NAVAIR 17-20MU-03

MU-03

TECHNICAL MANUAL

INSTRUMENT CALIBRATION PROCEDURE

TORQUE TESTERS

FLEXIBLE-BEAM AND TORSION-BAR TYPES
5 OZ-IN TO 1000 LB-FT

THIS PUBLICATION SUPERSEDES NAVAIR 17-20MU-03
DATED 1 MAY 1994

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PUBLISHED BY DIRECTION OF COMMANDER NAVAL AIR SYSTEMS COMMAND

1 JULY 2001

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SECTION 1

INTRODUCTION AND DESCRIPTION

1.1 This procedure describes the calibration of Flexible-Beam and Torsion-Bar Type Torque Testers within the range of 5 oz-in to 1000 lb-ft. The flexible-beam type has a beam as its measuring element that is flexed in proportion to the torque applied to the input shaft. A dial-pointer system indicates the amount of flexure in terms of the applied torque. The torsion-bar type operates in a similar manner, except that the measuring element is a round bar that is twisted in proportion to the applied torque. Instruments that may be calibrated using this procedure include, but are not limited to, the models listed in Appendix A. The instrument being calibrated is referred to herein as the TI (Test Instrument).

1.2 All comments concerning this procedure should be directed to Navy Measurement Science Directorate, Corona Division, Naval Surface Warfare Center, P.O. Box 5000, Corona, CA 92878-5000.

1.3 This procedure includes tests of essential performance parameters only. Any malfunction noticed during calibration, whether specifically tested for or not, should be corrected.

Table 1. Calibration Description

TI Characteristics	Performance Specifications	Test Method
Torque measurement	Range: 5 oz-in to 1000 lb-ft Tolerance: ±1% iv or ±1 scale graduation, whichever is greater	Comparison method using calibrated lever and weights.

SECTION 2

EQUIPMENT REQUIREMENTS

NOTES

Minimum use specifications are the principal parameters required for performance of the calibration, and are included to assist in the selection of alternate equipment, which may be used at the discretion of the using laboratory. Satisfactory performance of alternate items shall be verified prior to use. All applicable equipment must bear evidence of current calibration.

The instruments utilized in this procedure were selected from those known to be available at Navy calibration facilities, and the listing by make or model number carries no implication of preference, recommendation, or approval for use by other agencies. It is recognized that equivalent equipment produced by other manufacturers may be capable of equally satisfactory performance in this procedure.

Table 2. Equipment Requirements

Item	Minimum Use Specifications	Calibration Equipment
2.1 Torque standard including lever, weight holder, and weights	Range: 5 to 500 oz-in Uncertainty: ±0.1% (at standard gravity)	Torque Controls CTP 500Z, CTP 100Z and CTP 800Z; or Consolidated Devices 500ST-OI
2.2 Torque standard including lever and weight holder	Range: 20 lb-in to 1000 lb-in Uncertainty: ±0.1% (at standard gravity)	Torque Controls CTS 2000P; or Consolidated Devices 2000ST-PI
2.3 Torque standard including lever and weight holder	Range: 200 lb-in to 1000 lb-ft Uncertainty: ±0.1% (at standard gravity)	Torque Controls CTS 1000F; or Consolidated Devices 1000ST-PF
2.4 Weights	Weight: 0.5 to 321.5 lbs Uncertainty: Class C*	D-77, designed by Measurement Science Directorate
2.5 Mounting plate	To mount TI	D-108 or D-225, designed by Measurement Science Directorate
2.6 Adapter	Short extension; required for CDI 250/2000 PI	Apex EX-504B

*NIST Class F and Class Q or ASTM E617-81 Class 5 weights are also acceptable.

SECTION 3

PRELIMINARY OPERATIONS

3.1 Ensure that the TI is clean and free from defects that would impair its operation.

3.2 If the correction for local gravity (g_L/g_S) is within the limits of 0.9985 and 1.0015, record the values listed in column 2 on the checklist for the TI as the NOMINAL values for the calibration points; if not, determine the NOMINAL values according to the following formula:

$$\text{NOMINAL value} = \text{value in col 2} \times \frac{g_L}{g_S}$$

$$\frac{g_L}{g_S} = \text{local gravity correction factor}$$

$$= \frac{\text{local gravity in gals}}{980.665\,\text{gals}}$$

NOTE

If the local gravity correction factor is unknown, the approximate value can be determined from Appendix B.

NOTE

To determine torque values in oz-in for test points other than those listed, use the following formula:

$$\text{desired torque (oz-in) or TI indication (oz-in)} = \frac{\text{Radius (in) X Weights(g)}}{28.35\text{g/oz}}$$

or

$$\text{weight (grams)} = \frac{28.35\text{g/oz X desired torque (oz-in) or TI indication (oz-in)}}{\text{Radius (in)}}$$

3.3 Secure the mounting plate to a rigid work surface so that the torque standard can be attached to the input shaft and so that when the torque standard lever is placed on the shaft and weight is suspended from the lever, the weight cable is tangent to the radius portion of the lever, and the lever and weight will not be obstructed.

3.4 Secure the TI to the mounting plate.

SECTION 4

CALIBRATION PROCESS

NOTE

Unless otherwise specified, verify the results of each test and take corrective action whenever the test requirement is not met, before proceeding.

4.1 Place the appropriate lever arm (or wheel) on the TI shaft for application of cw torque. Use the adapter (item 2.6) as necessary.

NOTES

Be sure that the torque calibration point being measured falls within the range (listed in Section 2) of the lever arm selected. The 10 inch arm (item 2.2) should not be used for points above 1000 lb-in.

Assure that the weight pan cable is free from contact with any object that may change the angle of the cable from the vertical position.

4.2 If the TI is the torsion-bar type, exercise the TI as follows; if not, skip to step 4.3.

4.2.1 Place the appropriate weight holder and sufficient weights on the lever arm cable to obtain a TI fullscale indication.

4.2.2 After 1 minute, remove the torque by raising (or removing) the weight(s).

4.2.3 Reapply the torque by lowering (or replacing) the weight(s).

4.2.4 Repeat steps 4.2.2 and 4.2.3 four more times.

NOTE

If the TI is a dual-range instrument, the high-range calibration must be performed first.

4.3 If applicable, remove the weight holder from the lever arm.

4.4 Zero the TI in accordance with the manufacturer's instructions.

4.4.1 If the TI is supplied with a reference setting arm, check the reference arm by establishing the same reference point (usually 5 oz in) on the TI using the appropriate standard arm and weights. Remove the arm and weights and place the reference arm on the TI. If necessary, adjust the adjustment screw on the end of the reference arm to obtain the correct reference point. (Turn the adjustment screw counterclockwise to increase the torque or clockwise to decrease torque.)

4.5 Perform a measurement as follows at each selected torque calibration point:

4.5.1 Place the weight holder and the appropriate weight(s) on the lever arm to apply the nominal value of torque.

4.5.2 Decrease the torque slightly, set the TI pointer to some value less than the nominal value, carefully increase the torque so that the pointer moves slowly upscale until the full torque is applied, and verify that the TI indication is within the tolerance limits.

NOTES

This step should be repeated so that consistent results are obtained. For a TI having a memory-type indicator, the operation should be performed by carefully pushing the weight or arm upward, resetting the pointer, then slowly removing the upward force. This must be accomplished to avoid dropping or swinging the weight. On the Torque Controls ET series testers (except model ET 100Z-010), it may be sufficient to press the reset shaft (to decrease the force and reset the pointer), and then slowly release the reset shaft. The Torque Controls model ET 100Z-010 tester has an electric vibrator which must be turned on during torque measurements.

When calibrating Consolidated Devices 100/500 OI Testers, a slight tapping of the dial indicator while approaching the calibration point will help reduce inherent friction in the tester thereby providing readings that are more accurate.

Excessive shock or vibration in the area (from passing trucks, etc,) may cause erratic torque indications during static torque measurements. If necessary, select another work area, or perform the test when such forces are absent.

If there is no checklist for the TI, select calibration points at 10% intervals of fullscale.

If the TI is a bending-beam type that can be loaded in only one direction, ccw calibration may be obtained by turning the TI dial indicator 180 degrees and repeating steps 4.4 through 4.5.2. Three calibration points should be selected, one at the bottom of the range, one near the center, and one at fullscale. Then compare the values obtained at these points with the values obtained in cw direction. If the ccw values are compatible with the cw values, no further calibration is required. If difficulties are experienced in obtaining the correct TI indications, then a full calibration as outlined in step 4.6 is required.

4.6 If the TI is designed to measure ccw torque, repeat steps 4.1 through 4.5.2, applying torque in the ccw direction, except substitute ccw in step 4.1.

4.7 If the TI is a dual-range instrument, repeat steps 4.1 through 4.6 for the lower range; if not, proceed to step 4.8.

4.8 Unless other measurements are to be performed, secure the equipment in accordance with local laboratory practice.

CALIBRATION CHECKLIST

TEST INST(S) Sweeney 7065 Torque Tester

PROC. NO. NA 17-20MU-03		MFG.	MODEL			SER. NO.
PROCEDURE STEP NO	FUNCTION TESTED	NOMINAL	MEASURED VALUES		OUT OF TOL	CALIBRATION TOLERANCES
			FIRST RUN	SECOND RUN		
(1)	(2)	(3)	(4)	(5)	(6)	(7)
3.1	TI Inspection	- -	ck ( )		NA	
4.1	CW Torque					
4.2	Exercise TI	- -	ck ( )			
4.4	Zero TI	- -	ck ( )			
		lb-in	lb-in			
4.5	600 lb-in					±10 lb-in
4.5.2	1200 ”					±12 ”
”	1800 ”					±18 ”
”	2400 ”					±24 ”
”	3000 ”					±30 ”
”	3600 ”					±36 ”
”	4200 ”					±42 ”
”	4800 ”					±48 ”
”	5400 ”					±54 ”
”	6000 ”					±60 ”
	CCW Torque					
4.6	Exercise TI	- -	ck ( )			
”	Zero TI	- -	ck ( )			
		lb-in	lb-in			
”	600 lb-in					±10 lb-in
”	1200 ”					±12 ”
”	1800 ”					±18 ”
”	2400 ”					±24 ”
”	3000 ”					±30 ”
”	3600 ”					±36 ”
”	4200 ”					±42 ”
”	4800 ”					±48 ”
”	5400 ”					±54 ”
”	6000 ”					±60 ”

CALIBRATION CHECKLIST

TEST INST(S) Sweeney 7075 Torque Tester

PROC. NO. NA 17-20MU-03		MFG.	MODEL			SER. NO.
PROCEDURE STEP NO (1)	FUNCTION TESTED (2)	NOMINAL (3)	MEASURED VALUES FIRST RUN (4)	MEASURED VALUES SECOND RUN (5)	OUT OF TOL (6)	CALIBRATION TOLERANCES (7)
3.1	TI Inspection	- -	ck ( )		NA	
4.1	CW Torque					
4.2	Exercise TI	- -	ck ( )			
4.4	Zero TI	- -	ck ( )			
		lb-in	lb-in			
4.5	180 lb-in					±2.0 lb-in
4.5.2	360 ”					±3.6 ”
”	540 ”					±5.4 ”
”	720 ”					±7.2 ”
”	900 ”					±9.0 ”
”	1080 ”					±10.8 ”
”	1260 ”					±12.6 ”
”	1440 ”					±14.4 ”
”	1620 ”					±16.2 ”
”	1800 ”					±18.0 ”
	CCW Torque					
4.6	Exercise TI	- -	ck ( )			
”	Zero TI	- -	ck ( )			
		lb-in	lb-in			
”	180 lb-in					±2.0 lb- in
”	360 ”					±3.6 ”
”	540 ”					±5.4 ”
”	720 ”					±7.2 ”
”	900 ”					±9.0 ”
”	1080 ”					±10.8 ”
”	1260 ”					±12.6 ”
”	1440 ”					±14.4 ”
”	1620 ”					±16.2 ”
”	1800 ”					±18.0 ”

CALIBRATION CHECKLIST

TEST INST(S) Sweeney 7085 Torque Tester

PROC. NO. NA 17-20MU-03		MFG.	MODEL			SER. NO.
PROCEDURE STEP NO (1)	FUNCTION TESTED (2)	NOMINAL (3)	MEASURED VALUES FIRST RUN (4)	MEASURED VALUES SECOND RUN (5)	OUT OF TOL (6)	CALIBRATION TOLERANCES (7)
3.1	TI Inspection	- -	ck ( )		NA	
4.1	CW Torque					
4.2	Exercise TI	- -	ck ( )			
4.4	Zero TI	- -	ck ( )			
		oz-in	oz-in			
4.5	400 oz-in					±5.0 oz-in
4.5.2	800 ”					±8.0 ”
”	1200 ”					±12 ”
”	1600 ”					±16 ”
”	2000 ”					±20 ”
”	2400 ”					±24 ”
”	2800 ”					±28 ”
”	3200 ”					±32 ”
”	3600 ”					±36 ”
”	4000 ”					±40 ”
	CCW Torque					
4.6	Exercise TI	- -	ck ( )			
”	Zero TI	- -	ck ( )			
		oz-in	oz-in			
”	400 oz-in					±5.0 oz- in
”	800 ”					+8.0 ”
”	1200 ”					±12 ”
”	1600 ”					±16 ”
”	2000 ”					±20 ”
”	2400 ”					±24 ”
”	2800 ”					±28 ”
”	3200 ”					±32 ”
”	3600 ”					±36 ”
”	4000 ”					±40 ”

CALIBRATION CHECKLIST

TEST INST(S) Sweeney 7095 Torque Tester

PROC. NO. NA 17-20MU-03		MFG.	MODEL			SER. NO.
PROCEDURE STEP NO	FUNCTION TESTED	NOMINAL	MEASURED VALUES		OUT OF TOL	CALIBRATION TOLERANCES
			FIRST RUN	SECOND RUN		
(1)	(2)	(3)	(4)	(5)	(6)	(7)
3.1	TI Inspection	- -	ck ( )		NA	
4.1	CW Torque					
4.2	Exercise TI	- -	ck ( )			
4.4	Zero TI	- -	ck ( )			
		oz-in	oz-in			
4.5	80 oz-in					±1.0 oz-in
4.5.2	160 ”					±1.6 ”
”	240 ”					±2.4 ”
”	320 ”					±3.2 ”
”	400 ”					±4.0 ”
”	480 ”					±4.8 ”
”	560 ”					±5.6 ”
”	640 ”					±6.4 ”
”	720 ”					±7.2 ”
”	800 ”					±8.0 ”
	CCW Torque					
4.6	Exercise TI	- -	ck ( )			
”	Zero TI	- -	ck ( )			
		oz-in	oz-in			
”	80 oz-in					±1.0 oz-in
”	160 ”					±1.6 ”
”	240 ”					±2.4 ”
”	320 ”					±3.2 ”
”	400 ”					±4.0 ”
”	480 ”					±4.8 ”
”	560 ”					±5.6 ”
”	640 ”					±6.4 ”
”	720 ”					±7.2 ”
”	800 ”					±8.0 ”

CALIBRATION CHECKLIST

TEST INST(S) Sweeney 7705 Torque Tester

PROC. NO. NA 17-20MU-03		MFG.	MODEL			SER. NO.
PROCEDURE STEP NO	FUNCTION TESTED	NOMINAL	MEASURED VALUES		OUT OF TOL	CALIBRATION TOLERANCES
			FIRST RUN	SECOND RUN		
(1)	(2)	(3)	(4)	(5)	(6)	(7)
3.1	TI Inspection	- -	ck ( )		NA	
4.1	CW Torque					
4.2	Exercise TI	- -	ck ( )			
4.4	Zero TI	- -	ck ( )			
		oz-in	oz-in			
4.5	10 oz-in					±0.10 oz-in
4.5.2	20 ”					±0.20 ”
”	30 ”					±0.30 ”
”	40 ”					±0.40 ”
”	50 ”					±0.50 ”
”	60 ”					±0.60 ”
”	70 ”					±0.70 ”
”	80 ”					±0.80 ”
”	90 ”					±0.90 ”
”	100 ”					±1.0 ”
	CCW Torque					
4.6	Exercise TI	- -	ck ( )			
”	Zero TI	- -	ck ( )			
		oz-in	oz-in			
”	10 oz-in					±0.10 oz-in
”	20 ”					±0.20 ”
”	30 ”					±0.30 ”
”	40 ”					±0.40 ”
”	50 ”					±0.50 ”
”	60 ”					±0.60 ”
”	70 ”					±0.70 ”
”	80 ”					±0.80 ”
”	90 ”					±0.90 ”
”	100 ”					±1.0 ”

CALIBRATION CHECKLIST

TEST INST(S) Sweeney 7715 Torque Tester

PROC. NO. NA 17-20MU-03		MFG.	MODEL			SER. NO.
PROCEDURE STEP NO	FUNCTION TESTED	NOMINAL	MEASURED VALUES		OUT OF TOL	CALIBRATION TOLERANCES
			FIRST RUN	SECOND RUN		
(1)	(2)	(3)	(4)	(5)	(6)	(7)
3.1	TI Inspection	- -	ck ( )		NA	
4.1	CW Torque					
4.2	Exercise TI	- -	ck ( )			
4.4	Zero TI	- -	ck ( )			
		oz-in	oz-in			
4.5	50 oz-in					±0.50 oz-in
4.5.2	100 ”					±1.0 ”
”	150 ”					±1.5 ”
”	200 ”					±2.0 ”
”	250 ”					±2.5 ”
”	300 ”					±3.0 ”
”	350 ”					±3.5 ”
”	400 ”					±4.0 ”
”	450 ”					±4.5 ”
”	500 ”					±5.0 ”
	CCW Torque					
4.6	Exercise TI	- -	ck ( )			
”	Zero TI	- -	ck ( )			
		oz-in	oz-in			
”	50 oz-in					±0.50 oz-in
”	100 ”					±1.0 ”
”	150 ”					±1.5 ”
”	200 ”					±2.0 ”
”	250 ”					±2.5 ”
”	300 ”					±3.0 ”
”	350 ”					±3.5 ”
”	400 ”					±4.0 ”
”	450 ”					±4.5 ”
”	500 ”					±5.0 ”

CALIBRATION CHECKLIST

TEST INST(S) Sweeney 7725 Torque Tester

PROC. NO. NA 17-20MU-03		MFG.	MODEL			SER. NO.
PROCEDURE STEP NO	FUNCTION TESTED	NOMINAL	MEASURED VALUES		OUT OF TOL	CALIBRATION TOLERANCES
			FIRST RUN	SECOND RUN		
(1)	(2)	(3)	(4)	(5)	(6)	(7)
3.1	TI Inspection	- -	ck ( )		NA	
4.1	CW Torque					
4.2	Exercise TI	- -	ck ( )			
4.4	Zero TI	- -	ck ( )			
		lb-in	lb-in			
4.5	25 lb-in					±0.25 lb-in
4.5.2	50 ”					±0.50 ”
”	75 ”					±0.75 ”
”	100 ”					±1.0 ”
”	125 ”					±1.3 ”
”	150 ”					±1.5 ”
”	175 ”					±1.8 ”
”	200 ”					±2.0 ”
”	225 ”					±2.3 ”
”	250 ”					±2.5 ”
	CCW Torque					
4.6	Exercise TI	- -	ck ( )			
”	Zero TI	- -	ck ( )			
		lb-in	lb-in			
”	25 lb-in					±0.25 lb-in
”	50 ”					±0.50 ”
”	75 ”					±0.75 ”
”	100 ”					±1.0 ”
”	125 ”					±1.3 ”
”	150 ”					±1.5 ”
”	175 ”					±1.8 ”
”	200 ”					±2.0 ”
”	225 ”					±2.3 ”
”	250 ”					±2.5 ”

CALIBRATION CHECKLIST

TEST INST(S) Sweeney 7735 Torque Tester

PROC. NO. NA 17-20MU-03		MFG.	MODEL			SER. NO.
PROCEDURE STEP NO	FUNCTION TESTED	NOMINAL	MEASURED VALUES		OUT OF TOL	CALIBRATION TOLERANCES
			FIRST RUN	SECOND RUN		
(1)	(2)	(3)	(4)	(5)	(6)	(7)
3.1	TI Inspection	- -	ck ( )		NA	
4.1	CW Torque					
4.2	Exercise TI	- -	ck ( )			
4.4	Zero TI	- -	ck ( )			
		lb-in	lb-in			
4.5	200 lb-in					±2 lb-in
4.5.2	400 ”					±4 ”
”	600 ”					±6 ”
”	800 ”					±8 ”
”	1000 ”					±10 ”
”	1200 ”					±12 “
”	1400 ”					±14 ”
”	1600 ”					±16 ”
”	1800 ”					±18 ”
”	2000 ”					±20 ”
	CCW Torque					
4.6	Exercise TI	- -	ck ( )			
”	Zero TI	- -	ck ( )			
		lb-in	lb-in			
”	200 lb-in					±2 lb-in
”	400 ”					±4 ”
”	600 ”					±6 ”
”	800 ”					±8 ”
”	1000 ”					±10 ”
”	1200 ”					±12 ”
”	1400 ”					±14 ”
”	1600 ”					±16 ”
”	1800 ”					±18 ”
”	2000 ”					±20 ”

CALIBRATION CHECKLIST

TEST INST(S) Sweeney 7745 Torque Tester

PROC. NO. NA 17-20MU-03		MFG.	MODEL			SER. NO.
PROCEDURE STEP NO	FUNCTION TESTED	NOMINAL	MEASURED VALUES		OUT OF TOL	CALIBRATION TOLERANCES
			FIRST RUN	SECOND RUN		
(1)	(2)	(3)	(4)	(5)	(6)	(7)
3.1	TI Inspection	- -	ck ( )		NA	
4.1	CW Torque					
4.2	Exercise TI	- -	ck ( )			
4.4	Zero TI	- -	ck ( )			
		lb-ft	lb-ft			
4.5	100 lb-ft					±1.0 lb-ft
4.5.2	200 ”					±2.0 ”
”	300 ”					±3.0 ”
”	400 ”					±4.0 ”
”	500 ”					±5.0 ”
”	600 ”					±6.0 ”
”	700 ”					±7.0 ”
”	800 ”					±8.0 ”
”	900 ”					±9.0 ”
”	1000 ”					±10 ”
	CCW Torque					
4.6	Exercise TI	- -	ck ( )			
”	Zero TI	- -	ck ( )			
		lb-ft	lb-ft			
”	100 lb-ft					±1.0 lb-ft
”	200 ”					±2.0 ”
”	300 ”					±3.0 ”
”	400 ”					±4.0 ”
”	500 ”					±5.0 ”
”	600 ”					±6.0 ”
”	700 ”					±7.0 ”
”	800 ”					±8.0 ”
”	900 ”					±9.0 ”
”	1000 ”					±10 ”

CALIBRATION CHECKLIST

TEST INST(S) Torque Controls ET-100Z Torque Tester

PROC. NO. NA 17-20MU-03		MFG.	MODEL			SER. NO.
PROCEDURE STEP NO (1)	FUNCTION TESTED (2)	NOMINAL (3)	MEASURED VALUES FIRST RUN (4)	MEASURED VALUES SECOND RUN (5)	OUT OF TOL (6)	CALIBRATION TOLERANCES (7)
3.1	TI Inspection	- -	ck ( )		NA	
4.1	CW Torque					
4.4	Zero TI	- -	ck ( )			
4.4.1	Reference Set Point	- -	ck ( )			
		oz-in	oz-in			
4.5	10 oz-in					±0.10 oz-in
4.5.2	20 ”					±0.20 ”
”	30 ”					±0.30 ”
”	40 ”					±0.40 ”
”	50 ”					±0.50 ”
”	60 ”					±0.60 ”
”	70 ”					±0.70 ”
”	80 ”					±0.80 ”
”	90 ”					±0.90 ”
”	100 ”					±1.0 ”
	CCW Torque					
4.6	Zero TI	- -	ck ( )			
		oz-in	oz-in			(oz-in)
”	10 oz-in					±0.10
”	50 ”					±0.50
”	100 ”					±1.0

CALIBRATION CHECKLIST

TEST INST(S) Torque Controls ET-250P Torque Tester

PROC. NO. NA 17-20MU-03		MFG.	MODEL			SER. NO.
PROCEDURE STEP NO (1)	FUNCTION TESTED (2)	NOMINAL (3)	MEASURED VALUES FIRST RUN (4)	MEASURED VALUES SECOND RUN (5)	OUT OF TOL (6)	CALIBRATION TOLERANCES (7)
3.1	TI Inspection	- -	ck ( )		NA	
4.1	CW Torque					
4.4	Zero TI	- -	ck ( )			
		lb-in	lb-in			
4.5	25 lb-in					±0.25 lb-in
4.5.2	50 ”					±0.5 ”
”	75 ”					±0.8 ”
”	100 ”					±1.0 ”
”	125 ”					±1.3 ”
”	150 ”					±1.5 ”
”	175 ”					±1.8 ”
”	200 ”					±2.0 ”
”	225 ”					±2.3 ”
”	250 ”					±2.5 ”
	CCW Torque					
4.6	Zero TI	- -	ck ( )			
		lb-in	lb-in			
”	25 lb-in					±0.25 lb-in
”	125 ”					±1.3 ”
”	250 ”					±2.5 ”

CALIBRATION CHECKLIST

TEST INST(S) Torque Controls ET-500Z Torque Tester

PROC. NO. NA 17-20MU-03		MFG.	MODEL			SER. NO.
PROCEDURE STEP NO (1)	FUNCTION TESTED (2)	NOMINAL (3)	MEASURED VALUES FIRST RUN (4)	MEASURED VALUES SECOND RUN (5)	OUT OF TOL (6)	CALIBRATION TOLERANCES (7)
3.1	TI Inspection	- -	ck ( )		NA	
4.1	CW Torque					
4.4	Zero TI	- -	ck ( )			
4.4.1	Reference Set Point	- -	ck ( )			
		oz-in	oz-in			
4.5	50 oz-in					±0.50 oz-in
4.5.2	100 ”					±1.0 ”
”	150 ”					±1.5 ”
”	200 ”					±2.0 ”
”	250 ”					±2.5 ”
”	300 ”					±3.0 ”
”	350 ”					±3.5 ”
”	400 ”					±4.0 ”
”	450 ”					±4.5 ”
”	500 ”					±5.0 ”
	CCW Torque					
4.6	Zero TI	- -	ck ( )			
		oz-in	oz-in			
”	50 oz-in					±0.50 oz-in
”	250 ”					±2.5 ”
”	500 ”					±5.0 ”

CALIBRATION CHECKLIST

TEST INST(S) Torque Controls ET-1000F and Consolidated Devices 1000-PF Torque Tester

PROC. NO. NA 17-20MU-03		MFG.	MODEL			SER. NO.
PROCEDURE STEP NO (1)	FUNCTION TESTED (2)	NOMINAL (3)	MEASURED VALUES FIRST RUN (4)	MEASURED VALUES SECOND RUN (5)	OUT OF TOL (6)	CALIBRATION TOLERANCES (7)
3.1	TI Inspection	- -	ck ( )		NA	
4.1	CW Torque					
4.4	Zero TI	- -	ck ( )			
		lb-ft.	lb-ft			
4.5	100 lb-ft					±1.0 lb-ft
4.5.2	200 ”					±2.0 ”
”	300 ”					±3.0 ”
”	400 ”					±4.0 ”
”	500 ”					±5.0 ”
”	600 ”					±6.0 ”
”	700 ”					±7.0 ”
”	800 ”					±8.0 ”
”	900 ”					±9.0 ”
”	1000 ”					±10 ”
	CCW Torque					
4.6	Zero TI	- -	ck ( )			
		lb-ft	lb-ft			
”	100 lb-ft					±1.0 lb-ft
”	500 ”					±5.0 ”
”	1000 ”					±10 ”

CALIBRATION CHECKLIST

TEST INST(S) Torque Controls ET-2000P Torque Tester

PROC. NO. NA 17-20MU-03		MFG.	MODEL			SER. NO.
PROCEDURE STEP NO (1)	FUNCTION TESTED (2)	NOMINAL (3)	MEASURED VALUES FIRST RUN (4)	MEASURED VALUES SECOND RUN (5)	OUT OF TOL (6)	CALIBRATION TOLERANCES (7)
3.1	TI Inspection	- -	ck ( )		NA	
4.1	CW Torque					
4.4	Zero TI	- -	ck ( )			
		lb-in	lb-in			
4.5	200 lb-in					±2.0 lb-in
4.5.2	400 ”					±4.0 ”
”	600 ”					±6.0 ”
”	800 ”					±8.0 ”
”	1000 ”					±10 ”
”	1200 ”					±12 ”
”	1400 ”					±14 ”
”	1600 ”					±16 ”
”	1800 ”					±18 ”
”	2000 ”					±20 ”
	CCW Torque					
4.6	Zero TI	- -	ck ( )			
		lb-in	lb-in			
”	200 lb-in					±2 lb-in
”	1000 ”					±10 ”
”	2000 ”					±20 ”

CALIBRATION CHECKLIST

TEST INST(S) Richmont AAD-1650, AO-1650, ASD-1650, ASDS-1650, H-1650, or KT-1650 Torque Analyzer

PROC. NO. NA 17-20MU-03		MFG.	MODEL			SER. NO.
PROCEDURE STEP NO	FUNCTION TESTED	NOMINAL	MEASURED VALUES		OUT OF TOL	CALIBRATION TOLERANCES
			FIRST RUN	SECOND RUN		
(1)	(2)	(3)	(4)	(5)	(6)	(7)
3.1	TI Inspection	- -	ck ( )		NA	
4.1	CW Torque					
4.2	Exercise TI	- -	ck ( )			
4.4	Zero TI	- -	ck ( )			
		lb-in	lb-in			
4.5	200 lb-in					±2.0 lb-in
4.5.2	400 ”					±4.0 ”
”	600 ”					±6.0 ”
”	800 ”					±8.0 ”
”	1000 ”					±10 ”
”	1200 ”					±12 ”
”	1400 ”					±14 ”
”	1600 ”					±16 ”
”	1800 ”					±18 ”

CALIBRATION CHECKLIST

TEST INST(S) Consolidated Devices 100/500 OI or Torque Controls ET-600Z Torque Tester

PROC. NO. NA 17-20MU-03		MFG.	MODEL			SER. NO.
PROCEDURE STEP NO (1)	FUNCTION TESTED (2)	NOMINAL (3)	MEASURED VALUES FIRST RUN (4)	MEASURED VALUES SECOND RUN (5)	OUT OF TOL (6)	CALIBRATION TOLERANCES (7)
3.1	TI Inspection	- -	ck ( )		NA	
4.1	CW Torque					
4.4	Zero TI	- -	ck ( )			
4.4.1	Reference Set Point	- -	ck ( )			
		oz-in	oz-in			
4.5	50 oz-in					±0.5 oz-in
4.5.2	100 ”					±1.0 ”
”	150 ”					±1.5 ”
”	200 ”					±2.0 ”
”	250 ”					±2.5 ”
”	300 ”					±3.0 ”
”	350 ”					±3.5 ”
”	400 ”					±4.0 ”
”	450 ”					±4.5 ”
”	500 ”					±5.0 ”
	CCW Torque					
4.6	Zero TI	- -	ck ( )			
		oz-in	oz-in			
”	50 oz-in					±0.5 oz-in
”	250 ”					±2.5 ”
”	500 ”					±5.0 ”

CALIBRATION CHECKLIST

TEST INST(S) Consolidated Devices 100/500 OI or Torque Controls ET-600Z Torque Tester

PROC. NO. NA 17-20MU-03		MFG.	MODEL			SER. NO.
PROCEDURE STEP NO (1)	FUNCTION TESTED (2)	NOMINAL (3)	MEASURED VALUES FIRST RUN (4)	MEASURED VALUES SECOND RUN (5)	OUT OF TOL (6)	CALIBRATION TOLERANCES (7)
4.1	CW Torque					
4.7	Zero TI	- -	ck ( )			
		oz-in	oz-in			
”	10 oz-in					±0.1 oz-in
”	20 ”					±0.2 ”
”	30 ”					±0.3 ”
”	40 ”					±0.4 ”
”	50 ”					±0.5 ”
”	60 ”					±0.6 ”
”	70 ”					±0.7 ”
”	80 ”					±0.8 ”
”	90 ”					±0.9 ”
”	100 ”					±1.0 ”
	CCW Torque					
”	Zero TI	- -	ck ( )			
		oz-in	oz-in			
”	10 oz-in					±0.1 oz-in
”	50 ”					±0.5 ”
”	100 ”					±1.0 ”

CALIBRATION CHECKLIST

TEST INST(S) Consolidated Devices 250/2000 PI or Torque Controls ET 2250P Torque Tester

PROC. NO. NA 17-20MU-03		MFG.	MODEL			SER. NO.
PROCEDURE STEP NO (1)	FUNCTION TESTED (2)	NOMINAL (3)	MEASURED VALUES FIRST RUN (4)	MEASURED VALUES SECOND RUN (5)	OUT OF TOL (6)	CALIBRATION TOLERANCES (7)
3.1	TI Inspection	- -	ck ( )		NA	
4.1	CW Torque					
4.4	Zero TI	- -	ck ( )			
		lb-in	lb-in			
4.5	200 lb-in					±2.0 lb-in
4.5.2	400 ”					±4.0 ”
”	600 ”					±6.0 ”
”	800 ”					±8.0 ”
”	1000 ”					±10.0 ”
”	1200 ”					±12.0 ”
”	1400 ”					±14.0 ”
”	1600 ”					±16.0 ”
”	1800 ”					±18.0 ”
”	2000 ”					±20.0 ”
	CCW Torque					
4.6	Zero TI	- -	ck ( )			
		lb-in	lb-in			
”	200 lb-in					±2 .0 lb-in
”	1000 ”					±10.0 ”
”	2000 ”					±20.0 ”

CALIBRATION CHECKLIST

TEST INST(S) Consolidated Devices 250/2000 PI or Torque Controls ET 2250P Torque Tester

PROC. NO. NA 17-20MU-03		MFG.	MODEL			SER. NO.
PROCEDURE STEP NO (1)	FUNCTION TESTED (2)	NOMINAL (3)	MEASURED VALUES FIRST RUN (4)	MEASURED VALUES SECOND RUN (5)	OUT OF TOL (6)	CALIBRATION TOLERANCES (7)
4.1	CW Torque					
4.7	Zero TI	- -	ck ( )			
		lb-in	lb-in			
”	25 lb-in					±0.25 lb-in
”	50 ”					±0.50 ”
”	75 ”					±0.75 ”
”	100 ”					±1.00 ”
”	125 ”					±1.25 ”
”	150 ”					±1.50 ”
”	175 ”					±1.75 ”
”	200 ”					±2.00 ”
”	225 ”					±2.25 ”
”	250 ”					±2.50 ”
	CCW Torque					
”	Zero TI	- -	ck ( )			
		lb-in	lb-in			
”	25 lb-in					±0.25 lb-in
”	125 ”					±1.25 ”
”	250 ”					±2.50 ”

CALIBRATION CHECKLIST

TEST INST(S) Sweeney 7045 Torque Tester

PROC. NO. NA 17-20MU-03		MFG.	MODEL			SER. NO.
PROCEDURE STEP NO	FUNCTION TESTED	NOMINAL	MEASURED VALUES		OUT OF TOL	CALIBRATION TOLERANCES
			FIRST RUN	SECOND RUN		
(1)	(2)	(3)	(4)	(5)	(6)	(7)
3.1	TI Inspection	- -	ck ( )		NA	
4.1	CW Torque					
4.2	Exercise TI	- -	ck ( )			
4.4	Zero TI	- -	ck ( )			
		lb-ft	lb-ft			
4.5	100 lb-ft					±10 lb-ft
4.5.2	200 ”					”
”	300 ”					”
”	400 ”					”
”	500 ”					”
”	600 ”					”
”	700 ”					”
”	800 ”					”
”	900 ”					”
”	1000 ”					”
	CCW Torque					
4.6	Exercise TI	- -	ck ( )			
”	Zero TI	- -	ck ( )			
		lb-ft	lb-ft			
”	100 lb-ft					±10 lb-ft
”	200 ”					”
”	300 ”					”
”	400 ”					”
”	500 ”					”
”	600 ”					”
”	700 ”					”
”	800 ”					”
”	900 ”					”
”	1000 ”					”

CALIBRATION CHECKLIST

TEST INST(S) Consolidated Devices 500PF6000PI Torque Tester

PROC. NO. NA 17-20MU-03		MFG.	MODEL			SER. NO.
PROCEDURE STEP NO (1)	FUNCTION TESTED (2)	NOMINAL (3)	MEASURED VALUES FIRST RUN (4)	MEASURED VALUES SECOND RUN (5)	OUT OF TOL (6)	CALIBRATION TOLERANCES (7)
3.1	TI Inspection	- -	ck ( )		NA	
4.1	CW Torque					
4.4	Zero TI	- -	ck ( )			
		lb-ft	lb-ft			
4.5	100 lb-ft					±1 lb-ft
4.5.2	150 ”					±1.5 ”
”	200 ”					±2 ”
”	250 ”					±2.5 ”
”	300 ”					±3 ”
”	350 ”					±3.5 ”
”	400 ”					±4 ”
”	450 ”					±4.5 ”
”	500 ”					±5 ”
	CCW Torque					
4.6	Zero TI	- -	ck ( )			
		lb-ft	lb-ft			
”	100 lb-ft					±1 lb-ft
”	300 ”					±3.0 ”
”	500 ”					±5.0 ”
	Since the TI tolerance is ±1% iv or ±1 division, whichever is greater, this TI is not calibrated below 100 lb-ft. Therefore, apply a special calibration label and tag stating: “This instrument is not calibrated below 100 lb-ft.”					

CALIBRATION CHECKLIST

TEST INST(S) Consolidated Devices 2000 PI Torque Tester

PROC. NO. NA 17-20MU-03		MFG.	MODEL			SER. NO.
PROCEDURE STEP NO (1)	FUNCTION TESTED (2)	NOMINAL (3)	MEASURED VALUES FIRST RUN (4)	MEASURED VALUES SECOND RUN (5)	OUT OF TOL (6)	CALIBRATION TOLERANCES (7)
3.1	TI Inspection	- -	ck ( )		NA	
4.1	CW Torque					
4.4	Zero TI	- -	ck ( )			
		lb-in	lb-in			
4.5	200 lb-in					±2.0 lb-in
4.5.2	400 ”					±4.0 ”
”	600 ”					±6.0 ”
”	800 ”					±8.0 ”
”	1000 ”					±10.0 ”
”	1200 ”					±12.0 ”
”	1400 ”					±14.0 ”
”	1600 ”					±16.0 ”
”	1800 ”					±18.0 ”
”	2000 ”					±20.0 ”
	CCW Torque					
4.6	Zero TI	- -	ck ( )			
”	200 lb-in					±2.0 lb-in
”	1000 ”					±10.0 ”
”	2000 ”					±20.0 ”

CALIBRATION CHECKLIST

TEST INST(S) Consolidated Devices 200PF/2400PI Torque Tester

PROC. NO. NA 17-20MU-03		MFG.	MODEL			SER. NO.
PROCEDURE STEP NO (1)	FUNCTION TESTED (2)	NOMINAL (3)	MEASURED VALUES FIRST RUN (4)	MEASURED VALUES SECOND RUN (5)	OUT OF TOL (6)	CALIBRATION TOLERANCES (7)
3.1	TI Inspection	- -	ck ( )		NA	
4.1	CW Torque					
4.4	Zero TI	- -	ck ( )			
		lb-in	lb-in			
4.5	240 lb-in					±2.4 lb-in
4.5.2	480 ”					±4.8 ”
”	720 ”					±7.2 ”
”	960 ”					±9.6 ”
”	1200 ”					±12.0 ”
”	1440 ”					±14.4 ”
”	1680 ”					±16.8 ”
”	1920 ”					±19.2 ”
”	2160 ”					±21.6 ”
”	2400 ”					±24.0 ”
	CCW Torque					
4.6	Zero TI	- -	ck ( )			
		lb-in	lb-in			
”	240 lb-in					±2.4 lb-in
”	1200 ”					±12.0 ”
”	2400 ”					±24.0 ”

APPENDIX A

REPRESENTATIVE TEST INSTRUMENTS

Test Instruments that may be calibrated using this procedure include, but are not limited to, the following:

MODEL	MANUFACTURER	NOMENCLATURE	CHECKLIST PAGE NO
AAD-1650	Richmont	Torque Analyzer	33
AO-1650	”	”	33
ASD-1650	”	”	33
ASDS-1650	”	”	33
ET-100Z	Torque Controls	Torque Tester	23
ET-1000F	”	”	29
ET-2000P	”	”	31
ET-2250P	”	”	37, 38
ET-250P	”	”	25
ET-500Z	”	”	27
ET-600Z	”	”	35, 36
H-1650	Richmont	Torque Analyzer	33
KT-1650	”	”	33
L1	D.G. Mountz Associates	”	
100/500 OI	Consolidated Devices	Torque Tester	35, 36
1000-PF	”	”	29
200PF/2400PI	”	”	45, 46
2000 PI	”	”	43
250/2000 PI	”	”	37, 38
500PF6000PI	”	”	41
500-OI	”	”	
7045	B.K. Sweeney	”	39
7065	”	”	5
7075	”	”	7
7085	”	”	9
7095	”	”	11
7705	”	”	13
7715	”	”	15
7725	”	”	17
7735	”	”	19
7745	”	”	21

APPENDIX B

GRAVITY CORRECTION FACTOR VS LATITUDE AND ELEVATION