SURFACE VEHICLE INFORMATION REPORT

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Torque-Tension Tightening for Inch Series Fasteners

RATIONALE

This revision is limited in scope. Section 5.4 (Check Procedure) has been removed from this Information Report. It was determined to be outside the scope as an advisory guide.

FOREWORD

Fundamentally, threaded fasteners are required to create a clamping force or load on the assembled joint to prevent loosening. To accomplish this, a tensile loading is applied onto a bolt or screw by itself or by a nut tightened on the bolt or screw.

The axial stress in them produces a clamping force equal to the product of the proof-load stress, reduced by a design factor, and the core area of the bolt or screw.

Although clamping or tension load can be measured by load cells and strain gauges, these methods are impractical on the production line. The most practical methods of achieving control of joint clamp load involve torque control, tightening angle control, or combinations of torque and angle. In some cases, a torque versus angle yield method is utilized, particularly when tightening 5/8 in and larger fastener sizes, but measurement and assembly equipment is sensitive. Therefore, it becomes very important to understand the relationship between torque and tension.

1. SCOPE

This SAE Information Report is provided as an advisory guide. Individual application discretion is recommended. The content has been presented as accurately as possible, but responsibility for its application lies with the user. The document covers the variables in the torque-tension relationship: friction, materials, temperature, humidity, fastener and mating part finishes, surfaces, and the kind of wrenching employed.

Also, described in this document is the torque management required to achieve correct fastener joint tightening.

The thread fit of fasteners must be in accordance with Class 2A for external and Class 2B for internal inch threads.

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2. REFERENCES

2.1 Related Publications

The following publications are provided for information purposes only and are not a required part of this SAE Technical Report.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

SAE J174 Torque-Tension Test Procedure for Steel Threaded Fasteners - Inch Series

SAE J995 Mechanical and Material Requirements for Steel Nuts

SAE J1648 Protective Coatings for Fasteners

3. EXPLANATION OF TIGHTENING TERMS

3.1 **Torque** is the product of force x lever arm length. It is the moment resistance of the fastener and its components to tightening, expressed in in-oz, in-lb, and ft-lb.

3.2 **Turn Screw or Bolt and Turn Nut Terms** describe which mating part is tightened. For turn screw, the head of the screw or bolt is turned against a panel into either a panel with a tapped thread or separate nut component.

3.3 For turn nut, the nut is threaded onto a screw or bolt and is tightened against the panel surface.

3.4 **Clamping Load** occurs when the screw or bolt is stretched when the fastener is tightened. It is equal and opposite to the tensile force developed in the screw or bolt and is expressed as pounds (lb).

3.5 **Inertia** is the tendency of a body to continue in motion after being subjected to a force in a specific direction until acted upon by an outside force. In tightening, friction between mating parts and bearing against panel or part surfaces is the major contributing outside force and has to be overcome. Inertia of the rotating power tool is another factor which must be considered.

4. VARIABLES IN THE RELATIONSHIP OF CLAMPING LOAD TO APPLIED TORQUE

4.1 Friction

The friction resistance torque is the most important of all of the variables. It has two components, the friction resistance of the applied nut fastener with respect to mating part threads, and the bearing surface against joint members. Increasing the clamping tension force on the screw or bolt increases the resistance to turning.

4.2 Fastener Materials

Characteristic properties of hardness and surface condition can contribute to friction variability thus affecting tightening torque to obtain the same clamping load.

4.2.1 Nonheat-treatable low-carbon stainless steels and other soft alloys cause increased friction resistance resulting in higher tightening torque for a given clamp load.

4.2.2 Hardened steel or hard alloy fasteners have a harder slippery surface reducing friction and thereby requiring lower tightening torque.

4.2.3 Special materials, rubber, plastics, etc., either as fabricated fasteners or attached to them, also affect torque if they contact the rubbing surfaces during the tightening.