35,000 to 25,000 feet. While a contingency deployment is not anticipated with a fully functioning RCS, the possibility increases if one string of the dual-string RCS were to fail. The CPAS development and certification effort included CM test article air drops from aircraft at altitudes up to 25,000 feet. High-altitude drops were planned in the contingency range using a new balloon airdrop system, but were removed after Monte Carlo simulations showed the probability of CM aerodynamic instability within this range was very low, even when descending on one string of the RCS. It was anticipated that qualification of the contingency drogue deployment could be based on analytical predictions using CPAS modeling and simulation (M&S) tools validated with drop test data collected below 25,000 feet.

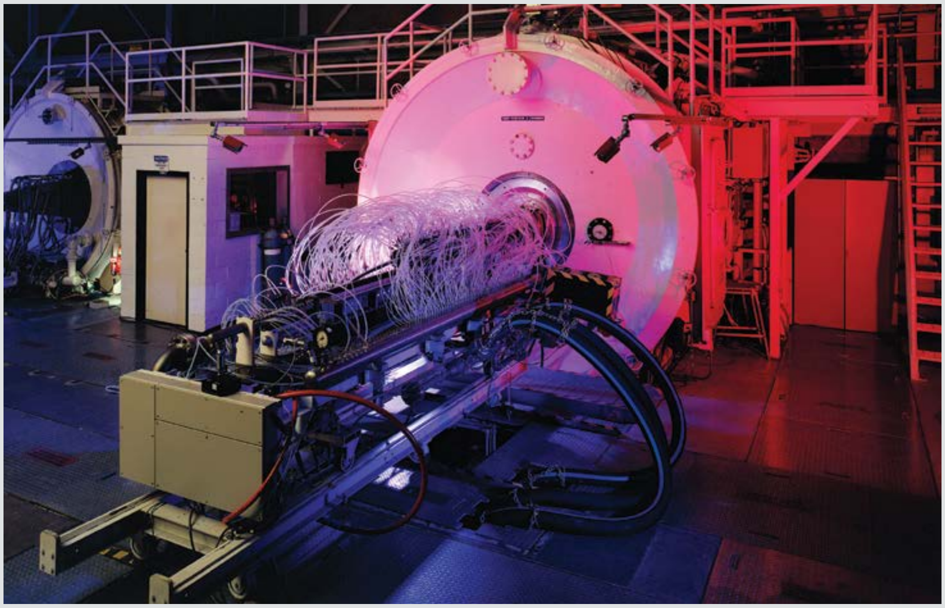
The NESC was asked to independently assess the CM aerodynamic instability M&S results and the CPAS M&S tools' drogue parachute high-altitude loads and inflation predictions. Aerodynamics, GNC, and M&S experts reviewed the RCS capability, atmospheric wind model, and pitch damping derivative model used in the CM stability simulation, while parachute design and test, M&S, and statistics experts reviewed the CPAS M&S tools capabilities, methods, and development history.

Orion boilerplate drop test article and pallet being extracted from C-17.

The NESC team found the project's CM stability tool could produce correct simulated motion and statistics for a descending CM. RCS and wind models were correctly modeled but the aerodynamic damping derivative (Cmq) model had issues, which led to incorrect stability predictions. Using the Apollo Program CM Cmq model, the team showed the probability of instability loss was several times greater than had been predicted. The team also found the CPAS M&S tool was well anchored with test data within the nominal drogue deployment envelope. However, contingency altitude opening load prediction using the tool have unknown levels of uncertainty in part because, like all other current parachute M&S tools, the CPAS tool uses a mix of empirical and physics-based models. Empirical models are usually not employed beyond regions anchored with data. The NESC recommended collecting high altitude air drop data using any capable airdrop asset to qualify drogue parachute deployment within the contingency deployment range.

Review of Apollo Thermal Protection Test Data

The NESC assessed the importance of differences in thermal protection system (TPS) material arc jet testing results from multiple facilities and their effect on TPS sizing. The team investigated the level of risk accepted by depending on a single facility for TPS certification. The assessment included a historical review of Apollo TPS certification data and other relevant programs to gain insight regarding the importance of multiple arc jet test facilities. The team performed data mining and engineering analysis to penetrate and understand facility differences. The team also defined a framework for newly commissioned tests and surveyed other arc jet facilities for future use.



JSC's Atmospheric Reentry Materials and Structures Evaluation Facility Arc Jet Test Position-2.

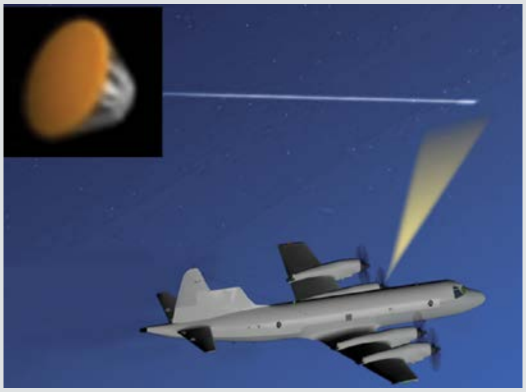
Micrometeoroid and Orbital Debris Design and Analysis Improvements

The NESC, in partnership with the JSC Human Exploration Science Office, is working to improve micrometeoroid and orbital debris (MMOD) damage predictions and risk assessments for the International Space Station, the Orion Multi-Purpose Crew Vehicle, and other spacecraft. Working with university partners, the team is developing hydrocode impact simulations to model damage from MMOD particles with higher densities than what has previously been considered. The team will also be performing hypervelocity (up to 5.6 miles/second) and ultra-high velocity (up to 6.2 miles/second) impact testing to test higher density projectiles and evaluate new materials that exhibit both radiation protection as well as MMOD shielding capabilities.

High-speed images from the front (left) and side (right) taken approximately 0.01 seconds after impact of a 0.11-inch diameter aluminum projectile traveling at 4.31miles/second into a proposed MMOD shield configuration.

Remote Imaging of the EFT-1 Entry for Aerothermal Flight Data Risk Reduction

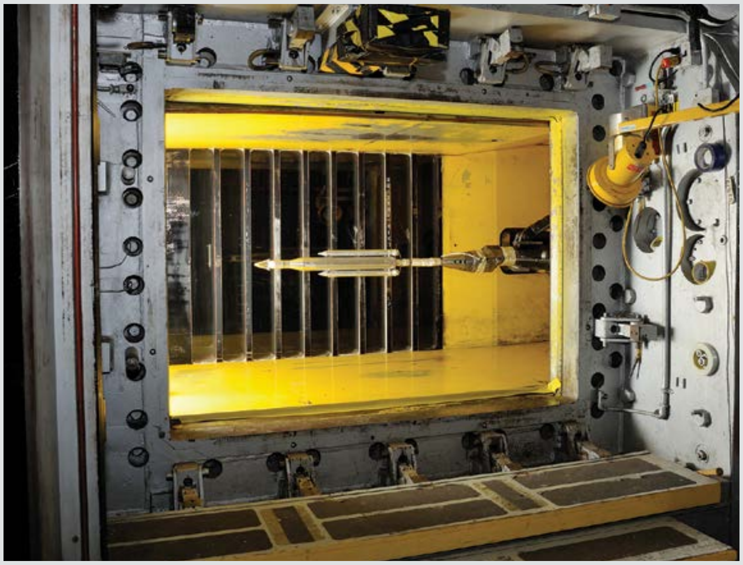
Artist's rendering of the Orion crew module thermal measurements from a U.S. Navy P-3 observation aircraft.



Exploration Flight Test-1 (EFT-1) will be the first flight test of NASA's Orion Multi-Purpose Crew Vehicle (MPCV) crew module exposing the vehicle to Earth entry from beyond Low Earth Orbit (LEO). Beyond LEO entry involves higher aerodynamic heating and spacecraft thermal protection systems that have not been used since Apollo. The NESC is employing remote infrared imaging of EFT-1 to provide global temperature measurements that will enhance and corroborate onboard thermocouple instrumentation. The remote imaging also serves as risk mitigation in the event onboard instrumentation should experience a failure. The remote imaging technology used in this test was developed and refined through imagery of the NASA Space Shuttle orbiters during reentry and landing.

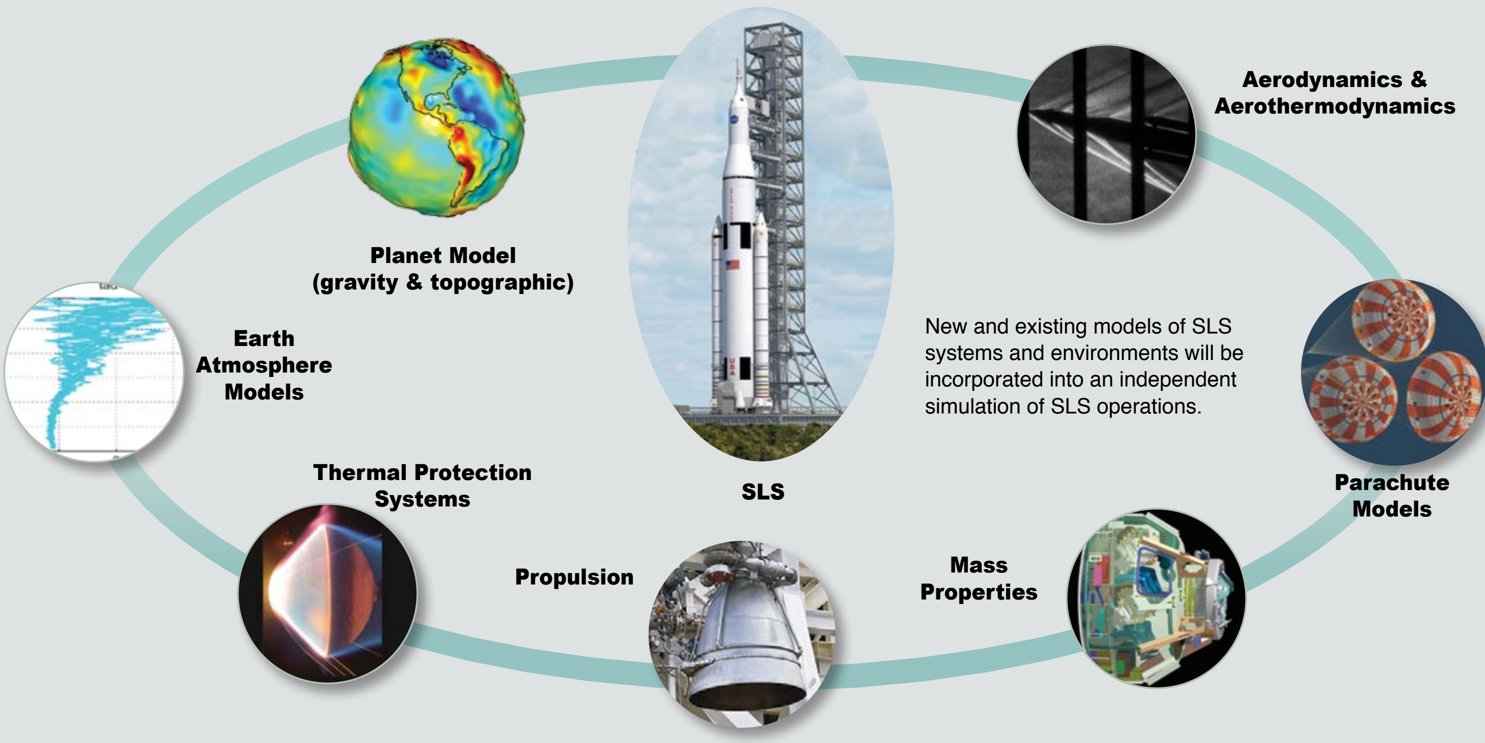
Aerodynamic Testing of Alternate Spacecraft on Space Launch System

The Space Launch System (SLS) will be human rated to carry the Multi-Purpose Crew Vehicle. Commercial crew providers have proposed a number of spacecraft shapes to service the International Space Station. These shapes range from a winged spacecraft to capsules and lifting bodies. The NESC is testing five generic shapes, representative of proposed spacecraft concepts, on an SLS wind tunnel model to determine their aerodynamic performance during ascent. These tests will provide preliminary aerodynamic data should alternate spacecraft be proposed for launch using the SLS.



Test section of LaRC Unitary Wind Tunnel with the HL-20 lifting body spacecraft on an SLS model.

HUMAN EXPLORATION AND OPERATIONS



New and existing models of SLS systems and environments will be incorporated into an independent simulation of SLS operations.

Independent Modeling and Simulation for Exploration Systems

NASA flight programs have benefited from independent system models and integrated simulations to identify and resolve highly-coupled system failure modes and technical risks, particularly those that occur at or near complex hardware, software, or discipline interfaces. These failure modes may only manifest themselves when components are operated as an integrated system; they do not necessarily occur when evaluating, testing, or operating single components or elements.

The NESC is assembling a multi-Center team to develop independent models, and perform independent simulations to mitigate risks that may result from the Human Exploration Office's Programs: Space Launch System (SLS), Orion Multi-Purpose Crew Vehicle, Ground Systems Development and Operations, and Commercial Crew Program partners. The effort will employ low, moderate, and high fidelity multiple degrees-of-freedom (DOF) flight simulations and physics or empirically based models to integrate, analytically evaluate critical element and subsystem models, and define and understand the boundaries of operational environments for which each system must perform.

The purpose of these efforts are two-fold: (1) enable the team to have an independent set of subject matter experts to provide early identification of unforeseen analysis issues or design interface and integration issues that occur within the highly integrated nature of these new systems and (2) proactively develop mature, verified, and validated independent models and integrated simulations to enable the NESC to be ready to provide independent assessments and technical analysis throughout the program life cycle as issues arise.

A 3-DOF simulation of the SLS Block I nominal ascent from launch to core stage engine cut-off using independent tools was completed in October 2012. A 6-DOF simulation for the same phase of flight is scheduled for completion by the end of January 2013.

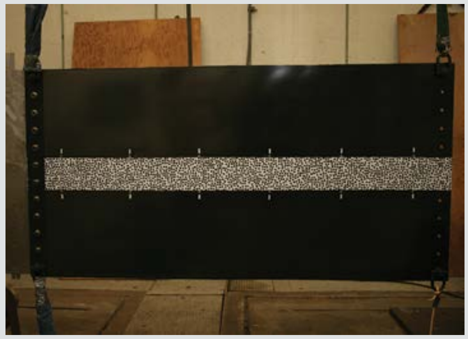
F-1 engine testing in the 1960s had to overcome a serious combustion stability problem. SLS is considering engines in the same thrust class as the F-1.

Integrated Combustion Stability Analysis

The accuracy of current combustion stability tools is limited by the level of empiricism, i.e., not fully physics-based, embedded in the models. The limited accuracy can lead to significant uncertainties in stability assessments, resulting in increased engine development costs. The Space Launch System (SLS) advanced liquid booster design is particularly in need of improved accuracy in this regard. The NESC will leverage recent testing and physics-based modeling advancements made under NASA and U.S. Air Force support to improve the combustion stability models used in the design process.

Pyroshock Characterization of Composite Materials

The NESC is developing an analytical tool that can be used to accurately predict the maximum expected flight environment (MEFE) for pyroshock events induced in composite material. Pyroshock tests will capture shock wave acceleration time history as it transverses across the composite panel at various locations (nearfield, midfield, and farfield). These data will provide the necessary information for the generation of attenuation curves for the composite materials being examined (solid and honeycomb core) resulting in an empirical analytical model for shock MEFE predictions.



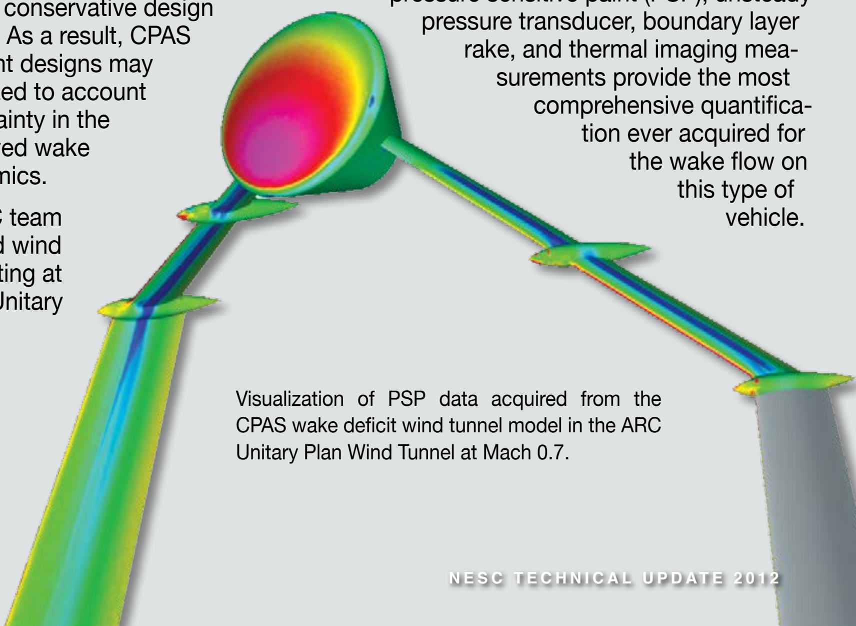
Suspended pathfinder solid laminate composite panel (3 by 6 foot) with photogrammetry speckle pattern and accelerometer attach points.

CPAS Wake Deficit Wind Tunnel Testing for MPCV-Class Spacecraft

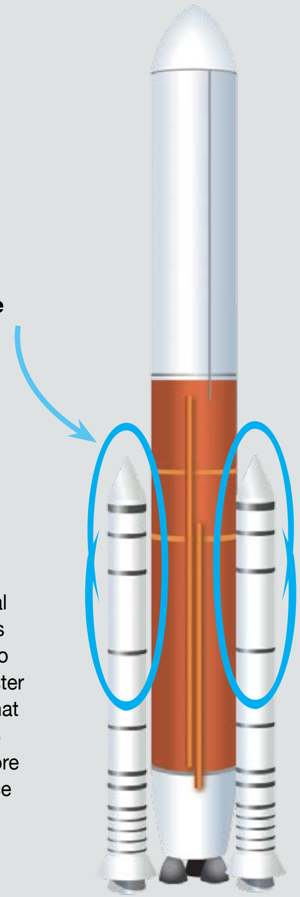
The capsule parachute assembly system (CPAS) is used to decelerate the Orion Multi-Purpose Crew Vehicle (MPCV) crew module (CM) for landing during reentry. The subsonic/transonic wake of the CM during heatshield forward descent interacts with the CPAS and is a critical factor that must be accounted for in the CPAS design. The aerodynamic character of the CM wake has a significant impact on the deployment and performance of the parachutes. Computational fluid dynamics (CFD) simulations play a key role in predicting the aerodynamic behavior of the wake because wind tunnel testing of CPAS concepts and configurations is costly and limited. However, below Mach 1, CFD prediction of the MPCV wake flow is questionable, leading to conservative design decisions. As a result, CPAS component designs may be oversized to account for uncertainty in the CFD-derived wake aerodynamics.

The NESC team sponsored wind tunnel testing at the ARC Unitary Plan Wind Tunnel to acquire detailed wake flow measurements behind a capsule model. The test used particle image velocimetry (PIV) in concert with more conventional test techniques to acquire high fidelity unsteady flowfield data in the capsule wake. These data will be used to characterize the flowfield behind MPCV-class vehicles, and as validation data for CFD simulations used in the CPAS design. Multiple NASA Centers teamed to complete test formulation, model design and fabrication, and data acquisition and analysis.

Wind tunnel testing of the capsule is complete and data analysis is in process. PIV test data are high quality and unique for this type of geometry operating at transonic speeds. These data, along with pressure sensitive paint (PSP), unsteady pressure transducer, boundary layer rake, and thermal imaging measurements provide the most comprehensive quantification ever acquired for the wake flow on this type of vehicle.



Visualization of PSP data acquired from the CPAS wake deficit wind tunnel model in the ARC Unitary Plan Wind Tunnel at Mach 0.7.



Regions of interest for interference

Design techniques employing computational aerodynamics will be used to develop booster geometries that minimize SLS booster-to-core stage interface loads.

SLS Booster Interface Loads Analysis

The Space Launch System (SLS) uses solid rocket boosters to overcome high aerodynamic and inertial forces during launch and initial ascent. The booster aerodynamic forces can produce large loads where they attach to the SLS core stage. The NESC is optimizing the booster shape to minimize the aerodynamic loads applied to the core stage. State-of-the-art computational aerodynamics design tools are used to design the booster shape and minimize the interface loads. Wind tunnel tests of candidate shapes showing the best potential for load reduction will be conducted to verify the computational design.

Orion MPCV recovery test article being stabilized during initial testing conducted in 2009.

Orion EFT-1 Landing and Recovery Planning Peer Review

The NESC was requested to conduct a peer review of the Orion Multi-Purpose Crew Vehicle (MPCV) Exploration Flight Test-1 (EFT-1) landing and recovery planning in support of the Landing and Recovery Office within the Ground Systems Development and Operations (GSDO) Program. The NESC is reviewing the concept of operations, plans, and procedures for two tests that the GSDO Program will conduct with the Orion MPCV Program and the U.S. Navy. Ultimately, these plans and procedures will be used to recover the Orion crew module (CM) as part of EFT-1 recovery 600 miles south of San Diego and deliver the CM to Sea Launch Astrotech in Long Beach, CA.

Composite Crew Module Leak Characterization

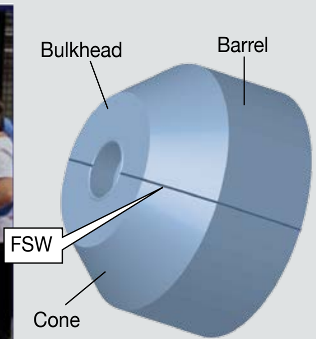
The composite crew module full-scale pressure vessel test article being readied for a vacuum test at MSFC.

One of the conclusions from the NESC's Composite Crew Module (CCM) Assessment was that the ability of a composite pressure shell to contain consumable gases was not well understood and, therefore, posed a significant technical risk relative to a metallic alternative. CCM and subsequent programs demonstrated that the permeability is sufficiently low even under reasonable design limit strains. However, several outstanding risks remain. They include permeability/leakage after impact, permeability of bolted joints, permeability of potted inserts, permeability after life cycling, and permeability of an out-of-autoclave splice, among others. With these risks in mind, the NESC carried out a CCM leak characterization evaluation to quantify some of these risks on the full-scale structure. In addition to examining bolted penetrations, the effort quantified permeability from coupons with and without impacts, which demonstrated that a simple liner solution could mitigate the impact problem. Following that demonstration, the liner solution was partially installed on the CCM to examine feasibility of full-scale implementation.

Leak testing demonstrated that low leak rates are achievable in the sandwich composite material system. The tests also demonstrated that at a coupon level, a polymeric liner (appliqué film) is capable of mitigating the concern of the leakage after impact. This mitigation scheme would allow for many low velocity impacts to go undetected, without compromising the leak performance that is required. Despite some difficulty in installation, the film was effective at reducing the leak rate associated with the through-thickness inserts. The film also appeared to reduce the leak rate associated with the out-of-autoclave cured splice. The leak rate associated with critical features, such as bolted penetrations, was quantified and demonstrated that very low leak rates are achievable.

Spin Forming of a Crew Module Metallic Forward Pressure Vessel Bulkhead

The NESC is conducting a feasibility study for spin forming a complex-shaped, single-piece aluminum lithium (Al-Li) Orion Multi-Purpose Crew Vehicle (MPCV) crew module (CM)-like forward pressure vessel bulkhead. Spin forming the bulkhead can eliminate multipiece fabrication and assembly methods currently used to construct the MPCV CM bulkhead, cone, and barrel regions. The design trade and materials/process studies being conducted at JSC, LaRC, and MSFC will identify the benefits and limitations associated with the one-piece Al-Li bulkhead design. Preliminary results suggest bulkhead spin forming could simplify fabrication, reduce processing cost, and lower system weight, while maintaining or increasing reliability and safety.



An aluminum alloy 2219 spin-formed MPCV CM-like bulkhead containing a single friction stir weld (FSW) region.

Assessment of Gravitational Loads and Environments

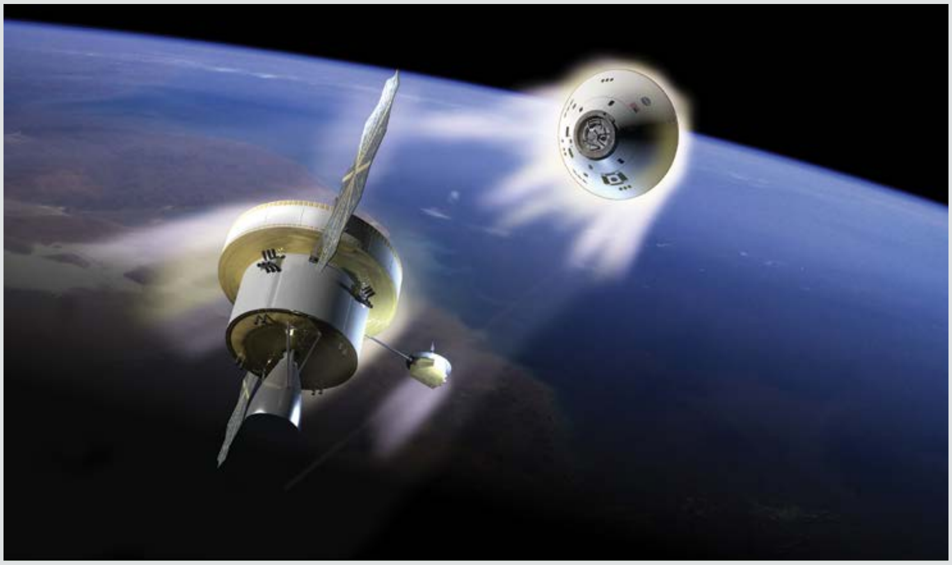
The NESC sponsored the Assessment of Gravitational Loads and Environments (AGILE) that informed and helped initiate a series of human-in-the-loop vibration studies to address specific thrust oscillation concerns that arose during the former Constellation Program (CxP). The resulting design-point assessments funded by the Human Research Program (HRP) and CxP established quantitative CxP requirements for maximum allowable vibration due to thrust oscillation. Subsequent HRP investigations demonstrated an innovative strobing countermeasure that restores display readability to nonvibrated levels, and consequently provided relief for future NASA vehicle designs.

Fundamental research questions identified during the AGILE study are being addressed in a more general investigation of vibration-relevant, trade-space parameters. The knowledge garnered from AGILE aided development of the human vibration chapter in NASA's Human Integration Design Handbook (SP-2010-3407). Furthermore, this knowledge allowed AGILE team members to help the Agency by addressing the Multi-Purpose Crew Vehicle Program and Space Launch System Program design questions.

Vibration chair occupant in the ARC Human Vibration Laboratory responding via touch-screen input. Eye and head movement are recorded.

Orion CM Thermal Protection System Margin

The Orion Multi-Purpose Crew Vehicle (MPCV) crew module (CM) thermal protection system (TPS) requires targeted consideration and/or reduction of individual material property uncertainties, model and flight regime-specific margin application, and credible reliability calculations to ensure an optimum design. A joint NESC/Orion MPCV Program assessment to formulate a heatshield reliability estimate based on bondline temperature margin was completed in 2011. High-value, follow-on work was identified and led to an assessment to formulate a heatshield reliability estimate based on bondline temperature margin.



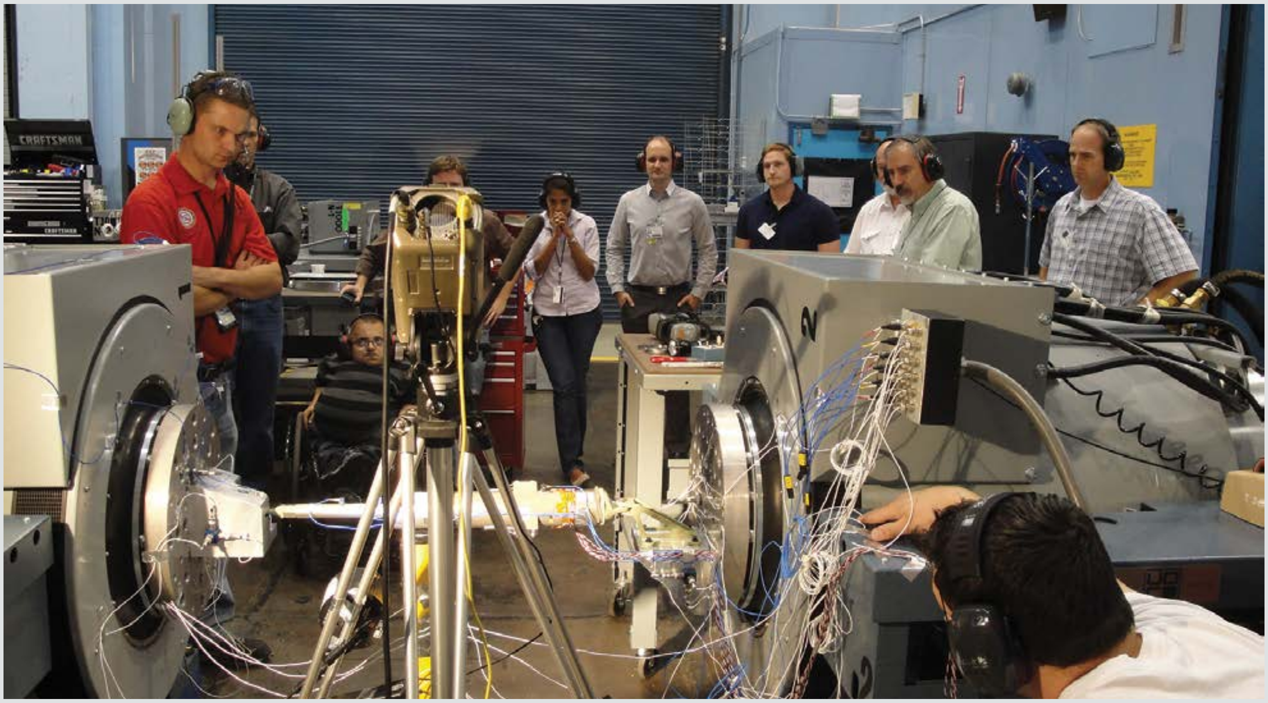
Artist's rendering of the Orion MPCV CM during reentry.

The joint NESC/Orion MPCV Program assessment team is leveraging the expertise of MPCV TPS and materials subject matter expertise with NESC technical and statistics expertise to formulate a reliability model, employ efficient experiment design methodologies, and apply Bayesian network methodology.

Activities will continue through September 2013, where the joint team will mature the Avcoat bondline-temperature reliability assessment process by selecting heatshield failure criteria, incorporating new arc jet test and material property data, and adopting improvements to the Avcoat thermal response analytical ablation model. Using the refined reliability assessment process, an updated reliability estimate will be established with the critical influencing parameters identified. Recommendations for updating the existing Avcoat sizing process using the TPS margin policy will be provided.

The updated reliability model will be used to investigate the amount and type of testing and analysis required to improve reliability. The team will develop and demonstrate a new statistically and probabilistically based means to define heatshield thickness for a target reliability.

A prototype resource allocation process to further reduce uncertainties and improve the reliability estimate will be developed using Bayesian network techniques.



NESC and Lockheed Martin personnel examine the spring strut prior to random vibration testing.

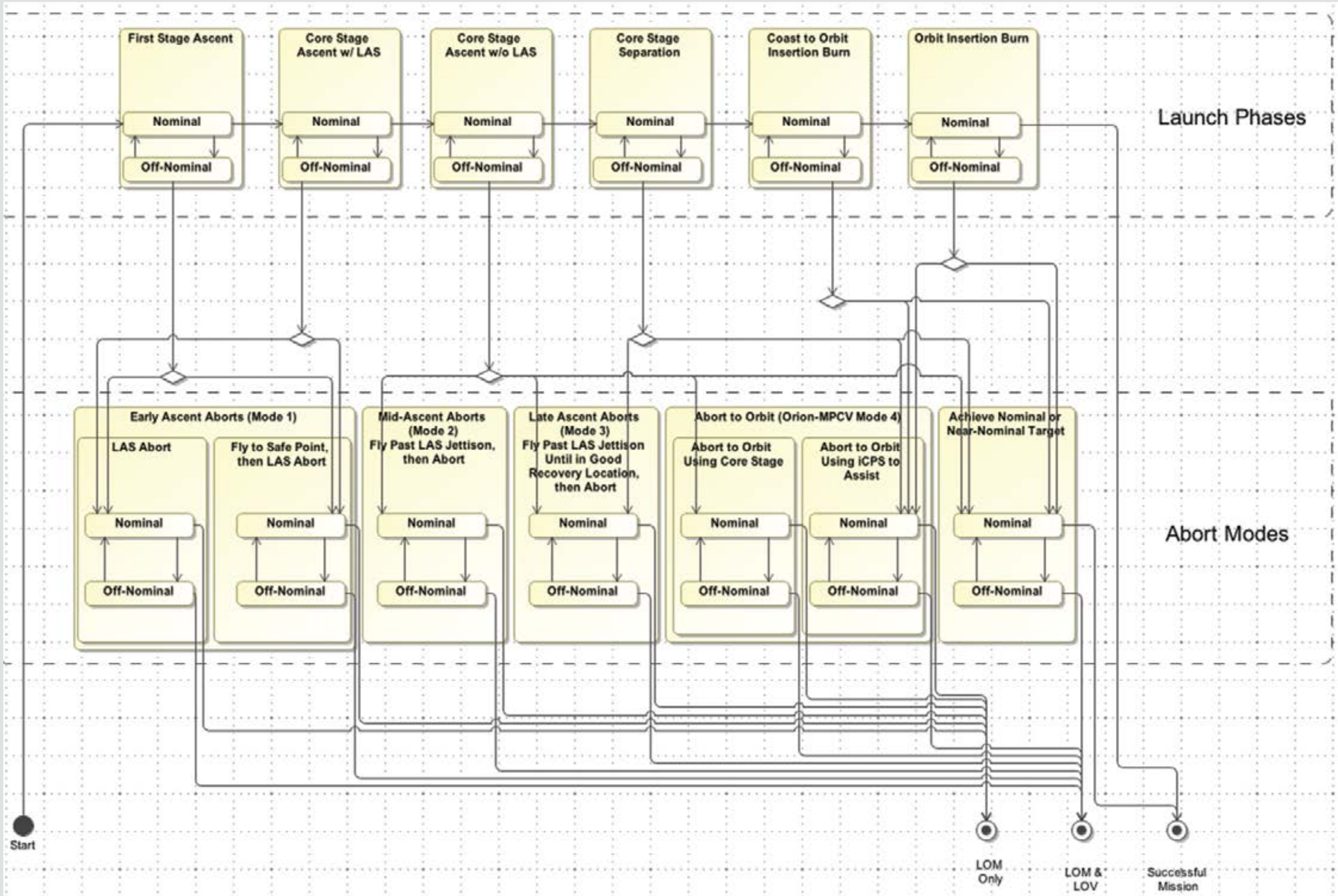
Orion Crew Module and Service Module Umbilical Strut Vibration Testing

Commodities are transferred between the Orion Multi-Purpose Crew Vehicle (MPCV) crew module (CM) and service module via an external umbilical that is driven from the CM by dual-spring struts. No development umbilical strut vibration testing was scoped in the Orion MPCV Program plan. To reduce program risk, the NESC, working with Lockheed Martin, performed qualification-level vibration and performance tests on a spring-strut development unit, which ultimately uncovered issues that would not have been identified until strut qualification testing. Based on the test results and a follow-on failure investigation, corrective actions are being implemented by the Orion MPCV Program for the upcoming Exploration Flight Test-1.

Carbon-Carbon Silicon Carbide Material Characterization

Work continues on the NESC assessment to characterize carbon-carbon silicon carbide (C/C-SiC) material used in the Multi-Purpose Crew Vehicle (MPCV) launch abort system attitude control motor (ACM). Testing at room and elevated temperature (up to 3000°F) is being conducted to understand material behavior under predicted operational environments. Test data will be used for the ACM component design database, to assess the capability of the analytical materials model, and identify C/C-SiC damage modes. Advanced characterization methods, including x-ray computed tomography, acoustic emission, and 3-dimensional surface strain imaging are being used to quantify the behavior of this complex ceramic composite.

Stewart Walker of the LaRC Advanced Materials and Processing Branch is shown conducting a 3-point strength test on a ceramic C/C-SiC composition material. The specimen is highly instrumented to understand performance.



Conceptual SLS/MPCV/GSDO interface model.

Model-Based Systems Engineering of the Exploration Systems Interfaces

An NESC team is modeling the interfaces between Space Launch System (SLS), Orion Multi-Purpose Crew Vehicle (MPCV), and Ground Systems Development and Operations (GSDO) components using model-based systems engineering techniques. Using the numerous documents and data sources describing these interfaces, the team is building a single model of the interface. Analyses to be performed using this model include the distribution of flight, health, and safety information between GSDO, MPCV, and SLS, and how SLS internally processes the data; the commands from GSDO/MPCV to SLS, and how those commands are processed by SLS, including distribution of command responses; and abort behavior initiation and SLS response, including how Eastern Range data are processed by SLS for the flight termination system. This work will help determine what interfaces are required and the expected behaviors that need to be engineered and documented.

Orion Docking Mechanism Jettison System Linear Shape Charge End Gap Testing

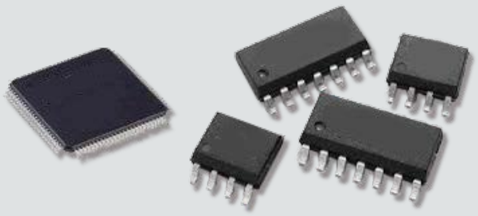
The Orion Multi-Purpose Crew Vehicle (MPCV) docking mechanism jettison system design uses a circumferential linear shape charge for separation. There is a concern the gap between the shape charge ends could prevent complete separation of the docking tunnel. The NESC was asked to assess options and perform concept demonstration tests to evaluate methods to achieve complete tunnel separation. Tests performed at the JSC Energy Systems Test Area demonstrated effective configurations, including an overlapped shape charge end arrangement that provided complete separation of the docking tunnel.

(From left) Maureen Dutton, Rick Dean, Nick Kidd of the JSC Energy Systems Test Branch examine a simulated docking mechanism jettison system tunnel section separation test firing setup.

HUMAN EXPLORATION AND OPERATIONS

Use of Commercial Electronic Parts in Commercial Crewed Spacecraft

An NESC assessment of the Commercial Crew Program's (CCP) use of commercial off-the-shelf (COTS) electronic components for space environment in safety-critical manned spacecraft avionics systems was requested by the International Space Station (ISS) Program. CCP providers were encouraged to develop new, lower-cost methods of avionics design and verification with the only constraint being that they demonstrate no hazard will be presented to the ISS. At least one CCP provider developed a process that relies heavily on COTS parts combined with assembled component qualification and acceptance testing to verify system safety and reliability. Alternative approaches to verification of systems with COTS parts, such as those used in industry and other government agencies, including the Federal Aviation Administration, are being suggested by CCP providers for review and assessment.



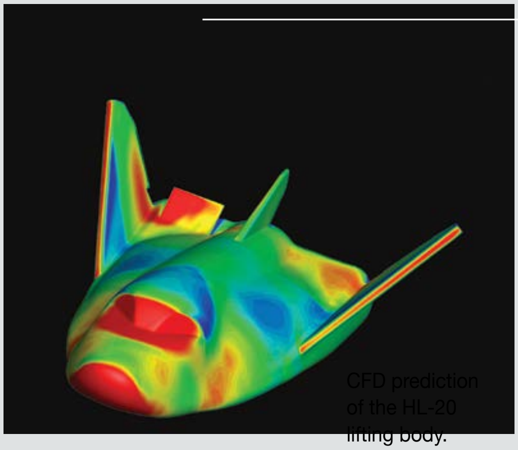
An NESC assessment team is evaluating whether these alternative approaches would be suitable for the use of COTS parts in safety-critical manned spacecraft avionics systems. Planned for completion in 2013, the NESC team will document guidelines necessary for CCP spacecraft. The guidelines will be based on the review of existing COTS parts application documents used by the aerospace and automotive industries, NASA, and other government agencies, and comparison and evaluation of their approaches with respect to electrical, electronic, and electromechanical parts-level, avionics system-level, and mission-level reliability, and system safety risk.

Use of Commercial EEE Parts in Commercial Crewed Spacecraft

Members of the Avionics Technical Discipline Team performed a study to respond to specific questions from the Commercial Crew Program (CCP) to help frame the technical, cost, and schedule risk trades associated with the desire of some CCP partners to employ electrical, electronic, and electromechanical (EEE) parts of a lower grade than traditionally used in most NASA safety-critical applications. The fundamental question posed was whether commercial off-the-shelf (COTS) EEE parts, with architectural similar redundancy and limited screening only through box or system-level testing, can be used in safety-critical flight hardware systems. NASA has successfully used COTS EEE parts in spacecraft for specific and sometimes mission-critical applications throughout the Agency's history by employing careful selection, qualification, and screening. The level of screening required for COTS EEE parts to ensure they will work successfully is highly dependent on the mission, their application, and part technology, and is well characterized in existing NASA parts documents such as EEE-INST-002.

Qualitative analysis by the NESC team indicated significant differences in reliability and safety can result between screened military-grade parts and unscreened COTS EEE parts. Differences are influenced by mission duration and system architecture, including the use of like or diverse backup systems. The team found that the term "COTS" is broadly defined and not consistently applied. Some industries employ supply chain controls to ensure the quality and reliability of COTS EEE parts used in their products, while others use COTS parts from commercial catalogs without any testing other than functionality.

The NESC team concluded that an alternative approach for the use of COTS EEE parts in critical applications, other than those which have proved successful, requires a firm basis for substantiation. To reduce the likelihood that COTS EEE parts failures result in unacceptable mission risk, the NESC recommended the CCP require vehicle providers to develop and implement a top-down mission assurance program to address EEE parts derating, qualification, traceability, and counterfeit control; demonstrate how it mitigates the risks associated with EEE parts applications; and provide data supporting the effectiveness of the proposed screening approach ensuring part failure rates are adequately bounded.



CFD prediction of the HL-20 lifting body.

Smart Buyer Assessment for Winged Reusable Spacecraft

NASA conducted significant research on the HL-20 winged reusable spacecraft in the 1980s. The HL-20 is similar in concept to some Commercial Crew Program vehicles proposed for access to the International Space Station (ISS). The concept was developed before computational fluid dynamics (CFD) and desktop flight simulation tools were broadly applied. This assessment employs modern CFD to enhance and extend the HL-20 aerodynamic database and develop desktop simulations for the vehicle. The simulation capability may be used by NASA engineers evaluating the flight performance of similar concepts during a return from the ISS or in the event of an ascent abort.

HUMAN EXPLORATION AND OPERATIONS

Nitrous Oxide Fuel Blend Experiment

Nitrous Oxide Fuel Blend Experiment (NOFBX) is an oxidizer/fuel blend monopropellant developed by Firestar Technologies, LLC. NOFBX is less toxic than the most commonly used monopropellant, hydrazine, and offers substantial increase in specific impulse. Flight testing of an NOFBX propulsion module is planned on the International Space Station (ISS). The ISS Engineering Directorate Safety Lead requested an independent consultation from the NESC in regards to the hazard mitigation and avoidance plan for the flight experiment. The NESC conducted a thorough review of available NOFBX data and provided the ISS Program with a list of recommendations for reducing the risk of conducting the flight test.

NOFBX flight experiment solid model rendering.

At a workstation in the ISS Harmony node, astronaut Dan Burbank replaces a catalytic reactor in the water recovery system.

ISS ORU Wet Storage Risk Assessment

The NESC is assessing the risk of storing spare components for the International Space Station (ISS) water recovery and oxygen generation systems that have been filled with deionized water. A concern is that these orbital replaceable units (ORUs) may be at risk for corrosion and/or biological growth (biofouling) during extended storage. Since there are no procedures to flush spare ORUs on the ISS, the NESC is evaluating the wet storage risk by sampling water from ground spares and reviewing the materials used in ORU construction.

The Progress spacecraft heads to the International Space Station from the Baikonur Cosmodrome in Kazakhstan.

Progress 44 Anomaly Investigation

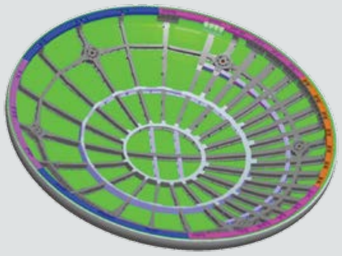
A Soyuz-U booster prematurely shutdown during flight causing the loss of Progress 44. The NESC participated in the NASA Anomaly Investigation Team, which was independent of a Russian team chartered to determine and correct the cause of the failure. NASA's technical analysis and understanding of a proposed engine fuel deprivation scenario showed it was feasible and consistent with the Russian team's findings. NASA concurred with the corrective actions and recurrence control proposed by the Russian team.
A successful launch of Progress 45 showed no booster performance issues.

HUMAN EXPLORATION AND OPERATIONS

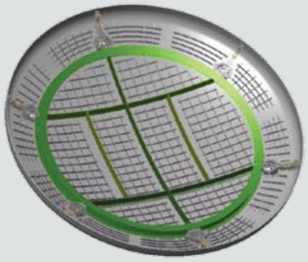
ISS Simplified Docking System

The International Space Station (ISS) Program requested the NESC participate in an independent reliability assessment of the Low Impact Docking System (LIDS) that is to be integrated onto ISS and review other proposed simplified docking systems. The team conducted technical interchange meetings with the LIDS engineers and with contractors proposing simplified docking system alternatives. Reviews of analyses, trade studies, and hardware test data provided the support for the NESC position that was presented to the ISS Program.

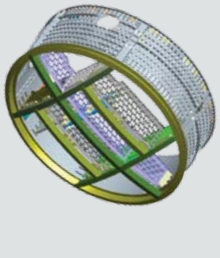
Engineering model of the LIDS being tested in the JSC 6 degrees-of-freedom test stand.



Existing heatshield design.



Proposed heatshield design with “H” interface structure.



Lower portion of pressure vessel and backbone with “H" heatshield carrier.

NESC Alternate Orion CM Heatshield Carrier Design

The NESC was requested to develop alternate designs to the Orion crew module (CM) heatshield carrier structure with a goal of reducing the overall mass by 25% or approximately 800 pounds. The NESC formed a team of engineers from LaRC, DFRC, JSC, and industry to develop and trade alternative concepts that could be implemented for the Exploration Mission-1 test flight.

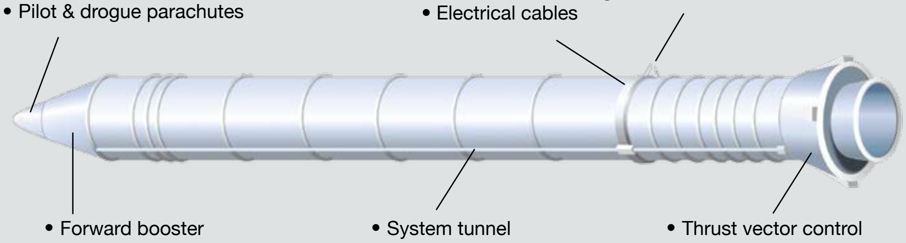
Existing Orion CM pressure vessel.

The NESC design is a load-sharing approach that allows the heatshield carrier structure to bear against the aft dome of the crew module pressure vessel, through an “H”-like interface structure that mirrors the backbone shape within the crew module pressure vessel. This allows the mass of the hardware, fixed to the crew module backbone, to pass its inertial load directly to the heatshield carrier structure during reentry and water landing. This makes for a more direct load path and a more efficient structure, saving approximately 400 pounds.

The NESC team is also looking at analytical techniques that consider buckling via dynamic analysis rather than static analysis. Dynamic analysis is required to properly analyze the impulsive, highly dynamic water landing event, which is a driving load case. This technique has the potential to save an additional 400 pounds. Lastly, the NESC is looking at a switch in material systems from the current composite skin to a metallic skin such as stainless steel or titanium orthogrid. This material change has the potential to save 200 to 500 additional pounds. All of these options are being considered for possible downselect in 2013 and if selected, will lead to detailed design as future work.

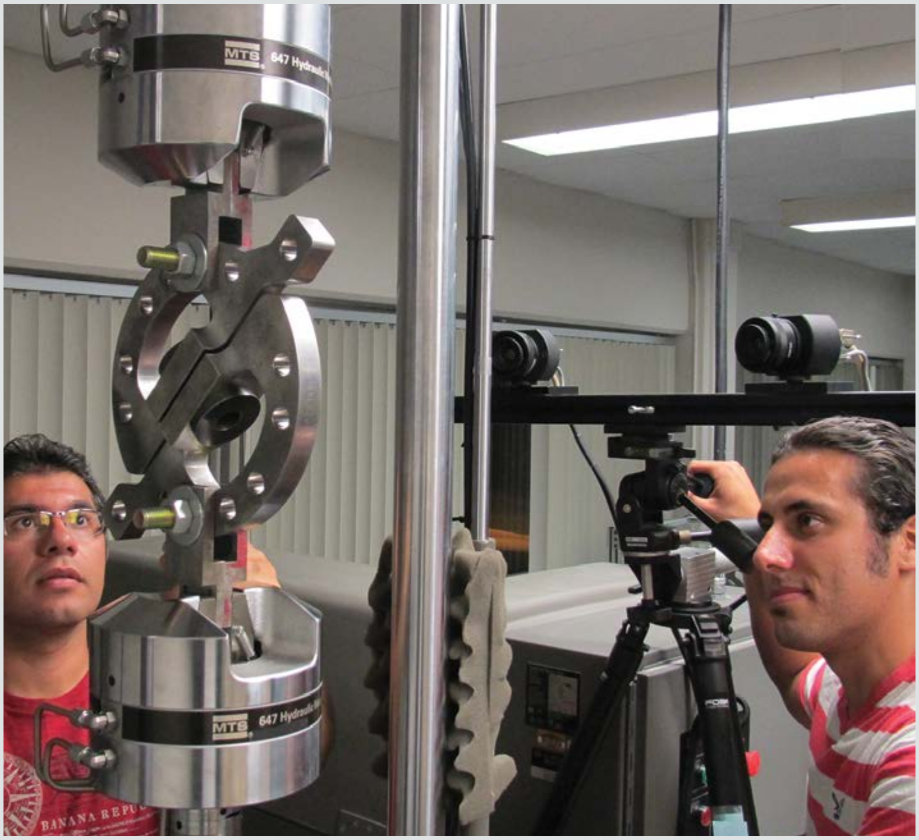
SSP Shock Test Experience for Reusable Flight Hardware

As commercial crew provider designs near the preliminary design review level, several providers are identifying processes for requalifying multiuse electrical and mechanical components for use in various shock environments that include pyrotechnics, mortar firings, and water impacts. To assist the commercial providers with their processes, the NESC formed a team of NASA experts to share experiences with qualifying hardware in shock environments for the Space Shuttle Program (SSP) and other NASA programs and projects. The team developed a report that is available to the commercial crew providers through the Commercial Crew Program Office.



Many parts of the solid rocket booster were subjected to pyroshock environments.

GENERAL



Pictured are Amir Kazemi, Ph.D. student (left) and Maurizio Joe Bentivegna (right) senior exchange student from Mannheim University, Germany, using the fastener shear tension fixture.

Threaded Fastening Systems Design, Verification, and Installation

A shear/tension fixture was designed at MSFC for NESC use in support of NASA-STD-5020 "Requirements for Threaded Fastening Systems in Spaceflight Hardware" development. Dr. Sayed Nassar, founding Director of the Fastening and Joining Research Institute (FAJRI) at Oakland University in Rochester, Michigan, and member of the NASA-STD-5020 development team, requested use of this fixture in research of multiaxial fatigue in threaded fasteners. The NESC loaned the fixture for use by students until FAJRI fabricated a duplicate fixture. According to Dr. Nassar, the fixture was instrumental in aiding undergraduate and graduate students in their research.

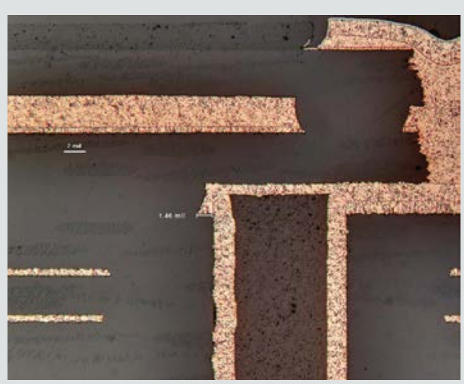
Dedicated Nano-launcher for Small Spacecraft

The Office of the Chief Technologist's (OCT) Small Spacecraft Technology Program (SSTP) seeks to advance and validate the utility of small spacecraft to execute space missions. To accomplish its goals, SSTP needs efficient and cost-effective access to space. Currently SSTP relies on a rideshare strategy but prefers a dedicated, affordable nano-launcher. The NESC is providing propulsion expertise to an OCT study team formed to examine the existence, maturity, and feasibility of dedicated SSTP nano-launcher systems.

Testing of low-cost engines for nano-launcher upper stage.

Assessment of Maxwell SBC Panels

The NESC received a request from the Chief of the GSFC Electrical Engineering Division to perform an independent assessment of the Maxwell single board computer (SBC) printed circuit board (PCB) panels. This assessment was designed to identify if the earlier PCB manufacturing problems had been resolved and identify any other problems early in the manufacturing process of the PCB, giving NASA greater insight about the reliability of the SBC PCB. In this ongoing assessment, the NESC team has been preparing and evaluating coupon microsections from current SBC panels to review the interconnect stress test data.



Partial coupon microsection illustrates measurement of internal annular ring and solid copper microvia structures at upper right edge.

GENERAL

High Fidelity Data Acquisition System Development

Current ground data acquisition systems offer high dynamic range and sample rates for multiple measurement channels. In contrast, flight data acquisition systems do not generally offer the same level of measurement fidelity due to the low technology readiness level associated with higher performing electronics. Specifically, current generation 24-bit analog-to-digital electronics have not been packaged and tested to expected launch vehicle/spacecraft environments. Limited flight data acquisition options increases the risk for flight test and launch programs to provide adequate data quantity and quality to meet users' needs for vehicle performance characterization.

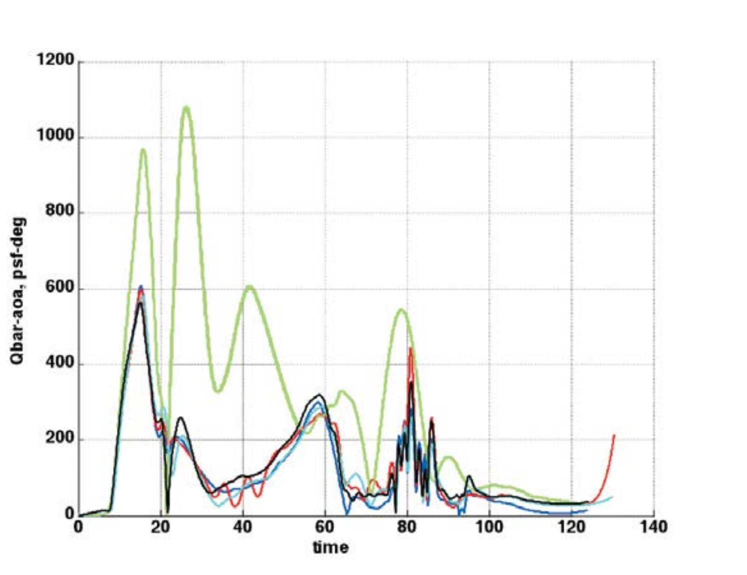
HiDAQ team members with fabricated rapid prototype unit.

To address the identified deficiency, the NESC created the multi-Center High Fidelity Data Acquisition System (HiDAQ) Project Team. The primary objective was to develop a prototype data acquisition unit capable of operating within specified flight environments, while delivering high fidelity data acquisition needs. The team baselined a set of performance, functional, and operational requirements for the HiDAQ demonstration unit. These requirements were used in multiple design and analysis cycles to define a configuration capable of meeting a broad range of data acquisition and avionics needs. The prototype unit design and supporting analyses were evaluated by multiple NESC Technical Discipline Team members during the HiDAQ design review.

The team has moved into the fabrication and development testing phase. The aluminum housing has been fabricated, and the high-quality analog-to-digital boards, capable of recording up to 102,400 samples per second with over 18 effective bits dynamic range, have been delivered for performance testing. The prototype will be capable of measuring 48 channels, with prescribed sensor power options for a variety of dynamic sensor types. Unit integration and environmental testing is scheduled to occur in 2013.

Development of Verification Data for Flight Simulations

Flight simulations are increasingly relied upon to aid in design optimization, reduce risk and development costs, and provide overall flight prediction of aerospace vehicle designs. Independently developed tools are typically used to perform these simulations, and this independence provides valuable cross-checking between the analyses conducted by project partners. However, the fundamental aspects of the simulation frameworks are implemented differently, which can lead to disagreement in predictions. In this ongoing NESC assessment, the team will provide test cases, which will verify that the underlying equations of motion (force and moment summation, moment transfer, acceleration and velocity integration, state propagation) and the basic models (gravity, geodesy, atmosphere) of a simulation framework are implemented properly. These test cases will serve as a benchmark for simulation frameworks used by NASA and others, and are expected to result in higher productivity and confidence in flight simulation predictions.



Comparisons between five simulations for an early Ares I-X concept.

GENERAL

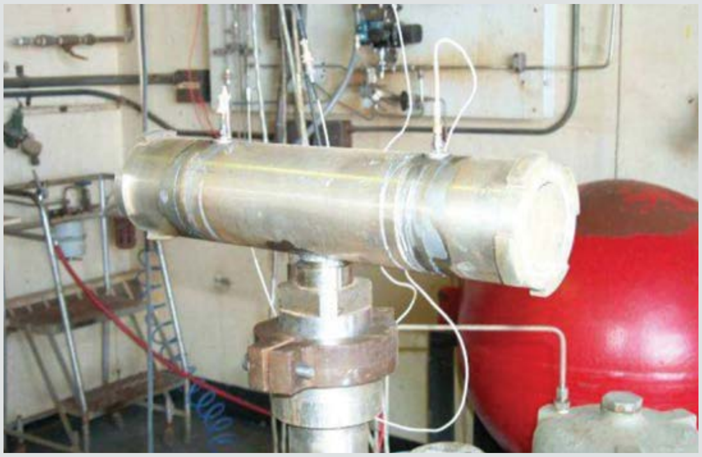
Development of a NASA Fault Management Handbook

Fault Management (FM) is an evolving field that includes fault tolerance, fault mitigation, fault protection, and system health management. It is most often affiliated with systems engineering and/or software engineering. FM plays a critical role in ensuring safe and reliable spaceflight, for both robotic and crewed missions. FM systems prevent or detect, isolate, diagnose, and respond to anomalous and failed conditions interfering with nominal mission operations. NASA engineers have established varied techniques and approaches for designing, implementing, and testing FM systems for spacecraft, launch vehicle, aeronautical vehicle, and ground system applications. Although NASA's FM systems have performed successfully, their implementation has, in some cases, adversely stressed programmatic and engineering resources. Flight projects have suffered from unexpected cost growth and schedule slips during final FM system integration and test. NASA needs reliable and affordable FM systems that are developed with the engineering rigor of other safety critical processes. Vetted recommended best practices and engineering guidelines are needed to establish an Agency-wide systematic engineering process for the design and development of NASA's FM systems.


FM systems play a prominent role within NASA's aeronautics, human, and robotic spaceflight missions.

Recognizing that FM systems increase safety, reliability, availability, and performance in NASA's systems, the NESC, in collaboration with JPL, has developed a NASA Fault Management Handbook, NASA-HDBK-1002, to provide overarching conceptual engineering guidelines and recommended best practices.

The handbook is in the NASA Standards Program Office System, and has completed a comprehensive Agency-level review process. The insights and concepts captured in this handbook provide a basis for moving the discipline toward a formal and consistent methodology. Application on future programs may help to avoid program cost overruns, schedule slips, in-flight failures traceable to a lack of established approaches, and disciplined and systematic FM development techniques.


T-burner test rig used for obtaining combustion response data.

Assessment of Combustion Instability in Black Brant Motors

The Black Brant motor has experienced combustion stability events during flight. To understand the cause of instability and ensure that the appropriate mitigation steps are taken, the motor combustion stability model needs to be updated. An NESC assessment team will use combustion response data generated by the Sounding Rocket Project Office to update the combustion response characteristics of the baseline and modified motor propellant. Analysis with this updated characteristic will increase understanding of the current motor configuration and insight into its stability characteristics.

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The NESC remains committed to being a value-added reso
whose efforts span a wide range of NASA programs and p

Human Exploration and Operations


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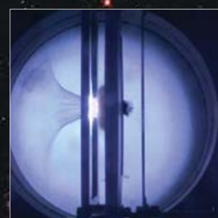
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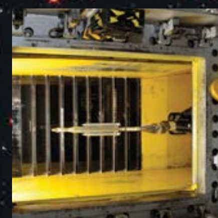
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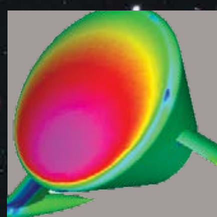
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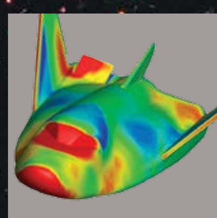
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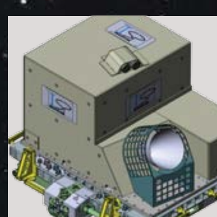
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Science

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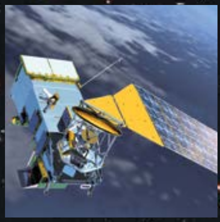

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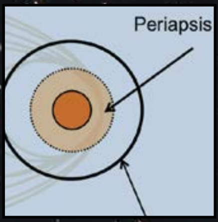

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General

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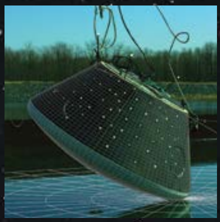

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SCIENCE

Mars Science Laboratory Ground Test and Checkout

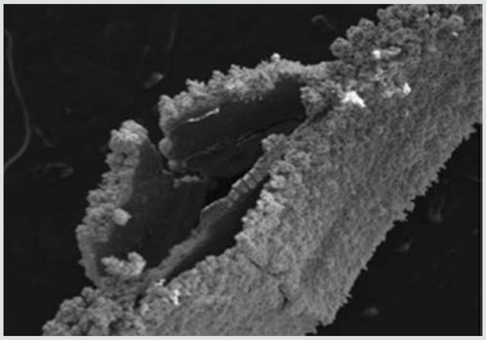
JPL requested the NESC provide technical expertise after several close calls were experienced during the Mars Science Laboratory (MSL) ground test and checkout activities. The NESC effort consisted of two primary tasks: reviewing procedures for critical ground processing operations, specifically flight hardware lifts and hoists, for potential human factors engineering and other technical issues; and reviewing the data, findings, and corrective actions from the incident documentation to identify potential gaps and/or recurring factors.

A lift/hoist procedure review resulted in several recommendations, which were implemented by the MSL Ground Processing Team. This review resulted in follow-on consultations regarding critical LaRC and GSFC lift/hoist operations. The close-call recurring cause analysis identified the top four proactive risk reduction opportunities, which the NESC made recommendations to address as they have the potential to adversely affect future missions.

Fitting of the aeroshell to the Mars Science Laboratory rover and sky crane.

Hubble Space Telescope Attitude Observer Anomaly

The Hubble Space Telescope (HST) experienced occasional losses of lock during fine guidance sensor guide star acquisitions, threatening a potential loss of science. These acquisition losses were associated with an increasing disparity between the fine guidance sensor-derived estimates of gyroscope bias calculated in orbit day and those calculated in orbit night. The attitude observer anomaly was the result of corrosion of the multiple flex leads, each the diameter of a human hair, which serve as the internal electrical connection to the gyroscope float. The NESC is supporting the HST Project by updating gyroscope life predictions and developing a new multidisciplinary model of the gyroscope flex lead degradation physics.



Micrograph of buckled nickel-silver motor flex lead found on a gyroscope returned from HST. Corrosion was due to submersion of lead in gyroscope fluid.

Chandra X-Ray Observatory COPV Risk Assessment

The Chandra X-Ray Observatory (CXO) Project requested evaluation of the integral propulsion system (IPS) composite overwrapped pressure vessel (COPV) hydrazine propellant tank to elevated temperatures. The investigation focused on concerns of composite overwrap stress rupture and metallic liner/hydrazine compatibility. Comparison of overwrap stress levels to current stress rupture assessment guidelines determined the IPS tank has a relatively low failure risk. The absence of long-term hydrazine/liner compatibility data identified the potential for increased risk for surface corrosion, stress corrosion cracking, and/or environmentally assisted crack growth. The NESC recommended the CXO Project obtain the necessary hydrazine exposure information to estimate any change in relative risk.

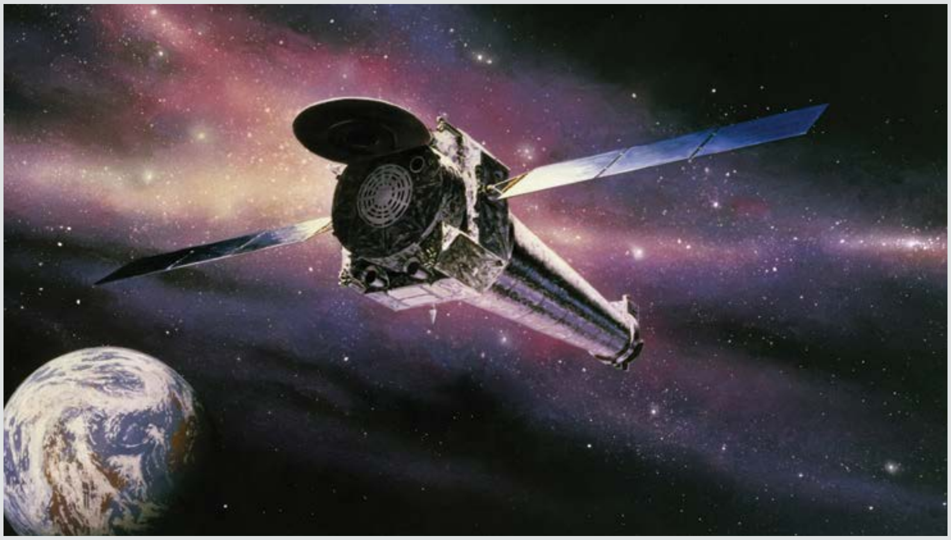


Illustration of Chandra X-Ray Observatory.

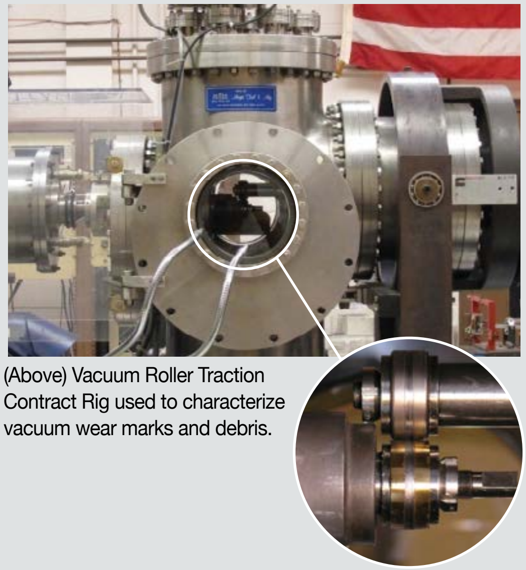
The advanced Stirling heater head is shown on the left side of the subassembly.

ASRG Heater Head Critical Flaw Analysis

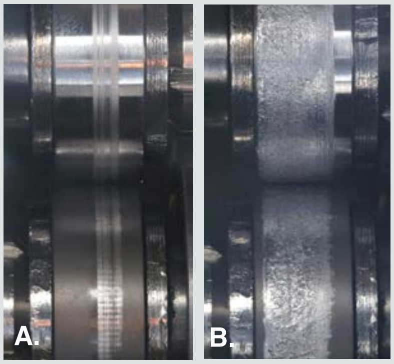
The NESC performed a technical assessment of the Advanced Stirling Radioisotope Generator (ASRG) heater head component to evaluate flight hardware acceptance criteria. Metallic oxides found in the heater head material act as embedded flaws, presenting a risk of fatigue failure during dynamic stress environments. The NESC determined that the use of traditional analytical methods to predict the maximum allowable flaw size was not appropriate due to the thin heater head wall thickness. The NESC also provided technical expertise to develop test methods for evaluating the critical flaw size and acceptance criteria.

JWST NIRSpec Microshutter Subsystem Investigation

The NESC provided an independent assessment of the James Webb Space Telescope (JWST) Near Infrared Spectography (NIRSpec) Microshutter Subsystem life test results. Although the mechanisms' performance met the two time design life requirement, debris noted during post-test inspection is a concern for instrument operation. The NESC team evaluated the effect of contamination on the instrument's performance and conducted a series of tests to determine when debris generation begins. Results of the engineering tests led to an NESC recommendation for a design modification to reduce the contamination potential. A follow-on assessment was initiated to evaluate alternate materials with results expected by February 2013.



(Above) Vacuum Roller Traction Contract Rig used to characterize vacuum wear marks and debris.

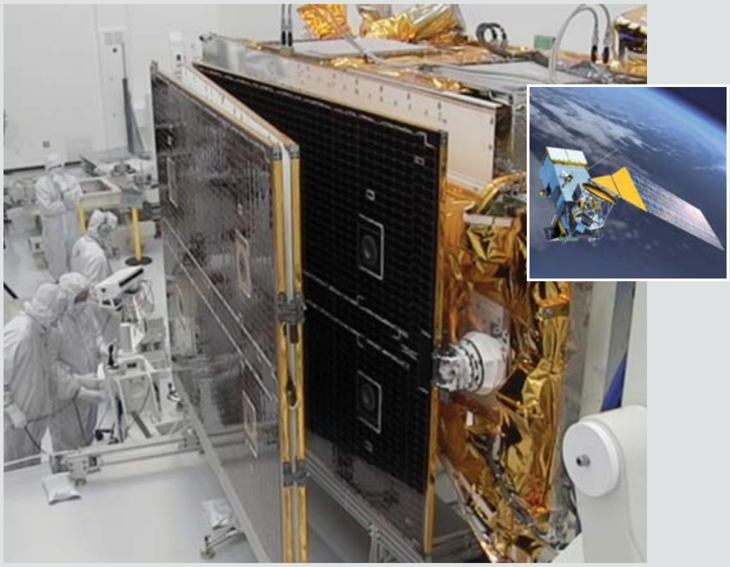


A. Rollers after 588 cycles. **B.** Rollers after 77,357 cycles. Rollers have a 1.5 degree misalignment.

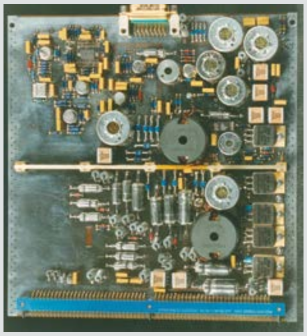
SCIENCE

NPP Solar Array Deployment Torque Margin Assessment

The NESC provided technical expertise for the National Polar-orbiting Operational Environmental Satellite System (NPOESS) Preparatory Project (NPP) solar array low torque margin investigation. The NASA Technical Fellow for Mechanical Systems provided an independent review of the contractor deployment margin analyses and tests. The torque margins were identified as not meeting project requirements during spacecraft final integration and test. At the recommendation of the NASA Technical Fellow, several tests were conducted, the analyses were updated, and hardware modifications were made, resulting in a more accurate (less uncertainty) margin determination. Final results were presented to the NPP and the Director of the National Oceanic and Atmospheric Administration. The NPP solar arrays were successfully deployed after launch.



(Above) NPP Satellite Solar Array Deployment Test. (Inset) NPOESS satellite.



CAPS low voltage power supply circuit board.

Southwest Research Institute

Cassini Spacecraft Electrical Anomaly

The NESC provided technical expertise for the Cassini spacecraft short circuit anomaly investigation. This anomaly was initially believed to have been caused by a capacitor short circuit in the Cassini Plasma Spectrometer (CAPS) instrument low voltage power supply. After thoroughly reviewing the available telemetry, and locating comparable vintage components, the NESC team determined that tin whiskers emanating from tin plate inductor covers were the most likely source for the short circuits experienced. The primary conclusions found that there was low risk associated with resuming CAPS operation, provided sufficient power margin was available from the radioisotope thermal generator.

Design Concept for New Sounding Rocket Sustainer Motor

NASA's Sounding Rocket Program (SRP) in the Science Mission Directorate (SMD) provides low-cost opportunities to conduct leading edge research. The SRP workhorse motor, used alone or as part of a multistage rocket, is a 1960s design manufactured in Canada. After years of reliable performance, recent flights have experienced various performance issues. A NASA internal design initiative takes advantage of modern design tools and production practices needed to ensure reliability of future sounding rocket missions.

The NESC formed a multi-Center team and developed a conceptual design of a new sounding rocket motor that met SRP performance and cost requirements. Propellant characterization and scale-up testing were completed in partnership with the U.S. Army. Various motor development options were studied and presented to the SRP Office.

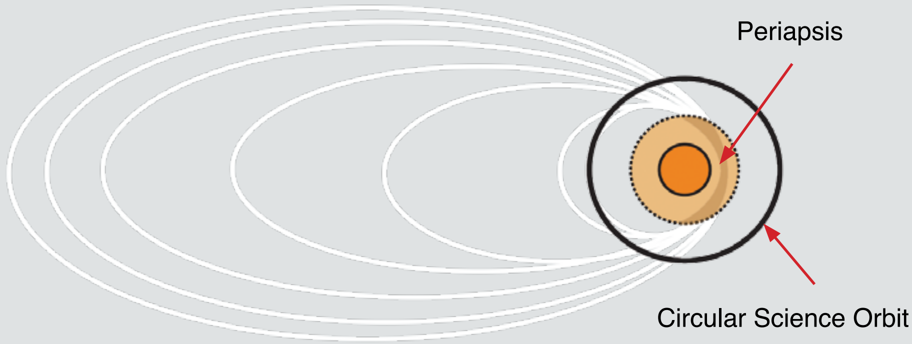
The NESC-led team advanced the motor design to the preliminary design review level. The SMD approved design development plan includes one ground hotfire test and three development flights. The next development phase will be completed under SMD sponsorship with additional support provided by the Office of the Chief Engineer and the Human Exploration and Operations Mission Directorate.

The Black Brant sounding rocket motor (black upper stage), operational since the 1960s, is the workhorse of NASA's SRP.

SCIENCE

Development of an Autonomous Aerobraking Capability

NASA uses aerobraking to reduce the propellant required to deliver a spacecraft into its desired final orbit around a target planet or moon with a significant atmosphere. While aerobraking reduces the propellant required to reach the final orbit, this reduction comes at the expense of added orbital insertion time (typically 3 to 6 months), continuous Deep Space Network (DSN) coverage, and ground staff to continuously monitor the spacecraft during the aerobreaking maneuvers. The requirements for ground monitoring and trajectory updates introduces potential error due to the communication lag between Earth and the spacecraft, including a reduced ability to correct aerobraking maneuvers in the final orbital insertion stages.



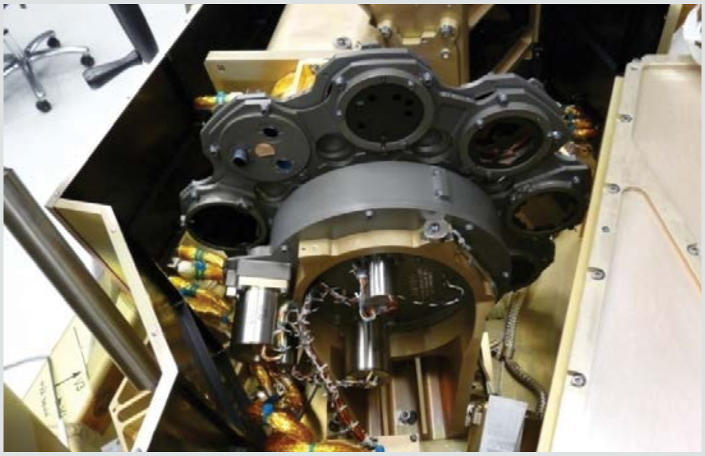
Aerobraking is used to reduce the propellant required to deliver a spacecraft into its desired final orbit around a target planet or moon that has an atmosphere.

An NESC team is developing the capability to move the iterative ground-based process to an onboard autonomous aerobraking maneuver process. Autonomous aerobraking allows onboard flight corridor evaluation and apoapsis maneuver calculations, offering mission cost avoidance by reducing ground operations staff and DSN coverage demands. These onboard processes include a state (orbital position) propagator, atmospheric density modeling, critical spacecraft element thermal modeling, and maneuver strategy logic. This model and algorithm suite is known as the Autonomous Aerobraking Development Software (AADS).

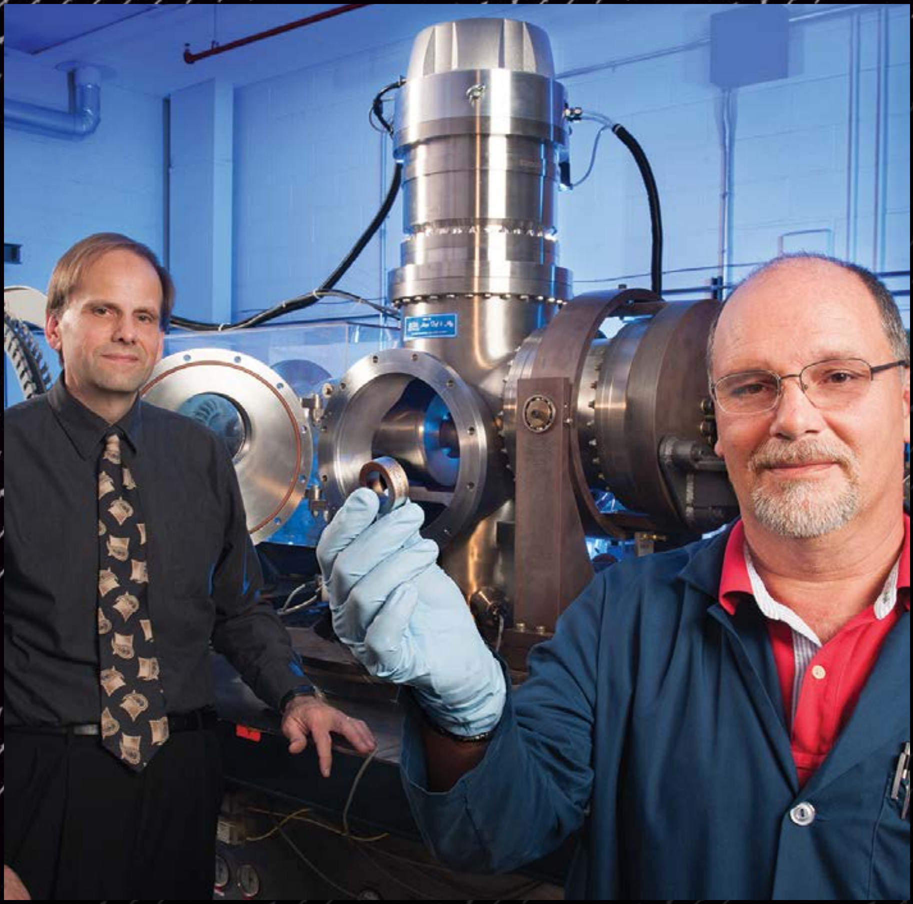
Phase 2 of this NESC study focused on AADS model updates and increased fidelity, Program to Optimize Simulated Trajectories II (POST2) simulation environment enhancements, and preparation for testing on a flight-like hardware-in-the-loop testbed. A new state propagator was developed with an architecture tailored for onboard spacecraft applications. This onboard tool improves the state determination and estimation, reducing position and timing errors in the prediction of the next periapsis state, which is critical in improving the performance of the atmosphere estimator. Concurrently, the auto-navigation tool will be incorporated as a separate option for state propagation. The atmosphere estimator development provided uncertainty estimates associated with the atmospheric density predictions, which are critical in understanding the predicted density confidence level of the next periapsis. The maneuver estimator was developed using these density uncertainties to bias the calculated maneuver. The estimates of the previous atmospheric passes' density (in addition to density prediction) allow the maneuver estimator to keep the spacecraft within a safe aerobraking corridor. The simulation environment improvements integrated the AADS with the latest POST2 version. Spacecraft models are being incorporated to allow for 6 degrees-of-freedom simulation analyses. AADS's accuracy performance was improved from Phase 1. Ultimately, AADS will be targeted for inclusion on a future spacecraft mission for flight evaluation in a "shadow mode," where onboard autonomous aerobraking commands would be compared to ground-based aerobraking commands. Once shadow mode flight validation is successfully completed, autonomous aerobraking could be used as the prime aerobraking operations strategy for subsequent missions.

JWST Fine Guidance Sensor Motor Anomaly

The James Webb Space Telescope (JWST) Project has experienced a lingering problem with a failed fine guidance sensor dual wheel mechanism. Technical expertise to the Material Review Board was requested to help determine the root cause and to provide corrective actions. The NESC provided support in reviewing the design and recommending modifications that would result in meeting mechanism life requirements. Design change implementation is expected by early 2013.



JWST fine guidance sensor filter wheel mechanism.



Center Focus

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Dr. Timothy Krantz (left) and Richard Manco at the GRC vacuum roller rig.

Nans Kunz
NESC Chief Engineer at ARC

Ames Research Center

21
ARC employees contributed to NESC assessments

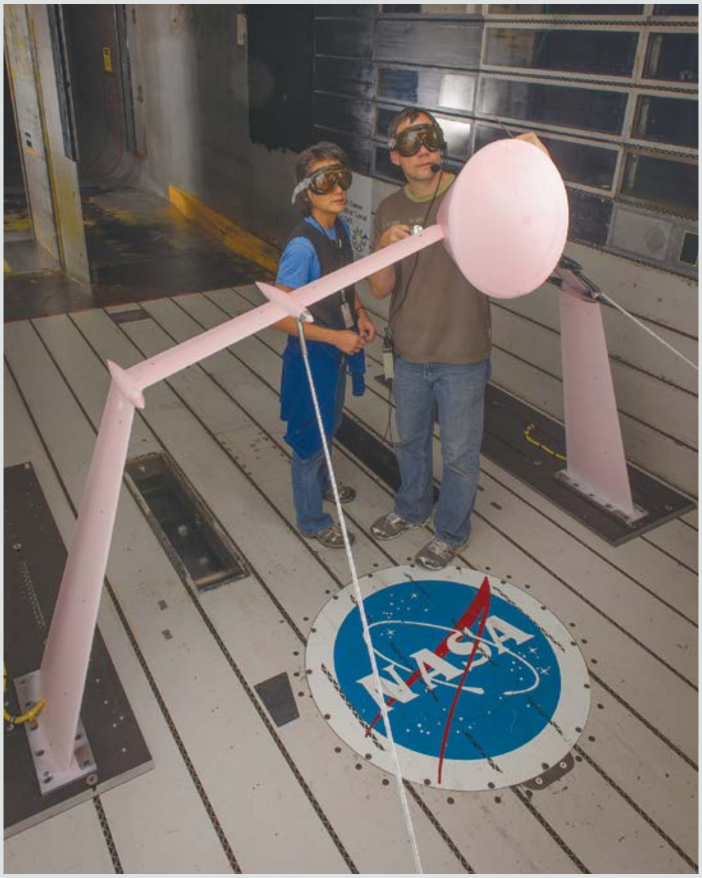
The Ames Research Center (ARC) has a diverse set of capabilities and specialized engineering expertise, including aeronautics; arc jet facilities; life sciences; human factors; astronomy; astrophysics; entry, descent, and landing; thermal protection systems; and computational fluid dynamics (CFD) supporting a variety of Agency programs and NESC activities. This past year, these capabilities and expertise supported more than 10 NESC assessments and 11 NASA Technical Fellow Technical Discipline Teams (TDTs). The NASA Technical Fellow for Human Factors is resident at ARC.

In support of aerodynamics assessments, ARC has unique infrastructure such as multiple wind tunnels, including the world's largest, and one of the world's most powerful computers running state-of-the-art CFD simulations/analyses. In this area, ARC led a major NESC assessment related to the Orion crew module Capsule Parachute Assembly System (CPAS) wake deficit investigations.

CPAS Wake Deficit Wind Tunnel Test

Dr. James Ross has spent the last several years coordinating ARC wind tunnel testing that has helped define the aerodynamic and loads databases for the Orion Multi-Purpose Crew Vehicle (MPCV) Program while also supporting multiple NESC assessments and Aerosciences TDT-related activities. As part of these support activities, he and the Orion MPCV Aerosciences Team noticed the analysis methods used with the test data to build the aerodynamic database showed poor accuracy in some flight regimes, particularly for subsonic/transonic flight. To address these shortcomings, Dr. Ross proposed a plan to measure the flow field around a generic reentry crew module. Recently completed, this NESC-sponsored test, led by Dr. Ross, obtained a data set that includes pressure distributions from pressure sensitive paint, skin friction, and boundary layer surveys on the heatshield; infrared thermography to visualize transition to turbulent flow and flow separation; and off-body particle image velocimetry (PIV) flow measurements. The PIV measurements are of particular interest to the Orion MPCV Program to validate estimates of the wake velocities used for the parachute system design. Dr. Ross stated, "The investment that the NESC made in funding this work has provided unique data for the validation of computational aerodynamics tools and has enhanced our ability to obtain measurements that have already benefited other NASA programs."

Dr. James Ross prepares a model of the Orion crew module, coated with pressure sensitive paint, in the ARC Unitary Plan Wind Tunnel.



Gloria Yamauchi and J. T. Heineck inspect the model of the Orion crew module prior to a laser profilimeter test at ARC.

CPAS Wake Deficit Wind Tunnel Test PIV Measurements

Mr. J. T. Heineck and Dr. Gloria Yamauchi obtained their PIV expertise along different paths. Mr. Heineck began scientific photography as an extension of his work as an ARC staff photographer. This interest led him to work at the ARC Fluid Mechanics Laboratory advancing a variety of novel flow measurement and visualization techniques. Dr. Yamauchi, of the ARC Aeromechanics Branch, has performed research in rotorcraft aerodynamics for most of her ARC career, and adopted PIV to obtain detailed flow field velocity measurements around a full-scale rotor in the National Full-Scale Aerodynamic Complex. While Mr. Heineck and Dr. Yamauchi have collaborated for many years, the NESC CPAS wake deficit test required the best from them to obtain the necessary measurements the Orion crew module parachute designers needed to verify key design assumptions. After completing the test, Dr. Yamauchi stated, "Keeping two independent PIV systems operational in the 11-foot by 11-foot transonic test section of the Unitary Plan Wind Tunnel was definitely a challenge." In spite of the test difficulty, Mr. Heineck appreciated the challenge and the opportunity and stated, "Our ability to measure the flow in a production wind tunnel has definitely benefited from the investment the NESC made in this test."

Dryden Flight Research Center

Dr. James F. Stewart
NESC Chief Engineer at DFRC

12
DFRC employees contributed to NESC assessments

The Dryden Flight Research Center (DFRC) provided technical expertise to the NESC for numerous activities, including the Alternative Fuel Effects on Contrails and Cruise Emissions Probing Aircraft Flight Test Hazard Mitigation Assessment; flight simulations to support the development of verification data for flight simulation; use of commercial off-the-shelf avionics safety-critical avionics systems for commercially crewed spacecraft; and arc jet testing as part of a review of Apollo thermal protection system test data to support the Orion Multi-Purpose Crew Vehicle development. DFRC engineers are members of NESC Technical Discipline Teams (TDTs) and have supported numerous TDT investigations.

Contributing Programmable Logic Devise Expertise

Mr. Mike Delaney is a DFRC instrumentation engineer and a member of the NESC Avionics TDT, where he is the chair of the Programmable Logic Devices (PLD) subcommunity of Practice (CoP). The PLD CoP website is on the NASA Engineering Network and has been used to inform the technical community of issues found in devices from two manufacturers. Mr. Delaney presented the PLD state-of-the-discipline briefing at the Avionics TDT annual meeting. Mr. Delaney stated, “It has been a great experience and I gained more knowledge on how the space side of NASA does avionics. In particular, what I’ve learned about device reliability and screening will be very useful on upcoming designs. I also got the opportunity to explain how the Dryden aircraft could be used for space research and technology risk reduction efforts.”

Dr. Gregg Bendrick, member of the NESC F-22 Assessment Team.

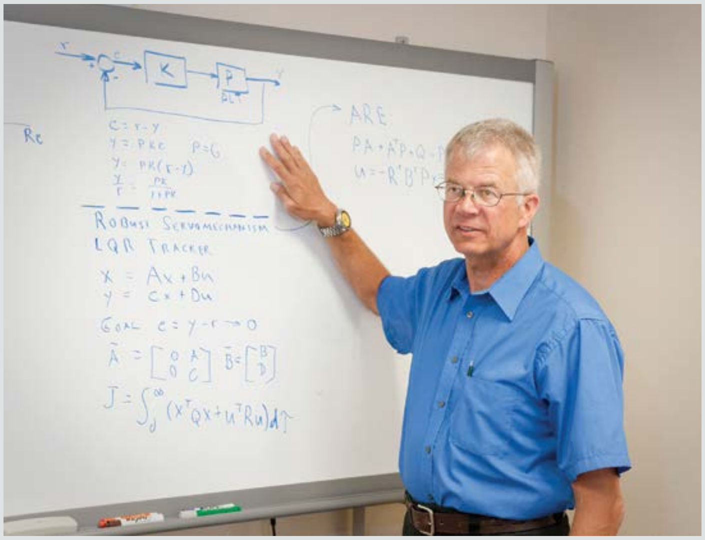
U.S. Air Force F-22 Life Support System Investigation

Dr. Gregg Bendrick, DFRC Chief Medical Officer, was a member of the NESC assessment formed to assist the U.S. Air Force in addressing hypoxia problems in the F-22 fighter aircraft. “It was a lot like being on a special ops team,” said Dr. Bendrick in describing his experience with the NESC. “By taking a dozen or so highly qualified individuals with different areas of expertise, we were able to provide some cross-cutting analysis for the Air Force that was helpful in finding the root cause, or rather the root causes, of this very complex issue.” Moreover, the experience gave Dr. Bendrick new insights on NASA’s capabilities. “By working with the other team members at the NESC, not only did I learn a lot about other peoples’ work disciplines, but I realized that NASA has a tremendous resource here in the NESC that can be used to address all sorts of complex technical issues in the future.”

Aircraft Flight Control TDT Training Development

Mr. John Burken is a DFRC engineer with over 36 years experience in control law design and a member of the Guidance, Navigation, and Control TDT. Mr. Burken developed a Fundamentals of Aircraft Flight Control Tutorial. This tutorial explores formal academic control theory and design implementation. This may help control designers to be more efficient and reduce the design cycle time. Mr. Burken stated, “All my work experience has been with atmospheric vehicles. Due to my interaction with the NESC, I have found it refreshing to work outside my ‘atmosphere’ and recognize the interesting challenges of spacecraft controls.”

Mike Delaney, Chair of the PLD subcommunity of practice.



John Burken reviewing his NESC Flight Control Tutorial.

Dawn C. Emerson
NESC Chief Engineer at GRC

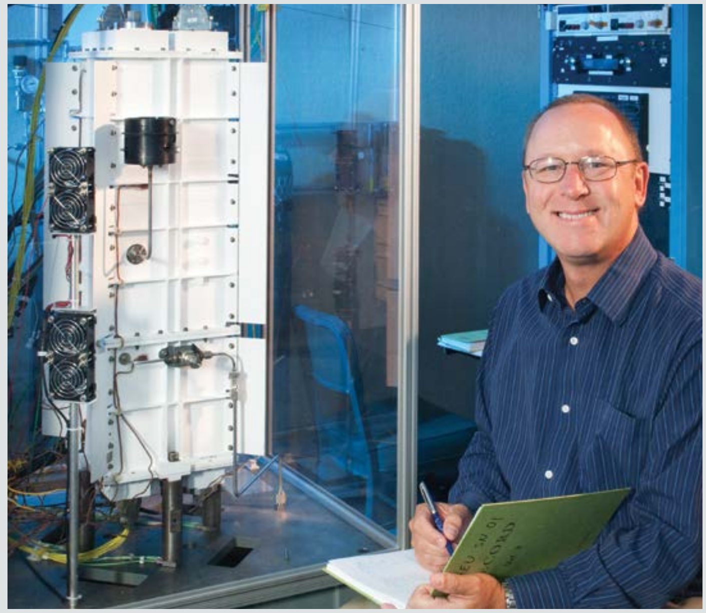
Glenn Research Center

47
GRC employees contributed to NESC assessments

The Glenn Research Center (GRC) provided a broad spectrum of technical expertise in support of NESC assessments and NESC Technical Discipline Teams. Using expertise in composite pressure vessel mechanics and modeling capabilities, GRC personnel supported an in-depth study and thermo-mechanical analysis of the Chandra X-Ray Observatory propellant tanks, alleviating concerns of stress rupture failure. In support of the Crew Module Water Landing Modeling Assessment, GRC experts used acceleration, pressure, and strain data from water drop tests to validate models, and improve modeling and simulation strategies. Results have led to higher fidelity water landing structural response predictions to support improved vehicle designs. GRC provides expertise in tribology and mechanical components to numerous NESC assessments, including producing a corrosion-immune shockproof bearing. This proof-of-concept hardware, made from an emerging nickel-titanium superelastic alloy, could replace conventional bearing alloys in applications such as the International Space Station (ISS) urine processor. GRC provided power system expertise to identify and evaluate failure mechanisms causing short circuits within the Cassini spacecraft, resulting in technical guidance necessary to resume safe operation of the plasma spectrometer.

Expertise in Nuclear Systems Benefits Cassini Investigation

Mr. Lee Mason is Chief of the GRC Thermal Energy Conversion Branch. His 25-year NASA career has focused on space power and propulsion technology development, with an emphasis on nuclear systems. His expertise has been crucial in aiding the Advanced Stirling Radioisotope Generator (ASRG) Flight Project. According to Mr. Mason, "My primary role is to oversee the transition for the high efficiency Stirling engine technology from laboratory test devices to highly reliable flight units." The ASRG will reduce the plutonium fuel requirements by more than a factor of four compared to radioisotope thermoelectric generators (RTGs). Mr. Mason provided assistance in evaluating the inspection and structural analysis of ASRG heater head oxide inclusions. His background was utilized for the NESC assessment of Cassini RTG electrical power shorts. Mr. Mason led the RTG root cause investigation, which included support from JPL and Orbital Sciences Corporation experts. Mr. Mason indicated, "We had to dig through test reports that were written many years before the 1997 launch. Fortunately, the engineers kept good records and we were able to pinpoint the likely causes for the apparent current leakage that was observed with the faulty RTG."



Lee Mason with the ASRG engineering unit.

Dr. Timothy Krantz (left) and Richard Manco at the vacuum roller rig.

Expertise in Mechanical Components and Tribology

In support of the James Webb Space Telescope Near-Infrared Spectrograph Microshutter Subsystem Assessment, Dr. Timothy Krantz, assisted by engineering technician, Mr. Richard Manco, performed wear tests using GRC's vacuum roller rig to quantify interface wear and develop recommendations regarding debris generation. Dr. Krantz was first employed by the Army Research Laboratory and since then has performed research at GRC for 25 years. His work has centered on improved gearboxes and drive systems for rotorcraft. This skill set and tools have proven invaluable to spacecraft mechanical system concerns. Dr. Krantz stated, "Research for rotorcraft drive systems has required me to obtain experience and skills in many aspects of mechanical systems. I've had to explore system-level effects on loads and motions, material strength and integrity, dynamics, efficiency, manufacture of precise geometry, wear, lubrication, reliability, and qualification testing. My coworkers and I have quickly adapted analysis codes and test rigs created for rotorcraft research to the NESC's assessments for spacecraft." Dr. Krantz has contributed to NESC efforts for Space Shuttle orbiter rudder speed brake gear margins, body flap actuator and rudder speed brake bearings, rudder speed brake gear chipping, and ISS Solar Alpha Rotary Joint Anomaly for which he received the NESC Engineering Excellence Award.

Goddard Space Flight Center

Timothy G. Trenkle
NESC Chief Engineer at GSFC

58
GSFC employees contributed to NESC assessments

The Goddard Space Flight Center (GSFC), including the Wallops Flight Facility, participated in a wide range of NESC activities. The NASA Technical Fellows for Avionics; Electrical Power; Guidance, Navigation, and Control (GNC); Mechanical Systems; and Software are resident at GSFC. GSFC personnel participated on Agency-wide teams to perform independent technical assessments and reviews and contributed technical expertise to programs, including the James Webb Space Telescope (JWST) Near-Infrared Spectrograph Micro-shutter; the JWST fine guider sensor motor; the Geostationary Operational Environmental Satellite – (GOES-R) series reaction wheels; the Hubble Space Telescope (HST) attitude observer; and the Cassini Plasma Spectrometer (CAPS) short investigation. NESC discipline activities that benefited GSFC projects included single-board computer producibility improvements; guidelines for the use of commercial off-the-shelf electrical, electronic, and electromechanical parts; green propellant research; and best practices for updating acoustics environments using flight data.

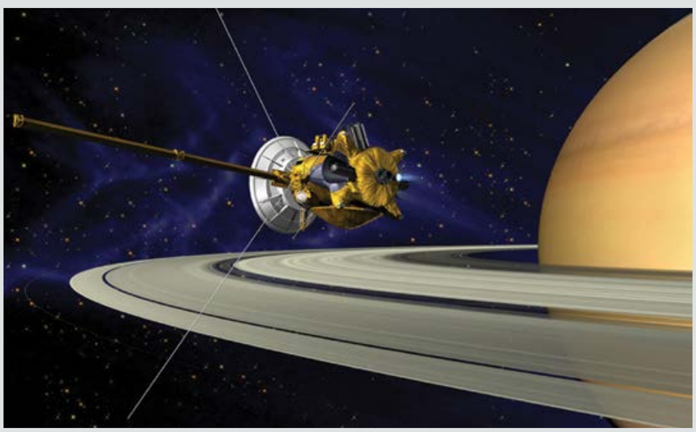


Illustration of Cassini spacecraft near Saturn.

PSpice Circuit Analysis for CAPS Power System Short Circuits

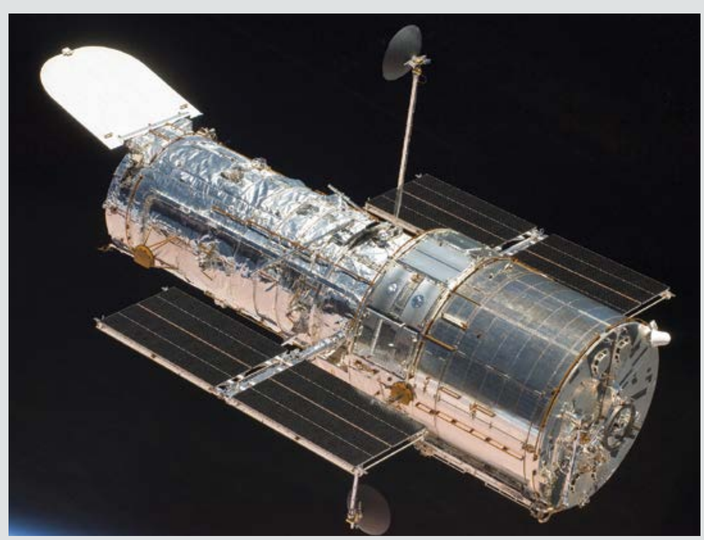
Ms. Amri Hernandez-Pellerano, a power system electronics designer in the GSFC Power Systems Branch, is involved in the design and implementation of power system electronics for scientific spacecraft. When the CAPS instrument encountered multiple short circuits on the power system causing operations to be temporarily halted, the NESC was requested to provide technical expertise to determine root cause and the risk of returning the CAPS to service. Ms. Hernandez-Pellerano generated detailed PSpice circuit simulations of the CAPS low-voltage power supply front-end interface to the radioisotope thermoelectric generator-based power bus. The simulations aided in characterizing the short circuit conditions, which allowed the NESC team to identify tin whiskers as the proximate cause of the shorts. CAPS was reactivated to support the Enceladus flyby. Ms. Hernandez-Pellerano stated, “The NESC has provided me the opportunity to participate in investigation teams where there is an interaction of experts from other NASA Centers, industry, and academia. It has been a tremendous experience to be part of and contribute in several investigations and assessments where there is an exchange of new perspectives, technical information, analysis methods, and opinions. It has been an honor to collaborate with team members external to GSFC and expand interaction with in-house personnel.”

Amri Hernandez-Pellerano

Analysis for Hubble Space Telescope Gyro Attitude Observer Anomaly

Mr. David Mangus is a GSFC aerospace engineer with over 30 years of experience in GNC systems and has been a member of the NESC GNC Technical Discipline Team since its inception. Mr. Mangus served on the NESC team that supported the HST Attitude Observer Anomaly (AOA) Review Board, where his knowledge of the HST attitude determination and control system provided indispensable technical insights into the origins and impacts of the HST AOA problem. Mr. Mangus developed concepts for analyzing the HST gyro telemetry data to update the existing gyro reliability models and to provide guidance to the HST Flight Operations Team to best manage gyro resources. The HST team followed the NESC recommendation to add open-loop anomaly compensation in the on-board flight software and is operating in this mode using three of six gyros. The other three gyros are maintained in a standby mode to conserve their remaining life. The NESC continues to support the HST Program by updating gyroscope life predictions and by developing a multidisciplinary model of the gyroscope flex lead degradation physics. Mr. Mangus stated, “Working with the NESC has been a major highlight of my career. Interacting with other Center engineers and teams on challenging assessments, and understanding their methodology and capabilities, has greatly expanded my resources for future collaboration.”

David Mangus



Hubble Space Telescope on orbit.

R. Lloyd Keith
NESC Chief Engineer at JPL

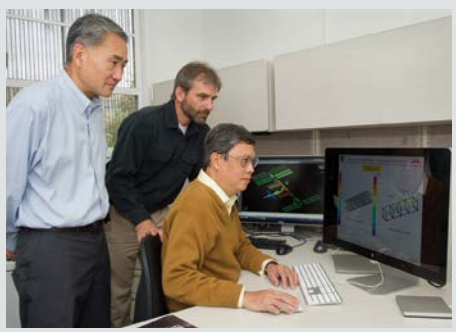
Jet Propulsion Lab

102
JPL employees contributed to NESC assessments

The Jet Propulsion Laboratory (JPL) participated in numerous NESC assessments and contributed to NASA Technical Fellows Technical Discipline Team (TDT) investigations. JPL engineers led the NESC's Orion Crew Module Water Landing Modeling Assessment, with data and analyses being provided to the Orion Multi-Purpose Crew Vehicle Program and to the Commercial Crew Program providers to aid in their capsule recovery environment and modeling tools. The NESC Composite Pressure Vessel Working Group developed a test plan for stress rupture, based on needs identified in previous NESC assessments. JPL provided critical support to a number of NESC assessments, including software tools, battery usage in operational missions, and pyrovalve reliability. Technical assessments were completed for the Cassini Plasma Spectrometer instrument and for the Mars Science Laboratory aero/reaction control system interaction model validation and evaluation of hardware handling near misses. JPL is developing thermal protection system thermal performance and entry, descent, and landing (EDL) databases to gather and secure at-risk historical data. The JPL-led Robotics Operations TDT is working several tasks to advance robotic exploration and to look across disciplines and missions to understand and influence the current state of the discipline.

Supporting the International Space Station

Mr. H. Q. Pham is the thermal team lead for the ISS Solar Array Wing Mast (Fast Mast) Shadowing Characterization Assessment. The goal of the test was to empirically assess the mast structural capability when exposed to expected nonuniform solar exposure, and to understand whether the ISS operational envelope can be safely expanded.



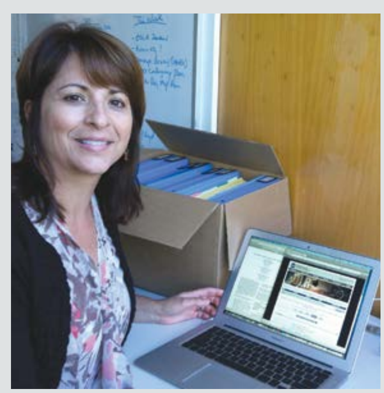
(Left to right) E. Sunada, D. Klein, and H. Pham reviewing ISS Fast Mast temperature predictions.

The NESC team delivered the mast test article to JPL, set up the test article prior to thermal vacuum (TVAC) testing, conducted the TVAC test, and performed the post-thermal/structural test correlation to map test article temperatures to the structural model. Since the TVAC test, a thermal model correlation has been successfully completed. Mr. Pham indicated, "NESC provided me with a unique opportunity to support an inter-Agency project with colleagues from various NASA Centers and industries. This experience helped me to develop new skills that I can apply to future projects that involve diverse, multi-Center multidisciplinary teams working in fast-paced environments."

Developing the EDL Repository

Ms. Elmain Martinez has been a JPL systems engineer and software developer for over 20 years. When the opportunity to work with the NESC as a team lead for an EDL repository project came available, she jumped at it. The team consisted of EDL experts, software developers, and information specialists to develop a NASA engineering archive for EDL data, models, diagrams, video/images, and other technical information. In parallel with the software effort, Ms. Martinez worked with the EDL experts to locate material from older missions. She worked with members of the EDL community, engineers, and records/library staff at a number of NASA Centers. In reflecting on her experience, Ms. Martinez stated, "Working with people from all over NASA has been an unmatched experience. In addition to learning about EDL and improving my leadership skills, the greatest reward was the team synergy and dedication. I would do it again."

The NESC Fast Mast Test Team at JPL.



Elmain Martinez led the EDL repository development.

Johnson Space Center

T. Scott West
NESC Chief Engineer at JSC

47
JSC employees contributed to NESC assessments

The Johnson Space Center (JSC) and the White Sands Test Facility (WSTF) provided engineering analysis, design, and test expertise to a wide range of NESC activities in support of the International Space Station (ISS), development of the Orion Multi-Purpose Crew Vehicle (MPCV), and consultation for Commercial Crew Program vehicle developers. The NESC Deputy Director for Safety; a Principal Engineer; and the NASA Technical Fellows for Life Support/Active Thermal, Loads and Dynamics, and Passive Thermal are resident at JSC. JSC personnel provided expertise and leadership to numerous internal and external assessments such as an investigation into the U.S. Air Force's F-22 fighter aircraft life support system. The JSC NASA Technical Fellows joined with other Agency discipline leaders to strengthen technical community connections through joint sponsorship and participation in activities such as the Thermal and Fluids Analysis Workshop; the Thermal and Environmental Control and Life Support Systems Steering Committee; and the Structures, Loads, and Mechanisms Steering Committee, including a Young Professionals Symposium. Finally, NESC personnel at JSC engaged in Standing Review Boards for the ISS Program, the ISS Stratospheric Aerosol and Gas Experiment III, the Materials on ISS Experiment–X, and the Human Research Program, and chaired Program Integration Reviews for the Earth System Science Pathfinder and Space Technology Programs.

WSTF Testing Support

Mr. Jon Haas has supported a number of NESC assessments during his 16-year WSTF career. Most recently, Mr. Haas is leading an ongoing project assessing stress rupture of composite overwrapped pressure vessels. He also participated in assessing the Air Force's F-22 life support system where he contributed his experiences testing oxygen and life support system components for NASA spacecraft to the team studying the complex interactions inherent in the human-machine interfaces of this advanced fighter jet. According to Mr. Haas, "Working alongside NASA Technical Fellows, Principal Engineers, and subject matter experts has been one of the great rewarding experiences of my career … The diversity of perspective in approaching the most technically challenging problems NASA faces has given me a host of new tools to use every day."

Orion MPCV Docking Mechanism Jettison System Testing

Mr. Scott Hacker is the pyrotechnics test group lead engineer in JSC's Propulsion and Power Division's Energy Systems Test Area, where he has worked for 20 years. This expertise led to his selection as the NESC technical lead pursuing design options and concept demonstration testing for pyrotechnic separation of the docking mechanism and the Orion crew module docking tunnel. According to Mr. Hacker, "The multi-Center project team brought a great wealth of experience ... It's also exciting knowing that our conceptual design efforts may influence a part of the final Orion configuration." Additionally, he "really enjoyed being part of a diverse, competent team and accomplishing such great, practical results. The seasoned engineers with decades of experience were invaluable, yet it was one of the least experienced members of our team that first suggested our final recommended solution. It's always rewarding to see the different team member contributions combine into a final successful outcome."

Scott Hacker (foreground) reviews a successful test with MPCV Program Manager Mark Geyer (left) and two technicians (background, Rick Dean left, Nick Kidd right).

ISS Life Support Systems

Dr. Nigel Packham is the NESC Discipline Deputy for Life Support. Dr. Packham's background in life support systems engineering for the NASA Space Shuttle, Space Shuttle-Mir, and the ISS Programs, coupled with his expertise in closed-environment air and water life support systems, brings considerable experience to the NESC. Dr. Packham participated in two recent NESC assessments for the ISS: a comparison of air quality monitoring systems to determine relative risk to the crew for potential trace contaminant exposure, and crew and system impacts due to potential corrosion and biological contaminant growth internal to prewetted environmental control and life support system replacement components stored on the ISS.

Jon Haas in the WSTF Carbon Overwrapped Pressure Vessel Pressurized Life Test Cell.

Dr. Nigel Packham examines a water sample returned from the ISS.

Stephen A. Minute
NESC Chief Engineer at KSC

Kennedy Space Center

39
KSC employees contributed to NESC assessments

The NESC is involved in multiple activities and projects at the Kennedy Space Center (KSC). KSC continues to provide support and expertise to a wide variety of NESC assessments and testing. KSC engineers provided expertise on 12 NESC Technical Discipline Teams, including Electrical Power, Flight Mechanics, and Loads and Dynamics. The KSC expertise plays a role in resolving many of the Agency's difficult problems, including SSC E-1 test stand blast effects and mitigation; Commercial Crew Program commercial off-the-shelf avionics parts usability, requirements, and verification development, certification framework, and landing gear consultation; Space Launch System Program shock testing; Orion crew module (CM) drogue parachute damping and CM landing and recovery support; NESC composite CM leak testing; Ground Systems Development and Operations Program system requirements review; Mars Science Laboratory ground processing; KSC's Rocket U course development support; and KSC Visitor's Center Space Shuttle Program *Atlantis* orbiter static display structural assessment.

Improving Safety of Human Spaceflight Programs

The NESC recognizes great value in mentoring junior-level engineers through direct involvement in complex, multidisciplinary issues within the Agency. Ms. Kelly Currin, formerly an aerospace engineer with the KSC Engineering Propulsion and Cryogenics Branch, was the lead test site engineer for the advanced exploration systems ground operations unit to demonstrate advanced liquid hydrogen loading and transfer concepts. With the NESC, she evaluated the Orion CM drogue parachute damping effects utilizing the Apollo legacy damping model, resulting in a technical paper presented at the American Institute of Aeronautics and Astronautics Applied Aerodynamics Conference. Ms. Currin performed tolerance analysis for the translation stage mechanism on the James Webb Space Telescope Near-Infrared Spectrograph Microshutter Subsystem. She was a member on the launch blast environments assessment, where she developed a database containing available launch vehicle accident and test program overpressure, impulse, fragmentation, and deflagration data. "The opportunity to participate in multiple assessment teams as a resident engineer with the NESC was the highlight of my career thus far with NASA. Specifically, the launch blast environments assessment has been incredibly rewarding in that I feel I am contributing to improving the safety of future human spaceflight programs." Ms. Currin recently left NASA and is now employed by the Sierra Nevada Corporation.


Kelly Currin was the structures lead on the Maraia Project at KSC.

Developing Advanced Flight Instrumentation

Mr. Peter Johnson is approaching 25 years since he was hired as part of KSC's post-Challenger Space Shuttle Program return-to-flight effort, working as the Flight Instrumentation Section lead. In support of the NESC, Mr. Johnson is the avionics lead for the Max Launch Abort System II (MLAS II) Project, balancing subsystem needs and performance requirements, and developing an avionics suite that meets these requirements. The prototype MLAS data acquisition avionics will be tested at the KSC electromagnetic interface and environmental labs. Mr. Johnson stated, "Honestly, I am always humbled by my experiences working with the NESC. The Smart Buyer Team, my first experience with the NESC, brought some of the finest, most creative NASA minds together. That team introduced me to the in-depth, technically based, rapid response approach that the NESC has become known for. Being able to draw from the industry, academia, and government triumvirate, working with the NESC gives me access to the most current technology, skills, processes, and, without a doubt, the finest minds in the country."

Peter Johnson compares a proposed avionics box manufactured by Quad Tron for the MLAS II flight test vehicle (foreground) with the same three shuttle-era boxes it functionally replaces.

Langley Research Center

Walter C. Engelund
NESC Chief Engineer at LaRC

155
LaRC employees contributed to NESC assessments

The Langley Research Center (LaRC) continues to support the NESC mission to address the Agency's high-risk programs and projects. LaRC personnel have contributed technical expertise in the areas of structures; materials; nondestructive evaluation; flight sciences; fabrication technology; loads and dynamics; computational fluid dynamics; mechanisms; guidance, navigation, and control; flight mechanics; and avionics. Several of the NESC assessment activities at LaRC included material characterization of the Orion crew module (CM) launch abort system (LAS) attitude control motor (ACM) carbon-carbon silicon carbide (C/C-SiC) pintle design; autonomous aerobraking capability development; exploration systems independent modeling and simulation; and shell buckling knockdown factor development for large-scale testing. LaRC is the host Center for the NESC Director's, Principal Engineers, Systems Engineering, and the Management and Technical Support Offices. The NASA Technical Fellows for Aerosciences, Flight Mechanics, Materials, Nondestructive Evaluation, and Structures are resident at LaRC.

Orion CM LAS ACM C/C-SiC Materials Characterization

Mr. Craig Ohlhorst and Dr. Wallace Vaughn are members of the NESC's C/C-SiC Materials Characterization Team for the Orion CM LAS ACM pintle design. The overall investigation goal was to deliver mechanical properties test data to the modeling team to validate their material models. Special test specimens were fabricated to simulate the ACM pintle and the pintle guide features. To help characterize the material failure using x-ray computed tomography (CT), acoustic emission, and Vic-3D (digital image correlation), measurements were made before, during, and after mechanical testing. Dr. Vaughn was responsible for developing the combined CT and cantilever beam test fixture, which allowed the three-point bend test coupon to be under load during the CT scan. This should allow for improved C/C-SiC crack imaging. Mr. Ohlhorst indicated, "Working in coordination with the nondestructive evaluation and modeling teams has been a great experience."

Dr. Wallace Vaughn (left) and Craig Ohlhorst.

(From left) Frank Vause, Brett Starr, Paul Tartabini, and Dr. James Beaty.

Exploration Systems Independent Modeling and Simulation

Mr. Brett Starr, Mr. Frank Vause, Dr. James Beaty, and Mr. Paul Tartabini, members of NESC's Independent Modeling and Simulation Team, are developing trajectory-based loads models for the Space Launch System (SLS) as part of an NESC independent verification assessment. This systems approach to predicting flight loads couples structural analysis and trajectory modeling to provide load estimates that will be more comprehensive and accurate than conventional load indicators like q-alpha (product of dynamic pressure and angle of attack). Linking the trajectory simulation to the structural analysis process makes it possible for the distributed vehicle aerodynamic, inertial, and propulsion forces at each time point along the trajectory to be fed into the structural force and moment solver. The multidisciplinary process can be readily implemented in SLS ascent trajectory Monte Carlo analyses to establish expected vehicle load limits. "Trajectory-based loads models were used successfully throughout the Ares I-X Project," explained Mr. Starr, "it makes sense to apply them to SLS."

Orion CM High Altitude Parachute System Deployment Analysis

Mr. Jeremy Shidner, an aerospace engineer in the LaRC Atmospheric Flight and Entry Systems Branch, is a member of the NESC team analyzing the likelihood of high altitude instability of the Orion CM resulting in the need for a contingency parachute deployment. Mr. Shidner advised the NESC on the complexities of parachute simulation in dynamic unknown environments by modeling the expected wind environments. Results from the evaluation helped identify greater instability rates leading to CM tumbling than were initially predicted by the Orion Multi-Purpose Crew Vehicle Program. "The experience of working with the best parachute experts in the world to answer the questions raised here has been awesome. It really opened my eyes to the reality of the demand we place on parachute systems, and the amazing engineering NASA uses to meet that demand."

Jeremy Shidner

Steven J. Gentz
NESC Chief Engineer at MSFC

Marshall Space Flight Center

The Marshall Space Flight Center (MSFC) provided subject matter expertise from engineers, scientists, and technicians to over 40 NESC assessments and investigations, and to 15 of the NESC Technical Discipline Teams. NESC studies involved areas of exploration systems, space operations, science, and crosscutting discipline activities. Some of the more significant investigations included shell buckling knockdown factor testing, sounding rocket sustainer motor design and development, composite crew module permeability testing, shock-proof bearing development, spin forming of complex structures, composite pyroshock characterization, and engine combustion stability analysis. The NASA Technical Fellow for Propulsion is resident at MSFC.

143
MSFC employees contributed to NESC assessments

Increasing NASA Flight Measurement Capabilities

Dr. Jeremy Kenny, propulsion system fluid dynamics analyst, led the development of a prototype high-speed flight data acquisition avionics unit. Through the High Fidelity Data Acquisition (HiDAQ) Project, Dr. Kenny obtained invaluable experience through the coordination of engineering multi-Center support from MSFC, LaRC, and KSC in project requirements, design, and analysis maturation. Leading an applied development project provided the opportunity to increase project and engineering management skills, which are not typically exercised during fluid dynamics analyses. “The NESC has given me a great opportunity to develop a data acquisition unit capable of supporting many different flight programs. Being the project lead has exposed me to the multiple aspects of flight hardware design, development, testing, and evaluation, as well as learning from an excellent engineering team.”

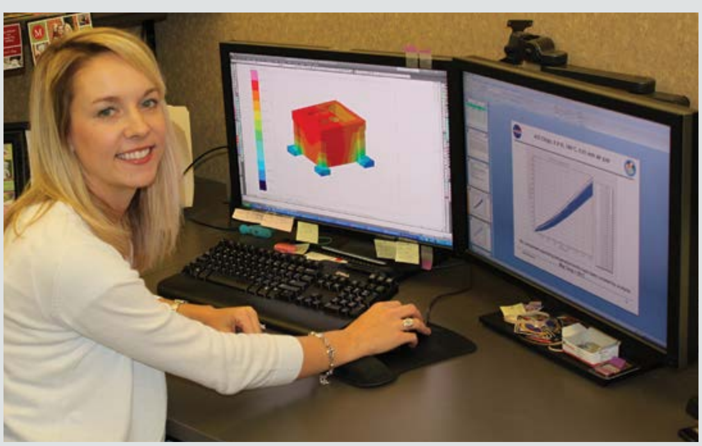
HiDAQ Project Thermal Design, Analysis, and Testing

Ms. Callie McKelvey has been an aerospace engineer with the Thermal Analysis and Control Branch for the last 5 years. Ms. McKelvey is participating in the HiDAQ Project through the design, analysis, and testing of its thermal control system. Ms. McKelvey generated a thermal model, including the chassis, boards, chips, heat spreaders, and aluminum chassis encapsulating epoxy. This model determined which components would benefit from a copper heat spreader and predicted internal box temperatures to the chip/component level. The model will be correlated to thermal cycle and thermal vacuum test results. Concerning her experience with the NESC, Ms. McKelvey stated, “The HiDAQ Project has allowed me the opportunity to work on a multi-Center project team, explore new modeling techniques and test flight hardware, and gain experience with data acquisition systems. It has been an educational and rewarding experience for a young engineer. In addition to HiDAQ, I have had the pleasure of participating in several other NESC-sponsored opportunities, such as the Thermal and Fluids Analysis Workshop and the NASA Engineering Network. I hope to continue working with the NESC in the future.”

Dr. Jeremy Kenny examines a ruggedized sensor for the HiDAQ.

Electromagnetic Environmental Effects Testing

Mr. Jonathan Mack, an electrical engineer, has been with NASA for 5 years. Currently, he is supporting the NESC on the HiDAQ Project. Mr. Mack provided electromagnetic environmental effects requirements, design guidance for grounding, electrical bonding, and electromagnetic interference (EMI) testing. He generated the test plan for the EMI portion of component environmental testing. Mr. Mack stated, “Working with the NESC was a great experience. I made several professional contacts both within MSFC and around the Agency. Developmental projects like HiDAQ are always fun to work on. They give you an opportunity to think outside the box and innovate in the way you approach your requirements and design.”



Callie McKelvey developed the HiDAQ thermal model.

Jonathan Mack developed EMI design guidance for the HiDAQ.

Stennis Space Center

Michael D. Smiles
NESC Chief Engineer at SSC

9
SSC employees contributed to NESC assessments

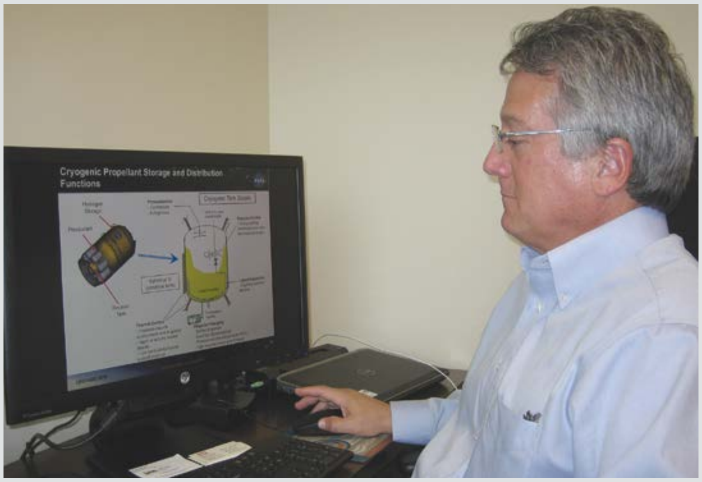
The Stennis Space Center (SSC) provided expert technical support to the NESC, including the E-1 Test Facility Blast/Acoustic Effect Mitigation Tools Assessment and the Cryogenic Propellant Storage and Transfer (CPST) Project Mission Concept Review (MCR) Board. SSC has members on several NESC Technical Discipline Teams. The NESC provided computational fluid dynamics (CFD) and blast mitigation expertise for the E-1 facility. The NESC was requested to develop analytical/empirical tools and techniques to characterize potential blast/acoustic environments from a test article in one cell, and determine mitigation designs/techniques to reduce or control those effects on a test article in an adjacent cell. The E-1 was conceived as a three-cell multiuser test facility for rocket components. Over time, E-1 evolved to testing large thrust chambers, engine systems, and large engines, which negated many of the original design protections for blast/fragmentation. SSC's ability to accommodate multiple simultaneous E-1 tenants is critical to the Agency's multifaceted approach to space access, with concurrent development of commercial and Space Launch System engine systems. NESC activities utilized the capabilities of SSC's Engineering and Test Directorate personnel and its unique facilities.

Tom Meredith (left) and Dr. Danny Allgood examine blast mitigation materials at the E-1 Test Facility.

E-1 Test Facility Analysis

Dr. Danny Allgood, an SSC CFD expert, developed E-1 blast and overpressure predictions. His assignment to the NESC assessment has been invaluable. Dr. Allgood stated, "Although I had a background in modeling propellant detonations, this project has allowed me the unique experience of modeling blast waves from solid explosives on a very large scale. In working with the NESC, SSC had the opportunity to gain valuable exposure to the complexity of modeling and mitigating the overpressure issues at the E-1 stand. Before this project was brought to light, the Agency as a whole did not have the documented knowledge of how to model the overpressure hazards that existed during test or launch. By the NESC pulling together the necessary technical expertise, a validated capability in modeling was demonstrated. As a result, safety in NASA's rocket testing and launch programs will be improved for the future."

Mr. Tom Meredith, E-1 Chief Engineer, focused on blast mitigation tools/techniques. His participation was critical with potential mitigation materials and coordinating facility blast testing. Mr. Meredith stated, "This study should prove to be beneficial to the Agency in keeping E-1 a multicell, multicustomer test facility for government or privately funded rocket test customers," and "the NESC will benefit from this project from the setting up of a real field experiment that will provide data with different overpressure sources throughout the facility to map out the reflective waves of E-1 and to show how those waves may affect other test articles in the facility. This project will provide a real-world situation to gather data to compare the real world data with model data."



David Coote reviewing cryogenic propellant storage and transfer concepts.

Cryogenic Propellant Storage and Transfer Review

The NESC was requested to provide a CPST Project Technology Demonstration MCR representative. Mr. David Coote was selected due to his experience and expertise. Mr. Coote stated, "SSC has a fairly comprehensive range of competencies and experience in analysis, design, and operations of cryogenic propellant storage and transfer systems that we regularly exercise on seven distinct and active test areas supporting NASA, DoD, and commercial propulsion systems development and test programs. Working with the NESC, SSC had an opportunity to share our technical competencies and experience to an area that extends beyond our mission of propulsion system testing. The Agency benefits by having a focal point for projects to solicit specific expertise they either don't have readily available or need more of, and works to optimize use of Agency resources."

The composite crew module full-scale pressure vessel test article being readied for a vacuum test at MSFC.

Core Leadership Team

Ralph R. Roe, Jr.

NESC Director

Mr. Ralph R. Roe, Jr. is the NESC's Director at Langley Research Center. Mr. Roe has over 29 years of experience in human spaceflight program management, technical management, and test engineering. Mr. Roe previously held several key positions in the Space Shuttle Program, including Vehicle Engineering Manager, Launch Director, and Kennedy Space Center Engineering Director.

Timmy R. Wilson

NESC Deputy Director

Mr. Timmy R. Wilson is the NESC's Deputy Director at Langley Research Center. Mr. Wilson was formerly the NESC's Chief Engineer at Kennedy Space Center (KSC). Prior to joining the NESC, Mr. Wilson served as Deputy Chief Engineer for Space Shuttle Processing at KSC. Mr. Wilson has over 31 years of engineering and management experience supporting the Space Shuttle Program.

Michael P. Blythe

NESC Deputy Director for Safety

Mr. Michael P. Blythe is the NESC's Deputy Director for Safety and is resident at Johnson Space Center. Prior to joining the NESC, Mr. Blythe served as the Acting Assistant Associate Administrator in the Office of the Administrator at NASA Headquarters. Mr. Blythe came to the Office of the Administrator from the Office of Chief Engineer, where he served as the Director for the Engineering and Program/Project Management Division. In this capacity, he was responsible for establishing and implementing Agency engineering and program/project management policy, procedures, and processes to improve the efficiency and success of NASA's investments.

Dawn M. Schaible

Manager, Systems Engineering Office

Ms. Dawn M. Schaible is Manager of the NESC's Systems Engineering Office at Langley Research Center. Prior to joining the NESC, Ms. Schaible worked in the International Space Station/Payload Processing Directorate at Kennedy Space Center. Ms. Schaible has over 25 years of experience in systems engineering, integration, and ground processing for the Space Shuttle and International Space Station Programs.

Daniel J. Tenney

Manager, Management and Technical Support Office

Mr. Daniel J. Tenney is Manager of the NESC's Management and Technical Support Office at Langley Research Center (LaRC). Prior to joining the NESC, Mr. Tenney served as the Deputy Chief Financial Officer for Systems at LaRC, where he managed over 30 information systems. Mr. Tenney has 23 years of professional financial, accounting, and systems experience at NASA.

Patrick G. Forrester

NESC Chief Astronaut

Mr. Patrick G. Forrester is the NESC's Chief Astronaut and is resident at Johnson Space Center. Mr. Forrester began his NASA career in 1993 after serving in the U.S. Army. As a Master Army Aviator, he logged over 4800 hours in over 50 different aircraft. He was selected as an astronaut candidate in 1996 and flew on STS-105 (2001), STS-117 (2007), and STS-128 (2009). He has logged over 950 hours in space, including four spacewalks totaling 25 hours and 22 minutes of extra vehicular activity time.

Dr. Daniel Winterhalter

Chief Scientist

Dr. Daniel Winterhalter is the NESC's Chief Scientist and is resident at Jet Propulsion Laboratory (JPL). Dr. Winterhalter has over 34 years of experience as a research scientist at JPL. His research interests include the spatial evolution of the solar wind into the outer reaches of the heliosphere, as well as its interaction with and influence on planetary environments. In addition, as a member of several flight teams, he has been intimately involved with the planning, launching, and operation of complex spacecraft and space science missions.

NASA Headquarters Liaison

Wayne R. Frazier

NASA Headquarters Senior SMA Integration Manager

Mr. Wayne R. Frazier currently serves as Senior Safety and Mission Assurance Manager in the Office of Safety and Mission Assurance (OSMA), where he is assigned as the Liaison Officer to the NESC, the Office of the Chief Engineer, the Software Independent Verification and Validation Facility in West Virginia, and other remote activities of OSMA. He was formerly Manager of System Safety in the OSMA at NASA Headquarters and has over 37 years of experience in system safety, propulsion and explosive safety, mishap investigation, range safety, pressure systems, crane safety, and orbital debris mitigation.

NESC Principal Engineers

Clinton H. Cragg

NESC Principal Engineer

Mr. Clinton H. Cragg is a Principal Engineer with the NESC at Langley Research Center. Mr. Cragg came to the NESC after retiring from the U.S. Navy. Mr. Cragg served as the Commanding Officer of the U.S.S. Ohio and later as the Chief of Current Operations, U.S. European Command. Mr. Cragg has over 34 years of experience in supervision, command, and ship-borne nuclear safety.

Dr. Nancy J. Currie

NESC Principal Engineer

Dr. Nancy J. Currie is a Principal Engineer with the NESC and is resident at Johnson Space Center (JSC). Dr. Currie was formerly the NESC Chief Engineer at JSC. Dr. Currie came to the NESC from, where she served as the Deputy Director of the Engineering Directorate. Dr. Currie has over 23 years of experience in robotics and human factors engineering. Selected as an astronaut in 1990, Dr. Currie is a veteran of four space shuttle missions and has accrued 1000 hours in space.

Dr. Michael G. Gilbert

NESC Principal Engineer

Dr. Michael G. Gilbert is a Principal Engineer with the NESC at Langley Research Center (LaRC). Dr. Gilbert was formerly the NESC Chief Engineer at LaRC. Before joining the NESC, he was Head of the LaRC Systems Management Office. Dr. Gilbert has over 34 years of engineering, research, and management experience with aircraft, missile, spacecraft, Space Shuttle, and International Space Station Programs.

Michael T. Kirsch

NESC Principal Engineer

Mr. Michael T. Kirsch is a Principal Engineer with the NESC at Langley Research Center. Mr. Kirsch joined the NESC from NASA's White Sands Test Facility, where he served as the Deputy Manager responsible for planning and directing developmental and operational tests of spacecraft propulsion systems and related subsystems. Mr. Kirsch has over 23 years of experience in managing projects and test facilities.

NESC Chief Engineers

Dawn C. Emerson

NESC Chief Engineer

Ms. Dawn C. Emerson is the NESC's Chief Engineer at Glenn Research Center (GRC). Ms. Emerson came to the NESC from GRC, where she most recently served as the Deputy Project Manager during formulation of the Solar Electric Propulsion Flight Demonstration Project. Ms. Emerson has over 27 years of management and technical experience with NASA and private industry.

Walter C. Engelund

NESC Chief Engineer

Mr. Walter C. Engelund is the NESC's Chief Engineer at Langley Research Center (LaRC). Mr. Engelund came to the NESC from LaRC, where he served as the Head of the Atmospheric Flight and Entry Systems Branch. Mr. Engelund has over 23 years of experience as a recognized expert in launch and entry vehicle aerodynamics, atmospheric flight dynamics, and hypersonic flight systems.

Steven J. Gentz

NESC Chief Engineer

Mr. Steven J. Gentz is the NESC's Chief Engineer at Marshall Space Flight Center. Mr. Gentz was formerly a Principal Engineer with the NESC at Langley Research Center. Mr. Gentz has over 29 years of experience involving numerous NASA, Department of Defense, and industry failure analyses and incident investigations, including Challenger, Columbia, Tethered Satellite System, and the TWA 800 Accident Investigations.

R. Lloyd Keith

NESC Chief Engineer

Mr. R. Lloyd Keith is the NESC's Chief Engineer, as well as support and backup for the Center Chief Engineer, at the Jet Propulsion Laboratory. Mr. Keith has over 35 years of experience working in both technical and managerial positions. Mr. Keith has supported a number of flight projects, including the Mars Pathfinder Project, SeaWinds, Stardust, Mars '98, New Millennium Deep Space 1, and the Flight Hardware Logistics Program.

Nans Kunz

NESC Chief Engineer

Mr. Nans Kunz is the NESC's Chief Engineer at Ames Research Center (ARC). Mr. Kunz came to the NESC from the Systems Engineering Division at ARC. Mr. Kunz has over 34 years of engineering experience leading and managing NASA programs and projects, including serving as the Chief Engineer of the Stratospheric Observatory For Infrared Astronomy (SOFIA) Project.

Stephen A. Minute

NESC Chief Engineer

Mr. Stephen A. Minute is the NESC's Chief Engineer at Kennedy Space Center (KSC). Mr. Minute came to the NESC from KSC, where he served as the Chief of the Space Shuttle Safety, Quality, and Mission Assurance Division. Mr. Minute has over 28 years of engineering and management experience in the Space Shuttle and International Space Station Programs.

Michael D. Smiles

NESC Chief Engineer

Mr. Michael D. Smiles is the NESC's Chief Engineer at Stennis Space Center (SSC). Mr. Smiles joined the NESC from SSC, where he served as the Safety and Mission Assurance (S&MA) Manager. Mr. Smiles has over 27 years of management and technical experience with NASA at SSC and Marshall Space Flight Center.

Dr. James F. Stewart

NESC Chief Engineer

Dr. James F. Stewart is the NESC's Chief Engineer at Dryden Flight Research Center (DFRC). Dr. Stewart joined the NESC from DFRC, where he served as the Dryden Exploration Mission Director. Dr. Stewart has over 46 years of management and technical experience leading missile and aircraft programs.

Continued next page

NESC Chief Engineers *Continued*

Timothy G. Trenkle

NESC Chief Engineer

Mr. Timothy G. Trenkle is the NESC's Chief Engineer at Goddard Space Flight Center (GSFC). Mr. Trenkle joined the NESC from GSFC, where he has over 20 years of technical experience serving as the technical lead for a number of flight programs and technical assignments, including serving as the Chief Engineer for the National Polar-orbiting Operational Environmental Satellite System (NPOESS) Preparatory Project (NPP).

T. Scott West

NESC Chief Engineer

Mr. T. Scott West is the NESC's Chief Engineer at Johnson Space Center (JSC). Mr. West came to the NESC from the Loads and Structural Dynamics Branch at JSC where he served as the Branch Chief. Mr. West has over 21 years of technical and management experience with Space Shuttle, International Space Station, Multi-Purpose Crew Vehicle and Exploration projects with NASA and private industry.

NASA Technical Fellows

Michael L. Aguilar

NASA Technical Fellow

Mr. Michael L. Aguilar is the NASA Technical Fellow for Software and is resident at Goddard Space Flight Center (GSFC). Mr. Aguilar joined the NESC from GSFC, where he served as the James Webb Space Telescope (JWST) Instrument Software Manager. Mr. Aguilar has over 36 years of experience on embedded software development.

Cornelius J. Dennehy

NASA Technical Fellow

Mr. Cornelius J. Dennehy is the NASA Technical Fellow for Guidance, Navigation, and Control (GNC) and is resident at Goddard Space Flight Center (GSFC). Mr. Dennehy came to the NESC from the Mission Engineering and Systems Analysis Division at GSFC, where he served as the Division's Assistant Chief for Technology. Mr. Dennehy has over 32 years of experience in the architecture, design, development, integration, and operation of GNC systems, and space platforms for communications, defense, remote sensing, and scientific mission applications.

Roberto Garcia

NASA Technical Fellow

Mr. Roberto Garcia is the NASA Technical Fellow for Propulsion and is resident at Marshall Space Flight Center. Mr. Garcia came to the NESC from the Solid Propulsion Systems Division, where he served as Division Chief. Mr. Garcia has over 21 years of experience in performing aerodynamic, hydrodynamic, and engine system design and analysis of rocket propulsion.

Oscar Gonzalez

NASA Technical Fellow

Mr. Oscar Gonzalez is the NASA Technical Fellow for Avionics and is resident at Goddard Space Flight Center (GSFC). Mr. Gonzalez came to the NESC from GSFC, where he served as the International Space Station/Express Logistic Carrier Avionics Systems Manager. Mr. Gonzalez has over 34 years of NASA and private industry experience where he has held a variety of critical leadership roles in power electronics, electrical systems, instrument systems, and avionics systems.

Denney J. Keys

NASA Technical Fellow

Mr. Denney J. Keys is the NASA Technical Fellow for Electrical Power and is resident at Goddard Space Flight Center (GSFC). Mr. Keys served as the Lead Power Systems Engineer in the Power Systems Branch at GSFC before joining the NESC. Mr. Keys has over 32 years of private industry and NASA experience with electrical power systems.

Dr. Curtis E. Larsen

NASA Technical Fellow

Dr. Curtis E. Larsen is the NASA Technical Fellow for Loads and Dynamics and is resident at Johnson Space Center. Prior to joining the NESC, Dr. Larsen was the Technical Discipline Manager for Cargo Integration Structures in the Space Shuttle Program's Flight Operations and Integration Office. Dr. Larsen has over 32 years of engineering experience with expertise in stochastic structural dynamics, structural safety, and probabilistic engineering applications.

Daniel G. Murri

NASA Technical Fellow

Mr. Daniel G. Murri is the NASA Technical Fellow for Flight Mechanics and is resident at Langley Research Center (LaRC). Mr. Murri served as Head of the Flight Dynamics Branch at LaRC before joining the NESC. He has over 31 years of engineering experience conducting numerous wind-tunnel, simulation, light-test, and theoretical studies in the exploration of new technology concepts and in support of aircraft development programs.

Dr. Cynthia H. Null

NASA Technical Fellow

Dr. Cynthia H. Null is the NASA Technical Fellow for Human Factors and is resident at Ames Research Center. Before joining the NESC, Dr. Null was a scientist in the Human Factors Division and Deputy Program Manager of the Space Human Factors Engineering Project. Dr. Null has 26 years of experience lecturing on Human Factors, and another 20 years of experience in Human Factors applied to NASA programs.

Joseph W. Pellicciotti

NASA Technical Fellow

Mr. Joseph W. Pellicciotti is the NASA Technical Fellow for Mechanical Systems and is resident at Goddard Space Flight Center (GSFC). Mr. Pellicciotti served as the Chief Engineer for the GSFC Mechanical Systems Division before joining the NESC. Mr. Pellicciotti has over 24 years of combined private industry and NASA experience designing structure and mechanisms for commercial, military, and civil spacecraft.

Dr. Robert S. Piascik

NASA Technical Fellow

Dr. Robert S. Piascik is the NASA Technical Fellow for Materials and is resident at Langley Research Center (LaRC). Dr. Piascik joined the NESC from the LaRC Mechanics of Materials Branch and the Metals and Thermal Structures Branch, where he served as a Senior Materials Scientist. Dr. Piascik has over 28 years experience in the commercial nuclear power industry and over 19 years of experience in basic and applied materials research for several NASA programs.

Continued next page

NASA Technical Fellows *Continued*

Dr. William H. Prosser

NASA Technical Fellow

Dr. William H. Prosser is the NASA Technical Fellow for Nondestructive Evaluation and is resident at Langley Research Center (LaRC). Dr. Prosser joined the NESC from the Nondestructive Evaluation Sciences Branch at LaRC. Dr. Prosser has over 25 years of experience in the field of ultrasonic and acoustic emission sensing techniques.

Dr. Ivatury S. Raju

NASA Technical Fellow

Dr. Ivatury S. Raju is the NASA Technical Fellow for Structures and is resident at Langley Research Center (LaRC). Dr. Raju was the Senior Technologist in the LaRC Structures and Materials Competency prior to joining the NESC. Dr. Raju has over 37 years of experience in structures, structural mechanics, and structural integrity.

Steven L. Rickman

NASA Technical Fellow

Mr. Steven L. Rickman is the NASA Technical Fellow for Passive Thermal and is resident at Johnson Space Center (JSC). Mr. Rickman joined the NESC from JSC's Thermal Design Branch, where he served as the Chief. Mr. Rickman has over 27 years of management and technical experience in passive thermal control.

Henry A. Rotter

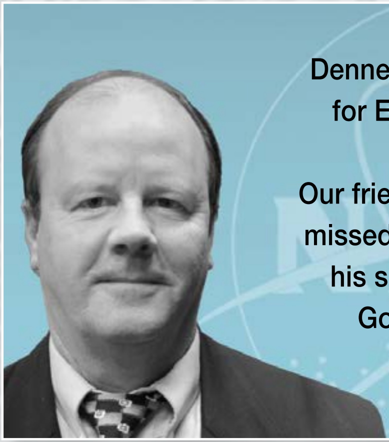
NASA Technical Fellow

Mr. Henry (Hank) A. Rotter is the NASA Technical Fellow for Life Support/Active Thermal and is resident at Johnson Space Center (JSC). Mr. Rotter joined the NESC from the JSC Crew and Thermal Systems Division and the Space Launch Initiative Program, where he was Engineering Manager and the Orbital Space Plane Team Leader for life support and active thermal control teams. Mr. Rotter has over 45 years of life support and active thermal control systems experience during the Apollo, Space Shuttle, and Orbital Space Plane Programs.

Dr. David M. Schuster

NASA Technical Fellow

Dr. David M. Schuster is the NASA Technical Fellow for Aerosciences and is resident at Langley Research Center. Prior to joining the NESC, Dr. Schuster was the Branch Head for the Structural and Thermal Systems Branch in the Systems Engineering Directorate. Dr. Schuster has over 34 years of experience in the aerospace industry with expertise in aeroelasticity and integrated aerodynamic analysis.



Denney Keys, NASA Technical Fellow for Electrical Power, passed away in December 2012.
Our friend and colleague will be greatly missed and he will be remembered for his significant contributions to the Goddard Space Flight Center, the NESC, and NASA.

Alumni

Frank H. Bauer
NESC Discipline Expert for Guidance, Navigation, and Control (2003–04) Left the NESC to become the Exploration Systems Mission Directorate Chief Engineer at NASA HQ and has since retired

Dr. Charles J. Camarda
NESC Deputy Director for Advanced Projects (2006–09) Left the NESC to become Senior Advisor for Innovation in the Office of the Chief Engineer at NASA Headquarters

Kenneth D. Cameron
NESC Deputy Director for Safety (2005–08) Left the NESC to accept a position with Northrop Grumman

Steven F. Cash
NESC Chief Engineer at Marshall Space Flight Center (MSFC) (2005) Left the NESC to become the Manager, Shuttle Propulsion Office at MSFC

Derrick J. Cheston
NESC Chief Engineer at Glenn Research Center (GRC) (2003–07) Left the NESC to participate in the Senior Executive Service Candidate Development Program and then returned to GRC as the Chief of the Mechanical and Fluid Systems Division

J. Larry Crawford
NESC Deputy Director for Safety (2003–04) Left the NESC to become Director of Safety and Mission Assurance at the Kennedy Space Center and has since retired

Mitchell L. Davis
NASA Technical Fellow for Avionics (2007–09) Left the NESC to become the Chief Avionics Systems Engineer in the Electrical Engineering Division at Goddard Space Flight Center

Dennis B. Dillman
NESC Chief Engineer at NASA Headquarters (HQ) (2005–08) Left the NESC to join the Science Mission Directorate at NASA HQ

Freddie Douglas, III
NESC Chief Engineer at Stennis Space Center (SSC) (2007–08) Left the NESC to become Manager, Office of Safety and Mission Assurance at SSC

Patricia L. Dunnington
Manager, Management and Technical Support Office (2006–08) Retired

Dr. Michael S. Freeman
NESC Chief Engineer at Ames Research Center (2003–04) Retired

T. Randy Galloway
NESC Chief Engineer at Stennis Space Center (SSC) (2003–04) Currently the Director of the Engineering and Test Directorate at SSC

Dr. Edward R. Generazio
NESC Discipline Expert for Nondestructive Evaluation (2003–05) Left the NESC to become a Senior Research Engineer, Research Directorate, Langley Research Center

Dr. Richard J. Gilbrech
NESC Deputy Director (2003–05) Currently the Center Director at Stennis Space Center

Michael Hagopian
NESC Chief Engineer at Goddard Space Flight Center (GSFC) (2003–07) Left the NESC to become the Chief Engineer in the Engineering Directorate at GSFC and has since left NASA to accept a position with Sigma Space Corporation

David A. Hamilton
NESC Chief Engineer at Johnson Space Center (2003–07) Retired

Dr. Charles E. Harris
NESC Principal Engineer (2003–06) Currently the Director, Research Directorate, Langley Research Center

Dr. Steven A. Hawley
NESC Chief Astronaut (2003–04) Left the NESC to become the Director of Astromaterials Research and Exploration Science at Johnson Space Center and has since retired

Marc S. Hollander
Manager, Management and Technical Support Office (2005–06) Left the NESC to accept a position as the Associate Director for Management, National Institutes of Health

George D. Hopson
NASA Technical Fellow for Propulsion (2003–07) Retired

Keith L. Hudkins
NASA Headquarters Office of the Chief Engineer Representative (2003–07) Retired

Danny D. Johnston
NESC Chief Engineer at Marshall Space Flight Center (MSFC) (2003–04) Left the NESC to work a detailed assignment at MSFC in the NASA Chief Engineer's Office and has since retired

Michael W. Kehoe
NESC Chief Engineer at Dryden Flight Research Center (DFRC) (2003–05) Left the NESC to become the DFRC Liaison in the Crew Exploration Vehicle Flight Test Office at Johnson Space Center and has since retired

Robert A. Kichak
NESC Discipline Expert for Power and Avionics (2003–07) Retired

Dr. Dean A. Kontinos
NESC Chief Engineer at Ames Research Center (ARC) (2006–07) Left the NESC to work a detailed assignment as the Technical Integration Manager of the Fundamental Aeronautics Program in the Aeronautics Research Mission Directorate at NASA HQ and has since returned to ARC in the Office of the Chief Engineer

Julie A. Kramer White
NESC Discipline Expert for Mechanical Analysis (2003–06) Currently the Chief Engineer, Multi-Purpose Crew Vehicle Program at Johnson Space Center

Steven G. Labbe
NESC Discipline Expert for Flight Sciences (2003–06) Currently the Chief, Aeroscience and Flight Mechanics Division at Johnson Space Center

Matthew R. Landano
NESC Chief Engineer at Jet Propulsion Laboratory (JPL) (2003–04) Returned to his assignment at JPL as the Director of Office of Safety and Mission Success

David S. Leckrone
NESC Chief Scientist (2003–06) Left the NESC to become the Senior Project Scientist for the Hubble Space Telescope at Goddard Space Flight Center and has since retired

Richard T. Manella
NESC Chief Engineer at Glenn Research Center (GRC) (2009–10) Left the NESC to become the GRC Chief Engineer

John P. McManamen
NASA Technical Fellow for Mechanical Systems (2003–07) Currently the Deputy Chief Engineer, Commercial Crew Program at Johnson Space Center

Brian K. Muirhead
NESC Chief Engineer at Jet Propulsion Laboratory (JPL) (2005–07) Returned to his assignment as the JPL Chief Engineer

Dr. Paul M. Munafo
NESC Deputy Director (2003–04) Left the NESC to become the Assistant Director for Safety and Engineering at Marshall Space Flight Center and has since retired

Stan C. Newberry
Manager of the NESC's Management and Technical Support Office (2003–04) Left the NESC to become the Deputy Center Director at Ames Research Center and has since left NASA to accept a position at DoD

Dr. Tina L. Panontin
NESC Chief Engineer at Ames Research Center (ARC) (2008–09) Returned to her assignment as the ARC Chief Engineer

Dr. Shamim A. Rahman
NESC Chief Engineer at Stennis Space Center (SSC) (2005–06) Left the NESC to become the Deputy Director of the Engineering and Test Directorate at SSC

Jerry L. Ross
NESC Chief Astronaut (2004–06) Returned to his assignment as Chief of the Vehicle Integration Test Office at Johnson Space Center and has since retired

Dr. Charles F. Schafer
NESC Chief Engineer at Marshall Space Flight Center (2006–10) Retired

Steven S. Scott
NESC Chief Engineer at Goddard Space Flight Center (GSFC) (2008–09) NESC Discipline Expert for Software (2003–05) Returned to his assignment as the GSFC Chief Engineer

Bryan K. Smith
NESC Chief Engineer at Glenn Research Center (GRC) (2008–10) Left the NESC to serve as Chief of the Systems Engineering and Systems Analysis Division at GRC

John E. Tinsley
NASA Headquarters Senior Safety and Mission Assurance Manager for NESC (2003–04) Left the NESC to become the Director of the Mission Support Division at NASA Headquarters and has since left NASA to accept a position with Northrop Grumman

Clayton P. Turner
NESC Chief Engineer at Langley Research Center (LaRC) (2008–09) Returned to his assignment as the LaRC Chief Engineer

Left to right: Dawn Schaible, SEO Manager/presenter; Erin Moran, Analytical Mechanics Associates, Inc.; Lloyd Keith, JPL; Peter Parker, LaRC; David Alexander, JSC; Russell Wincheski, LaRC; Robert Kichak, MEI Technologies, Inc.; Scott Cryan, JSC; James Womack, The Aerospace Corporation; Jay Perry, MSFC; Hope Venus, NESC; James Blackwood, Bangham Engineering, Inc.; Robert Graber, Science Applications International Corporation; Robert Wingate, MSFC; Karen McNamara, JSC; Pat Forrester, NESC Chief Astronaut/presenter; Sherry Erskine, MSFC; Jill Prince, LaRC; Ralph Roe, Jr., NESC Director/presenter.
Not pictured: John Anderson, Jacobs Technology, Inc., and Elmain Martinez, JPL.

NESC Honor Award Recipients for 2012

NESC Leadership Award

Honors individuals who have had a pronounced effect upon the technical activities of the NESC

Scott P. Cryan In recognition of outstanding technical leadership and rendezvous sensor expertise in the performance of the LIDAR Relative Navigation Rendezvous Sensor Detailed Test Objective Performance Evaluation Assessment

Elmain M. Martinez In recognition of outstanding leadership and technical competence in designing and building the first NASA-wide Entry, Descent, and Landing database

Peter A. Parker In recognition of outstanding technical leadership and project execution in the performance of the LIDAR Relative Navigation Rendezvous Sensor Detailed Test Objective Performance Evaluation Assessment

Jill L. Prince In recognition of outstanding technical leadership of the successful autonomous aerobraking feasibility study

NESC Engineering Excellence Award

Honors individual accomplishments of NESC job-related tasks of such magnitude and merit as to deserve special recognition

John C. Anderson In recognition of engineering excellence in support of the NESC Pyrovalve Reliability Expendable Launch Vehicle Payloads Assessment

James M. Blackwood In recognition of engineering excellence in researching, evaluating, analyzing, and disseminating near-pad historical launch vehicle accident blast environments to improve safety system design and crew survivability for NASA Human Space Flight Programs

Robert R. Graber In recognition of engineering excellence and leadership in the application of a logical framework for assessing risk for the Pyrovalve Reliability Expendable Launch Vehicle Payloads Assessment

Karen M. McNamara In recognition of engineering excellence in support of the NESC International Standards Organization Technology Readiness Level Standard Assessment

Jay L. Perry In recognition of engineering excellence in support of the NESC International Space Station Air Quality Monitoring System Assessment

Russell A. Wincheski In recognition of engineering excellence in the examination of manufacturing defects and stress corrosion cracking associated with the Antares II vehicle Aerojet AJ-26 engines

Robert J. Wingate In recognition of engineering excellence for outstanding contributions to the NESC Structures and Mechanical Systems Technical Discipline Teams in the development of the NASA Requirements for Threaded Fastening Systems in Spaceflight Hardware Standard

James M. Womack In recognition of engineering excellence in developing test plans and providing test data analyses for evaluating and optimizing a fine water mist portable fire extinguisher for the International Space Station and other crewed spacecraft

NESC Administrative Excellence Award

Honors individual accomplishments or contributions that contributed substantially to support NESC's mission

Sherry Y. Erskine In recognition of exemplary performance and sustained, dedicated support to the NASA Engineering and Safety Center as the Business Point of Contact for the Marshall Space Flight Center

Erin Moran In recognition of sustained and exemplary technical writing and leadership support through disciplined attention to organizational processes and methodical organizational skills in the documentation of NESC products

NESC Group Achievement Award

Honors a group of employees comprised of government and non-government personnel for outstanding accomplishment through the coordination of individual efforts that have contributed substantially to the accomplishment of the NESC's mission

Commercial Crew Electrical, Electronic and Electromechanical Parts Study Team

In recognition of outstanding support to the NESC in establishing technical guidelines for safe, reliable, and cost-effective electrical, electronic, and electromechanical parts management activities for the Commercial Crew Program

NASA Engineering and Safety Center Academy Team

In recognition of outstanding support of NESC knowledge capture and transfer through implementation of the NESC Academy online learning system

NASA Engineering and Safety Center Entry, Descent, and Landing Repository Team

In recognition of outstanding contributions to design and build the first NASA-wide Entry, Descent, and Landing database

F-22 Life Support System Independent Analysis Team

In recognition of outstanding contributions in support of the F-22 Life Support System independent analysis activity

NESC/NASA Published Technical Memoranda

1. Composite Structures Damage Tolerance Analysis Methodologies NASA/CR-2012-217347
2. Orion - Super Koropon Torque/Tension Report NASA/CR-2012-217587
3. Process Sensitivity, Performance, and Direct Verification Testing of Adhesive Locking Features NASA/CR-2012-217760
4. Structural Assessment of the International Space Station (ISS) European-Manufactured Modules Appendices .... NASA/TM-2011-217172/Volume II
5. Orion Flight Test-1 (OFT-1) Radiometer Feasibility Study (Phase I) NASA/TM-2011-217180
6. Comparison of the Booster Interface Temperature in Stainless Steel (SS) V-Channel Versus the Aluminum (Al) Y-Channel Primer Chamber Assemblies (PCAs) .... NASA/TM-2011-217182/Volume I
7. Comparison of the Booster Interface Temperature in Stainless Steel (SS) V-Channel Versus the Aluminum (Al) Y-Channel Primer Chamber Assemblies (PCAs) Appendices .... NASA/TM-2011-217182/Volume II
8. Independent Review of the Constellation Program (CxP) Ares-I Launch Vehicle Control Sensitivity to Orion Service Module (SM) Tank Slosh Dynamics - Version 2.0 .... NASA/TM-2011-217183
9. Composite Crew Module: Primary Structure NASA/TM-2011-217185
10. Composite Crew Module: Design NASA/TM-2011-217186
11. Composite Crew Module: Materials and Processes NASA/TM-2011-217187
12. Composite Crew Module: Analysis NASA/TM-2011-217188
13. Composite Crew Module: Manufacturing NASA/TM-2011-217189
14. Composite Crew Module: Test NASA/TM-2011-217190
15. Composite Crew Module: Nondestructive Evaluation NASA/TM-2011-217191
16. Orion Thermal Protection System (TPS) Margin Study Assessment NASA/TM-2011-217299
17. Space Transportation System (STS)-133/External Tank (ET)-137 ET Foam Crack and Repair Assessment Thermal Analysis Report NASA/TM-2011-217306
18. Likely Mechanism and Contributors to the Root Cause for Orbiter Wing-Leading-Edge Joggle RCC SiC Coating Spallation NASA/TM-2011-217312
19. Progressive Failure Analysis of a RCC Slip-Side Joggle Region NASA/TM-2011-217313
20. Space Transportation System (STS)-133/External Tank (ET)-137 Intertank (IT) Stringer Cracking Issue and Repair Assessment: Proximate Cause Determination and Material Characterization Study NASA/TM-2011-217318
21. Doppler Radar Profiler for Launch Winds at the Kennedy Space Center (Phase 1a) NASA/TM-2011-217321
22. Development of Autonomous Aerobraking (Phase 1) NASA/TM-2012-217328
23. Orion Launch Abort System Carbon/Carbon Silicon Carbide Material Behavior: Phase I: Review of Existing Data and Recommended Phase II NASA/TM-2012-217333
24. Probabilistic Requirements (Partial) Verification Methods Best Practices Improvement - Variables Acceptance Sampling Calculators: Derivations and Verification of Plans .... NASA/TM-2012-217335/Volume I
25. Probabilistic Requirements (Partial) Verification Methods Best Practices Improvement - Variables Acceptance Sampling Calculators: Empirical Testing .... NASA/TM-2012-217335/Volume II
26. Space Transportation System (STS)-133/External Tank (ET)-137 Intertank (IT) Foam Crack and Repair Assessment - Overview NASA/TM-2012-217338
27. Evaluation of GenCorp Incorporated Aerojet AJ26 Engine 4 (E4) Engine Investigation for Use on Orbital Science Corporation (OSC) Antares Launch Vehicle NASA/TM-2012-217339
28. Orion Crew Module (CM) Crew Seat Attenuation NASA/TM-2012-217345
29. International Space Station (ISS) Heat Rejection Subsystem (HRS) Radiator Face Sheet Damage NASA/TM-2012-217348
30. Use of Commercial Electrical, Electronic and Electromechanical (EEE) Parts in NASA's Commercial Crew and Cargo Program (CCP) NASA/TM-2012-217558
31. Assessment of Microphone Phased Array for Measuring Launch Vehicle Lift-off Acoustics NASA/TM-2012-217563
32. Composite Pressure Vessel Working Group (CPVWG) Task 3: Stress Rupture Test Approach NASA/TM-2012-217564
33. International Space Station Air Quality Monitoring System Assessment NASA/TM-2012-217572
34. Flight Data Entry, Descent, and Landing (EDL) Repository NASA/TM-2012-217574
35. Reacting Multi-Species Gas Capability for USM3D Flow Solver NASA/TM-2012-217575
36. Linguistic Preprocessing and Tagging for Problem Report Trend Analysis NASA/TM-2012-217576
37. Max Launch Abort System (MLAS) Parachute System NASA/TM-2012-217579
38. Best Practices for Updating Acoustic Environments With Measured Flight Data NASA/TM-2012-217594
39. Independent Technical Assessment of James Webb Space Telescope (JWST) Cryocooler Disturbance (Random and Pulsating) Model NASA/TM-2012-217596
40. Space Shuttle Program (SSP) Shock Test and Specification Experience for Reusable Flight Hardware Equipment NASA/TM-2012-217599

41. Cassini Spacecraft Short Anomaly NASA/TM-2012-217756
42. James Webb Space Telescope's (JWST) Near-Infrared Spectrograph (NIRSpec) Micro Shutter Subsystem (MSS) .... NASA/TM-2012-217757/Volume I
43. James Webb Space Telescope's (JWST) Near-Infrared Spectrograph (NIRSpec) Micro Shutter Subsystem (MSS) Appendices .... NASA/TM-2012-217757/Volume II
44. Space Transportation System (STS)-133 External Tank (ET)-137 Intertank (IT) Foam Crack and Repair Assessment: Elastic-Plastic, Thermo-Mechanical Nonlinear Structural Analyses NASA/TP-2012-217773
45. Icing Research Tunnel (IRT) Force Measurement System (FMS) .... NASA/TP- 2012-217784

Presentation Papers

1. Null, C. H.: How one Functional Human-Factors Requirement Influenced a Rocket. Presented at NASA Project Management Challenge, February 22-23, 2012, Orlando, Florida.
2. White, Jr., K.; and Johnson, K. L.: Empirical Tests of Acceptance Sampling Plans. Presented at 10th International Conference on Operations Research, March 6-9, 2012, Havana, Cuba.
3. Carr, G.; Ging, A.; and Keys, D. J.: Cassini Mission Short Circuit Anomalies Investigation. Presented at 30th Annual Space Power Workshop, April 16-19, 2012, Manhattan Beach, California.
4. Sammons, M.; Powell, C.; Pellicciotti, J. W.; Buehrle, R. D.; and Johnson, K.: Passive Thrust Oscillation Mitigation for the CEV Crew Pallet System. Presented at 41st Aerospace Mechanisms Symposium, May 16-18, 2012, Pasadena, California.
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