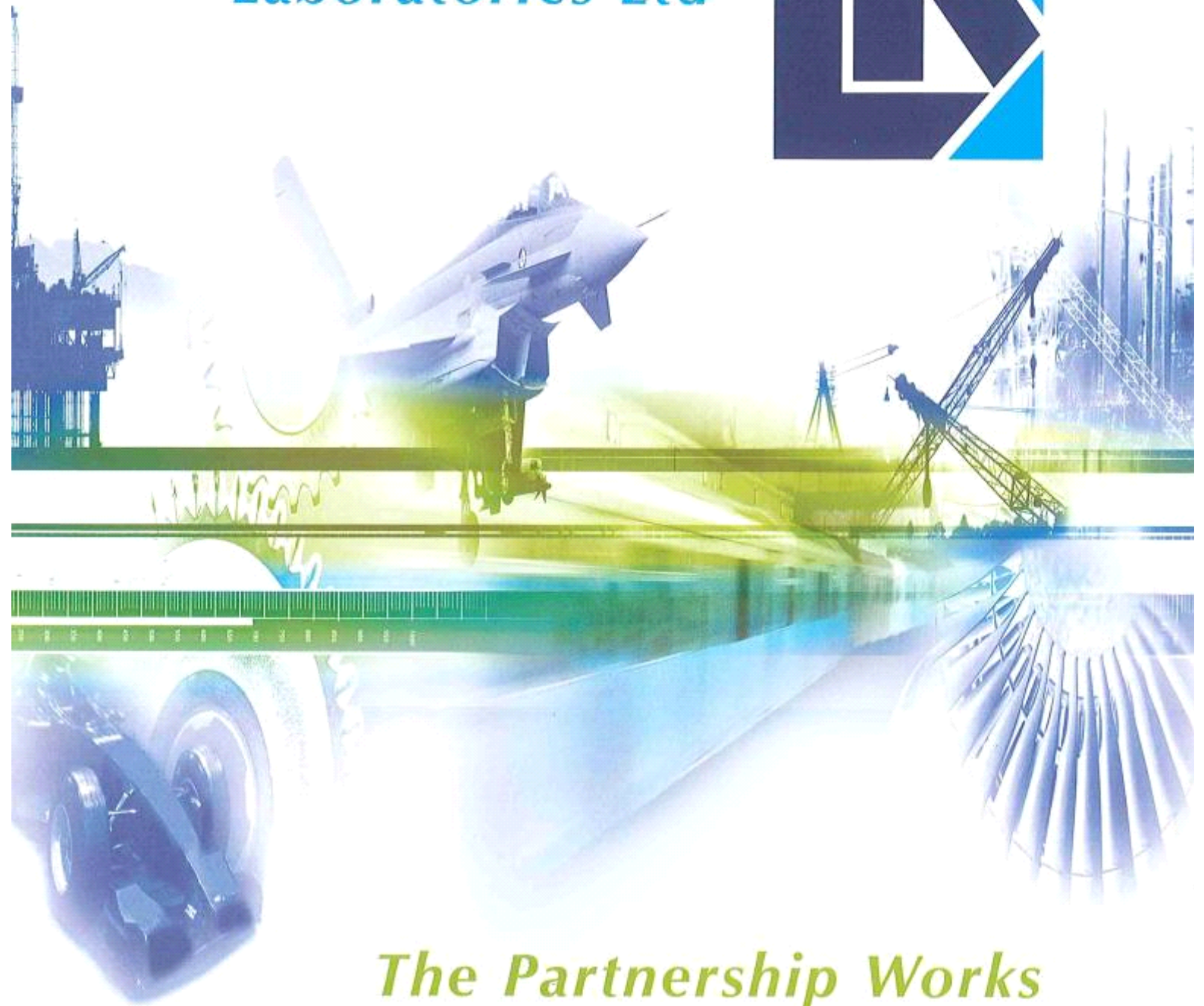


*Keighley
Laboratories Ltd*



The Partnership Works

***Specialists in the
analysis, testing and
heat treatment of metals***

Contact details: Croft House South Street Keighley West Yorkshire
BD21 1EG

Tel No: 01535 664211 email: info@keighleylabs.co.uk



Contacts:

David Wright— ext 305. dwright@keighleylabs.co.uk
 Richard Wormald—ext 111. rwormald@keighleylabs.co.uk
 Michael Emmott—ext 302. memmott@keighleylabs.co.uk
 James Menzies—ext 131. jamesm@keighleylabs.co.uk

Heat Treatment Services

Carburizing/Carbonitride/Press Quench

Carburizing is a carbon diffusion controlled process used to case harden steel, primarily low carbon steel . It enables a hard wear resistant case to be produced with a softer, tougher core. Case depths up to 5mm are achievable, dependant on material selection.

Carbonitriding is similar to gas carburization with the addition of ammonia to the carburizing atmosphere, which provides a source of nitrogen. Nitrogen is adsorbed at the surface and diffuses into the work-piece, along with carbon. Typical case depths are 0.07 - 0.5mm

Components are generally quenched in oil. Fast quench oils are available for lower hardenability steels. Molten salt is also available to minimise distortion.

Programmable Logic Controllers (PLCs) and oxygen probes enable temperature, atmospheres and cycle times to be controlled accurately and repeatedly.

Components up to 1.78m long can be treated vertically using special jiggng to minimise distortion.

Gleason press quenchers are available to control ovality and flatness.



Normalizing

Normalizing can soften, harden or stress relieve a material depending on its' initial state and chemical composition. Components are normally cooled in air.

Annealing

The primary purpose is to reduce the hardness of a material for subsequent machining. In steels and nodular irons it increases ductility and results in a controlled microstructure. It can be applied to iron castings which exhibit chill. Components are cooled slowly, in a furnace to allow full precipitation of the micro- constituents and produce a refined microstructure.

Stress Relieving

Stress relieving removes or reduces internal stresses created in a material, ranging from cold working to non-uniform cooling. Stress relieving is usually requires heating the material to below the lower critical temperature and then cooling uniformly.

Induction Hardening

Induction hardening is the rapid heating and quenching of components using a strong alternating magnetic field to generate heat and quenchants (oil, water & polymer) to form hard surface structures.

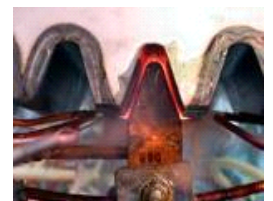
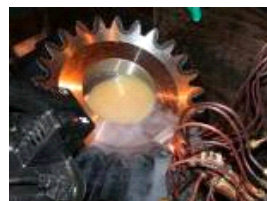
Induction hardening can be used to selectively harden certain areas of a part.

This localised treatment offers low distortion and economic processing.

Facilities include:

- ◆ Shaft/pin hardening
- ◆ Gear hardening
- ◆ Internal bore hardening

Inductors and coils are manufactured in-house to fit your requirements.





Heat Treatment Services

Contacts:

David Wright— ext 305. dwright@keighleylabs.co.uk
Richard Wormald—ext 111. rwormald@keighleylabs.co.uk
Michael Emmott—ext 302. memmott@keighleylabs.co.uk
James Menzies—ext 131. jamesm@keighleylabs.co.uk

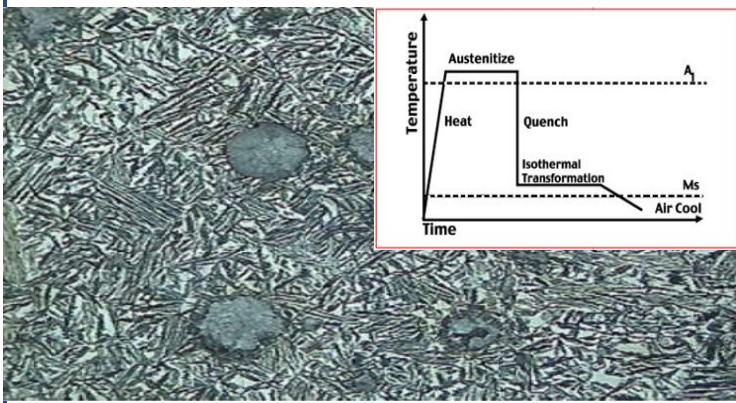
Austempered Ductile Iron (ADI)

Austempering is an isothermal heat treatment process which significantly improves both the strength and wear resistance of ductile iron whilst retaining the impact resistance and ductility for which the material is noted.

It can also be applied to, cast, compact and malleable irons.

Austempering offers predictable stability allowing components to be cast near net shape, minimising machining required.

Typical microstructure and heat treatment cycle



Martempering

Martempering effectively carries out a harden and temper operation at the same time, keeping distortion to a minimum.

It results in properties which combine good wear resistance, high strength, ductility and toughness.

Tufftride® (Ferritic Nitrocarburizing)

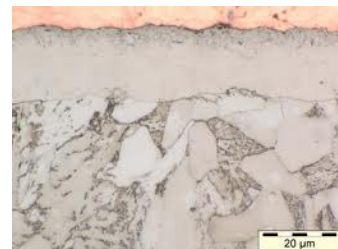
Tufftride® is a salt bath process which can be carried out to most ferrous materials and improves component quality by:

- ◆ Retarding wear
- ◆ Increasing fatigue strength
- ◆ Resisting corrosion
- ◆ Increasing hardness
- ◆ Enhancing appearance

Tufftride® AB1 improves corrosion resistance, promoting a black finish.

Tufftride® QPQ can give even higher corrosion resistance and excellent surface finishes which can exceed other surface treatments.

Tufftride® offers a rapid turnaround with treatment times in the order of 30 minutes to 3 hours.



Nitrocarburized layer consisting of the outer compound layer and the diffusion layer. Material— low carbon, unalloyed steel.





Heat Treatment Services

Contacts:

David Wright— ext 305. dwright@keighleylabs.co.uk
 Richard Wormald—ext 111. rwormald@keighleylabs.co.uk
 Michael Emmott—ext 302. memmott@keighleylabs.co.uk
 James Menzies—ext 131. jamesm@keighleylabs.co.uk

Hardening & Tempering

Hardening and Tempering is used to produce the optimum combination of hardness, strength and toughness in many commercially available steels. By heating the material to a temperature in excess of 780°C and subsequently cooling it quickly, the material is hardened.

Components may be quenched in oil, fast quenching oils are available for deeper hardening and the processing of lean carbon/alloys steels. Alternatively, a molten salt quench (180°C—400°C martemper) may be used to minimise distortion as appropriate.



Subsequently, uniform tempering, carried out to reduce the hardness and increase the toughness is typically undertaken using electric air circulating pit furnaces.



Benefits include:

- ◆ Using endothermic atmospheres with oxygen probe control scaling and de-carburization are minimised.
- ◆ Using special jiggling to minimise distortion, components up to 1.78m can be treated.

Typical Materials Processed:

Hardening and Tempering is carried out mainly to medium carbon, alloy and tool/die steels, these include— 080M40, 817M40, 709M40, O1, D2 D3.

Deep Freezing of components is available. This transforms the structure and prepares components for working in cold environments. A stress relieving operation should be carried out after deep-freezing.

Heat Treatment Capacities

Annealing	: 1.78m long x 0.97m dia.
Normalizing	: 1.78m long x 0.97m dia.
Carbonitriding	: 1.22m long x 0.71 dia.
Hardening & Tempering	: 1.78m long x 0.97m dia.
Carburize Case Hardening	: 1.78m long x 0.97m dia
Induction Hardening—Spin	: 12mm—300mm dia.
Induction Hardening Tooth by Tooth	: Bevel Gears up to 18MOD, max 1.02m dia standard gears tooth by tooth 4m dia max, max lift weight 3 T.
Induction Hardening—Shaft	: 150mm dia x max length 1.52m. : 300mm dia x max length 600mm.
Martempering/ Austempering—ADI	: 0.71m dia x 1.2m deep.
Ferritic Nitrocarburizing	: 0.61m dia x 0.91m deep.
Stress Relieving	: 1.78m long x 0.97m dia.
Press Quench	: 0.6m dia.

◆ The above are standard dimensions. It may be possible to process larger items. Please contact the persons above to discuss further.





Metallurgical & Technical Laboratory Services

Contacts:

Matthew Mellor—ext 306. mmellor@keighleylabs.co.uk

Jeremy Duignan—ext 110. jez@keighleylabs.co.uk

Richard Gaunt—ext 101. rgaunt@keighleylabs.co.uk (corrosion)

Mechanical Testing

Tensile and Compression Load Testing

- ◆ Undertaken at ambient, sub-ambient and elevated temperatures.
- ◆ Stress-strain and load deflection curves are produced for loads up to 1100kN.

Impact Testing

- ◆ CHARPY and IZOD testing.
- ◆ Undertaken to European and American standards.

Hardness Testing

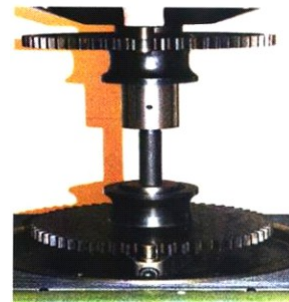
- ◆ BRINELL, ROCKWELL, VICKERS macro- hardness, VICKERS & Knoop micro-hardness

Fastener Testing

- ◆ Full metallurgical testing in accordance with BS EN ISO standards.

Fatigue Testing

- ◆ We use digital equipment to fatigue test specimens and components at ambient temperatures.
- ◆ Max. load test capacity 150kN.
- ◆ Operating frequency 60-180Hz, dependent on stiffness of specimen.



Corrosion Tests

- ◆ Neutral Salt Spray (NSS), Acetic Acid Accelerated Salt Spray (AASS), Copper Acetic Acid Accelerated Salt Spray (CASS).
- ◆ Typical specifications include: ASTM B117 (NSS), ASTM B368 (CASS), ISO9227 (NSS, AASS and CASS).
- ◆ Fog/Dry Cyclic Salt Spray tests, 'Prohesion' type (typically ASTM G85:Annex A5)
- ◆ 100% humidity testing, typical durations from 24 hours upwards, constant temperature (typically ASTM D2247) or cyclic temperature (typically BS 3900:Pt F2).
- ◆ Intercrystalline/Pitting/Crevice corrosion (typically includes BS 5903, ASTM A262, ASTM G28 Ferric Sulphate, ASTM G48 Ferritic Chloride, Sodium Chloride, Sodium Chloride/CO₂).
- ◆ Paint/Coating tests include: solvent/chemical resistance, water soak, paint thickness, adhesion and heat resistance.





Metallurgical & Technical Laboratory Services

Contacts:

Matthew Mellor—ext 306. mmellor@keighleylabs.co.uk

Jeremy Duignan—ext 110. jez@keighleylabs.co.uk

Roger Wheatley—ext 307. ndt@keighleylabs.co.uk (ndt)

Keith Blower—ext 304. kblower@keighleylabs.co.uk (investigation)

Non Destructive Testing (NDT)

Personnel

- ◆ Available at short notice for in-house or on-site work in UK and overseas.
- ◆ All inspectors qualified to a minimum of PCN Level 2.
- ◆ PCN Level 3 supervision is available for PT, MT, UT.
- ◆ Offer consultancy services for procedure writing and commentary; auditing of techniques; Level 3 Supervisor cover.
- ◆ Working to current, national, international and customer driven standard specifications

Penetrant Testing (PT)

- ◆ Detection of surface breaking discontinuities in non-magnetic materials.

Magnetic Particle Testing (MT)

- ◆ Detection of surface breaking and slightly sub-surface discontinuities in magnetic materials.

Ultrasonic Flaw Detection (UT)

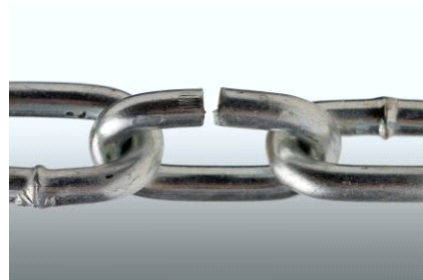
- ◆ Detection of volumetric discontinuities in welds, forgings, castings, bar stock/plate etc

Radiography

- ◆ Booked through sub-contract.
- ◆ Notice required for on-site work.

Problem and Failure Investigation

- ◆ Experienced consultants available for failure and fracture investigations, reverse engineering examinations, insurance claim and forensic type investigations.
- ◆ Advice on test and set-ups, including interpretation of UK and International specifications.
- ◆ Expert Witness work, including personal injury, accident work and single joint expert.



Metallography and Product Testing

- ◆ Full metallographic facility, including projection, stereo binocular microscopes all with digital image capture.
- ◆ Standard and bespoke testing to customer requirements, including the development of non-standard test facilities.

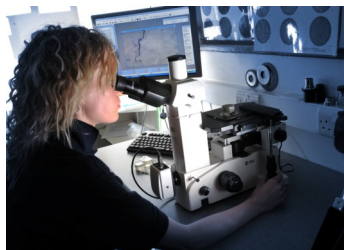


Image Capture

- ◆ Captures digital images.
- ◆ Demonstrates linear measurements with certainty.
- ◆ Measures grain size, phase counts, % cavitation and volume fraction.
- ◆ Provides quick and accurate evaluation of microstructures.
- ◆ Up to and including 1000 x's magnification





Metallurgical & Technical Laboratory Services

Contacts:

Matthew Mellor—ext 306. mmellor@keighleylabs.co.uk

Jeremy Duignan—ext 110. jez@keighleylabs.co.uk (PMI)

- ◆ Keighley Laboratories Ltd has recently upgraded and added to their already impressive list of test and analytical equipment, to target specific market areas.

An X-ray Fluorescence (XRF) machine. Classified as a semi-quantitative instrument, this item has allowed its technicians to carry out alloy categorisation of ferrous and some non-ferrous materials by **Positive Material Identification/ Alloy Verification (PMI/AV)** methods.

- ◆ The equipment is portable and hand held so that identification can be undertaken in-house or on-site.



- ◆ Data is stored on the instrument and instant reports are produced at the time of testing, thus eliminating material mix-ups that ultimately could result in field failures/accidents.

We have added an **Automatic Micro and Macro Hardness Tester** to our test house.

- ◆ Featuring fully automatic Vickers indentation measurement and dedicated hardness testing software with test loads between 100gms and 10kg, the new equipment delivers improvements in accuracy, repeatability and productivity. Although testing is generally to ISO 6507 the equipment can be fitted with an alternative Knoop indenter.

- ◆ The equipment comes complete with built in microscope and camera, motorised turret, an automatic motorized XY table and automatic focus providing an additional Z axis for bringing the test surface into sharp resolution without operator involvement.



Coating Thickness Meter: This instrument comes complete with connected cable probe ideal for measuring coating thickness on components of various specimen shapes.

- ◆ A unit for measuring coatings on all materials (ferrous and non-Ferrous), easily, quickly and non-destructively.

Applications include:

- ◆ Paint, varnish or plastic coating on ferrous and non-ferrous Metals such as aluminium, stainless steel, iron or steel
- ◆ Checking the thickness of anodised coatings on aluminium
- ◆ Electroplated coatings of zinc, chromium, copper etc

- ◆ The instrument has the ability to automatically recognise substrate materials under the coatings and select its appropriate test method.





Metallurgical & Technical Laboratory Services

Contacts:

Matthew Mellor—ext 306. mmellor@keighleylabs.co.uk

Jeremy Duignan—ext 110. jez@keighleylabs.co.uk

Roger Wheatley—ext 307. ndt@keighleylabs.co.uk(ndt)

Electrical Conductivity Measurement: Electrical conductivity is an important property that not only informs about how well a metal conducts electrical current but also provides information about its composition, microstructure or mechanical properties.

- ◆ This modern piece of equipment measures electrical conductivity using the Eddy current method according to DIN EN 2004-1 and ASTM E 1004.
- ◆ Brimming with many up to date electronic features, the high-precision instrument can be used for the following:
- ◆ Determination of the electrical conductivity of non-magnetic materials i.e. Aluminium alloys, Copper, even Stainless Steels
- ◆ Monitoring heat treatment processes, strength and hardness of wrought aluminium alloys in the aerospace and automobile industries
- ◆ Inspection of heat treatment damage
- ◆ Determining the degree of purity



Another non-destructive check is **Magnetic Permeability Testing**. This simple test measures the ability of the material to be magnetised.

- ◆ The equipment, an electronic Permeability Meter undertakes an accurate assessment of the materials relative permeability (commonly referred to by the Greek letter μ) and capable of measuring magnetic permeability in increments between 1.001μ to 1.999μ to a resolution of 0.001μ .
- ◆ Typical materials tested include austenitic stainless steels, austenitic irons and copper alloys such as aluminium bronze.



The addition of a Ferrite meter will enable the company's technicians to check, on-site or in-house the **Ferrite Content** of corrosion and acid resistant steels used in aggressive environments.

- ◆ Applications are numerous and include austenitic stainless steel welds, clad materials and base duplex steel.
- ◆ Data is stored on the instrument giving the operator instant results as to the levels of delta ferrite.
- ◆ Other ferritic phases and transformed martensite are also recognised.





Metallurgical & Technical Laboratory Services

Contacts:

Matthew Mellor—ext 306. mmellor@keighleylabs.co.uk

John Whitaker—ext 501. jwhitaker@keighleylabs.co.uk

Chemical Laboratory—ext 114. chemlab@keighleylabs.co.uk

Jeremy Duignan—ext 110. jez@keighleylabs.co.uk (commercial)

Peter Hanson—ext 118. petehanson@keighleylabs.co.uk (aerospace)

Chemical Analysis

Full Chemical Analysis of a wide range of metallic materials:

- ◆ Cast and Ductile Irons
- ◆ Carbon and Alloy Steels
- ◆ Stainless and Duplex Steels
- ◆ Tool Steels
- ◆ Nickel and Cobalt Alloys
- ◆ Zinc Alloys
- ◆ Aluminium and Aluminium Alloys
- ◆ Copper and Copper Alloys
- ◆ White Metals

Analytical techniques include:

- ◆ Full Traditional wet laboratory facility—gravimetric, volumetric, photometric analysis etc
- ◆ Atomic absorption
- ◆ Inductively coupled plasma spectroscopy
- ◆ Spectrographic Analysis—Glow Discharge, Optical Emission Spectrometer (OES)
- ◆ Combustion analytical methods for carbon, sulphur, nitrogen and oxygen



Weld Testing

- ◆ Welder Qualification and Approvals, including invigilation at your site.
- ◆ Procedure Consultancy and Approval.
- ◆ UKAS accredited testing and certification to many standards and specifications, including:
 - ◆ Commercial standards such as BS EN and ASME.
 - ◆ Aerospace standards such as Civil Aviation Authority (CAA), BAe Systems (BAe), Rolls Royce (RR) and Westland Helicopters.
 - ◆ Keighley Laboratories now have CAA signatories available for on site aerospace weld component invigilation.
 - ◆ **Typical Specifications include:**
 - CAA Chapter A8-10
 - Airbus ABP2-4099
 - Rolls Royce RPS912
 - AVP 84 D505
 - BS EN ISO 15614, BS EN 287
 - ASME 1X
 - BS 4872 and many others





Accreditations and Approvals

Core approvals held by
Keighley Laboratories Ltd are:

April 2013



0034
Laboratory Services



Materials Testing

Certificate No: 8488151465



FM 00891
Heat treatment

Metallurgical Laboratory
Services

UKAS (UK Accreditation Service)
ISO/IEC 17025:2005



Heat Treatments
BSI Quality Assurance
BS EN ISO 9001
BS EN 9100; AS 9100 rev C (AS9104)

Work is also carried out to meet requirements of insurance
and inspectorate bodies, industry primes and other leading
companies within the many industrial areas serviced

Further details of accreditations can be supplied
upon request



Not all metallurgical laboratory tests listed are covered by our UKAS accreditation
For a full schedule please refer to our website at: www.keighleylabs.co.uk

Keighley Laboratories Ltd are members of the following trade organisations:



Recognised aerospace specific accreditations include:



Keighley Laboratories Ltd



*Providing industry with innovative,
leading-edge technological services
to achieve cost-effective solutions
within the fields of heat treatment
and metallurgy.*

Invest In Your Future

Address Details:

Keighley Laboratories Ltd

Croft House . South Street . Keighley . West Yorkshire . BD21 1EG . England

Tel: +44 (0) 1535 664211

Fax: +44 (0) 1535 680604

Email: info@keighleylabs.co.uk

Web: www.keighleylabs.co.uk