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CALIBRATION CERTIFICATE

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Certificate No:	2003058
Issue Date:	30 March 2020
Calibration Date:	30 March 2020
Technician:	R Moore

Description: A 25 kN compression and tension strain gauged load cell, used with an associated digital indicator, both manufactured by Interface.

Identification: 278764 on load cell. (TM0199)
59019 (TM0200) (Channel B) on indicator.
TM0200 on cable.

Basis of Calibration: BS EN ISO 376:2011

Classification: The force proving instrument satisfies the requirement of BS EN ISO 376:2011 for the following classification range:-

Compression,	**Class 0.5 ,**	**25 kN down to 0.5 kN**
Tension,	**Class 0.5 ,**	**25 kN down to 0.5 kN**

Issued by:
L Shenton

Senior Force Calibration Technician
Force Laboratory

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The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor k=2, providing a level of confidence of approximately 95%. The uncertainty evaluation has been carried out in accordance with UKAS requirements.

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Method:

The calibration was made in the laboratory's No. 4 Force Standard Machine in terms of the SI unit of force, the kilonewton (kN). The uncertainty of the forces applied during the calibration is ± 1 part in 5 000 (±0.02%).

An overload test as specified in Clause B.1 of Annex B of BS EN ISO 376:2011 was carried out prior to the calibration.

A creep test as specified in Clause 7.4.4 of BS EN ISO 376:2011 was performed for between 30 and 300 seconds at maximum load after the final pre-load, the results of which were within the classification parameters stated in Clause 8.2.5 table 2 of BS EN ISO 376:2011.

Two tests were made in compression followed by two tests in tension. Two further tests were then made in compression followed by two further tests in tension. The forces were applied to the device in compression through a soft pad, provided by Element, placed centrally on the domed upper loading boss. In tension the forces were applied to the device through adaptors, also provided by Element.

Measurements:

1. The bearing pad test, Clause B.2 of Annex B of BS EN ISO 376:2011, was carried out during a previous calibration in March 2012, certificate Serial No. 12121615. The force proving instrument satisfies the requirements of the bearing pad test for the following classification range(s):-

   Class 0.5 25 kN down to 0.5 kN

2. The temperature during the calibration tests varied between 19.5°C and 19.9°C.

3. During the tests, the no-load reading varied between -0.1 and 0.6 N for compression and between -0.7 and 0.0 N for tension.

4. The measurements were taken in the "GrsB" mode with the sensor select set to channel B and 278764 also the cable plugged into Load B on the rear of the indicator.

5. The forces applied and the resulting deflections are given in Tables 1 and 2: no correction for temperature has been applied to the results.

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6. For calibration in the compression mode in increasing forces, the estimate of the mean deflection was calculated as the mean of the tests 1, 3 and 4.

7. The procedure above was repeated for the calibration in the tension mode.

   For each mode of application of force, the coefficients of a third degree equation relating the estimate of the mean deflection as a function of the applied calibration force were calculated by the method of least squares. The differences between the mean value of deflection with rotation for each force and the computed value of deflection given by the equation were used to determine the relative interpolation error. The coefficients of a third degree equation relating a given applied force to the estimate of the mean deflection were also calculated.

Notes:

1. Clause 8.3.2 of BS EN ISO 376:2011 states that the maximum period of validity of the calibration of a force proving instrument shall not exceed 26 months. The force proving instrument shall be recalibrated if it sustains an overload which exceeds the maximum force by 12%.
2. Clause 9 of BS EN ISO 376:2011 states that the force proving instrument shall be loaded in accordance with the conditions under which it was calibrated. Precautions shall be taken to prevent it from being subject to forces greater than the maximum force to which it is classified.
3. If given or calculated forces are required to be in terms of one of the technical units of force, then the following conversion factors may be used:

Required unit of force	Factor by which the force in kilonewtons must be multiplied
kilogram-force (kgf)	101.972
pound-force (lbf)	224.809
ton-force (tonf)	100.361×10^{-3}

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Results Table 1 : Compression

Test Number	1	2	3	5	Unbiased estimate of mean	Expanded Uncertainty kN
Orientation	0°	0°	120°	240°		
Force (kN)	Deflection (N)					±
0.5	499.4	499.5	499.4	499.5	499.4	0.000465
1	999.0	999.3	999.5	999.6	999.4	0.000584
2.5	2497.9	2498.3	2498.5	2498.8	2498.4	0.001974
5	4999.5	5000.0	4999.8	5000.0	4999.8	0.001664
7.5	7499.2	7499.7	7499.6	7499.9	7499.6	0.001926
10	9999.1	9999.3	9999.4	9999.5	9999.4	0.002264
12.5	12499.3	12499.8	12499.7	12499.7	12499.5	0.002882
15	14999.7	15000.1	15000.3	15000.3	15000.1	0.003409
17.5	17500.6	17500.9	17501.2	17501.2	17501.0	0.003952
20	20002.8	20002.2	20002.5	20002.6	20002.6	0.004571
22.5	22503.8	22504.0	22504.2	22504.3	22504.1	0.005044
25	25005.7	25006.0	25006.4	25006.3	25006.1	0.005613

Maximum Relative Uncertainty = 0.09%

Coefficients

For a given applied force F (in kN), the expected deflection D (in N) OR For a given delection D (in N), the applied force F (in kN) is calculated from the following:

$$D=B_0+B_1F+B_2F^2+B_3F^3 \qquad F=A_0+A_1D+A_2D^2+A_3D^3$$

where:

B_0 = -7.98953E-01 A_0 = 7.98771E-04
B_1 = 1.00005E+03 A_1 = 9.99954E-04
B_2 = -1.02187E-02 A_2 = 1.01813E-11
B_3 = 7.85161E-04 A_3 = -7.83618E-16

If the expanded uncertainty is required for forces other than above it can be calculated from the following:

$$U_{exp}=(C_0+C_1F+C_2F^2)x2$$

where:

C_0 = 0.00000E+00
C_1 = 7.90812E-05
C_2 = 7.41077E-07

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Results Table 2 : Tension

Test Number	1	2	3	5	Unbiased estimate of mean	Expanded Uncertainty kN
Orientation	0°	0°	120°	240°		
Force (kN)	Deflection (N)					±
0.5	-499.3	-499.4	-499.4	-499.4	-499.4	0.000531
1	-998.2	-998.4	-998.5	-998.7	-998.4	0.000377
2.5	-2496.0	-2495.9	-2495.9	-2496.1	-2496.0	0.001053
5	-4993.5	-4993.3	-4993.5	-4993.8	-4993.6	0.001194
7.5	-7491.7	-7491.9	-7491.8	-7492.1	-7491.9	0.001802
10	-9990.0	-9990.0	-9990.3	-9990.5	-9990.2	0.002290
12.5	-12488.6	-12489.0	-12489.1	-12489.3	-12489.0	0.002891
15	-14988.2	-14988.3	-14988.6	-14988.7	-14988.5	0.003401
17.5	-17488.1	-17488.3	-17488.3	-17488.3	-17488.3	0.003955
20	-19988.3	-19988.5	-19988.7	-19988.6	-19988.5	0.004516
22.5	-22488.3	-22488.2	-22488.8	-22489.0	-22488.7	0.005094
25	-24989.2	-24989.3	-24989.6	-24989.5	-24989.4	0.005639

Maximum Relative Uncertainty = 0.11%

Coefficients

For a given applied force F (in kN), the expected deflection D (in N) OR For a given delection D (in N), the applied force F (in kN) is calculated from the following:

$$D=B_0+B_1F+B_2F^2+B_3F^3 \qquad F=A_0+A_1D+A_2D^2+A_3D^3$$

where:

B_0 = 1.36259E-01 A_0 = 1.37095E-04
B_1 = -9.98480E+02 A_1 = -1.00152E-03
B_2 = -6.13099E-02 A_2 = -6.14678E-11
B_3 = 6.91136E-04 A_3 = -6.94581E-16

If the expanded uncertainty is required for forces other than above it can be calculated from the following:

$$U_{exp}=(C_0+C_1F+C_2F^2)x2$$

where:

C_0 = 0.00000E+00
C_1 = 9.31275E-05
C_2 = 5.19545E-07

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