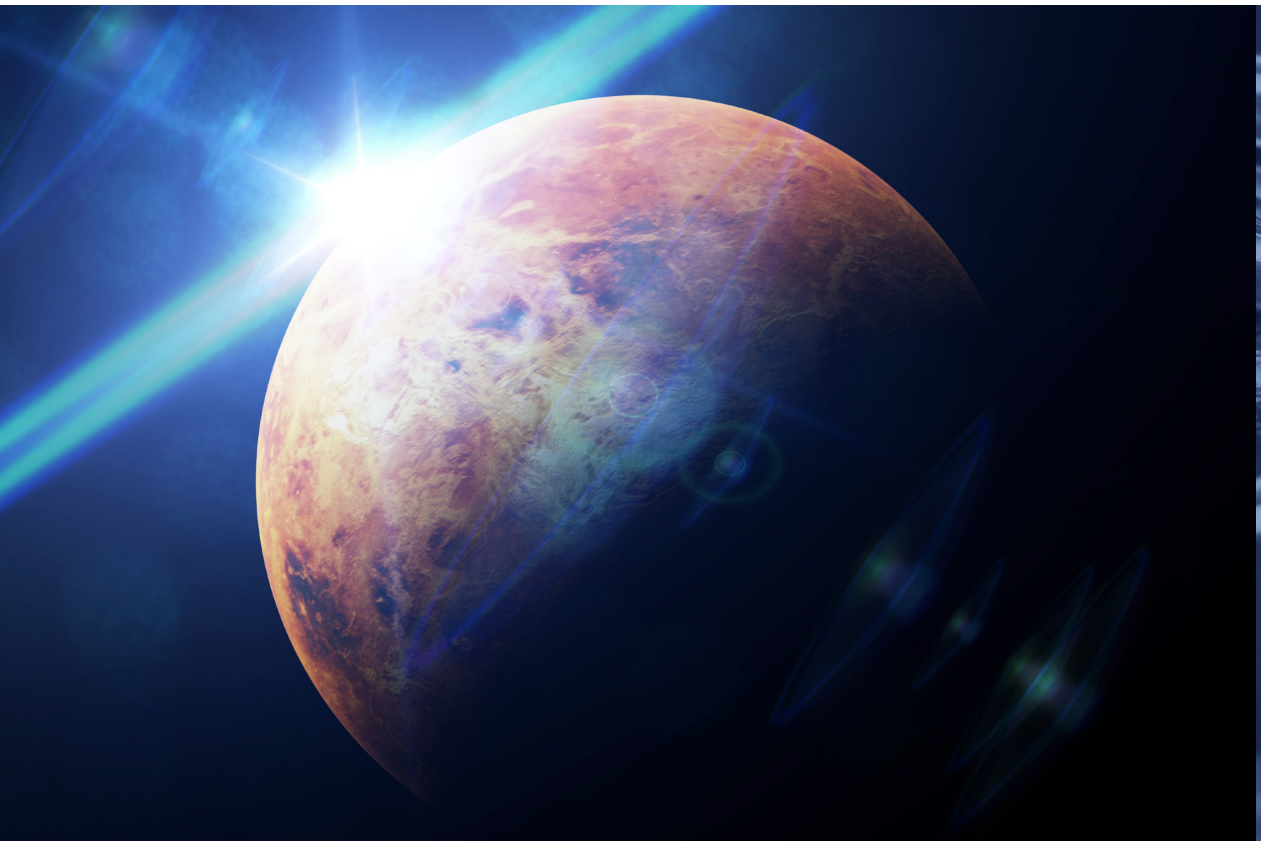
ENERGY STORAGE

The unique laboratory requirements needed to test battery safety and performance for out-of-this-world conditions

CSA Group's Cleveland battery lab provides testing for NASA



As part of NASA's investigation of a mission to Venus, critical data must be collected from the planet's surface using specially designed and tested scientific instruments. Long-Lived In-situ Solar System Explorer (LLISSE) is a small battery-powered probe being developed to provide long-term measurements of simple but important scientific parameters from the surface of Venus.[1] However, given the extremely hostile environmental conditions of the planet, testing scientific instruments to determine their survivability presents unique challenges since similar lab-created atmospheres that can test the viability of this equipment are rare.

The LLISSE project includes the design and demonstration of a prototype instrument suite and supporting system to function at the surface conditions of Venus and communicate periodic measurements of temperature, pressure, wind velocity and

[1] Long-Lived In-Situ Solar System Explorer (LLISSE) (2018). Tibor Kremic, Gary Hunter, and Jennifer Rock. Retrieved from: https://ntrs.nasa.gov

direction, and chemical composition, providing a unique and significant science impact.[2] This data will help pave the way for future Venus expeditions of greater duration, as expedition teams will have a deeper understanding of climate conditions. The main product for the first three years of LLISSE development will be a battery-powered version capable of surviving approximately 60 Earth days on the Venus surface with capability to transmit data to the orbiting host spacecraft.

[3]CSA Group® was able to provide a viable solution through its Cleveland, Ohio testing facilities using its history of battery testing and high level of technical expertise.

Key Challenges

There are several key parameters used by industry to define battery performance. Apart from the basic battery design, performance actually depends on how the batteries are used and in what type of environmental conditions. The 'how' and the 'environmental conditions' associated with NASA's proposed mission to Venus presented unique challenges.

Battery life is directly related to the discharge profile and the level and duration of stress inflicted. In most applications on Earth, temperature is the primary stressor, but in addition to temperature, the high pressures on the surface of Venus provide for an extreme operating condition. The battery, meant to power a scientific tool for the surface of Venus, must not only be built to survive the harsh atmosphere, but it must survive for a sufficient amount f time to be able to effectively record relevant data. This test was designed to determine if the environmental conditions on Venus, in addition to the discharge load profile of the scientific instrumentation and communication equipment, would degrade the performance of the battery to the extent that the mission might be compromised.

Test facilities that can safely handle the hazards of a large primary lithium battery under high-pressure test conditions are rare, and the facility at NASA Glenn Research Center is extremely busy with more complicated atmospheric exposure tests. In addition, the battery needed to be subjected to a complicated discharge profile intended to mimic the real-life loads it will see while conducting the powered portion of the mission.

A Focused Solution Using a History of Battery Testing Experience

The LLISSE battery test was a project with many moving parts – from specific laboratory requirements to safety issues to handling sensitive information. CSA Group was poised to assist NASA in reaching these testing goals by harnessing our valuable expertise in testing & certification, product evaluation, and standards-based solutions for the energy and power industry.

Our state-of-the-art battery laboratory, complete with safety features in the event of fire or explosion including ventilation, pressure relief panels, and a fire suppression system to name just a few, provided the setting for a solution. The robust design and protective measures of the facility allowed this testing to be done safely in the event of an extreme battery failure. "While we are most known for our certification testing to safety standards, our abuse testing capabilities and experience enable us to do extreme custom testing projects like this one with NASA", said Jim Green, CSA

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[2] 49th Lunar and Planetary Science Conference 2018 (LPI Contrib. No. 2083). Retrieved from: https://www.hou.usra.edu/meetings/lpsc2018/pdf/2796.pdf

[3] 49th Lunar and Planetary Science Conference 2018 (LPI Contrib. No. 2083). Retrieved from: https://www.hou.usra.edu/meetings/lpsc2018/pdf/2796.pdf

Group's Business Manager for Global Energy Storage. "We have also supported a recent university/ NASA joint research project in the area of structural batteries, and we are always happy to work with clients who can utilize our array of battery testing capabilities to advance their product or technology development."

CSA Group created a unique test fixture to provide the high amount of pressure, 10.3 MPa (1500 psig), required to run the test, as well as programming an electronic load to match the load profile, which varied at rapid intervals.

The goal was to characterize the effects of Venus surface pressure on a typical thermal battery case design, and see if the battery functioned normally after exposure to high pressures.

The thermal battery was exposed to 10.3 MPa (1500 psig) for 24 hours at the CSA Group facility and discharged successfully. It retained its internal structural integrity as seen in CT scans performed after discharge testing. The outer case deformed, however the CT scan showed only minimal damage to the internal battery components. This test provided a preliminary basis for design of a Venus high temperature thermal battery for the LLISSE project.

In addition to playing a pivotal role in achieving information necessary for battery design, CSA Group also followed NASA's direction to acknowledge the sensitive nature of the project. We took additional measures to isolate the final test data and store it securely from any network connection.

"Having promising results from tests like these contributes to future mission plans."

Positive Results

NASA was able to capture the critical data they needed in a safe and economical manner. "The mission planners will modify future test plans to optimize their designs and re-assess performance in a proven test fixture", says Tom Miller, Research Engineer at NASA Glenn Research Center. "Having promising results from tests like these contributes to future mission plans."

Contact Us

To learn how CSA Group can help with your battery and energy storage testing requirements, contact us today.

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10/2018