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RADIOACTIVE MATERIAL PACKAGING TORQUE REQUIREMENTS COMPLIANCE

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Abstract

Shipping containers used to transport radioactive material (RAM) in commerce employ a variety of closure mechanisms. Often, these closure mechanisms require a specific amount of torque be applied to a bolt, nut or other threaded fastener. It is important that the required preload is achieved so that the package testing and analysis is not invalidated for the purpose of protecting the public. Torque compliance is a means of ensuring closure preload, is a major factor in accomplishing the package functions of confinement/containment, sub-criticality, and shielding. This paper will address the importance of applying proper torque to package closures, discuss torque value nomenclature, and present one methodology to ensure torque compliance is achieved.

Introduction

The tool used to apply torque to a bolt or other threaded fastener is a torque wrench. There are a variety of different types of torque wrenches such as deflecting beam, clicker, dial, electronic, and programmable electronic. The type of torque wrench used does not typically mater for compliance with RAM transportation compliance. What is important is that the torque wrench is calibrated for the specified torque range so that the correct amount of torque is applied to a bolt, nut or other threaded fastener.

Torque wrenches are categorized under the industry term M&TE (measurement and test equipment) which means that they are calibrated and controlled equipment for the purpose of maintaining accuracy. They should always be part of a formal calibration program and stored/handled to protect the torque wrench from damage. Poor storage or handling techniques (i.e. excessive hitting or dropping) can "knock" a wrench out of calibration.

This paper does not address the effectiveness of using torque as a means of establishing preload on RAM packaging closures. There are many studies available in the literature which examines the relationship between torque and preload. Rather since torque as a means of ensuring pre-load still dominates RAM package procedures, this paper focuses on the practical aspects of demonstrating compliance with torque range requirements for RAM packaging closures.

Shipping Container Torque

The closure torque values for radioactive material (RAM) shipping containers are documented in the vendor closure instructions for industrial packages, vendor closure instructions for Type A packages, Safety Analysis Report (SAR) or Safety Analysis Report for Packages (SARP) for Type A(F) packages, and SAR or SARP for Type B packages. The torque values specified in these documents ensure that the package will perform its intended function with respect to safety of the material being shipped and the public that comes in contact with the container.

Torque values can be specified in a variety of ways, giving a torque value and some tolerance expressed with a "+/-". Some examples of torque values from SARPs are presented in Table 1. None of which are incorrect, but some can be confusing. Each one of the values in Table 1 has a range and midpoint of the range. Notice that for the 50 ft-lb torque value the midpoint is the same even though the torque value is expressed differently. The midpoint is defined as the middle of the specified torque range. The midpoint is important because setting a torque wrench at this value optimizes the chance of applying the correct torque.

Table 1
Torque Value Nomenclature Examples

Torque Specification (ft-lb)	Torque Range (ft-lb)	Torque Midpoint (ft-lb)
25 (+/-5)	20 – 30	25
50 (+5/-0)	50 – 55	52.5
50 (+10/-5)	45 – 60	52.5
75 (+0/-5)	70 – 75	72.5
75 (+10/-10)	65 – 85	75

When using a torque wrench the user must also know the torque wrenches calibrated range and accuracy. Torque wrenches should not be used for the bottom and top 20% of there calibrated range. In other words a torque wrench with a range of 0 – 110 ft-lb should not be used to apply 100 ft-lbs of torque. The maximum torque this wrench should be used for is 88 ft-lbs (110 ft-lb x 20% = 22 ft-lb, 110 ft-lb – 22 ft-lb = 88 ft-lb). Likewise the minimum torque this wrench should be used for is 22 ft-lbs (110 ft-lb x 20% = 22 ft-lb, 0 ft-lb + 22 ft-lb = 22 ft-lb). A better suited torque wrench for the 100 ft-lb value could be one with a calibrated range of 20 – 150 ft-lb which has a useable range of 46 to 124 ft-lb (150 ft-lb – 20 ft-lb = 130 ft-lb, 130 ft-lb x 20% = 26 ft-lb, 20 ft-lb + 26 ft-lb = 46 ft-lb and 150 ft-lb – 26 ft-lb = 124 ft-lb).

Torque Compliance Methodology

This section describes the measures taken by one facility to assure that the 9975 Type B Packages it shipped were compliant with the 9975 SARP torque values which were in effect at the time of shipment. Table 2 shows the applicable 9975 SARP torque values the facility was working to achieve.

A users first inclination might be to use a standard M&TE torque wrench. The problem is that most M&TE torque wrenches are calibrated to +/- 4% accuracy which may not be adequate to meet all the specified torque ranges. Take the case of the 9975 torque values from Table 2 [1]. A 4% accuracy wrench used at the 102.5 ft-lb midpoint for the 100 ft-lb torque falls outside of the specified range of 100- 105 ft-lb because the torque wrench could yield a torque of 98.4 – 106.6 ft-lb.

Table 2 9975 SARP Torque Specifications

Torque Specification	Torque Range	Torque Midpoint
50 (+5/-0) ft-lb	50 – 55 ft-lb	52.5 ft-lb
100 (+5/-0) ft-lb	100 – 105 ft-lb	102.5 ft-lb
30 (+5/-0) ft-lb	30 – 35 ft-lb	32.5 ft-lb
10 (+/- 2) in-lb	8 – 12 in-lb	10 in-lb
30 (+/- 2) ft-lb	28 – 32 ft-lb	30 ft-lb

To ensure torque compliance the facility took a very conservative approach and decided to use wrenches with 1% accuracy for all torques. This approach was not really necessary but worked for all torque values. A better approach might have been to use 4% accuracy torque wrenches for the torque values up to 50 ft-lb and use a 2% accuracy wrench for the 100 ft-lb torque value [2].

Table 3 How Torque Wrench Accuracy Affects Applied Torque

Torque Specification	100 (+5/-0) ft-lb	30 (+/- 2) ft-lb
Torque Range	100 – 105 ft-lb	28 – 32 ft-lb
Torque Midpoint	102.5 ft-lb	30 ft-lb
Torque Applied by 4% Accuracy Wrench	98.4 -106.6 ft-lb	28.8 – 31.2 ft-lb
Torque Applied by 2% Accuracy Wrench	100.5 – 104.6 ft-lb	29.4 – 30.6 ft-lb
Torque Applied by 1% Accuracy Wrench	101.5 – 103.5 ft-lb	29.7 – 30.3 ft-lb

A couple of example 9975 SARP torque and torques that would be applied by 4%, 2%, and 1% accuracy torque wrenches are given in Table 3. As illustrated in Table 3 using a 4% accuracy wrench for the 100 ft-lb torque value could yield torques outside of the specified torque range.

Using a 2% or 1% accuracy wrench for the 100 ft-lb torque value would yield torques within the specified torque range; however, the range of the 2% wrench is very close to the upper and lower values of the specified torque range. For the 30 ft-lb torque value the 4%, 2%, and 1% accuracy torque wrenches would yield torques within the specified torque range.

Not only is it important for the facility to chose a wrench that delivers the proper torque, but in the case of 9975 operations it took several actions as insurance for maintaining torque wrench accuracy. The facility purchased multiple torque wrench sets, each set contained a wrench for each specified torque. The wrench set calibration was performed on 3 month intervals (typical M&TE calibration is 6 or 12 months). In order to protect the wrenches from being "knocked" out of calibration each wrench was placed in a storage case and a dedicated storage cabinet was used for the wrench sets. Also the facility installed calibrated torque testers which were used to perform pre and post load checks on the wrenches prior to every shift of use. The pre and post load checks were documented checks within the facility packaging procedure that were done to confirm wrench calibration before and after use. The torque wrenches could not be used until they passed the pre load check and if they failed the check, another wrench was selected and the questionable wrench was sent off for recalibration. When the wrenches passed the post load checks, the package was considered closed with the proper torque applied. In the event a wrench failed the post load check the package was considered nonconforming and could not be shipped until the questionable torque had been corrected with another wrench. The pre and post load checks were used to address torque wrench out-of-calibration cases that sometimes occurred between calibration intervals

Typically torque wrench calibrations and issuance of calibration reports occurs after the RAM package has been shipped. If a torque wrench is determined to be out of calibration and the RAM shipment has been placed into commerce, then a potential reportable transportation incident has occurred unless the shipper has documentation to show the wrench operability has been checked since the last calibration. With documented successful torque wrench pre and post load checks the wrench can be deemed within calibration at the time of package closure avoiding a violation. Torque testers are not required by the transportation regulations for RAM packaging, but not using them for pre and post load checks on each closure could lead to nonconformance reports (NCR) and regulator notifications.

Conclusion

Proper torque is important in the transportation of radioactive material (RAM) in commerce to ensure that the package testing and analysis is not invalidated for the purpose of protecting the public. Torque compliance is a means of ensuring closure preload, is a major factor in accomplishing the package functions of confinement/containment, sub-criticality, and shielding. Applying proper torque goes beyond selecting a torque wrench and setting it correctly. Users must also be aware of good wrench handling techniques, wrench accuracy, the specified torque range, and wrench calibration.

References

1. WSRC-SA-2002-00008, Revision 0, Model 9975 B(M)F-85 Safety Analysis Report for Packaging

2. Dan Marinucci, Motor Magazine, February 2002

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