



# TurnaSure LLC

## Tension Indicating Fasteners

for bolts, anchors and studs

*The proven path to accurate bolt tensioning, used on major structures worldwide for over 50 years - now manufactured to a highly engineered ASTM standard F2437 for B7 studs, Grade 55 and 105 KSI Anchor Bolts and Grade 5 and Grade 8 SAE (automotive) cap screws!*



[www.TurnaSure.com](http://www.TurnaSure.com)



*“DTIs are the only cost-effective solution that we trust to provide proof-positive evidence that bolt load is achieved on each and every stud.”*



*Bill Washington  
Director of Business Development, Fastorg*

# The TurnaSure DTI

## Setting the Standard for Correctly Tensioned Bolted Connections!

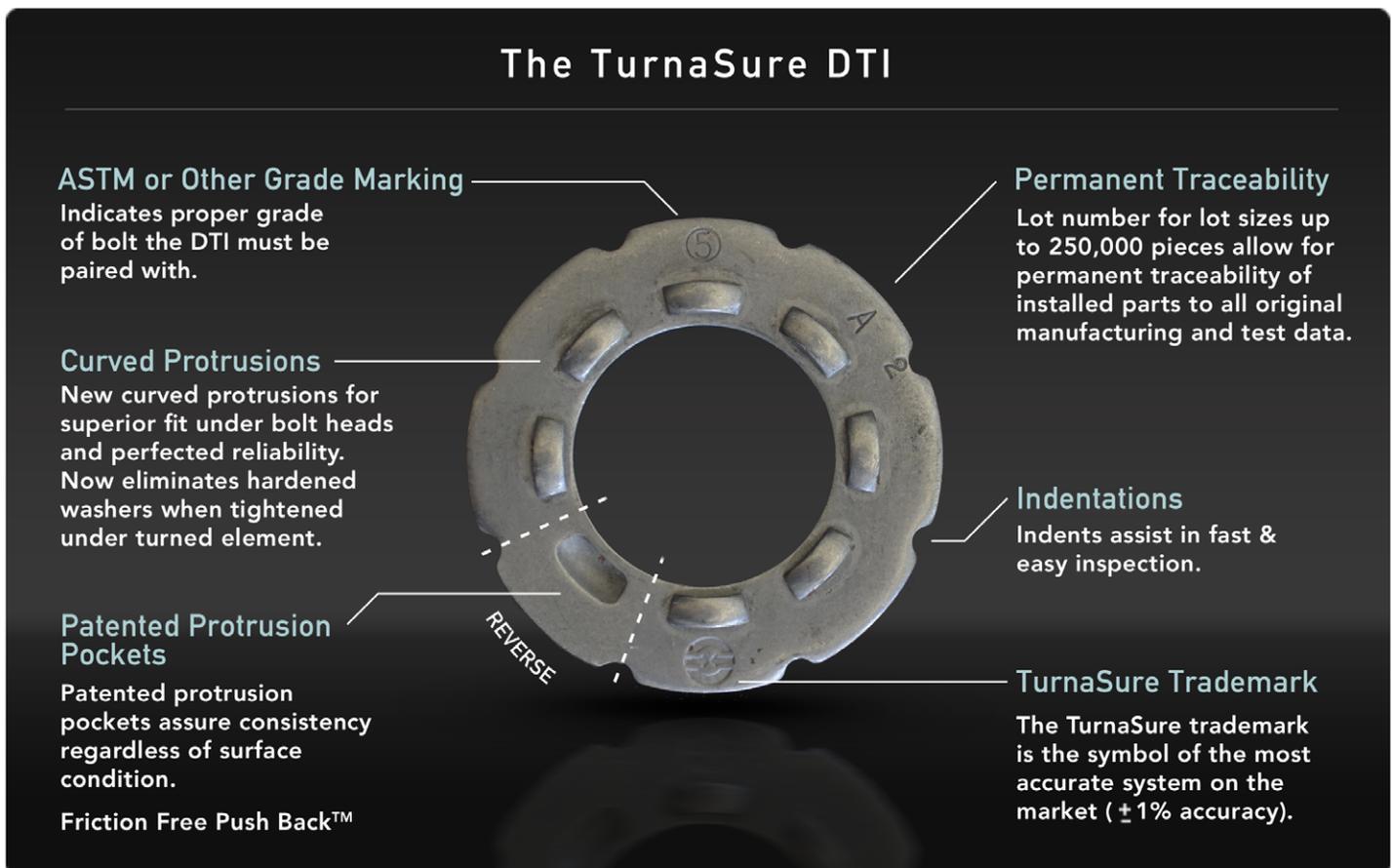
The TurnaSure DTI is the world's simplest cost effective solution to control the tensioning of bolts. These unique, patented fasteners deliver consistent, reliable bolt tension, along with installation and inspection efficiency. They are used every day to achieve required tension loads on bolts in countless applications including: structural steel buildings and bridges, studs used in the petro-chemical industry, anchor bolts and SAE cap screws for automotive applications.

## Used Wherever Tension Matters

For half a century, TurnaSure DTIs have been used throughout the world on major buildings, bridges and other important steel structures. They are also ideal for use on pressure vessels, valves, pipe flanges, anchor bolts, wind turbine blades, cantilevered road signs and traffic signals, truck chassis maintenance and countless other applications.

## Tested and Proven

The accuracy and reliability of TurnaSure DTIs have been proven time and time again in laboratory tests and industry studies. In test after test, the TurnaSure DTI (and the gap inspection method of checking tension) has prevailed against other methods of bolt tensioning. And just as importantly, bolts tensioned with TurnaSure DTIs retain their tension for the long haul. TurnaSure DTIs retain their accuracy regardless of their surface condition during tightening, whether oiled, coated or even rusted!



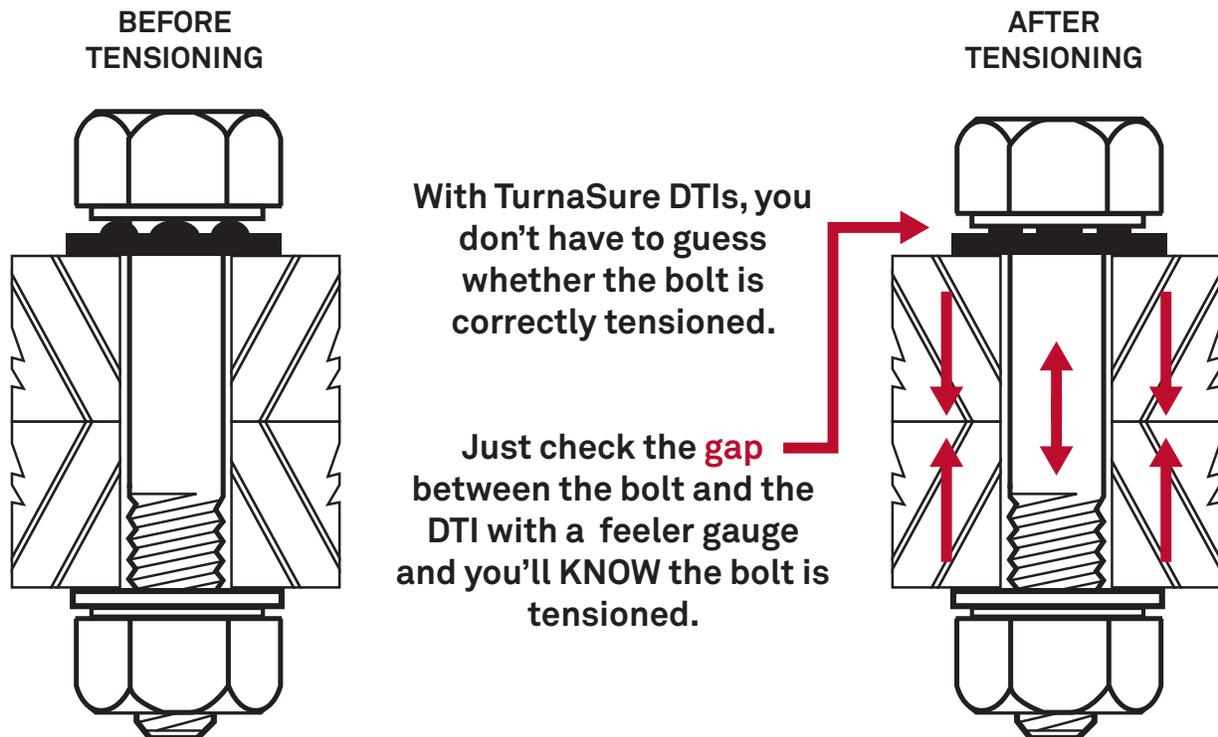
# How a TurnaSure DTI Works



Direct Tension Indicators work when the patented protrusions are compressed as the axial tension force in a bolt or stud is increased by rotating a nut.

Due to the protrusions, the bolt achieves correct tensioning while still leaving a small gap between the bolt head and the surface of the DTI. This gap provides an easy and reliable method of checking the bolt tension, by inserting a feeler gauge between the protrusions (our edge indentations make it easy to find the right place to insert the gauge). When the feeler gauge indicates you have compressed the gap to the correct size, you know the bolt is correctly tensioned. It's quick, easy and reliable, and its the best way to ensure correct tensioning.

## MIND THE GAP!



# How a TurnaSure DTI Works

## But What About Torque?

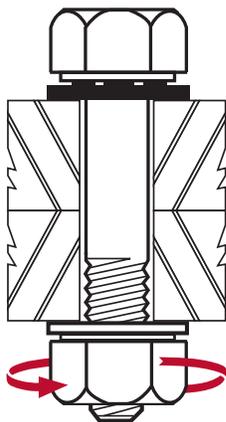
Except for sufficient lubrication to allow the nut of the assembly to be rotated under load, “torque” has no effect on the process. (Note: It is bolt tension, not torque that determines the preload in a joint).

## Flexibility in Assembly!

DTIs can be used in several alternate assembly methods, giving you the flexibility you need:

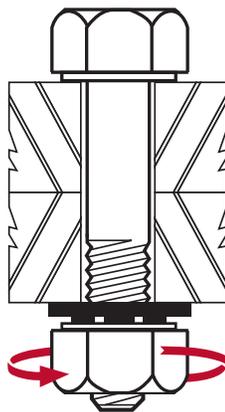
### Method 1

DTI under head – Turn nut to tension, bolt head held.



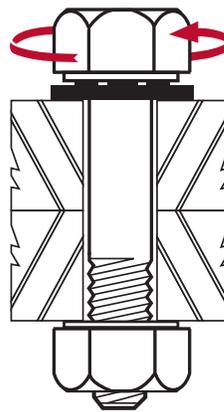
### Method 2

DTI under the nut – Turn the nut to tension.



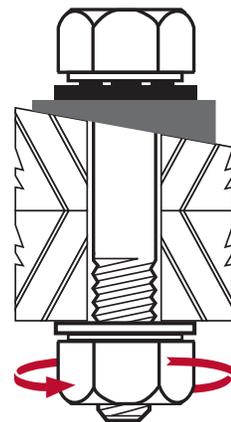
### Method 3

DTI under the bolt head – Turn the bolt head to tension.



### Bevel Washers

DTIs can also be used with bevel washers to accommodate over a 1:20 bevel.



## Leave the Hardened Washers Behind

TurnaSure’s unique curved protrusions have been shown in studies to work more effectively if the hardened washer is eliminated when tensioning the DTI directly under the nuts. That’s one less part you have to buy and one less part you have to include in the assembly process!

## Respected Worldwide

TurnaSure DTIs are covered by patents and trademarks granted and pending worldwide, including the USA, European Union, India, China and Japan.



TurnaSure DTIs are the ideal solution whenever achieving and maintaining bolt tension is critical. They are in use in some of the biggest buildings, bridges and structures in the world, but they are also the perfect solution for a wide range of other applications.

## Petro-Chemical

Today's bolted joints must be designed with tomorrow's ever stricter safety and environmental challenges in mind. TurnaSure DTIs provide correct tensions for secure leak-free bolted and gasketed joints.

TurnaSure DTIs were introduced to the petro-chemical industry at the Offshore Technology Conference in Houston Texas in 1994, where they received an Award of Merit, and have been seen continuous use in the industry ever since.

Shortly after that introduction, a DTI user commented on their use in a Sonat pipeline replacement on Platform-Vermilion 265: ***“ We bought the system up to pressure by increments up to a maximum working pressure of 2,140 PSI without a leak! With an accuracy of ±2% in determining individual bolt load, and user friendliness, DTIs should find an important niche in facility safety and environmental protection.”***



These DTIs are now covered under the ASTM designation ASTM F 2437. They are available for B7 and B16 studs. TurnaSure's unique patented geometry produces protrusions with enhanced load resistance, making it possible to keep hardness below 22HRC, per the ASTM maximum hardness requirement for these studs.

TurnaSure DTIs are used by major companies like Shell and BP, which has recently used new enormous 2 ¾" super high load DTIs measuring 535,000 lbs on studs on an offshore platform. Another customer has employed our DTIs on gasketed joints on a major project in Algeria to successfully solve a problem with leaking flanges.

# DTI Applications

## Wind Turbines.

Wind turbines are engineered to generate clean power day in and day out for decades. It is bolts that hold it all together and make that possible. It is essential that these bolts are correctly tensioned the first time around, and it important to be able to easily inspect them for this, so they stay that way.

TurnaSure offers a complete range of DTIs for wind turbines, from blade bolts, to anchor bolts for the foundation (covered under ASTM F2437) and tower bolts and nacelle and gearbox bolts. Every bolt in the system must be correctly installed and tensioned to ensure the integrity of the entire system. TurnaSure DTIs make certain that every bolt is correctly tensioned to the engineered clamp loads.

DTIs have also been specially developed to bolt on composite turbine blades where exact tensions are absolutely critical for this special material.



## Automotive

Use of DTIs manufactured to ASTM F2437 for automotive applications is steadily growing. DTIs are excellent for assuring high accurate clamping forces that insure against vibration loosening or fatigue failure of fasteners due to insufficient tension.

DTIs have been used when replacing bolts for truck chassis maintenance and when replacing Caterpillar carrier bolts. They have even been used in submarines for assuring exact tensions on valves. They are also used in the installation of assembly line robots in automotive manufacturing facilities.

TurnaSure can provide DTIs for SAE Grade 5 and grade 8 cap screws, as well as a metric version for grade 8.8 and 10.9 SAE cap screws. These are also covered under ASTM F2437.

For more on the use of DTIs for Wind or Automotive applications, contact us at  
**800-525-7193** (US & Canada) or **215-750-1300** (International)

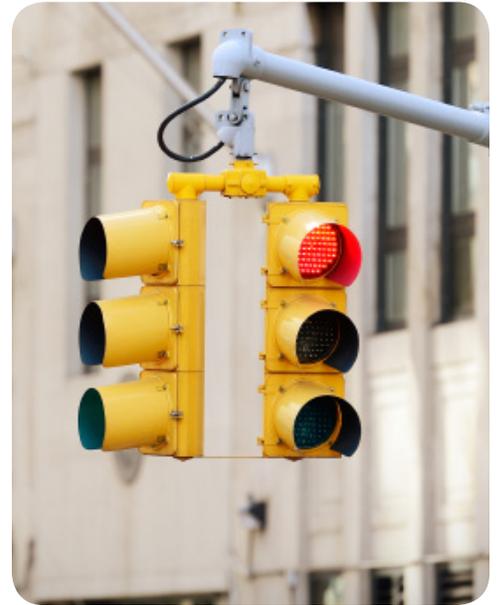
# DTI Applications

## Highway and Traffic

Tension matters on the highway. There have been cases of catastrophic failures of signal, light and sign structures due to poor assembly practices in these installations. This is because the wind generates forces that exert tensile loads on anchors that are insufficiently tensioned. When anchor bolts are not correctly tensioned and are subjected to variations in wind loading stress reversal can occur; this can result in failure of the anchor bolts by fatigue.

Installation with DTIs ensures that the installed preloads are greater than the tensile loads that they can experience in service, especially in hurricane force winds.

Both 55 KSI DTIs and 105 KSI DTIs to ASTM F2437 are gaining popularity for fixing down large traffic light installations and road signs. Several departments of transportation are now demanding these.



## Other Anchors and Proprietary Applications

TurnaSure DTIs are the ideal choice for any bolted connection where tension matters. DTIs for 55 and 105 KSI Anchors to ASTM F2437 as well as specially designed DTI fasteners are some popular examples. The roller coasters at Knotts Berry Farm Amusement Park in California utilize 1 ½" DTIs on their holding down anchor bolts. DTIs were also used on the Mark Gibian Sculpture entitled "Crescendo" in the Hudson River Park in New York City.

Specially designed ½" DTIs are extensively utilized on walling anchors. The Proto - II™ wall systems replaced the previous tightening method of a torque wrench with DTIs; the DTI generates a much tighter range of tension in the system rods (see the following page – comparison of tightening with DTIs and torque wrench). The close range of tension in the systems' tension rods mean that the required tension can be applied without the risk of overstressing the masonry wall and causing failure of the wall.

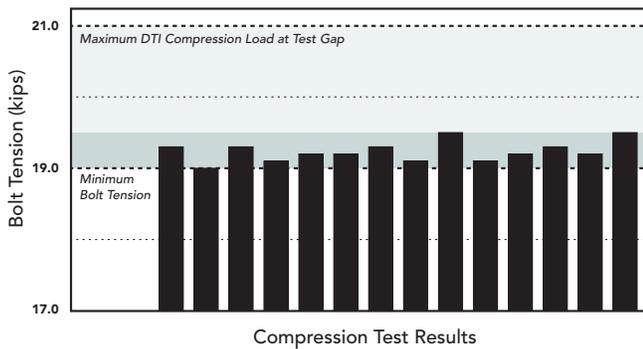
# The Benefits of Using DTIs

## Accuracy

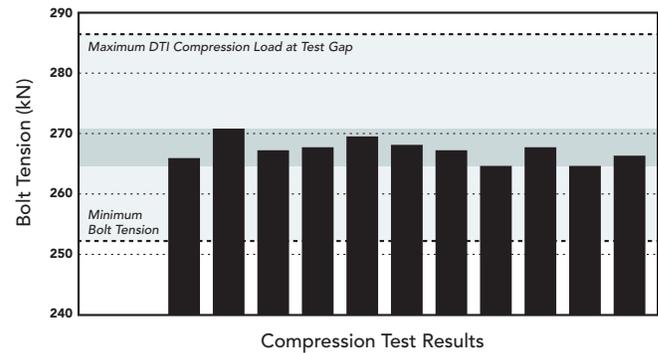
TurnaSure DTIs allow accurate bolt tensioning across a wide range of conditions.

TurnaSure's goal has always been to enable the most accurate bolt tensioning, no matter the condition or size. Advances in raw materials (such as hardening via precise cold rolling, followed by annealment prior to manufacturing) have allowed us to continue to raise the bar on DTI accuracy. Laboratory tests have shown that TurnaSure DTIs consistently achieve the minimum required bolt tension.

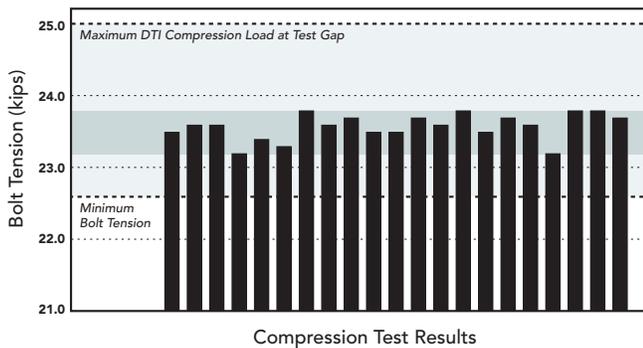
**ASTM F2437 1" Grade 55 (for Anchor Bolts)  
DTI Lot 0155A1 MG**



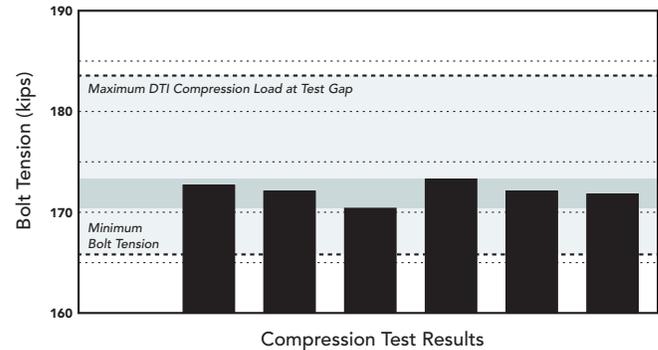
**M30 SAE 8.8 (for Cap Screws)  
DTI Lot 30C8A2**



**ASTM F2437 3/4" SAE Grade 5 (for Cap Screws)  
DTI Lot 34G5A1**



**ASTM F2437 2" Grade 105 (for Anchor Bolts or B7/16 Studs)  
DTI Lot 02BA4MG**



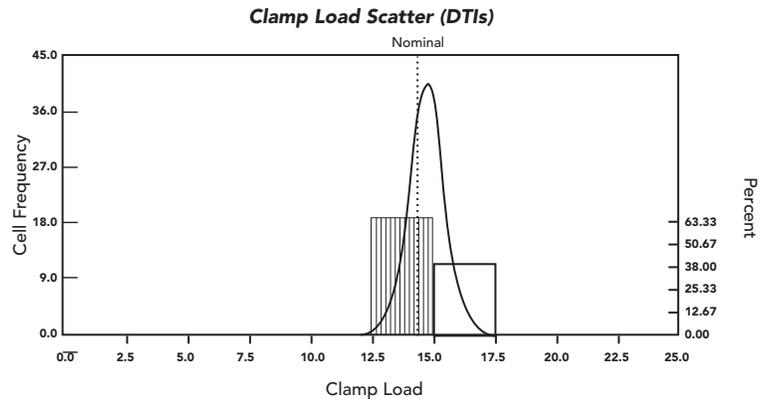
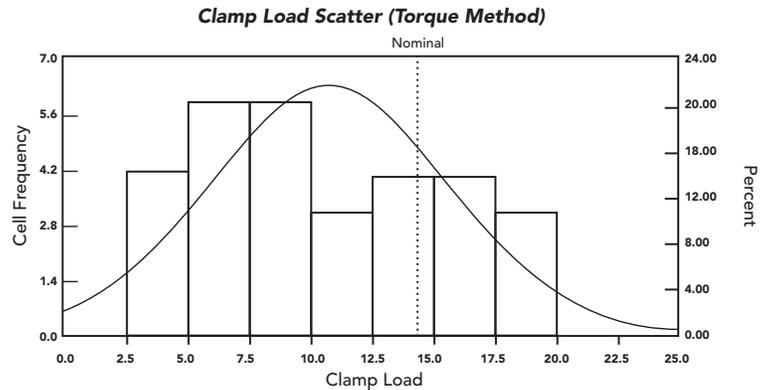
TurnaSure's test certificates are prepared in A2LA independent accredited laboratories. Compression loads are directly traceable to the National Institute of Standards and Technology (NIST) and frequently reveal approximately 1% standard deviations at specified test gaps on the 29 piece test samples. Each manufactured production lot is identified by a lot number impressed permanently into each DTI, assuring full traceability to all production records.

# The Benefits of Using DTIs

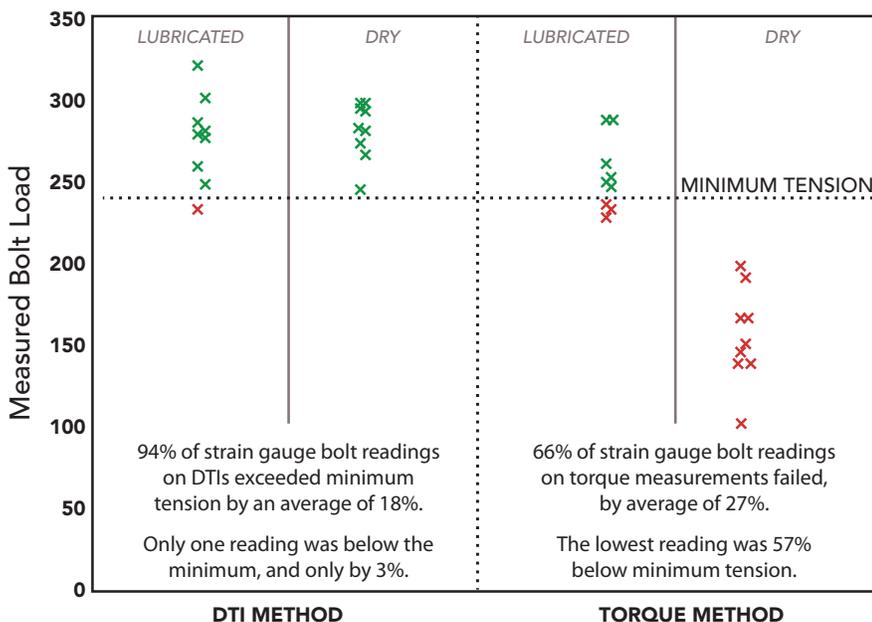
## Compared to the Torque Method

The most common tightening method is torque control. Torque is not measuring tension in a bolt or anchor. It merely measures the force required to turn a nut as a threaded fastener is tightened.

As the two graphs to the right indicate, the actual clamp load generated while using the torque method shows a tremendous amount of variation, while that generated by using TurnaSure DTIs is remarkably consistent. The DTI method is far more accurate than the torque method.



*DTIs in actual structural connections compared to torque.  
Final tensions monitored with 9 strain gauged bolts per connection.*



A test conducted in the Applus Laboratories in Barcelona, Spain, in a tightly controlled research setting using strain-gauged bolts, compared the bolt load observed in bolts tightened using DTIs vs those tightened using the torque method in both lubricated and dry conditions. The results (illustrated here) show that while only a single DTI-method bolt missed the minimum required tension (and only by 3%), a stunning 2/3 of the torque method bolts failed to achieve the required load!

For the full report, visit  
[www.TurnaSure.com/research](http://www.TurnaSure.com/research) and  
 view report 15

# The Benefits of Using DTIs

## Long-term Reliability and Minimization of the Effects of Prying Action

Long term relaxation in a DTI bolted joint was first studied between 1963 and 1971. **After initial tightening there was no measured relaxation of the DTI bolting assembly over that eight year period.**

A more recent in depth study on long term bolt relaxation with or without DTIs was conducted in 2012 by Load Control Technologies of Pennsylvania USA, using ultrasonic measurement techniques; the study was overseen by Rowan University. This study shows not only were all bolts properly tensioned when using DTIs with feeler gauge inspection, but bolts not tightened using DTIs were often not properly tensioned. The higher the induced bolt tension the more the relaxation, of around 8% maximum, whether DTIs were in the assemblies, or not.

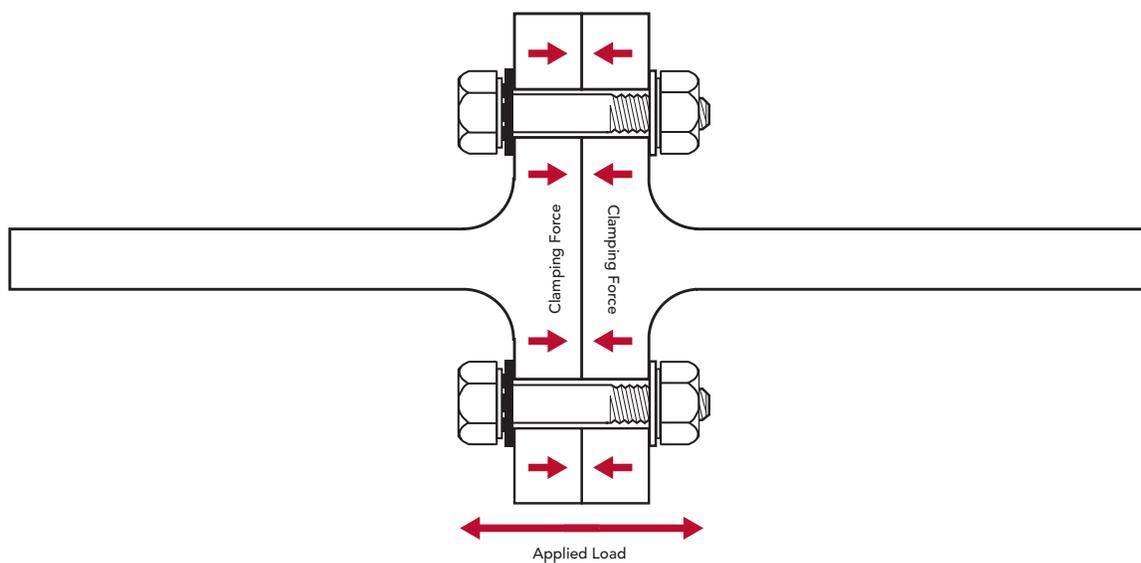
Another study at the University of Leeds in England in 1982 showed that DTIs are a benefit if a joint is subject to overloading. The bolt load recovery was enhanced by nearly 20% as the bumps retain more elasticity than the bolts. The University of California confirmed this beneficial shock absorption using DTIs on seismic isolators.

Properly tensioned bolts experience very little change in stress under prying loads. The presence of a DTI has been shown by research to inhibit permanent loss of bolt pretension when the connection is subjected to high prying action. Minimizing prying action and maximizing bolt preload improves the fatigue life of fasteners.

For more on the Reliability of TurnaSure DTIs, visit [www.TurnaSure.com/research](http://www.TurnaSure.com/research) and view reports **01, 08, 10** and **14**

## Fatigue Loading and Cyclical Stresses

The first study for possible fatiguing in joint incorporating DTIs was conducted in Cambridge, England in the 1960s. Bolt condition was studied after nearly three million stress cycles of loading and unloading, where the applied forces equaled 60% of the induced bolt tension determined by DTI gap closures. **There was no change in bolt load or any loosening after the multiple stress cycles had been applied.**



Also a study conducted at SPS Contract Research on a Junkers test bed which exerted transverse vibrations with and without DTIs. **None of the bolts with DTIs in the assemblies loosened during the test.** Conclusions were that the bumps also afforded some keying assisting in resistance to loosening as well.

# The Benefits of Using DTIs

On connections subject to cycles of stress along the bolt axis, it is very important to make sure that the applied force is always significantly lower than the clamping force. If applied loads are greater than the clamping force, bolts will loosen or fail by fatigue. TurnaSure DTIs assure the required clamping force is present in the connection.

For more on Fatigue Loading of DTIs, visit [www.TurnaSure.com/research](http://www.TurnaSure.com/research) and view reports **07** and **12**

## Corrosive Environments

Research has shown that TurnaSure DTIs are well suited for corrosive environments. Several corrosion studies have been completed on bolt joints using DTIs and on the DTI themselves. The first study was undertaken in the USA in 1985 by Mellon Institute in Pittsburgh PA. This research proved that when installed to a .005" gap or smaller, there was no significant long term penetration of moisture through gaps. In 2002, another study was conducted by KTA Tator also of Pittsburgh PA on unpainted Type-3 weathering steel DTIs. This study concluded that **the curved DTI protrusions actually prevented corrosion inside the bolt heads or nuts**. The gaps were sealed up by the rust patina. Another study on TurnaSure DTIs themselves proves they were wholly unaffected by rusting or oiling over time.

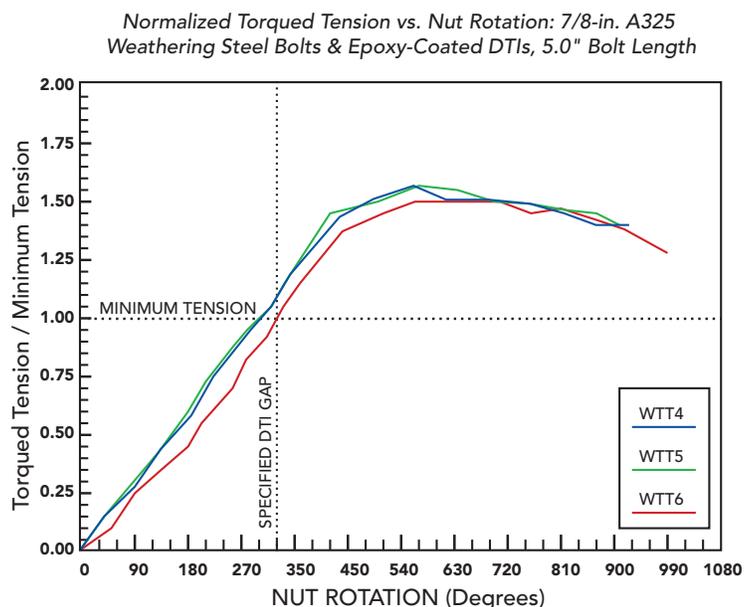
For more on DTIs in Corrosive Environments, visit [www.TurnaSure.com/research](http://www.TurnaSure.com/research) and view reports **03** and **04**

## Reduced Likelihood of Yielding

DTIs offer additional benefits beyond just assurance of tension. Using DTIs in your bolted connections dramatically reduces the likelihood of bolt yielding. The additional compression potential of the DTI protrusions once the bolt has achieved the desired load is able to absorb supplemental nut rotation without passing that stress on to the bolt.

The extra "compliance" when a DTI is in grip is shown dramatically in this graph. On 7/8" x 5" A325 bolt, DTI contributes to a massive 550° of extra nut rotation before bolt ruptures. Note load never falls below minimum.

Source University of Idaho Research Report published in 1999 by AISC



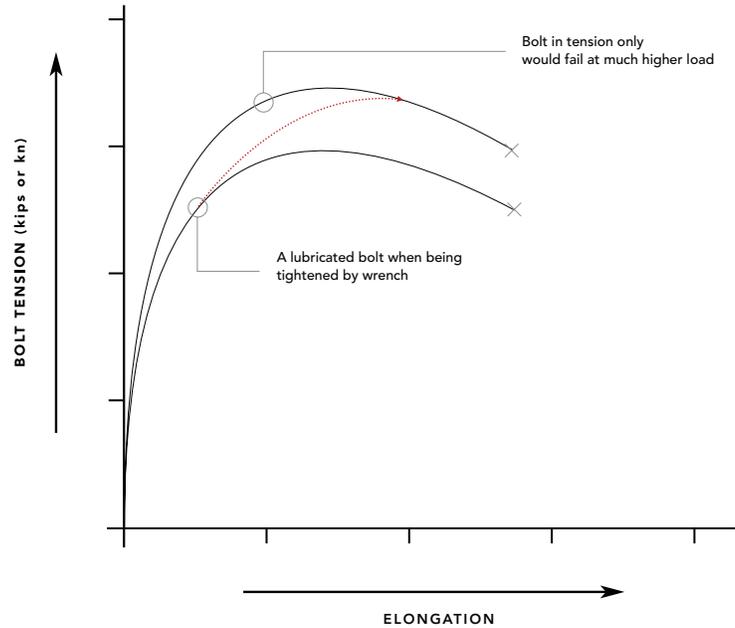
For more on Yielding in bolts using TurnaSure DTIs, visit [www.TurnaSure.com/research](http://www.TurnaSure.com/research) and view report **05**

# The Benefits of Using DTIs

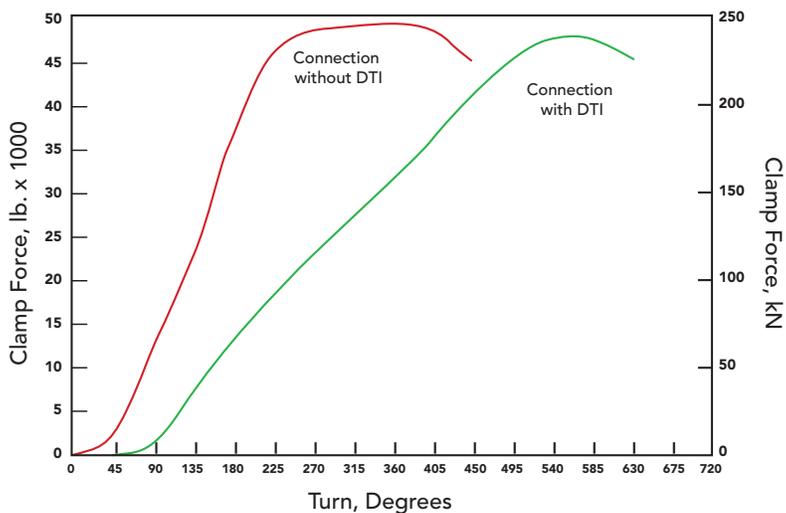
This diagram demonstrates a bolt yielding while it is being "twisted" (i.e. nut being torqued) at much lower loads vs. the same bolt yielding in direct tension at much higher loads. The conclusion is bolts are much stronger after tensioning than whilst being tightened.

Bolts can rupture at very low tensions if the threads are dry or damaged as the nuts freeze or lock up. TurnaSure have experienced no delayed fracture of a bolt with fully flattened DTIs in fifty years!

GRAPH SHOWING RESERVE TENSILE STRENGTH OF BOLTS AFTER TIGHTENING



Turn-Tension Comparison  
3/4" SAE Grade 8 with and without DTIs



This graph demonstrates that with a DTI in the grip, considerably more rotation of turned element is needed as one approaches yielding of bolt. This is even after DTI has been fully flattened. DTIs provided added security against excessive yielding during the tightening process.

## Cost Savings

DTIs can enhance your profitability. The quick, easy, reliable inspection (using the feeler gauge method) saves time and money.

While efficiency in installation and inspection offer real savings, the biggest cost saving from the use of TurnaSure DTIs is insurance against fastener loosening or fracture in service. Costly maintenance and even complete catastrophic failures have resulted from poorly installed bolts and nuts.

The highly accurate clamping forces afforded by DTIs significantly reduces these incidents and improves the durability of your assemblies.

# Types, Grades and Sizes

## The Perfect Fit for the Perfect Tension

TurnaSure manufactures the world's largest variety of Direct Tension Indicators (DTIs). Our extensive catalog of sizes and grades (see page 14) offers up the perfect size for virtually any bolting need. DTIs can be furnished in any coating that is also applied to the bolts and nuts themselves.

TurnaSure also supplies special DTIs to customer's individual specifications in a variety of materials including stainless steel.

ASTM F2437 for 55 KSI anchor bolts (DTI sizes are as per ASTM Standard)

1/2 5/8 3/4 7/8 1 1 1/8 1 1/4 1 3/8 1 1/2 1 5/8 1 3/4 2 2 1/4 2 1/2 2 3/4

ASTM F2437 for 105 KSI Anchor bolts (DTI sizes are as per ASTM Standard)

1/2 5/8 3/4 7/8 1 1 1/8 1 1/4 1 3/8 1 1/2 1 5/8 1 3/4 2 2 1/4 2 1/2 2 3/4

ASTM F2437 for Grade 5 and Grade 8 SAE Cap Screws (DTI sizes are as per ASTM Standard)

1/4 5/16 3/8 7/16 1/2 9/16 5/8 3/4 7/8 1 1 1/8 1 1/4 1 3/8 1 1/2 1 5/8 1 3/4 2 2 1/4 2 1/2

DTIs for SAE Grade 8.8 and 10.9 Metric Cap Screws (DTI sizes are as per Bolt Standards)

M 8 M10 M 12 M14 M16 M18 M20 M 22 M24 M 27 M30 M33 M36

DTIs for DIN 6914 (DTI sizes are for 10.9 as per Bolt Standards)

M 12 M16 M20 M 22 M24 M 27 M30 M33 M36 M42 M48 M56 M64 M72

EN 14399-9 EU Standard for H8 and H10 Structural Bolts (DTI sizes are as per CEN Standard)

M 12 M16 M20 M 22 M24 M27 M30 M36

ASTM F959M USA Standard for type 8.8 (325) and 10.9 (490) Structural Bolts (DTI sizes are as per ASTM Standard)

M 12 M16 M20 M 22 M24 M27 M30 M36

ASTM F959 USA Standard for type 325s and 490 Structural Bolts (DTI sizes are as per ASTM Standard)

1/2 5/8 3/4 7/8 1 1 1/8 1 1/4 1 3/8 1 1/2

TurnaSure also manufactures DTIs to individual customer sizes and clamp load specifications. These include our latest capability of manufacturing **super high load Direct Tension Indicators** up compression loads of 600,000 lbs tension and internal diameters of up to 3" or 76MM.



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