OPERATOR'S MANUAL

NORBAR UNSUPPORTED CALIBRATION BEAMS

CONTENTS

PART NUMBERS COVERED BY THIS MANUAL

Part Number	Torque Radius	Minimum Applicable Torque	Maximum Applicable Torque	Construction
21400	0.1 m	0.05 N·m	1.0 N·m	Test Disc
	0.1 m	5 ozf·in	160 ozf·in	
21429	0.25 m	0.5 N·m	60 N·m	Plate Beam
21421	0.5 m	5 N·m	150 N·m	Plate Beam
21427	0.5 m	5 N·m	500 N·m	Plate Beam
21430	10"	10 lbf·in	500 lbf·in	Plate Beam
21424	12"	10 lbf·ft	100 lbf·ft	Plate Beam
21425	24"	50 lbf·ft	500 lbf·ft	Composite Beam
21426	48"	100 lbf·ft	1000 lbf·ft	Composite Beam
21428	1 m	10 N·m	1500 N·m	Composite Beam

Matching Weight Sets

The weight sets listed below are designed to give specific torque ranges with each test beam. Individual weights are available from Norbar to create different torque ranges. These torques must be within the minimum and maximum applicable torques listed above.

Beam Model Part Number	Weight Set Details	
	Part Number	Set Comprises
21400	21452.NAM	10 x 0.5 N
	21450.NAM	10 x 1.0 N
	21479.NAM	10 x 2.5 N
	21455.NAM	10 x 1.27 ozf
	21453.NAM	10 x 2.54 ozf
	21451.NAM	10 x 4.064 ozf
21429	21476.NAM	10 x 2 N
	21454.NAM	10 x 4.0 N
	21458.NAM	10 x 20.0 N
21421	21477.NAM	10 x 10 N
	21458.NAM	10 x 20.0 N
21427	21459.NAM	1 x 10 N, 10 x 50 N
	21460.NAM	1 x 10 N, 10 x 100 N
21430	21465.NAM	10 x 1.0 lbf
	21466.NAM	10 x 5.0 lbf
21424	21467.NAM	10 x 10.0 lbf
21425	21468.NAM	10 x 25.0 lbf
21426	21468.NAM	10 x 25.0 lbf
21428	21459.NAM	1 x 10 N, 10 x 50 N
	21460.NAM	1 x 10 N, 10 x 100 N
	21483.NAM	1 X 10N, 2 x 50 N, 14 x 100 N

SAFETY

It is recommended that safety shoes are worn. Use safe manual handling techniques when lifting.

INTRODUCTION

These test beams are designed for the static calibration of torque transducers.

They are ideally suited to Norbar torque transducers, but can be employed on other manufacturer's equipment if certain constraints are met. See page 5 for more details.

Torque is generated by the application of a known force at a known radius from the centre of rotation of the torque transducer.

Norbar test beams have several unique design features which are intended to minimise errors during the calibration process.

Features of Radius Ended Beams

- Beam length machined to +/- 0.01% (100 microns per metre) allowing for wire thickness.

- Clockwise and counterclockwise operation.

- Radiused ends maintain length over +/- 8 degrees of rotation from horizontal.

- No bearings to cause energy loss during loading.

- Beams balanced to maximise energy transfer to transducer during loading.

- Radiused ends offset to bring plane of loading within transducer and so reducing bending moments.

- High beam accuracy allows use of cast iron weights rather than stainless steel. Weight accuracy is required to be equal to or better than 0.01% which approximates to class M1.

Features of Test Disc

- One disc now capable of SI or imperial calibrations.

- Choice of weight sets for 0.5 N·m, 1.0 N·m, 50 ozf·in, 100 ozf·in and 160 ozf·in (10 lbf·in).

- Compatible with male and female ¼" transducer drives.

- Minimised inertia for greater accuracy.

The beam is mounted directly into the transducer. This eliminates the frictional losses present in bearing mounted beams.

The +/- 8 degrees usable arc allows for square drives misalignment which may cause the beam to tip downwards under load.

NOTE: **Use of adaptors may create clearances which exceed the 8º.**

All transducers have a certain amount of rotation under torque loading, due to their elastic elements. (For Norbar Static Transducers the rotation is approximately 1º of rotation from zero to full scale torque loading). Therefore the +/-8º allows for calibration without having to adjust the beam back to horizontal after each additional load increment.
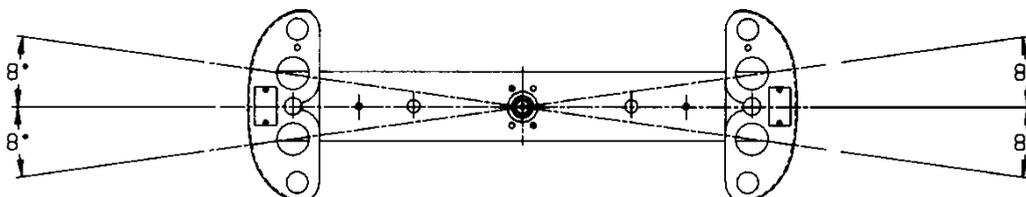

FIGURE 1 – Side View

Norbar test beams are designed with square drives machined to the top limit of ISO2725:198. This minimises any play between the beam and the transducer. The use of commercially available adaptors may compromise this close fit and cause the beam to exceed the 8º limits mentioned above. In extreme cases the true centre of rotation may be altered, thus invalidating the calibration.
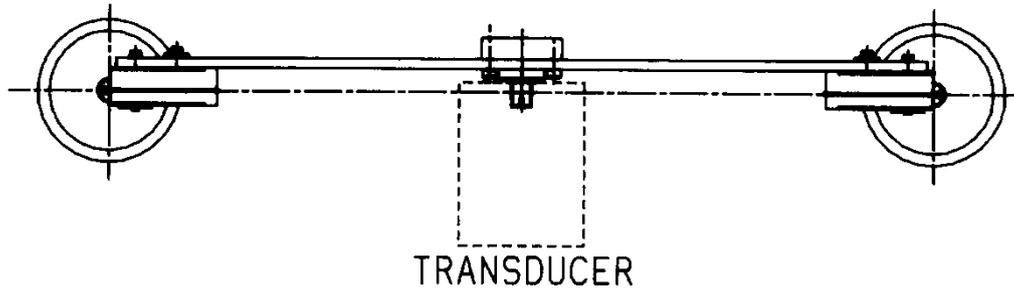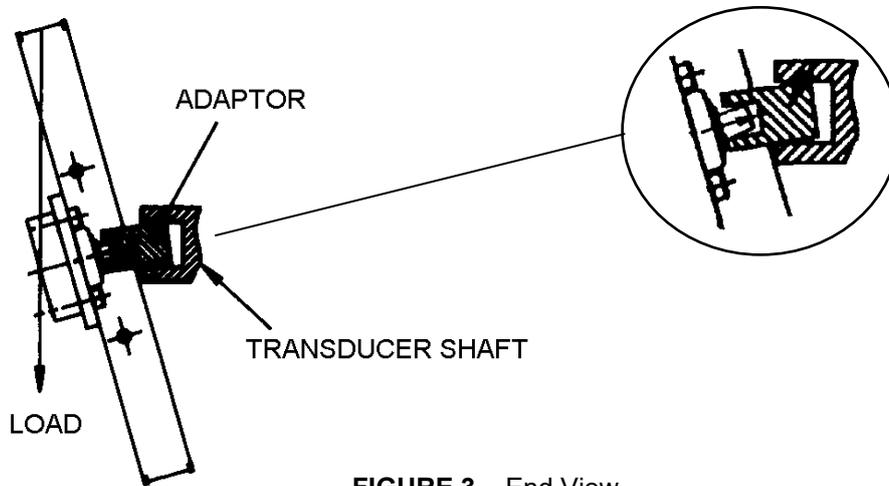

TRANSDUCER

FIGURE 2 – Top View

Additionally the beams are designed to apply load on vertical plane which cuts through the square drive inside the transducer. This minimises bending movements on the transducer and also for safe operation ensures that the beam will not fall out.

SCOPE OF USE

Most torque transducers having a female square drive can be calibrated using these test beams. The limitations are that:


FIGURE 3 – End View

- Adaptors must not be used which extend the distance between the beam and the transducer. (See Figure 2), or which create excessive misalignment between the beam and transducer, (See Figure 3).

- Mechanical transducers using hydraulic or spring systems may have a large rotation under load which exceeds the +/- 8 degrees usable arc. In such a case some form of tilting table is required to keep the beam within +/- 8 degrees horizontal as load is increased. Norbar part number 80005 can be purchased for use with calibration pedestal 80000.

- Some transducers may be sensitive to the bending moment induced by hanging the test beam on the end of the transducer. If in doubt this can be established by observing zero shift when the beam square is inserted into the transducer.

- Some transducers are incorporated with the display in casings which interfere with the beam radius ends. This problem may be avoided by rotating the casing by 90 degrees.

EQUIPMENT REQUIRED

The transducer must be fixed to a firm structure such that the reaction is taken without deflection of the structure. Norbar manufacture a pedestal, which when bolted to the ground, is suitable for calibrating torques up to 1000 N·m or 1000 lbf·ft.
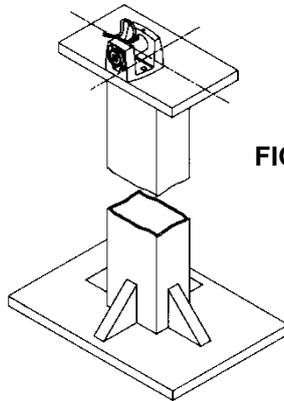
FIGURE 4 – Transducer Calibration Pedestal (Part No. 80000)

If other structures are used, then the weight hangers must not be obstructed. The figures below do not allow for the operator's working space.

Beam Radius	Dimension					
	A	B	C	D	E	F
100 mm	266	410	65	135	210	65
250 mm	600	788	100	400	612	100
500 mm	1100	955	100	900	665	100
1000 mm	2248	1610	248	1752	1132	248
10"	623	800	115	393	622	115
12"	760	840	150	460	620	150
24"	1409	1195	190	1029	865	190
48"	2628	1430	190	2248	890	190
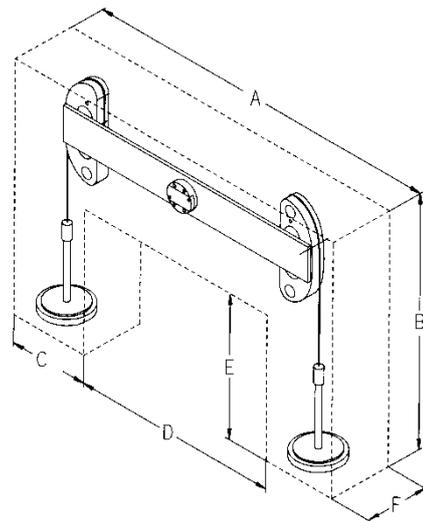
FIGURE 5 – Space Requirements

EXTERNAL EFFECTS

Temperature Compensation

Norbar test beams are manufactured from aerospace alloys. These materials have a higher expansion coefficient than steel and should therefore be used in a temperature controlled environment of 20˚C +/- 2˚C. If the beam must be used outside these limits, the temperature must be stable (within 1˚C change per hour) and the effective length of the beam calculated according to the details below.

The temperature coefficient is 23×10^{-6} /˚C or (0.000024 per ˚C)

The formula for calculating the change in effective beam length is:

Change in length =
Initial beam radius x Coefficient of linear expansion x Change in temperature (from 20˚C Nominal)

Example: 1 metre radius beam used at 24˚C
Change in length = Initial beam radius x (23×10^{-6}) x 4
Change in length = 1 x (23×10^{-6}) x 4
Change in length = 9.6×10^{-5}
Change in length = 0.000096 metre
New effective beam radius = Initial beam radius + Change in length
New effective beam radius = 1.000096 metre

Example: 1 metre radius beam used at 16˚C
Change in length = Initial beam radius x (23×10^{-6}) x -4
Change in length = 1 x (23×10^{-6}) x -4
Change in length = -9.6×10^{-5}
Change in length = -0.000096 metre
New effective beam radius = Initial beam radius + Change in length
New effective beam radius = 0.999904 metre

Gravitational Effects

It is very important that the gravitational value for the Laboratory is established. The effect of not doing this in the UK could be a variation in the force produced by the weight (masses) of up to approximately 0.05%, which is five times the 0.01% tolerance of the weight. Outside of the UK this variation in force could be significantly more.

It is therefore strongly recommended that you establish the local value of gravity (g) for your Laboratory and use weights that have been calibrated at that gravitational constant.

Norbar will supply weights calibrated to gravitational constants specified by the customer. However, if the customer does not specify a value for 'g' they will have been calibrated at the standard UK gravitational constant of 9.81500 m/s^2. As already noted this figure is subject to approximately 0.05% variation across the UK.

Buoyancy Effects

The Norbar system uses calibrated masses to generate a force downwards. It differs from mass balances where masses are compared like with like, because the masses are compared with a transducer.

This means that Archimedes principle applies which means there is a force upwards on the masses caused by air pressure under them. This force reduces the effective force generated by the masses and they should be increased to allow for this.

Under standard conditions, (ie. air pressure 1.2kg/m^3 and 20 degrees centigrade) and working in conventional mass terms the increase required is by a factor of:

$$\frac{1}{(1 - 1.2 / 8000)}$$

For example, assuming that the masses are being calibrated on a mass balance, instead of being adjusted to show an effective force of 1.00000 Newtons, they should show an effective force of:

$$1 \left[\frac{1}{(1 - 1.2 / 8000)} \right] = 1.00015 \text{ Newtons}$$

Masses purchased from Norbar will already have this factor taken into account.

It should also be noted that the double ended beam design employed by Norbar means that each half of the beam is balanced with regard to buoyancy of the beam. This is a significant advantage over single-arm counterbalanced systems.

SUGGESTED OPERATING PROCEDURE

1. Bolt the transducer bench housing to the pedestal or a work bench. Ensure that there is a clear area from work bench height to floor level on either side of the transducer position. The length of beam will determine space required. (See Figure 5).

2. Insert the transducer into the mounting and connect to display unit. Then connect output of display to a suitable digital voltmeter if additional resolution is required.

3. Allow minimum of twenty minutes warm up for transducer and display unit. (see manufacturer's specification).

4. Set transducer fine zero, to zero display if necessary.

5. Insert beam square drive into female of transducer and attach wire weight hangers. Ensure that letters A and B on hangers match those on their respective radius ends. Ensure also that the wires hang around the centre line of the radius ends.

6. Re-check zero, as 4. above.

7. Load weights onto right-hand weight hanger, (for clockwise calibration). Ensure that Newton weights are used for a metric beam, and imperial weights for an imperial beam. The transducer should be exercised by loading to full scale torque and back to zero three times. The display output should be watched during this process to avoid overloading.

8. Remove all weights and re-zero if required.

9. Load beam in either 5 or 10 increments, allowing each reading to stabilise before recording figure. Gentle application of the weights is advised to prevent the torque applied from oscillating too much. Standard Norbar weight sets allow a progressive increase in torque applied without the need to remove one weight before adding the next. This avoids possible hysteresis effects which could be caused by momentarily reducing the torque applied.

10. Remove all weights and check zero. Remove weight hangers from beam and remove beam from transducer.

11. For Norbar products, any alterations required may be made in accordance with the appropriate operators manual or service manual.

INTERCHANGE OF SQUARE DRIVES

To allow for different transducers, the latest test beams have interchangeable spindles with driving squares that are compatible with the capacity of the beam.

This also allows for the use of specialised centres where a spline drive or other form is frequently required.

Please contact Norbar for further details.

Model No.	Square Drive Supplied	Maximum Torque
21429	¼"	30 N·m
	⅜"	60 N·m
21421	⅜"	135 N·m
	½"	150 N·m
21430	¼"	220 lbf·in
	⅜"	500 lbf·in
21424	⅜"	100 lbf·ft
	½"	100 lbf·ft
21425	½"	250 lbf·ft
	¾"	500 lbf·ft
21426	¾"	740 lbf·ft
	1"	1000 lbf·ft
21427	½"	250 N·m
	¾"	500 N·m
21428	½"	340 N·m
	¾"	1000 N·m
	1"	1500 N·m

The above table states the capacity of the driving square in accordance with ISO 6789:1992 up to the maximum capacity of the beam.

When using the beam for calibration in accordance with BS 7882:1997 clause 4.6A Overload Test it is permitted to exceed the maximum torque of the beam and square by 8-12%.

When frequently using ⅜" and ½" squares close to their maximum torque on Model No.s 21421, 21424 and 21425 these should be inspected and replaced periodically.

To change the spindle, first remove the two cap head screws and carefully push out the existing spindle. Insert the new spindle and replace the cap head screws. Tighten to 3 N·m.

The accuracy of the test beam relies on a close fit between the beam and spindle. Please take care not to damage the mating surfaces.

REPAIR AND RECALIBRATION OF BEAMS

Norbar Unsupported Calibration Beams are designed for transducer calibration at low levels of uncertainty. They are robust for normal handling by technicians, but if dropped or otherwise damaged, may lose their calibration integrity. It is therefore essential that the beam is recalibrated after any such incident.

Recalibration involves establishing the beam length from the centre of the driving square to a locus of points on the beam end. (See original calibration certificate for further details). This is difficult to achieve with conventional length standards, although use of a Co-ordinate Measuring Machine may give satisfactory results. (Remember to allow for wire radius when calculating beam length). Planned calibration intervals will depend of usage, and should be decided by the laboratory.

Norbar offers a full repair and recalibration service, with traceable certification of status before and after repair. Due to the complex nature of the beams, please contact Norbar in the event of any damage requiring repair.

RECALIBRATION OF WEIGHTS

Following the details on Page 8, it should be possible to obtain local recalibration of weight sets. Please contact Norbar if further assistance is required.

NOTES

NORBAR TORQUE TOOLS LTD

Wildmere Road, Banbury,
Oxfordshire, OX16 3JU

UNITED KINGDOM

Tel + 44 (0)1295 270333

Email enquiry@norbar.com

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