Morehouse Terms and Standard Loading Procedures pertaining to calibration of load cells, force gauges, dynamometers and proving rings.

ALIGNMENT:

The position of the unit under test in relation to the force being applied or measured that influences the introduction of bending moments into the instrument under test during compression or tension loading. (Morehouse recommends using a ball type adaptor in compression when possible to eliminate to ensure proper alignment and reduce eccentric loads)

AMBIENT TEMPERATURE:

The temperature of the medium surrounding the instrument under test. (Morehouse maintains a constant temperature of +/- ½ degree 23 degrees Celsius in our force calibration laboratory)

ASCENDING LOAD:

A series of known forces generally 5 to 10 known loads applied in increasing increments generally from 10-20% of full scale capacity.

ASTM: E4 Standard Practices for Force Verification of Testing Machines (General information)

Testing machines that apply and indicate force are used in many industries, in many ways. They may be used in a research laboratory to measure material properties, and in a production line to qualify a product for shipment. No matter what the end use of the machine may be, it is necessary for users to know the amount of force that is applied and indicated, and that the accuracy of the force is somehow traceable to the National Institute of Standards and Technology (NIST). E 4 provides a procedure to verify these machines, in order that the indicated forces may be traceable. A key element to this NIST traceability is that the devices used in the verification have known force characteristics, and have been calibrated in accordance with Practice E 74 (Morehouse offers calibration in accordance with ASTM E74 with calibration standards that are directly traceable to NIST).

Morehouse generally calibrates and provides Load Cell Systems and Proving Rings with calibration in accordance with ASTM-E74 for our customers to do ASTM-E4 calibrations.

ASTM-E74: Standard Practice of Calibration of Force-Measuring Instruments for Verifying the Force Indication of Testing Machines.

This standard general consists of applying 10-11 known non zero forces at 0 degree orientation throughout the loading range of the instrument under test . The instrument under test is then rotated 120 degrees and the same 10-11 known non zero forces are applied and the output or deflection is recorded. The instrument is then rotated an additional 120 degrees and the same forces are applied and output is recorded. When the instrument is both COMPRESSION and TENSION 2 runs are done in 1 mode then 3 runs in the other mode and then the calibration is finished in the mode in which the calibration was started. Finally the data is analyzed and an uncertainty for the test instrument is calculated.

AXIAL LOAD:

A load applied along the PRIMARY AXIS.

BRINELL HARDNESS TEST:

An indenter (tungsten carbide ball) is forced into the surface of a test piece and the diameter of the indentation left in the surface after removal of the test force is measured. (Morehouse manufactures and calibrates Brinell calibrators for the calibration of Brinell Hardness testers) We currently do not offer Brinell harness testing)

CALIBRATION:

The comparison of a force measuring instrument output or deflection against standard test loads.

CAPACITY:

The maximum Axial Load a force measuring instrument is designed to measure within its specifications.

CLASS A AND AA LOADING RANGES:

CLASS A loading ranges are assigned in accordance with ASTM E74 using both PRIMARY FORCE STANDARDS (DEAD WEIGHT) and SECONDARY STANDARDS (Proving Rings, Load Cells) the Class A loading range is 400 times the uncertainty (calculated using ASTM E74) of the instrument

CLASS AA loading ranges are assigned in accordance with ASTM E74 using PRIMARY FORCE STANDARDS (DEAD WEIGHT) only the Class AA loading range is 2000 times the uncertainty (calculated using ASTM E74) of the instrument. Class AA calibrations can only be done using DEAD WEIGHT STANDARDS. Morehouse Instrument Company offers CLASS AA calibrations through 120,000 LBF

COMPRESSION:

A loading condition in which a force is applied to the instrument under test introducing negative stress (instrument under test is being pushed)

COMPRESSION LOADING PROCEDURE:

This is a procedure followed by Morehouse Instrument Company in our force calibration laboratory. When loading instruments in compression our general practice is to apply an axial load against the instrument under test with a threaded spherical or ball adaptor seated against the shoulder of the instrument. When an instrument does not have a shoulder to load against a threaded adaptor is used and threaded to full engagement and then backed off 1/2 turn to prevent a possible jam. Other considerations are to load an instrument with a hardened block or soft pad depending on the loading surface of the instrument.

CRANE SCALE:

A digital or analog scale usually used for overhead weighing.

CREEP:

The time-dependent increase in strain on a test instrument resulting from force when referring to LOAD CELLS creep is the change in LOAD CELL SIGNAL occurring with time while under load and with all environmental conditions and other variables remaining constant. Normally expressed in units of % of applied load over a specified time interval. It is common for characterization to be measured with a constant load at or near CAPACITY.

CREEP RECOVERY:

The change in LOAD CELL SIGNAL occurring with time immediately after removal of a load which had been applied for a specified time interval, environmental conditions and other variables remaining constant during the loaded and unloaded intervals. Normally expressed in units of % of applied load over a specified time interval. Normally the applied interval and the recovery interval are equal. It is common for characterization to be measured with a constant load at or near CAPACITY.

CREEP RETURN:

The difference between LOAD CELL SIGNAL immediately after removal of a load which had been applied for a specified time interval, environmental conditions and other variables remaining constant during the loaded interval, and the SIGNAL before application of the load. It is common for characterization to be measured with a constant load at or near CAPACITY.

DEAD WEIGHT MACHINES: (see PRIMARY FORCE STANDARD)

A Machine in which calibrated weights are applied directly without intervening mechanisms such as levers, hydraulic multipliers, or the like, whose mass has been determined by comparison with reference standards traceable to national standards of mass. Morehouse offers Dead Weight force calibration machines from 50 LBF – 120,000+ LBF or equivalent. The Morehouse force measurement and calibration laboratory features highly accurate dead weight machines with capacities through 120,000 LBF. The uncertainty of these machines vary from .002% - .003% of applied force.

DEFLECTION:

The degree to which a structural element (FORCE MEASURING INSTRUMENT) is displaced while a known axial load is applied.

DESCENDING LOAD:

A series of known forces generally 5 to 10 known loads applied in decreasing increments generally from 10-20% of full scale capacity.

DIGITAL FORCE GAUGE:

A gauge used to measure an applied force. An elastic steel load ring with a precision digital indicator that gives a direct reading in LBF,KGF, N or kN

DYNAMOMETER:

An Instrument used for load testing applications and occasional weighing, these devices are usually more compact and lightweight than crane scales. Morehouse ring dynomoters are constructed of a steel load ring with fully jeweled precision dial indicator to show the deflection under load. They are more accurate than a force gage and are not used for weighing applications.

ECCENTRIC LOAD:

Any load applied parallel to but not concentric with the PRIMARY AXIS. (Morehouse recommends using a ball type adaptor in compression when possible to eliminate eccentric loads)

ELASTIC CALIBRATION DEVICE:

A device used in verifying the force readings of a testing machine consisting of an elastic member(s) to which forces may be applied. (Morehouse manufactures Proving Rings, Force Gauges, Dynamometers for the calibration of or verification of testing machines)

ELASTIC LIMIT:

The greatest stress which a material is capable of sustaining without any permanent strain remaining upon complete release of the stress.

FORCE :

A vector quantity of fundamental nature characterized by a magnitude, a direction, a sense, and a discrete point of application, that acts externally upon a test object and creates stress in it.

FORCE GAUGE:

A gauge used to measure an applied force. An elastic steel load ring with a precision dial indicator that gives a direct reading in LBF,KGF, N or kN (also available with a digital readout)

FULL SCALE:

The OUTPUT or DEFLECTION corresponding to MAXIMUM LOAD in any specific test or application.

HARDNESS:

The resistance of a material to deformation, particularly permanent deformation, indentation, or scratching.

HYSTERISIS:

The algebraic difference between OUTPUT at a given load descending from MAXIMUM LOAD and OUTPUT at the same load ascending from MINIMUM LOAD. Normally expressed in units of %FS. It is common for characterization to be measured at 40-60% FS.

INPUT RESISTANCE:

The resistance of the LOAD CELL circuit measured at the excitation terminals with no load applied and with the output terminals open-circuited.

LOAD CELL(S):

An electronic device (transducer) that is used to convert a force into an electrical signal. This conversion is indirect and happens in two stages. Through a mechanical arrangement, the force being sensed deforms a strain gauge. The strain gauge converts the deformation (strain) to electrical signals. A load cell usually consists of four strain gauges in a Wheatstone bridge configuration. The electrical signal output is typically in the order of a few millivolts and requires amplification by an instrumentation amplifier before it can be used. Load cell types include double ended shear beam, single ended shear beam, shear- web, single column, multi column, pancake.

Morehouse recommends the following types of LOAD CELLS as force standards or field calibration standards. For those using load cells as secondary standards we recommend morehouse ultra precision grade load cells which we guarantee an ASTM CLASS A lower limit of better than 2% of capacity. These load cells can used as lab standards and can be mounted in Morehouse Universal Calibrating machines using the proper Morehouse Adaptors.

For various field calibrations which include calibration according to ASTM E4 Morehouse recommends the following load cells; for tension or/and compression loading up to 300-500 LBF we recommend S-Beam load cells specifically if the application is in tension (these cells are also recommended for tension applications up to 12,000 LBF). The reason we do not recommend S-beam type load cells in compression is that they are very susceptible to non AXIAL or off center loading conditions. For tension or/and compression loading from 300 LBF to 100,000 LBF morehouse recommends using shear-web load cells which are our Ultra Precision, Precision and Calibration Grade load cells. For tension or/and compression loading from 100,000 LBF – 1,000,000 LBF morehouse recommends single column type load cells because it is impractical to transport shear-web load cells past the 100,000 LBF capacity (A 600,000 LBF morehouse compression calibration column load cell weighs about 50 LBS and a 600,000 LBF shear –web load cell weighs over 300 LBS.). We offer these load cells as a Calibration grade column and offer 8 strain gage configurations to improve repeatability in tests that the load cell is rotated (ASTM E74 calibration).

MAXIMUM LOAD :

The highest load in a specific test or application, which may be any load up to and including CAPACITY + 10% , but may not exceed CAPACITY significantly.

MAXIMUM AXIAL LOAD, ULTIMATE

The maximum AXIAL LOAD which can be applied without producing a structural failure. Normally expressed in units of % CAPACITY

MEASURING RANGE:

The difference between MAXIMUM LOAD and MINIMUM LOAD in a specific test or application. It may not exceed CAPACITY

MECHANICAL TESTING:

The determination of the properties or mechanical states of a material that are associated with elastic and inelastic reactions to force or that involve relationships between stress and strain.

MINIMUM LOAD:

The lowest load in a specific test or application, differing from NO LOAD by the weight of fixtures and load receptors which are attached plus any intentional pre-load which is applied

MODE:

The direction of load. Compression and Tension are each one mode.

Millivolt :

a unit of potential equal to one thousandth of a volt

NO LOAD:

The condition of the LOAD CELL when in its normal physical orientation, with no force input applied, and with no fixtures or load receptors attached.

NONLINEARITY:

The algebraic difference between OUTPUT at a specific load and the corresponding point on the straight line drawn between MINIMUM LOAD and MAXIMUM LOAD. Normally expressed in units of %FS. It is common for characterization to be measured at 40-60 %FS.

NONREPEATABILITY:

The maximum difference between OUTPUT readings for repeated loadings under identical loading and environmental conditions. Normally expressed in units of %RO.

ROCKWELL HARDNESS TEST:

An indentation hardness test using a verified machine to force a diamond sphero-conical indenter (diamond indenter) or ball indenter, (steel or tungsten carbide) under test in two operations, and to measure the difference in depth of the indentation under the specified condition of preliminary and total test forces (minor and major loads, respectively) Morehouse manufactures a Rockwell Calibrator this calibration instrument works with most of the older Rockwell machines. A Morehouse low profile force gauge may be a suitable to calibrate specific Rockwell Testers.

SECONDARY FORCE STANDARD:

An instrument or mechanism, the calibration of which has been established by comparison with PRIMARY FORCE STANDARDS.

STRAIN:

The per unit change, due to force, in the size or shape of a body referred to its original size or shape. Strain is a non dimensional quantity.

TENSION LOADING PROCEDURE:

This is a procedure followed by Morehouse Instrument Company in our force calibration laboratory. When loading instruments in tension our general practice is to apply an axial load against the instrument under test with tension adapters threaded so that they are not tight against the instrument being calibrated. When calibrating load cells the general procedure is to make sure the live end of the load cell is facing the same direction as the force being applied. Other considerations are to load an instrument in tension with rod ends or other fixtures supplied by the customer.

TESTING MACHINE:

A mechanical device for applying force to a specimen. – Morehouse does not manufacture testing machines but provides and calibrates force measuring instruments for the verification and calibration of various testing machines.

TORQUE:

A moment (of forces) that produces or tends to produce rotation or torsion.

OUTPUT:

The algebraic difference between the SIGNAL at applied load and the SIGNAL at MINIMUM LOAD

OUTPUT RESISTANCE:

The resistance of the LOAD CELL circuit measured at the SIGNAL terminals with no load applied and with the excitation terminals open-circuited

PRIMARY AXIS:

The axis along which the LOAD CELL is designed to be loaded

PROVING RING: (MOREHOUSE PROVING RING):

A steel ring properly manufactured to perform as a nearly perfect elastic member. When forces are applied along the diameter of the ring, the diameter will change, or deflection, the amount of the applied load can be determined. The advantages of a Morehouse Proving Ring over other standards include very little drift or change from one calibration to another, very long lifespan (approximately 5 times longer life than most load cells) if used properly and they are not sensitive to rotational problems .

RATED OUTPUT:

The OUTPUT corresponding to CAPACITY, equal to OUTPUT at FULL SCALE – the OUTPUT with NO LOAD applied.

RESOLUTION:

The smallest change in load which produces a detectable change in the output or the level of detail on a display device

SHUNT CALIBRATION:

Electrical simulation of OUTPUT by connection of shunt resistors of known values at appropriate points in the circuitry

SIDE LOAD:

Any load at the point of AXIAL LOAD application acting at 90° to the PRIMARY AXIS

SIGNAL:

The absolute level of the measurable quantity into which a force input is converted

SPAN:

Another name for RATED OUTPUT

STATIC ERROR BAND or SEB

The band of maximum deviations of the ascending and descending calibration points from a best fit line through zero OUTPUT. It includes the effects of NONLINEARITY, HYSTERESIS, and non-return to MINIMUM LOAD. Normally expressed in units of %FS

SEB OUTPUT:

A computed value for OUTPUT at CAPACITY derived from a line best fit to the actual ascending and descending calibration points and through zero OUTPUT

SYMMETRY ERROR:

The algebraic difference between the RATED OUTPUT in tension and the average of the absolute values of RATED OUTPUT in tension and RATED OUTPUT in compression. Normally expressed in units of %RO

TARE LOAD:

A mass or force being applied to the instrument such as the weight of a calibration frame or loading fixtures before the actual calibration tests begin.

TEMPERATURE EFFECT ON OUTPUT:

The change in OUTPUT due to a change in AMBIENT TEMPERATURE. Normally expressed as the slope of a chord spanning the COMPENSATED TEMPERATURE RANGE and in units of %/°F or %/100°F

TEMPERATURE RANGE, COMPENSATED:

The range of temperature over which the LOAD CELL is compensated to maintain OUTPUT and ZERO BALANCE within specified limits

TEMPERATURE RANGE, OPERATING:

The extremes of AMBIENT TEMPERATURE within which the LOAD CELL will operate without permanent adverse change to any of its performance characteristics

VOLT:

A unit of potential equal to the potential difference between two points on a conductor carrying a current of 1 ampere when the power dissipated between the two points is 1 watt; equivalent to the potential difference across a resistance of 1 ohm when 1 ampere of current flows through it

ZERO BALANCE:

The SIGNAL of the LOAD CELL in the NO LOAD condition

ZERO FLOAT:

The shift in ZERO BALANCE resulting from a complete cycle of equal tension and compression loads. Normally expressed in units of %FS and usually characterized at FS = CAPACITY

ZERO STABILITY:

The degree to which ZERO BALANCE is maintained over a specified period of time with all environmental conditions, loading history, and other variables remaining constant