FAQ's: FREQUENTLY ASKED QUESTIONS, GOOD PRACTICE AND TROUBLESHOOTING

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29/12/10

How to choose a load cell?

Below is a practical guide for the selection of a load cell. It has to be taken into account that there may be other technical circumstances or requirements, and it must take as an orientation that may be valid for most cases. This guide is only suitable for systems totally supported on load cells and systems with evenly distributed loads without great asymmetries and is not suitable for systems where the power is transmitted to cells by means of levers, systems with great asymmetries in the distribution of loads or systems with rolling loads.

In order to choose or recommend a load cell, basically, the following questions should be answered:

1st: What load is going to be applied on the load cell.
2nd: What environment is it going to work in.
3rd: Other considerations.

The load to be applied on the cell will give an orientation about the Nominal Capacity of the cell necessary for the load cell. With this, we can restrict the number of possible models from which to choose.

The working environment, together with other considerations and the Nominal Capacity will help us to choose the model.

Selection of the Nominal Capacity:

The aim is to estimate the real load on each supporting point in all operating circumstances and life of the system, including extreme situations, and choose a load cell with a suitable capacity and enough safety margins.

The capacity of a load cell is determined in the following way:

- **Dead Load**: Estimate the dead load of the structure, tank or silo, including all its elements: pipes, pumps, motors, agitators, insulators, heating fluids and accessories.
- **Product Weight**: The capacity and maximum range of the scales or the weight of the product must be known.
- **Gross Weight**: It is the addition of the **Dead Load** plus the **Product Weight**.
- **Number of Supports N**: It is the amount of supports on which the weighing structure, tank or scales is supported. It usually has from 3 to 6 supports.
- The theoretical load per support is the result of dividing the Gross Weight into the Number of Supports.
- Select a load cell with a nominal capacity higher than the theoretical load per support according to:

Cell Nominal Capacity = k x Gross Weight / N

Where k has a value between 1,25 and 2,2 , as safety coefficient to increase the capacity of the cells between 25% and 120% of the theoretical value, according to the presence of static or dynamic loads, vibrations, asymmetries, effect of the wind, impacts or rolling loads.

A good choice for static loads in indoor tanks is to use **k= 1,5** and round up a nominal capacity of a commercial cell.

Examples of common applications:

3 supports interior tank	**k = 1,3**
4 supports interior tank	**k = 1,5**
Tank with agitation (moderate)	**k = 1,7**
4 cell platform	**k = 1,8**
Bridge scales for weighing trucks of 6 or 8 cells	**k= 2**

Note: When the Dead Load is over 50% of the Gross Weight, it is recommended to increase the safety margin to **k=2**, as it is usually due to large motors, accessories or heating systems and very probably, there exist non-centred and not uniform loads on the supporting points.

Note: Alter instalation it is important to check the load distribution for each bearing point.

Generally, the load cells may be over-dimensioned up to over twice the weight of the product without any loss of accuracy. It is very common in scales and the only thing to bear in mind is that the sensitivity of the electronic indicator used or the micro-volts per division is enough.

Environmental issues

It is very common that there exist various models of load cells of the same nominal capacity and so, the most suitable for the concrete environmental working conditions should be chosen:

- For corrosive environments or in presence of permanent humidity, it is recommended the stainless steel load cells, instead of aluminium or nickel plated steel.
- The degree of environmental protection increases with the choice of hermetically sealed load cells with a welded capsule.
- For potentially explosive environments, there also exist specific load cells.
- Verify the need of additional safety elements for those areas with special requirements against earthquakes or strong winds.

Final check:
Finally, try to answer the following questions and correct the nominal capacity of the cell if necessary:

- Is the value of the Dead Load exact?

- Can the load be distributed non-uniformly?
- Are there any agitations or impacts?
- Is it possible that the tank has a superior capacity and it may overflow exceeding thus the estimated Product Weight?
- Is there the possibility of strong winds or earthquakes in the area?
- Can a vehicle impact on or overload the system?
- Can you asure a good leveling for obtaining a good load distribution for each bearing point after the instalation?

14/03/09

The scale does not repeat weight

When the scales do not repeat the value of the weight, experience tells that it is almost certain that there exists a mechanical problem, of rigid anchoring, of flexions in the structure, of unstable bases or frictions. A weighing system must have a firm base, a rigid weighing structure and a certain freedom of movements in its joints. If this is not so, it will not repeat and, as a consequence, perhaps it will not return to zero either.

Identify and separate clearly the weighing area and the rest of the structure. The weighing area supports itself exclusively on the load cells and should be able to go up and down freely. There must not be another contact between both areas except the load cells, without any friction.

The cells are almost rigid, but they have a necessary flexibility. They are deformations that can hardly be seen, therefore, check the following:

- That the load is applied on the right area of the cell. Normally, the load is placed on a dimple or load groove, or around the load drill and must not be placed on the general surface of the cell (back or areas sensitive to deformation or parts with silicone, etc.).
- That the assembly accessories are suitable and are properly assembled.
- That the bases of the load cells are firm, without movement or flexions.
- That the area around the load cells is clean and there is no accumulated dirt.
- That there are no excessive flexions in the weighing area (weak weighing platforms, bent tank legs).
- That the pipes connecting the tanks are flexible.
- That the lift-off or overload bolts do not create a friction or block it from moving.
- That no rigid anchoring has been used in both extremes of a cell. It is not advisable to place the load on the cell and fasten it with rigid bolts. There must be a joint, silent block flange, ball support, enough space between them, etc.
- That the load arrives in the orientation for which the load cell is designed, with no lateral forces in other directions or torsion moments.

Try to disconnect momentarily the joints or feed pipes of the tank in order to verify once more the repeatability of the scales.

Verify the correct adjustment of the corners by loading with the same weight on different points of the scale, platform or tank. Adjust it by means of a summing box with fine tuning if necessary.

14/03/09

The no-load output signal of the load cell is high

The output signal without load or zero level from factory is usually of a 2% value of the Full Scale (F.S). So, for a cell of 2mV/V of nominal sensitivity it is a value of ±0,04 mV/V or ±0,4 mV, supposing that we are feeding the cell at 10V. However, if the zero signal value observed in a used cell is still inferior to 10% F.S., that is to say, inferior to ±2 mV feeding at 10V, and it still keeps stable, the cell usually works and it is enough with carrying out a new calibration of the zero of the instrument (scale).

However, in case of finding a zero displacement, it must be questioned if, when using the application normally, there are shocks, mechanical overloads or perhaps it is already a fatigue. If this is the case, change the cell and protect the installation or apply any other remedy to prevent the problem from happening again.

Special attention must be paid to cells of very low nominal capacity, inferior to 10kg, where at the moment of assembly, handling and/or fastening of anchoring bolts, it may overload and displace them from zero just by the mere force of the hand remaining easily "bent".

14/03/09

The signal is unstable

- Verify that the power source is in good conditions and it is stable.
- Connect another load cell to check.
- There may be a humidity problem in the connections, wires, summing box or inside the cell.
- Measure the insulation between the coloured wires and the body of the cell.
- If there is humidity in the summing box, you may try to dry it using a hair drier.
- If there is humidity in the cell, you may try to dry it by keeping it 24 hours in a dry oven at about 50°C.
- Check the choice of the cell in regards to environment.
- As much as possible, reduce the humidity potential of the installation. Protect it against high pressure jets by means of screens and ensure a good drainage.

09/01/09

The input resistance of a load cell is higher than normal

All the load cells exit the factory individually verified and have individual compensations with different values of their resistances within an input and output range of resistance values. A significant increase of the input resistance indicates that there has been a change in the electric circuit in respect to the moment of its manufacturing. In this case, the cell is damaged. The inner damage is probable due to the breakage of one of its inner resistances, either in the component or in its connections, soldering or connecting wires. It is not possible to determine the cause accurately, whether it is due to an external agent or a manufacturing fault. In both cases, faults may be produced or defects may accelerate for external reasons, such as shocks, mechanical or electrical overload (electrostatic or lighting discharge). In some cases, the load cell keeps working but with a different gain or sensitivity to the original.

14/03/09

Differences between a steel load cell and an aluminium one

There are load cells of the same shape appearance, but made of different materials, as steel or aluminium. Both may even have similar accuracy, repeatability and linearity characteristics but not the same mechanical resistance to overload, shocks or fatigue.

In order to reduce costs in manufacturing, different aluminium alloys may be used and they bear good results in regards to accuracy but they have the disadvantage that they are much weaker than the ones manufactured of steel alloy, in the sense that if certain stress levels are exceeded, the cells are more easily deformed and undergo displacements of the output signal. Therefore, they are also weaker in front of overloads and much more sensitive to shocks. Furthermore, they wear out more easily with dynamic loads and last less.

Therefore, in case the choice is an aluminium load cell, precautions should be increased in overload stoppers and choose load cell nominal capacities with a higher over-dimension in respect to the applied load than for a steel load cell.

The aluminium load cells are usually used in great consumption applications because they save costs in great series, where the scales designing team may have studied, project, over-dimension and test this solution properly in order to avoid problems.

For industrial weighing processes, of little production, it is safer and more reliable to directly use versions of cells made of high resistance steel alloys.

Also, to mention that there exist other materials with a very high resistance to fatigue, as the Beryllium-Copper, but very seldom used due to its high cost. Currently, they are only justified in high fatigue applications.

05/12/08

Can we be supplied with information about the type of steel or certificate of the material the load cells are made of?

As a company general policy, we do not supply information about the steel alloys used in the manufacturing of our load cells. For years, we have invested a continuous effort in the selection of the best types of steel for the manufacturing of our load cells, including the selection of the best alloys, manufacturing processes and thermal treatments supplied by international suppliers. Steel is an art! This is the reason why we beg your comprehension in regards to the fact that we consider this information as an internal and confidential “know how” asset.

09/11/11

What is the v_{min} parameter of a load cell?

In order to define the metrologic characteristics of a load cell, in general, the standard developed by OIML (International Organization of Legal Metrology) is used, which in the case of a cell is the OIML R60 recommendation “Metrological regulation for load cells”.

According to those recommendations, the v_{min} parameter is the “Minimum load cell verification interval”, which is the data supplied by the manufacturer of the cell to indicate the recommended minimum size in order to define the size of each division or resolution of the load cell.

The v_{min} value is in units of mass (weight). Usually, v_{min} is a value between 6.000 and 10.000 fractions of the nominal capacity of the load cell.

This data can be used by the manufacturer of the scale to validate if the chosen division for the specific scale is compatible with the minimum division that the load cell can supply, according to the following formula:

$v_{min} \leq e / \sqrt{N}$ or $e \geq v_{min} * \sqrt{N}$

being,

e the verification scale interval or division of the scale
N the amount of load cells in the scale

11/12/12

What is the precision that I may expect from a weighing system?

The precision that we may expect from a weighing system is the highest value obtained between the two following calculations (a) and (b):

(a) Limit by minimum division of the load cell (related to repeatability):

$e_{min}(rep) = v_{min} * \sqrt{N}$ **(a)**

Being,
$e_{min}(rep)$ =minimum error that can be obtained by the minimum division of the cell
v_{min} = the minimum load cell verification interval
N = number of load cells

(b) Limit by range of use of the cell (related to linearity):

$e_{min}(lin) = Max / n_{lc}$ **(b)**

being,
$e_{min}(lin)$ =minimum error that can be obtained by range of use of cell
Max = Net product weight
n_{lc} = number of load cell verification intervals

Result: e_{min} = the highest of $e_{min}(rep)$ o $e_{min}(lin)$

Recommendation:

The precision is the error. The resolution or division of “display” is the fraction that is displayed. In certified scales, the resolution or division of display should not be finer than the error of the instrument itself. In certain industrial environments, an increased resolution is used, twice as fine than the real error or the precision of the system.

Examples:

Ej. 1) Normal scale
Data of the weighing system:
Product Max= 600 kg
Dead Load DL = 120 kg
Total Load = 720 kg
Supports N = 3

Data of the Cells:
3 units Model 350 i 500 kg
E_{max} = 500 kg
n_{lc}= 3000 divisions
$v_{min} = E_{max} / Y = 500 / 10.000 = 0,05$ kg

Calculations:

(a) Limit by minimum division of cell (related to repeatability):

$e_{min}(rep) = v_{min} * \sqrt{N} = 0,05 * \sqrt{3} = 0,0865$ kg

(b) Limit by range of use of cell (related to the linearity):

$e_{min}(lin) = Max / n_{lc} = 600 / 3000 = 0,2$ kg

Result:

$e_{min} = 0,2$ kg

For these scales we shall choose a display resolution of d = 0,2 kg

Ej. 2) Scale with quite a lot of dead load in respect to the weight of the product
Data of the Weighing System:
Product Max= 400 kg
Dead Load DL = 320 kg
Total Load = 720 kg
Supports N = 3

Data of the Cells:
Model 350 i 500 kg
E_{max} = 500 kg
n_{lc}= 3000 divisions
$v_{min} = E_{max} / Y = 500 / 10.000 = 0,05$ kg

Calculations:

(a) Limit by minimum division of cell (related to the repeatability):

$e_{min}(rep) = v_{min} * \sqrt{N} = 0,05 * \sqrt{3} = 0,0865$ kg

(b) Limit by range of use of cell (related to linearity):

$e_{min}(lin) = Max / n_{lc} = 400 / 3000 = 0,133$ kg

Result:

e_{min} = 0,133 kg

For this scale we shall choose a resolution of display of d = 0,2 kg in an environment of certified scales for commercial transactions or also the smaller d = 0,1 kg for an environment of industrial control.

Ej. 3) Scales with a great amount of dead load and very little product weight

Data of the Weighing System:
Product Max= 220 kg
Dead Load DL = 500 kg
Total Load = 720 kg
Supports N = 3

Data of the Cells:
Model 350 and 500 kg
E_{max} = 500 kg
n_{lc}= 3000 divisions
$v_{min} = E_{max} / Y$ = 500 / 10.000 = 0,05 kg

Calculations:

(a) Limit by minimum division of cell (related to the repeatability):

$e_{min}(rep) = v_{min} * \sqrt{N}$ = 0,05 * √ 3 = 0,086 kg

(b) Limit by range of use of cell (related to the linearity):

$e_{min}(lin) = Max / n_{lc}$ = 220 / 3000 = 0,073 kg

Result:

e_{min} = 0,086 kg

For these scales we shall choose a display resolution of d = 0,1 kg.

22/05/09

How to calculate the signal that a load cell delivers by division (µV/div)?

The signal that one or several cells of a weighing system deliver for a specific increase of load, normally the display division, is:

$\Delta u = (C * 1000 * U_{exc} * e) / (N * E_{max})$

Where,

Δu = Increase of signal in µV/div (micro-volts/division)
C = Nominal Sensitivity of the cell in mV/V
U_{exc} = Excitation Voltage of the cells in V (Volts)
e = Size of the division in kg
N = Number of load cells
E_{max} = Nominal capacity of the cells

Typical values:

Δu = 0,8 a 5 µV/div (micro-volts/division)
C = 1 a 3 mV/V (milli-volts per volt)
U_{exc} = 3 a 12 V (Volts)
e = 0,001 kg a 100 kg
N = 1 a 10
E_{max} = 1 kg a 400.000 kg

Examples:

Ej. 1) Scale of Max range=15 kg, division e=0,005 kg (5g)
N = 1 cell of E_{max} = 20 kg, C= 2mV/V
Load Cell Excitation U_{exc} = 10 Volts

$\Delta u = (2 * 1000 * 10 * 0{,}005) / (1 * 20) = 5$ µV/div

Ej. 2) Same example as Ex.. 1) but with Load Cell Excitation at U_{exc} = 5 Volts

$\Delta u = (2 * 1000 * 5 * 0{,}005) / (1 * 20) = 2{,}5$ µV/div

Ej. 3) Scale of Max range= 600 kg, division e=0,200 kg
N = 4 cells of E_{max} = 500 kg, C= 2mV/V
Load Cell Excitation U_{exc} = 5 Volts

$\Delta u = (2 * 1000 * 5 * 0{,}2) / (4 * 500) = 1$ µV/div

Ej. 4) Scale of Max range= 1500 kg, division e=0,5 kg
N = 4 cells of E_{max} = 750 kg, C= 2mV/V
Load Cell Excitation U_{exc} = 6 Volts

$\Delta u = (2 * 1000 * 6 * 0{,}5) / (4 * 750) = 2$ µV/div

Ej. 5) Same scale as Ex..4) with slightly bigger cells:
N = 4 cells of E_{max}= 1000 kg, C= 2mV/V
Load Cell Excitation U_{exc} = 6 Volts

Δu = (2 * 1000 * 6 * 0,5) / (4 * 1000) = 1,5 μV/div

Ej. 6) Truck weighing type scale of a Max Range of =60.000 kg, division e=20 kg
N = 6 cells of E_{max} = 20.000 kg, C= 2mV/V
Load Cell Excitation U_{exc} = 10 Volts

Δu = (2 * 1000 * 10 * 20) / (6 * 20.000) = 3,3 μV/div

Ej. 7) Truck weighing type scale of a maximum Range =60.000 kg, division e=20 kg
N = 8 cells of E_{max} = 30.000 kg, C= 2mV/V
Load Cell Excitation U_{exc} = 6 Volts

Δu = (2 * 1000 * 6 * 20) / (8 * 30.000) = 1 μV/div

Recommendation:

As we have seen in the examples above, the signal values that the cells deliver per each "display" division are very small; between 1 and 2 μV/div. Therefore, specific high sensitivity electronic instruments should be used for the load cells, that have super-stable power supply voltages, stable differential amplifiers, high resolution analog-digital converters of between 16 and 24 bits and filters and suitable protections.

The shielding of the conduit of the cell wires and a grounding of the complete system will help to protect these weak signals in environments with interferences, such as the industrial ones.

16/3/09

Some Good Practices in regards to load cells

- Select the correct nominal capacity of the load cell, which should be higher than the maximum load operative in the installation. Do not load them over their nominal capacity.
- Select the Model of load cell suitable for the application and the environment.
- Be aware that a cell is a delicate sensor, both electrically and mechanically. Its choosing and installation should be carried out only by professionals of the sector. Take precautions for the safety of the system. Do not allow that the safety of people or things depends on the mechanical resistance of a cell or of the signals delivered by a cell. Properly over-dimension and use the safety external elements that you consider necessary.
- Use the cell accessories designed by the manufacturer for the specific cell.
- Assemble the cells and/or accessories on a clean, flat, solid and strong surface.
- Design suitable protection elements against mechanical overloads, wiring protection, problems with rodents and any other risks.

- Avoid temperature gradients in the load cell. Temperature must be stable all through the body of the cell. If there is a heat source nearby, insulate it by means of insulating plates in order to reduce the transmission or radiation of heat towards any part of the cell.
- Do not hold a load cell by the wire or pull it. Properly protect the wires in the installation.
- Protect both the scales and the load cell from shocks.
- Returns must be properly packaged against shocks.
- Do not open the load cells or try to repair them.
- Do not carry out welding tasks near the load cells.
- Keep the area where the load cell is installed clean.
- Have a suitable drainage system in the installation in order to avoid floods for a long time. Both the load cells as the wires must never be submerged for long periods of time.
- Do not strain the cells or submit them to force torsion moments, different of the ones in the main direction of measuring.
- Use a stable and free of noise power supply. Do not feed it with a higher voltage than the recommended one and prevent the load cells from overloads and electrical discharges.
- Do not set the electronic equipment to a higher resolution than the logical one available for the cell or higher than the necessary for the user of the application.
- Do not exceed any specification limit of the load cell or its accessories, nor of the usual practices of the sector.
- The above recommendations are just an orientation as general information and they are not the only ones to take into account. The person in charge of the installation should analyze the needs of each concrete case.