

BOLT SCIENCE



Fundamentals of Threaded Fasteners and Bolting

An online distance learning course for Technicians, Inspectors, Maintenance and Field Engineers who are responsible for or involved in the use and application of threaded fasteners and bolted joints.

Practically every engineering product with any degree of complexity uses threaded fasteners. Although threaded fasteners are generally considered a mature technology, significant problems exist with their use. Incorrect selection and tightening of a fastener can result in loosening, fatigue, and thread stripping issues, amongst others, that can have serious implications for a joint's structural integrity. Such joint failures are widespread across many industries and often involve material loss and sometimes fatalities.



This online training course on the fundamentals of threaded fasteners and bolting seeks to provide the background knowledge to allow problems to be identified and the likely root cause established. It also identifies what constitutes best practice.

The training covers an introduction to fastener threads, strength of bolts and why they should normally be tightened. Failure modes of fasteners and their identification is covered, such as self-loosening, fatigue, and thread stripping. Torque tightening, bolt preload and the practices used to check the tightness of bolts are presented. This training does not cover in any calculations. Another course offered by Bolt Science covers this aspect (the Bolting Technology for Engineers and Designers online course).

The material covered in this online distance learning course is presented below. Each person will be provided with unique details to allow them to access the training (a user ID and password). These will allow you to log onto the training from wherever you have an Internet connection, at whatever time, on whatever device provides web access. The course is made up of a number of presentations, quizzes, and other material.

Included in the training are case studies. These case studies are drawn from various industry sectors. Catastrophic accidents have occurred as a result of the failure of bolted joints, they illustrate what can go wrong when bolted joints fail and what lessons can be learned. There is a course handbook provided as part of the training that can be viewed online and downloaded and printed.

Introduction to Threaded Fasteners

- Some thread terminology.
- Background to modern threads - the roles of Whitworth and Sellers and the development of the metric thread.
- The Coarse, Fine and Constant Pitch thread series.
- The difference between a fine and coarse thread and the advantages/disadvantages of each.
- The design profiles of the Unified and metric thread forms and the relevance to thread tolerancing.
- Thread tolerance positions and grades and the different tolerance classes that are available.
- How strong is a screw thread. The stress area, what it is and how is it derived.

Introduction to the Strength of Bolts and Nuts

- The essential material characteristics for a bolt.
- The principles of bolt elongation, bolt stress and load.
- Yield, tensile strength, and proof load properties.
- Details of common bolting specifications.
- Upper and lower strength limits for bolts.
- Identifying bolts and nuts. Bolt and nut head markings and identification of their strength grade.
- Stainless steel fasteners.
- Nut/bolt combinations, nut strength versus bolt strength. The matching of the nut to the bolt.
- Proof load testing of bolts and nuts.
- The correct selection of washers.
- Bolting specifications and their importance.

Fastener Failure Modes

- Overview of the ways threaded fasteners can fail.
- Tensile fracture of bolts.
- Galling of the thread or bearing face.
- Internal and environmental hydrogen embrittlement.
- Thread stripping of the internal and external threads.
- Loosening of bolts – relaxation and self-loosening of bolts.
- Fatigue failure of bolts.
- Thread Stripping Failures - internal and external threads.
- Bolt overload and wear failures.
- Bearing stress under the bolt head or nut face.

Why bolts should be tightened

- Why bolts should be tightened.
- How a preload joint sustains an axial load.
- How shear load is transmitted, a friction grip joint.
- Joint separation – what is it and why is it important.
- Why tightening bolts is important for shear loaded joints.
- Explanation of why the bolt usually sustains a small proportion of an axial load.

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.
- Scatter in the bolt preload resulting from friction variations.
- 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.
- Tests to determine the coefficient of friction of threaded fasteners and the optimum torque value.

Torque Auditing

- What is meant by torque auditing. Why is the checking of a torque value completed.
- The residual torque value of a bolt.
- The break loose torque of a bolt.
- Over and under-tightening of bolts.
- The different torque auditing methods available.
- The on-torque residual torque method.
- The off-torque residual torque method.
- The marked fastener residual torque method.
- What is a static audit torque.
- Issues with torque auditing, relaxation loss and the re-use of threaded fasteners.
- Witness or stripe marking of bolts.

Introduction to the Self-Loosening of Bolts.

- Non-rotational loosening (relaxation) and rotational loosening (self-loosening).
- What are the reasons why threaded fasteners come loose.
- The Junker theory of loosening and the transverse vibration test for fasteners.
- The effectiveness of different locking methods in preventing self-loosening. The effectiveness of fasteners having a prevailing torque to resist loosening.
- Videos and the results of tests on various locking devices.
- Conclusions from the research and how loosening can be prevented.

Case Studies.

Investigation of previous failures and accidents can assist in educating Engineers in preventing problems from re-occurring. Learning from the failures of previous generations is one way in which progress is achieved.

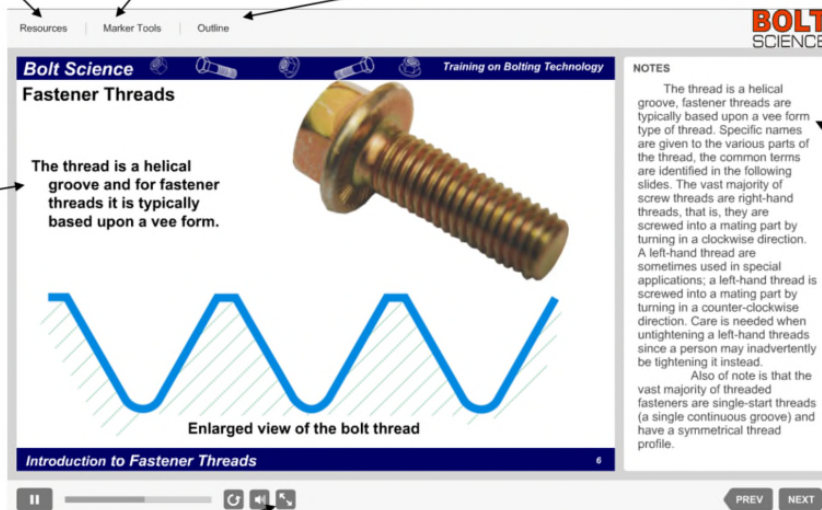
Features of the Training

Resources – Additional resources relating to the presentation

Marker Tools – Allows you to highlight parts of the presentation.

Outline – Shows a list of all the screens to aid navigation.

Screen Area showing the presentation itself.



Notes – Provides additional information relating to the material shown on the screen.

Maximise – Maximises the presentation to full screen

Navigation – Move forward or backward on the presentation

Nature of the training material

- ❑ The training is completely online and can be taken whilst at work on a PC, or if you wish, from home or other location using a laptop, or a tablet device such as an iPad.
- ❑ The pace at which you go through the training is up to you. The LMS (Learning Management System) that the presentations are linked to, will track your progress as you complete the training modules and quizzes.

Access to the Training

- ❑ You will have been provided with details that give you access to the training (a user ID – which is normally your email address and password) that will be unique to you. The training is available for at least three months from being provided with your user ID.
- ❑ These will allow you to log onto the training from wherever you have an Internet connection, at whatever time, on whatever device provides web access.
- ❑ The course is made up of a number of presentations, quizzes and other material. We recommend that you study the course in the order that it is presented on the course content list.

What do people say about Bolt Science Training

'This course provided an exceptional insight into bolting technology. It covered a thorough range of topics from fastener design first principles to failure analysis. From an engineer's perspective it is an excellent course delivering a unique insight into a subject that is an often misinterpreted basic engineering fundamental. The engineers who attended from BAE Systems found the course extremely valuable, gained a great deal of knowledge over the 2 days and ranked it as a superb, informative course.'

Andy Lovatt BAE Systems Land (UK)

'It is amazing how much from the course we are able to apply on a daily basis.'

Jason M Hall Cummins Turbo Technologies

'I just finished the Bolt Science course, which was really informative, thanks.'

Mitchell Kane Science and Technology Facilities Council (STFC)

'I thoroughly enjoyed the course and will definitely use the knowledge in my day-to-day activities.'

Paul Posterino Ford Motor Company