*An on-site training course from Bolt Science*

*Essential skills training for Engineers*

# Bolting Technology

***An on-site training course produced and managed by Bolt Science.***

***The course is designed for Designers and Engineers who are responsible for the installation, specification or design of bolted joints.***

BOLT SCIENCE
Expertise in Bolted Joint Technologies

***This course is also available online from www.bolting.info***

# Training Course on Bolting Technology

## Why you should enrol on this online course?

*Threaded fasteners are a notable cause of service and other related problems. Besides possible safety implications, fastener failures can represent a significant proportion of a product's warranty costs. This training course presents key knowledge and facts to an Engineer to enable reliable bolted joints to be assembled.*

## Who should enrol on this course?

*The course material is designed for:*
*Maintenance Engineers*
*Design Engineers.*
*Project Leaders.*
*Engineers with responsibility for solving service problems.*
*Engineering Supervisors*
*Engineering Managers*

## Ten key benefits of this training course

*This training course will help you to*

1) *Be able to identify the markings on bolt head and nuts and to match the nut to the bolt to avoid thread stripping problems.*
2) *Understand key terms used in reference to bolting.*
3) *Have knowledge and be able to recognise the common modes of failures of fasteners.*
4) *Understand why there can be such a significant variation in the clamp force that results when a bolt is tightened and how this can be reduced.*
5) *Appreciate how the torque is distributed within a bolted assembly.*
6) *Learn the differences between a manufacturing and design quality defect in relation to threaded fasteners.*
7) *Understand the several methods that can be used to tighten bolts and the pros and cons for each.*
8) *Understand what is the main cause of fasteners coming loose and how it can be prevented.*
9) *Have knowledge of the effect that elastic interaction can have on the load distribution within a multi-bolt joint and how such effects can be reduced.*
10) *Understand what a tightening procedure is and be able to provide an outline of the content for a suitable procedure for a particular joint.*

## Course Documentation

*A training course handbook is provided online in Adobe pdf format to all people who enrol on this course. The handbook contains background information to the material presented in the course presentations together with appendices containing tables of thread size details, fastener material strengths and a glossary detailing the key terms used in bolting technology.*

*The course has tests and quizzes that allow you to assess your knowledge and understanding of the course material.*

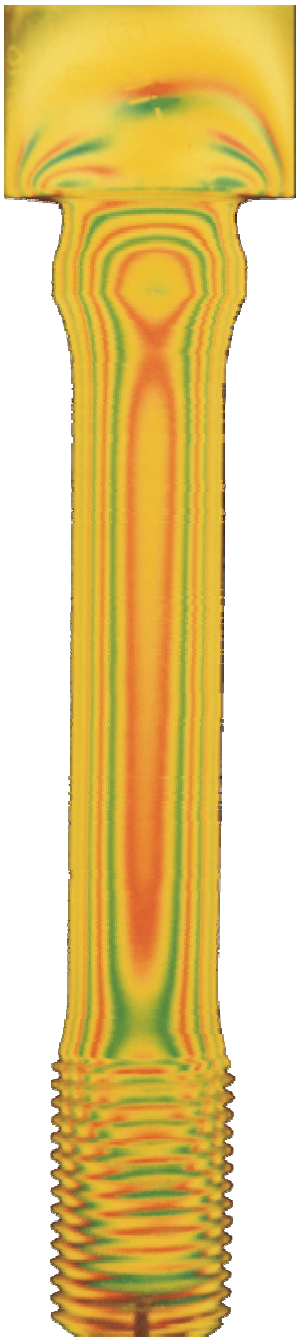
## Help and Assistance

Bill Eccles is a consultant mechanical engineer with 30 years experience in mechanical engineering with the last 13 specialising in bolted joint technology and analysis. He is a Chartered Engineer, a member of the Institution of Mechanical Engineers and a registered European Engineer.

### *Tailor-made training for your organisation*

*This course can be presented exclusively for your organisation on an in-company basis, tailored to meet your specific requirements. The course material can also be provided for use by your employees over your company Intranet.*

*To discuss your needs and find out what Bolt Science can offer you please ring Bill Eccles on +44 1257 411503.*



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# Training Course Agenda

### Introduction to Threaded Fasteners

- *Know the meaning of thread terminology.*
- *Learn when it is appropriate to use a fine rather than a coarse thread.*
- *Be aware of the principal bolt and nut strength property classes and how they should be specified.*
- *How to match the nut strength to that of the bolt so that thread stripping problems are prevented.*
- *Why bolt tensile fracture is preferable to the threads stripping.*
- *Learn what the proof load is and why it is used.*
- *Be able to identify the meaning of the markings on bolt heads and nuts.*
- *Learn about the thread stress area and how it is derived and used.*
- *Be able to calculate the tensile strength of a threaded fastener.*
- *Understand how a pre-tensioned bolted joint sustains an applied load.*

### Preload Variation in Threaded Fasteners

- *Learn why there can be such a significant variation in the preload (tension in the bolt) and the consequences of this.*
- *How the torque is distributed between the threads and the nut face when free spinning and torque prevailing fasteners are used.*
- *Why preload is so crucial in a bolted joint.*
- *How preload variation can be accounted for at the design stage.*
- *The effect of the tightening method on the preload variation sustained by a fastener.*

### Galling of Threaded Fasteners

- *What is galling and what types of materials tend to be affected.*
- *Examples of fastener threads that have galled, sectioned and x-ray photos.*
- *Four ways that galling can be eliminated.*

### Methods of Tightening Threaded Fasteners

*Have an understanding of the principles behind each of the following tightening methods:*

- *Torque controlled tightening.*
- *Torque-angle controlled tightening.*
- *Yield controlled tightening.*
- *Bolt stretch method.*
- *Heat tightening.*
- *The use of load indicating methods.*
- *The use of ultrasonics to determine bolt loading.*

### Failure Modes of Threaded Fasteners

- *Learn the differences between a manufacturing and design quality defect.*
- *Be able to identify whether a failure is due to a fault in the design specification or is manufacturing related.*
- *Learn the 5 main design related failure modes of threaded fasteners and bolted joints.*
- *Have knowledge of the critical importance of a fastener's clamp force in ensuring a joint's structural integrity.*
- *Why the joint design normally prevents bolt overloading.*
- *Learn about fatigue and where failures normally occur on a threaded fastener.*
- *Why bearing stress can be crucial in ensuring a reliable joint.*
- *Learn about the nature of internal and external thread stripping failures.*

### Vibration Loosening of Threaded Fasteners

- *Have an overview of the research completed over the last 50 years into establishing the cause of the self-loosening of threaded fasteners.*
- *Appreciate the forces that are acting on the threads that tend to self loosen a fastener. Why fine threads can resist loosening better than coarse threads. The inclined plane analogy.*
- *Learn about the work completed by Goodier and Sweeney into loosening due to variable axial loading.*
- *The work completed by ESNA and the theory of shock induced loosening and resonance within fasteners.*
- *The MIL-STD 1312-7 vibration test for fasteners.*
- *Junker's theory on self-loosening of fasteners and why fasteners self-loosen.*
- *The Junkers/transverse vibration test for fasteners.*
- *The influence that vibration amplitude has on the fastener self-loosening rate.*
- *Preload decay curves and the effectiveness of various fastener types in resisting vibrational loosening.*
- *The findings of Haviland and Kerley and how fasteners can come loose as a result of bending, shock or impact and differential thermal expansion.*
- *Conclusions from the research and how loosening can be prevented.*

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## Also Available online from www.bolting.info

# Training Course Agenda

## (Continued)

### Torque Control

- *What is meant by a tightening torque, units used to measure torque.*
- *What are the consequences of not applying sufficient torque to a bolt.*
- *How torque is absorbed by a nut/bolt assembly.*
- *The torque-tension graph.*
- *The relationship between the tightening torque and the resulting bolt preload (tension).*
- *The factors which affect the torque-tension relationship.*
- *The nut factor method of determining the correct tightening torque.*
- *Example calculation of how to determine the correct tightening torque.*
- *Scatter in the bolt preload resulting from friction variations.*
- *Determining the bolt preload (tension) resulting from a tightening torque.*
- *Prevailing torque fasteners (such as those containing a nylon insert) and how it affects the torque distribution and what is the correct torque to use.*

### Load Sensing Fasteners

- *The use of strain gauged bolts.*
- *The use of load cells.*
- *The use of Rotabolts™.*
- *The use of Smartbolts™.*
- *The use of direct tension indicators (load indicating washers).*
- *Squirter™ direct tension indicators.*
- *Tension control bolts.*

### Hydraulic Tensioning of Threaded Fasteners

- *The principles behind hydraulic tensioning.*
- *The number of tensioners and that are used to tighten a joint – 100%, 50%, 33% and 25% tensioning methods.*
- *The effect of elastic recovery on the tension induced into a bolt.*
- *The use of hydraulic nuts and the sequence used to tighten them.*
- *The use of oil filled nuts.*
- *The use of rubber filled nuts.*

### Tightening Procedures

- *The problems of tightening multi-bolt assemblies.*
- *Elastic interaction or bolt cross-talk.*
- *The use of a tightening sequence.*
- *The single pass tightening sequence.*
- *Tightening sequences for non-circular bolt patterns.*
- *Tests completed to verify tightening sequences.*
- *The two pass tightening sequence.*
- *The use of multiple tightening tools.*
- *Bolt cross talk and hydraulic tensioning.*
- *Methods that can be used to check the tightening sequence.*
- *The solder plug method.*
- *The use of pressure sensitive films.*
- *Establishing a tightening procedure.*
- *Examples of tightening sequences for circular joints consisting from 4 to 32 bolts are given in the handbook together with an example tightening procedure.*

## On-site Training

This course can be tailored to meet your specific training needs. Material can be added from other courses we offer, such as our course on the analysis of bolted joints. For a quotation or a discussion on your requirements please contact:

***Any questions? Contact Bill Eccles on +44 1257 411503***

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