R 60 OIML-CS rev.2

Additional requirements from the United States

Accuracy class III L

Revision number	Date of the revision	Nature of the revision
Rev.0	29 September 2006	Initial document
Rev.1	03 March 2014	Update with latest requirements
Rev.2	05 January 2018	1. Replace reference to OIMIL MAA with reference to OIML-CS. 2. Updated references from Handbook 44, 2014 edition to 2018 edition. 3. Updated references from Publication 14, 2013 edition to 2017 edition.

The National Conference On Weights and Measures (NCWM) and the National Type Evaluation Program (NTEP) identifies specific specifications and tolerances for load cells. These additional requirements are defined in the following national Publications:

- NIST Handbook 44;
- NCWM Publication 14.

Abstracts of these above-mentioned Publications are given below. The information related to the additional requirements is highlighted in yellow.

Introduction

In the US, the revised step tolerances on measuring instruments and load cells marked with a III L Accuracy Class was developed in the 1970's and 1980's. This tolerance class is typically used for weight determinations in the range of 30 000 lb (15 t) and greater. It can best be described as a set of tolerances that falls between a Class III and a Class IIII. It should be noted that US Accuracy Class IIII is used only for the enforcement of traffic and highway enforcement laws and cannot be used in legal-for-trade applications.

Most of the information that follows is taken directly from NIST Handbook 44, *Specifications, Tolerances, and other Technical Requirements for Weighing and Measuring Devices* which is the standard adopted by the States in the US for legal-for-trade measuring instruments and NCWM Publication 14, *Weighing Devices, Technical Policy, Checklists, Test Procedures;* Forces Transducers (load cells). One should be aware that both NIST Handbook 44 and NCWM Publication 14 are revised annually. In addition there are some visual aids in Appendices A and B to assist in the understanding of Class III L.

Generally, if a load cell is evaluated and found to meet all requirements for a declared maximum number of load cell verification intervals, n_{max}, for Class III (e.g. 5000 v) then it would also meet all of the requirements for Class III L for the same n_{max}. However, due to the Class III L tolerance structure, applicants typically request larger values of n_{max} for the Class III L load cell (e.g. 10 000 v). It is this higher number of verification intervals for Class III L that must be evaluated. Normally this can be accomplished by simply obtaining one or two additional readings during the increasing/decreasing load tests at a lower test weight (see Appendix A). This allows the data to be evaluated at the required critical test loads (near 500v) with respect to 10 000 v Class III L. There is a sample of the error limits for Class III L shown in Appendix B.

1. 2018 Handbook 44 Information:

Table 3.
Parameters for Accuracy Classes

Class	***Value of the Verification Scale Division (d or e[1])***	***Number of Scale[4] Divisions (n)***	
		Minimum	***Maximum***
SI Units			
I	*equal to or greater than 1 mg*	*50 000*	*--*
II	*1 to 50 mg, inclusive*	*100*	*100 000*
	equal to or greater than 100 mg	*5 000*	*100 000*
III[2,5]	*0.1 to 2 g, inclusive*	*100*	*10 000*
	equal to or greater than 5 g	*500*	*10 000*
III L[3]	*equal to or greater than 2 kg*	*2 000*	*10 000*
IIII	*equal to or greater than 5 g*	*100*	*1 200*
Inch-Pound Units			
III[5]	*0.0002 lb to 0.005 lb, inclusive*	*100*	*10 000*
	0.005 oz to 0.125 oz, inclusive	*100*	*10 000*
	equal to or greater than 0.01 lb	*500*	*10 000*
	equal to or greater than 0.25 oz	*500*	*10 000*
III L[3]	*equal to or greater than 5 lb*	*2 000*	*10 000*
IIII	*greater than 0.01 lb*	*100*	*1 200*
	greater than 0.25 oz	*100*	*1 200*

[1] *For Class I and II devices equipped with auxiliary reading means (i.e., a rider, a vernier, or a least significant decimal differentiated by size, shape, or color), the value of the verification scale division "e" is the value of the scale division immediately preceding the auxiliary means.*

[2] *A Class III scale marked "For prescription weighing only" may have a verification scale division (e) not less than 0.01 g.*

(Added 1986) (Amended 2003)

[3] *The value of a scale division for crane and hopper (other than grain hopper) scales shall be not less than 0.2 kg (0.5 lb). The minimum number of scale divisions shall be not less than 1000.*

[4] *On a multiple range or multi-interval scale, the number of divisions for each range independently shall not exceed the maximum specified for the accuracy class. The number of scale divisions, n, for each weighing range is determined by dividing the scale capacity for each range by the verification scale division, e, for each range. On a scale system with multiple load-receiving elements and multiple indications, each element considered shall not independently exceed the maximum specified for the accuracy class. If the system has a summing indicator, the n_{max} for the summed indication shall not exceed the maximum specified for the accuracy class.*

(Added 1997)

[5] *The minimum number of scale divisions for a Class III Hopper Scale used for weighing grain shall be 2000.*)

[*Nonretroactive as of January 1, 1986*]

(Added 2004) (Amended 1986, 1987, 1997, 1998, 1999, 2003, and 2004)

Table 6. Maintenance Tolerances (All values in this table are in scale divisions)				
Tolerance in scale divisions				
	1	**2**	**3**	**5**
Class	**Test Load**			
I	0 - 50 000	50 001 - 200 000	200 001 +	
II	0 - 5 000	5 001 - 20 000	20 001 +	
III	0 - 500	501 - 2 000	2 001 - 4 000	4 001 +
IIII	0 - 50	51 - 200	201 - 400	401 +
III L	0 - 500	501- 1 000	(Add 1d for each additional 500 d or fraction thereof)	

T.N.4.6. Time Dependence (Creep) for Load Cells During Type Evaluation. – A load cell (force transducer) marked with an accuracy class shall meet the following requirements at constant test conditions:

(a) Permissible Variations of Readings. – With a constant maximum load for the measuring range (D_{max}) between 90 % and 100 % of maximum capacity (E_{max}), applied to the load cell, the difference between the initial reading and any reading obtained during the next 30 minutes shall not exceed the absolute value of the maximum permissible error (mpe) for the applied load (see Table T.N.4.6. Maximum Permissible Error (mpe) for Load Cells During Type Evaluation). The difference between the reading obtained at 20 minutes and the reading obtained at 30 minutes shall not exceed 0.15 times the absolute value of the mpe (see Table T.N.4.6. Maximum Permissible Error (mpe) for Load Cells During Type Evaluation).

(b) Apportionment Factors. – The mpe for creep shall be determined from Table T.N.4.6. Maximum Permissible Error (mpe) * for Load Cells During Type Evaluation using the following apportionment factors (p_{LC}):

p_{LC} = 0.7 for load cells marked with S (single load cell applications),
p_{LC} = 1.0 for load cells marked with M (multiple load cell applications), and
p_{LC} = 0.5 for Class III L load cells marked with S or M.

(Added 2005) (Amended 2006)

Table T.N.4.6. **Maximum Permissible Error (mpe)* for Load Cells During Type Evaluation**			
mpe in Load Cell Verifications Divisions (v) = p_{LC} x Basic Tolerance in v			
Class	P_{LC} x 0.5 v	P_{LC} x 1.0 v	P_{LC} x 1.5 v
I	0 - 50 000 v	50 001 v - 200 000 v	200 001 v+
II	0 - 5 000 v	5 001 v - 20 000 v	20 001 v +
III	0 - 500 v	501 v- 2 000 v	2 001 v+
IIII	0 - 50 v	51 v - 200 v	201 v +
III L	0 - 500 v	501 v - 1 000 v	(Add 0.5 v to the basic tolerance for each additional 500 v or fraction thereof up to a maximum load of 10 000 v)
v represents the load cell verification interval P_{LC} represents the apportionment factors applied to the basic tolerance P_{LC} = 0.7 for load cells marked with S (single load cell applications) P_{LC} = 1.0 for load cells marked with M (multiple load cell applications) P_{LC} = 0.5 for Class III L load cells marked with S or M * mpe = P_{LC} x Basic Tolerance in load cell verifications divisions (v)			

(Table Added 2005) (Amended 2006)

T.N.4.7. Creep Recovery for Load Cells During Type Evaluation. – The difference between the initial reading of the minimum load of the measuring range (D_{min}) and the reading after returning to minimum load subsequent to the maximum load (D_{max}) having been applied for 30 minutes shall not exceed:

(a) 0.5 times the value of the load cell verification interval (0.5 v) for Class II and IIII load cells;

(b) 0.5 times the value of the load cell verification interval (0.5 v) for Class III load cells with 4000 or fewer divisions;

(c) 0.83 times the value of the load cell verification interval (0.83 v) for Class III load cells with more than 4000 divisions; or

(d) 2.5 times the value of the load cell verification interval (2.5 v) for Class III L load cells.

(Added 2006) (Amended 2009 and 2011)

T.N.8.1.1. If not specified in the operating instructions for Class I or II scales, or if not marked on the device for Class III, III L, or IIII scales, the temperature limits shall be: -10° C to 40° C (14° F to 104° F).

T.N.8.1.3. Temperature Effect on Zero-Load Balance. – The zero-load indication shall not vary by more than:

(a) three divisions per 5 °C (9 °F) change in temperature for Class III L devices; or

(b) one division per 5 °C (9 °F) change in temperature for all other devices.

(Amended 1990)

Table 7a. Typical Class or Type of Device for Weighing Applications	
Class	**Weighing Application or Scale Type**
I	Precision laboratory weighing
II	Laboratory weighing, precious metals and gem weighing, grain test scales
III	All commercial weighing not otherwise specified, grain test scales, retail precious metals and semi-precious gem weighing, grain-hopper scales, animal scales, postal scales, vehicle on-board weighing systems with a capacity less than or equal to 30 000 lb, and scales used to determine laundry charges
III L	Vehicle scales, vehicle on-board weighing systems with a capacity greater than 30 000 lb, axle-load scales, livestock scales, railway track scales, crane scales, and hopper (other than grain hopper) scales
IIII	Wheel-load weighers and portable axle-load weighers used for highway weight enforcement
Note: A scale with a higher accuracy class than that specified as “typical” may be used.	

(Amended 1985, 1986, 1987, 1988, 1992, 1995, and 2012)

2. 2017 Publication 14 items:

C. Testing Accuracy Required

The error in the test process for force transducer (load cell) evaluations may not exceed one-third of the tolerance applied at the force transducer (load cell) (0.7 times the tolerance for the weighing system). The important characteristics for the test process for force transducers (load cells) (and indicators) for compliance with the influence factors requirements is linearity and repeatability, not absolute accuracy. This means that the accuracy of the applied load is not critical, but the change in performance of output of the force transducer (load cell) (or indicator) under the same load but different environmental conditions is important. Consequently, the uncertainty in the reference standard may not be significant provided the uncertainty of the linearity of the total system is within one-third of the tolerance to be applied to the force transducer (load cell).

The accuracies specified in Table 2 are required for testing force transducers (load cells) for a weighing system using single and multiple force transducers (load cells). Force transducers (load cells) used in multiple-cell scales are permitted a larger tolerance because some random errors cancel in multiple-cell scales.

Table 2.
Accuracy Required of the Test System Class III Applications
(Based upon Single and Multiple Load Cell Applications)

Smallest Applicable Weighing System Acceptance Tolerance			Required Linearity and Repeatability of the Test System	
Divisions	**Divisions**	**Percent**	**Single Cells Percent**	**Multiple Cells Percent**
500	0.5 at 500 d	0.1	0.023	0.033
1 000	1.0 at 1000 d	0.1	0.023	0.033
2 000	1.0 at 2000 d	0.05	0.0117	0.0167
3 000	1.5 at 3000 d	0.05	0.0117	0.0167
4 000	1.5 at 4000 d	0.0375	0.0088	0.0125
5 000	1.5 at 5000 d	0.03	0.0088	0.0125
6 000	1.5 at 6000 d	0.025	0.0088	0.0125
7 000	2.5 at 7000 d	0.036	0.0083	0.0119
8 000	2.5 at 8000 d	0.0312	0.0073	0.0104
9 000	2.5 at 9000 d	0.0278	0.0065	0.0093
10 000	2.5 at 10 000 d	0.025	0.0058	0.0083

Class III L Applications
(Based upon Single and Multiple Load Cell Applications)

Smallest Applicable Weighing System Acceptance Tolerance			Required Linearity and Repeatability of the Test System	
Divisions	**Divisions**	**Percent**	**Single Cells Percent**	**Multiple Cells Percent**
500 to 10 000	0.5 per 500 d	0.1	0.023	0.033

Class IIII Applications
(Based upon Single and Multiple Load Cell Applications)

Smallest Applicable Weighing System Acceptance Tolerance			Required Linearity and Repeatability of the Test System	
Divisions	**Divisions**	**Percent**	**Single Cells Percent**	**Multiple Cells Percent**
50	0.5 at 50 d	1.0	0.2333	0.3333
200	1.0 at 200 d	0.5	0.1167	0.1667
400	1.5 at 400 d	0.375	0.0875	0.125
1 200	2.5 at 1200 d	0.208	0.0486	0.0694

E. Single Force transducer (load cell) Systems

It is acceptable to use a load cell with the "S" or Single Cell designation in multiple load cell applications as long as all other parameters meet applicable requirements.

The error in the test process for single load cell evaluations may not exceed one-third of the tolerance applied at the load cell (0.7 times the tolerance for the weighing system). *See Section C for additional information on accuracy requirements.*

F. Multiple Force transducer (load cell) Systems

A load cell with the "M" or Multiple Cell designation can be used only in multiple load cell applications.

The value of the minimum verification scale division for the load cell shall be based on the tolerance for a single load cell application. The value for v_{rmin} shall be less than or equal to the cell capacity divided by the maximum number of divisions for which the load cell complies with the applicable requirements ($v_{min} \leq$ cell capacity/n_{max},). This value shall be marked on the load cell or contained in an accompanying document. However, these force transducers (load cells) may be used in multiple force transducer (load cell) applications wherever:

$$\mathcal{V}_{\min} \leq \frac{e}{\sqrt{N}}$$

Where:

$\mathcal{V}_{\min}$ = minimum verification division for the load cell

e = the value of the verification scale division for the scale

N = the number of force transducers (load cells) in the scale

Table 4.
Tolerance for Class III L Load Cells

***NIST Handbook 44* Reference**	**Single Cell Requirement**		**Multiple Cell Requirement**	
Load Cell Error Table 6., Class III L; T.N.3.2. and T.N.8.1.1.	**0.7 Factor Applied**		**1.0 Factor Applied**	
	Load	**Tolerance**	**Load**	**Tolerance**
	0 – 500v	0.35v	0 – 500v	0.50v
	501 – 1000v[1]	0.70v	501 – 2000v[2]	1.00v
	[1]Add 0.35v to the tolerance for each 500v of load or fraction thereof up to a maximum load of 10 000v		[2]Add 0.50v to the tolerance for each 500v of load or fraction thereof up to a maximum load of 10 000v	

[1] Add 0.35v to the tolerance of each 500v of load or fractions thereof up to a maximum load 10 000v
[2] Add 0.50v to the tolerance of each 500v of load or fractions thereof up to a maximum load 10 000v

I. Determination of:

- load cell error
- Repeatability error

- Temperature effect on minimum dead load output (TEMDLO)

1. At 20 °C ambient, insert the load cell into the force-generating system. **If the operating temperature range for the load cell is** significantly different from **-10 °C** to 40 °C, **then the first and last temperature for testing shall be near the midpoint of the extremes of the load cell operating range.**

2. If the indicating element for **the load cell is provided with a** convenient means of checking itself, conduct the **self-test at this time.**

3. Monitor minimum load output of test until stable. Record instrument indication at minimum dead load. Do not zero the indicator before starting each test because the actual values are needed for computation of TEMDLO. Data sets will be rejected if the indicator is zeroed before each run and the required data is not available.

4. All test load points in a loading and unloading sequence shall be spaced at approximately equal time intervals. The time to load or unload test weights and read the indicator shall be as short as possible and shall not exceed the time specified in Table 5 below. The reading shall be taken as soon as it is stable. The test shall be conducted under constant conditions.

5. Prior to the initial test of each cell at each test temperature, exercise the force transducer (load cell) three times by loading the cell to capacity and returning to the minimum load of the test after each load application. Wait only the time needed to take the minimum load reading so the timing of the first test cycle is very similar to the timing for the remaining two cycles. Apply increasing loads to a maximum load of at least 90 percent but not more than 100 percent of maximum cell capacity. Manufacturers may test to a maximum load greater than 100 percent if this is the only load combination permitted by the test equipment to reach at least 90 percent of the cell capacity. Increasing load points shall be at least 5 in number and shall include loads at approximately the highest values in the applicable steps of the tolerances. Whenever possible, test loads for class III L cells should be near 500v, 1000v, 4000v, 75 percent, and 100 percent of the measuring range for this test. The test loads near 75 percent and 100 percent are required.

6. Record the instrument indications.

7. Remove the test loads to the minimum load in a similar manner to the steps used for loading the cell.

8. Record the instrument indications for the minimum load.

9. Repeat the operations described in steps 4 through 8 four more times for accuracy classes I and II or two more times for accuracy classes III, III L and IIII.

10. Repeat the operations described in steps 2 through 9 for both the high and low temperature limits (in the order best suited to the test laboratory) for the accuracy class or, if the manufacturer has specified a smaller or larger range, at the limits marked on the cell, provided the temperature range is at least the range required for the accuracy class.

11. Repeat the operations described in steps 2 through 9 at 20 °C (or at the mid-point of the extremes of the force transducer (load cell) operating range if it is significantly different from -10 °C to 40 °C).

12. Determine the magnitude of force transducer (load cell) error at each data point and compare the tolerances. All individual-run data points must be within the applicable tolerances.

13. From the resulting data, determine the repeatability error and compare it to the tolerances.

14. From the resulting mean of the three minimum low output values for each temperature determine, the temperature effect on minimum dead load output and compare it to the tolerances. Do not use a separate test to determine the temperature effect on minimum dead load output.

II. Determination of Creep and Creep Recovery, Test Procedure and Permissible Variations

1. At 20 °C ambient, insert the load cell into the force generating system and load to the minimum dead load. If Procedure I. (which includes increasing and decreasing load tests) has just been completed, wait 1 hour. If a separate creep test is being conducted, exercise the load cell as in Procedure I.5. and then wait 1 hour.
2. If the indicating element for the load cell is provided with a convenient means for checking itself, conduct the self-test at this time.
3. Monitor minimum load output until stable.
4. **Test for Creep**
    a. Apply a load equal to 90% to 100% of the maximum capacity of the load cell. The time to load test weights shall be as short as possible. A portion of the time specified in Table 5 shall be used for loading. The remaining time specified in Table 5 shall be used for stabilization. The tests shall be conducted under constant conditions. Time shall be recorded in the test report in absolute, (hh:mm:ss) not relative, units. The initial reading shall be taken at the applicable time indicated in Table 5. With the load remaining on the load cell, continue to record indications periodically, thereafter at time intervals over a 30 minute period. Be certain to obtain a reading at 20 minutes. (8.b. below)
5. **Test for Creep Recovery**
    a. Remove a load equal to 90% to 100% of the maximum capacity of the load cell that has been applied for 30 minutes. The time to unload test weights shall be as short as possible. A portion of the time specified in Table 5 shall be used for unloading. The remaining time specified in Table 5 shall be used for stabilization. The test shall be conducted under constant conditions. Time shall be recorded in the test report in absolute, (hh:mm:ss) not relative, units. The initial reading shall be taken at the applicable time indicated in Table 5.
6. Repeat the operations described in steps 2 through 5 at the high and low temperature limits for the accuracy class. If the manufacturer has specified a smaller or a larger range, repeat operations at the limits marked on the cell, provided the temperature range is at least the range required for the accuracy class.
7. With the resulting data, and accounting for the effect of barometric pressure changes, determine the magnitude of the creep and compare it to the tolerance in *NIST Handbook 44* Scales Code Table T.N.4.6.
8. **Permissible Variations of Readings for Creep**
    a. With a constant maximum load for the measuring range (D_{max}) between 90% and 100% of maximum capacity (E_{max}), applied to the load cell, the difference between the initial reading and any reading obtained during the next 30 minutes shall not exceed the absolute value of the maximum permissible error (mpe) for the applied load (see Table T.N.4.6. Maximum Permissible Error (mpe) for Load Cells During Type Evaluation.)
    b. The difference between the reading obtained at 20 minutes and the reading obtained at 30 minutes shall not exceed 0.15 times the absolute value of the mpe (see Table T.N.4.6. Maximum Permissible Error (mpe) for Load Cells During Type Evaluation.)
9. **Permissible Variations of Reading for Creep Recovery**

a. The difference between the initial reading of the minimum load of the measuring range (D_{min}) and the reading after returning to minimum load subsequent to the maximum load (D_{max}) having been applied for 30 minutes shall not exceed:

1. 0.5 times the value of the load cell verification interval (0.5 v) for Class I, II, and IIII load cells.
2. 0.5 times the value of the load cell verification interval (0.5 v) for Class III load cells with 4000 or fewer divisions.
3. 0.83 times the value of the load cell verification interval (0.83 v) for Class III load cells with more than 4000 divisions.
4. 2.5 times the value of the load cell verification interval (2.5 v) for Class III L load cells.

Table 5.
Initial Reading Times

Load		**Time**
Greater Than	**To and Including**	
0 kg	10 kg	10 seconds
10 kg	100 kg	20 seconds
100 kg	1000 kg	30 seconds
1000 kg	10 000 kg	40 seconds
10 000 kg	100 000 kg	50 seconds
100 000 kg	-	60 seconds

Table T.N.4.6.
Maximum Permissible Error (mpe) * for Load Cells During Type Evaluation

mpe in Load Cell Verifications Divisions (v) = p_{LC} x Basic Tolerance in v			
Class	**p_{LC} x 0.5 v**	**p_{LC} x 1.0 v**	**p_{LC} x 1.5 v**
I	0 – 50 000 v	50 001 v – 200 000 v	200 001 v +
II	0 – 5000 v	5 001 v – 20 000 v	20 001 v +
III	0 – 500 v	501 v – 2000 v	2001 v +
IIII	0 – 50 v	51 v – 200 v	201 v +
III L	0 – 500 v	501 v – 1000 v	Add 0.5 v to the basic tolerance for each additional 500 v or fraction thereof up to a maximum load of 10 000 v

v represents the load cell verification interval
p_{LC} represents the apportionment factors applied to the basic tolerance
p_{LC} = 0.7 for load cells marked with S (single load cell applications)
p_{LC} = 1.0 for load cells marked with M (multiple load cell applications)
p_{LC} = 0.5 for Class III L load cells marked with S or M
* mpe = p_{LC} x Basic Tolerance in load cell verifications divisions (v)

M. Load Cell Data Format for NTEP Submission

1.
.
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9.

10. Numerical Computations

The numerical computation of the critical test results given in the Summary Table (see 12. below) using the test data circled and identified by marginal notes in the Data Table (see 9. above).

Include the computation of the reference output corresponding with 75 percent of the measuring range and the computation of the factor relating net mean output (in mVN or in indicator units) to the force transducer (load cell) verification interval (v).

Computations that are imbedded in a computer printout or standard report format should be clearly identified and clarified by added marginal notes and/or supplemental computations.

11. Error Plot (refer to Appendix B for example)

A plot of the errors due to non-linearity, hysteresis, and temperature effect on sensitivity span and having the following characteristics.

a. Both axes are labeled in terms of force transducer (load cell) verification intervals (v).
b. A plotted point represents the mean output of 3 runs, at one load, either loading or unloading, at one test temperature. Consecutive points are connected by straight lines and the resulting loops are labeled with the test temperature.
c. The load axis of the plot passes through both the mean minimum load output and the mean output for a load of 75 percent of the measuring range (not necessarily the cell capacity), both measured during ascending load and during the initial test at room temperature. If there is not a 75 percent test load, the reference output should be linearly interpolated between adjacent test loads.
d. Stepped bounds indicate the applicable error tolerances.

12. Summary Table

A three-column table of the following critical test results, the corresponding limiting values of each quantity, and the ratio of each critical test result to the correspondence limiting value shall be provided. An example is given in Table 6.

a. Force transducer (load cell) error - The combined error due to non- linearity, hysteresis, and temperature effect on sensitivity.
b. Repeatability error - The greatest absolute value of non-repeatability in relation to the tolerance value for that test load.
c. Temperature effect on minimum dead load output - The greatest value of this effect for consecutive test temperatures.
d. Creep - The greatest differences between the initial reference output (at 20 seconds) and any output recorded during the remaining period of the test.
e. Barometric pressure sensitivity.

Table 6.
Example of a Summary Table for a Class III 3000 Single Load Cell

Summary Table **(As requested in Item 12 of the load cell data format paper)**			
	Critical Result[1]	Tolerance[2]	Result/Tolerance
Load Cell Error	0.68 v	0.7 v	0.97
Repeatability Error	0.19 v	0.35 v	0.55
Temperature Effect on MDLO	0.57 v_{min}/5 °C	0.7 v_{min}/5 °C	0.82
Creep (time dependence)	0.98 v	1.5 v	0.65
Effect of Barometric Pressure	0.185 v_{min}/kPa	1.0 v_{min}/kPa	0.15

Appendix A:

This is the same 50 000 lb load cell
at different number of v

Load lb	v	v	v	v
0				
500	30	50	60	100
1000	60	100	120	200
1500	90	150	180	300
2000	120	200	240	400
2500	150	250	300	500
3000	180	300	360	600
3500	210	350	420	700
4000	240	400	480	800
4500	270	450	540	900
5000	300	500	600	1000
7500	450	7500	900	1500
10 000	600	1000	1200	2000
12 500	750	1250	1500	2500
15 000	900	1500	1800	3000
20 000	1200	2000	2400	4000
30 000	1800	3000	3600	6000
40 000	2400	4000	4800	8000
50 000	3000	5000	6000	10 000
Ratio n_{ma}, vs. load	16.66667	10	8.333333	5

What this shows is with 5 steps it will be necessary, depending on the number of v requested (if less than 10 000) for the load cell for OIML testing, it will require one or two additional weight readings at lower load values for US Class III L.

Highlighted area shows possible loads to be used to obtain data close to break points. (five steps is typical for testing, more steps are OK)

[1] The critical test result is the test result that gives the greatest ratio of result to tolerance. There may be other errors of greater absolute value but that give smaller ratios of result to tolerance.
[2] The tolerance is the value from the tolerance table of the NTEP procedure that corresponds to the critical test result.

This is for example purposes only. The load can easily be changed to other values; other $n_{n,,,}$ values can also be used. A new ratio would then be calculated and the various values can be determined.

Note: it is not mandatory to apply the exact loads indicated in this table. This ideal would be to obtain information at approximately 1/2 the value of the first step tolerance and one value right at the first step tolerance. This is not always either practical or possible with the limitations of testing equipment. This table is for reference purposes only and to show that for Class HI L it is necessary in most cases to obtain a value that is less than the first step that is necessary for Class III. You will see this in the example plot in Appendix B.

Appendix B:

Example of typical Class III L plot.