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Load Cells, Force and Torque Calibration Systems
When Performance and Quality Matter Most



MAUTOMATED FORCE CALIBRATION SYSTEMS

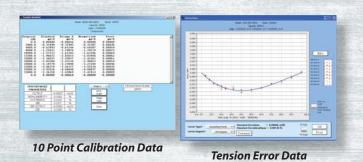
Tovey Automated Systems.

Tovey Engineering is the industry leader in force transfer standard calibration systems. TEI developed the first automated systems on the market and has the largest installed base in the US. Over the years, we have continued to engineer and refine our systems for maximum performance and custom-



55K lbf System

er ease-of-use. Tovey systems are designed specifically for metrology grade calibration, rather than being modified test systems, and achieve the lowest measurement uncertainties of any competitive systems. All key components of our systems are manufactured by the company in-house to meet exacting standards for metrology use. Reliability is excellent, and the alignment is second to none. TEI automated systems closely approximate results from deadweight calibrators.



System Features:

- Systems include load frame, transfer standard load cells, hydraulic power unit, automated control, and data analysis software.
- Durable multi-column load frames exhibit high frame stiffness, highly symmetric stiffness, and exceptional alignment.
- Universal fixturing allows tension and compression calibration without changeover.
- Systems feature Tovey CS Series metrology grade transfer standards, which meet the highest performance standards of any load cell manufacturer.
- · Systems enable fully automated calibration, exercise transducers automatically with specified forces and number of cycles.
- Calibrate transducers in load sequences using up to thirty different load points with simultaneous measurement of up to three bridges (standard) or up to 8 bridges (optional).
- Automated closed-loop system calculates performance parameters and performs data evaluations per ASTM E74 and/or ISO 376.
- Model 9150 ratio-metric instruments provide excitation of 5 or 10 Volts, signal conditioning and A to D conversion with 24 bit digital resolution and a useable resolution to < 100 nanovoltz.
- Model TS-10-2 Transducer Simulator with 30ppm measure-
- ment uncertainty (1 year) simplifies instrument calibration and provides an instrument check standard.
- Data files and graphs for calibration records are produced and stored.
- Data analysis and output is compliant with national and international standards



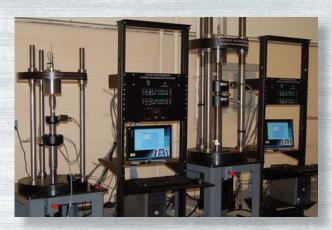
1000K lbf System

Phone: (623) 434-5110 • Fax: (623) 434-5130 Email: tei_sales@toveyengineering.com Web: www.toveyengineering.com



System Capacity and Performance.

Tovey Engineering transfer standard force calibration systems are available in capacities ranging from 20 lbf to 1 million lbf. These versatile automated calibration systems reduce calibration time and cost, permitting efficient in-house transducer calibration. Systems meet ASTM E74 required measurement uncertainty of applied forces of less than 0.005% of range, or overall measurement uncertainty of 0.025%-0.050% of reading. Systems feature Tovey CS Series metrology grade load cells, with industry leading performance.

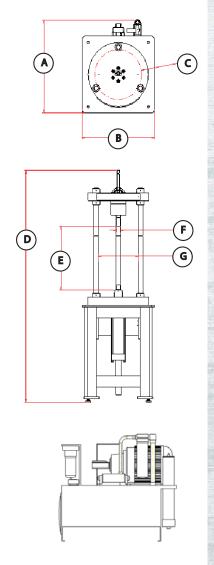


11K and 110K lbf System

DIMENSIONS

Load frames 3K-55K

		Load fram	ies 3	K-55K					
Dimension	Capacity >	3K			11K		55K		
Α	Base Depth	29 in (74 d	m)	29 in	(74 cm)		29 in (74 cm)		
В	Base width	24 in (61 d	m)	24 in	(61 cm)		24 in (61 cm)		
С	Working diameter	12.9 in m (32.8 cm			3 in max 3.9 cm)		14.9 in max (37.9 cm)		
D	Overall height	76 in (193	cm)	83 in	(211 cm)	ç	98 in (249 cm)		
E	Vertical working space	21.5-30.0 (54.6 cm-76.			1-30.0 in m-76.2 cm)	(73	29.0-40.0 in .7 cm-101.6 cm)		
F	Thread size	1/2-20 UNC 3A (Both ends)		1-14 UNS 3A (Both ends)		1	3/4 -12 UN 3A (Both ends)		
G	Column opening	10.8 in m (27.4 cm		13.2 in	(33.5 cm)	1	2.6 in (32 cm)		
	Weight of load frame	480 lbs (219 kg		920 lbs (419 kg)			1,380 lbs (628 kg)		
	•	Load fram	es 11	0K-1N	1				
Dimension	Capacity >	110K		2	20K		1M		
Α	Base Depth	29 in (74 d	m)	36 in	(92 cm)		38 in (97 cm)		
В	Base width	24 in (61 d	m)	36 in	(92 cm)		38 in (97 cm)		
С	Working diameter	14.9 in max (37.8 cm)		21.0 in max (53.4 cm)			34.5 in max (87.6 cm)		
D	Overall height	95 in (242 cm)		117 in (298 cm)		1	49 in (379 cm)		
Е	Vertical working space					21.5-30.0 in 4.6 cm-76.2 cm)			
F	Thread size	1 3/4 -12 UI (Both end		, .	-8 UN 3A th ends)	6 - 5 ^{1/}	8 UN 3A (Head) ² -8 UN 3A (Cyl)		
G	Column opening	12.6 in max (32.0 cm)		17.9 in max (45.4 cm)		23.5 in max (59.7 cm)			
	Weight of load frame	1,820 lb (828 kg			900 lbs 228 kg)		32,000 lbs (14,545 kg)		
	•	Hydrau	lic pu	ımp					
Length	Width	Height	We	eight	Electrica	ıl	Pressure		
44 in (112 cm)	30 in (77 cm)	38 in (97 cm)			60 lbs 00 kg) 10 HP		4000 psi max (282 kg/cm)		





/// CALIBRATION GRADE LOAD CELLS-

Tovey Engineering CS Series calibration load cells are designed for metrology lab use. These load cells meet ASTM E74 requirements for Class AA (up to 100K lfb) to 10% of range and Class A (up to 100K lbf) to 2% of range, achieving ASTM E74 uncertainty of less than .005% of range or ISO 376 Class 00 levels. Tovey CS load cells exhibit exceptional rotational performance and unequaled capacity to compensate for misaligned loads. They are used in hundreds of metrology labs worldwide. Highly stable from year-to-year, Tovey CS load cells are preferred in research and government labs and among sophisticated corporate customers. Available with custom adapters, case, and complementary instruments as complete kits. Capacities 300 to 600,000 lbf.



SPECIFICATIONS

MODEL	CS10	CS10M	CS10	CS10M	CS20	CS20M	CS30	CS30M	CS40	CS40M	CS42	CS42M	CS60	CS60M
CAPACITY PARAMETERS	lbf 300, 500, 1K, 2K	kN 1.5,2.5 5,10	lbf 5K 10K	kN 25 50	lbf 25K, 50K	kN 100, 250	lbf 100K	kN 500	lbf 200K	kN 1000	lbf 270K	kN 1200	lbf 500K, 600K	kN 2200 2700
Accuracy														
Lower Load Limit % R.O.	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	4.0	4.0	4.0	4.0	4.0	4.0
Static Error Band, % R. O.	±.02	±.02	±.03	±.03	±.03	±.03	±.03	±.03	±.05	±.05	±.06	±.06	±.10	±.10
Nonlinearity, % R.O.	±.02	±.02	±.03	±.03	±.03	±.03	±.03	±.03	±.05	±.05	±.06	±.06	±.10	±.10
Hysteresis, % R.O.	±.02	±.02	±.04	±.04	±.04	±.04	±.04	±.04	±.05	±.05	±.06	±.06	±.10	±.10
Nonrepeatability, % R. O.	±.005	±.005	±.005	±.005	±.005	±.005	±.005	±.005	±.005	±.005	±.005	±.005	±.01	±.01
Creep, % in 20 minutes	±.015	±.015	±.015	±.015	±.015	±.015	±.015	±.015	±.015	±.015	±.015	±.015	±.025	±.025
Off-Center Load Sensitivity, %/inch	±.05	±.05	±.05	±.05	±.05	±.05	±.05	±.05	±.1	±.1	±.1	±.1	±.2	±.2
Side Load Sensitivity, %	±.05	±.05	±.05	±.05	±.05	±.05	±.05	±.05	±.1	±.1	±.1	±.1	±.2	±.2
Zero Balance, % R.O.	±1.0	±1.0	±1.0	±1.0	±1.0	±1.0	±1.0	±1.0	±1.0	±1.0	±1.0	±1.0	±1.0	±1.0
Temperature														
Range, Compensated, °F (°C)	+15 to +115	(-10 to +45)	+15 to +115	(-10 to +45)	+15 to +115	(-10 to +45)	+15 to +115	(-10 to +45)	+15 to +115	(-10 to +45)	+15 to +115	(-10 to +45)	+15 to +115	(-10 to +45)
Range, Operating, ° F (°C)	-65 to +200	(-55 to +90)	-65 to +200	(-55 to +90)	-65 to +200	(-55 to +90)	-65 to +200	(-55 to +90)	-65 to +200	(-55 to +90)	-65 to +200	(-55 to +90)	-65 to +200	(-55 to +90)
Effect on Sensitivity, % Rdg/°F (°C)	±.08	(±.15)	±.08	(±.15)	±.08	(±.15)	±.08	(±.15)	±.08	(±.15)	±.08	(±.15)	±.08	(±.15)
Effect on Zero, % R.O./100°F (°C)	±.08	(±.15)	±.08	(±.15)	±.08	(±.15)	±.08	(±.15)	±.08	(±.30)	±.08	(±.30)	±.08	(±.30)
Electrical														
Rated Output, mV/V, Nominal	2.0	2.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Excitation Voltage, VDC	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Input Resistance, Ohms	350	350	350	350	350	350	350	350	350	350	350	350	350	350
Output Resistance, Ohms	350	350	350	350	350	350	350	350	350	350	350	350	350	350
Insulation Resistance, Megohm	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000
Mechanical														
Safe Overload Range, % R.O.	±150	±150	±150	±150	±150	±150	±150	±150	±150	±150	±150	±150	±150	±150
Weight, lbs (kg)	2.8	(1.32)	6.9	(3.13)	23.6	(10.80)	57.8	(26.17)	166	(75)	176	(80)	519	(235)
Flexure Material	Aluminum	Aluminum	Steel	Steel	Steel	Steel	Steel	Steel	Steel	Steel	Steel	Steel	Steel	Steel

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/// PORTABLE CALIBRATION SYSTEMS

Tovey provides self-contained mobile platforms for remote system verification with reference standard load cells and/or dead weights. These systems provide everything an operator needs to perform a verification at a testing machine or in a stress lab test cell. Portable systems include several reference load cells, cables, fixtures, an instrument, a load cell simulator and a laptop computer. Systems are calibrated at the factory as an integrated unit. Software is provided to acquire data and verify that the system under test produces measured forces within a specified tolerance band. The calibration system also provides a measurement of non-repeatability. Tovey's portable systems are often used to perform verifications consistent with ASTM E4 or other requirements. Push cart or carry case formats are available.



System Accessories Cart

/// CALIBRATION ACCESSORIES

- Adapters and Loading Fixtures. Tovey manufactures a wide variety of standard thread adapters and custom made fixtures to satisfy the requirements of our customers. All parts are heat treated to provide high strength and wear resistant surfaces. All parts are engineered to provide excellent alignment. Premium materials are utilized in manufacture. Rod end bearings, clevises, compression load plates, and special adaptors for many applications are also provided by Tovey.
- **Rotation washers** are designed to provide for rotation of the unit under test for ASTM E-74 /ISO 376 calibrations. These washers allow precise rotation of the unit under test and permit quick setups for significant time savings.



System Accessories

SYSTEM ALIGNMENT VERIFICATION

- Alignment dynamometers. Tovey alignment dynamometers permit high accuracy misalignment measurement. Dynamometers have three or four strain gages equally spaced around the circumference of the part at either two or three axial positions. When installed in a load frame and a force is applied, readings from the individual strain gages can be used as a measure of misalignment, providing a quantitative measure of that misalignment.
- Multi-axis load cells measure force and moment in orthogonal planes. The
 moment readings from these load cells provide information that permits alignment adjustments to be made and also quantifies the amount of moment that
 may be applied along with the axial force. Tovey's standard and special multiaxis load cells are among the world's most accurate.



Dynamometers

SHUNT CALIBRATION PRODUCTS

Shunt calibration is often used to provide a means of setting up an instrument in the field. Tovey offers two options to meet this need. An automated shunt cal module features four separate shunt calibration values. Any number of these resistor values can be switched into the circuit in sequence or used individually. This instrument is capable of performing shunt calibration on single, double, or triple bridge load cells simultaneously and in a fully automated manner. A lower cost option consists of shunt calibration adapters that attach directly to the connector of the unit under test.



/// TORQUE CALIBRATION SYSTEMS

Tovey Engineering transfer standard torque calibration systems are available in capacities ranging from 200 in-lb to 100,000 in-lb. These versatile automated calibration systems reduce calibration time and cost, permitting efficient in-house transducer calibration.

FEATURES:

- System includes torque frame, transfer standard load cells, hydraulic actuator, automated control and data analysis software.
- Precision torque arm and meticulously machined components.
- Efficient transition from clockwise to counterclockwise calibration.
- True zero deadband measurement.
- · Alignment couplings to reduce transducer misalignment errors.
- Metrology grade transfer standards with industry leading accuracy, or dead weight hangers and weights for primary standard torque calibrations
- Fully automated calibration; exercise transducers automatically with specified forces and number of cycles.
- Comprehensive software for data acquisition and data reduction.
- Data files and graphs for calibration records are produced and stored.
- Data analysis and output is compliant with national and international standards.

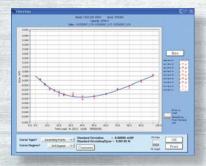


6,000 in-lb System

CALIBRATION & TEST SOFTWARE



10 Point Calibration Data



Tension Error Data



ISO 376 Compression Data

Tovey Engineering offers several software packages to support calibration and testing. The software is applicable to strain gage based force, torque, and pressure transducers.

Available software packages include:

CalSoft-DW for dead weight calibration systems.

CalSoft-FTS for transfer standard calibration systems.

CalAnalysis for comprehensive data analysis.

CalSoft-Test for test applications.

Software Features:

- Supports automated or manual exercise cycles.
- Supports automated or manual load setting.
- Automated data acquisition.
- Performs standard performance analysis including determining non-linearity, hysteresis, and static error band.
 ASTM E74 Analysis.
 ISO 376 Analysis.

All data presented graphically or in tabular form.

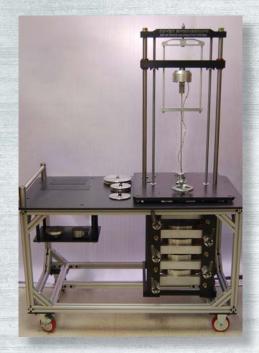
- Statistically determines degree of curve fit according to ASTM E74 procedure, or user may override to select from 1st to 5th degree.
- Calibrates stand-alone systems with independent readout instruments.
- Allows simultaneous calibration of bridges in multi-bridge transducers.
- Can be customized to meet special customer requirements.

ACCREDITATIONS:

NVLAP Lab Code 200662-0 ANSI Z540, ISO/IEC 17025 ASTM E74, ISO 376 Phone: (623) 434-5110 • Fax: (623) 434-5130 Email: tei_sales@toveyengineering.com Web: www.toveyengineering.com



DEADWEIGHT FORCE CALIBRATION SYSTEMS



Portable Deadweight Rig

Tovey Engineering offers fully automated, as well as manually operated, dead-weight calibration systems. Designed specifically for the most stringent calibration labs, university settings, and government facilities, these systems provide the most accurate calibration of load cells in both tension and compression. System capacities available from 50 lbf to 10K lbf.

Features:

- System includes load frame, certified weight stack, pneumatic hand operated or automated control system, data acquisition and analysis software.
- Accurate to as low as .002% of applied force (acceptable for ASTM Class AA calibration requirements).
- Easy setup hardware allows tension and compression calibration.
- Automated data acquisition, analysis, and storage.
- · Simple file export and report writing.
- Data analysis and output is compliant with national and international standards.

Options include:

- Wide variety of mounting adapters.
- Metric capacities.
- Custom designs- based on customer specific application requirements.



Deadweight System

MANUAL FORCE CALIBRATION SYSTEMS

Tovey Engineering now offers a very economical, manually operated calibration system. Designed specifically for smaller calibration labs, these systems provide accurate calibration of load cells in both tension and compression. Capacities available from 2klbf to 100klbf.

Features:

- System includes load frame, transfer standard load cells, hydraulic hand operated pump, data acquisition and analysis software.
- Universal fixture hardware allows tension and compression calibration without changeover.
- · Easy setup and operation.
- Automated data acquisition, analysis, and storage.
- Simple file export and report writing.
- Data analysis and output is compliant with national and international standards.

Options available include:

- Hydraulic power unit.
- · Wide variety of mounting adapters.
- Metric capacities.
- Custom designs- based on customer specific application needs.



CALIBRATION SERVICES

Tovey Engineering offers accredited force transducer calibration from 1 gf to 1 million lbf. and primary torque calibration to 2,000 in-lb. State-of-the-art calibration facilities include both deadweight and servo-controlled hydraulic transfer standard calibration rigs. Force calibrations are performed in compliance with ISO 17025 requirements (under NVLAP Lab Code 200662-0), and meet the requirements of NIST Handbook 150, ISO/IEC 17025 and ANSI Z540.

Experienced Staff, Quick Turnaround

Calibrations are performed by experienced and knowledgeable technical staff. The calibration lab is overseen by the current Chairman of ASTM Committee E28.01 for calibration of load cells and testing machines, a NVLAP Technical Expert in force calibration. All force calibrations are performed quickly and efficiently to minimize customer downtime.





ACCREDITATIONS:

NVLAP Lab Code 200662-0 ANSI Z540, ISO/IEC 17025 ASTM E74, ISO 376

CALIBRATION REPORTS

Customers receive comprehensive reports with calibration data presented in both graphical and tabular form. All data analysis and output is compliant with national and international standards. As an example, a standard E74 report package includes a Certificate of Calibration, a Calibration Report, a curve fit analysis report and associated graphs for tension and compression. Additional graphical representations of calibration data can be supplied upon request.



1150			DayManth/Year 29-Apr-04				
Customer:							
Load Cell:	Medel Number		Serial Number				
	CS10-1K-8000		102311A				
	Calibration Excitation IEVDC		Calibration Temperature (Deg. F)				
Performance:	Results from Applie	d Axial Loac					
Test Lead	Readings mV/V						
Applied (HIDIN)	RUN 1 (0°)	Te RUN 2 (120°)	msion I RUN 3 (240°)				
	Output Errer v10*4	Output Error : 10*4	Output Street x10*4				
0.0	0.0000 0.0	0.0000 0.0	0.0000 0.0				
0.1	0.1978 -0.2	0.1977 -0.5	0.1977 -1.1				
0.2	0.3956 -0.2	0.3056 -0.2	0.3955 -0.3				
0.3	0.5033 -0.5	0.5933 -0.7	0.5933 -1.1				
0.4	0.7911 -0.6	0.7911 -0.5	0.7910 -1.3				
0.5	0.9869 -0.5	1.1867 -0.6	11066 -1.0				
0.6	1,1867 -0.3	1.1867 -0.4	1.1866 -1.0				
0.8	1.5823 0.4	1.5823 -0.6	1.5822 -0.8				
0.9	1.7800 -0.2	1.7800 -0.8	1.7801 0.1				
1.0	1,9776 0.0	1.9779 0.0	1,9779 0.0				
0.4	0.7911 -0.9	0.7911 -0.4	0.7911 -1.0				
0.0	0.0000 0.4	-0.0001 -0.5	0.0000 -0.1				
	RUN 1 (0°)	Te RUN 2 (120°)	msion RUN 3 (240°)				
Bridge: A Output, mVV	1,9778	1.9779	1,9779				
Non-Linearity, %	-0.0030	-0.0040	-0.0071				
Mysteresis, %	-0.0015	0.0005	0.0015				
sen's	0.0035	0.0029	0.0049				
SEB Cusput, HVV	1.9778	1.9778	1.9778				
Shunt Cal., WITH	1.4360						
90 Kelime, 4- 01%							
Lite	726.0						
Performed By: Title:	Calibration Lab Tect		Day/Month/Year: 28-Apr-64				
Title: Notes:	Calibration Lab Tect	Inkiar					
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			nd desembling calibration points from				
a best fit straight line	through zero output. Streck	ides the effects of too-inearty	y, Psystemetria, and non-return to minercent load.				
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			and - Dhard Cal (- Signal). For pompression, residui-				
California Epigen	Dente (+ Sociation) and	Sent Cal (- Signer)					
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Electronic Finlands		10812 MST Te					
Electronic Pendout		502341					
Electronic Personal		502342					
	to livel pail interest above						
		tal, without written approved					
			to the National Institute of Diandards and Technology and that the				
		sparromenty a 20% continu					
ever Engineering.		23902 N. 17m i					
alaphana (623) 434	4110	Fax (823) 434 4 Page 2	of 7				

		C	spacity: 10	1K-8000 00.0 Direct NG CURVE F		ION	
LOAD NLBS	04000004 750 midV	0.4p.8 2 04/05/0004 8 87 6/07/	Dayat 2 Sections also scoty				
0.000	0.00000	1,0000	0.00000	_			
0.100	0.19776	0.19774	0.19766	_			
0.200	0.39555	8.39696	0.39554				
0.300	0.593300	0.18030	0.59325				
0.400	0.79108	0.79111	0.79102				
0.500	0.90007	0.00000	0.90000				
0.600	1.19667	1.10000	1.18082				
0.700	1.99440	1.58463	1.35440				
0.800	1.95231	1.56225	1.79009				
1.000	1,73004	1.97709	1.97767				
1 100	130/34	1.9/102	1.81140				
		_					
					- 7		
LOAD	Street 1	firm 2	Singr)	F T			
MLR1	www	www	widy				
0.000	0.00001	.000004	0.00001				
0.100	0.00001	-0.00004	-0.00007				
0.200	0.00003	0.00064	0.50002				
0.000	0.00001	E-00004	-0.00004	_	_		
0.500	0.00001	1,00000	-0.00006				
0.000	0.00002	0.00004	-0-00003				
6.700	0.00001	11 000004	-0.00005				
0.000	0.00006	8.00000	-0.00003				
1,000	-0.00003	-0.00004 0.00002	0.00000				
1.000	-0.10003	0.00002	0.00000	_			
LOAD HLBS	Fitted ect/V	Ascending Coefficients		Deviation		03 mVIV	
0.000	-0.00001	A0~49519E-6		nty = 0.000 I			
0.100	0.19773	A1+1 9/759E+0		Lower Load L			
0.200	0.39652 0.59329	A2+235159E-4	CHASSA	COMEL COSO C	mm. = 0.0	10 LF02	
0.400	0.79407	-					
0.500	0.79107	_					
0.600	1.18665	_					
0.708	1.36445						
0.800	1.58225						
0.900	1.79000						
1.000	1.97767						
		_					
	_	_		23000			Force Cellbridge Data Assista
	_	_		Page 1 of 1			Force Cellinson Data Analysis YOMEY ENGINEERING INC.