



Fundamentals of Bolted Joint Assembly Training Topics

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Following is a summary of potential training topics that can be delivered to suit a company's or organization's specific requirements. Customization may include unique fastener sizes, materials or conditions, particular problems, or other topics the client provides.

Introduction to Course

- *Introductions*
- *Primary Bolted Joint Application Types*
- *Bolted Joints – There is more to it than you may have thought!*
- *Dunning-Kruger Effect*
- *Reference Books and Standards*

Overview of the Methods of Tightening Threaded Fasteners

- *Overview of the methods used to tighten bolts.*
- *Load-angle of turn graph for a bolt tightened to failure.*
- *Torque control tightening.*
- *Torque control and angle monitoring tightening*
- *Torque plus angle control tightening.*
- *Yield control tightening.*
- *Direct tensioning.*
- *Tension-indicating methods using load-indicating bolts and washers.*
- *Application of ultrasonic technology and other instrumentation in bolt tightening.*

Torque Control Tightening

- *What is meant by a tightening torque?*
- *How a nut/bolt assembly absorbs torque.*
- *The relationship between the tightening torque and the resulting bolt preload (tension).*
- *The factors that affect the torque-tension relationship.*
- *The nut factor method of determining the correct tightening torque.*
- *The full torque-tension equation.*
- *Example calculation to determine the tightening torque*
- *Scatter in the bolt preload resulting from friction variations.*
- *Prevailing torque fasteners, how they affect the torque distribution, and the correct torque to use.*
- *Tests to determine the coefficient of friction of threaded fasteners.*
- *Combined stress during torque tightening.*

Torque vs Angle Curves – Trouble Shooting

- *Normal torque vs curve zones*
- *Issues During Assembly*
 - *Yield of Fastener*

- *Fracture of Fastener*
- *Thread Strip*
- *Thread Cross Thread*
- *Coating Thickness Issues*
- *Weld Spatter*
- *Compressive Yield of Clamped Component*
- *Torsional Shear Fracture*
- *Galling*
- *Stick-Slip*
- *Common Issues with DC Nut Runners*
- *Double Hits*
- *Paint or Debris in Threads*
- *Excess Relaxation*

Tightening Tools

- *Manual torque wrenches*
- *Impact drivers*
- *Pulse tools*
- *Nut runners: Non-reporting / Reporting*
- *Fixtured nut runners*

Tightening Procedures

- *Problems associated with the tightening of the multi-bolt joint.*
- *Elastic interaction.*
- *Single pass tightening sequence.*
- *Two-pass and multi-pass tightening sequences.*
- *Tightening sequences for non-circular bolted joints.*
- *Tests investigating the effects of elastic interaction.*
- *Use of multiple tightening tools.*

Torque Auditing

- *Torque Auditing – Why is it done?*
- *Torque auditing methods*
 - *On torque methods*
 - *Off-torque method*
 - *Marked socket/fastener method*
- *Torque audit test approaches*
- *Issues with torque auditing*
- *Witness Marking/Pointers*

Unintended Loosening Processes

- *Relaxation*
 - *Explanation of relaxation*
 - *Explanation of embedment*
 - *Current understanding of embedment and parameters that affect it.*
 - *Embedment and the Joint Diagram*
 - *Loss of preload due to embedment – springs in series.*
 - *Effect of joint thickness on embedment and other forms of relaxation.*
 - *Effects of paint in bolted joints.*
 - *Methods of reducing relaxation.*
- *Self-Loosening*
 - *Appreciate the forces acting on the threads that tend to self-loosen a fastener.*
 - *The inclined plane analogy.*
 - *Junker's theory on self-loosening of fasteners and why fasteners self-loosen.*

- *The Junkers transverse vibration test.*
- *The phases of self-loosening.*
- *Preload decay curves of various locking devices resisting vibrational loosening.*
- *Micro slip in joints resulting in self-loosening.*
- *Conclusions from the research and methods of reducing the likelihood of loosening.*

Vibrational Detachment of Threaded Fasteners

- *A quick overview of research on dynamic analysis of threaded fasteners subjected to axial vibration.*

Galling of Threaded Fasteners

- *Background and explanation of galling.*
- *Types of fastener material and finishes susceptible to galling.*
- *Examples of thread galling.*
- *Approaches that are used to prevent/minimize galling.*

Demonstrations with a Skidmore Device

- *Demonstration of the preload scatter achieved using torque tightening.*
- *Effect of repeated tightening of Electro-Plate Zn bolt and nuts.*
- *Demonstration of Torque-Angle Tightening (time permitting)*
- *Demonstration of normal and problematic joint relaxation.*

Training Course Instructor

Jon Ness, PE, will present the training course. Jon has over 35 years of engineering and design experience in developing mobile equipment components and sub-systems, including dynamically loaded bolted joints. His work has included the design of multiple gearboxes, powertrain systems, engine installations, and developing test and validation plan strategies. He has taught numerous classes related to Failure Modes and Effects Analysis and Bolted Joint Design for design engineers.