

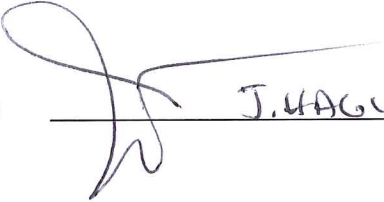

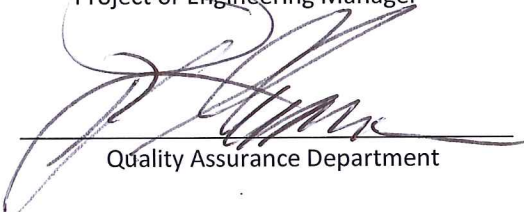


TEP-3-023
REVISION 4

TECHNICAL ENGINEERING PROCEDURE

TITLE:

**IN-SITU CALIBRATION OF PLANT VALVE STEMS
INSTRUMENTED WITH THRUST AND/OR TORQUE-
SENSING STRAIN GAGE BRIDGES**

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1.0 **SCOPE**

- 1.1** This procedure provides information and instructions for performing the in-situ calibration of valve stems instrumented with thrust and torque-sensing strain gage bridges.

2.0 **APPLICATION**

- 2.1** This procedure may apply to any size valve stem having thrust and torque-sensing strain gage bridges.

- 2.2** This procedure is applicable for calibrations with the actuator either on or off.

2.3 **Prerequisites**

- a) The valve is available and accessible for testing.
- b) The amount of load and torque that is to be applied to the stem has been provided by Engineering.
- c) Electric power is available.
- d) The reference load and torque cells have been calibrated.
- e) Familiarity with the data acquisition system being used to record the stem strain gages and the standard reference load cell data.

3.0 **EQUIPMENT REQUIRED**

- a) A calibrated portable data acquisition system which consists of electronic hardware to acquire the electrical data, a verified software package to process the acquired data and the associated interface cabling.

TLTS's QUIKLOOK FS, QUIKLOOK II, QUIKCAL, and CAL PRO are verified software packages designed to complement dedicated calibrated hardware in acquiring, processing and determining a sensitivity value for the strain gage bridge on valve stems.

- b) Reference load and torque cells, compatible with the thrust and torque loads that are to be applied.
- c) A hydraulic reservoir and ram unit, capable of applying the required loads.
- d) The appropriate calibration fixture, designed for the valve and loads that are to be applied.

4.0 **METHOD - THRUST SETUP**

- 4.1** Two methods are described in this procedure. Steps 4.2 and 4.3 describe the calibration fixture assembly for the stem thrust sensing strain gages. Step 5.0 describes the calibration fixture assembly for the stem torque sensing strain gages.

4.2 **Calibration Fixture Assembly for Compression Loading**

Note: Use Figure 1 as a reference for assembly.

- 4.2.1** There is one hydraulic cylinder, two support plates and two Adapter plates for this system.

- a) The 10" and 16" support plates and 8" and 12" Adapter plates with a RCH-302 hydraulic cylinder are used with SMB-000 through SMB-3 to apply up to 60,000 pound loads on several bolt patterns marked with stamp designations on the support and Adapter plates.
- b) The 8" and 12" Adapter plates are used when the actuator is removed from the yoke.

4.2.2 Choose the Hole Pattern to match operator pattern with the use of the support and Adapter plates.

Note: The valve should be in the fully closed position. If the valve is not in the closed position more hex stand-off stock may have to be added to close the valve. Use the right hex stand-offs with the right support plate per assembly print supplied with calibration unit.

4.2.3 Connect the hex stand-off stock to the flange surface using the appropriate size hex stand-off set. Use Adapter plate, if required, only when actuator is removed.

4.2.4 Attach the hydraulic cylinder to the top of support plate, bottoming threads to plate.

Note: When removing cylinder use break bar and hardware supplied.

4.2.5 Thread handnut onto load cell and insert through cylinder before attaching to hex stand-offs.

4.2.6 Attach the support plate to the hex stand-off stock using the appropriate size socket head capscrew.

4.2.7 Adjust handnut to rest against cylinder saddle.

4.2.8 Thread stem Adapter, if required over valve stem.

4.2.9 Thread load stem to stem Adapter, if required making sure threads bottom out.

4.2.10 Connect the pump to the hydraulic cylinder. When connecting make sure fitting of cylinder is accessible for connection.

4.2.11 The calibration fixture assembly is ready for the compression load or the close direction calibration.

Note: See Figure 5 for maximum thrust ratings.

4.2.12 Refer to Section 6.0 to perform the calibration.

4.3 **Calibration Fixture Assembly for Tension Loading**

Note: Use Figure 2 as a reference for assembly.

4.3.1 There is one hydraulic cylinder, two support plates and one Adapter plate for this system. Support plates and hydraulic cylinder should be as shown in Figure 2.

- a) The 10" and 16" supports and 8" and 12" Adapter plates with a RCH-302 hydraulic cylinder are used with SMB-000 through SMB-3 to apply up to 60,000 pound loads on several bolt patterns marked with stamp designations on the support and Adapter plates.

- 4.3.2 Connect the hex stand-off stock to the flange surface using the appropriate size hex stand-off set. Use Adapter plates only when actuator is removed.
- 4.3.3 Add or subtract hex stock length as needed to obtain the height necessary for the support plate and cylinder to be able to pull the valve out of the closed seat and/or to pull the valve into the back seat. Connect the support plate and hydraulic cylinder to the hex stand-off stock using appropriate size socket head cap screw.
- 4.3.4 The threaded end of load cell will be attached to the stem Adapter. Once attached then thread on to stem, bottoming threads against valve stem.
- 4.3.5 Adjust handnut to rest against cylinder saddle.
- 4.3.6 Connect the pump to the hydraulic cylinder.
- 4.3.7 The calibration fixture assembly is ready for the tension load or open direction calibration.

Note: See Figure 5 for maximum thrust ratings.

- 4.3.8 Refer to Section 6.0 to perform the calibration.

5.0 **METHOD - TORQUE SETUP W/ACTUATOR ON OR OFF**

5.1 **Calibration Fixture Assembly for Torque Loading with Actuator On**

Note: Use Figures 3.1 and 3.2 as a reference for assembly.

- 5.1.1 The torque mechanical fixture consists of the following components:

- a) Stem Adapter
- b) Load and Torque Adapter
- c) Torque Adapter
- d) 2 Socket Wrench Torque Sensors
- e) Geared Head Multiplier with 3/4" Input Drive and 1" Output Drive
- f) 3/4" Drive Sliding T-Handle with 20" Handle
- g) 3/4" Drive Breaker Bar with 20" Handle
- h) Extension Handle
- i) 2 Single Square Drives 3/4" and 1"
- j) Adapters 3/4" and 1"
- k) Guide Sleeves
- l) 10" and 16" Support Plates
- m) Hex Stand-Off for Mounting to Actuator

- 5.1.2 Install the correct size stem Adapter to the valve stem.

- 5.1.3 Attach correct size load and torque Adapter to stem Adapter leaving a gap approximately 1/16 to 1/8 between both parts as shown on Figure 3. This will prevent locking.

- 5.1.4 Install appropriate torque Adapter to the load and torque Adapter.

- 5.1.5 Attach appropriate socket wrench torque sensor to torque Adapter.

- 5.1.6 Use various size guide sleeves, if required, with 10" or 16" support plates to hold stem stable during this operation.

5.1.7 The calibration fixture assembly is ready for torque calibrating with actuator on using the various tools listed above. Refer to Section 6.0 to perform the calibration.

5.2 Calibration Fixture Assembly for Torque Loading with Actuator Off

5.2.1 The torque mechanical fixture consists of the following components:

- Stem Adapter
- Torque Adapter
- Fenner Manheim Trantorque Collets
- 2 Socket Wrench Torque Sensors
- Geared Head Multiplier with 3/4" Input Drive and 1" Output Drive
- 3/4" Drive Sliding T-Handle with 20" Handle
- 3/4" Drive Breaker Bar with 20" Handle
- Extension Handle
- 2 Single Square Drives 3/4" and 1"
- Adapters 3/4" and 1"
- Guide Sleeves
- 10" and 16" Support Plates
- Hex Stand-Offs for Mounting to Yoke
- 8" and 12" Adapter Plates

5.2.2 Install the correct size stem Adapter to the valve stem.

5.2.3 Attach correct size load and torque Adapter to stem Adapter leaving a gap approximately 1/16 to 1/8 between both parts as shown on Figure 3. This will prevent locking.

5.2.4 Install appropriate torque Adapter to the load and torque Adapter.

5.2.5 Attach appropriate socket wrench torque sensor to torque Adapter.

5.2.6 Use various size guide sleeves with 10" or 16" support plates to hold stem stable during this operation.

5.2.7 The calibration fixture assembly is ready for torque calibrating with actuator on using the various tools listed above. Refer to Section 6.0 to perform the calibration.

6.0 CALIBRATION METHOD

6.1 Connect the reference load cell or torque sensor and the appropriate valve stem strain gage bridge lead to the acquisition hardware.

6.2 Apply load to the stem, (thrust or torque). Do not apply a load higher than the upper limit of the stem.

6.3 Release the load slowly to obtain the return data for hysteresis analysis.

6.4 Determine the least square line fit using the acquired standard cell and stem strain gage data. The sensitivity of the strain gage bridge is the slope of the line.

6.5 Software packages like the QUIKLOOK II, QUICKCAL and TTS CAL PRO will automatically calculate this slope using the least square line fit when the option is selected. The slope units will be lb/mV/V for THRUST and ft-lb/mV/V for TORQUE.

- 6.6** Save the test data for achieving and printing a Calibration Certificate form. (See Figure 4 as an example.)

7.0 **ABBREVIATED CALIBRATION METHODS**

- 7.1** The information in this section is based on a TTS investigation into abbreviate methods of the calibration of the QSS on a valve stem. TTS Report TR-A722-5: documents the abbreviated calibration method. The three areas investigated are listed below:

- 1.) Extrapolation of sensitivity values from lower levels of load to higher levels of load.
- 2.) Application of unidirectional sensitivity values to bidirectional loads. Ex: The application of compressive calibration values to tensile loadings.
- 3.) Determination of torque sensitivity values from thrust calibrations.

- 7.2** Calibrating the QSS in all four directions will provide a calibration with a 3.00% inaccuracy statement. Applying the calibration of a QSS in the compression and clockwise directions only to higher load extrapolation and to the thrust and counter clockwise directions will widen the inaccuracy to 4.25% for thrust and 3.25% for torque.

- 7.3** Calibrating the QSS in the compression direction only and applying that calibration to the tension direction and the clockwise and counter clockwise torque will widen the thrust inaccuracy to 4.25% and the torque inaccuracy to 5%.

- 7.4** The method for calculating the torque sensitivity from the compression only calibration is provided in the steps below.

- 7.5** Obtain the following information once the valve stem has been calibrated in thrust:

$SENS_{TH}$ = thrust sensitivity, lb/mv/v

D = stem diameter, inches

GF_{TQ} = gage factor of QSS torque gages

GF_{TH} = gage factor of QSS thrust gages

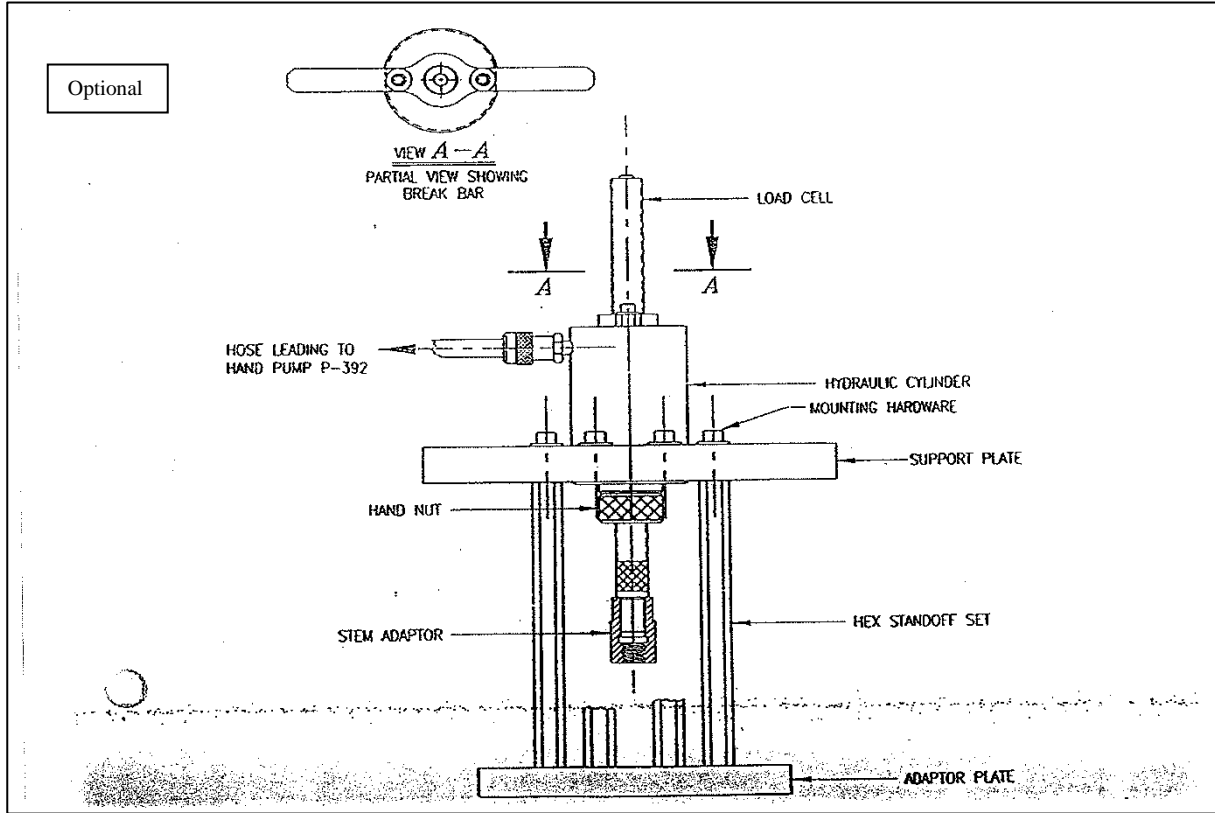
- 7.6** Perform the following calculation, using the form provided (see Figure 6).

$$SENS_{TQ} = \frac{D}{96} \left(\frac{GF_{TH}}{GF_{TQ}} \right) SENS_{TH}$$

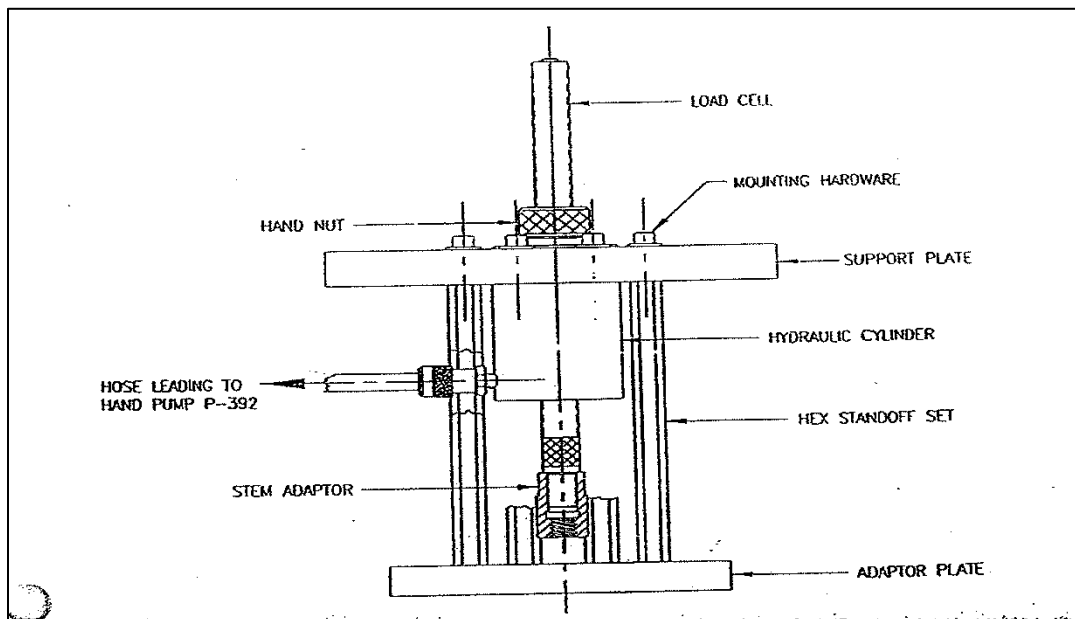
where: $SENS_{TQ}$ = torque sensitivity

8.0 ATTACHMENTS

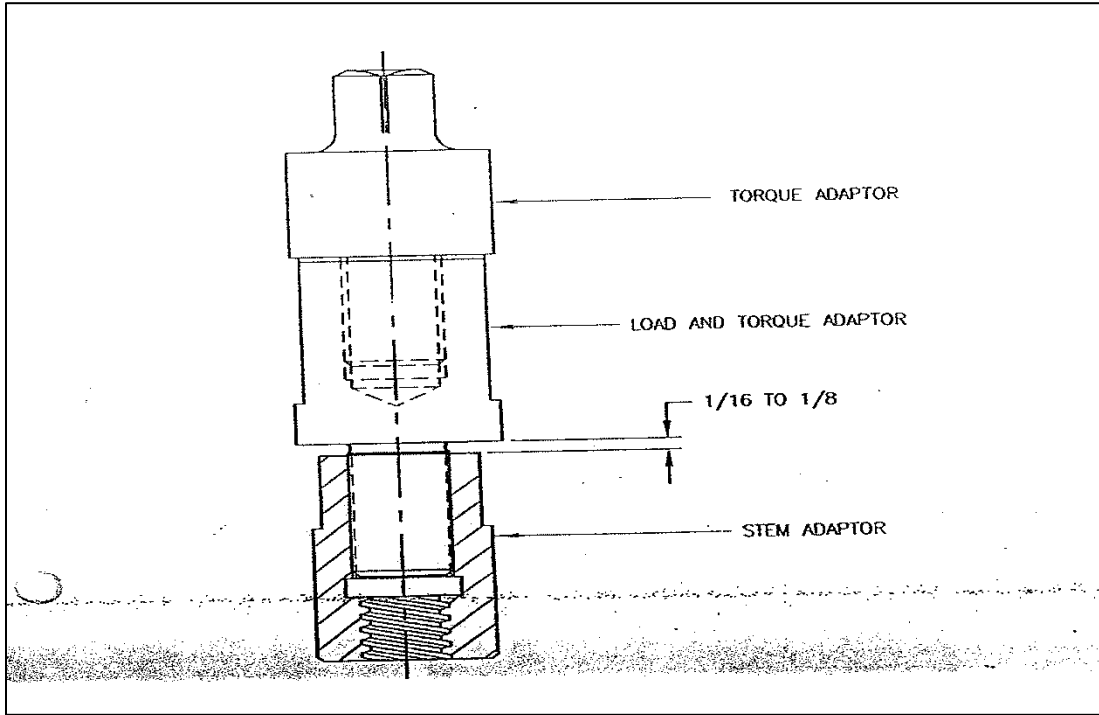
8.1 Figure 1 - Thrust Calibration Compression



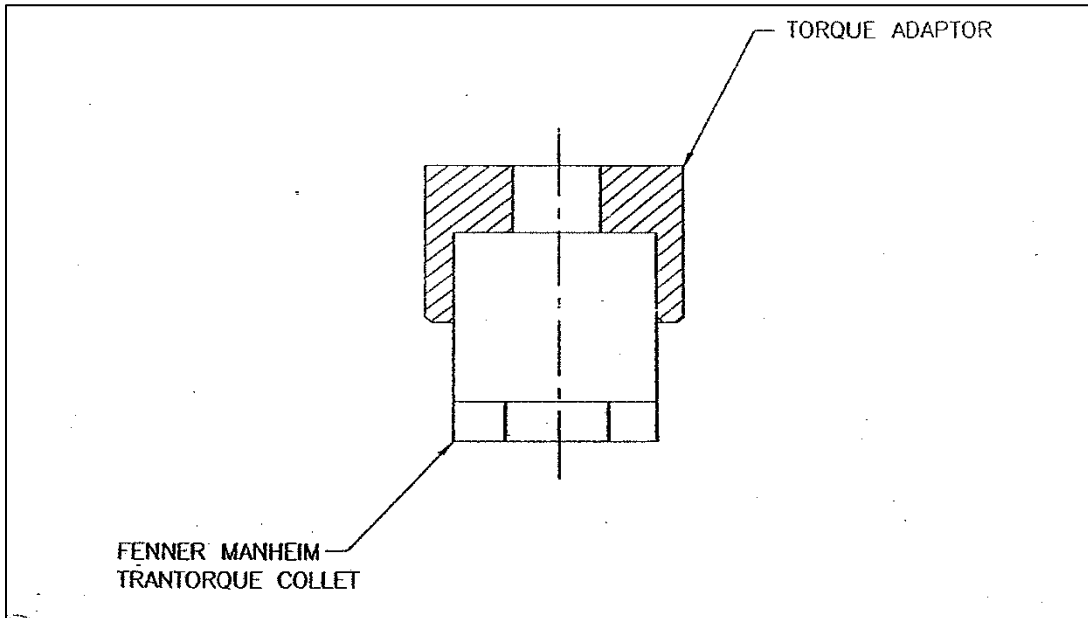
8.2 Figure 2 - Thrust Calibration Tension



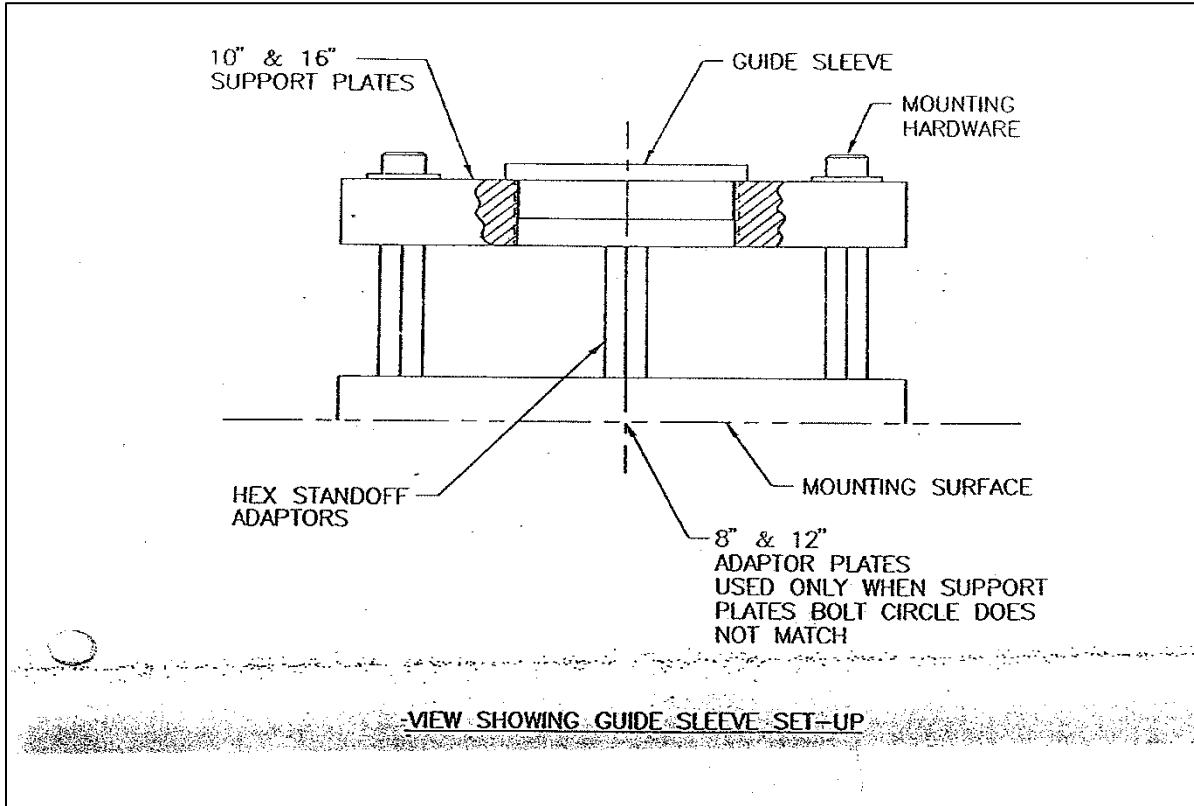
8.3 Figure 3 - Torque Calibration Actuator On




8.4 Figure 3.1 - Torque Calibration Actuator Off



8.5 Figure 3.2 - Torque Calibration Guide Set-Up



8.6 Figure 4 - Certificate of Calibration

CERTIFICATE OF CALIBRATION				
Client: _____ Project No: _____ Purchase Order No: _____ Type: _____ Serial No: _____ Model: _____ Range: _____				
CALIBRATION STANDARD				
Manufacturer	Model No.	Serial No.	Calibration Date	Calibration Due
CERTIFIED BY: Technician: _____ Date: _____ Engineer: _____ Date: _____				
 TELEDYNE INSTRUMENTS <i>Test Services</i> A Teledyne Technologies Company 513 Mill Street • Marion, Massachusetts 02738-1549 • Telephone: 508-748-0103 • Fax: 508-748-2029				

In-Situ Calibration of Plant Valve Stems Instrumented with Thrust and/or Torque-Sensing Strain Gage Bridges

 8.7 Figure 5 - Limitorque Commercial Ratings

Type	Size	Maximum Torque, ft-lb			Maximum Thrust, lb	Max Threaded Stem Dia. in.	
		Nuclear Rating	Commerical Rating			SB	SBD
SMB	000	90	120	8,000	1-3/8		
SMB	00	250	260	14,000	1-3/4		
SMB	0	500	700	24,000	2-3/8		
SMB	1	850	1,100	45,000	2-7/8		
SMB	2	1,800	1,950	70,000	3-1/2		
SMB	3	4,200	4,500	140,000	5		
SMB	4&4T	7,500	8,300	250,000	5		
SMB	5&5T	20,000	20,000	500,000	6-1/4		
SMB	5XT	60,000	60,000	500,000	6-1/4		
					SB	SBD	
SB	000	90	120	8,000	5/8	--	
SB/SBD	00	250	260	14,000	1-1/4	1-1/2	
SB/SBD	0	500	700	24,000	2-3/8	2-1/4	
SB/SBD	1	850	1,100	45,000	2-5/8	2-1/2	
SB/SBD	2	1,800	1,950	70,000	3-1/2	3-1/2	
SB/SBD	3	4,200	4,500	140,000	4	3-1/2	
SB/SBD	4	7,500	8,300	250,000	5	5	

8.8 Figure 6 - Torque Calculation Form
TORQUE SENSITIVITY CALCULATION

Client: _____

Project No.: _____

Purchase Order No.: _____

Valve: _____

QSS No.: _____

Stem Diameter: _____ inches

 GF_{TH}: _____

 GF_{TQ}: _____

Calibration Date: _____

By: _____

Thrust Sensitivity: _____ lb/mv/Vdc

$$SENS_{TQ} = \frac{D}{96} \left(\frac{GF_{TH}}{GF_{TQ}} \right) SENS_{TH} (ft-lbs) / (mv / Vdc)$$

$$SENS_{TQ} = \frac{\text{-----}}{96} \left(\frac{\text{-----}}{\text{-----}} \right) \text{-----}$$

$$SENS_{TQ} = \text{-----} (ft-lbs) / (mv/Vdc)$$

By: _____

Date: _____

Checked By: _____

Date: _____