

Capability Profile

# Component Testing & Technology Manufacture



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Doosan Babcock Energy is committed to maintaining a reputation built on providing the highest industry standards

### **Our accreditations include:**

- ISO 9001: Quality Management Systems
- ISO 14001: Environmental Management Systems
- OHSAS 18001: Occupational Health & Safety Management
- Pressure Equipment Directive 97/23/EC (CE Mark)
- ASME Boiler & Pressure Vessel Code: S, U, U2, PP
- ASME Boiler & Pressure Vessel Code: NBBI Repair “R” and “NB”
- Peoples Republic of China, Manufacturing Licence
- TUV – TRD 201, AD2000-Merkblatt HPO
- TUV – EN ISO 3834-2
- UKAS Inspection Body (Type C): BS EN ISO/IEC 17020
- UKAS Testing Laboratory: BS EN ISO/IEC 17025
- SWEDAC Testing Laboratory: EN ISO/IEC 17025
- Safety Checklist Contractors (SCC) VCA\*\* 2004/04
- CEFRI/SPE-E-400: Radiation Safety Management & Admin System
- HSE Approved Dosimetry Service – Coordination & Record Keeping

### **Our client list includes:**

- British Energy
- Technip
- BP
- Acergy
- Total
- Chevron
- Statoil
- Rolls Royce
- Bombardier Aerospace

# Our Business

## Engineering innovative power and energy technologies

Doosan Babcock is a multi-specialist energy services company operating in the Thermal Power, Nuclear, Petrochemical, Oil & Gas and Pharmaceutical industries. Doosan Babcock is also a leading international steam generation OEM and supplier of the cleanest, most efficient coal powered technology in the world. We provide innovative technology that supports and enhances the service life of energy assets across the globe.

We are part of the Doosan Group - the oldest and one of the most successful conglomerates in Korea.

We have universally recognised expertise in each of our key areas of activity. For over a century our people have been adding bottom line value for our customers. We develop cutting edge technologies to improve plant performance, reduce emissions and ensure safe and efficient plant operation. Today Doosan Babcock can claim an unequalled track record of successfully completed projects with more than 150,000 MWe installed capacity worldwide. In the past two years alone we have installed over 23,000 MWe of supercritical technology.

Our business provides powerful solutions for our clients, wherever they are in the world. With over 20 offices globally, we have the scope to deliver.



### Main Office Locations

- Crawley, UK
- Renfrew, UK
- Halle, Germany
- Rybnik, Poland
- Atlanta, US
- Chennai, India
- Shanghai, China

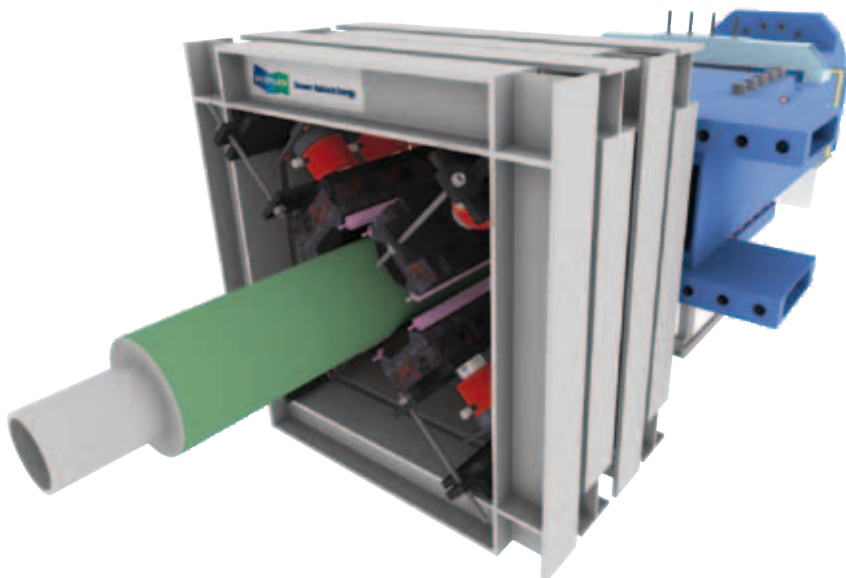
# Component Testing

## Overview

Although the Doosan Babcock name is synonymous with the power generation market, we also provide a full-scale component test service in our Technology & Engineering Building at Renfrew, Scotland. We test products from clients operating within the Oil & Gas, Thermal Power, Nuclear, Aerospace and Civil Engineering industries.

Our customers trust us to take the latest emerging technology and establish its performance envelope, giving them confidence in the product that can only be gained through full-scale testing.

Our team of over 40 technical staff consists of qualified engineers, test technicians and skilled craftsmen. We also have a UKAS-accredited mechanical test laboratory that provides tensile, compression, Charpy impact and hardness testing.



The Component Test & Manufacture department is supported by a number of in-house specialist technical services. These include metallurgical services, noise, vibration and fatigue monitoring and assessment, finite element stress analysis, failure investigation, creep and low-cycle fatigue analysis as well as specialist non-destructive testing.

The extensive range of test facilities in our Renfrew laboratories means we can offer the capabilities below:

- Up to 30MN loading in compression
- Up to 20MN loading in tension
- Multi-axis control of servo-hydraulic actuators
- Fatigue loading at frequencies up to 50Hz (dependant on specimen deflection)
- Pressure testing up to 2760 barG (40,000psi) and up to 700°C
- Large scale four-point bend testing up to 6MNm
- Simulated service testing of subsea wet insulated pipelines
- Real-time contact stress measurement using Tekscan sensors

We specialise in fabricating bespoke test facilities to meet the needs of our clients, incorporating the latest load application and data acquisition systems. All instruments used in our test rigs are calibrated to traceable national standards.

# Oil & Gas Qualification Tests

Our testing capabilities allow us to offer a comprehensive qualification service to customers operating in the oil and gas subsea pipeline industry. These services include our large scale four-point pipe bend rig and our recently developed simulated service test (SST) facility.

### Four-Point Pipe Bend Testing

Our four-point bend rig has the capacity to test pipe lengths of up to 12 metres, diameters up to 32" NB and apply a bending moment of up to 6MNm. Typically, a test set-up will incorporate a section of uniform bending over an unsupported central span of 5 metres.

In addition to testing the performance of pipeline designs, the rig has also been used to qualify strain measurement systems for pipeline applications.

Data provided from a four-point bend test includes applied load and bending moment, multi-channel strain data and real-time radius of curvature (global strain) and ovality measurements of the pipe at the central span.

### Simulated Service Testing of Pipeline Insulation

A recent development is our Simulated Service Test rig for testing the efficiency of wet insulation and pipe-in-pipe systems.

Overall Heat Transfer Coefficient (OHTC) is calculated using heat flux measurement and direct power

monitoring. Insulation compression is also monitored throughout the test.

Our internal heating system can provide temperatures of up to 150°C, while our pressurisation system will allow insulations to be tested under an external pressure of up to 300 barG. The rig can accommodate specimens with an outside diameter of up to 445mm where insulation compression measurement is required, or up to 500mm where this is not required.

### Hydraulic Burst Testing

We have the capability to carry out hydraulic burst testing of subsea pipeline samples at pressures of up to 2760 barG and at elevated temperatures.

Test samples are fully instrumented using multiple strain gauges, displacement transducers and thermocouples.

Burst testing is carried out in our purpose-built, 76m<sup>3</sup> blast-proof test pit and the instrumentation monitored from a control room. The burst is recorded using remote video camera systems.



1: Simulated Service Testing Facility

2: Hydraulic Burst Testing

# Component Testing

## Oil & Gas Qualification Tests *continued*

### Axial Compression Tests

Compression tests can be carried out on specimens of between 0.9m and 4m in length and axial compression forces up to 9MN.

Tests can be carried out at elevated and sub-zero temperatures.

Multiple real-time strain, displacement and temperature measurements can be made throughout the test. Our test rig can also allow video camera examination of the pipe bore during the test.

### Umbilical Component Tests

A variety of test configurations for qualifying subsea umbilicals can be accommodated, including fatigue, torsion and bend restrictor tests. Electrical continuity and internal pressure measurement can also be undertaken during testing.

### Wet Insulation Coefficient of Friction Tests

We have developed a test system which can determine coefficient of friction values for pad and pipe-insulation combinations, either in a full or small-scale configuration.

Tests can be carried out at elevated temperatures, with customer-defined load cases and with ASTM-specification substitute ocean water within the interface.

We can test two, four or six-pad arrangements, with clamping loads of up to 3MN and axial loads of up to 4MN.

### Flexible Riser Tests

A further capability is Flexible riser crush testing in accordance with API Specification 17B. These tests can be carried out with an axial load of up to 4MN and a compressive load of 3MN per track applied to a riser of up to 7m in length.

Flexible riser Tension-Tension fatigue tests can also be carried out at frequencies of up to 0.3Hz and axial loads of 7.5MN depending on specimen geometry. Specimens of up to 12m in length can be accommodated. In-situ radiographic inspection with the specimen under tensile loading can also be carried out. Internal pressure can be controlled and adjusted during fatigue cycles.

### Pipe-in-Pipe Centraliser Qualification

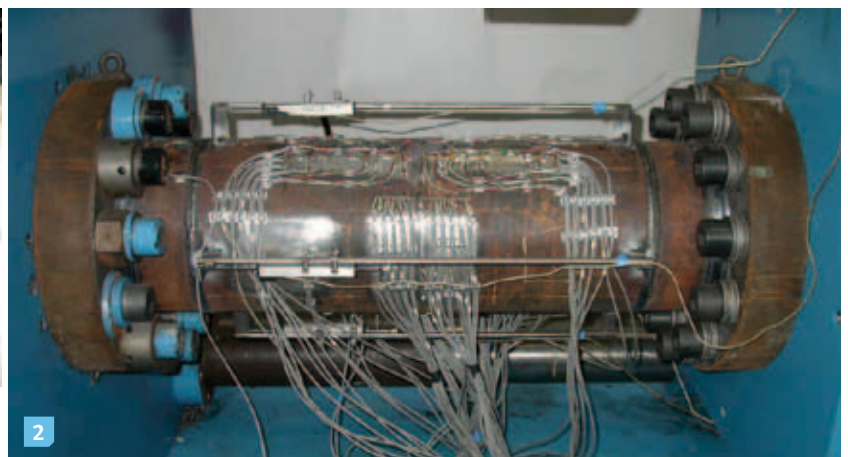
In order to ensure that a proposed centraliser design is suitable, Doosan Babcock can carry out a comprehensive test programme on the product.

A typical qualification test programme includes the following tests:

- Slippage load on the flowline
- Abrasion due to movement over the carrier pipe and weld roots
- Creep experienced during the service life
- Bolt torque relaxation
- Centraliser material testing: thermal conductivity, melt point analysis and mechanical testing



1:  
Wet Insulation Coefficient  
of Friction Tests



2:  
Axial Compression Tests

## Aerospace Structural Testing

### **Aero-Engine Component Testing**

In recent years, we have expanded our facilities and capabilities to include structural testing on aero-engine components.

We have the capabilities to design, manufacture and operate multi-axis, servo-hydraulic test arrangements to apply even the most complex of loading cycles.

Our testing experience includes the validation of aero-engine components under static and fatigue loading at room and elevated temperatures and with internal pressures.

### **Aircraft Structural Testing**

Our extensive range of test machines allow us to offer bespoke solutions for aircraft structural testing.

We have tested a variety of aircraft structural components, including strain-gauged fibre-reinforced composite wing components and honeycomb section crush specimens.



**1:**  
Aero-Engine  
Component Testing

# Component Testing

## Civil Engineering Tests

### Concrete Post-Tensioning Components

We have been testing concrete post-tensioning components to ETAG 013 requirements for a number of years. We test products supplied for use in bridge and building construction and nuclear pressure vessel applications.

In accordance with ETAG 013, the qualification programme includes fatigue tests, static efficiency tests, coefficient of friction tests, deviation and deflection of tendon tests and a test of load transfer to the structure.

Our test machines can apply up to 20MN to such components.

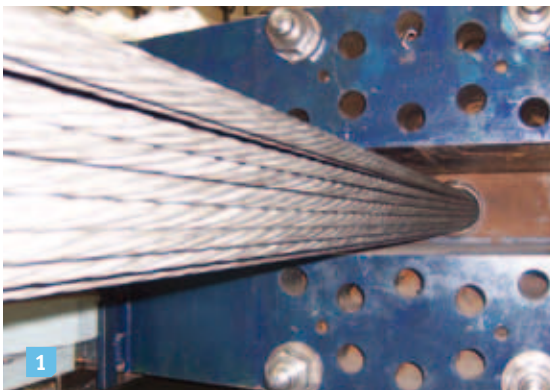
### Bridge Structure Components

Testing of production and prototype bridge sections is an area in which we have valuable experience. We can carry out proof load tests, loading to failure, or fatigue tests to simulate the loading cycles over the lifetime of the product.

Previous tests have included extensive strain gauging of bridge delta components, followed by several months of load cycling to investigate fatigue performance of critical welds.

For such applications, we have individual hydraulic actuators with capacities ranging from 100kN to 8MN which can be incorporated into custom-built test rigs.

Additional tests carried out for Civil Engineering applications have included prototype and proof tests for seismic lock-up devices prior to use on high-speed rail tracks.



1:  
Concrete Post-Tensioning  
Components



2:  
Bridge Structure  
Components

# Acoustic Emission & Fatigue Crack Growth

## Acoustic Emission Monitoring

For over 15 years we have carried out installation and monitoring of Acoustic Emission systems during laboratory full scale destructive testing and on site. This technology provides our customers with the benefit of detecting the early onset of a material or component failure, allowing them to prevent complete failure and unscheduled downtime.

We have also been involved in evaluations of Acoustic Emission techniques in laboratory-based research programs funded by the EU and the UK's DTI.

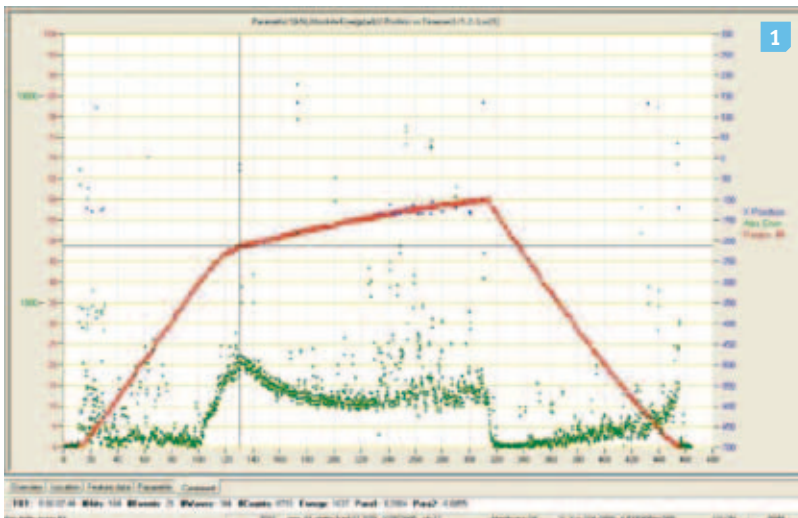
We carry out Acoustic Emission monitoring in accordance with the following standards:

- BS EN 13554:2002 Non-destructive testing. Acoustic emission. General principles
- BS EN 14584:2005 Non-destructive testing. Acoustic emission. Examination of metallic pressure equipment during proof testing. Planar location of AE sources

## Fatigue Crack Growth

We have experience in fracture and fatigue testing of a variety of materials for industrial applications. Fatigue crack growth rate testing can be performed to provide “da/dN” data for both weld and parent materials. The fatigue crack depth can be monitored by AC potential drop, DC potential drop and compliance methods. Fracture toughness testing can also be carried out in-house to provide data on crack growth resistance and defect tolerance.

High cycle and low cycle fatigue testing facilities are available utilising screw driven and servo-hydraulic test machines. Fatigue crack growth is also utilised in the production of custom test and calibration specimens for destructive and non-destructive testing applications.



1:  
Acoustic Emission  
Output Chart

# Materials Testing

## UKAS Accredited Materials Testing Laboratory

Our Materials Testing Laboratory is equipped to carry out a wide variety of material tests which can be carried out and certified within short timescales.

Our UKAS accreditation allows us to test to British Standards and ASTM Standards.

We can verify material properties against a supplied mill-certificate, while our Analytical Chemistry Laboratory staff work with us in providing full chemical analysis and Positive Material Identification (PMI).

All test specimens are machined in-house from the supplied material, and conform to the relevant British and ASTM Standards.

- Tensile tests up to 1200kN
- Compression tests up to 1200kN
- Elevated and Sub-zero Temperature Tensile Tests
- Charpy Impact Testing : Ambient and Sub-zero Temperatures
- Hardness Testing : Brinell, Vickers and Rockwell

- Weld Procedure Qualification Testing
- Heat Treatment
- Photography : Micro & Macrographs
- Low Cycle Fatigue Tests
- Plane Strain Fracture Toughness Testing
- Crack Tip Opening Displacement (CTOD) Tests
- Co-Efficient of Thermal Expansion Tests
- Corrosion Tests
- Stress Relaxation Tests
- Creep Crack Growth Tests

In addition to UKAS accredited tests, the wide variety of our test frames allows us to adapt and develop test methodology and tooling to suit customer requirements.

We also conduct creep tests both on standard small-scale test specimens and on full-scale components. Full scale specimens can be tested at temperatures up to 650°C with up to 205 barG internal pressure or with an applied mechanical load. Creep-fatigue interaction testing can also be carried out on small and full scale specimens.

## 1: Material Tensile Testing



Laboratory Number: 0256



# Machining Services

## Machine Shop Capabilities

Our fully-equipped machine shop not only supports the manufacturing and testing activities of the department, but it also provides a sub-contract machining service.

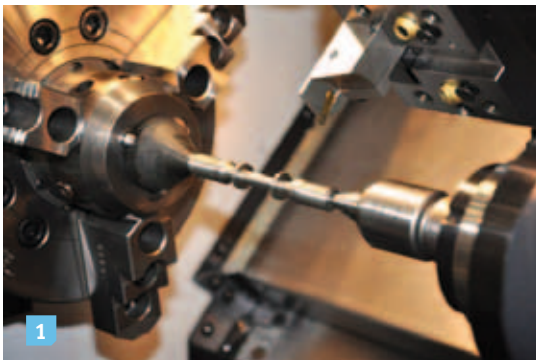
We have recently invested in the latest lathe and milling technology, together with Autodesk Inventor and Delcam FeatureCAM softwares. The combination of these tools allows us to produce complex parts very quickly.

Since our machine shop specialises in lower quantity or bespoke parts, we can accommodate your requirements at short-notice. We work closely with our network of approved material suppliers which provide certified materials from trusted sources quickly. We are

experienced in working with carbon steels, stainless steels, cast iron, aluminium, titanium and nickel alloys as well as polymer materials.

The services we offer include:

- Turning operations (manual and CNC)
- Facing and boring operations
- Drilling
- Internal and external threading
- Milling (manual and CNC)
- Surface grinding
- Sawing
- Spark erosion (defect implantation, slot cutting, removal of trapped tools)
- Production of material testing samples



**1:**  
Machining of Material  
Test Samples

**2:**  
CNC Vertical Milling Machine

# Specialised Manufacturing

## Bespoke Design & Fabrication

In our Technology Manufacturing group, we specialise in offering a comprehensive manufacturing package from product conceptual design through to fabrication and commissioning. Our Technology Manufacture operations often utilise and bring together all of our department services and expertise: material and component testing, machining services, instrumentation as well as our renowned capabilities in welding.

High integrity items are a particular speciality; we have a wealth of experience in the manufacture of pressure parts to the relevant standards and rotating equipment for nuclear applications.

Our comprehensive manufacturing service provides the following benefits:

- Highly experienced welders qualified to ASME and British Standards
- Weld procedure development and qualification through our own Metallurgy & Structural Integrity Department and UKAS accredited Materials Testing Laboratory

- Pre and Post-Weld Heat Treatments, even of large-scale components
- Non-Destructive Testing, conducted in-house by qualified Technicians
- Material procurement from our network of approved material suppliers which provide certified materials
- Independent material verification through chemical analysis and materials testing

Some of our recent projects include:

- Manufacture of a non-destructive testing qualification test piece for a nuclear application, with “implanted” defects in the weld
- Design and manufacture of a temperature monitoring system for retro-fitting into nuclear boiler headers
- Manufacture of nuclear reactor gas circulator impellers
- Manufacture of creep testing machines for our in-house creep laboratory



1:  
Temperature Monitoring  
System for Nuclear Boiler  
Header



# On-Site Instrumentation Services

## Strain Gauging

Our extensive use of strain gauge technology in our full-scale component testing business has built our expertise in this area, and allowed us to offer an on-site strain-gauge installation service for a number of years. All of our Engineers and Technicians hold British Society for Strain Measurement (BSSM) qualifications.

We can provide data-acquisition systems for use on your site which are capable of recording data at rates of up to 2400Hz. We can provide a complete package from suitable gauge selection through to full data-processing and analysis following the data collection.

Our staff have helped customers on industrial sites worldwide as well as on offshore oil installations and gas transportation ships. We can provide a strain gauging solution to suit temperatures up to 800°C.

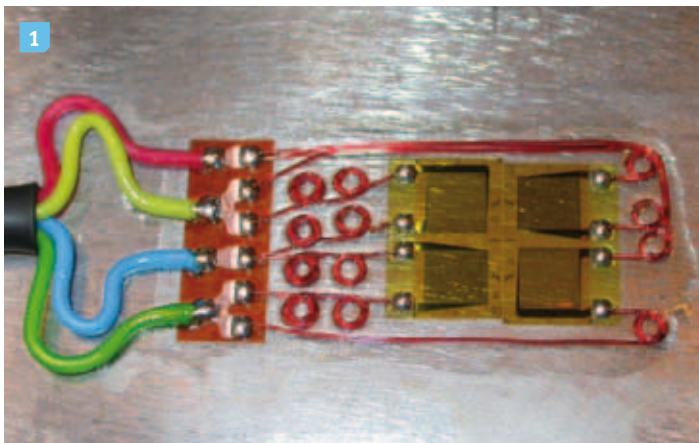
## Thermocouple Installation

We have developed and installed temperature monitoring systems for a wide variety of applications. These have ranged from temporary thermocouple

installations on pipework to permanent temperature profiling systems installed in radiological environments.

We can install thermocouples with a temperature capability of over 2000°C. Attachment methods include micro-spot welding, capacitance discharge welding, magnetic base attachment, metal flame spraying as well as boiler tube chordal hole drilling and peening.

Our proven track record extends to many industry sectors where we deliver tailor made solutions including an engineering design review of the process or operation of the plant, thermocouple type and location selection, full installation and monitoring and analysis of the acquired data. The data yielded from such instrumentation can typically assist in plant condition monitoring or control.



**1:**  
Installed Strain Gauge  
Wheatstone Bridge

# Test Machines

## 20MN Tension & Compression Rig



Maximum Specimen Length:  
12000mm

Stroke Length:  
300mm

*TWO 20MN MACHINES IN  
OPERATION*

## 30MN Compression Rig



Maximum Specimen Length:  
1000mm

Stroke Length:  
150mm

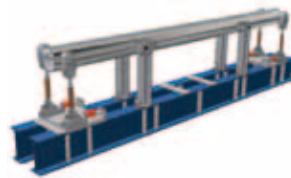
## 8MN Tension & Compression Rig



Maximum Specimen Length:  
4500mm

Stroke Length:  
600mm

## 6MNm 4-Point Bend Rig



Maximum Specimen Length:  
12000mm

Maximum Specimen Diameter:  
32" NB

## 4MN Tension & Compression Rig



Maximum Specimen Length:  
5000mm

Stroke Length:  
150mm

## Insulated Pipeline Simulated Service Test Rig



Required Insulation Length:  
3554mm

Maximum Insulation Diameter:  
500mm

Minimum Pipe Bore:  
4" NB

Maximum Temperature:  
150°C

Maximum Pressure:  
300 barG

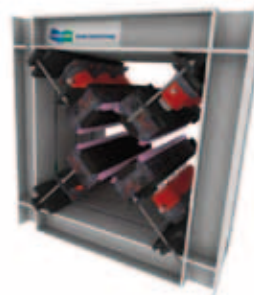
## 2MN Schenck Test Machine



Maximum Specimen Length:  
1000mm

Stroke Length:  
300mm

## Pipeline Tensioner Pad Test Rig



Maximum Insulation Diameter:  
900mm

Maximum Compressive Load:  
3MN per opposing set

### 800kN ESH Test Machine



Maximum Specimen Length:  
1000mm

Stroke Length:  
100mm

Maximum Frequency:  
20Hz

### 600kN Dartec Test Machine



Maximum Specimen Length:  
1395mm

Stroke Length:  
470mm

Maximum Frequency:  
4Hz

### 600kN Losenhausen Test Machine



Maximum Specimen Length:  
1800mm

Stroke Length:  
150mm

Maximum Frequency:  
20Hz

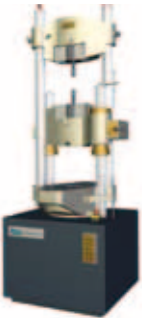
### 250kN Zwick Test Machine



Maximum Specimen Length:  
1000mm

Stroke Length:  
1000mm

### 600kN DMG Test Machine



Maximum Specimen Length:  
750mm

Stroke Length:  
200mm

### 50kN ESH Test Machine



Maximum Specimen Length:  
1000mm

Stroke Length:  
150mm

## Contact Us

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Our facility is located in Renfrew, on the outskirts of the City of Glasgow. We are close to the M8 motorway, and adjacent to Glasgow International Airport making us easily accessible by road and air. We invite you to visit us to view our capabilities or to discuss your requirements in person.