

Torque-Position Assembly Guidelines for API Casing and Tubing Connections

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Contents

	Page
1 Scope	1
2 Normative References	1
3 Terms and Definitions	1
4 Background	2
4.1 Torque-Position Application	2
4.2 API Connection Sealing Mechanism	2
4.3 Thread Compound	3
4.4 Coupling Coating or Plating	3
4.5 Thread Features, Measurements, and Inspection	4
4.6 Torque Control and Monitoring	5
5 Procedure	5
5.1 General	5
5.2 Torque-Position Tables	6
5.3 Position Control-Templates	6
5.4 Thread Compound Application	7
5.5 Make-up Speed	9
5.6 Mill-end Axial Position Stripe	9
Annex A (informative) Implementation Aids	11
Annex B (normative) Torque-Position Tables	16
Bibliography	30
Figures	
1 Torque-Position Assembly Schematic	3
2 Connection Assembly Acceptance Criteria for Torque-Position	6
3 Example Reference Sheet for Torque-Position	7
4 Dimensional Example for Torque-Position Template	8
5 An Example of Axial Position Stripe Applied Across Interface	10
Tables	
1 Converted 5B Tolerances for Average Crest Diameter	4
2 Suggested Target Range for Average Crest Diameter for Torque-Position	4
3 Tolerances on Thread Ovality for Torque-Position	5
4 Suggested Template Slot Width	9
B.1 Torque-Position Tubing	17
B.2 Torque-Position Casing	18
B.3 Torque-Position Buttress	23
B.4 Torque-Position Buttress 4T	26

Torque-Position Assembly Guidelines for API Casing and Tubing Connections

1 Scope

This document provides alternative connection assembly procedures to those found in API 5B (power turns) and those found in API 5C1 (optimum torque). The procedures set forth are referred to as “torque-position” because the make-up torque and final position are used as acceptance criteria for the assembly operation. The connections are threaded in accordance with API 5B. The torque-position assembly parameters have been developed for most SC (short round thread casing), LC (long round thread casing), BC (buttress thread casing), and EU (external upset tubing) connections.

Torque-position is a precision assembly method that relies on a controlled process for successful implementation. When defined threading and assembly procedures are followed, the performance of the resulting assembled connection is optimized.

2 Normative References

This document contains no normative references. For a list of documents and articles associated with API TR 5TP and torque-position assembly guidelines, please see the Bibliography.

3 Terms and Definitions

For the purposes of this document, the following definitions apply.

3.1 addendum

The distance from the crest cone to the pitch cone.

3.2 connection

A connection is defined as a single pin assembled into one side of a coupling.

3.3 crest diameter

A measurement of the diameter of the crests of the pin or coupling threads at a specified axial position measured from the pin nose or coupling face.

3.4 field-end make-up

The side or end of the coupling that is assembled at the rig floor as the pipe is being run into the well.

3.5 mill-end make-up

The side of the coupling that is assembled (bucked on) before the pipe is shipped to the field location. This connection assembly operation is typically performed at the facility where the pin end is threaded (mill or thread processor). See Figure 1.

3.6 position band

A stenciled color mark applied at a specific axial distance from the nose of the pin that serves as an external reference point for the position of the pin within the coupling during assembly (see Figure 3). In addition, the position of the coupling face can be compared visually to judge for acceptance or rejection of the final assembly (see Figure 2).

3.7

torque-position

An assembly technology for selected API connections that features criteria for acceptance of the assembly based on engagement of the pin within the coupling (position) and final torque.

3.8

4T

A variation of torque-position intended for BC connections on 8 5/8-in. through 20-in. OD casing that requires tin-plated couplings and a thread compound that has polytetrafluoroethylene (PTFE) particles. The term “4T” represents torque, triangle, tin, and PTFE.

4 Background

4.1 Torque-Position Application

Torque-position is a precision assembly method for assembling API connections. The connection is made up within a prescribed torque range using hydraulic power tongs, such that the face of the coupling progresses into a position band stenciled on the OD of the pipe. Connections that do not meet **both** the torque and position criteria are rejected.

The use of torque-position connection assembly procedures and the application of this document shall be by agreement between the user/purchaser and the manufacturer. These guidelines shall be used at the designated mill, processor's facility, and rig site in order to ensure appropriate assembly of the connections (see Figure 1 and Figure 2).

4.2 API Connection Sealing Mechanism

API connections rely on contact pressure on the thread flanks to form an effective seal and a particulate thread compound to plug the root-to-crest gap on 8-round connections (SC, LC, EU) and thread flank gaps on buttress connections.

In an interference connection, the threads on both the pin and coupling are cut at a matching angle or taper. As the connection is made up, the pin becomes wedged into the coupling creating contact pressure. This contact or bearing pressure is the sealing mechanism for this connection. To form a leak-resistant seal, the bearing pressures on the thread flanks must be greater than the internal pressure.

In addition to thread flank bearing pressures, it is also necessary to use a thread compound and a suitable coating or plating on the coupling threads to form a leak-resistant seal. This combination of thread compound and coating or plating prevents the migration of gas or fluid through the root-to-crest and thread flank clearances.

Sealing performance of some sizes and connections is enhanced by using modified seal-ring couplings conforming to API 5CT, SR13. Seal rings are recommended for these connections because of the high make-up torques that would be required without them. In a seal-ring coupling, a groove is cut in the coupling and a nonmetallic ring is installed in the groove prior to any thread compound application and connection assembly.

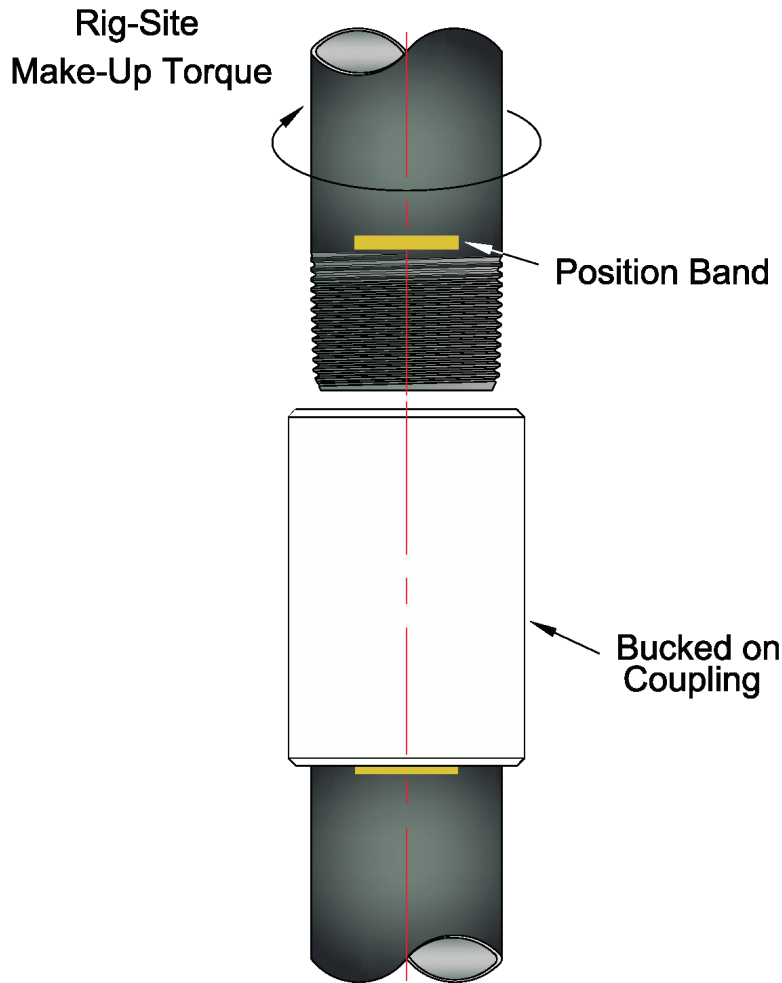


Figure 1—Torque-Position Assembly Schematic

4.3 Thread Compound

Thread compound serves three basic functions:

- 1) seals the thread clearances in the thread profile,
- 2) lubricates the threads during make-up, and
- 3) resists galling that results from metal-to-metal contact.

Most thread compounds consist of particles suspended in carrier grease. The types and ratios of the particles generally determine the performance of a thread compound.

Torque-position technology was developed using API 5A3 Reference compound (formerly called API Modified) for 8-round and non-4T buttress connections and a PTFE-based thread compound for BC 4T make-up.

4.4 Coupling Coating or Plating

API couplings intended for assembly with torque-position parameters should have a phosphate coating or tin plating on the threads to prevent galling during assembly and to assist in providing seal integrity. The type of coating or plating used will affect the assembly torque. Torque values for tin-plated couplings are much lower than for phosphate coated couplings; therefore, a separate torque range is given in the tables. The torques

tabulated for seal-ring couplings assume phosphate-coated threads and the BC 4T assembly requires tin-plated coupling threads.

Phosphate coatings are typically applied to a coupling to a thickness of less than 0.001 in. With tin-plated couplings, both the thickness and uniformity of the tin should be carefully checked. Lack of uniformity can cause erratic make-up, galling, and potential leak paths. Tin plating should be applied to a thickness between 0.0025 in. and 0.0045 in.

4.5 Thread Features, Measurements, and Inspection

Maintaining all thread parameters set forth by API 5B will ensure downhole performance and smooth assembly operations. Significant variations in thread height, lead, and taper can affect the assembly torque and subsequent performance.

Two additional measurements are critical but are not specified in the 15th Edition of API 5B: crest diameter and ovality. Specifying requirements for crest diameter and ovality measurements when ordering pipe is recommended in order to achieve more consistent assembly results, fewer rejected make-ups, and better field performance for the resulting connections. Note that satisfying the crest diameter tolerances may require tighter control of other API 5B thread element dimensions. Additionally, addendum measurements that relate the crest diameter to the pitch diameter may be necessary when setting up for threading.

Follow the crest diameter gauge manufacturer's measurement procedures to obtain a maximum and minimum reading of local crest diameter around the circumference of the thread (typically expressed as a variation from the nominal value). The average crest diameter referenced in Table 1 and Table 2 is defined as the average of the minimum and maximum readings. The ovality of the thread is defined as the algebraic difference between the minimum and maximum readings. Formulas for determining ovality limits are provided in Table 3.

Note that some pin and coupling combinations that have thread features that meet API 5B gauging specifications will not successfully meet the torque-position assembly parameters. However, pin and coupling threads that meet the suggested target crest diameter ranges shown in Table 2 provide a greater probability that the assembly will satisfy the torque and position requirements.

Table 1—Converted 5B Tolerances for Average Crest Diameter

Thread Type	Coupling	Pin
8-round	± 0.008 in.	± 0.008 in.
Buttress $\leq 13 \frac{3}{8}$ in.	–0, +0.006 in.	–0, +0.006 in.
Buttress $> 13 \frac{3}{8}$ in.	–0, +0.008 in.	–0, +0.008 in.

Table 2—Suggested Target Range for Average Crest Diameter for Torque-Position

Thread Type	Coupling	Pin
8-round	± 0.004 in.	–0, +0.006 in.
Buttress $\leq 13 \frac{3}{8}$ in.	–0, +0.004 in.	–0, +0.006 in.
Buttress $> 13 \frac{3}{8}$ in.	–0, +0.004 in.	–0, +0.008 in.

Table 3—Tolerances on Thread Ovality for Torque-Position

Pipe OD/ <i>t</i> ratio	Formula for Max Ovality
<20	OD × 0.003 in.
≥20	OD × 0.004 in.

Any surface-breaking flaws in the threaded area could affect assembly and performance of the connection. Perform a magnetic particle inspection (MPI) of the pin end areas and coupling in accordance with API 5A5 and API 5CT. However, a wet MPI is recommended on the pin ends of all grades, unless access to the ID is restricted (e.g. tubing less than 4 1/2-in. diameter), then dry MPI may be substituted. If MPI is performed before threading the pin ends, then a visual inspection shall be performed after threading. If MPI is performed before threading the coupling, then a visual inspection shall be performed after threading and before coating or plating. The purchaser may designate when the pin end area inspection is performed by specifying this on the purchase order.

4.6 Torque Control and Monitoring

Accurate torque measurement enhances the torque-position connection assembly. The preferred method to monitor torque is to use a calibrated load cell in conjunction with a digital torque readout. Torque accuracy shall be demonstrated to be within 3 %. Torque measurement based solely on hydraulic pressure is not recommended.

5 Procedure

5.1 General

Assembly make-up procedure for torque-position is as follows.

- a) Determine the appropriate position and torque ranges for the connection from the torque-position tables (see 5.2).
- b) Stencil a yellow position band on the pipe at a specific distance from the end of the pin (see 5.3).
- c) Apply thread compound to the pin and coupling (see 5.4).
- d) Assemble the connection with a buck-on machine or a set of power tongs. The face of the coupling progresses into the position range (i.e. between D_1 and D_2) within the specified torque range (i.e. between $T_{\min}$ and $T_{\max}$).
 - Reject the connection if the coupling face falls short of D_1 at maximum torque, $T_{\max}$.
 - Reject the connection if the coupling face progresses through the position band before attaining the minimum torque $T_{\min}$.

An acceptable made up connection is compared with rejected make-ups in Figure 2. The tabulated torque and position ranges also define the assembly acceptance and rejection criteria.

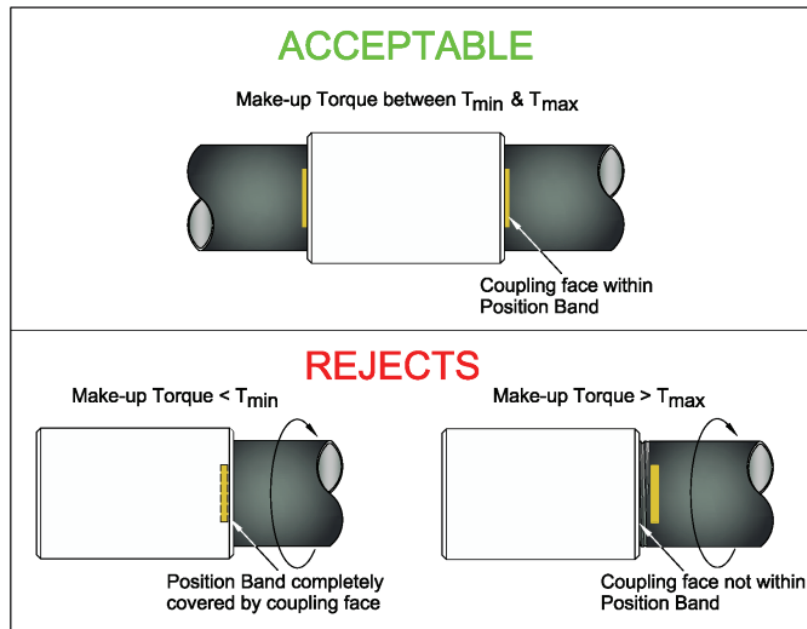


Figure 2—Connection Assembly Acceptance Criteria for Torque-Position

5.2 Torque-Position Tables

Torque-position assembly ranges for the most common SC, LC, BC, and EU connections are provided in tables contained in this document (see Annex B). The listings are organized by size, weight, thread type, grade, coupling OD, and coupling surface coating or plating. The following four values are specified for each connection:

- D_1 = minimum position (relative to the nose of the pin),
- D_2 = maximum position (relative to the nose of the pin),
- T_{min} = minimum torque,
- T_{max} = maximum torque.

5.3 Position Control—Templates

The technique used to apply the yellow position band(s) to the joint behind the pin threads must be capable of preserving the precision of the torque-position assembly method. Rather than trying to apply a tolerance to the position bands after they are applied on the tubular, a tolerance of ± 0.003 in. is applied to the D_1 and D_2 dimensions on the templates used to apply the position bands. Figure 4 is a drawing of a typical template that is durable and capable of applying position bands with accurate dimensions. The yellow position bands are applied at several locations around the pipe, ensuring band visibility as the pipe is being rotated. Note that other methods of controlling the position of the pin nose relative to the coupling face may be acceptable if it can be demonstrated that the precision of the assembly method is maintained.

The width of the template slot shown in Figure 4 will vary according to OD size. Some example template slot widths are suggested in Table 4 below. All dimensions below are in inches.