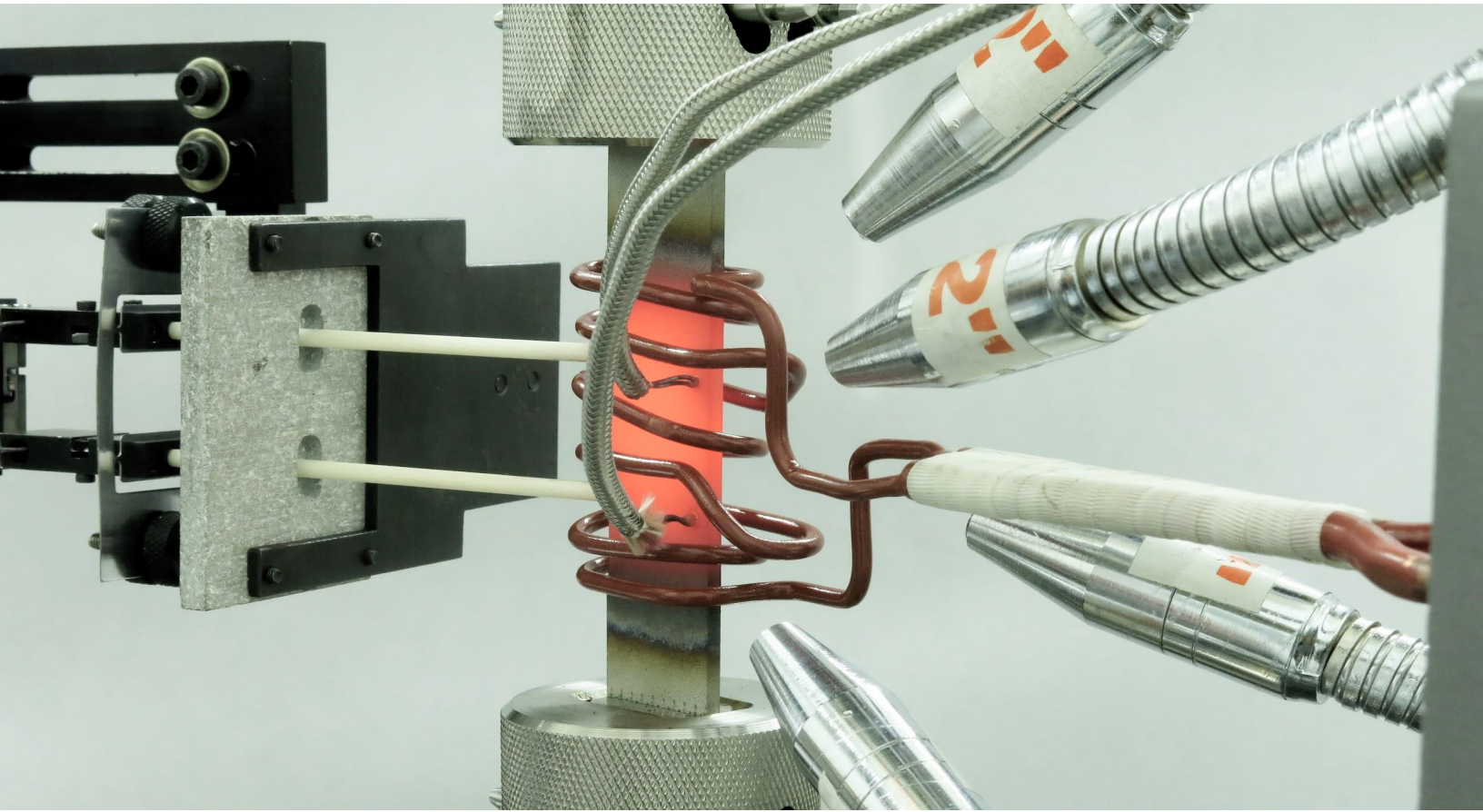


# Thermomechanical Fatigue (TMF) Test System



*Complete Solution for Fatigue Testing up to 1200 °C*

TestResources Thermomechanical Fatigue (TMF) test systems adds the sophistication of performing realistic thermal cycling with mechanical fatigue testing to simulate real-world service conditions of materials and engineered components. Thermomechanical fatigue tests characterize materials response to cyclic mechanical loading with fluctuating temperature, common to high-temperature alloy component materials used in jet engines and heat exchangers, using combined in-phase and out-of-phase mechanical and thermal cycling. TMF compatible test systems include special application software that can read temperature and total strain measured by an extensometer and calculate and control mechanical strain in real-time.

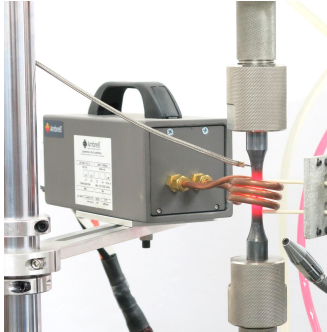
ASTM E2368 covers TMF properties of metals under uniaxially loaded strain-controlled conditions. Within ASTM E2368, a fatigue cycle is considered as a condition where uniform temperature and strain fields over the specimen gage section are simultaneously varied and independently controlled. ASTM E2368 TMF tests are performed in support of such activities as materials research and development, mechanical design, process and quality control, product performance, and failure analysis.

**TESTRESOURCES**



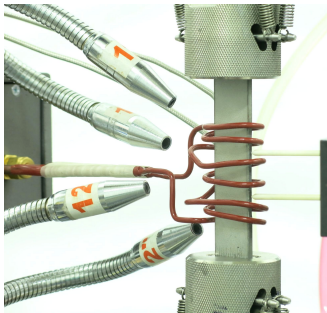
## TMF Test System

25 kN and 50 kN fatigue rated hydraulic frames are used. The frame is a modular design that has fully integrated hydraulic power, and electronics into the baseplate. The thermomechanical test system is quite, low maintenance and uses low energy.



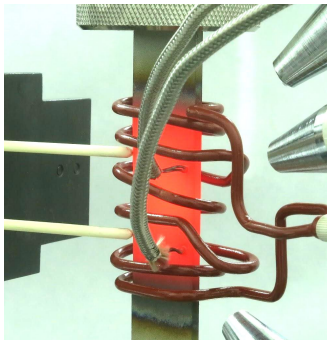
## Induction Heater

Ambrell ® induction heaters are integrated with TestResources servo controller for perfectly linear heating rates. Precision temperature control with a 24 bit servo output allows for highly accurate thermal strain mapping. Induction coils are custom built by Amrell ® for optimized sample temperature gradients.



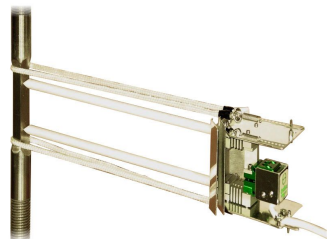
## Cooling Nozzles

Multi-directional air jets cool the specimen faster than could be done with ambient air cooling. Air is directed through a servo controlled pneumatic proportional valve for perfect linear cooling rates.



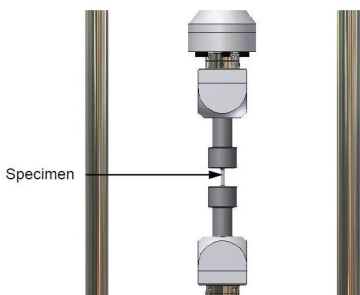
## Thermocouple Sensors

Top of the line calibrated thermocouples are spot welded onto the specimen for feedback to the induction heater and cooling nozzles. Systems include 3 thermocouple inputs, but TestResources controllers can be customized at low cost to add up to 16 inputs for thermocouples.



## High Temp Extensometer

Easy installation and accurate reloading. Temperature rating ambient to 1,200°C (2,200°F) allows for accurate, high temperature strain measurement. The extensometer will be sized to specimen and expected strain ranges.



## Low-Cycle Fatigue Grips

Self-aligning, zero backlash LCF grips with cooling ports. These grips can be fitted with heads for flat, threaded or button head specimens. Water is pumped through the grip bodies to cool them during induction heating.

# SPECIFICATIONS

|                                           |                                                        |
|-------------------------------------------|--------------------------------------------------------|
| Force Capacity                            | 25 kN - 50 kN (larger sizes available )                |
| Maximum Specimen Temperature              | 1,200°C (2,192°F)                                      |
| Typical Heating Rate*                     | 10°C/s (18°F/s)                                        |
| Typical Cooling Rate*                     | 10°C/s (18°F/s)                                        |
| Coil Geometry                             | Customized for specimen gauge length, and extensometer |
| Specimen Types                            | Round w/ threaded ends or button head ends             |
|                                           | Hollow w/ threaded ends or button head ends            |
|                                           | Flat                                                   |
| Standard Specimen Geometry                | Approximate Length: 125 mm (5 in) - 250 mm (10 in)     |
| Induction Heater Power                    | 10 kW (smaller sizes available)                        |
| Induction Heater Frequency Range          | 50 to 200 kHz at 10 kVA                                |
| Thermocouple Type                         | K                                                      |
| Number of Temperature Monitoring Channels | Up to 16                                               |

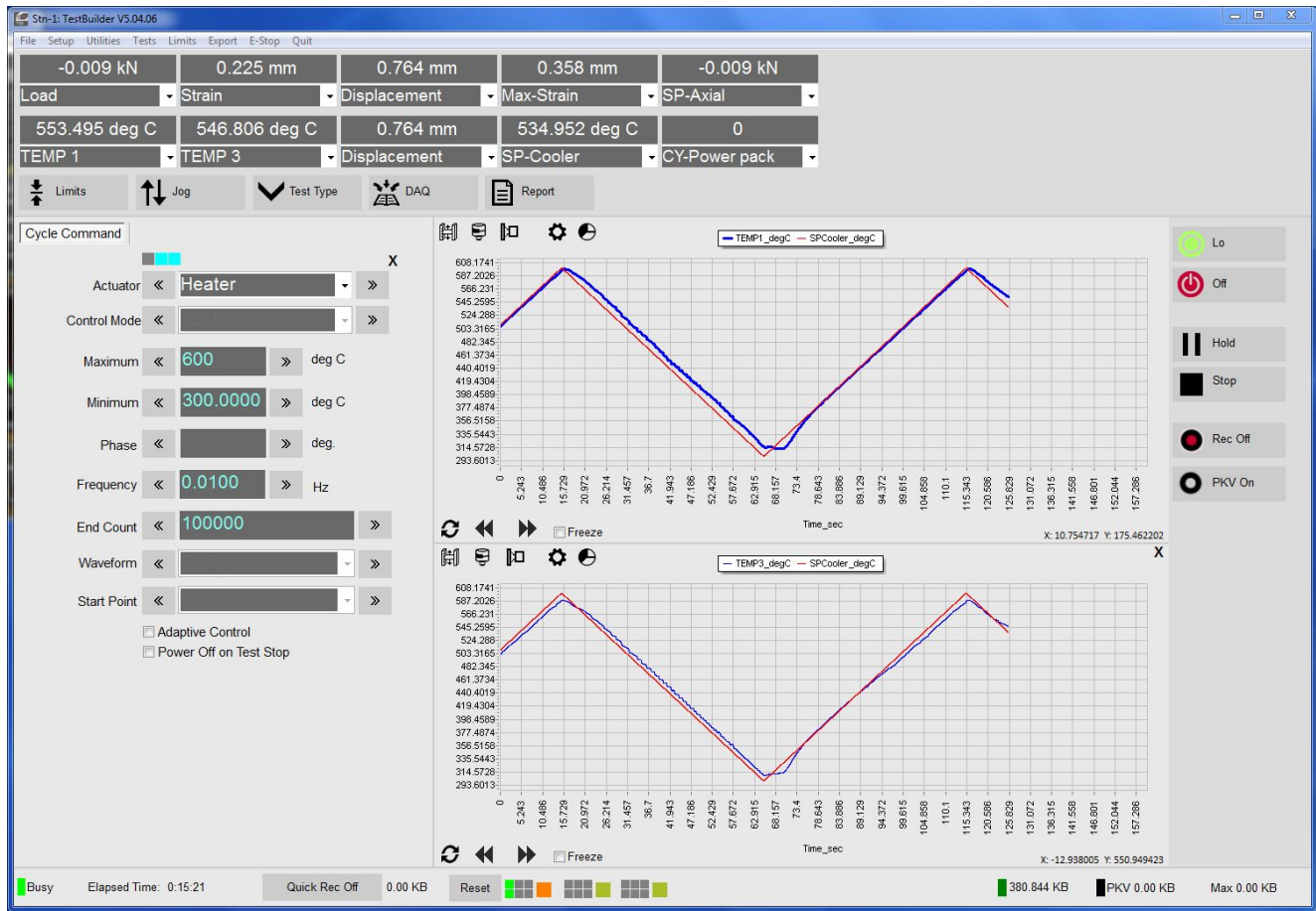
\*Dependent on specimen material, specimen geometry, and required temperature range.



# SOFTWARE

There are two TMF specific testing software versions available. The first is the standard fatigue testing software that allows for multi-channel independent control. The second is the TMF software specifically designed per ASTM E2386. TMF systems include software and will allow for data acquisition of all channels (load, strain, computed strain, temperature, position, etc.) that can be exported for reporting purposes.

## TestBuilder Preview

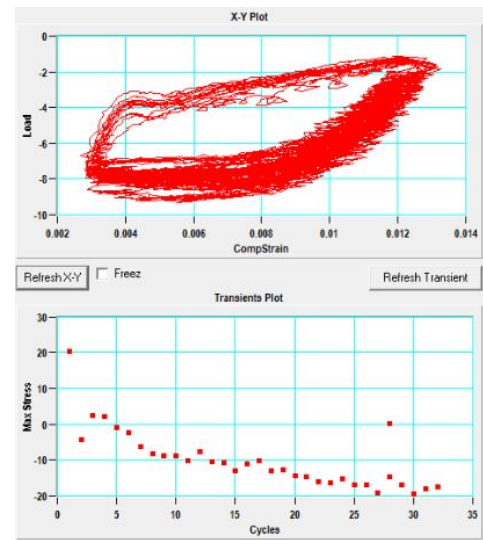


## Load vs. Computed Strain

The load vs computed strain is more accurate of what the turbine blade will experience because it is only fixed in 1 location, so there is not any additional loading from the thermal expansion. If the blade was fixed on both sides, the thermal expansion would produce a very large load on the blade. The same is true in the test system. Since the material is fixed on both sides, we need to remove the thermal loading from the analysis so we only put mechanical load on the specimen.

## Max Stress vs. Cycles

This measures cycles to failure. Designers will have a number of cycles the part needs to take in its lifetime, and critical stress. This allows designers to verify that the metal they are using for a critical part will have the strength and fatigue life needed for the application.



# SUPPORT

With over 20 years of providing support around the world we have it figured out. TestResources is recognized globally for delivering reliable, low maintenance and budget friendly solutions. It all starts with well-designed products, the right people and a machine with easy to replace components.

## **TestConnect. Better Support--Faster**

TestConnect, included as part of our Newton support toolset, delivers powerful communication capabilities that bring our most experienced support engineers even closer to your organization and operators. Secure online screen share connection technology enables us to provide you with fast and straightforward technical support when you need it.

TestConnect reduces wait times, shortens support times and saves you money.

## **Additional Services**

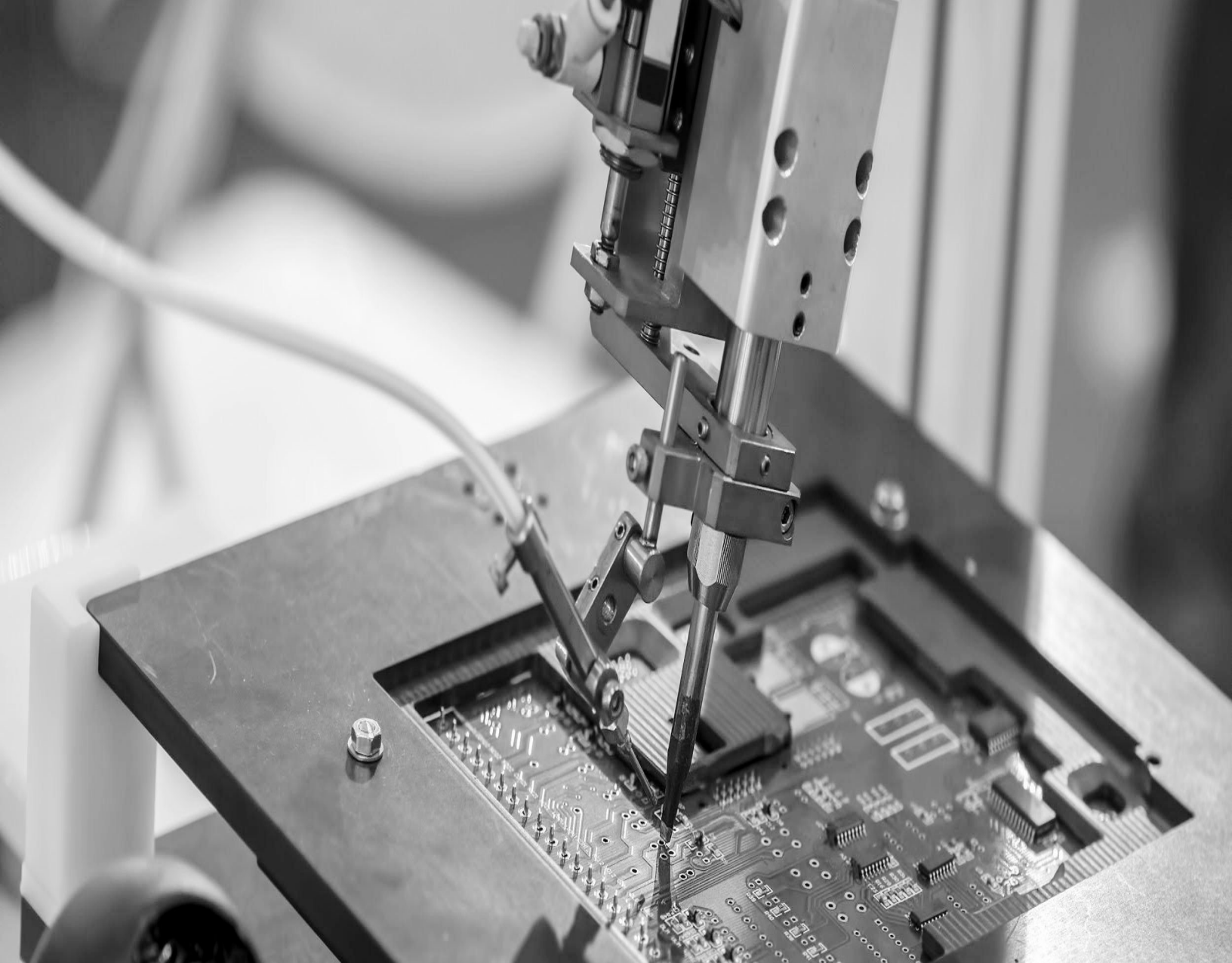
We offer on-site calibration, new operator training, refresher training, emergency repair and replacement parts which ensures that you can start testing faster and stay testing longer.

## **Facts about TestConnect**

**94%** of our customers have no service calls within the first 5 years of operation

**83%** of our support calls are resolved within 4 hours





# TestResources

Our team of experienced engineers help our customers find exact solutions based on their test requirements. Find out how we can help you ensure accurate and consistent test results!

## CONTACT US

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