

A close-up photograph of a metal test specimen held in a mechanical fixture. The specimen is a rectangular metal bar with two circular holes. The fixture is made of dark, polished metal. The background is a plain, light-colored wall.

***CURTISS -  
WRIGHT***  
**IMR TEST LABS**

# INTRODUCTION TO FATIGUE TESTING

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Discover the various ways that fatigue testing can ensure safety and reliability as well as determine the longevity of a part or product

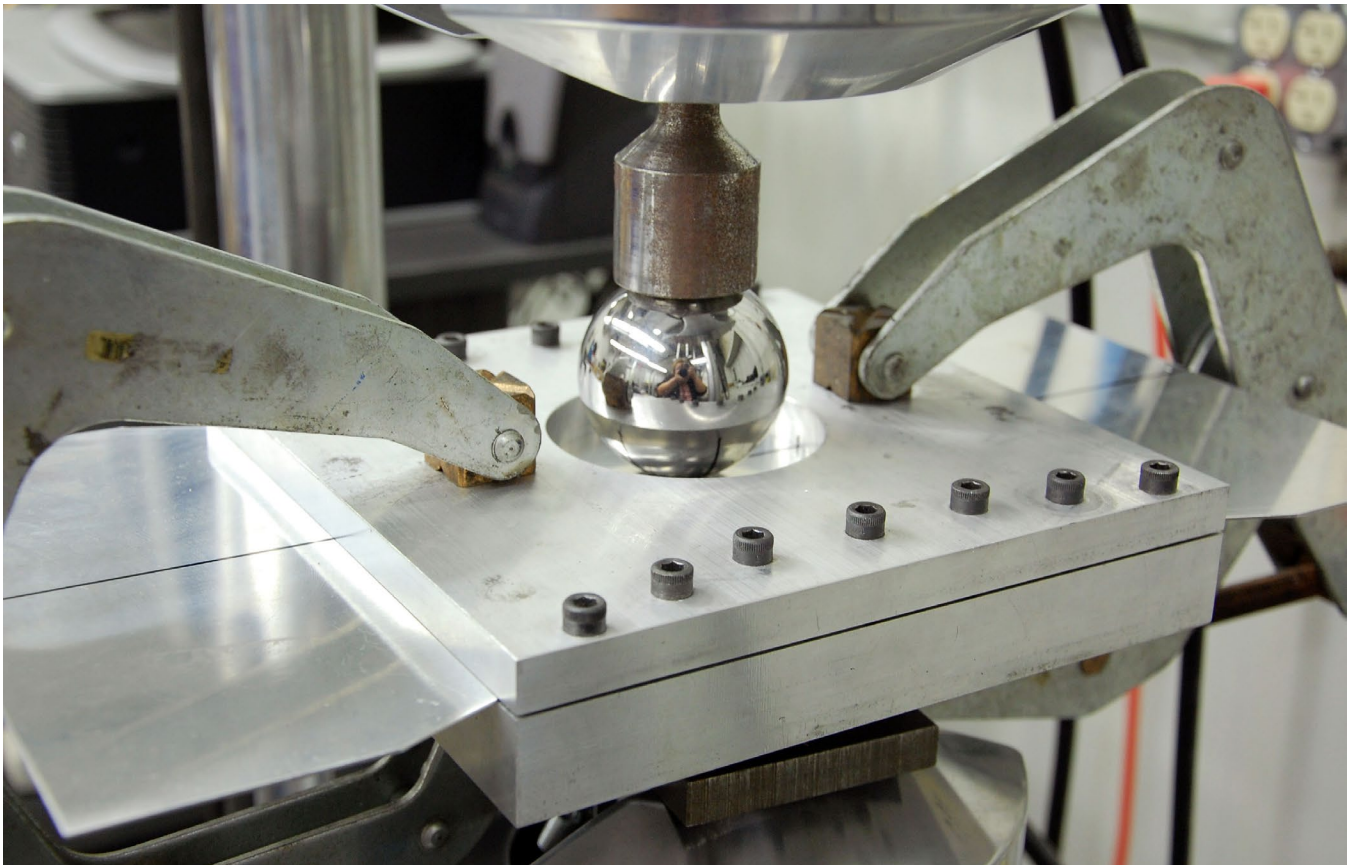
## WHAT IS FATIGUE TESTING?

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Fatigue is defined as the exposure of a component to repetitive cyclic stresses such as in tension, compression, and/or bending and is the predominant mode of failure in most mechanical systems. Fatigue testing is designed to span the range of the cyclic stresses a material might experience once manufactured into a given component. Typically performed as a part of product modeling and design, the tests are carried out to provide a better understanding of how mechanical products will perform over the course of their lifetime.

Most commonly, fatigue testing is performed on a number of specimens, at various stresses, with a measurement of the number of cycles applied until fracture at each stress level. This produces an *S/n* curve (Stress vs number of cycles to failure) which can be used to predict the expected life of a component based on the designed stress levels it will experience.

Fatigue testing is essential in safety-critical industries such as the aerospace, oil and gas, and medical sectors, in which an unanticipated failure can result in significant monetary loss and, more importantly, present serious safety hazards. A robust fatigue testing program is also the backbone of damage-tolerant design.



# FATIGUE TESTING WITH IMR TEST LABS

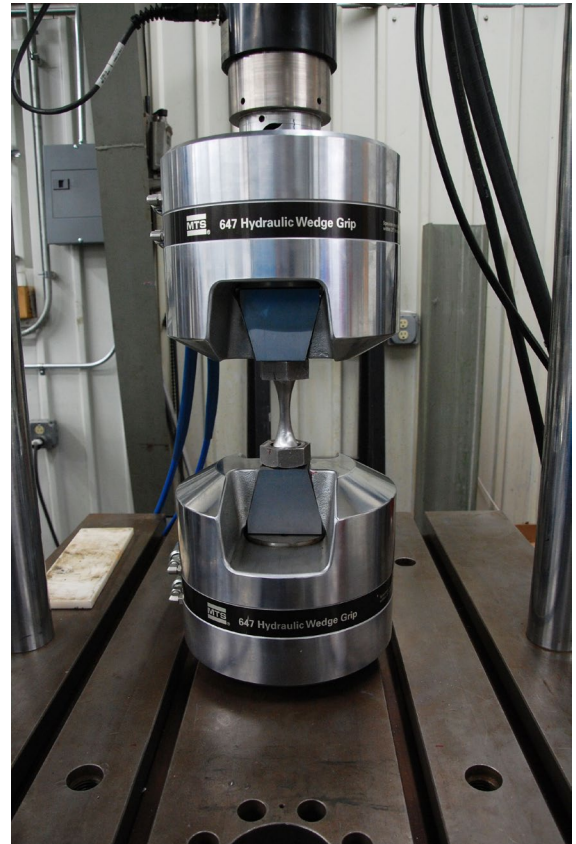
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Understanding the importance of reliable, versatile fatigue testing, IMR Test Labs is proud to offer a range of services to help ensure smooth functioning of critical parts. Our team offers extensive fatigue testing expertise to help with the design of comprehensive test programs to meet the needs of clients in safety-critical industries.

As recent incidents in the news have shown, the costs associated with part failure in the **aerospace** industry are extremely high. Companies operating in this industry must maintain a strong safety record and work with materials that provide high strength and a long life span while also minimizing weight.

Similarly, the failure of a **medical device**, such as an implant, can put patients' lives in danger. To ensure people receive the best health care possible, all materials involved must be carefully studied and tested for required strength and reliability.

The **oil and gas industry** also relies on high-strength, reliable materials for the exploration, extraction, refinement, and transportation of petroleum products. In this sector, the chemicals involved are often flammable and corrosive, and failure of any material used for their transportation and storage can have disastrous effects on worker and public safety, the environment, and companies' bottom lines — not to mention their reputations.



## Capabilities

IMR Test Labs offers a wide range of fatigue testing services to meet specific application needs. For example, the effect of axial fatigue can be simulated over a wide range of temperatures (from  $-320^{\circ}\text{F}$  to  $1800^{\circ}\text{F}$ ), with precise control over displacement, strain, and load to ensure accurate testing conditions. Load ranges from less than 200lbs to 55kip can be created based on sample geometry and other requirements. IMR is A2LA and Nadcap accredited to perform both low displacement/high cycle and high displacement/low cycle fatigue tests, covering a large range of possible loading conditions.



Similarly, the strength and reliability of a coating can be tested by simulating cycles of tensile or shear fatigue. Various other types of tests, such as fracture toughness and Fatigue Crack Growth Rate can be performed in addition to high- and low-cycle fatigue. The effect of various mechanical load conditions can also be simulated during rotating beam fatigue and three/four point bend fatigue testing.



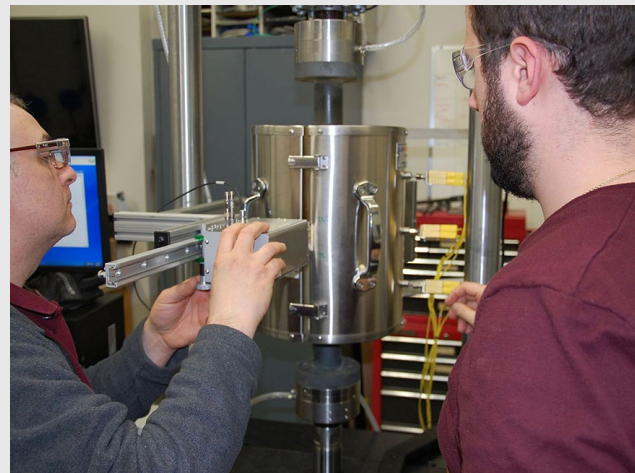
## Product Testing Capabilities

Offering highly advanced technical capabilities, our facility can accommodate and test finished products as well. Our experienced Mechanical Engineering team can design and create custom fixturing for holding and positioning a customer's product so that cyclic loading can be applied in the appropriate locations.

### Case Study: Testing Thermal Spray Coatings for the Aerospace Industry

The following case study serves to better illustrate our testing capabilities.

As is typical in the defense and aerospace fields, one of our clients had applied several varieties of thermal spray coatings to a 300M steel substrate and submitted it to run under various loads upward of 200 ksi until failure, or until it ran out at 1,000,000 cycles. The reliability of this layered coating had to be tested to ensure optimal safety and performance.



The team at IMR Test Labs performed fatigue testing and provided a series of S/n curves. After 60 samples, the test showed that the coating had the characteristics necessary to ensure success in its intended application.

Our team created special wedges with threads for these unique coating qualifications. The wedges were then machined, heat treated, and polished to the required finish. The client was very pleased with the results, and plans a series of follow up programs.

## IMR Test Labs Specifications

Below is a list of offered Test Methods. IMR is accredited for a number of different methods, which means we likely offer the specific fatigue test required for your unique industrial application.

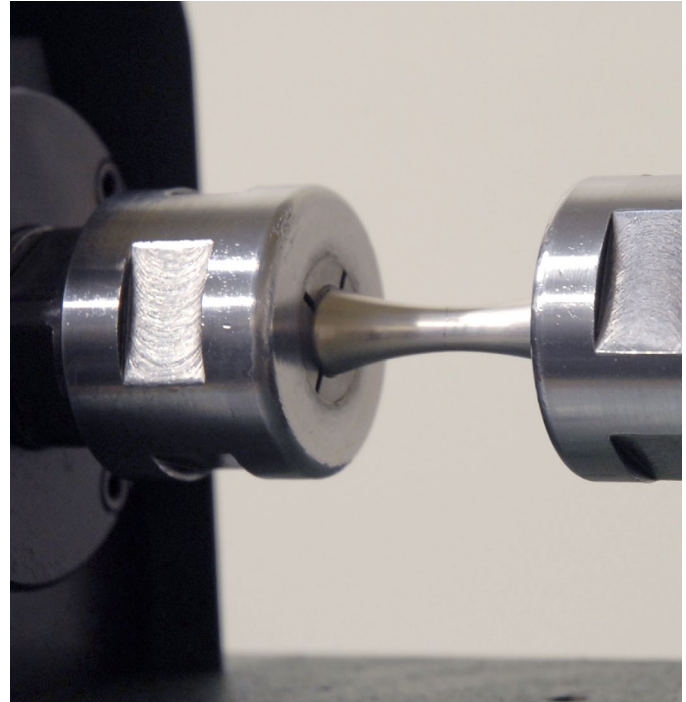
Designation	Title
ASTM E399	Standard test method for linear-elastic plane-strain fracture toughness $K_{Ic}$ of metallic materials
ASTM E466	Standard practice for conducting force-controlled constant-amplitude axial fatigue tests of metallic materials
ASTM E468	Standard practice for standard practice for presentation of constant-amplitude fatigue test results for metallic materials
ASTM E606	Standard practice for strain-controlled fatigue
ASTM F1160	Standard test method for shear and bending fatigue testing of calcium phosphate and metallic medical coatings
ASTM E1820	Standard Test Method for Measurement of Fracture Toughness
ASTM E647	Standard Test Method for Measurement of Fatigue Crack Growth Rates
ASTM B645	Standard Practice for Linear-Elastic Plane-Strain Fracture Toughness Testing of Aluminum Alloys
ISO 1143	Metallic materials — rotating bar bending fatigue testing
JIS Z 2274	Method of rotating bending fatigue testing of metals
MPP-008	Rotating beam fatigue

## LEARN MORE

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At IMR Test Labs, we have the technology and expertise needed to conduct reliable fatigue testing on an array of critical products and materials. Our labs are capable of accommodating a range of different sample types, and can easily incorporate extreme temperatures, complex mechanical forms, and various forces into the test paradigm.

Our expert team is here to help you assess the strength of the materials to be employed in your specific application, and all of our services are backed by a cutting-edge metallurgical lab, skilled chemical analysis department, and deeply experienced failure analysis department. Ready for a fatigue testing consultation for your unique application? [Reach out](#) to the team today.



## ABOUT US

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We're an international firm offering a complete scope of materials testing services, including chemical analysis, cleanliness testing, corrosion testing, mechanical testing, metallurgical analysis, failure analysis, fatigue testing and much more.

We have five facilities, located in Ithaca, New York; Louisville, Kentucky; Portland, Oregon; Singapore; and Suzhou, China. IMR demonstrates an on-going commitment to serve our clients' analytical needs, wherever they may be.

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