

Space Test Capability in Scotland

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Summary

This short report contains a list of organisations in Scotland that provide test capability for space activities, along with a breakdown of their particular capabilities and activities.

The services have been split into four areas Environmental tests (Table 1) and with Systems, Software and Service (Table 2).

Notes related to the particular tests are given in the section “Methodology”.

A list of contacts is provided in Table 3.

Table 1 Environmental Tests

Organisation	ASB	Clyde Space	HW	Leonardo	Optocap	UKATC	UoS	York EMC
Environmental								
Thermal	X	X		X	X	X	X	
Vacuum	X	X		X	X	X	X	
Thermal Vacuum	X	X		X	X		X	
Sinusoidal Vibration	X	X		X	X	X	X	
Random Vibration	X	X		X	X	X	X	
Leak tests	X				X		X	
Pressure					X		X	
Acoustic (including audible)					X			
Acceleration	X	X		X		X	X	
Shock	X	X		X	X	X	X	
EMC			X	X	X	X	X	X
Magnetic								X
ESD					X			X
Bake Out		X		X	X	X	X	
Radiation					X		X	
Outgassing					X	X	X	
Aerodynamics							X	
Humidity	X			X	X			

Table 2 Systems, Software and Service

Organisation	ASB	Clyde Space	HW	Leonardo	Optocap	UKATC	UoS	York EMC
System Level Testing								
Radio			X				X	X
Antennas			X	X			X	X
Bus Communication		X				X	X	
Battery	X	X					X	
Power	X	X		X		X	X	
Optical				X		X	X	
Hardware in Loop		X					X	
Software								
Test Harnesses		X					X	
Services								
Mass <10kg	X	X	X		X	X	X	
Mass <100kg	X	X	X				X	
Mass >100kg				X			X	
Clean Room Testing		X			X	X	X	
24/7 Access	X	X		X			X	
Technician Support	X	X	X	X	X	X	X	
Analysis, Advice and Guidance	X	X	X	X	X	X	X	X
Accredited				X	X		X	X
Long Term Use			X	X		X		

Methodology

The services have been split into four areas: **environmental**, **systems**, **software** and **service**.

Environmental

These tests are designed to test the environmental aspects of a complete system, subsystem, component or material. Space and launch are harsh environments and the elements that make up a complete system need to be able to survive this environment. The following environmental tests were selected:

Thermal

Space has a wide thermal operating range. For low Earth orbit -20 to +65°C is stated but this is only one layer of the Earth's atmosphere and is not relevant to deep space or other planetary bodies. The system designed and the components and materials used need to operate at the extremes of the thermal environment. Though some components and systems will operate a heater to ensure the lower temperature range is managed, this system will need to be tested within a thermal chamber.

Vacuum (inc' Thermal)

The operation of the system and how the components and materials react in a vacuum needs to be tested. In addition how the system reacts to extremes of temperature under vacuum conditions needs to be tested as well.

Sinusoidal Vibration

During launch the systems, components and materials experience large vibrations. It is normally a requirement to show that the system will withstand certain conditions during flight.

Random vibration

During launch the systems, components and materials will experience large vibrations. It is normally a requirement to show that the system will withstand certain conditions during flight.

Leak tests

To ensure that the systems have no leaks (used for systems with fuels, liquids, gases and pressurised vessels) leak tests are carried out. The aim of the test is to ensure that no leaks are identified. This test also covers leak before burst testing.

Pressure

The systems will endure a range of different atmospheric pressures.

Acoustic (inc' audible)

During launch the systems, components and materials will experience a large range of vibrations. It is normally a requirement to show that the system will withstand certain conditions before flight. The acoustic range is lower than <20kHz and is normally used for flexible systems (solar panels and deployables).

Acceleration

During launch the systems, components and materials will experience large accelerations. It is normally a requirement to show that the system will withstand certain conditions before flight.

Shock

During launch the systems, components and materials will experience shocks. It is normally a requirement to show that the system will withstand certain conditions before flight.

EMC

All electronic systems will generate EM noise or could be susceptible to EM noise, either through emitted or conducted means. The level of noise generated or the susceptibility of the system to noise should be tested to ensure that correct operation is achieved in the operational environment.

Magnetic

All electronic systems have the capability to generate magnetic fields, or could be susceptible to magnetic fields. Some systems operate on the magnetic field of the Earth and or require magnetic conditions to operate in. The systems magnetic field is required to be established to inform the other the systems being flown, or to establish how susceptible the system under test is to magnetic fields.

ESD (Electro-Static Discharge)

The systems, components and materials used need to be immune to ESD likely to occur in flight. In addition the components and materials used need to be shown not to be the source of any ESD. Testing the susceptibility of ESD on systems is therefore an important part of the environment test program.

Bake out

Some missions will require that all elements of the system can withstand bake outs. The use of a thermal chamber than can maintain a high temperature for a prolonged period is required for a bake out.

Radiation

The space environment is a harsh radiation environment. Radiation testing is often a critical requirement for components / subsystems – particularly those on a large GEO satellite. Radiation testing also provides increase confidence of reliability for operation of small platforms in LEO. Full systems can also be tested in radiation environments.

Outgassing

For materials, outgassing is a critical test to be undertaken. This test will allow information on how materials react in a vacuum.

Aerodynamics

For launch and descent modules the aerodynamics of the system used needs to be understood in different planetary environments. Both launch and descent stages are critical and the correct aerodynamic design can lead to successful missions. In

addition, the methods of deorbiting satellite and the design of very low Earth orbit satellites need to be considered from an aerodynamic view point.

Humidity

For certain systems and materials the response to humidity needs to be tested as systems may be transported/stored in humid environments.

System

System level testing is undertaken using a test-bed where the system is tested to ensure it meets the design requirements and operates as expected. Test-bed provide external inputs and outputs. Development of custom test-bed is generally expensive, and availability of generic test beds can significantly reduce costs.

ADCS/AOCS Related

To properly test an ADCS/AOCS system, either a hardware in the loop test system needs to be developed or a testbed that mimics the environment the system will operate in. This type of system normally consists of an air bearing system and a Helmholtz cage.

Explosive testing

There is a push for space ports in Scotland. One aspect of this is the requirement to test the devices that could be used on the rockets and planes.

Radio

Most space related systems have a requirement for a radio. Normally this is the only means to communicate to a space segment so any support for radio testing would increase the confidence in the complete system.

Antennas

The radio system will use an antenna or system of antennas to communicate through. The testing of antennas to ensure correct operation should be carried out.

Bus Communication

Between subsystems the communications, buses play a vital role. The elements needed to ensure correct communication between systems need to be tested to demonstrate that the physical and protocol layers are correct.

Battery

The batteries on-board the space segment devices require a range of testing (both environmental and system level). The system level testing requires repeated discharging and charging of the battery and load tests of the battery. Life testing of the battery may also be considered. This is selected as a separate unit as, at times, the capacity of the battery may mean testing is difficult to do using standard off the shelf loads and power supplies.

Power

The power systems on-board space segment devices require a range of testing (both environmental and system level). The system level testing requires that the power system be loaded and operated correctly. How the system deals with transients,

overloads and constant loading are also essential tests. This is selected as a separate unit as, at times, power to be delivered by the system may mean testing is difficult to do using standard off the shelf loads and power supplies.

Optical

Optical communication and optical devices are used in the space segment. These devices require different testing devices from radios and other devices. Typically tests would involve the power transmitted by an optical communication device through to the performance of the detector array for an optical imager.

Hardware in Loop

From a system point of view many of the elements of a mission cannot be tested on Earth. In these cases hardware in the loop testing can provide support. The inputs to the system are simulated and entered into the system and the response of the system is monitored. The range of tests that can be carried out by hardware in the loop testing is varied.

Software

Software is a critical part of any system and should be heavily tested to ensure no issues will occur. This involves specialised software test harnesses or hardware in the loop designed systems. A full system test can be employed to ensure that the software operates but testing individual functions and code segments can provide confidence in the system.

Test harnesses

Software test harnesses are professional software constructs that are used to test software. The concept is to use a program to run a piece of software through all the available possibilities allowing a test of how the software reacts.

Services

The services section for testing covers the value added areas that may be deemed necessary to support the test being carried out.

Mass < 10kg

The test facilities can test systems <10kg.

Mass < 100kg

The test facilities can test systems <100kg.

Mass > 100kg

The test facilities can test systems > 100kg.

Clean Room testing

The test can be undertaken in a cleanroom environment.

24/7 Access

During the testing there is 24/7 access available.

Technician Support

Before, during and after the test there is technician support to aid in the setup, operation and dismantling of the test.

Analysis, Advice and Guidance

The test to be carried out can be discussed and recommendations made on the type or range of test. During the testing advice can be given on where issues may lie or how to assist in identify where issues are detected. Support can be given to improve the design and interpret the results that are acquired.

Accredited

An accredited test house has been independently verified that the equipment used and the tests carried out are within certain tolerances.

Long term Use

In some instances (for example accelerated life testing) there may be a need to book out a test house or test equipment for a long period of time (> 1week). Some tests houses may not offer this.

Table 3: Contacts

Organisation	Location	Web (links do not click through so must be copied)	Contact
MSB	Coatbridge	www.adsgroup.org.uk/members/missiles-space-batteries-ltd/	+44 (0) 1236 437775
Clyde Space	Glasgow	www.clyde.space	+44 (0) 141 946 4440
Heriot Watt University	Edinburgh	www.hw.ac.uk/research/facilities/technical-facilities.htm	+44 (0) 131 451 3070
Leonardo	Edinburgh	www.leonardocompany.com/en/product-services/sistemi-avionici-spaziali-airborne-space-systems-2/support-1/test-solutions/environmental-testing	+44 (0) 131 343 4242
Optocap	Livingston	wpo-altertechnology.com/optocap/	+44 (0) 1506 403550
Higgs Innovation Centre	Edinburgh	www.stfc.ac.uk/innovation/campuses/business-incubation-a-key-speciality/the-higgs-centre-for-innovation/	+44 (0) 131 668 8100
University of Strathclyde	Glasgow	www.strath.ac.uk/engineering/strathclydespaceinstitute/	space@strath.ac.uk
York EMC	Grangemouth	www.yorkemc.com	+44 (0) 1324 469 000

Report Contact

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Disclaimer

This document does cover all space test capability in Scotland, nor is it a recommendation for any of the entities providing test services.

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