National Aeronautics and Space Administration

AeroSpace FRONTIERS

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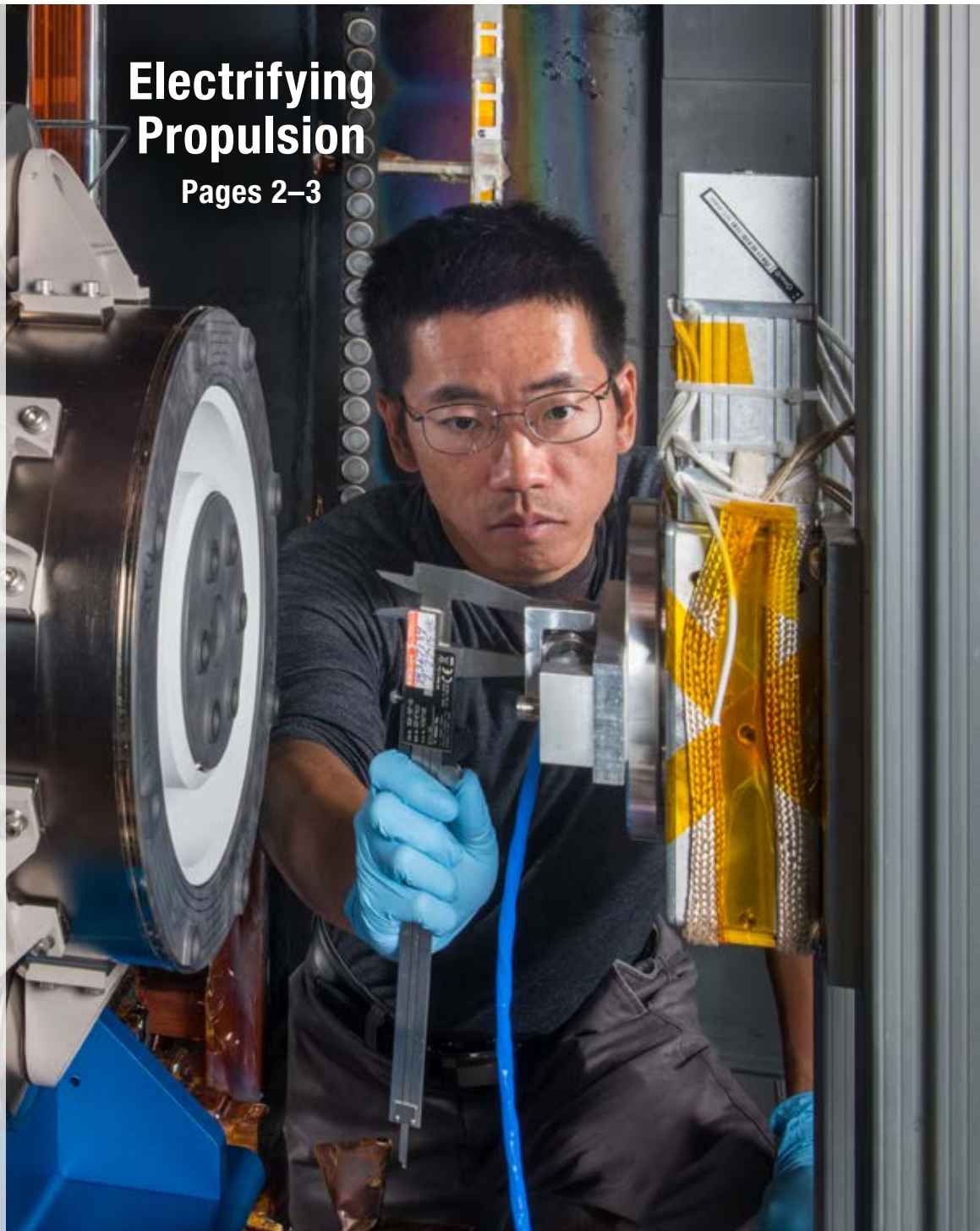

Electrifying Propulsion

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Welcome to the New Year

Welcome back! I recognize the past year presented hardships for many, and I truly appreciate and thank you for your dedication. As we start 2021, your health and safety remains my top priority. With this in mind, we will continue Stage 2 preparations and look forward to continued success in delivering on our key space and aeronautics mission priorities, including Artemis/Orion, power and electric propulsion, electrified aircraft technologies, and key testing in our facilities. We will also be investing and transforming our infrastructure in support of our mission, and further developing our partnerships, collaborations, and communications to promote innovation and technology commercialization. Join me as we implement our priorities safely and with excellence.

Happy new year,

AeroSpace Frontiers
is an official publication of Glenn Research Center, National Aeronautics and Space Administration. It is published the second Friday of each month by the Office of Communications in the interest of the Glenn workforce, retirees, government officials, business leaders, and the general public.

Submit short articles and calendar items to the editor at doreen.b.zudell@nasa.gov.

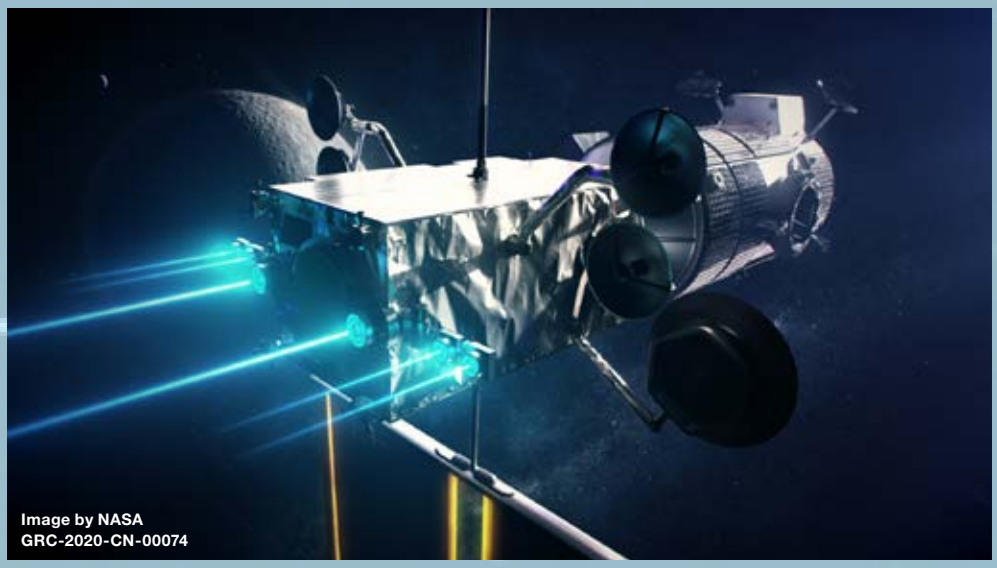
Editor: **Doreen B. Zudell**, ATS, 216–433–5317

Assistant Editor: **S. Denise Veris**, ATS

Design: **Rhys Sampson**, ATS

Managing Editor: **Kelly R. DiFrancesco**

Circulation: **Angela Williams**, ATS, 216–433–8921



An illustration of the PPE and habitation and logistics outpost (HALO) in lunar orbit.

The Propulsion We're Supplying…It's *Electrifying*

Since the beginning of the space program, people have been captivated by big, powerful rockets—like NASA's Saturn V rocket that sent Apollo to the lunar surface or the Space Launch System that will produce millions of pounds of thrust as it sends Artemis astronauts back to the Moon.

But what if the most powerful propulsion system in NASA's toolbox produces less than 1 pound of thrust while reaching speeds of up to 200,000 mph? What if it costs less, carries more, and uses less fuel?

This radical system is in-space electric propulsion. It can reduce the amount of fuel, or propellant, needed by up to 90% compared to chemical propulsion systems, saving millions in launch costs while providing greater mission flexibility.

Newton's Third Law in Space

Chemical propulsion uses a fuel and an oxidizer, converting energy stored in the chemical bonds of the propellants, to produce a short, powerful thrust, or what we see as fire.

An electric propulsion system uses energy collected by either solar arrays (solar electric propulsion) or a nuclear reactor (nuclear electric propulsion) to generate thrust, eliminating many of the needs and limitations of storing propellants onboard.

That power is then converted and used to ionize—or positively charge—inert gas propellants like xenon and krypton (no, it is not from Superman's home planet). A combination of electric and magnetic fields (Hall effect thruster) or an electrostatic

On the Cover:

Researcher Wensheng Huang examines diagnostic hardware for a test of the Advanced Electric Propulsion System (AEPS) Engineering Test Unit 2. Flight model AEPS Hall thrusters will propel the power and propulsion element to lunar orbit.

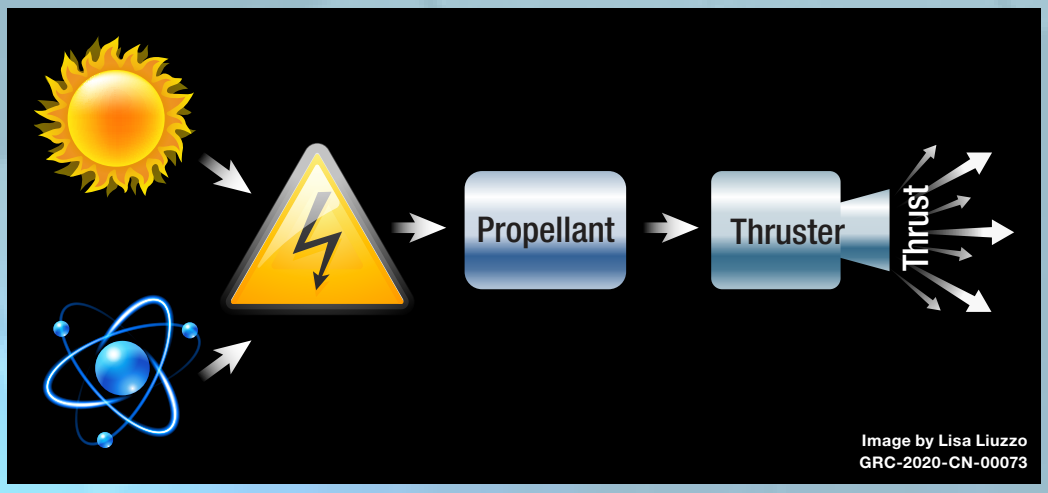
Photo by Bridget Caswell
GRC-2019-C-13123

(gridded ion) field then accelerates the ions and pushes them out of the thruster, driving the spacecraft to tremendous speeds over time. Instead of fire, its exhaust is a glowing greenish-blue trail, like something straight out of science fiction.

Drag Race Versus Road Trip

A chemical spacecraft is a top fuel dragster as it departs Earth's orbit toward its destination. The initial burst is quite powerful, but it can really only go in the direction it is pointing when you stomp on the gas pedal. The spacecraft is off like a bullet, but after its fuel supply is exhausted, there is little ability to speed up, slow down, or change direction. So, the mission is locked into specific launch windows and orbital departure timeframes, and it can make only minimal corrections along the way.

An electric propulsion spacecraft, once it is in space, is out for a cross-country drive, limited only by the gas in the tank. The initial thrust is quite low, but it can continue accelerating for months or even years, and it can also slow down and change direction.



An illustration of how electric propulsion systems work.

NASA's Dawn mission is a perfect example. After launch, it accelerated toward Vesta in the asteroid belt. Because of the spacecraft's small solar arrays, it took over 5 years to get there, but as it approached, the spacecraft flipped 180 degrees, burned its thrusters to slow down, and orbited for a year. When it was done, it fired back up and traveled to Ceres, where it still orbits today. This would not be possible with chemically propelled spacecraft.

Systems like the one on Dawn are in wide use across NASA and the commercial sector, typically operating in the 1- to 10-kilowatt range. As we prepare to use electric propulsion for more complex science and technology missions and on human missions for the first time, we are going to need more power.

More Power for People!

The power and propulsion element (PPE) for Gateway will demonstrate advanced, high-power solar electric propulsion around the Moon. It is a 60-kW-class spacecraft, 50 of which can be dedicated to propulsion, making it about four times more powerful than current electric propulsion spacecraft. We do this not by building one big thruster, but by combining several into a string with giant solar arrays.

This advanced system will allow our orbiting platform to support lunar exploration for 15 years given its high fuel economy, and its ability to move while in orbit will allow explorers to land virtually anywhere on the Moon's surface.

While it is a critical piece of our Artemis lunar exploration plans, the PPE will also help drive U.S. commercial investments in higher power electric propulsion systems, like those that could be used to get to Mars.

Next Stop, Mars

Future Mars transfer vehicles will need around 400 kW to 2 megawatts of power to successfully ferry our astronauts or cargo to and from the Red Planet. We are still exploring vehicle and propulsion concepts for Mars, including a combination of nuclear electric and chemical propulsion and other emerging options like Nuclear Thermal Propulsion.

No matter how we get to the Moon and eventually Mars, one thing is for certain…the future of space exploration is exciting. One might even say, it's electrifying.

By Jimi Russell

2020 NASA and Center Honor Awards

The 2020 NASA Glenn Virtual Agency Honor and Center Awards Ceremony, held Dec. 2, 2020, honored individuals and teams who have made a dramatic impact in executing NASA's mission and have distinguished themselves above and beyond NASA's high standards of performance. Center Director Dr. Marla Pérez-Davis and special guest Deputy Associate Administrator Melanie Saunders provided congratulatory remarks, and Elizabeth Turnbull and Dr. Lyndsey McMillon-Brown served as the event moderators.


Carter


Meinert


Millard


Smith


Smith


Rist


Ceh


DeGreen


Keith


Koudelka


Kuhl


Noebe


Palyo


Stocker


Williams


Williamson

HONOR AWARDS

OUTSTANDING LEADERSHIP MEDAL

Robert W. Carter
Karen M. Meinert
Jonathan S. Millard
Lynn N. Smith
Timothy D. Smith

OUTSTANDING PUBLIC LEADERSHIP MEDAL

Caroline A. Rist

EXCEPTIONAL SERVICE MEDAL

Helen M. Ceh
John J. DeGreen
Sallie A. Keith
John M. Koudelka
Cassey D. Kuhl
Ronald D. Noebe
Renee D. Palyo
Dennis P. Stocker
Tonyia J. Williams
Gary S. Williamson

EXCEPTIONAL PUBLIC SERVICE MEDAL

Margarita Aponte
Paul A. Catalano
Gregory P. Frederick
Richard J. Kearney
Arnold Kuchenmeister


Aponte


Catalano


Frederick


Kearney


Kuchenmeister


Chambers


Connelly


Doglio


Feldhake


Hawkins


Jackson


Lippus


McCallum


Numbers


Reed


Schmidt


Shaw


Smith


Spangler


Garcia


Lewis


Downey


Falck


Fincannon

*Not pictured

EXCEPTIONAL ACHIEVEMENT MEDAL

Jeffrey A. Chambers
Nicholas A. Connelly
James A. Doglio
Glenn S. Feldhake
Kristin B. Hawkins
James W. Jackson
Sherri A. Lippus
Peter W. McCallum
Scott A. Numbers
Erin M. Reed
Elliot A. Schmidt
Heidi D. Shaw
James E. Smith
Robert T. Spangler

EXCEPTIONAL PUBLIC ACHIEVEMENT MEDAL

Christopher P. Garcia
Sharon L. Lewis

EXCEPTIONAL ENGINEERING ACHIEVEMENT MEDAL

James M. Downey
Robert D. Falck
Homer J. Fincannon

EXCEPTIONAL SCIENTIFIC ACHIEVEMENT MEDAL

Ken K. Lee*

EXCEPTIONAL TECHNOLOGY ACHIEVEMENT MEDAL

Daniel E. Paxson

EXCEPTIONAL ADMINISTRATIVE ACHIEVEMENT MEDAL

Stacy Alcorso


Paxson


Alcorso


Berndt


Acosta


Artino


Belair


Burke


Justice


McDonald


Molnar


Munro


Pepen


Schnulo


Smith

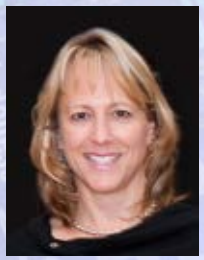

Rouse


Rozema

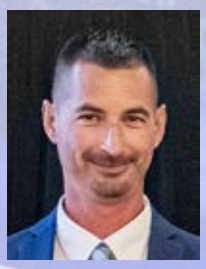

Salkin


Allen


Bury


Crable


Cutlip


Edmonds


Hicks


Mindek

Sondra D. Atkins*
Wendy A. Berndt

EARLY CAREER ACHIEVEMENT MEDAL

Waldo J. Acosta
Brianna L. Artino
Michael L. Belair
James P. Burke
Julie T. Justice
Candice M. McDonald
Rebecca C. Molnar
Ryan J. Munro
Michael A. Pepen
Deboshri Sadhukhan*
Sydney L. Schnulo
Timothy M. Smith

EARLY CAREER PUBLIC ACHIEVEMENT MEDAL

Brian S. Rouse
Matthew R. Rozema
Jordan I. Salkin

SILVER ACHIEVEMENT MEDAL

Joshua E. Allen
Kristen M. Bury
Vicki J. Crable
Scott B. Cutlip
Patrick S. Edmonds
Lisa M. Hicks
Eric S. Mindek
George C. Soulas
David E. Stark

SILVER ACHIEVEMENT GROUP AWARDS

Advanced Colloids Experiment (ACE) Team

South Chilled Water Plant Restoration Team

*Not pictured


Soulas


Stark


Barrett


Hagerman


Lobo


Martzaklis


McCartney


Puchmeyer


Schubert


Straub


Whitfield


Cheston


Gordon


Motil


Smith


Bonesteel


Corban


Doherty


Follen


Hurd

*Not pictured

Shape Memory Alloy Actuated Vortex Generator Development Team

Cybersecurity Standards and Engineering Team (CSET)

Asymmetric Ka-Band Waveguide Power Combiner Development Team

SENIOR EXECUTIVE SERVICE APPOINTMENT

Michael J. Barrett
Vicki L. Hagerman
Mary J. Lobo
Konstantinos S. Martzaklis
Timothy P. McCartney
Callista M. Puchmeyer
Kathleen E. Schubert
Kurt A. Straub
Susan L. Whitfield

PRESIDENTIAL RANK

Derrick J. Cheston
Robyn N. Gordon
Susan M. Motil
Bryan K. Smith

CAREER SERVICE AWARDS

40 YEARS OF SERVICE

Andrea R. Bonesteel
Robert R. Corban
Michael P. Doherty
Gregory J. Follen
Gerald A. Hurd
Frances I. Hurwitz
Joseph J. Kan*
Lisa L. Kohout
Kevin J. Melcher

Hurwitz

Kohout

Melcher

Miller

Mudry

Oldenburg

Buttler

Fralick

Thomas B. Miller
John J. Mudry
John R. Oldenburg

45 YEARS OF SERVICE

Robert D. Buttler

55 YEARS OF SERVICE

Gustave C. Fralick

GROUP ACHIEVEMENT AWARDS

Orion Thermal Vacuum/Thermal Balance Test Team

10x10 Critical Hardware Repair Team

SHIIVER Engineering and Testing Team

S–3B Viking Aircraft

Hybrid Gas Electric Propulsion Team

8x6/9x15 Wind Tunnel Complex Acoustic Improvement Team

System for Tracking Audits/Assessments and Reviews Team

World Radio Conference 2019 Team

Orion Artemis I Test Facility Preparation Team

Second European Service Module (ESM–2) Orbital Maneuvering System–Engine (OMS–E) Anomaly Recovery Team

NASA Glenn Research Center Small Business Innovation Research (SBIR) Team

Conformal Lightweight Antenna Structures for Aeronautical Communications Technologies (CLAS—ACT) Team

Glenn Research Center NEXT—C Protoflight Vibration Test Team

Glenn Research Center Fleet Management and Transportation Team

Center Awards

STEVEN V. SZABO ENGINEERING EXCELLENCE AWARD

Crew and Service Module Structures and Mechanisms Team

CRAFTSMANSHIP AWARDS

Manufacturing Technologies—Individual

Timothy J. Heineke

Manufacturing Technologies—Group

NASA H71M—PM Low-Power Hall-Effect Thruster Team

DISTINGUISHED PUBLICATION AWARD

Chunill Hah

The Inner Workings of Axial Casing Grooves in a One and a Half Stage Axial Compressor With a Large Rotor Tip Gap: Changes in Stall Margin and Efficiency

DIVERSITY LEADERSHIP AWARD

Cynthia C. Calhoun

Herbert W. Schilling

SAFETY AWARD

Gordon M. Berger

Sandra H. Valenti

Building 309 Hazmat Exercise Team

SUPERVISOR AWARD

Gene Fujikawa

Richard A. Slywczak

ALCYON TECHNICAL SERVICES (ATS) EXCEPTIONAL ADMINISTRATIVE/CLERICAL PERFORMANCE AWARD

Barbara H. Madej

Paula M. Pal

Justyna Ragiel-Smith

Heineke

Hah

Calhoun

Schilling

Berger

Valenti

Fujikawa

Slywczak

Madej

Pal

Ragiel-Smith

Dr. Pérez-Davis

Cleveland Magazine Recognizes Dr. Marla Pérez-Davis

Cleveland Magazine has recognized Center Director **Dr. Marla Pérez-Davis** with two prestigious honors in its January 2021 issue. She was selected as one of the 30 Most Interesting People—an annual list of people who have captured the city's attention. She also was selected for the Community Leader's first annual Cleveland 500—a list of the most powerful and influential people in Northeast Ohio. Cleveland Magazine is available at newsstands in grocery, convenience, specialty, and bookstores throughout the city.

Dr. Okojie

Okojie Inducted Into Inventors Hall of Fame

Dr. Robert Okojie, a research electronics engineer in NASA Glenn's Smart Sensing and Electronics Systems Branch, has been inducted into NASA's Inventors Hall of Fame. He is a world-renowned expert on silicon-carbide-based microelectromechanical systems (MEMS) used in extreme environments. Since joining Glenn's silicon carbide research group in 1999, Okojie has earned 21 U.S. patents with two additional patents on the way.

Glenn Intern Selected Astronaut Scholar

Robertson

Brianna Robertson, a Louisiana State University Honors College student and spring 2020 NASA Intern in Glenn's Cognitive Signal Processing Branch, has been named a 2020 Astronaut Scholar. Robertson, a senior physics and computer engineering major, came to Glenn to enhance her knowledge of artificial intelligence applied to cognitive communications applications and advance her long-term goal to become an astronaut. Glenn mentor Aaron Smith introduced Robertson to some smarter algorithms for his research in intelligent communication systems, which Robertson not only absorbed, but also helped to advance.

RETIREMENTS

Farkas

Klem

Otero

Rivera

Weismantel

Les Farkas, Integration Office, Office of Chief Information Officer, retired Dec. 31, 2020, with 36 years of service.

Cleve Horn, Aviation Test Branch, Aeronautics Directorate, retired Dec. 30, 2020, with 41 years of service.

Mark D. Klem, Chemical and Thermal Propulsion Systems Branch, Propulsion Division, retired Dec. 31, 2020, with 37 years of federal service, including 33 with NASA.

Kelly J. McEntire, Mechanisms and Tribology Branch, Materials and Structures Division, retired Dec. 31, 2020, with 38 years of service.

Melissa (Missy) Merrill, Exploration Systems Branch, Procurements Division, retired Dec. 31, 2020, with 35 years of service.

Noel Nemeth, Multiscale and Multiphysics Modeling Branch, Materials and Structures Division, retired Dec. 31, 2020, with 30 years of service.

Suzanne (Sue) Otero, Technical Excellence Office, NASA Safety Center, retired Dec. 31, 2020, with 28 years of service.

Ricky N. Rivera, Wind Tunnel Branch, Facilities, Test and Manufacturing Division, retired Dec. 31, 2020, with 31 years of service.

Dennis L. Weismantel, Wind Tunnel Branch, Facilities, Test and Manufacturing Division, retired Dec. 31, 2020, with 32 years of service.

More retirements to come in the February AeroSpace Frontiers.

Urgent: CFC Needs Your Help

The Combined Federal Campaign (CFC) needs your help. CFC donations are at a record low. If you plan to give, but you are waiting until you have time, the time is now. Please go to https://cfcgiving.opm.gov/ to make your donation. If you have any questions, see your keyworker. The CFC Committee thanks you in advance for your consideration and wishes you a prosperous new year. The campaign ends on Jan. 15, 2021.

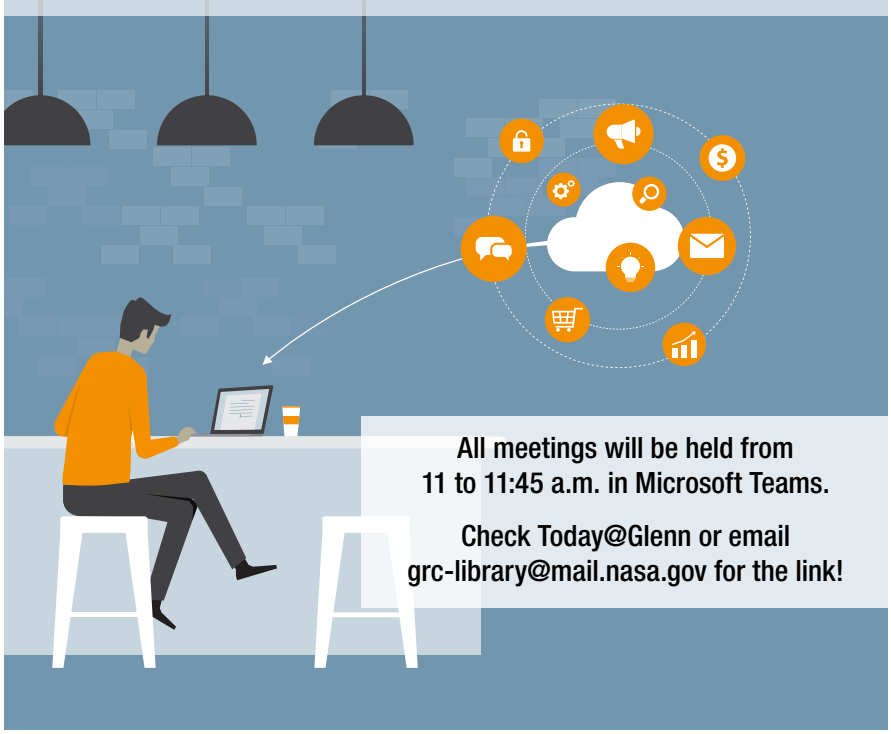
Upcoming Center Events

Join Glenn's Library for their new monthly series

Information Café

The Library will host mini lessons about Glenn and Library-related topics. Here are the first 4 months.

Jan. 20: NASA Tech Standards (IHS/TechStreet)
Feb. 17: Virtual tour of the library site/resources/services
March 17: Publishing at Glenn
April 21: Filing your NTR (new technology report) with Tech Transfer



All meetings will be held from 11 to 11:45 a.m. in Microsoft Teams.

Check Today@Glenn or email grc-library@mail.nasa.gov for the link!

DAY OF REMEMBRANCE

NASA will hold its 2021 Day of Remembrance on Thursday, Jan. 28, to honor members of the NASA family who lost their lives while furthering the cause of exploration. This includes the crews of Apollo 1, Space Shuttle Challenger, and Space Shuttle Columbia.

OUTDOOR SIREN TESTING

The Emergency Management Office staff will conduct a mass notification voice test at bldg. 6 on Wednesday, Feb. 3, at Lewis Field. An audible siren test on the "severe thunderstorm" tone on Saturday, Feb. 6.

POC: Allen Turner, 3–6826

OSTEM SEEKING VIRTUAL MENTORS

Glenn's Office of STEM Engagement (OSTEM) is seeking mentors for the 2021 Virtual Volunteer High School Internship Project. Mentors will be paired with high school students who are excited to explore STEM career opportunities as well as professional business fields at NASA. Internships will take place in May 2021 for a duration of 4 weeks. POCs: Vanessa Webbs at vanessa.r.webbs@nasa.gov or Eric Hayes at eric.w.hayes@nasa.gov.

Stay tuned to Today@Glenn for updates on these activities

Deadline for next calendar section is **Jan. 20, noon**. News and feature stories require additional time.
NASA Glenn Employees: For more calendar information, visit **https://wing.grc.nasa.gov/event-calendar/**.

National Aeronautics and Space Administration

John H. Glenn Research Center

Lewis Field
21000 Brookpark Road
Cleveland, Ohio 44135

Plum Brook Station
3597 E. Scheid Road
Sandusky, Ohio 44870

www.nasa.gov

Read AeroSpace Frontiers online at http://www.nasa.gov/centers/glenn/news/AF/index.html.

Happy 80th Anniversary, NASA Glenn!

Image by Dan Frydl

On Jan. 23, 1941, local authorities, military representatives, and National Advisory Committee for Aeronautics (NACA) officials came together to celebrate the selection of a new engine lab in Cleveland. This engine lab, called the NACA Aircraft Engine Research Laboratory, would later become the NASA Glenn Research Center.

Throughout 2021, the anniversary planning team invites you to celebrate this historic milestone by participating in virtual activities and events that are being planned. Watch Today@Glenn for details! 80th Anniversary co-leads: Anne Mills and Zachary Lucas

Call for 80th Anniversary Hall of Fame Class Nominations

As a part of the center's 80th Anniversary celebration, a third class of inductees will be inaugurated into the Glenn Hall of Fame later in 2021. The first classes were chosen in honor of the NACA Centennial and Glenn 75th Anniversaries in 2015 and 2016. The Glenn Hall of Fame reminds us that our success is built on the work of those who have come before us and serve to inspire current and future employees.

Inductees are selected based on their contributions having a sustained and far-reaching influence on the direction and mission of the center, whose work at the center has generated fundamental advancements in their field, and/or serve as an inspiration to employees through their character and embodiment of the NASA spirit. You can learn more about past inductees at https://www1.grc.nasa.gov/glenn-history/hall-of-fame/.

Current employees will be invited to nominate potential new members for this induction class. Watch Today@Glenn for further information on the nomination process, which will kick off in late January.

Emergency and Inclement Weather Lines

Lewis Field: 216–433–9328 (WEAT)
Plum Brook Station: 419–621–3333

Connect With Glenn