ABOVE AND BEYOND

1. GRC leads the Space Communications and Navigation (SCaN) Testbed multicenter team. NASA’s SCaN Testbed now is the world’s first flight-validated, in-space U.S. Global Positioning System (GPS) – European Galileo Global Navigation Satellite System (GNSS) receiver.

2. Deployment test of commercial solar arrays in Plum Brook Station’s Space Power Facility is providing assurance of performance in space.

3. Ultralightweight solar arrays are being built and tested to enable new space exploration capabilities.

4. Stirling Research Laboratory (SRL) surpassed 600,000 hours of cumulative test operations, reducing risk for new energy conversion systems to be used on long space exploration missions that cannot employ solar power.

5. “Cool Flames” from burning droplets in zero gravity were newly discovered in GRC’s Combustion Integrated Rack on the International Space Station.

6. GRC-developed cross-linked polyimide aerogels are strong, durable, flexible, and insulating when formed as lightweight, flexible films, making them ideal for Earth and space applications.

7. GRC leads the Solar Electric Propulsion project—helping to enable new technologies that reduce costs, extend durations, and improve capabilities of new space exploration missions, such as traveling to Mars and asteroids.

DIRECTOR’S INTENT

Our strategic plan is just that: our strategic plan. As we developed this plan, I asked that it be of value to all of us. The plan provides guidelines to follow as we do our work today and pursue what we are going to do in the future. Under each goal we have objectives and initiatives that will help us to focus the work of each day so that it fits into what we will be doing in the years ahead. We all make our strategy happen. With all of us pulling together, the NASA Glenn Research Center (GRC) will stay healthy, relevant, and sustainable.

1Not in this overview.

Cover images, left: GRC is working on innovative concepts and technology to enable revolutionary advances in air vehicles to help them fly faster, cleaner, quieter, and with improved fuel efficiency. The technical challenges related to the propulsion system of a Hybrid Gas-Electric aircraft is one area in which GRC plays a role.

Right: GRC is leading the Solar Electric Propulsion effort, which will enable space exploration missions by developing new technologies that reduce costs, extend mission durations, and improve spacecraft capabilities.
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agency’s Strategic Direction and Mission</td>
<td>2</td>
</tr>
<tr>
<td>The Agency Vision</td>
<td>2</td>
</tr>
<tr>
<td>The Agency Mission</td>
<td>2</td>
</tr>
<tr>
<td>The Agency Goals</td>
<td>2</td>
</tr>
<tr>
<td>GRC’s Strategic Direction and Mission</td>
<td>3</td>
</tr>
<tr>
<td>GRC’s Mission</td>
<td>3</td>
</tr>
<tr>
<td>GRC’s Goals and Objectives</td>
<td>3</td>
</tr>
<tr>
<td>GRC’s Goals and Objectives—Goals 1 and 2</td>
<td>4</td>
</tr>
<tr>
<td>GRC’s Goals and Objectives—Goals 3 to 5</td>
<td>5</td>
</tr>
<tr>
<td>GRC’s Core Competencies</td>
<td>6</td>
</tr>
<tr>
<td>Air-Breathing Propulsion</td>
<td>6</td>
</tr>
<tr>
<td>Communications Technology and Development</td>
<td>6</td>
</tr>
<tr>
<td>In-Space Propulsion and Cryogenic Fluids Management</td>
<td>7</td>
</tr>
<tr>
<td>Power, Energy Storage and Conversion</td>
<td>7</td>
</tr>
<tr>
<td>Materials and Structures for Extreme Environments</td>
<td>8</td>
</tr>
<tr>
<td>Physical Sciences and Biomedical Technologies in Space</td>
<td>8</td>
</tr>
<tr>
<td>Planning for Today…and Beyond</td>
<td>9</td>
</tr>
<tr>
<td>Venture Development and Partnerships</td>
<td>10</td>
</tr>
</tbody>
</table>
AGENCY’S STRATEGIC DIRECTION AND MISSION

The Agency has established our strategic direction with the NASA vision, mission, and goals.

The Agency Vision
We reach for new heights and reveal the unknown for the benefit of humankind.

The Agency Mission
Drive advances in science, technology, aeronautics, and space exploration to enhance knowledge, education, innovation, economic vitality, and stewardship of Earth.

The Agency is guided by three strategic goals.
GRC is vital to NASA achieving these goals, and GRC will continue to make significant contributions to NASA’s future.

1. **NASA Goal 1**
   Expand the frontiers of knowledge, capability, and opportunity in space.

2. **NASA Goal 2**
   Advance understanding of Earth and develop technologies to improve the quality of life on our home planet.

3. **NASA Goal 3**
   Serve the American public and accomplish our Mission by effectively managing our people, technical capabilities, and infrastructure.

GRC’s goals are directly aligned with and support NASA’s goals.
GRC’s Strategic Direction and Mission

We have defined our strategic direction using our mission, goals, core competencies, and mission-enabling capabilities.

GRC’s Mission
We drive research, technology, and systems to advance aviation, enable exploration of the universe, and improve life on Earth.

GRC’s Goals and Objectives

We have identified five GRC goals that are directly aligned with and support the implementation of NASA’s goals.

1. GRC Goal 1
   Provide world-class research and technology, revolutionizing aeronautics and space exploration.

2. GRC Goal 2
   Advance space missions and aeronautics by leveraging our core competencies to deliver from concept through applications.

3. GRC Goal 3
   Deliver program and project management excellence that results in safe and successful missions for our customers and challenging, long-term assignments for the Center.

4. GRC Goal 4
   Provide excellent institutional capability to enable NASA mission success.

5. GRC Goal 5
   Be an integral part of the Ohio community and the Nation.
GRC’S GOALS AND OBJECTIVES

GOAL 1
Provide world-class research and technology, revolutionizing aeronautics and space exploration.

Objective 1.1: (Aero) Enable faster, safer, more efficient, more environmentally friendly aircraft, and enable more efficient airspace operations.

Objective 1.2: (Space) Expand human and robotic exploration capabilities for safer, faster, more reliable, more flexible, and more efficient space travel that increases scientific return and discovery, destinations of choice, and value-based transitions to commercialization.

Objective 1.3: (Others) Identify and infuse aerospace technologies and expertise into emerging markets.

GOAL 2
Advance space missions and aeronautics by leveraging our core competencies to deliver from concept through applications.

Objective 2.1: Make operational aeronautic flight systems safer, more efficient, and more capable by taking new technology to flight through advanced development efforts (TRLs\(^1\) 4 to 6).

Objective 2.2: Increase the capability, reliability, and safety of space flight systems through advanced development efforts (TRL 4 to 6).

Objective 2.3: Enable mission success by developing mission components, subsystems, and/or systems (TRL 6 or mature technology to flight).

Objective 2.4: Provide affordable world-class and unique capabilities for testing.

\(^1\)Technology Readiness Levels.
GRC’S GOALS AND OBJECTIVES

GOAL 3
Deliver program and project management excellence that results in safe and successful missions for our customers and challenging, long-term assignments for the Center.

Objective 3.1: Increase and share project management knowledge, skills, and proficiency through education, training, mentoring, certification, detail assignments, established communities of practice, and development opportunities.

Objective 3.2: Develop, use, and improve processes, tools, and standards that are appropriately rigorous and add value, incorporate best practices and procedures that are aligned with Agency and Center policy and requirements, and are streamlined and tailored as appropriate.

Objective 3.3: Establish a project management operating cadence and execution metrics that are highly effective, responsive, measurable, and well integrated with Agency and Center governance.

GOAL 4
Provide excellent institutional capability to enable NASA mission success.

Objective 4.1: Foster a highly skilled, diverse, and engaged workforce to achieve mission success.

Objective 4.2: Optimize and maintain institutional capabilities and readiness for mission success (workforce, facilities, labs, information technology, and services capability).

GOAL 5
Be an integral part of the Ohio community and the Nation.

Objective 5.1: Establish community relationships to enhance understanding of Glenn’s value through

- Education
- Community activities
- Interactions with political stakeholders
- Industry outreach

Summary:
At GRC, we go “above and beyond” to create new knowledge, deliver new technology, and manage our projects and infrastructure efficiently and effectively—in service to NASA, the regional community, and the Nation.
GRC’S CORE COMPETENCIES

The Center has many technical and institutional competencies. GRC’s six core competencies are critical to the health and future of the Center and the Agency. These core competencies and GRC’s mission-enabling capabilities are integral parts of the Agency capability portfolio that supports NASA’s strategic plan and missions.

Air-Breathing Propulsion

This competency includes revolutionary concepts, technologies, and new systems aimed at significantly advancing air-breathing propulsion for aerospace vehicles that enable reduced energy consumption, use of alternative energy sources, reduced noise and emissions, increased versatility, improved safety of operations, faster modes of air transportation, and reduced costs for aerospace travel. Research and development areas critical to success include systems assessments; innovative engine cycles and advanced propulsion systems; component improvements; controls and dynamics; harsh environment sensors, electronics, instrumentation, health monitoring and management, materials, and structures; power extraction and management; icing; fuels and propellants; acoustics, fluid mechanics, and heat transfer; aerothermodynamics and plasmas, multidisciplinary design, optimization, modeling, and simulation; and testing and evaluation in a broad range of aeronautical conditions.

Communications Technology and Development

This key technical area includes research, development, demonstration, and transition to operations of communications systems. This work enables orders-of-magnitude increases in mission data transfer and provides continuous, cost-effective, and secure high-data-rate communications. Expertise in spectrum management, data standards, and protocols along with systems engineering practices helps to develop aeronautical and space communications architectures, systems, subsystems, and components. Those architectures then drive investments in research and technology development. Exploitation of new radiofrequency spectrum and maximizing data throughput on existing spectrum allocations are continuous endeavors. Focused technologies with subject matter expertise include antennas, propagation, optical and radiofrequency devices, high-power amplifiers, intelligent sensors, software-defined radios, cognitive radios, and networking. Model-based systems engineering tools and emulation capabilities allow for analysis of the impacts of changes to existing networks and extension to future network operations. Flight demonstration of components and systems is used as a path to transition new capability to operational use.
GRC’S CORE COMPETENCIES

In-Space Propulsion and Cryogenic Fluids Management

This competency includes the research, technology development, technology demonstration, and flight development of components, subsystems, and systems for spacecraft propulsion systems, propulsion stages, and cryogenic fluid flight systems to enable new mission capability; increased reliability, safety, and affordability; and reduced trip times. This involves the design, testing, and evaluation of in-space propulsion technologies and systems such as propellants, chemical propulsion, electric propulsion (ion, Hall, and plasma), nuclear propulsion, and other advanced concepts; reaction control; and orbital maneuvering. It also involves the knowledge, capabilities, and practices associated with cryogenic fluid management, including cryogenic fluids hardening, characterization, storage, delivery, demonstrations, and flight packages. Research and development areas critical to success include the development of advanced technologies; integrated systems analysis; multidiscipline optimization; the development of predictive tools; and the thermal fluids, combustion, structures, controls, dynamics, systems safety, and test and evaluation disciplines for a broad range of in-space conditions.

Power, Energy Storage and Conversion

Aerospace power system capabilities at GRC encompass all technology readiness levels from basic research through flight hardware. This includes extensive capabilities in power system analysis and modeling, and all requisite skills, expertise, and facilities for power generation, energy storage, and electric power distribution. Power generation capabilities include the development of solar cells, solar arrays, primary fuel cells, radioisotope power systems, fission power systems, and associated thermal systems. Energy storage capabilities consist of the buildup of batteries, regenerative fuel cells, and flywheels. Electric power distribution capabilities include the regulation of power generation and storage systems; the delivering of both low- and high-voltage generated power to users; the providing of conditioned power to a wide variety of loads; and the automatic controls to facilitate the management of power systems. We have extensive expertise in the integration of each of the respective technologies into end-to-end systems, and we have the facilities required for the testing, verification, and validation of those end-to-end systems.
GRC’S CORE COMPETENCIES

Materials for Extreme Environments

This competency includes the research, development, demonstration, and flight application of advanced materials, structural concepts, and mechanisms to enable high-performance, long-life aerospace systems subjected to the extreme environments encountered in propulsion and power, planetary entry, planetary surface operations, and the space environment. These extreme environments include a combination of high temperatures, complex gaseous atmospheres ranging from oxidizing to reducing, high pressures, large dynamic and impact loads, molten materials, cryogenic temperatures, electromagnetic fields, and space radiation. Research and development areas essential to success include high-temperature and lightweight structural materials, functional materials and coatings, multifunctional and lightweight structural concepts, tribology, robust mechanism and drive system concepts, computational design tools and predictive capabilities for materials and structures, and testing in a broad range of extreme environments.

Physical Sciences and Biomedical Technologies in Space

This competency includes the research, development, demonstration, and flight of advanced physical and biomedical systems to enable sustainable exploration of space with enhanced safety, extended mission durations, and increased resistance to the damaging effects of space. Space-flight and ground-based research are conducted to study the effects of the space environment to obtain insight into fundamental mechanisms, develop predictive frameworks and advanced technologies, and develop and implement countermeasures to mitigate any adverse effects. The research provides vital knowledge needed to design and operate a wide range of reliable and efficient life support, fire safety, crew health monitoring and support, space resource utilization, thermal management, and other systems essential for NASA and commercial spacefaring customers. The space environment includes microgravity, reduced gravity, ionizing and non-ionizing radiation, alternative crew atmospheres, and combinations of these and other variables. Utilization of the International Space Station to conduct research and validate technology is a cornerstone of this competency.
PLANNING FOR TODAY...AND BEYOND

We will be launching a critical new effort called “GRC Beyond” to ensure a healthy, relevant, and sustainable future for GRC by creating a 10- to 20-year vision and a plan to achieve that vision. We will make our vision a reality by assessing and analyzing our infrastructure and our facilities, information technology capabilities, our research and development laboratories, our workforce strategy, our operations, and our partnerships in the region, and by agreeing on what we want these capabilities to be (in accordance with Strategic Action Plan goals) and how we want to get there.

We will initiate these longer activities in parallel so that the recommended actions can be integrated easily, and we will seek to finalize a full plan or report within 2 years. With more than 80 percent of NASA’s facilities beyond their design life, unending size constraints on NASA’s workforce, and flat budget forecasts, we at GRC (and all of NASA) need to adapt, innovate, and position ourselves in new ways. Goal 4 in the NASA GRC Strategic Action Plan is the near-term embodiment of this effort, and over the next 2 years, we will integrate it with our effort’s longer-term perspective.

1. **First Year:** Define purpose, vision, success criteria, organizing framework, teams, team leads and members, and communications strategy, including branding.

2. **Second Year:** Establish baseline status (incorporate Technical Capabilities Assessment Team results and assess competitive landscape); then create and prioritize specific actions, perform return-on-investment analysis, and finalize the full plan or report.

3. **Third Year:** Establish Red Team review, gain GRC Senior Management Council approval, communicate with NASA Headquarters and other stakeholders, seek advocacy and gain funding, set up an implementation office, and begin to implement.

4. **Fourth Year and Beyond:** Transition to full implementation.
VENTURE DEVELOPMENT AND PARTNERSHIPS

GRC continues to actively reach out to the regional community, looking for partnership opportunities that will employ GRC capabilities (people, facilities, and technologies) in crucial sectors of our regional and national economy. In the long run, we want these efforts to result in a direct link between NASA collaborations and private-sector job creation and retention. To the greatest extent possible, GRC is looking to partner not only with individual organizations but with regional economic development clusters in key sectors like aerospace, advanced energy, transportation, advanced manufacturing, and human health. GRC’s objectives align well with the Presidential Memorandum of October 28, 2011: “to foster innovation by increasing the rate of technology transfer and the economic and societal impact from Federal research and development (R&D) investments.”

GRC’s business development and partnership efforts are focused on the key products and services that the Center can offer the regional community as a basis for partnership creation and follow-on collaboration projects.

1. Intellectual property—The Center’s growing portfolio of patents in critical technology areas—such as materials and structures, sensor systems, communications, and turbomachinery—create significant opportunities for licensing and commercialization by the private sector.

2. Facilities test services—GRC’s array of unique facilities—from basic research laboratories through full- and large-scale ground test facilities and specialized flight research assets—offer an expanding array of collaboration opportunities not only with other Government agencies but with the private sector and academia. Currently the largest percentage of partnerships and collaborations (in terms of reimbursable dollars brought to the Center) come from test and evaluation services.

3. Subject matter experts—GRC’s world-recognized subject matter experts (SMEs) bring a wealth of knowledge and skills that were developed to support NASA missions but that can provide unique, problem-solving expertise to other sectors of our economy.

4. Research, development, test, and evaluation services—GRC’s SMEs and facilities and testing abilities are well positioned to co-create and/or customize technologies to the proper readiness levels for use by the private sector in follow-on commercialization efforts.
GRC continues to go “above and beyond.” Let’s celebrate some of our recent successes. See the images on the following pages.
1. New coating systems are being developed to enable 2700 °F ceramic matrix composite (CMC) turbine engine airfoils, allowing for increased engine efficiency.

2. New Mission Integration Center brings engineers and managers together.

3. Studies in our Propulsion Systems Laboratory (PSL) improve understanding of engine icing to help aircraft avoid problems in flight.

4. Our engine inlet testing may enable low-boom supersonic flights.


6. New Shipping and Receiving Facility offers safer and more convenient deliveries.

7. Introduction of Glenn Micro Market provides a variety of food options to employees.
DIRECTOR'S INTENT

Our strategic plan is just that: our strategic plan. As we developed this plan, I asked that it be of value to all of us. The plan provides guidelines to follow as we do our work today and pursue what we are going to do in the future. Under each goal we have objectives and initiatives that will help us to focus the work of each day so that it fits into what we will be doing in the years ahead. We all make our strategy happen. With all of us pulling together, the NASA Glenn Research Center (GRC) will stay healthy, relevant, and sustainable.

2. Deployment of commercial solar arrays in Plum Brook Station's Space Power facility is providing assurance of performance in space.
3. Ultra-lightweight solar arrays are being built and tested to enable new space exploration capabilities.
4. Stirling Research Laboratory (SRL) surpassed 600,000 hours of continuous test operations, reducing risk for new energy conversion systems to be used on long space exploration missions that cannot employ solar power.
5. "Coral Flames" from burning droplets in zero gravity were newly discovered in GRC's Combustion Integrated Rack on the International Space Station.
6. GRC-developed cross-linked polysiloxane aerogels are strong, durable, flexible, and insulating when formed as lightweight, flexible films, making them ideal for Earth and space applications.
7. GRC leads the Solar Electric Propulsion project--helping to enable new technologies that reduce mass, extend durations, and improve capabilities of new space exploration missions, such as traveling to Mars and asteroids.