Northstar Technical Bulletin
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Title:

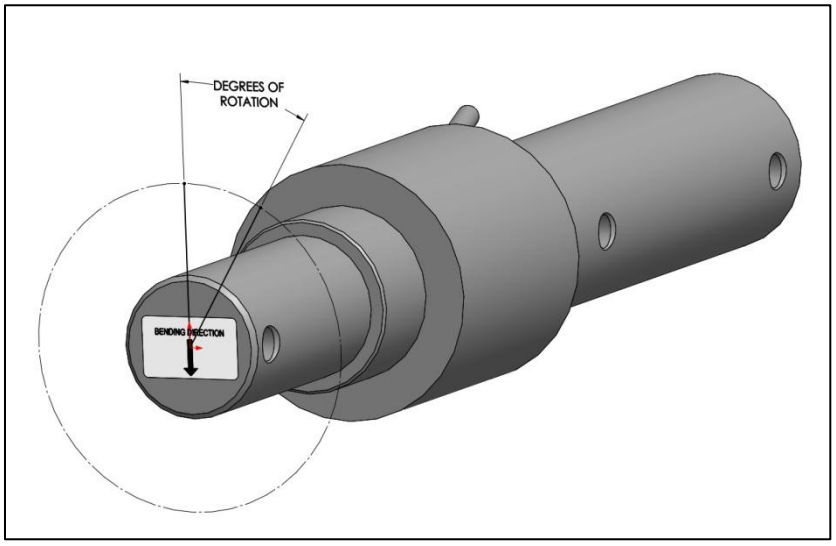
Load Cell Error Per Degrees of Rotation.

Overview:

Most users of load cells understand that the load applied should be straight up-and-down in almost all cases. But sometimes the application calls for a non-vertical load, or perhaps there's something not quite right about the installation that makes the load angle suspect. In those situations, how does one answer the question, "How far off am I?"

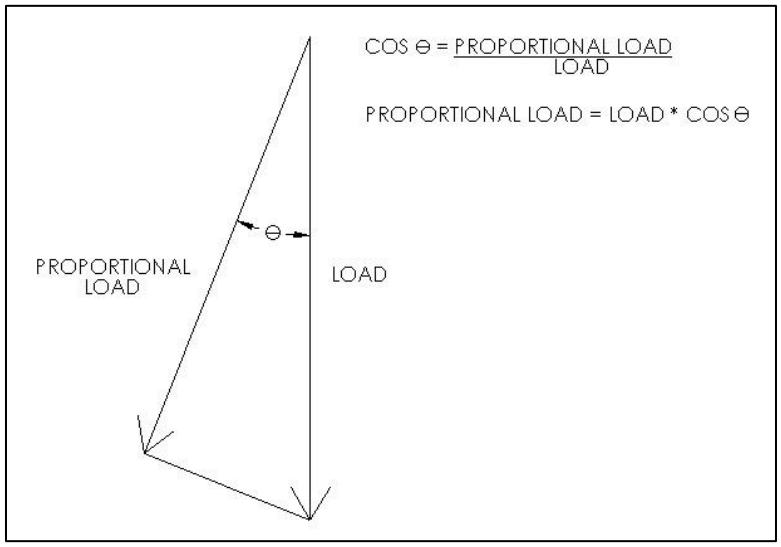
The following example will focus on a round, differential-bending load cell, often referred to as a DB cell. However, all load cells are susceptible to error caused by loads that are out of alignment.

Let's say for example that you have a DB cell with 10,000lbs capacity. It might look something like this, with an arrow sticker or engraving on the end where the load is applied. The other end is the 'fixed' or mount end, and the large diameter section in the middle is the 'can' or cover.



Underneath the cover is where all of the load cell circuitry is hidden away and protected from the elements. Without going into a lot of detail about how it all works, it's enough to say that the circuit is made of strain gages and other resistors wired into a Wheatstone bridge. The strain gages are positioned exactly on the top and bottom of the cell - that's how they are able to measure 100% of the load that is applied.

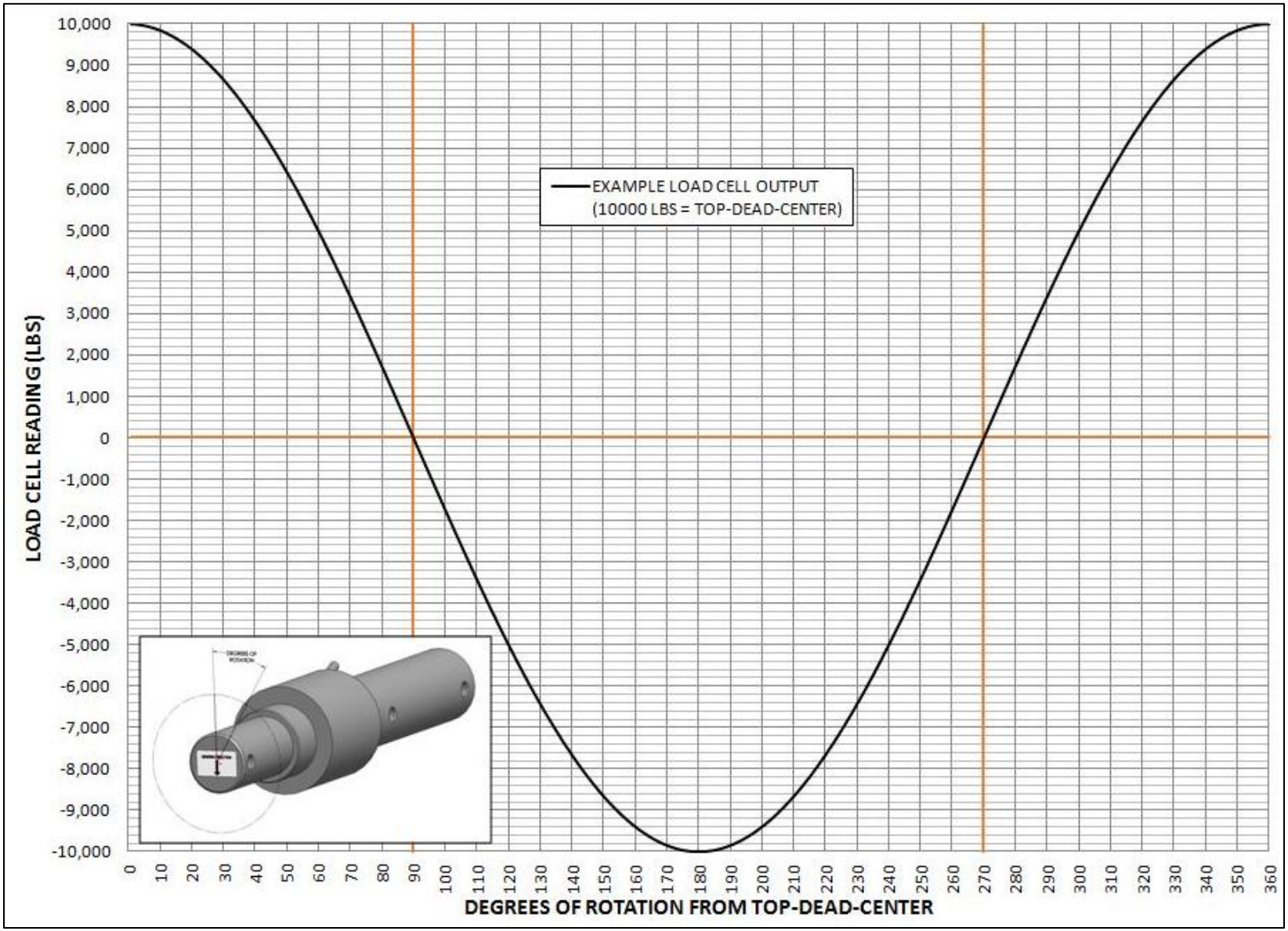
If the bar were to be rotated away from top-dead-center while the load stayed vertical, the strain gages would no longer be exactly on the top and bottom anymore. As a result, they would only be able to sense a smaller proportion of the total load. That proportion is calculated by using the formula:

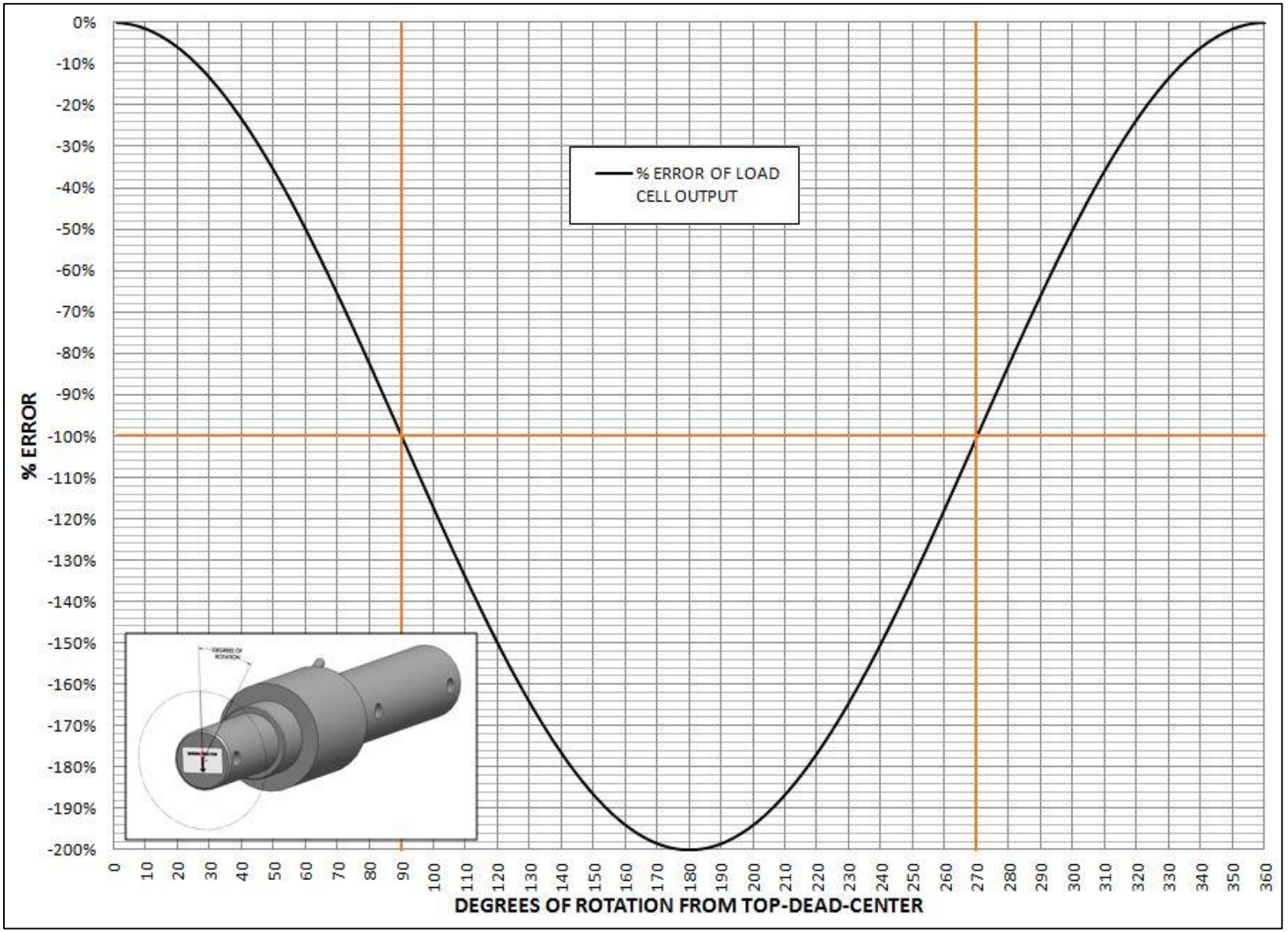


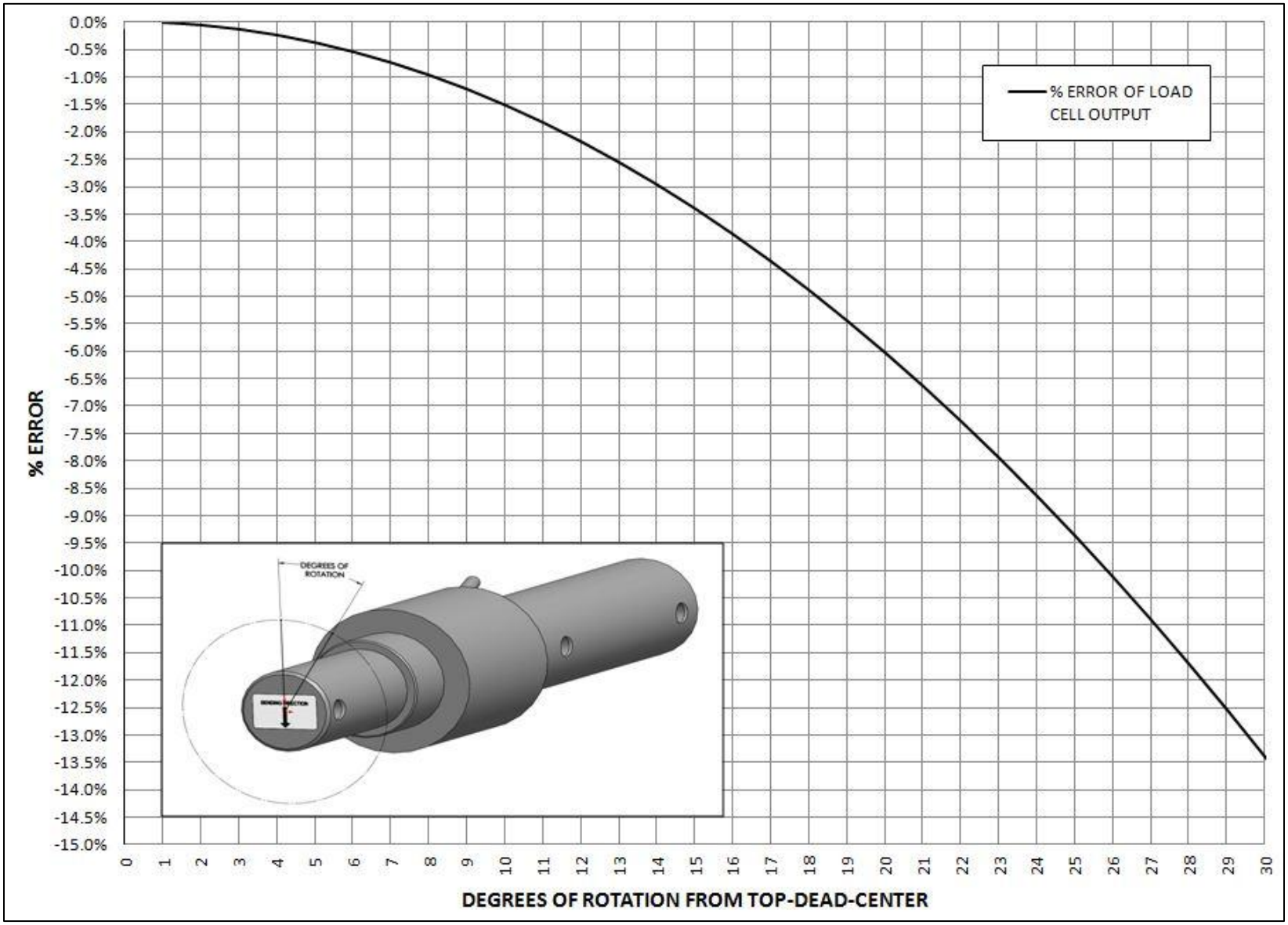
The percent error is then calculated by using this formula:

$$\% \text{ Error} = \frac{(\text{PROPORTIONAL LOAD} - \text{LOAD})}{\text{LOAD}} \times 100$$

To bring it all together, the error per degrees of rotation for a 10,000lbs capacity load cell is summarized in a graph on the following page. Then, the next graphs show a generalized application of the percent error, including a close-up of the 0° to 30° degree range.


EXAMPLE LOAD CELL OUTPUT
(10000 LBS = TOP-DEAD-CENTER)
LOAD CELL READING (LBS)
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
-1,000
-2,000
-3,000
-4,000
-5,000
-6,000
-7,000
-8,000
-9,000
-10,000
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250 260 270 280 290 300 310 320 330 340 350 360
DEGREES OF ROTATION FROM TOP-DEAD-CENTER


% ERROR OF LOAD CELL OUTPUT
% ERROR
0%
-10%
-20%
-30%
-40%
-50%
-60%
-70%
-80%
-90%
-100%
-110%
-120%
-130%
-140%
-150%
-160%
-170%
-180%
-190%
-200%
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230
240
250
260
270
280
290
300
310
320
330
340
350
360
DEGREES OF ROTATION FROM TOP-DEAD-CENTER


% ERROR OF LOAD CELL OUTPUT
% ERROR
DEGREES OF ROTATION FROM TOP-DEAD-CENTER
DEGREES OF ROTATION
0.0%
-0.5%
-1.0%
-1.5%
-2.0%
-2.5%
-3.0%
-3.5%
-4.0%
-4.5%
-5.0%
-5.5%
-6.0%
-6.5%
-7.0%
-7.5%
-8.0%
-8.5%
-9.0%
-9.5%
-10.0%
-10.5%
-11.0%
-11.5%
-12.0%
-12.5%
-13.0%
-13.5%
-14.0%
-14.5%
-15.0%
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

Summary:

As can be seen in the graphs, load cell misalignment can quickly lead to significant errors in the weight reading of a scale system. In real-world applications, there will likely be some angular deviation from top-dead-center in almost any application, but the more care that is taken to keep this deviation to a minimum the better the scale system will perform.

References:

www.northstarloadcell.com