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DEVELOPING A NATIONAL SATELLITE TESTING CAPABILITY

A major new national satellite testing facility in the UK is to receive vibration testing equipment from one of the aerospace sector's leading suppliers

// KEVIN W. MCINTOSH AND THOMAS REILLY

Contracts worth £19 million (US$24 million) have been awarded for the first of the major facilities for the UK's National Satellite Test Facility which is to be built and operated by the Science and Technology Facilities Council's Rutherford Appleton Laboratory on behalf of the UK government.

The contracts are the first steps in meeting the UK space industry's need for a set of co-located world-class facilities for environmental testing of space payloads and satellites. Data Physics and Team Corporation will supply the vibration facility and two other contractors will supply the large space test chamber, and the combined electromagnetic compatibility (EMC) and antenna measurement system.

Satellite test facilities at this scale in one location do not currently exist in the UK. Once operational in 2022, the National Satellite Test Facility (NSTF) will provide the space sector across the UK with all the major testing facilities they need under one roof, without incurring expensive international shipping costs.

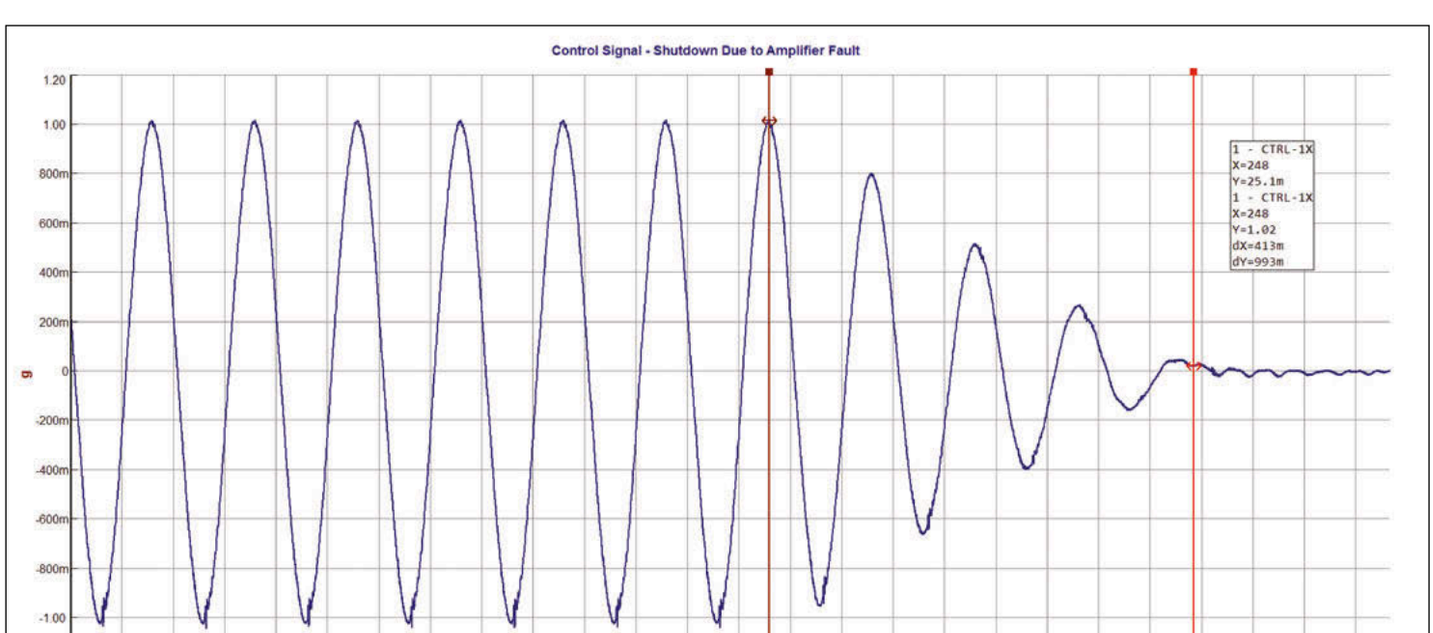
Construction of the building is planned to run through to the spring of 2021. RAL Space is an integral part of Science and Technology Facilities Council's (STFC) Rutherford Appleton Laboratory (RAL) in Oxfordshire, UK. RAL Space carries out world-class space research and technology development with involvement in over 210 space missions.

1 // The Data Physics 900 Series Vibration Controllers can also be used for signal analysis with the addition of SignalCalc Analysis software

SYSTEM DETAILS

The vibration facility will be capable of testing satellites of over seven tons using two Data Physics SignalForce LE-5022-3 water cooled electrodynamic shakers.

To realistically simulate the mechanical loads experienced during a rocket launch, one shaker will operate in the vertical plane (Z axis), while the other will operate horizontally (X and Y axes). Each shaker is capable of developing up to 50,000 lbf (222kN) of force and has up to 3in (76.2 mm) peak-peak displacement. One of the key features of the LE-5022-3 is the use of dual hydrostatic bearings for axial



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guidance and cross-axial restraint.

The horizontal system will employ a slip table incorporating Team Corporation's unique T-Film bearing system, which offers the rugged overturning moment capacity of the Team hydrostatic bearings combined with the full low-pressure oil support of a granite or journal bearing oil film type slip table. This table system is assembled from a number of patented modular T-Film bearings. Each bearing measures 12" x 12" (300mm x 300mm) and allows the table to be configured to the customer's test article size and load requirements. The use of multiple bearings to completely support and guide the slip plate will offer excellent dynamic stability and damping for better test results. The design of the T-Film bearing provides a direct load path from the slip plate to the base and is much more rigid than other guidance systems.

Team hydrostatic pad bearings are also used to guide and restrain test articles during vibration testing. These unique bearings form a hydrostatic oil film between a working surface on the package or fixture, and the "pad" of the bearing surface interface. Team hydrostatic pad bearings are extremely stiff, providing the high level of restraint required to keep cross-axis motion to a minimum. When used in conjunction with a 3,000 psi (206 bar) oil supply, Team hydrostatic pad bearings are friction free and require almost no maintenance.

INTELLIGENT CONTROL SYSTEM

A Data Physics 900 Series vibration controller will be employed to orchestrate the sometimes extreme vibration forces – while sensitive satellite components will be protected by the controller's unique features. Delivering exceptional dynamic range & phase accuracy, the Abacus 900 hardware to be used offers features flexible input/output/tach channel configuration and distributed signal processing on each channel card. Meanwhile the accompanying SignalCalc 900 Series software suite features a single, easy-to-use environment with a relational database to facilitate efficient management of testing, analysis, and reporting while greatly enhancing the user experience.

Valuable flight hardware must be protected from damage that can occur if a test must abruptly shut down due to any failure of amplifiers, shakers, and slip tables. The Safe Shutdown feature of the Data Physics vibration controller ensures a smooth controlled shutdown for any test

2 // Plot of Data Physics' Controller Safe Shutdown Event

3 // Data Physics IGBT Power Amplifier

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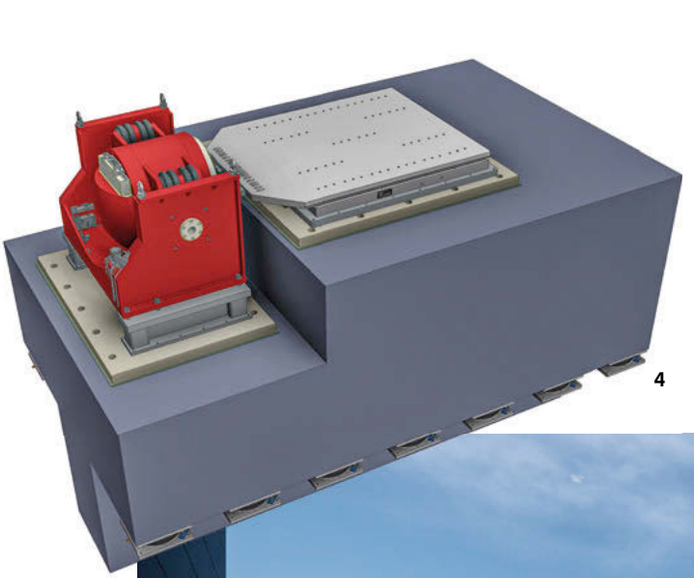

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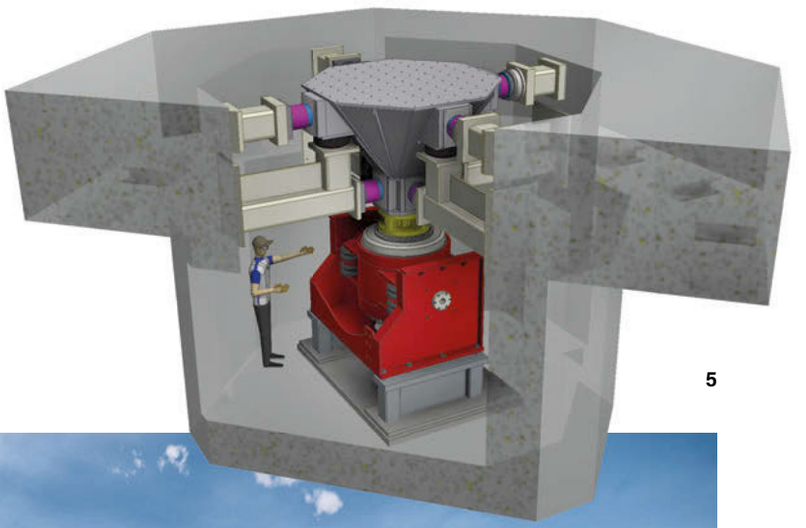

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4 & 5 // Model showing Data Physics' and Team Corporation's horizontal and vertical vibration systems at the National Satellite Test Facility RAL Space, UK

6 // Artists impression of the National Satellite Test Facility

failures. All test shutdowns result in the drive signal smoothly ramping down to zero. External shutdowns are monitored using a digital input in the signal processing hardware that instantaneously ramps down the shaker drive signal.

TABLE HEALTH CONTROL SYSTEM

This is a computer and sensor system that protects a high-value test article from potential damage due to unexpected vibrations, should failure of the vibration test system occur during testing. The Table Health Control System monitors various subsystems including overall hydraulic supply pressure, hydrostatic supply pressure locally at each bearing, and pneumatic pressure and position of the air isolation system. It also provides communication between the interlocks and the vibration controller. It must provide a 'permissive' signal, indicating that all systems and the table are working and in the proper state, for the vibration controller to start a test.

Upon detection of a fault condition, the Table Health Control System will stop the vibration test at a user-definable ramp-down rate. It also controls the startup operations for the shaker systems, bringing the vibration test system from park to the operative state in a controlled manner. At the end of testing, the Table Health Control System turns off the hydrostatic bearing and air isolator.

A PROPRIETARY VIBRATION CONTROL SYSTEM

The vibration controller has modifications to the sine signal generation code to ensure that all shutdowns from the controller include a 400ms ramp-down. The sine signal generation code runs in the digital signal processor hardware on the controller front-end and receives instructions from the control loop processing code. A watchdog feature looks for instructions from the control loop. If the control loop does not issue a command to the drive generation within the expected time, a soft shutdown is initiated. This mitigates risk of over-test due to controller malfunction.

All interlocks are connected to a trigger input in the controller hardware front-end. The trigger input is continuously monitored to detect a trip of one of the interlocks. Trip of an interlock will initiate a soft shutdown within a few milliseconds. An uninterruptible power supply (UPS) provides the ability to continue operation of the vibration controller instrumentation after loss of power. Should power loss occur, the UPS signals the controller to initiate a soft shutdown.

MODIFIED AMPLIFIERS

The amplifiers that deliver power to the electrodynamic shakers are designed to support a soft shutdown after complete loss of power. Modifications to the amplifier include larger capacitors and a UPS that supplies power to IO modulators. Given a power loss event, these features enable continued operation so the controller can smoothly shut down the test.

With the experience gained from the significant projects at NASA's Plum Brook and Goddard facilities, Data Physics and Team will endeavor to advance the satellite testing capabilities at the UK's new NSTF facility. \\

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ADVANCING THE FUTURE OF SATELLITE TESTING

The UK's new National Satellite Test Facility will be led by RAL Space who will oversee the assembly, integration, and testing of critical space payloads and satellites.

Data Physics and Team Corporation are proud to supply the NSTF's new vibration test facility – designed to advance the UK's satellite and aerospace testing programs well into the future.

Ready to take your vibration testing programs to the next level?

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