

# BOLTED

**DAKAR RALLY DRIVER ON WHY  
HE HAS CHOSEN NORD-LOCK**

**NEW SC WASHERS**

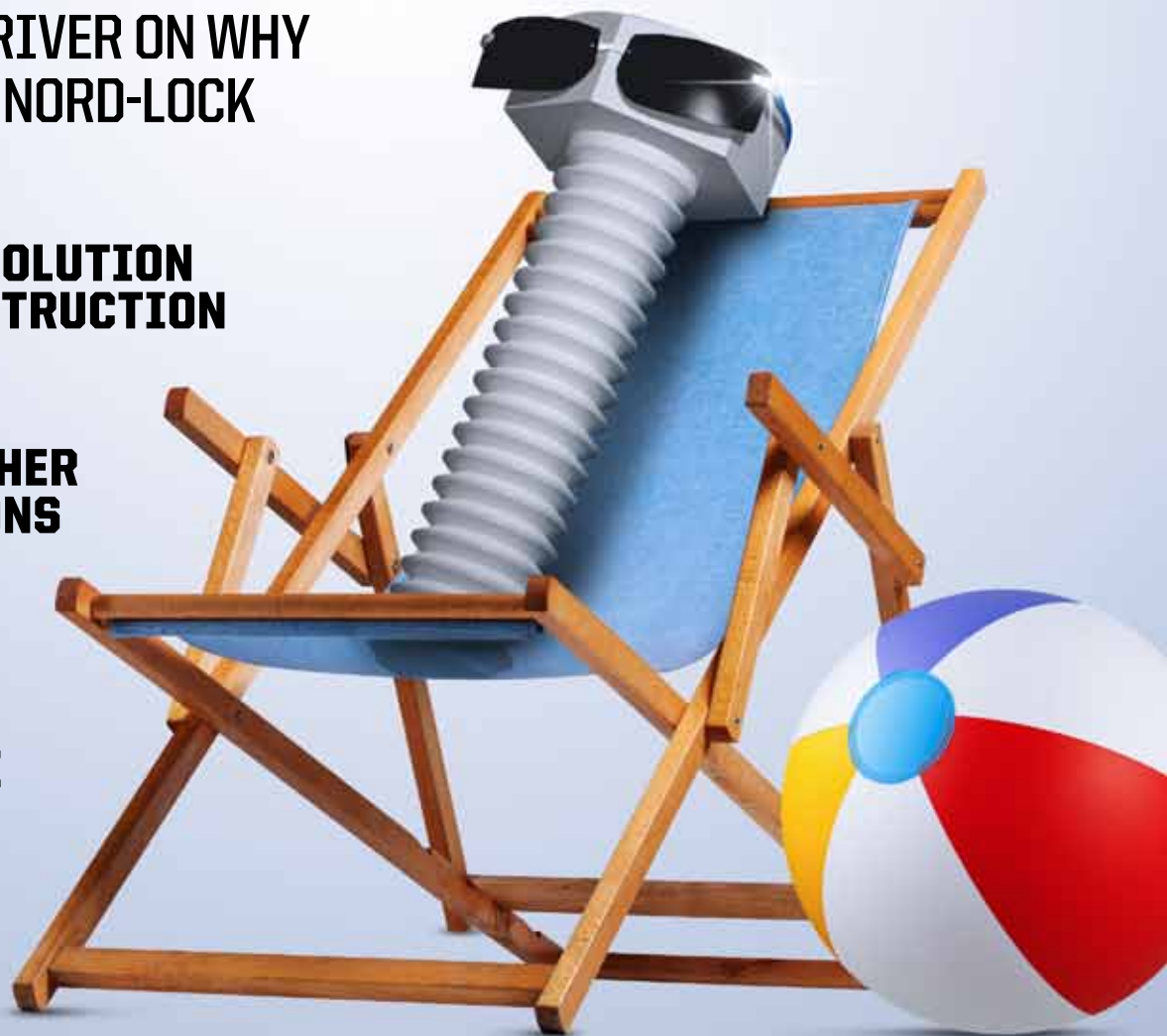
**THE ULTIMATE SOLUTION  
FOR STEEL CONSTRUCTION**

**FULLY PRESSED**

**HOLDING TOGETHER  
UNDER 8,000 TONS  
OF PRESSURE**

**THE REUSABLE RIG**

**A WORLD-FIRST  
MADE POSSIBLE  
BY SUPERBOLT**



## THE DANGERS OF RELAXATION

**HOW TO ENSURE TIGHT BOLTED JOINTS**

# Improve your Oil & Gas safety



Cranes are swinging heavy objects across the deck; drills, pumps and shakers are in constant operation. The pace at an oil rig needs to be high and a single minute of downtime would be costly. Nord-Lock's bolt securing systems are not only safe and reliable, but also cost effective. Find out how Nord-Lock can help you on your drilling equipment, top drives, rotating equipment, cranes, blowout preventers, turbines, compressors, fracturing pumps, and more!



Get your **free copy** of the Nord-Lock Oil & Gas brochure today!

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**NORD-LOCK®**  
Bolt securing systems





Bolted magazine is published by Nord-Lock and strives to increase knowledge about bolt assemblies. The Nord-Lock Group is a world leader in bolt securing systems and offers a wide product portfolio, including wedge-locking technology and Superbolt tensioners. These unique solutions withstand vibration and dynamic loads. For further information visit [www.nord-lock.com](http://www.nord-lock.com)

Bolted is published twice a year in English, German, Japanese, French, Chinese, Swedish & Finnish. It is free to customers of Nord-Lock worldwide. Published by Spoon in Gothenburg, Sweden, [www.spoon.se](http://www.spoon.se)

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**PREPRESS:**

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Printed in Sweden by VTT Grafiska. Printed on UPM Finesse Gloss 100 gram and Maxigloss 200 gram.

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**NORD-LOCK®**

## How much can you really learn about bolting?

I SPOKE TO Chalmers University of Technology, one of the most prominent universities in Sweden, and asked how much time is focused on bolted joints and fasteners when studying to become a mechanical engineer. I talked with Göran Brännare, Senior Lecturer, and the answer he gave me was 20 hours. Is that a high or low number of hours? I suppose it depends on who you ask. However, to put it in perspective, I made a calculation with Göran Brännare's help: Students of Mechanical Engineering study for 5 years, each year comprising 4 study periods of 7 weeks. Every week consists of 30 hours of scheduled study time. This adds up to 4,200 hours of scheduled study time in total – dividing 20 hours by 4,200 hours gives 0.48% i.e. less than half a percent! Engineers do dedicate a lot of additional time on self-study in their engineering education but that does not affect the percentage.

In the Nord-Lock Group, we focus 100% on bolting, and providing an education about safe bolting is part of the mission of this magazine. The theme of each issue is chosen in order to investigate new or interesting challenges for people who work in bolting. In this issue we will be looking at the challenge of settlements and relaxation, a topic we encounter increasingly in our interaction with customers as a result of

soft metals, composites, polymers and painted or powder-coated surfaces being used more and more in demanding applications. Further information on this topic, and how it can be counteracted, may be found on page 8.

In addition, the Chalmers Formula Students' racing car is part of this issue. The car is equipped with Nord-Lock products, of course. It won against all other competing universities (see page 17). As always, the magazine is full of other interesting stories and unexpected applications, including the motorcycle Thomas Berglund used in the Dakar Rally, which was fitted with Nord-Lock X-series (see page 15) or Mitsubishi Heavy Industries' gas turbines on page 16.

For us, the importance of bolting is pretty obvious, and the more critical the application, the more time should be spent on it.



**CARIN ESBERG**  
GLOBAL MARKETING  
MANAGER



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A bolt is in constant battle against settlement, relaxation and creep, with the slightest loosening or slackening having potentially devastating results.

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For the 2013 Dakar Rally, Thomas Berglund has chosen to use Nord-Lock X-series washers on his motorcycle.

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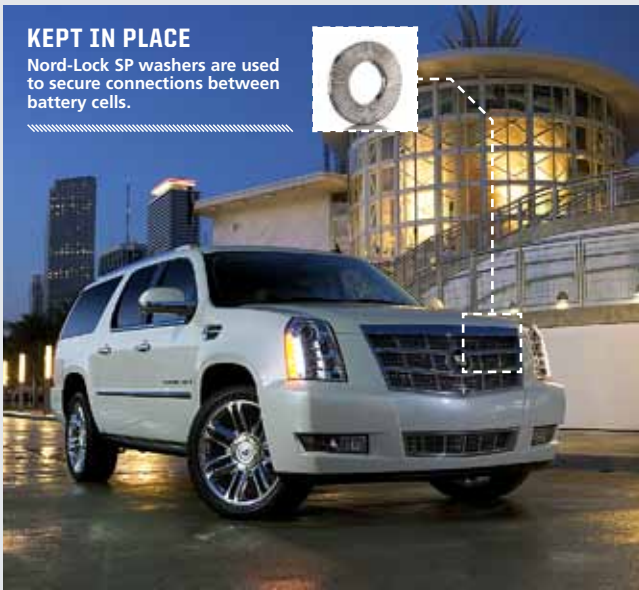
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# SECURED BY THE NORD-LOCK GROUP

WORDS: DAVID WILES

## KEPT IN PLACE

Nord-Lock SP washers are used to secure connections between battery cells.



## TAKING THE SHOCK OUT OF EVS

### CUSTOMER:

EVTV MOTOR VERKS

### PRODUCT:

ELECTRIC POWERED 2008 CADILLAC ESCALADE

### POWER PLANT:

2 X 1,000 AMP DC MOTORS

### BATTERIES:

57 X 400A/HOUR CELLS

### RANGE:

140-160 KM

### TOP SPEED:

190 KM/H

### 0-100 KM/H:

7.5 SECONDS

**THE INTERNAL COMBUSTION** engine may have dominated motoring's past, but today most observers agree that electric propulsion is the future.

The major automotive OEMs are starting to produce electric vehicles, but there is also a small but growing subculture of private enthusiasts and small workshops converting existing cars and trucks to electric power.

However, electric propulsion has its own challenges. A small but significant one is that batteries are connected in series, and a combination of vibration and thermal cycling can stress and loosen the connections between the cells. A loose connection causes increased resistance and can have catastrophic consequences, such as fire or explosion.

EVTV Motor Verks in Cape Girardeau, Missouri, which sells motors, batteries and other components to enthusiasts around the world, has found a simple solution to this issue. By using Nord-Lock SP washers on the braided straps that link one cell to the next, these connections are secured.

EVTV's customers are able to avoid the strenuous monthly task of tightening bolts in inaccessible locations, and can instead enjoy a clean environmental conscience, freedom from rising petrol prices, and lightning-fast acceleration. ■





# FORGING AHEAD

CUSTOMER: A. FINKL & SONS	PRESS CAPACITY: 8,000 TONS
TOTAL HEIGHT: 15.5 METERS APPROX.	DAYLIGHT OF PRESS: 4.5 METRES
DISTANCE BETWEEN COLUMNS: 4.8 METRES	NO. OF SUPERBOLT STCs: 8

**HOW DO YOU** hold together a press which exerts 8,000 tons of pressure to shape red-hot pieces of metal which themselves weigh tens of tons? For A. Finkl & Sons, a leading supplier of forging die steels and custom open-die forgings, there was only one answer: Superbolt.

Finkl, a stalwart of the US steel industry based in Chicago, wanted a new press for its new \$150m steel manufacturing campus and decided to design it in-house, from scratch.

When it came to the tensioning of the four huge 750 mm diameter press columns, Finkl wanted an alternative to existing methods such as thermal heating and hydraulic tensioning, which are often difficult to use, time consuming and potentially dangerous.

Finkl turned to Superbolt, their trusted supplier of bolt securing solutions for over a decade. Engineers from the Nord-Lock Group came up with a patented Superbolt Split-Nut Thrust Collar (STC). The STC consists of a threadless thrust collar with jackbolts threaded through, while a split-nut is fitted above the collar, and clamped together with small multi-jackbolt tensioners. The press' eight STCs allow for very defined pre-stress on the columns and enable easy installation and removal, using only small tools. The result is yet another satisfied customer using Superbolt. □



## STRESS RELIEF

Eight Superbolt STCs on each press allow for very defined pre-stress on the columns.





## SECURED BY THE NORD-LOCK GROUP

### SAFE AND SECURE

Nord-Lock wheel nuts helped Lamborghini win a safety innovation prize.



### THE RURAL ROCKET

**CUSTOMER:**  
LAMBORGHINI

**CYLINDERS:**  
6

**DISPLACEMENT:**  
6,057 CC

**POWER:**  
224 HP

**MAX TORQUE:**  
851 NM

**WHEELBASE:**  
2,817 MM

**AS YOU MIGHT** expect from a vehicle emblazoned with the name Lamborghini, there's nothing sluggish about the R6.VRT.190.

One of the new breed of "fast tractors", this vehicle can reach speeds of 60 km/h, which is a full 20 km/h faster than standard agricultural vehicles.

Why the need for speed? For the farmer behind the wheel, every minute spent chugging along on the tarmac is a minute less being productive in the fields.

The move towards faster, more powerful tractors such as the R6.VRT.190 is driving the development of new braking systems, transmissions and, in particular, safety systems. When engineers at Lamborghini wanted to showcase the latest cutting edge safety developments at an international agricultural exhibition, they turned to Nord-Lock and its Safe Wheels concept.

The resulting vehicle, which featured technologies such as all-wheel braking, seat occupancy sensors and Nord-Lock's locking wheel nuts, won a prize for its safety innovations.

Today all high-powered tractors from Lamborghini feature Nord-Lock wheel nuts as standard, guaranteeing that wheels won't loosen, no matter how tough the terrain. ■

### DIG THIS SOLUTION

**CUSTOMER:**  
SKF MEKAN

**PRODUCT:**  
SED BEARING HOUSING

**SHAFT DIAMETER RANGE:**  
430 TO 900 MM

**BEARING DIMENSION SERIES:**  
30, 31, 32 AND 39

**NO. OF SUPERBOLTS FITTED:**  
4

**LUBRICATION:**  
GREASE, OIL

**YOU WOULDN'T** want to put a lawnmower engine in a Lamborghini, or vice versa. So when Swedish SKF sells precision bearing solutions for demanding heavy duty applications, it recommends high performance bearing housings to match.

A housing, which is static, holds the bearing, lubricating it and protecting it from dust and water. In mining applications such as elevators and conveyor belts, both bearing and housing are subjected to intense vibrations and massive loads.

For its new SED modularised bearing housings, which can weigh anywhere from 2 to 7 tons, SKF's Mekan division fits Superbolt multi-jackbolt tensioners from the Nord-Lock Group as standard. Four are fitted to each housing, allowing for easy assembly and maintenance, which is crucial when the housing is fitted 50m above ground in an elevator tower or hundreds of metres below it in a mine.

SKF Mekan's customers, which includes other companies with similarly inaccessible installations, ap-



PHOTO: SKF

### QUICK AND SAFE

Four Superbolt multi-jackbolt tensioners allow for easy mounting and maintenance in demanding and hard-to-reach mine installations.

preciate the fact that one person using a hand-held torque wrench can quickly and safely install the

multi-jackbolt tensioners. And they know the joint is secure, even in the harshest operating conditions. ■



**ALLAN STEINBOCK**  
SENIOR ADVISOR



**SIMON SEILER**  
SERVICE ENGINEER/FAE



## ASK THE EXPERTS

Do you have a question about bolt securing? Put the Nord-Lock experts to the test.

## The story behind the phenomenon

**Q: What is "the Virgin Bolt Phenomenon"?**

**A:** 'Virgin Bolt Phenomenon' was a phrase coined by Rolf Steinbock during early research on Superbolt tensioners. To establish preload values, corresponding test studs were stretched by torquing a Superbolt tensioner, and the overall length was measured pre- and post-test (using Hooke's Law to calculate load). Inconsistencies in testing were occurring that resulted in a strange curve in the charted data that could not be explained. When re-measuring the studs after the test load had been released, a curious phenomenon was observed whereby the test studs did not always return to their original overall length, causing a significant error (34% in one test).

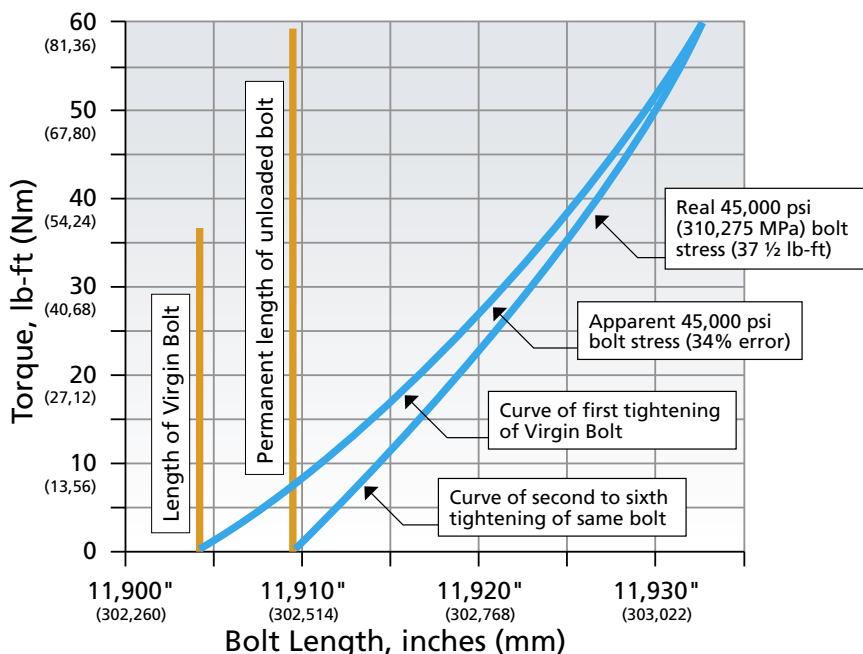
Curiously, this only happened on the very first test. Following this, the studs always returned to their newly established base length. The apparent 'permanent stretch' was not caused by material yielding as tests were performed below yield values. Further

testing indicated that this is an issue with pre-heat treated material being machined down to a stud. It was not observed for post-heat treated bolts. It was suggested that heat treating causes the outside of a bar to harden quickly, placing the core under severe compression and pushing the grains together. Peeling off the outer layer for manufacturing purposes relieves this pressure. An externally applied tensile load on the finished stud effectively re-orientates the grains (like un-kinking a chain).

When critical stretch measurements are required on "virgin" machined studs for test or field service, it is imperative to stretch a stud once and re-establish a new base length to ensure correct values. The 'Virgin Bolt Phenomenon' is not commonly known but is an important variable to take into account when evaluating stretch measurements properly'.

AS

Example indicating the 'Virgin Bolt Phenomenon' on one particular bolt test



A hardened washer transfers the forces into the joint and protects the flange face.



## Sharing the load

**Q: Why does Nord-Lock supply a hardened washer with every Superbolt tensioner?**

**A:** Each multi-jackbolt tensioner (MJT) is supplied with a hardened washer. This is needed because, on the one hand, it transfers the forces into the joint and, on the other hand, it protects the face against high loads.

During the tightening process a very high surface pressure is produced under the jackbolts. The hardened washer spreads the load over the full contact area and offers the jackbolts a hard and flat contact surface. This helps to ensure that the MJTs can be tightened accurately.

Soft surfaces tend to deform or settle. Thicker and larger washers are therefore used to keep the surface pressure as low as possible and to transfer the load optimally.

Washers that are not hardened would deform due to the high localized stresses under the jackbolts, and the pre-load could potentially be compromised. Joints where load is not distributed properly can loosen with potentially serious consequences. Thus, it is absolutely critical to use only genuine Superbolt hardened washers.

Note for maintenance: A hardened washer can be used in spite of wearing marks. Impressions of a few hundreds of a millimetre are normal and acceptable.

SS





## COVER STORY

# MAINTAINING A TIGHT GRIP

Throughout its entire lifespan, a bolt is in constant battle against settlement, relaxation and creep, with the slightest loosening or slackening having potentially devastating results.

WORDS:  
ALANNAH EAMES

PHOTO:  
COLOURBOX & NORD-LOCK







**I** **MAGINE IF A** bolt came loose on a crane, resulting in a 10-ton load dropping on passersby on the street below. Or what would happen if slackening on the bolted joint of a conductor on a power transmission line led to a power outage for several days in a large urban area?

Bolts are the crucial components that hold many critical products in our everyday life together. They need to be robust enough to withstand all types of weather conditions, extreme wear and tear, and, sometimes, being installed incorrectly. All too often, they must battle all of the above, meaning that sometimes the bolt can come loose or slacken. Over time, these miniscule shifts in the bolted joint turn into defects and end up as a costly, time consuming, and, in a worst case scenario, dangerous situation.

For years physicists and experts have battled to come up with solutions to combat loosening, relaxation and creep in bolted joints. More recently, they have been investigating the use of bolted joints in heavy industry where there is a risk of loosening as a result of vibration and dynamic loads from spontaneous movement such as wind or inconsistent usage.

Two terms, 'settlement' and 'relaxation', often crop up in issues related to bolt failures. Settlement is the amount of microns lost between →

## Slackening: an explanation

Slackening is loss of preload due to plastic deformations without any rotary movement, and can cause loosening among other problems. There are three mechanisms that can cause slackening:

**a) SETTLEMENT.** This is caused by plastic deformation of the contact surfaces inside the joint. Settlement changes the length of the clamped members, so the resulting loss of preload can be detected by measuring the length of the bolt.

**b) RELAXATION.** Restructuring of the crystal lattice of the materials converting existing elastic deformation into plastic deformation over time. Relaxation does not change the length of the clamped members or bolt, so the resulting loss of preload cannot be detected. Thus, relaxation is critical for a bolted joint.

**c) CREEPING.** Restructuring of the crystal lattice of the materials causing additional plastic

deformation over time. Creeping changes the length of the clamped members and bolt. Loss of preload can be detected by measuring the length of the bolt.

In bolted joints, creeping and relaxation occur simultaneously, thus both fall under the same category of relaxation, i.e. loss of preload due to plastic deformations from material restructuring over time. □

## “There are a lot of cost-saving issues which, at the end of the day, mean a higher risk of the product failing.”

WOLFGANG TROPFAUER, INNOVATION DIRECTOR AT MOSDORFER

→ the contact surfaces in the joint, for example, the adaptation of the surface roughness. Relaxation is mainly caused by the relaxation of the stressed materials over time. The bolts or the clamped parts might lose their elastic strain, creating a loss of preload into the bolted joint.

“The challenge is related to the balance between the elongation of your bolt and the loss of compression in your parts,” explains Maxime Thonnerieux, Global R&D Director at Nord-Lock. “If you lose microns because of settlement then you will lose elongation of your bolt because everything is connected. The challenge for our customers is to first of all figure out if they have significant settlement in their joint or not.”

If the customer faces settlement or relaxation because of failing to install an adequate secure bolting solution, the next challenge, according to Thonnerieux, is ‘how to fix the problem?’ “If they can access the joint they can retighten it if they have figured out the problem, but this will

be a time-consuming process. Sadly, in a lot of cases, they don’t figure it out until the issue has escalated.”

Having spent over 22 years at Austrian company Mosdorfer working with fittings for overhead transmission lines in the energy industry, Wolfgang Troppauer, Innovation Director, has had first-hand experience about how the combination of creep and poor installation techniques risked jeopardising power lines in Asia. This is one of the reasons why the 300-year old company is taking the problem of creep very seriously.

“**THIS PHENOMENON** of loosening bolts did actually occur a while ago,” reveals Troppauer. “What happened was a combination of a simple bolt and washer connection and relatively poor installation work by the linesman on site, resulting in undue pressure and, in the long term, failure of the bolted joint.”

Creep, especially in conductors, is one of the biggest challenges facing Mosdorfer, which supplies utilities and transmission system operators (TSOs) worldwide with tension and suspension towers, tension strings, fittings from low temperature steel, vibration dampers and roller suspension clamps for low voltage lines. In addition, the quality, and means, of installation on transmission lines varies dramatically from country to country.

“Generally in Europe, workmen are well trained and use cable carts to install the damping system on to the conductors, which makes it much easier for them to work,” he explains. “However, in some other countries, the linesmen have to physically climb onto the conductor bundles and hang 30 to 40 metres in the air. If the bolts are not tightened properly, there’s a real danger that the clamp will loosen and the conductors get damaged or fail completely. There are a lot of cost-saving issues which, at the end of the day, mean a higher risk of the product failing.”

**ONE OF MOSDORFER’S** core products is spacer dampers which are fixed in bundled configurations to keep conductors at a certain distance

from each other on the transmission line and are used to dissipate energy within the conductors. “These are really very important products because if you do not dampen the conductors and dissipate the wind induced energy, and, if, in a worst case scenario, they fall down, the line could blackout for hours or even days,” says Troppauer.

The spacer dampers have bolted clamp connections where the clamp is bolted on to the conductor. The hinged joint is tightened with bolts and nuts. The conductors are usually very dynamic as they tend to vibrate because of wind. If the connection is not robust, there’s a risk that the bolt may come loose.

The conductors are fixed between two towers which are 30-80 meters high; they are weights with static loads which must withstand dramatic temperature differences. At peak times such as lunchtime, the conductors become very warm as a result of the high demand for electricity, while during the night they cool down due to a reduction in the demand for power, as well as cooler evening temperatures. This can mean a temperature difference of 50 to 70-degrees Celsius, resulting in a high speed creeping process.

Conductor creep, due to constantly changing temperatures, can cause the diameter of the clamp to decrease and lose preload. Creep is also exacerbated by the fact that the conductors are made from aluminum, a relatively cheap, lightweight and high conductivity material with high corrosion resistance.

“In our business we have millions of these bolted connections so for each bolted connection that relaxes, there is a major risk of loosening. If there is too much relaxation and the bolt loosens, this could loosen the clamp from the conductor and the clamp could end up moving on the conductor. Even if it moves by just one millimetre, this will damage the aluminium conductor, which is a very serious issue,” says Troppauer.

“Digging a bit deeper into this incident, we discovered that in order to combat creep, the washer would require additional elasticity. We needed to come up with an alternative product that could withstand faults that arose during the installation process, plus extreme weather conditions and heavy loads, in such critical applications,” he continues.

**NORD-LOCK HAS RECENTLY** launched the patented X-series washer that features a unique wedge-effect design combined with an exceptional spring effect. X-series washers have been specifically designed to protect bolted joints from spontaneous loosening and compensate

### FACTS:

#### ABOUT MOSDORFER

**MOSDORFER WAS** founded in 1712 and initially made knives and blades before moving into manufacturing machine parts after the World War II. Mosdorfer specialises in parts for overhead transmissions, supplies utility and grid companies, contracting companies and wholesalers worldwide. The company produces over 30,000 different kinds of overhead transmission line fittings for voltages from 1kV up to 1200 kV. They also make low temperature steel fittings, vibration dampers, and roller suspension clamps for low voltage lines. Mosdorfer’s has clients worldwide, although they are mainly in Europe, the Far East, India, USA, South America and Canada. The company is located two hours south of Vienna, Austria.



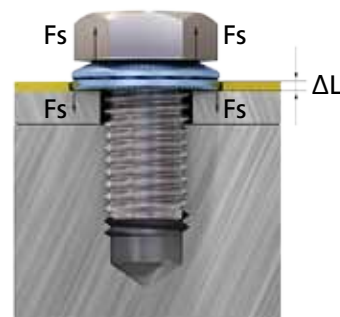
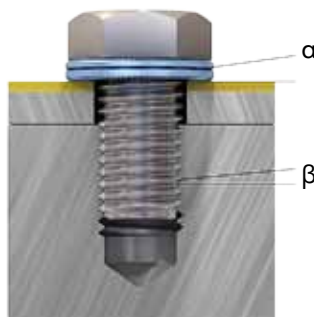
# Combining wedges and spring

**NORD-LOCK'S NEW** patented X-series washer combines the company's wedge-locking technology which prevents spontaneous bolt loosening with an exclusive spring effect that protects against slackening caused by settlement and relaxation. This unique combination means the X-series can offer the highest security for critical bolted joints. As with Nord-Lock's original washers, each washer pair has cams on one side and radial teeth on the other to secure the bolted joint through tension instead of friction. The conical shape of the X-series washers also creates an elastic reserve in the bolted joint to compensate for the loss of preload and prevent slackening. □



The new X-series from Nord-Lock offer the highest security for critical joints and protects against slackening resulting from settlement and relaxation.

## How it works



**UPON TIGHTENING** the fastener, the washers flatten and the serrations engage the contact surfaces. Since the cam angle ( $\alpha$ ) is greater than the thread pitch ( $\beta$ ), the wedge-locking effect will prevent any rotation of the fastener. Directly after tightening, the joint settles and the fastener sinks into the surface material. The washers immediately deflect and the spring effect ( $F_s$ ) counteracts

the slackening movement ( $\Delta L$ ) of the bolt, thereby preventing loss of preload in the joint.

These multiple functions continuously act on the bolted joint to maintain preload and prevent spontaneous bolt loosening, serving as an effective solution for vibration, dynamic loads, settlement and relaxation. (More information: [www.x-series.com](http://www.x-series.com))

for loss of preload caused by slackening. "The X-series is the result of our goal to design a system that would eliminate insecurity," says Maxime Thonnerieux, who is behind the development of the X-series. "Beyond vibration and dynamic loads, the X-series allows us to serve customers with a multitude of other challenging application

areas, such as painted or powder-coated surfaces, soft metals, composites and polymers."

Wolfgang Troppauer and his team are currently testing the anti-loosening feature and the static and dynamic behaviour of the new X-series washers in the Mosdorfer vibration test lab in Austria. The final results will be available in 2013.

"As most of our products are designed for a 30 to 50-year lifespan, we need to simulate them in a 30-year environment. Once they've been installed on high voltage lines, it's not easy to switch the lines off and leave people without power for hours," Troppauer explains, adding that, so far, the results look promising. □

# OPENING UP NEW FIELDS

It seemed like an impossible task. Build an offshore gas platform that was strong and stable enough to withstand the elements in the middle of the North Sea, yet flexible enough that it can still be dismantled and relocated. Using Superbolt assemblies almost six-metres long, Heerema Fabrication Group achieved a world first.

**WORDS:**  
NIC TOWNSEND

**PHOTO:**  
FRANZ RAYMANN & MARTIN JOSSE

**THE F3-FA GAS PLATFORM** is located in the Dutch sector of the North Sea, around 240 km from the Netherlands. On the surface, it looks like any other offshore oil and gas platform – but it boasts one important difference. Unlike all other platforms, when the gas field runs dry, the platform doesn't need to be decommissioned. It will simply be packed up, moved to another location and continue production.

Never before has a self-installing platform of

this size and magnitude been constructed in water this deep. The entire structure, including topside, four suction piles and legs, reaches a total height of 133 metres and weighs over 8,800 tonnes. It's installed far out to sea, in deep water where it will be subjected to strong winds and high waves.

Heerema Fabrication Group (HFG), the company commissioned to build the platform, estimates that over one million man hours have gone into the project. The result is an incredible feat of engineering, and something that is set to change the whole offshore oil and gas industry. →







The entire platform, including legs, is transported out to sea via barge. On arrival the legs are lowered to the seabed. The platform is then raised using strain jacks, before being secured by 16 Superbolt assemblies.

**“The Superbolt MJTs we supplied offer the same security as welding, except they are faster and easier to install.”**

**FRANZ RAYMANN,**  
SERVICE MANAGER, NORD-LOCK GROUP



Franz Raymann, Nord-Lock Service Manager, checks the preload on one of the sixteen Superbolts. Throughout the whole project, Nord-Lock engineers were able to assist with the installation.

## FACTS: HEEREMA FABRICATION GROUP (HFG)

**ABOUT:**  
Leading contracting group, specialising in large and complex structures for the offshore oil and gas industries.

<b>PART OF:</b> Heerema Group	<b>FOUNDED:</b> 1948
<b>NUMBER OF EMPLOYEES:</b> Approx. 1,000	



## Business arguments

- **FAST AND EASY** – Superbolts can be fastened and loosened quickly, unlike welded connections.
- **REUSABLE** – Superbolts can be loosened without damage, and reused.
- **MAINTENANCE** – preload can be monitored at any time.

➔ Gas was first discovered at the F3-FA field of the North Sea in the early 1970s, but has been left untouched until now as the gas deposits are too small to justify building a permanent platform. The industry's current economic model dictates that the value of deposits in any given field must exceed the cost of erecting an offshore rig.

However, since the new reusable platform can service multiple fields in its lifetime, it will change the whole industry and the ramifications are huge. All of a sudden, its now economically viable to tap into the world's smaller reservoirs of oil and gas.

**THE PROJECT STARTED** in 2009 when HFG was originally commissioned to build a SIP (Self-installing platform) – an offshore platform that can be installed without the need of a crane vessel and heavy pile-driving equipment. Similar SIPs had been used before, however only for smaller platforms in shallower, calmer seas. The new installation needed to support a much heavier platform, in much harsher conditions. On top of all that, it also needed the ability to be dismantled and relocated.

So how did HFG solve this seemingly impossible task? Their solution was to use the simplest and oldest fastener in human engineering history – bolts. Supplied by the Nord-Lock Group, the bolts are 5.5 metres long, 24 cm in diameter and weigh over 2,000 kg. Even the nut-style Superbolt tensioners used weigh over 350 kg.

“The Superbolt assemblies we supplied offer the same security as welding, except they are faster and easier to install,” says Franz Raymann, Service Manager, Nord-Lock Group. “We used a special sealed design, which protected the jackbolts in rough conditions. Each of the 36 jackbolts per Superbolt tensioner is individually sealed to protect it from the corrosion and conserve the lubricant. Thus, the jackbolt can be loosened without any damage and the entire connection can be reused.”

With a project of this magnitude having never been attempted before, Nord-Lock engineers were also able to assist the project team with testing, calculations and installation. Another advantage offered by Superbolt assemblies was the ability to check load and preload at anytime.

**THE ENTIRE PLATFORM**, including legs, was constructed onshore and then transported out to sea via a flattop barge. On arrival at the F3-FA gas field, the legs were lowered to the seabed floor, where they were fixed to four suction piles. Using strain jacks, the platform was lifted off the barge and moved to the top of the legs. Once in position, it was fastened with sixteen Superbolt assemblies – four on each leg – preloaded to 12,000 kN each. When fastened, the strain jacks were removed, leaving the entire 4,000 tonne platform hanging on just 16 Superbolts.

Total installation time, from the time the barge arrived on location, took just two days and four hours – quite remarkable for a construction of this size. “Compared to any other fastening method, Superbolt is much quicker and easier,” adds Raymann. Speedy installation was also important as the barge was vulnerable to rough weather until the platform was secured.

“The use of Superbolts also ensures the installation process is reversible and repeatable. Bolts can be unfastened and reused, which is the essence of a re-locatable platform.”

For HFG, the Superbolts are a perfect solution. “Nord-Lock's nicely designed Superbolts and the smart tensioning system made the innovative F3-FA platform possible,” claims Frank Slangen, the F3-FA project manager for HFG.

Currently the F3-FA platform is the only offshore platform of its kind, but the success of the whole project and the potential it offers means it won't be long before more are built. With a proven bolting solution that has also shown it can meet the demands of such an application, Nord-Lock can expect to be called upon again. □



Thomas Berglund uses Nord-Lock washers on his bike when participating in the legendary Dakar Rally from Peru through Argentina to Chile.

## FACTS: THOMAS BERGLUND

**ROLE:** Dakar Rally Contestant for the fifth time.

**BACKGROUND:** Has been with the Swedish army since completing his military service. Today, he is captain of the Life Guards, a combined cavalry/infantry regiment with responsibility for training. Practices amphibious running to stay in shape for Dakar.

**LIVES IN:** Vallentuna, Sweden.



# Competing in the world's most dangerous race

**WORDS:**  
LINDA KARLSSON ELDH  
**PHOTO:**  
RICKARD KILSTRÖM

**IN JANUARY 2013**, the legendary Dakar Rally started in Peru for the first time and end in Chile, having crossed the Andes into Argentina. The rally has resulted in numerous deaths over the last 34 years and is known to be more about competing with the harsh environment than with the other contestants. Participating for the fifth time in the motorcycle class, Swede Thomas Berglund aimed to put the 8,000 km route behind him as one

of the top 10 drivers. Bolted had a chat with Thomas before the start of the rally.

**Why is the Dakar rally considered to be so dangerous?**

"We drive up to 900 km every day for a total of two weeks in some of the world's most extreme off-road terrain. In temperatures of up to 50°C, we cross deserts that shift from huge sand dunes to camel grass, as well as mountainous areas with stretches of sharp, loose rocks. More than half of the contestants are forced to quit because of injury or mechanical problems."

**What is the biggest mechanical challenge?**

"Many unexpected problems can occur. Last year, the petrol boiled in my tank and the bike just wouldn't run. But the biggest problem is the vibrations. A Dakar rally motorcycle has to be customised with a lot of additional equipment mounted on the chassis. Most important is the navigation tower in front of the bike containing road book, GPS, compass, double trip meter, antennas and other electronics. The navigation tower weighs 8kg and is mounted on the bike's steering head, which

has a very small mounting surface. It is common for the bolts to loosen due to the extreme vibrations and the whole navigation tower can fall off. It happened once in 2012 and in 2011 the whole handlebar came loose twice."

**Is it not possible to retighten the bolts during the race?**

"The real check is made by my service team during the nighttime break. When I'm out on the track in the middle of the desert, I'm on my own with just a few tools for an emergency repair. I don't have any extra washers with me and retightening bolts takes too much time. Since I'm on the road for up to 12 hours every day, I need to rely on the bolts not loosening."

**Have you found a solution to this problem?**

"For the 2013 rally, I secured all the bolted joints of the additional equipment mounted on my bike with Nord-Lock X-series washers. I chose these because they offer the highest security on the market. One of their biggest strengths is that they also lock the bolts against soft materials like aluminum and plastic, which tend to move and change shape during a race."

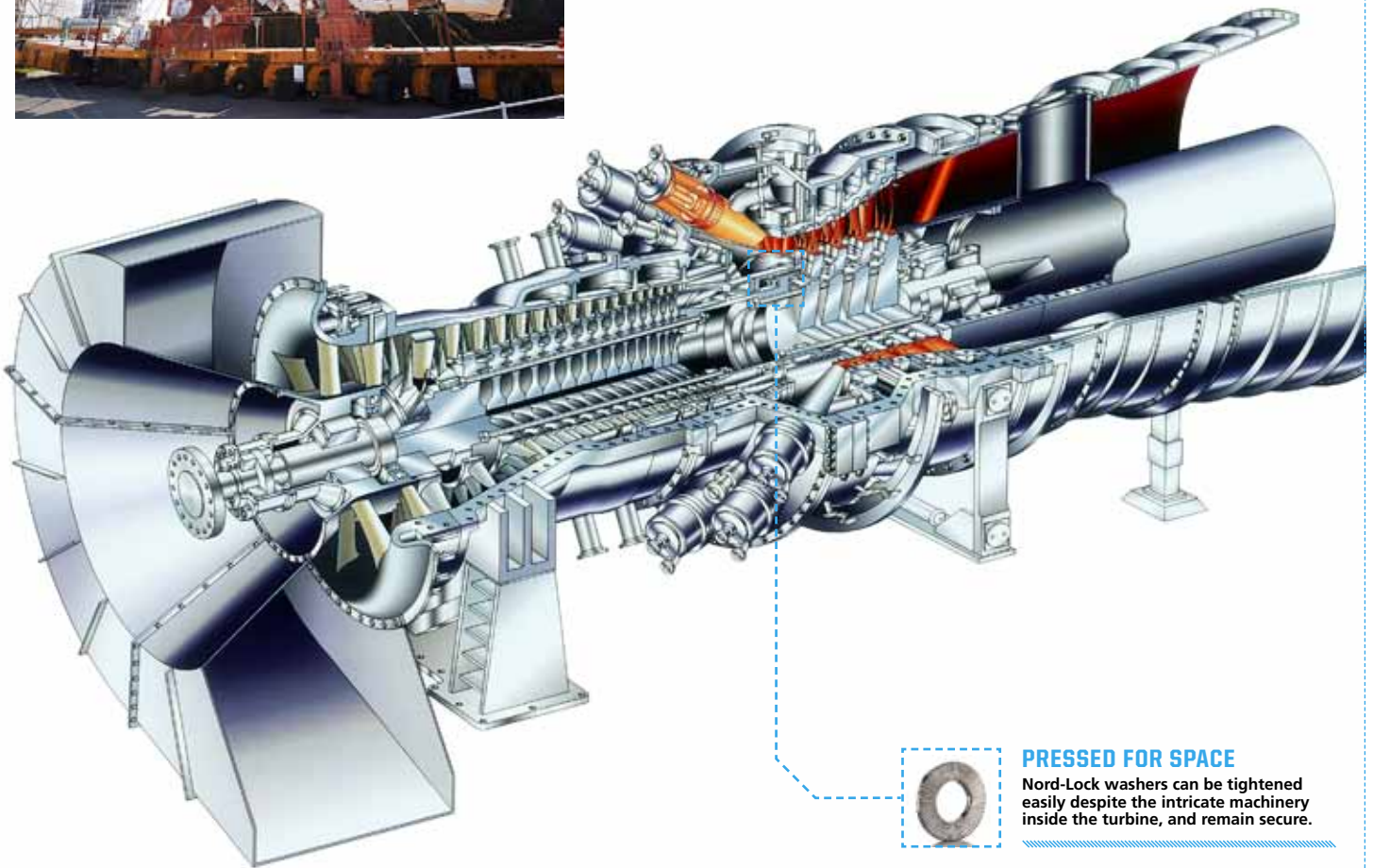
**What outcome do you expect?**

"What I have been dreaming about for the past few years is a Dakar rally where everything simply works as it is supposed to. The two biggest changes in 2013 are the new bolt security and a new tank system. I hope these will prevent problems and give me the flow that I have been waiting for since my Dakar rally back in 2007." □

**UPDATE:** During the editing of the magazine Thomas had to withdraw at the 12th stage of the rally.



Mitsubishi Heavy Industries' ultra-large turbines are more than six metres tall and over 16 metres long, making challenges of heavy vibration unavoidable.



### PRESSED FOR SPACE

Nord-Lock washers can be tightened easily despite the intricate machinery inside the turbine, and remain secure.

# Eliminating bolt loosening for good

**WORDS:**  
CAROL AKIYAMA

**PHOTO:**  
MITSUBISHI HEAVY INDUSTRIES, LTD.

**THE CHALLENGE** At power plants across the world, gas turbines are becoming increasingly vital to the world's power supplies. Mitsubishi Heavy Industries currently manufacture ultra-large gas turbines, which are more than six metres tall and over 16 metres long. With such huge precision rotating machinery, vibration is unavoidable, and until recently wiring or tongued washers have been used as fastener rotation-prevention systems.

However, since the inside of a gas turbine

is an intricate piece of machinery filled with a wide variety of assembled components, space is limited and work is difficult to perform. Wiring and tongued fixtures require skill to install, and so Mitsubishi Heavy Industries decided to look for a new solution that was easier to assemble and inspect periodically.

**THE SOLUTION** In their quest to find a new solution, Ryosuke Fuji of Mitsubishi Heavy Industries visited Nord-Lock, where they performed fastener-loosening tests. The results exhibited were exceptional, showing that Nord-Lock washers prevented rotation even under extreme vibration.

Mitsubishi Heavy Industries also had good experience with Nord-Lock, having used their

washers on a gas turbine in a demonstration plant in Takasago, Japan. For over four years, all critical joints remained secured.

**THE RESULT** Currently, Nord-Lock washers are being applied in Mitsubishi gas turbines at power plants in Japan and overseas, including the new J model gas turbine, which was shipped in 2011 and boasts the world's highest electricity-generation efficiency.

For Mitsubishi Heavy Industries' customers, Nord-Lock washers mean preventing bolt loosening is now easy and secure, ensuring stable supply of power. In fact, since the application of Nord-Lock washers there has not been even one case of bolt loosening. □



## Chalmers takes the chequered flag

**YOUNG ENGINEERS** from Gothenburg's Chalmers University of Technology – proudly partnered by Nord-Lock – have won the world's largest student engineering competition.

After ten months of designing, building, testing and competing, a team from Chalmers took the chequered flag in the Formula Student competition held at the UK's Silverstone Circuit.

"Winning this competition is a really big deal for Chalmers and an awesome feeling for the students involved," says Chad Thomas, Technical Chassis Team member, who is studying for a Masters at the university. "The team really poured their lives into the car."

The Chalmers car, secured with dozens of Nord-Lock washers at crucial bolted joints, beat 102 other single-seaters in the Class One classification of July's competition. The car was entirely built by the students, with the only exceptions being the highly complex components such as the engine electronic control units.

"Formula Student is an excellent educational tool which helps deliver the engineers of tomorrow; learning by acquiring the skills we as teachers cannot teach in a classroom situation," says Jonathan Rice, project leader.

"We carried out a pre-study for two weeks, followed by an eight week design phase," says Prashanth Sekhar, Communication Team member, who is also taking a Masters at Chalmers. "The manufacturing phase lasted for twelve to fourteen weeks, followed by ten to twelve weeks of testing before the actual competition itself."

The same Chalmers team also placed third in the Formula Student German competition in August, meaning the university is now ranked 10th out of some 500 teams worldwide.

**NORD-LOCK'S PARTNERSHIP** with the Chalmers team is now in its second year. Race rules state that it must be possible to visually inspect bolt locking solutions. Thus, the team was obliged –



**FACTS:**  
**CHALMERS'**  
**SINGLE-SEAT**  
**RACECAR**

**ENGINE:** 90 hp Yamaha  
four-cylinder, 600 cc  
**ACCELERATION:** 0 to  
100km/h in 3.5 seconds  
**WHEELBASE:** 1,250 mm

After ten months of designing, building, testing and competing, a team of young engineers from Gothenburg's Chalmers University of Technology won the Formula Student competition held at the UK's Silverstone Circuit.

PHOTO: ANNA SIGVARDSSON

unnecessarily, from a technical point of view – to also use nylon insert lock nuts.

"We used the Nord-Lock washers to maintain pre-tension on the bolts," says Thomas. "We found that when we lost pre-tension, the handling suffered and the car became really sloppy to drive. Maintaining pre-tension also allowed us to

design for constant pre-tension, instead of for shear loads."

So what is the opinion of these aspiring engineers regarding the Nord-Lock solution? "Really awesome," says Thomas. "In 1,000 km of testing we never had a single issue with bolts backing off." □

DAVID WILES

## Nord-Lock among Lean award finalists

**NORD-LOCK'S LEAN** Production System has led to major improvements since it was introduced at the company's Swedish factory in 2006. Now Nord-Lock's efforts have gained national recognition, with the company among the five finalists for the Swedish Lean Awards 2012.

Eric Jonsson, Nord-Lock's Lean Manager, shared the company's experiences as keynote speaker at the recent lean seminars at the MAX

Manufacturing & Automation Expo in Stockholm in October, together with glue line operator Jonas Panther, and Tooling Department team leader Leif Petersen.

The results of Nord-Lock's Lean production work have impressed both inside and outside the company, achieving the kind of improvements that usually take ten years or more to realise. This year, employees at Nord-Lock's Mattmar factory

have come up with 900 suggestions for improvement in their own work. About 550 have been implemented so far.

For customers, the results of the new lean culture are visible in terms of significantly improved lead times. Improved order precision and reduced waste are among the other benefits. The Lean Production System is now being introduced at Nord-Lock's US and Swiss manufacturing sites. □



Have fun on your smartphone with Nord-Lock.

## Entertaining and enlightening app



**GOT TIME TO** kill while waiting for a flight or a delayed business meeting? A new app from Nord-Lock lets you put that time to good use; you can learn about common causes of bolt failures and how to prevent them, while enjoying yourself.

The aim of 'Avoid the Traps', which is available for iPhones and Android phones, is to successfully navigate a ball bearing through a challenging maze. While you play, you are offered useful tips on how to achieve the ultimate bolted joint design.

The app is part of the launch campaign for Nord-Lock's new X-series washers, which counter both spontaneous bolt loosening caused by vibration and dynamic loads, and also slackening resulting from settlement and relaxation. □

Scan the QR-code to download your version of 'Avoid the Traps' from Nord-Lock.



## No loosening in steel structures

Issues with loosening bolts in steel constructions are solved with Nord-Lock's new SC-washers.

**UNTIL RECENTLY THERE** was no satisfactory way to secure HV bolts (according to EN 14399) used in structural steelwork such as bridges or ceiling-mounted cranes. When bolts came loose due to vibration or dynamic loads, there was no solution apart from the time-consuming and expensive process of retightening.

But now Nord-Lock has introduced a new range of washers specially designed to fit the HV bolting systems used for steel construction in Europe. The SC-washers (steel construction washers) have received certification in Germany from the DIBt (German Institute for Civil Engineering) and European certification is pending.

"When vibrations occur in these structures, the bolts fitted with the original washers from HV sets loosen and it is not possible to maintain the clamp load," says Frank Hüssing, Nord-Lock sales engineer in Germany. "The industry has long been searching for a solution, so we came up with a specific new product to fit the existing bolting system and the very specific geometries that are demanded."

In Germany the commonly used HV sets consist of one bolt, two washers with special chamfering,



Nord-Lock's new SC-washers are specially designed to fit the HV bolting systems used in steel construction in Europe.

and one lubricated nut. All parts are zinc coated. Nord-Lock's SC-washers can be exchanged for the original washers as they have the same inner and outer diameter. In order to fit the special geometry of the bolt head, the Nord-Lock washers have a particular chamfer at the inner diameter. The pair of Nord-Lock's SC-washers feature chamfers on both sides to eliminate the risk of incorrect assembly.

Nord-Lock started marketing the product directly to customers in Germany this year. As our SC-washers are used mainly in conjunction with HV sets, they will be available through distributors as well as through direct sales.

Hüssing says that feedback from customers so far has been very positive. "Whenever bolts in these steel constructions start to loosen the company has to send a technician to retighten them. This is costly and means the bolt security is no longer guaranteed. So customers really appreciate having a bolt securing system in which these problems do not occur, even under dynamic loads and vibrations."

Sales to customers in the rest of Europe will start once European certification has been received. "However, this will never be a standard product, but a highly specialised product that is desperately needed in this specific industry," says Hüssing. □

DAVID WILES

## Oil & Gas brochure available now

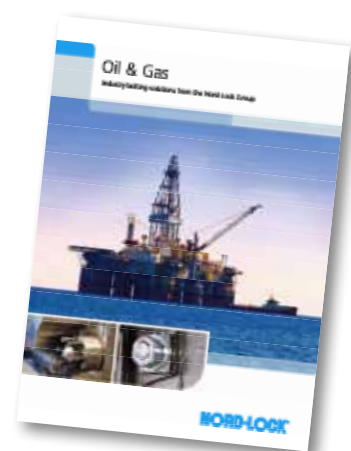
**THE NORD-LOCK GROUP'S** bolting solutions for the oil and gas industry are presented in a new brochure. The brochure, which can be downloaded from the Nord-Lock website, highlights the specific bolting challenges of the industry today and how Nord-Lock Group products are solving them.

Containing case studies and application information, the publication is targeted at engineers and maintenance personnel working

with equipment for the oil and gas industry, and decision makers in all sectors who value safety, profitability and minimal maintenance.



Nord-Lock has extensive bolting experience in the industry and its products are used throughout the sector, from drilling equipment and remotely operated vehicles to derricks, cranes and petrochemical plants.

Download the brochure at [www.nord-lock.com/oil-gas](http://www.nord-lock.com/oil-gas). □





## Comparing Nord-Lock X-series with serrated spring washers

	NORD-LOCK X-SERIES	SERRATED SPRING WASHERS
		
DYNAMIC LOADS	Proven to be extremely effective against vibration induced loosening in a wide range of application environments.	Generally adequate resistance against vibration but only when tightened to a high preload.
FRICTIONAL SCATTER	Less frictional scatter resulting in low preload deviation.	Not easy to obtain the required preload due to dispersion of friction. Thus, the functional preload range is narrow.
STACKING	Nord-Lock X-series should be used one pair at a time and are not meant to be stacked.	Stacking is not recommended.
SETTLEMENT AND CREEP	Nord-Lock X-series provide significant elastic reserve to counter settlement and creep.	Provide no elastic reserve.
REUSABILITY	Can be reused.	Not recommended.
BOLT GRADES	Can be used with bolt grade up to 12.9.	Can be used with bolt grade up to 10.9.

## MYTH BUSTERS

**THE MYTH:** It takes longer to install a Superbolt (MJT) than the solution you already have.

**THE TRUTH:** If only the time to turn or stretch an individual fastener is considered, other methods appear to be faster. However, if handling of heavy hydraulic equipment is considered, which often requires two workers to operate, it is much faster to mount MJTs in terms of man hours. An M48 Superbolt tensioner can be tightened in only 90 seconds with a standard manually operated torque wrench. Large MJTs can be tightened with pneumatic torque wrenches very quickly.

Example: (18) 5"-8 tpi (approx 130 mm diameter) MJTs were tensioned on a boiler feed pump in 2-1/2 hours versus 10-12 hours with the old method using large hydraulic wrenches. MJTs tighten in pure tension and eliminate thread galling which causes damage and delays. Since only simple hand tools are required, no crane time or large tool sharing is needed, allowing several workers to install multiple MJTs at the same time. Many examples and time studies are available at [www.superbolt.com](http://www.superbolt.com). □

## Forums to continue following hydro success

**NORD-LOCK'S SUCCESSFUL** first industry forum, which focused on the renewable energy sector and was attended by both customers and industry experts, is to be followed by similar events for other sectors.

The aim of the Renewable Energy Forum was to share ideas and experience and to discuss solutions to some of the key challenges of the hydropower sector, such as maintenance intervals in demanding environments, and corrosion.

Rather than being a sales-led event, the technical forum, held at

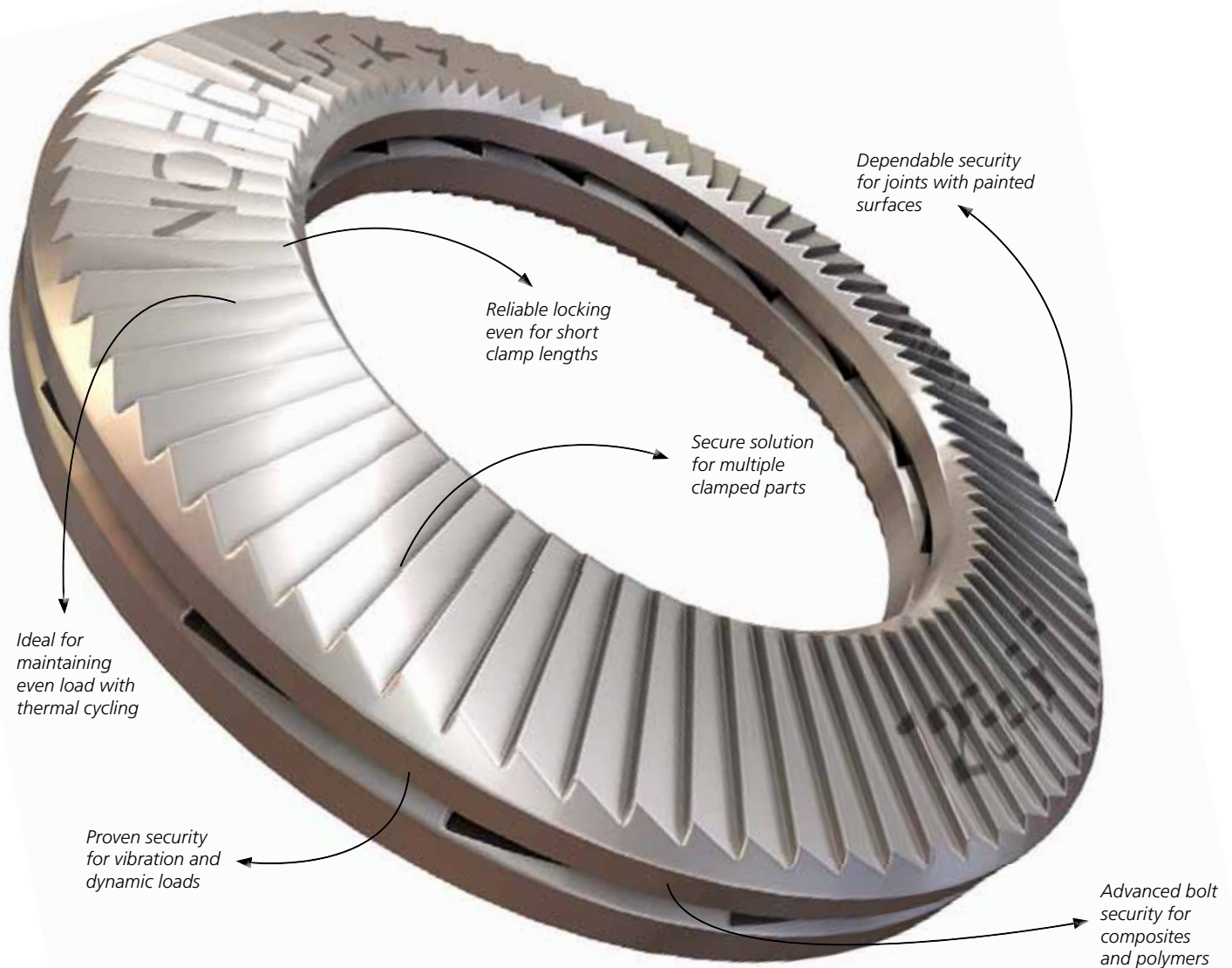
Nord-Lock in Saint-Priest, France over two days in June, was hosted by Nord-Lock as a multidisciplinary, integrated seminar addressing technical issues. Participants included engineers and managers from some of Nord-Lock's global hydropower key accounts.

A similar event, this time for the rail industry, is now being planned by Nord-Lock for this year, again in France. Following this, a second renewable energy forum in mid-2013 will continue the discussions that started at the first event. □



Nord-Lock is planning an industry forum for the rail industry.

# A new evolution in bolt security



Now, Nord-Lock adds a new dimension of safety to bolt security with a unique multifunctional wedge-locking solution.

X-series washers ensure that you can find exactly what you need to handle multiple challenges — vibration, dynamic loads, settlement and relaxation — in a single solution.

Find out how Nord-Lock X-series washers can help you solve multiple bolt securing challenges at once.

[www.x-series.com](http://www.x-series.com)

**Bolt security without compromise**



**NORD-LOCK®**  
Bolt securing systems