HORIZONS

National Aeronautics and Space Administration

NASA SETMO Newsletter | SUMMER 2023

NASA SETMO
SPACE ENVIRONMENTS TESTING MANAGEMENT OFFICE

NEW AND NOTABLE

SETMO's New Director

Jason Coker has joined SETMO as its new Director, assuming the post this past January. Jason was previously Vice Director for the Air Force's Arnold Engineering Development Center, at Arnold Air Force Base in Tennessee. Jason shares his perspectives on testing both in this issue's From the Director note, as well as in his welcome message posted on the SETMO website, where he points out that demands on NASA's physical testing assets will escalate.

Deflection Test a Success

This past October, NASA pronounced the Double Asteroid Redirection Test (DART) mission a complete success. The DART spacecraft targeted the asteroid, Dimorphos, altering that body's orbit. It was the first time humans purposefully changed the motion of a celestial object, and the first full-scale demonstration of asteroid-deflection technology. Such a capability could mitigate or eliminate potential terrestrial asteroid-impact threats should one ever be detected.

X-59's Updated "Eyes"

In late March, NASA engineers completed physical installation of an external vision system — XVS — on the experimental X-59 Quiet SuperSonic Technology (QueSST) aircraft. Final systems integration is ongoing. Because there is no place on the X-59's elongated nose for any windows, a forward-facing multi-camera and display system takes their place, while also providing graphical flight data for approaches, landings and takeoffs.

TEMPO Tracks Pollutants

In early April, a SpaceX Falcon 9 rocket launched the Intelsat 40e satellite with NASA's Tropospheric Emissions: Monitoring of Pollution (TEMPO) instrument onboard. TEMPO will observe Earth's atmosphere in ultraviolet and visible wavelengths to determine concentrations of many key atmospheric pollutants. From geostationary orbit, these observations can be made several times each day when North America is facing the Sun instead of once per day.

FROM THE DIRECTOR

For a kid growing up in Idaho, the idea of American astronauts literally setting foot on another planet — specifically, the Moon — was riveting. After Apollo 11 landed, I remember standing next to the white picket fence at home with my mom, and her looking up and saying, "Men are up there, walking …" Boy, that sure did it as far as capturing my imagination about space exploration.

And now, here I am, at NASA, the world's leader in that very exploration. It's an honor to be leading a terrific SETMO team that's helping the Agency analyze and prioritize its testing capabilities in support of ongoing missions.

Testing is what literally gets us — rockets, spacecraft, astronauts — off the ground. Without it, we wouldn't be preparing for another return to the Moon, this time in the form of the Artemis missions.

A Different, but Same, Battlefield

When I was a much younger person with space on my mind, and passions for astronomy and science fiction (still have both!), my father said there were only three things that college should prepare you for: medicine, law and engineering. For me, engineering was unique in what it allowed you to do, to create, to build.

By the time I graduated from college, NASA wasn't then recruiting, but the U.S. Defense Department (DoD) was. So there I headed to do technical work, putting what I had learned into actual practice. Much of what I did during my time with DoD prepared me for the opportunity here at NASA. I often say I will still fight the same war — prioritizing, developing, sustaining and maintaining testing infrastructure — just on a different battlefield.

What NASA is doing is creating and building a robust future in space exploration. Space is hard, as the saying goes, but even with considerable hurdles to clear, the opportunities are vast. With these issues of SETMO's Horizon newsletter, we're highlighting some of those achievements, keeping in mind the central role that testing plays in each.

In This Issue

Speaking of testing's central role, it's the people that actually make or break a given test. That's why we're focusing this issue on one of the best: Terry Fisher, who is SETMO's subject matter expert on thermal vacuum chambers.

As you read about Terry's life, and his many contributions to NASA, you'll realize just dedicated and focused those working to validate and verify complex vehicles and their equally complex equipment are and have to be. We're fortunate to have Terry with us to offer his advice and guidance based on his decades of experience and service.

We also look at the aftermath of the LOFTID mission, surely one of the most successful demonstrations ever of a proof of concept. As the article notes, its success opens up an array of opportunities to safely (and economically) transport much larger payloads to places on planetary bodies that otherwise would be difficult to access. LOFTID, of course, relied on extensive terrestrial testing, and prior demonstrators, for its dramatic achievement, once again proving that all that comes before is essential to that which follows.

We also mention in this edition SETMO's inaugural attendance at the 2023 SciTech Exposition, at National Harbor in Maryland. It was our first outreach event at such a large gathering and won't be our last: we're planning to go to Orlando in January 2024 for the next SciTech. We've pinpointed other such conferences that our team members will likely attend in fiscal year 2024. It's worthwhile to do so, in terms of networking and our own awareness of what's new and upcoming

Jason Coker

Terry Fisher

Testing complex spacecraft and their components and equipment is not for the faint-hearted. Just ask Terry Fisher, SETMO's subject matter expert for vacuum chambers, facilities where severe conditions can be mimicked. Hard vacuums must be established, stabilized and maintained, as do temperatures that, depending on the test, can run anywhere from extreme cold to extreme heat. Instruments that validate results must be finely calibrated. No detail is too small to ignore.

So: how stressful is it?

"You can't make a mistake, Terry says. "Tests are conducted to verify that what's tested is actually going to work — and survive — in space," he asserts. "When you're testing a full-size spacecraft, the one that actually is going to fly, there's no room for error. You have to make sure the data collection is perfect and conditions in the chamber are perfect as well."

Terry says that everything he's worked on has been critical: components for the Mariner, Cassini, Galileo, Viking and Voyager missions, even the backpacks astronauts wore for EVAs on the (now retired) space shuttle fleet.

"… There's no room for error. You have to make sure the data collection is perfect and conditions in the chamber are perfect as well."

Terry's father was an electrician, an occupation that Terry briefly considered, but then on second thought … "I was ready to follow in my dad's footsteps," he recalls. "But that's the kind of work that requires you to climb into attics and go under houses. I thought that maybe I should go another way."
On the Road to NASA

On the Road to NASA

That way would be engineering, a field that would end up fascinating Terry. He really liked to work with his hands and had a mechanical inclination. Working on cars was a natural transition. Terry earliest job was at a gas station even during college, including making oil changes and doing brake jobs.

"When you come down to it, I was a gearhead. I loved working on cars; I still do," he says. "Right now, out in my garage, I have a 1940 Chevrolet I'm restoring."

Terry's first job out of college was at Douglas Aircraft, an aerospace and defense company originally based in Southern California (and, later, part of Boeing). Only there for six months before being laid off, he participated in thermal stock studies, and altitude and vibration testing for components for aircraft and missiles.

A friend of Terry's told him there were opportunities with NASA, at the Jet Propulsion Laboratory (JPL), now managed by Cal Tech for the Agency. Terry would work for JPL for 17 years, transitioning to Martin Marietta in Denver when the company reached out with a hard-to-resist proposition.

"Junior engineering-design positions were hard to get at JPL. I was lucky to have gotten a job there in the first place," Terry recalls. "But at that time, Martin Marietta was expanding, and they made me a great offer, both financially and position-wise. I was there for eight years."

It was only when Terry's former boss at JPL contacted Terry to invite him back as a test manager for the Lab's instrument thermal vacuum group that he decided to return. Terry would stay with JPL until his official retirement in 2005.

Learning and Learning More

An eventual move from Southern California to North Carolina to be closer to his wife's family was, as Terry confesses, "a culture shock,"

For all the intense pace of his work, Terry did have time for family, although he remembers "it wasn't easy." Even so, he was the father of four, who themselves had children. Today, Terry is the proud grandfather of eight and the great-grandfather of seven.

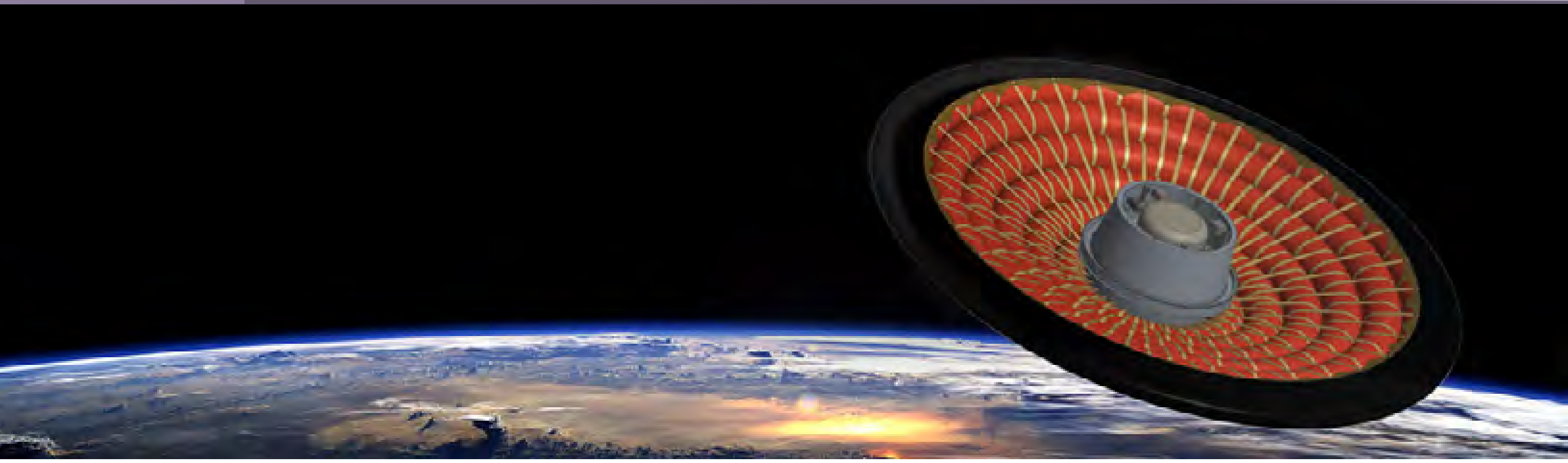
Terry officially retired from NASA in the early 2000s, but quickly picked up work as a consultant for his old employer, as well as stints at NASA Goddard Spaceflight Center and NASA Glenn Research Center.

"If I wasn't having a good time, I'd retire for good and putter around my garage … Bottom line is, I still really enjoy the work."

A few years later, he would begin work with the Agency's Strategic Capability Assessment Program, SETMO's predecessor. It is with SETMO that he remains.

"I'm still having a good time. If I wasn't having a good time, I'd retire for good and putter around my garage," Terry says. "Problem solving is a big part of being a good mechanic. Bottom line is, I still really enjoy the work."

Terry, who continues to work for NASA as a consultant, lauds both the intelligence of his colleagues and the kind of work he continues to love. His attitude comes down to a relatively simple mantra: always be on the hunt for new knowledge: "My philosophy is you have to keep learning, from day one to the day you die. If there's a day you haven't learned something new, it's been a wasted day."



Fans of the Star Trek science fiction franchise have long groused about problematic starship shields that seem to go haywire at a moment's notice, threatening death and destruction. Such was not the case with the shielding afforded during NASA's Low-Earth Orbit Flight Test of an Inflatable Decelerator (LOFTID) mission.

LOFTED endured the extreme heat of atmospheric reentry unscathed.

"LOFTID was a huge success. We were testing materials to mimic the heat pulse experienced during re-entry," explains Tara Tveten, LOFTID Deputy Project Manager. "It fully demonstrated you could pack up a soft-goods aeroshell that's light and small, then fully deploy it, and then fully protect a payload. It was a first."

About an hour after a November 2022 launch on a United Launch Alliance Atlas V rocket, LOFTD inflated and deployed in space. After being released by the Centaur upper stage, the heat shield, or aeroshell, began its perilous re-entry journey through Earth's atmosphere, entering the atmosphere at more than 18,000 miles per hour.

"LOFTID was a huge success … [demonstrating] you could fully protect a payload. It was a first."

LOFTID created enough drag to slow to less than 80 miles per hour by the end of its demonstration. LOFTID's onboard parachutes then deployed, carrying the heat shield to a gentle splashdown in the Pacific Ocean.

The LOFTID research team recovered its aeroshell within a few hours. In addition to surviving the intense dynamic pressure and heating of re-entry, the aft side of the heat shield – opposite LOFTID's nose – was well protected from the extreme temperatures of falling back through Earth's atmosphere, proving that inflatable aeroshells can keep payloads safe and secure.

"LOFTID was a flight of opportunity," Tventen says. "This is the first time we've taken the technology out and then back in. It's the largest blunt body that has reentered Earth's atmosphere intact. That was a very cool thing."

A Next-Generation Approach

LOFTID is a technology descendant of NASA's Inflatable Re-entry Vehicle Experiment (IRVE) and the Agency's Hypersonic Inflatable Aerodynamic Decelerator (HIAD) demonstrator: both concepts employ inflatable structures for aerodynamic deceleration. Although such research dates back to the 1950s, it was not until 2009 that a successful IRVE flight test would pave the way for a later IRVE/HIAD prototype in 2012, demonstrating the ability to decelerate and stabilize a spacecraft during atmospheric entry at speeds up to Mach 7.

NASA also tested a HIAD prototype in 2016, which at about 20 feet, or 6 meters, in diameter was the largest ever tested at the time.

In 2020, NASA's Mars 2020 mission used a HIAD-based heat shield to protect the Perseverance rover during its entry, descent, and landing on Mars. The heat shield successfully slowed the spacecraft from over 12,000 miles per hour to a safe landing speed of about 2 miles per hour.

LOFTID was intended to address the need for more cost-effective and efficient methods of returning spacecraft from low-Earth orbit. The traditional method of using rigid heat shields made of metal or composite materials is expensive and adds considerable weight. Because conventional protections are difficult to effectively deploy, inflatable heat shields offer a promising solution.

The inflatable heat shield technology used in the LOFTID mission was based on a multi-layered, flexible fabric design, building upon the earlier IRVE/HIAD flight tests, providing a cushion of air between the spacecraft and the heat of re-entry into Earth's atmosphere.

Designed to be compact and lightweight, with a diameter of a little under 12 feet, or just 3.5 meters, when fully inflated, LOFTID's shield was stored compactly during launch, and then deployed in space using a small gas canister.

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Its material consisted of several layers of heat-resistant materials, including Kevlar, a high-strength synthetic fiber commonly used in ballistic vests, and Nextel, a ceramic fiber that can withstand high temperatures. The layers were sandwiched between an outer shell made of thermal insulation and an inner layer made of airtight material.

"We were testing materials to mimic the active environment: the heat pulse experienced during reentry," Tveten explains. "We wanted to make sure LOFTID could withstand the extreme temperatures and pressures."

Putting LOFTID Through Its Testing Paces

Terrestial tests were essential in enabling LOFTID's success. Two years of component testing started in August 2020, during which time its thermal protection system was extensively stressed and vetted.

Vibration studies were conducted to make sure the vehicle held together during the rigors of launch, and electromagnetic interference tests validated that LOFTID's electronic components worked as designed. Its avionics boxes underwent evaluation in a thermal vacuum chamber, with the final fully integrated and packed aeroshell tested as an entire system well before liftoff.

"Testing and analysis provides you the confidence to go forward … You can't pull off a mission like LOFTID without doing your due diligence."

"Testing and analysis provides you the confidence to go forward," Tventen affirms. "You have to do all the testing you can to make sure

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IN FOCUS | LOFTID Test Proves an Unprecedented Reentry *continued*

all of NASA's and stakeholders' investment isn't wasted, and that the mission has a good chance of success. You can't pull off a mission like LOFTID without doing your due diligence."

Aeroshells like LOFTID could be used in Moon and Mars missions to deliver larger payloads. The bigger the inflatable shield is, the faster it can decelerate and, as an additional bonus, land at higher planetary latitudes than is currently possible. Both crewed and uncrewed missions could benefit, as equipment weights and sizes increase.

Inflatable heat shields also could safeguard upper-stage rocket engines so that engines remain intact, not breaking into pieces and disintegrating from frictional heat, and thus holding the ultimate promise of reuse.

"It's an exciting time," Tventen says. "We've gone from playing in the sandbox to working in the real world. All the blood, sweat and tears were worth it."

IN FOCUS | SETMO Attends SciTech '23

In its first formal appearance at a large conference, SETMO attended the AIAA 2023 SciTech Exposition, held in late January at the Gaylord National Resort and Conference Center, in Prince George County, Maryland.

The annual symposium provides a platform for scientists, researchers, and technologists to showcase their latest discoveries and developments for a wider audience, offering opportunities for industry professionals to network, exchange ideas, and collaborate on future projects.

Event organizers say 5,800 attended, representing 50 countries. Seventy-one exhibitors were present, SETMO included, and 780 technical sessions took place, with 2,700 presentations in all.

The convention focused on daily key themes:

- Solving societal grand challenges
- Investing in the future
- Enabling progress through science and engineering
- Accelerating confidence in this digital world
- Making science fiction a reality

During the event, NASA Administrator Bill Nelson, along with NASA Deputy Administrator Pam Melroy and DARPA Director Stefanie Tompkins, announced a partnership in the development of DRACO, short for the Demonstration Rocket for Agile Cislunar Operations.

The DRACO program aims to demonstrate a nuclear thermal rocket (NTR) in orbit. NTRs use a nuclear reactor to heat fuel to extreme temperatures, funneling it through a nozzle to achieve a higher thrust-to-weight propellant ratio than either chemical or electric accelerants.

SETMO Joins NASA Exhibitors

SETMO joined colleagues from NASA's Game Changing Program, representatives from the Rocket Test Propulsion Program, and personnel from NASA Glenn Research Center and the Agency's Aeronautics Research Mission Directorate. The overall NASA booth attracted intense interest, especially during times between presentations.

SETMO's introductory video played on a loop without sound throughout. SETMO stickers were the most popular take-homes, and a number of the Office's capabilities "baseball cards" — in particular ones highlighting SETMO support of NASA Ames' Arc Jet Complex and space environments test chambers — were also pocketed by visitors.

During the event, SETMO introduced a poster featuring a cross-country map with images and details of the facilities the Office supports. Passersby posed questions about where facilities were located, exactly what they did, and what their role was within NASA. These conversations led to discussions about testing, its value, why it's needed, and why testing is necessary if space missions are to succeed.

SETMO is planning to attend the 2024 SciTech Exhibition, slated to take place in Orlando, Florida, January 8-12.

Studying Sticky Regolith

NASA's Marshall Space Flight Center (MSFC) has expanded the capability of its largest thermal vacuum chamber. Part of the MSFC's Environmental Test Facility, the V-20 chamber will be able to simulate a lunar surface environment.

The new capability will provide NASA and its partners with a sophisticated means to assess how mobile and stationary equipment hold up when exposed to the Moon's surface coating of regolith.

Regolith, while looking superficially like terrestrial dust, is actually an aggregate of tiny grains of lunar rock-like material that easily sticks to landers, rovers and spacesuits.

Engineers have already prepared a regolith-like simulant bed for scheduled tests, slated to be conducted by both NASA and the Agency's commericail partners.

The Moon's New Ride

NASA is seeking industry proposals for a next-generation lunar terrain vehicle (LTV) that will allow Artemis mission astronauts to go farther and conduct more science than ever before during exploration of the south polar region of the Moon.

The LTV will function like a cross between an Apollo-style lunar rover and a Mars-style uncrewed rover, allowing astronauts while driving to explore and sample more of the Moon's surface than otherwise would be the case on foot. Its role will be similar to that of an uncrewed mobile science exploration platform, such as NASA's Curiosity and Perseverance Mars rovers.

NASA won't own the LTV; rather, the Agency will contract the rover as a service from the manufacturer, which will retain full ownership.

A Summer Starship Try

The first all-systems-integrated test flight of the SpaceX Starship on April 20 — propelled by the world's largest and most powerful rocket — ended abruptly when Starship was destroyed by ground control after it careened off course. Now, pad modifications and engine tests are ongoing as SpaceX plans for a second test flight in the months ahead, reports Chris Bergin, writing for the website nasaspaceflight.com.

Bergin notes that SpaceX is aiming to avoid the flying concrete of the maiden launch by installing a water-cooled steel plate and deluge system under the orbital launch mount. Preparation for its installation has been ongoing over recent weeks at the launch site, ahead of steel plates [being transported and installed].

Bergin also writes that one of the major issues identified on Starship's first flight was related to the efficiency of the flight termination system. The system is intended to break apart the vehicle tanks during flight should something go wrong. However, during that first flight, this system only punched holes in the tanks but never broke the vehicles apart as planned.

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