

WMT&R[®]

WESTMORELAND MECHANICAL TESTING & RESEARCH, INC.



*Corporate Officers
Michael, Donald and James Rossi*

INTERNATIONAL



INTRODUCTION



Specialists in Aerospace, Automotive, Nuclear and Medical Material Testing Fields.

FOCUS
INNOVATION
ACTION
RESULTS

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Welcome to WMT&R

Westmoreland Mechanical Testing & Research, Inc. is recognized as a world leader in testing materials for the **Aerospace, Automotive, Nuclear and Medical** industries. The company has a reputation for high volume, quick turnaround testing with fully integrated, state-of-the-art facilities.

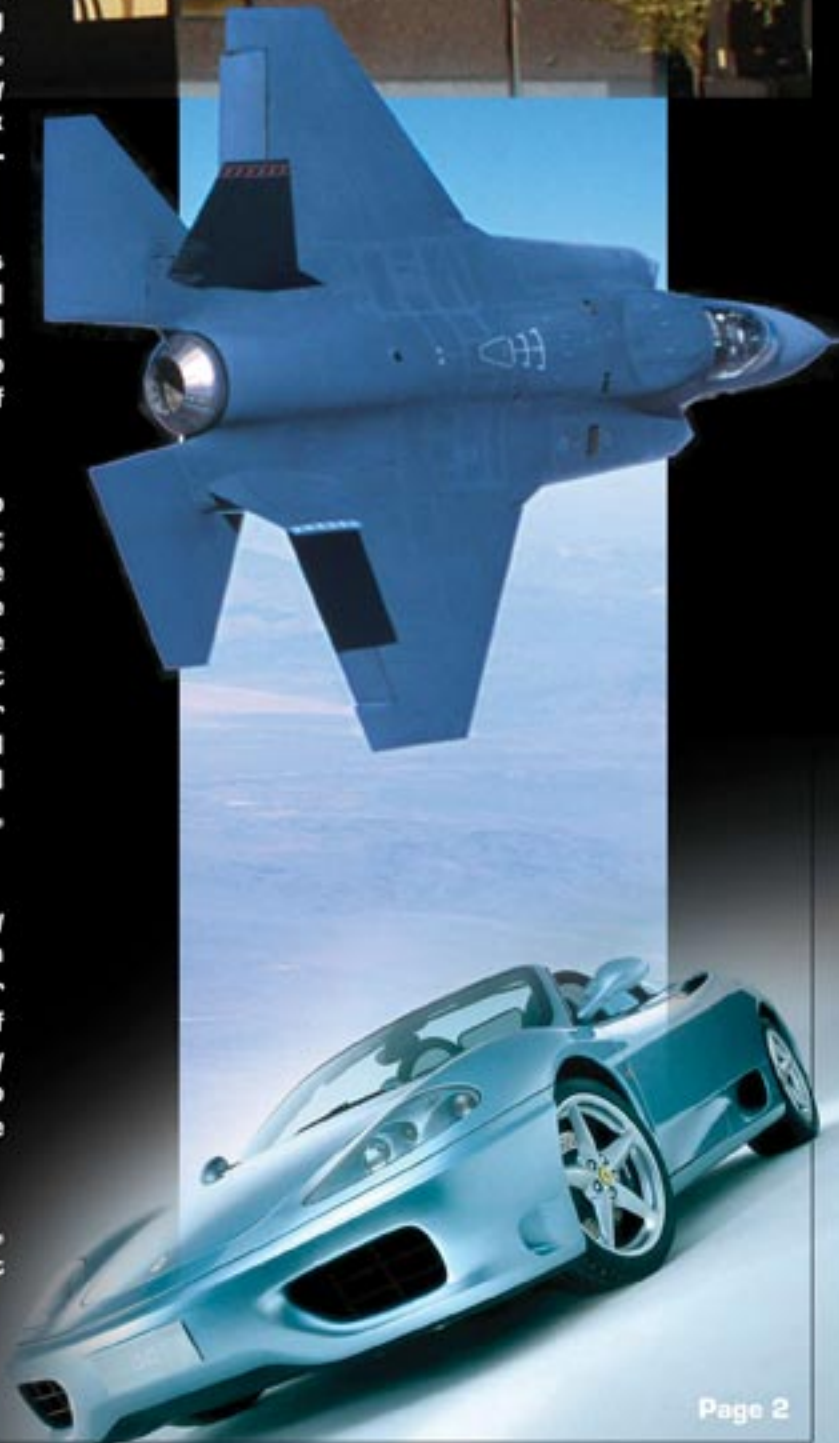
WMT&R's never ending commitment to it's customers is strongly supported by a dedicated and enthusiastic staff. Our highly qualified technicians and engineers are professionals who have the breadth of knowledge and depth of experience to get the job done right for you.

The laboratories of **WMT&R** are organized into seven advanced groups: **Mechanical Testing; Stress Rupture and Creep Testing; Fracture Mechanics; Physical Metallurgy Group; Fatigue Testing; Chemical/Analytical Group; and the Machine Shop.** In addition to standard testing at temperatures ranging from **Liquid Helium** to over **2200°F**, **WMT&R** has the proven ability and resources to custom design tests for special applications such as finished parts, odd shapes, and exotic materials.

Quick turnaround, reliable results, and a quality system that is second to none will be a substantial competitive advantage for your company. Dedicated to a philosophy of continuous improvement, **WMT&R** is constantly seeking out new technologies and methods to make our service to you better, quicker, and more cost-effective.

Westmoreland Mechanical Testing & Research, Inc. was established in **1967**, and is located about **35 miles east of Pittsburgh, Pa.**

COME SEE US - YOU'RE ALWAYS WELCOME!!



FRACTURE TOUGHNESS

WMT&R's Fracture Toughness Department has established a world-renowned reputation for dependable Fracture Toughness testing. Our new state-of-the-art Fracture Lab is designed for the high volume quick turnaround projects demanded by the aerospace, power generation, nuclear, and automotive industries.

Fracture Toughness tests are generally performed on specimens containing a flaw and this is accomplished during an operation called precracking. Precracking can be performed on any of WMT&R's 110+ servo machines, which cover a range of load capacities up to a 1,000,000-lb. fatigue load. The actual crack, which initiates at the top of a machined notch, is generally measured using various automatic techniques including EPD and Compliance.


Tests are performed at temperatures ranging from Liquid Helium to over 2000°F under various controlled conditions or atmospheres including salt water, argon, vacuum, and high humidity.

WMT&R's Fracture Toughness Department primarily performs the KIC test per ASTM E-399 which includes disc shape, arc tension, arc bend, single-edge bend, and compact tension. Regarding compact tension testing, we are equipped to perform tests on sizes ranging from .25" thick up to 4.25" thick for most applications. We have also machined and tested a steel compact tension specimen that was 8" thick (1000 lbs.).

Additional fracture mechanics based services include JIC, KIE- Surface Crack Tension, KR, R-Curve, KIV- Short Rod and Short Bar, K-EE - Equivalent Energy, CTOD - Crack Tip Opening Displacement; KISCC and K-Salt Stress Corrosion.

WMT&R conducts KR, R-Curve testing to ASTM E-561 on both compact specimens C(T) and center-cracked tension panels M(T). We have the unique ability to test large M(T) panels, including panels 30 inches wide. We are experienced and capable in testing M(T) panels at cryogenic temperatures. The KR, R-Curve test provides valuable data about the toughness development as a crack is stably propagated under an increasing applied stress intensity factor K. R-Curves and applied K curves are used to predict the critical stress intensity that will cause the onset of unstable fracturing.

$$J = J_{el} + J_{pl} = \frac{K^2(1-\nu)}{E}$$



Another type of Fracture Toughness specimen with which we have extensive machining and testing experience is the Chevron Notch Short Rod/Short Bar. WMT&R has the machining and testing expertise to handle a wide range of specimen sizes ranging from 0.25 inches to over 2.0 inches in the B dimension. The fracture toughness determined by this test shows the resistance of a material to fracture from a gradually advancing steady state crack, utilizing a severe tensile constraint, in a neutral environment. A KIV, KIVJ or KIVM value may be assigned to estimate the correlation of failure stress and defect size.

Surface-Crack Tension (SCT) testing is conducted to ASTM E-740 and is relied upon to estimate the load-carrying capacity of sheet or plate components with a flaw that could possibly occur during actual use. Our fracture toughness department routinely conducts this test to cryogenic temperatures down to -423°F . Research uses for this test include studying failure characteristics of cracks under simulated service conditions.

In addition to fracture mechanics based testing this department also specializes in conducting various other types of tests including peel tests, flexure, shear (single, double, slotted or lab) and rising load testing to name a few.

Reports are automatically generated using our innovative database system, which can be transferred directly and securely to your database via an Electronic Data Interface system (EDI).

*Unparalleled Capacity, Experience, and Knowledge in
High-End Test Development*

FATIGUE TESTING

WMT&R is an acknowledged leader in the field of Fatigue Testing. No one can compare with our versatility. Our substantial on-site capabilities allow us to customize each project. We design and write our own proprietary software to control and analyze your test results. To ensure the best turnaround time on your projects we design and machine our own specialized grips and fixtures. For unique testing needs we have the people, resources, experience, and testing capacity to get the job done right for you.


We are specialists in conducting axial tests on many different types of specimens. These tests are conducted in load, strain, or position control on servo-hydraulic test equipment at temperatures ranging from Liquid Helium to over 2000°F. We have the flexibility and resources to accommodate a wide range of sample sizes with our machine capacity ranging from 25 Grams to 1,000,000 lbs.

For example, WMT&R is an industry leader in Low Cycle Fatigue (LCF) Testing. This test is normally run in strain control with the load being a dependent variable. The strain variables that are usually defined by the Customer are wave type, frequency (and hold time for a trapezoidal wave), mean strain, strain amplitude, and discontinue cycles. There are three stages to low cycle fatigue testing. The first stage is designed to detect crack initiation on a polished specimen. The second stage is propagation life, which occurs after initiation. The third stage is failure, which is usually determined by some percentage of load drop from a stable condition. Data reported on this test includes load peaks, strain peaks, hysteresis loops at specific intervals, calculated plastic and elastic strain, first cycle information, and half-life cycle loop information.

In addition to axial tests, we also test materials in bending and rotating modes. Bending fatigues could involve three or four-point flexural tests or cantilever fatigue tests. Rotating beam fatigues are commonly done and are available at room or elevated temperatures.

Machining samples from exotic or difficult material is no problem for our in-house machine shop.





Need testing on full-size components or assemblies? We've designed and executed tests on railroad locomotive suspension springs, automotive components, aircraft supports, helicopter rotor blades, coal mining equipment, and artificial hip stems to name a few.

Artificial hip stems are tested for a variety of discerning manufacturers. WMT&R has extensive experience in conducting two of the most common types of artificial hip fatigue testing - the three point bend and the distally potted hip method per ISO specifications 7206-3 and 7206-4 or the ASTM F1440-92 specification. In our fatigue lab, it is possible to simulate 5 years of normal use in only six days! This data is used to improve the quality of the implants, which improves the quality of life for the recipients.

Another area that directly relates to people's lives is Fastener testing, because the failure of a fastener can have catastrophic consequences. Every minute of every day all of us rely on fasteners in our cars, homes, and places of work. Our Fatigue Department is involved with a diverse array of fastener tests such as fatigue, tensile, wedge tensile, double shear, stress rupture, stress durability, microstructure and chemical analysis. WMT&R is an approved Laboratory under the Fastener Quality Act (FQA).

To achieve the best in performance, all of our tests may be run under computer data acquisition. This allows us to obtain data on how a material changes in response to fatigue loading. This data is available to you typically in a tabular data summary and as graphical representations. Additionally, raw data can be provided on floppy disks, CDs, or securely transferred across the Internet from our FTP site. Due to the nature of fatigue testing, it is positively necessary to keep you informed as to the status of your testing. We work closely with our customers using voice, fax, and electronic communication to ensure they are kept current and in the loop.

fastener testing

Think of our state-of-the-art equipment substantial resources, and decades of fatigue testing as a competitive advantage for your company.

380

A380

METALLOGRAPHIC

WMT&R's Metallographic Labs are designed to meet all common and specialized needs from lot release and material-overcheck testing to failure analysis and problem solving on test specimens, finished parts, and fasteners.

A major investment in Metallographic facilities has allowed us to incorporate all metallographic and analytical related activities into one state-of-the-art building. These specialized areas are the Metallographic Section, Analytical Department, Heat Treating Section, and the Stress Corrosion Testing Laboratory.

Our experienced technicians and metallurgists work closely with the analytical and physical testing groups to provide an overall view of material characteristics so that even the most difficult problems can be identified and solved quickly.

Conventional specimen preparation and automated polishing procedures using 1.25" to 2" diameter compression mounts ensure superior edge retention and flatness of specimens. Other methods include cold mounting and slot polishing.

- ✓ General Microstructure
- ✓ Microcleanliness
- ✓ Macro/Grain Flow
- ✓ Carbide Distribution
- ✓ IGA/IGO
- ✓ Decarburization
- ✓ Alloy Depletion
- ✓ Grain Size
- ✓ Porosity/DAS
- ✓ Alpha Case
- ✓ Diffusion Layers
- ✓ Plus many other examinations.

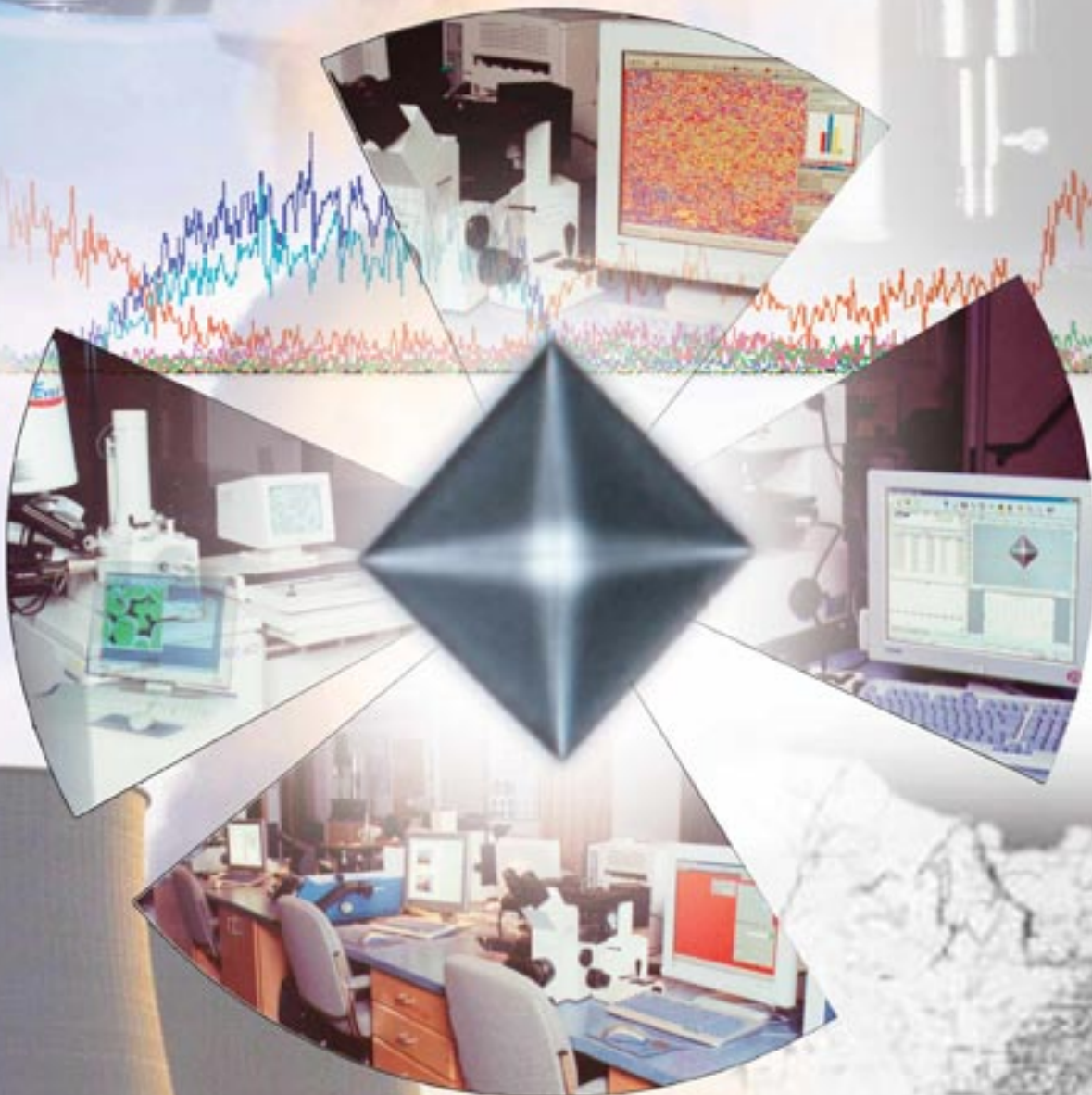
Our computerized image analysis system is used for fast and accurate statistical evaluation, as well as viewing of specimens with multiple observers at the same time. Digital photo pages are available in PDF, Standard Tiff, jpeg, and Bitmap single image formats for emailing.



Our Hardness Test facilities conduct Rockwell Hardness tests using the latest instrumentation for quick, accurate results on all scales covered in ASTM E-18. We specialize in referee testing.

Reliable Microhardness testing per ASTM E-92 and E-384 is available using the Knoop and Vickers scales with capabilities from 10-grams to 10-kilogram loads. Automatic stage and automatic read features offer quick turnaround with computerized data transfer capabilities.

Brinell Hardness testing from 500Kg to 3000Kg loads is available.



Failure Analysis facilities contain a Scanning Electron Microscope capable of viewing up to 100,000X. EDS X-ray analysis is available (including a light element detector), on site, for identification of particles with dimensions of only a few microns!

Standard tests include X-ray mapping, line scans, semi-quantitative analysis, contamination checks, fractography, alloy identity, and general photography up to 50,000X. Data and photographs are available in digital format to ensure maximum flexibility in electronic storage.

CORROSION TESTING

WMT&R is an acknowledged leader in alternate immersion stress corrosion testing for the Aerospace, Automotive, and Materials industries. We have custom designed our own programmable frames to ensure proper time intervals between NaCl submersion and air environment exposure. In addition, we pride ourselves on our proven experience in designing and fabricating innovative fixturing and test setups for the most difficult of customer demands.

The ASTM B-117 Salt Spray test is used to determine normal corrosion resistance to ocean water type environments. In addition to having Salt Fog Cabinets for testing in accordance with ASTM B-117, WMT&R can also conduct Salt Fog testing with the time introduction of sulfur dioxide (ASTM G-85 and ASTM G-87). In conjunction with the SO₂ test, WMT&R has the resources to perform cyclic, variable salt for the more common to the most unique environmental testing. The ASTM B-368 (CASS Test) is widely used to evaluate aggravated conditions, such as road salt on automotive parts.

Corrosion testing can be done in accordance to ASTM A262 Practice E, G-34, G-38, G-44, G-47, G-49, G-60, G-66, and G-48 Practice A.

By utilizing state-of-the-art Humidity Chamber technology, additional testing can be done in either a static or programmable humidity/temperature environment, WMT&R has the flexibility and experience to test a large number of specimen types including, but not limited to SCC and Electronic Devices.

Testing Includes:

- ✓ Exfoliation
- ✓ C-Ring
- ✓ Round and Flat Tensiles
- ✓ Bent Beam
- ✓ Alternate Immersion
- ✓ SCC Testing of High Strength Aluminum Alloys
- ✓ Direct Tension
- ✓ Asset
- ✓ U-Bend
- ✓ Constant Load Capabilities
- ✓ KISCC



ANALYTICAL

The Analytical Section of WMT&R works closely with our physical and metallographic laboratories as a problem-solving tool in case of material failures. In addition, you can rely on our Analytical Section for material-overcheck tests, referee tests, and product verification tests as an independent source.

Utilizing spectrometer technology in conjunction with ICP and Graphite Furnace AA, ensures quick turnaround by eliminating the need for lengthy wet chemical tests.

Our Analytical Lab also employs Optical Emission Spectrometry (OES or Arc Spark) for routine analysis of metals and their alloys. The OES has been designed specifically to meet the demands of quality assurance in the metal production and metal testing industries. OES technology is used for quick turnaround analysis of Iron, Aluminum, Cobalt, Titanium, and Nickel-Based alloys.

Carbon, Sulfur, Hydrogen, Oxygen, and Nitrogen analysis is performed using Leco instrumentation.



Typical Materials Analyzed Include:

- ✓ Iron
- ✓ Aluminum
- ✓ Cobalt
- ✓ Titanium
- ✓ Inconel Alloys
- ✓ Low and High Alloy Stainless Steels
- ✓ Bronze

RESEARCH & DEVELOPMENT

The Research & Development Department of WMT&R has an extensive range of testing capabilities. Experts in tests such as Spectrum Fatigue, Fatigue Crack Growth Rate (da/dN), Creep Crack Growth Rate (C^*), and Elastic-Plastic Fracture Toughness (JIC), our R&D staff is also responsible for unique design, testing, and analysis often required by customers.

We have the capability of testing fatigue specimens under variable amplitude load or spectrum loading. This type of loading is essential to the aircraft industry for such components as landing gear and stabilizer bars. Our people are experienced in running various custom spectrums provided by the customer. Data reported on this test includes number of segments to failure and a record of the peaks for the last spectrum.

The R&D department continues to design and maintain all of the cutting-edge automated testing systems that set WMT&R apart from the competition. Unquestionably resourceful, knowledgeable, and innovative, the R&D department is staffed by experienced professionals in engineering, computer programming, electronics, and mechanics. Our commitment to in-house automation systems allows customized programs for specialized testing as well as user friendly individually tailored data output. What does this mean for you? You won't be "stuck" with someone else's format. You can request your own format for faster, easier data analysis at your company.

Creating data acquisition and analysis programming is one more way we stay ahead of the crowd. New standards and test methods are constantly being developed. WMT&R is not dependent upon outside software vendors to supply new programs for new standards or upgrading software for updated standards. This saves you time, and saving time is a competitive advantage.

"Every great advance in science has issued from a new audacity of imagination." John Dewey 1929.



ation

Fatigue Crack Growth Rate (da/dN) Testing is designed to determine the rate of cracking under specified loading conditions once a flaw has been initiated in the specimen. The graph of Cyclic Stress is plotted against the Crack Growth Rate, with stress intensity being the controlling variable. The R&D department employs numerous crack measuring techniques including Electric Potential Drop (EPD), Compliance, Bonded Crack Gages, and Visual Measurements. The loading conditions typically are R-ratio, material yield strength, specimen geometry, waveform loading type, frequency, K-gradient, test temperature, and environment. We can handle numerous specimen geometries, as well as C(t) specimens with widths up to 5 inches, and Center Crack CC(t) panels up to 20 inches wide. Along with standard specimen configurations, other geometries can be tested as well, including Single Edge Notch Tensiles (SENT), Extended Compact Tension (ECT) specimens, including various surface flaw specimens like the Kb bar and Surface Crack Tension (SCT) specimens. We have also developed testing protocols for custom sample designs, components, and fasteners.

We have the capability to test using frequencies in excess of 100Hz, depending upon specimen size and test condition. In addition to testing specimens under constant loading conditions (sinusoidal, triangular, trapezoidal, and saw tooth), WMT&R can also test specimens under various loading conditions such as K Gradient, Constant K, Spectrum Loading, Block Loading, and Periodic Overloads.

da/dN and Delta K test results are reported in both tabular and graphical formats, including the measured values (EPD voltages, compliance, measured loads, R-ratio, cycles, delta cycles, and crack lengths) used to calculate the results. A crack length vs. cycles curve is also provided to you.

$$da/dN = C' (\Delta K^2 - \Delta K_0^2) \frac{(1 + \Delta K)}{(K_c - K_{max})}$$

ADVANCED MATERIAL TESTING

Another type of crack growth rate testing is the Creep Crack Growth Rate commonly known as C-Star (C^*) testing. The type of specimen used in this test is a compact tension, and the test results are used to plot the time rate of crack growth versus a crack tip parameter (C^*). Although tests can be run at any temperature, this type of testing is often performed at temperatures ranging from 1000°F to over 2000°F where creep is a major concern for many engineering materials. Many companies in the power generation and jet engine industries are interested in this type of test due to the extremely high temperatures associated with their operations.


The (C^*) test method uses both the load line opening displacement and the crack length to determine the amount of plasticity occurring at the crack tip. Measuring both of these parameters becomes difficult when using both Electric Potential Drop and a Clip Gage. However, we studied the problem and developed a unique process to isolate the EPD voltage from the clip gage. WMT&R has worked with a wide range of customers on developing our effective approach to the (C^*) test. Data reported on this test includes the maximum load, clip gage opening, crack length, time, C^* , K, and Jpl.

WMT&R is very active in the development of Elastic-Plastic Fracture Toughness testing. This test, conducted per ASTM E-1820, is exceptionally useful for material comparison, selection, and quality control applications. Values obtained using this test method are JIC, JC, KIC, and CTOD. An elastic-plastic stress intensity factor (KJIC) is calculated for each JIC value reported.

Our Research and Development team has extensive experience in testing of ferritic steels for the ductile-to-cleavage transition temperature. The test is conducted per ASTM E-1921. The results include a master curve, which can be used to define a transition temperature shift related to metallurgical damage mechanisms.

techno

EPD Testing



Of increasing interest and importance is short crack testing. WMT&R has been working with some of our customers to develop leading-edge technology which will allow measurement of crack length changes to one thousandth of an inch and less! We can also replicate these cracks and visually, at high magnification, verify our calibrations. This research is of critical importance in fields like Eddy-Current Calibrations and Microwave Crack detection.

Testing can be performed on any one of over 110 servo-hydraulic machines, 15+ electro-mechanical machines, or 180+ stress frames. The servo-hydraulic machines at WMT&R have a load capacity of up to 1 million pounds! Since not all test applications occur in ambient "lab-air" environments, we provide you with non-ambient options including high humidity air, vacuum, and inert gas. Testing in fluids such as Jet Fuel, Hot Oil, and Salt water is not uncommon. We can also achieve stable test temperatures from below liquid Helium to over 2200° F.

*Leading the Technological Revolution
in Materials Testing.*

J1C Testing

Acoustic Emissions Testing

MACHINE SHOP

Although the major emphasis at WMT&R has always been on material testing, the company had the foresight, over 30 years ago, to see the importance of a captive, in-house machine shop.

WMT&R's high-technology Machine Shop encompasses a clean, temperature environment and state-of-the-art equipment which includes: CNC lathes, CNC mills, wire EDM's, plunge EDM's, CNC cylindrical grinders, CNC surface grinder, and notching low-stress grinders. In addition, the shop utilizes pneumatic tubes and conveyor belts to facilitate movement of materials and test samples. Coolants are recycled to remove pollutants and metal particles. Machine and grinding chips are carefully separated, graded and converted into "hockey-puck" wafers for salvaging. The shop is air-conditioned to maintain a constant temperature year-round.

WMT&R machines all test specimens onsite, thereby eliminating the delay of outsourcing. Our reputation for quality machining and superior turnaround times brings us production work from other laboratories and mills. With our advanced in-house capabilities and substantial engineering experience, we are known as specialists in low stress grinding and machining subsized specimens to very close tolerances.

In addition to machining standard specimens, WMT&R has the proven ability and resources, on site, to custom design and machine fixturing for testing finished parts, odd shapes, and difficult/exotic materials. We are constantly seeking out new machining technologies and methods to make our service to you better, quicker, and more cost effective. It is for your advantage that we have this full range of complete capabilities fully integrated into one company, on one site.

With a state-of-the-art in-house machine shop, augmented by other supportive departments, WMT&R offers a definite competitive advantage to our customers. In addition our fully integrated laboratories enable WMT&R to continue providing the same quality and service that is a hallmark of our material testing. **ON TIME DELIVERY** is our commitment to all customers.

- ✓ Standard Specimen Machining
- ✓ Low Stress Grinding
- ✓ Longitudinal and Radial Polishing
- ✓ CNC Mills
- ✓ CNC Lathes
- ✓ Saws with Capacity up to 45" wide
- ✓ CNC Surface and Cylindrical Grinding
- ✓ Wire and Plunge EDM's
- ✓ Various Manual Mills and Lathes
- ✓ Specialists in Machining Difficult Materials

HEAT TREATMENT

WMT&R has capabilities to heat treat material to various conditions onsite. Our facilities can handle a wide variety of thermo-mechanical processing. For ferrous alloys, our radiant furnaces and environmental chambers can accomplish normalizing, hardening, and tempering up to +2700°F and cryogenic treatments down to -320°F. For non-ferrous alloys, our forced convection furnaces can accomplish solutioning, annealing, and artificial aging up to +1200°F.

Furnaces are surveyed in accordance with AMS 2750. Our Production Furnaces are surveyed using the nine standard thermocouple locations. Readings from those nine thermocouple locations are maintained for every heat treat batch, enabling a continuous monitor of furnace performance. All furnaces are equipped with an over temperature sensor to ensure quality processing. Furnace controllers include parameters for regulating the heating and cooling rates and are capable of following temperature time programs composed of sixteen to twenty discrete points.

To safeguard against material being exposed to products of combustion, all heat treating furnaces at WMT&R are heated by electrical elements. Confidence of electronic data acquisition is accomplished by linking all furnaces using computer software developed by WMT&R. Data can be captured either in a tabular format or in a temperature vs. time plot reporting the soak time, average temperature, and standard deviation of each of any 120 thermocouples available for temperature monitoring. The heat treat department has the capacity and flexibility to model production processing on a smaller scale to assist with processing decisions by providing data on experimental batches. Additionally, the heat treat department has conducted production-scale processing of finished parts including aluminum castings and extrusions. Our staff has treated many alloys, including 4340 Steel, Stainless Steels, A2 Tool Steel, Inconel 718, Aluminum 7050, and Aluminum Lithium 2195. We are eminently experienced in conducting processes in accordance with specifications from ASTM, AMS, ASME, GE, military and government departments.

- ✓ Customized forced convection bottom-drop furnace with a maximum temperature of 1200°F and the ability to quench 1200 lbs. of material into either of its two quench tanks in under ten seconds!
- ✓ 20+ lab and 4 production heat treating furnaces ensure your job won't have to wait for open capacity.

MECHANICAL TESTING



Tension and Compression tests are conducted on an impressive range of machines with capacities from 10 grams to 1,000,000 lbs. Testing is conducted in various atmospheres (Argon, Vacuum, Corrosive Mediums) at cryogenic, ambient, and elevated temperatures (Liquid Helium to + 2200°F).

Our proprietary testing software provides us with the capability to run standard tests plus full stress / full strain tests at various strain rates, crosshead speeds, load ranges, and strain ranges as your requirements demand.

In addition to standard size specimens, we have developed the expertise in preparing and testing round micro-size specimens (less than 0.500" in length) and also very thin gage sheet specimens (0.005" thick).


Superior technology, responsive versatility, and quality performance ensures reliable and fast turnaround on all your test results.

Impact testing consists of Charpy and IZOD Specimen configurations. The Charpy tests are conducted on instrumented machines capable of measuring less than 1 ft. lb. to 300 ft. lbs. at temperatures ranging from -320°F to over 2000°F. Specimen types include notch configurations such as V-Notch, U-Notch, Key-Hole Notch, as well as Unnotched and ISO (DIN) V-Notch, with capabilities of testing subsize specimens down to 1/4 size. IZOD testing can be done up to 240 ft. lbs. on standard single notch and type-X3 specimens.

WMT&R also has the resources to conduct instrumented Impact testing. This test provides data which measures the energy required to initiate a crack, propagate a crack, and the maximum load of the test represented as Fracture Toughness at K_{IC}.

Drop Weight testing is performed to ASTM E208. This test is conducted to determine the nil ductility transition temperature (NDT) of materials. Tests can also be conducted to your temperature requirements from elevated temperature down to -320°F.

Dynamic Tear Testing has a wide range of Research and Development applications. Used to study the effects of metallurgical variables like heat treatment, composition, and processing methods on the dynamic tear fracture resistance of material. Manufacturing processes, such as welding, can be effectively evaluated for their effect on dynamic tear fracture resistance. Additional uses for this test include evaluating the appropriateness of selecting a material for an application where a baseline correlation between Dynamic Tear energy and actual performance has been developed.



Stress and Creep Rupture tests are conducted at temperatures up to 2200°F to either ASTM E139 or ASTM E292. Temperature and creep readings are continuously monitored and recorded digitally to ensure utmost accuracy. The creep test program is capable of recording Julian time and strain readings up to 60 times per hour. This data is utilized to maintain temperature tolerances during the test, and to create a unique temperature history report. The reduced section of a creep test specimen can also be strain-gaged as a means of measuring the amount of strain during testing.

Stress and Creep Rupture tests also can be conducted in environments under vacuum, corrosive, or inert atmospheres. Maximum temperature for these tests exceeds 1700°F and are usually performed on materials that exhibit excessive corrosion at elevated temperatures in an air environment.

Cyclic Rupture testing is designed to load and unload a test specimen at certain time intervals. The test temperatures range from room to +2200°F. Prior to starting a test, four strain gages are attached to a test specimen to ensure that bending strains are within specified requirements.

The Static Notch test is performed at room temperature under a constant load for a minimum of five hours to determine if the material is notch sensitive at room temperature. The Embrittlement Relief test is also performed at room temperature, but for 200 hours under a load of some percentage of either the yield strength or ultimate tensile strength. Typically, this test is conducted in accordance with ASTM F519 at 75% of the yield strength to determine if the material is susceptible to hydrogen embrittlement.

The above tests are performed on round or flat specimens with gage lengths ranging from ½ inch to 2.0 inches. Anticipating the need to accommodate various specimen sizes, WMT&R has testing machines with ratios of 16:1 (6,000 lbs.) to 30:1 (30,000 lbs.).

Mechanical Testing Includes:

- ✓ Tensile Testing
- ✓ Compression Testing
- ✓ Charpy Impact Test
- ✓ IZOD Impact Test
- ✓ Drop Weight Testing
- ✓ Double Shear Test
- ✓ Bend Testing
- ✓ Stress Rupture
- ✓ Creep Rupture
- ✓ Cyclic Rupture
- ✓ Hydrogen Embrittlement Test
- ✓ Static Notch Testing
- ✓ Dynamic Tear Testing

QUALITY ASSURANCE

0.0045

WMT&R has established a rigorous Quality Assurance Program for the conduct of work under its jurisdiction. Our quality system (accredited by NADCAP and A2LA for Mechanical and Chemical testing) assures that all test specimens are properly handled, machined, tested, examined, and inspected in accordance with your requirements. The mission of the Quality Assurance Department is to maintain our established standards of quality, and for the development and application of the systems and procedures necessary to meet or exceed the quality requirements of our customers.

0.0015

The Quality Assurance Department conducts frequent and vigorous internal audits to ensure the highest possible level of quality in support of the services we provide to you.

0.001

0.0005




WMT&R's Inspection Department inspects and measures all specimens prior to releasing them to the labs. Aside from standard measuring devices such as Micrometers, Calipers, Digital Indicators and an Optical Comparator, the Inspection Department utilizes advanced metrology devices, including Laser Gage and a non-contact Optical Measuring Machine, to ensure the most accurate, repeatable measurements of specimens.

Our Inspection Department is staffed by three shifts to ensure the flow of specimens to testing is not delayed unnecessarily. Measurement data is also channeled back to production management for Statistical Process Control purposes, thereby ensuring the highest quality of specimen preparation.

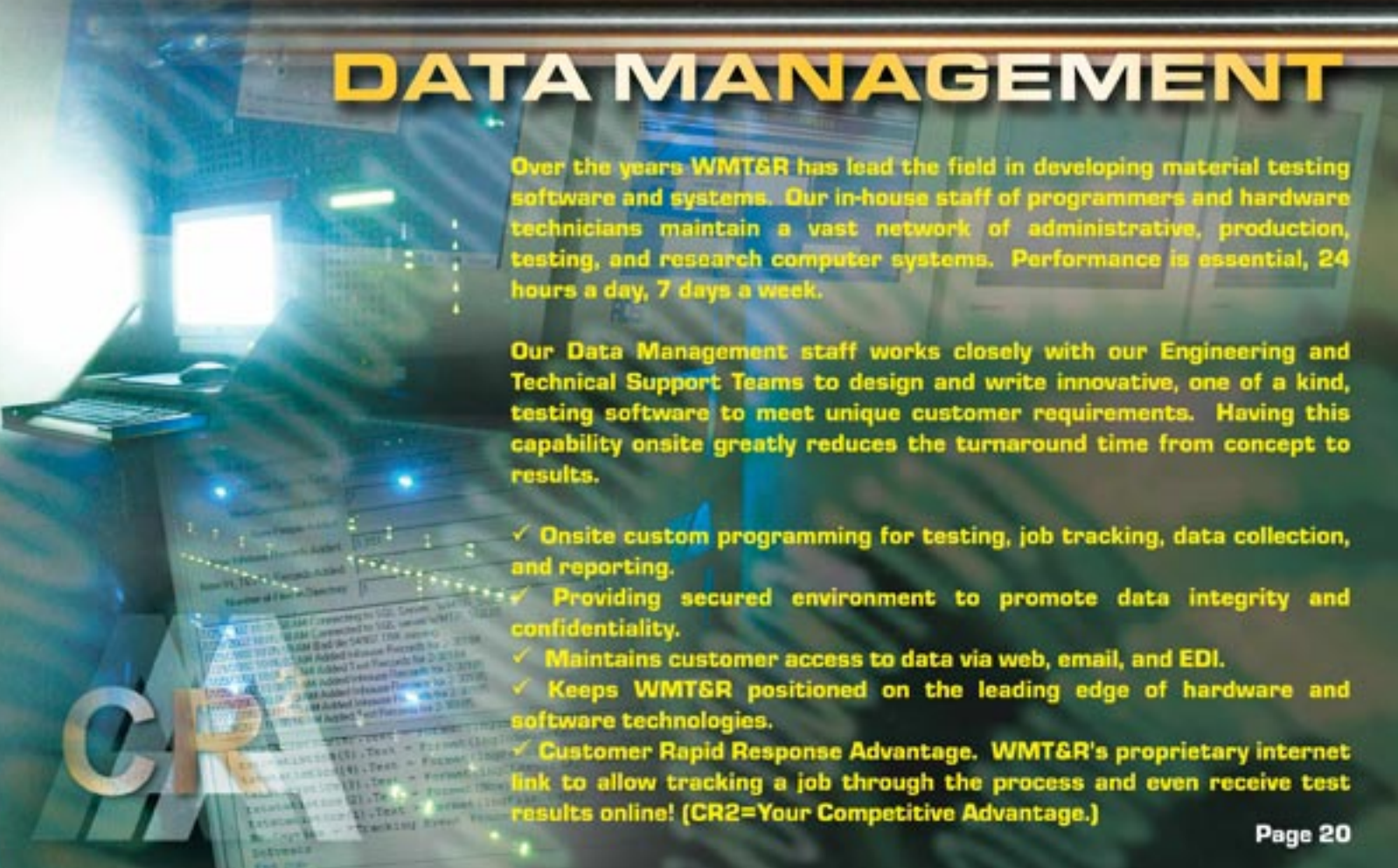
WMT&R's Data Management Inspection Matrix and Specimen Bar Code Identity System captures measurement results at the point of inspection (in most cases digitally direct from the measurement device) and transfers that data to the appropriate testing program electronically. This fully integrated information safeguard was developed, in-house, to effectively control the quality of data delivered to the testing laboratories.

MECHANICAL ENGINEERING



The Mechanical Engineering Group at WMT&R are specialists in the product evaluation of actual and proto-type components and sub-assemblies. From custom design and fabrication of fixturing to conducting the test, our mechanical engineering staff has the experience and resources to assist the various testing departments in getting data to the customer in an efficient and timely manner. To ensure there are no delays in custom design work, a specialty machine shop is assigned to the M.E. Group. The specialty machine shop is responsible for making new fixtures, modifying current fixtures, and manufacturing special fixturing for proto-type testing. Trailer under-carriages, bicycle parts, chains used in the mining industry, and railroad car components are just a few of the testing challenges the Mechanical Engineering Group has tackled in the past. The innovativeness of these engineers, along with the ever-evolving needs of our customers, means there is no end in sight for what this group can do.

DATA MANAGEMENT



Over the years WMT&R has lead the field in developing material testing software and systems. Our in-house staff of programmers and hardware technicians maintain a vast network of administrative, production, testing, and research computer systems. Performance is essential, 24 hours a day, 7 days a week.

Our Data Management staff works closely with our Engineering and Technical Support Teams to design and write innovative, one of a kind, testing software to meet unique customer requirements. Having this capability onsite greatly reduces the turnaround time from concept to results.

- ✓ Onsite custom programming for testing, job tracking, data collection, and reporting.
- ✓ Providing secured environment to promote data integrity and confidentiality.
- ✓ Maintains customer access to data via web, email, and EDI.
- ✓ Keeps WMT&R positioned on the leading edge of hardware and software technologies.
- ✓ Customer Rapid Response Advantage. WMT&R's proprietary internet link to allow tracking a job through the process and even receive test results online! (CR2=Your Competitive Advantage.)

UNITED KINGDOM LAB

WMT&R, LTD.

WESTMORELAND MECHANICAL TESTING & RESEARCH LTD.

WMT&R established the UK subsidiary in Banbury, Oxfordshire in April 2003 as part of its expansion programme. Equipment is housed in a 16,000 sq. ft. building, with Tensile, Fatigue, Metallography, Adhesive Pre-treatment, Bonding, Corrosion, and Heat Treatment laboratories. An additional machining centre provides customers with material cut up and test specimen manufacturing.

The Banbury facility employs experienced professionals and can provide a range of mechanical testing services. Also offered are specialities in thin sheet fatigue, foil tensile, (tensile including 'r' 'n' and K value measurement) as well as pre-treatment and bonding test technologies. Other capabilities are Metallography and Corrosion testing. It is also envisaged that testing of composites and polymers will be a key activity. The tensile and fatigue laboratories are fully air-conditioned and serviced by state of the art equipment, primarily Instron, ranging in capabilities from loads of 1N to 250kN.

The prime central location in the UK is seen to be a positive advantage in serving 'local' automotive, motorsport, and aerospace sectors, as well as, the rest of Europe and indeed the world as the need arises.

The fundamental principles of high quality work ethic and fast turnaround of the parent company are observed and implemented as a matter of routine.

SPECIALIST & RESEARCH TESTING SERVICES

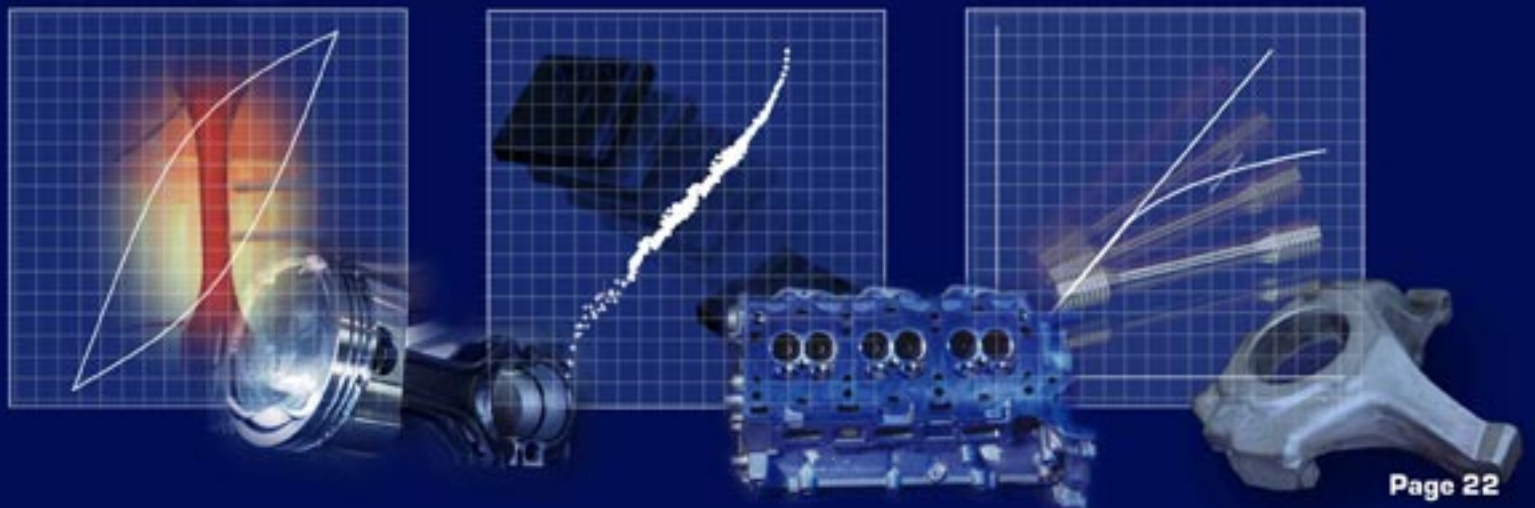
Specialist tensile and compression services include; Wire and Foil testing from 6 μm , Tension Testing including 'n' plastic strain ratio and 'n' strain hardening exponent measurements, Kahn Tear and Fracture Toughness measurements. WMT&R is also leading the field in Metal Sheet Testing and the testing of Machined Samples from other product forms including Composites.

Fatigue Testing capabilities also include the testing of Metal Sheet and samples machined from other product forms including composites. Other than standard High and Low Cycle fatigue testing WMT&R is also proficient in Joint Testing (welding, adhesively bonded and mechanically fastened) at both ambient and elevated temperature.

WMT&R, Ltd is a fully integrated laboratory offering onsite sample manufacturing and heat treatment capabilities. Also available is a fully functional analytical and metallographic laboratory with services including Accelerated Corrosion (ASTM B117-95), Stress Humidity Testing, and Immersion Testing (Exfoliation, Constant Load, Constant Strain & ASSET). Corrosion Testing also extends to testing for Filiform Corrosion.

A specialist area for the UK lab is Bonding Testing which includes Lap Shear evaluation of Bond Durability and Accelerated and Joint Degradation Testing. Also available is benchmarking of bond system variables e.g. pre-treatment, adhesive and curing cycle.

WMT&R, Ltd with the support of the US lab (WMT&R, Inc.) is able to offer a broad spectrum of material testing services that are carried out by the internationally recognized US laboratory.



OTHER TESTING INCLUDES:



Slow Strain Rate Testing



Product Evaluation



Panel da/dN, and R-Curve Testing



Pressure and Burst Testing



Pin Shear Testing



Full Section Testing

**Find out the latest on advanced material testing
and Request a Quote online at:**

WWW.WMTR.COM

CONTACTING WMT&R:

➤ Contact WMT&R[®] Inc. (World Headquarters)

Westmoreland Mechanical Testing & Research, Inc.

Mail To:
P.O. Box 388
Youngstown,
Pennsylvania 15696-0388 U.S.A.

Ship To:
221 Westmoreland Drive,
Youngstown,
Pennsylvania 15696-0388 U.S.A.

Tel: (+1) 724-537-3131
Fax: (+1) 724-537-3151

e-mail: admin@wmtr.com
Web Site: <http://www.wmtr.com>

➤ Contact WMT&R[®] Ltd. (UK Location)

Westmoreland Mechanical Testing & Research, Ltd.

Mail/Ship To:
Westmoreland Building
5 Beaumont Road,
Beaumont Road Industrial Estate,
Banbury,
Oxon. OX16 1RH
United Kingdom

Tel: +44 (0)1295 261211
Fax: +44 (0)1295 263096

e-mail: admin@wmtr.co.uk
Web Site: <http://www.wmtr.co.uk>