BHARAT HEAVY ELECTRICALS LIMITED

TIRUCHIRAPPALLI

CONTROLS AND INSTRUMENTATION / FB

QUALITY ASSURANCE

PROCEDURE FOR PERFORMANCE TESTING

OF

WEIGHING MODULE
(LOAD CELL)

REV	DATE	PREPARED		REVIEWED	APPROVED	Revision History
01	19/03/2018	[KV]	[VA]	[TK]	[RMV]	Revised to Correct Quantum of Inspection
00	11/12/2016	[KV] SD/-	[VA] SD/-	[RMV] SD/-	[SDM] SD/-	Initial Release

Load Cell Performance Testing Guidelines

This guideline provides general-purpose test procedures for testing load cells.

1. Tests

1.1 Test Methods and parameters specified in this guideline are in accordance with IS: 9281.

1.2 Tests

I. Routine Test (Inspection - 10% of offered lot shall be performed)

1. Calibration (Following parameters are inferred from Calibration curve): -
   a) Non-Linearity
   b) Hysteresis
   c) Repeatability

2. Zero balance

II. Type Test (Inspection - 1 No. per PO shall be performed)

1.Temperature effect
2.Creep test

NOTE:

- If there is no test load equivalent to rated load, employ a test load which is as close to rated load. The output shall extrapolated to the maximum load in the curve.
- Application of load shall be done using force calibrator/Universal Testing Machine (UTM)/ standard weights (Calibrated in any national accredited labs).
- Inspection shall be in presence of BHEL inspectors at vendor works or any NABL accredited labs.
- The excitation voltage for the load cell is 10V DC.
- The measurement of output signal from load cell (mV) shall be done using digital multimeter having error ± 0.01% of accuracy.

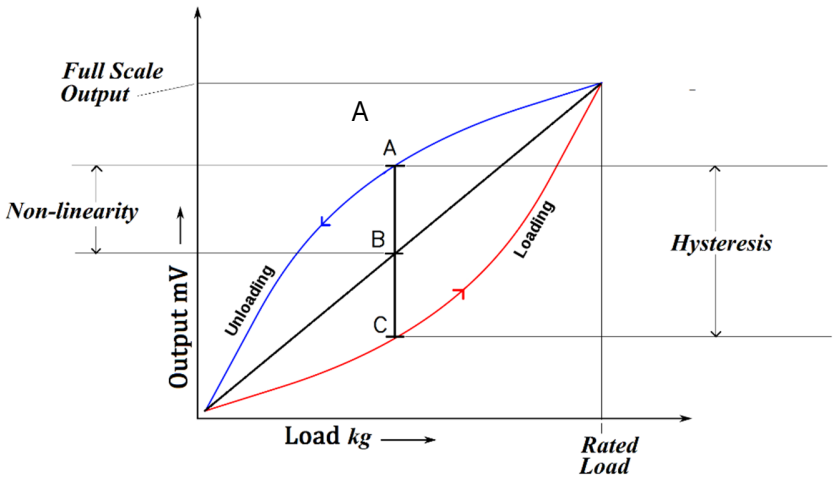
2. Calibration

a) Apply the maximum load (68 kg) then remove the load. (0 kg). Repeat this step for three times (warming up process).
b) Wait for the output to stabilize.
c) Measure the initial output without load.
d) Apply loads in ascending order to maximum load as per table 1.1. Take readings after a stabilization period for each load increment.
e) Remove the same test loads in a descending order as per Table 1.1. Take readings after a stabilization period for each load decrement.
f) Upon removal of the last test load, record the output at minimum load (0 kg).
g) Repeat (a) through (f) two more times.
h) Corresponding readings (average readings from 3 runs) of the output at the various loads are taken (refer table 1.1). Plot a graph showing output versus load as shown in Figure 1.1.
i) Note: Number of load points can be increased to obtain smooth graph.

Table 1.1

SL. NO.	Load (kg)	Output (mV) (Ascending)				Output (mV) (Descending)			
		a_1	a_2	a_3	a_{avg}	d_1	d_2	d_3	d_{avg}
1.	0								
2.	15								
3.	30								
4.	45								
5.	68								

Figure 1.1
Typical Graph for illustration



3. Calculations:

a. Non-linearity

The calibration data (refer table 1.1) is used to determine non-linearity. The curve joining the various points is drawn (refer Figure 1.1). The maximum deviation of the curve from the straight-line joining the end points (Terminal linearity) is then interpreted as the nonlinearity factor.

$$\% \textbf{NonLinearity} = \frac{A - B}{S} * 100$$

S = Full scale (FS) output at rated load

Acceptable Limits: ±0.05 %FS

b. Hysteresis

The calibration data (refer table 1.1) is used to determine hysteresis. The curve joining the various points is drawn (refer Figure 1.1). The maximum deviation (nominally occurring at 50% load) from the line joining the end points shall give the hysteresis value.

$$\% \text{ Hysteresis} = \frac{A - C}{S} * 100$$

S = Full scale output at rated load

Acceptable Limits: ±0.03 %FS

C. Repeatability

The calibration data (refer table 1.1) is used to determine non-repeatability. For each set of the three data points (refer table 1.2), taken at the same temperature, non-repeatability is the maximum deviation between any two readings expressed as percentage of rated output.

Table 1.2

SL. NO.	Load (kgs)	Output (mV) (Ascending)			Max.Difference Δ	Repeatability $= \frac{\Delta}{E} * 100\ \%$
		a_1	a_2	a_3	$\Delta\ (a_1, a_2, a_3)$	
1.	0					
2.	15					
3.	30					
4.	45					
5.	68					
					Average =	

Data for Table 1.2 is taken from Table 1.1 (Calibration data).

E = Rated output RO in mV

Acceptable Limits: ±0.02 %RO

d. Zero Balance

Zero balance is the load cell's zero load output which will likely read some value slightly off true zero.

$$Zero\ Balance = \frac{e0}{E} * 100\ \%$$

e0 = mV output at No Load
E = Rated output RO in mV

Acceptable Limits: ±1 %RO

e. Temperature Effect

$$\text{Temperature effect on No Load Output} = \frac{Z2 - Z1}{(T2 - T1) * E} * 100\ \frac{\%}{C}$$

$$\text{Temperature effect on Rated Output} = \frac{S2 - S1}{(T2 - T1) * S} * 100\ \frac{\%}{C}$$

Z1 = mV output at T1 (T1= -15°C) at No load.
Z2 = mV output at T2 (T2= 65°C) at No load.
E = Rated output

S = Full scale output (Output at rated load)
S1 = mV output at T1 (T1= -15°C) at 68kgs.
S2 = mV output at T2 (T2= 65°C) at 68kgs.

Acceptable Limits:-
Effect on Zero: ±0.0027 % RO/°C
Effect on Rated Output: ±0.0015 %/°C

f. Creep

The change in LOAD CELL SIGNAL occurring with time under constant load and with all environmental conditions and other variables also remaining constant.

Apply the full rated load and read the output immediately after the load has been applied after a short stabilization period (t1) and after at 20 minutes (t2).

t2-t1 = creep measurement period (20 min)

$$\text{Creep \% of Rated output} = \frac{e2 - e1}{E} * 100$$

e1 = mV output at t1
e2 = mV output at t2
E = Rated output RO in mV

Acceptable Limits: ±0.025 %RO

Test Results:

Sl.No	Tests	Acceptable Limit	Results
a.	Non-linearity	±0.05 %FS (FS-Full Scale)	
b.	Hysteresis	±0.03 %FS	
c.	Repeatability	±0.02 %RO (RO-Rated Output)	
d.	Zero Balance	±1 %RO	
e.	Temperature Effect	Effect on Zero: ±0.0027 % RO/°C Effect on Rated Output: ±0.0015 %/°C	
f.	Creep	±0.025 %RO	