World Leaders in Expanded Products

FATIGUE TECHNOLOGY

A PCC Company

COLD EXPANSION EXPERTS

All of FTI products are based on our cold expansion technology. Our engineers have advanced this science to develop innovative fastener, bushing, and fitting products for metal, composite, and hybrid structures. These products are specifically engineered to provide cost savings for structural optimization, manufacturing and maintenance time-savings, and improved aircraft structural performance.

How does cold expansion work in composite structures?

Installation of expanded products into composite laminate was adapted from the same principles used to expand bushings and nut plates into metal structures. Each product is radially expanded from an initial clearance fit to yield it into the structure and provide uniform interference with the hole surface. Though the expansion level is lower in composites than in metals, the expanded product outperforms similar options without damaging the composite structure.

ADVANTAGES OF EXPANDED PRODUCTS IN COMPOSITES:

- *Improved electrical conductivity through fastened joints and grounding locations*
- *Reduced arcing and laminate damage caused by lightning strike*
- *Improved open hole compression strength*
- *Faster product installation and joint assembly*
- *Hole protection in areas where bare holes can wear*
- *Ease of repair*
- *Better open-hole fatigue life*
- *Improved joint durability*

Zone of compressive residual stress surrounding a cold-expanded hole as seen through a polarized filter.

What is Cold Expansion?

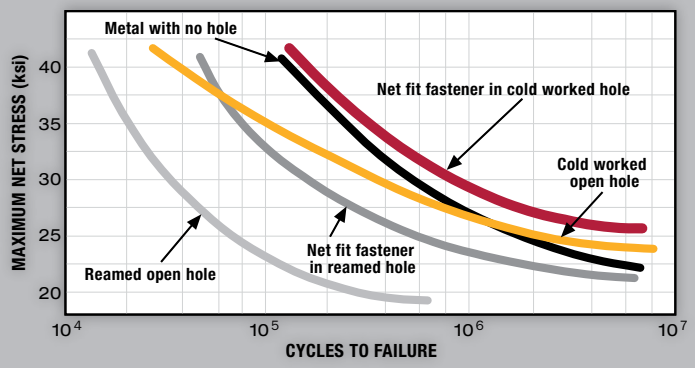
FTI's technology of cold expansion is a process applied to holes in metals that induces a beneficial zone of residual compressive stress around them. The process radially expands the hole, typically using a tapered expansion mandrel pulled through the hole, which yields the surrounding material. The resultant reactive force leaves a large zone of residual compressive stress around the hole. This compressive stress zone shields the hole from the effects of cyclic tensile loads which causes fatigue cracks. FTI pioneered this technology with the Boeing Company in the 1960's and continues to work with industry partners to adapt and optimize the cold expansion process for today's new aerospace materials and structural requirements.

Simplifying Production and Modernization Programs

The aerospace industry is constantly changing. New aircraft programs are coming online with complex design and manufacturing logistics, while older aircraft are in need of modernization and retrofit solutions to keep them flying longer.

FATIGUE LIFE IMPROVEMENT

S–N Curves for 2024-T851 Aluminum



S–N curve data from "Fatigue Improvement of Sleeve Cold Working" by Joseph L. Phillips, Boeing Commercial Airplane Company, SAE Presentation, October 1973.

FTI PRODUCTS WORK IN BOTH OF THESE AREAS BY:

1. Improving Producibility
2. Reducing Life-Cycle Costs
3. Reducing Structural Weight
4. Increasing Fatigue Life
5. Increasing Load Improvement Factors
6. Improving Aircraft Structural Performance
7. Reducing Maintenance Cost
8. Reducing Manufacturing Time

On-site training is an integral part of FTI's customer service

Making a Difference in the Aerospace Industry

Over 40 Years of History

As a pioneer of the cold expansion process, FTI helped develop this technology back in 1969. Since that time, we have continued to grow along with the aviation industry. Our commitment is to provide practical solutions to aircraft manufacturing, rework, and structural fatigue related problems.

Innovation

FTI employs a motivated and experienced staff who work closely with our customers. We utilize the most sophisticated tools available including a fully equipped testing facility, CAD/CAM, and finite element analysis technology.

FTI maintains an extensive library consisting of thousands of technical documents and test reports that quantify the effectiveness of our systems. We have also developed and maintain over 40 U.S. and international patents.

Our engineers apply a hands-on, practical approach to researching and developing new methods and refining existing processes to support our customers' needs.

Materials Testing

Since 1980, FTI's Materials Testing Facility has provided an industry requirement for independent testing services, specifically environmental and mechanical tests of metallic and composite materials. Our testing capabilities support internal research and development of our systems and validates their effectiveness.

Manufacturing

To ensure the highest quality and timely delivery of FTI products to our customers worldwide, we have established a state-of-the-art manufacturing facility. FTI parts are created by experienced machinists on modern CNC equipment.

Reliability is designed into the manufacturing capability with backup equipment available for every machine and operation. FTI uses statistical process control procedures that ensure tooling and products are processed, manufactured, and tested to exacting tolerances that meet or exceed industry standards. Our quality system is certified to AS 9100.

Finite Element Analysis is used in support of product validation.

Our extensive Materials Test Facility operates to exacting industry standards.

Coordinate Measuring Machines generate SPC data for quality/manufacturing consistency.

Statistical Process Control is an integral part of our manufacturing excellence.

FTI products are used in commercial aircraft, military aircraft, and helicopters worldwide.

Outstanding Customer Service

FTI strives to provide the very best for our customers. We have won numerous awards over the years from the top OEM producers in the world because of our legendary customer service. Our expert staff is available to answer any of our customer's technical questions within 24 hours. Even after shipment, we continue to support our customers by providing on-site training and installation technical assistance. FTI also offers product installation services for our customers. Our service teams are highly trained and can expertly install our products on customer's aircraft on-site, or in our facility for smaller applications.

WORKING WITH CUSTOMERS TO CREATE INDUSTRY-CHANGING PRODUCTS

ForceMate Bushings and the B-52

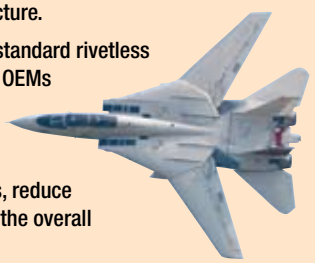
Our ForceMate bushing installation process came about back in 1983 when the maintainers of the B-52 had serious issues with their standard shrink-fit bushing installations on the engine pylon. FTI worked closely with them and provided engineering support, testing services, and manufacturing expertise to create a better method of installing a bushing using cold expansion technology. The ForceMate system provided a faster installation with a high interference-fit bushing that resisted the most strenuous migration and rotational forces.

Today, FTI's ForceMate system delivers superior fatigue and mechanical performance in critical locations on thousands of commercial, military, fixed, and rotary-wing aircraft worldwide.

ForceTec Rivetless Nut Plates Invented for the F-14

In the late 80's, the F-14 was experiencing cracking on its rear fuselage longeron due to metal fatigue associated with the satellite holes of its riveted nut plates. After going on-site and working closely with the F-14 support engineers, FTI invented a rivetless nut plate that would eliminate the fatigue prone rivet holes and improve the overall performance of the nut plate assembly and the parent structure.

ForceTec is now the industry standard rivetless nut plate used by commercial OEMs and military operators to not only increase their aircraft's structural fatigue life, but to also increase production rates, reduce structural weight, and reduce the overall costs of the aircraft.



FTI products are the basis of hundreds of Service Bulletins and Technical Orders for aircraft repair solutions.

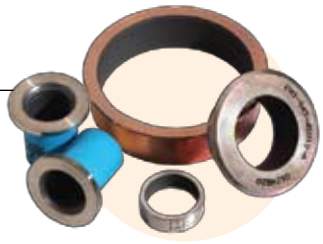
FTI PRODUCTS

BUSHINGS / GROMMETS

ForceMate®

Today's aircraft technicians use FTI's ForceMate process to expand a clearance fit bushing into place. The resulting interference-fit leads to greater resistance to rotation, fretting, pushout and also increases fatigue life and damage tolerance.

ForceMate saves both manufacturing and maintenance time. The process facilitates wider hole tolerances and maintains the integrity of corrosion resistant plating and coatings on the bushing and the bore of the hole. A wide variety of bushing configurations can be installed with ForceMate. ForceMate can be installed into metal or composite structures.



ForceMate reduced a 2-man, 2-day operation to a 1-man, 2-hour operation for one of our customers.

ForceMate®2

The ForceMate 2 system uses the same concept as ForceMate but installs two nested bushings into a hole simultaneously using FTI's cold expansion tooling. Both bushings are fitted onto the end of a special expansion mandrel before installation. The mandrel is then drawn through the outer bushings expanding radially into the hole while simultaneously pulling the inner bushing into place and locking it into the outer bushing by the elastic springback after expansion. This inner bushing may be a lined metal bushing, a stand-alone liner, or a specially made bearing or spherical bearing. The process is particularly effective in composite structures.

ForceMate 2's inner bushing may be a lined metal bushing, a stand-alone liner, or a bearing.

ForceMate®2 PANEL REPAIR

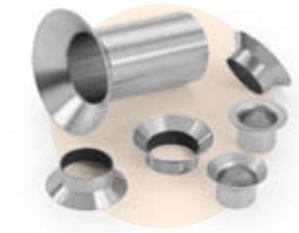
ForceMate 2 Panel Repair uses the ForceMate 2 system to repair damaged countersunk holes in access panels and other thin skin surfaces. The process brings fastener holes that have been ovalized, oversized, shifted off-center, or otherwise damaged back to nominal size. The ForceMate 2 Panel Repair System offers continued hole protection where high cyclic loads and repeated installation and removal of fasteners can contribute to wear of the fastener holes. The system replaces a number of other hole repair methods like large dimpled washers, riveted custom doublers, and bonded patches. The panel repair method can be applied to both metal and composite panels.

These two bushings bring damaged panel holes back to nominal size.

GromEx®

GromEx is designed specifically for use in composites as a cost-effective method for reinforcing fastener holes using a thin interference-fit metal sleeve or grommet. The amount of radial expansion of the grommet in the hole is carefully tailored to ensure adequate grommet retention and at the same time prevent localized damage to the composite.

GromEx is easier to install, more reliable, and has improved performance over adhesive bonded or swaged grommets. GromEx greatly enhances the durability of a load transfer joint by enabling interference fit fasteners in composite structures. GromEx provides lightning strike protection in zone 1A and improves electrical conductivity.



GromEx protects composite laminate in areas where bare holes can wear or elongate.

FITTINGS

FleXmate™

FleXmate fittings connect aircraft systems (fuel, inert gas, ECS, and electrical) through structural bulkheads/panels etc. using cold expansion technology. The fitting is radially expanded from an initial clearance fit to lock it into the structure and provide a uniform interference fit.

Unlike a traditional fitting, an expanded FleXmate fitting resists movement and seals the penetration without fasteners. Additional weight savings are gained by reduction of the flange envelope on the FleXmate fitting and the possible reduction of the structural pad-up around the penetration due to the elimination of fastener holes and associated stress risers.

FleXmate offers a smaller footprint for optimal system routing.

A Complete System of Tooling and Kitting

FTI also specializes in working with our customers to design kits comprising all of the necessary tools to perform an application for greater convenience and work flow efficiency. These kits typically include a complete system of tooling for all our processes. Depending on the application, this system may include drills, reamers, check gauges, mandrels, and other assemblies; puller units, power packs, and the final product to be installed. The whole system is designed to provide ease of installation and optimal product performance.

FTI creates kits per our customer's requests that include all the necessary tooling required to support their application.

FASTENING SYSTEMS

ForceTec®

Prior to ForceTec, nut plates were installed with rivets, gang channels, or, after stringent surface preparation were adhesively bonded.

ForceTec is installed in the structure by radially expanding the nut plate retainer into the hole. This expansion creates an interference fit that resists torque and pushout that meets or exceeds the NASM25027 specification.

ForceTec saves both manufacturing and maintenance time with the added benefit of fatigue life enhancement. A standard floating nut is easily attached to the retainer; or for wet areas, a sealed domed nut is available. Manufacturing costs are realized through the speed of installation and reduced flow time.

On a major USAF program, 260,000 ForceTec retainers were installed with zero defects on over 80 aircraft sets.

ForceTec® LITE

ForceTec Lite offers all the benefits of ForceTec in a factory-installed (open or sealed) nut and is installed quickly using FTI's Accelerated Installation Method (AIM). ForceTec Lite is designed for high-volume applications in lieu of riveted, bonded, or gang channel nut plate products to meet overall installed cost, reduced weight, and life cycle targets.

ForceTec Lite offers a factory-installed nut and rapid one-step installation process.

ForceTec® MODULAR

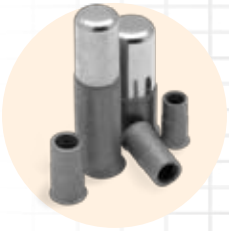
The key component of the ForceTec Modular System is the light-weight nut holding element called the retainer. The modular retainer can accept several different configurations of nut elements including open, sealed, and quick-release configurations. The retainer may be installed in both metal and composite structures using the Accelerated Installation Method (AIM). The ForceTec Modular system simplifies nut plate installation and reduces overall installation time when compared to bonded and riveted type nut plate systems. Other benefits include excellent conductivity and improved open hole compression strength in composite applications and protection of the hole due to wear and cyclic load. An Environment Protection Cap (EPC) is available to protect the nut element from dirt, grease, and other types of debris and in some situations, can be used as a sealed element.

The ForceTec Modular retainer accepts open, sealed, or quick release nut elements. An Environment Protection Cap (EPC) is also available.

TukLoc®

TukLoc is a blind installed nut that is secured in the structure by radially expanding the nut into the hole. This expansion creates an interference fit that is resistant to torque and pushout that also meets or exceeds the NASM25027 specification.

TukLoc uses a straightforward simple hole preparation and a standard countersink. It permanently seals with no stringent surface cleaning and no additional sealants required.



The cold expansion process locks the TukLoc blind nut into the structure for use with common aerospace screws that are installed to finish the fastened joint.

ForceLoc®

ForceLoc is a blind installed modular fastening system designed to be a threaded insert or a blind installed stud for light structural attachment. It provides a precise interference fit bushing and a locknut, secured with a collar. This combination creates a unique balance between structural enhancement and application versatility.

ForceLoc can be installed in either metals or composites to provide a secure fastening method.

COLD WORKING

Split Sleeve Cold Expansion™

FTI's Split Sleeve Cold Expansion system is a cost-effective solution to problems associated with fatigue cracks in holes in metal structures. Split Sleeve Cold Expansion is accomplished by pulling a tapered mandrel, pre-fitted with a lubricated split sleeve, through a hole in aluminum, steel, or titanium. The disposable sleeve reduces mandrel pull force, ensures uniform radial expansion of the hole, and allows one-sided processing.

Cold expansion counteracts the stress concentration around a hole by creating a compressive residual stress field, effectively shielding the hole from the cyclic tensile stress loads that cause cracks to form and grow.

The cold expansion process typically improves the fatigue life of a metal hole by 3 to 10 times.

FTI provides an integrated complete system of tooling for all processes.

FTI Products are approved and used worldwide by virtually every airplane and helicopter OEM.

ForceMate®

ForceTec®

FleXmate™

TukLoc®

GromEx®

Split Sleeve Cold Expansion™

MARKETS SERVED:
Aerospace, Medical, Railroad, Transportaion/Infrastructure

FTI's corporate headquarters and manufacturing plant are located just 5 minutes from the Sea-Tac International Airport and 10 minutes from downtown Seattle, Washington.

FATIGUE TECHNOLOGY
A PCC Company

An ISO 9001/AS9100 Certified Company

CORPORATE HEADQUARTERS
401 Andover Park East
Seattle, WA 98188-7605 USA

Phone: 206.246.2010
Fax: 206.244.9886
Email: sales@FatigueTech.com

FatigueTech.com

OFFICES:
Atlanta, GA
Dallas, TX
Los Angeles, CA
Oklahoma City, OK
Salt Lake City, UT
Washington, DC
Broughton, United Kingdom
Hamburg, Germany
Toulouse, France

REPRESENTATIVES:
Australia
China
India
Israel
Italy
Japan
Singapore
Spain
South America

5/2011 100D S/WD #107786