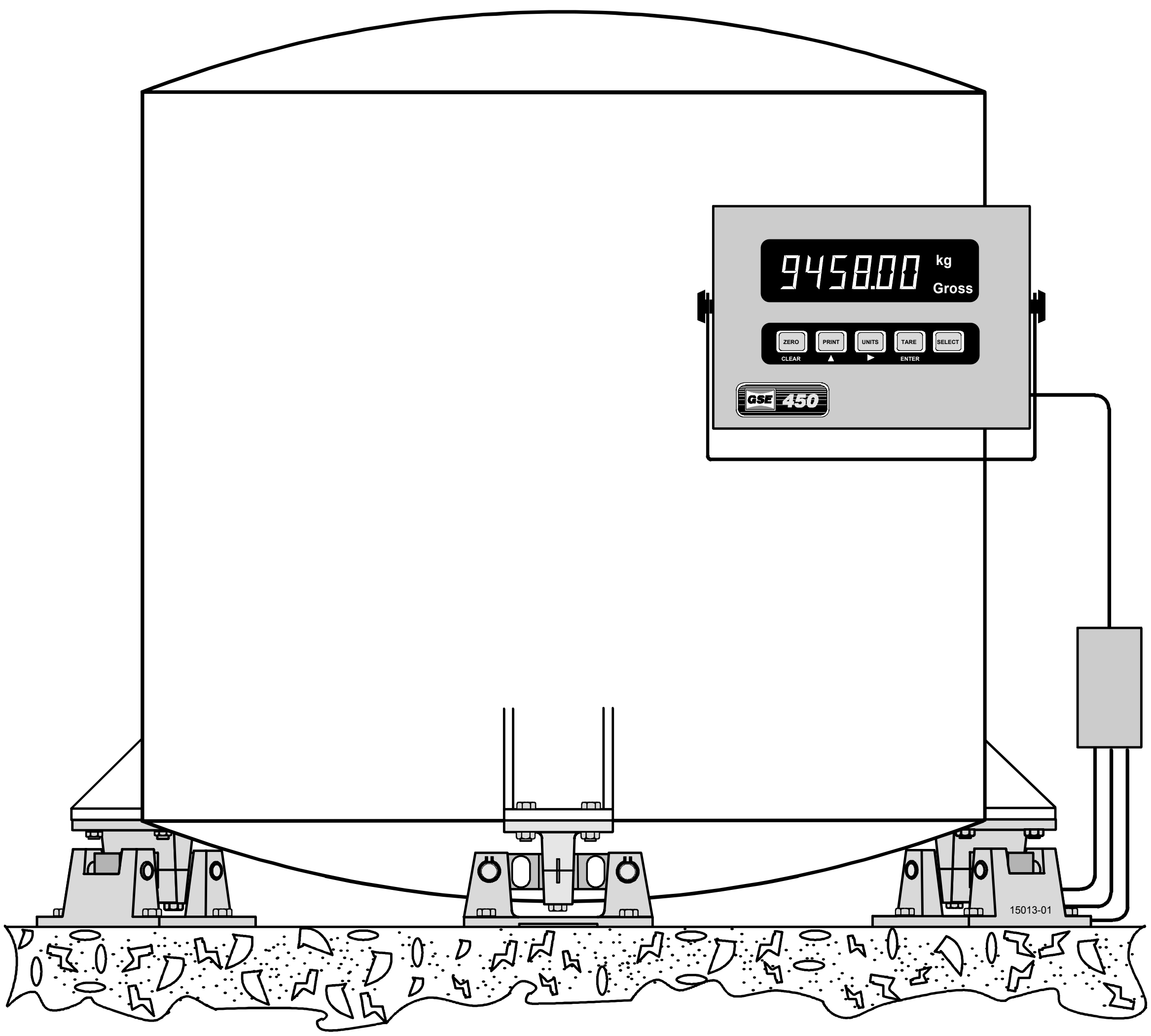
Vessel Weighing Guide

& LOADCELL MOUNT MANUAL

- ***A guide to weighing Tanks, Silos, Bins and Vessels, and the principles involved***
- ***Dos and Don'ts of Vessel Weighing***
- ***Selecting the right loadcells and indicator***
- ***Selecting the right capacity loadcells***
- ***Restraints and seismic protection***
- ***Wiring***
- ***Pipe-work***
- ***Installation manual for Pro Weigh loadcell mounts***



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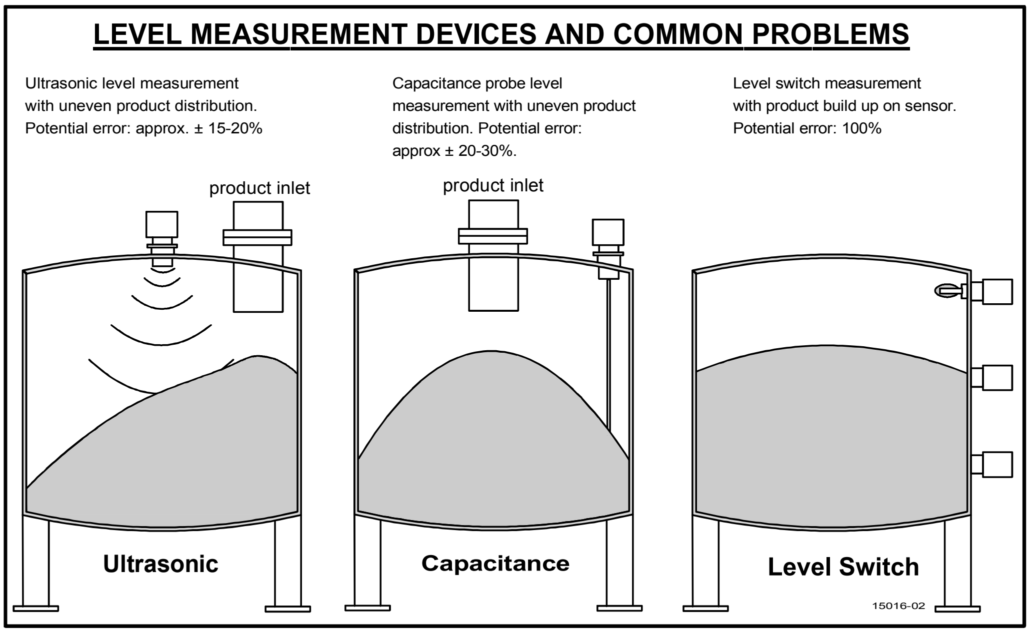
Introduction To Vessel Weighing

Why Weigh it?

Weighing verses other methods

For most vessels, weighing offers by far the most accurate way of measuring their contents. Where **accuracy** is the most important factor when deciding on a contents measurement system, then weighing is usually the obvious choice. Most other methods of measuring contents such as flow-meters, ultrasonic level, hydrostatic level, mechanical sensors etc all have quite severe limitations on repeatability and absolute accuracy, unless they are used in ideal situations.



Most of the above methods become unsuitable when measuring dusty bulk solids, bulk solids that do not sit evenly, bulk solids that *bridge* or *rat-hole,* foaming liquids, vessels with a non-linear centre-line, etc.

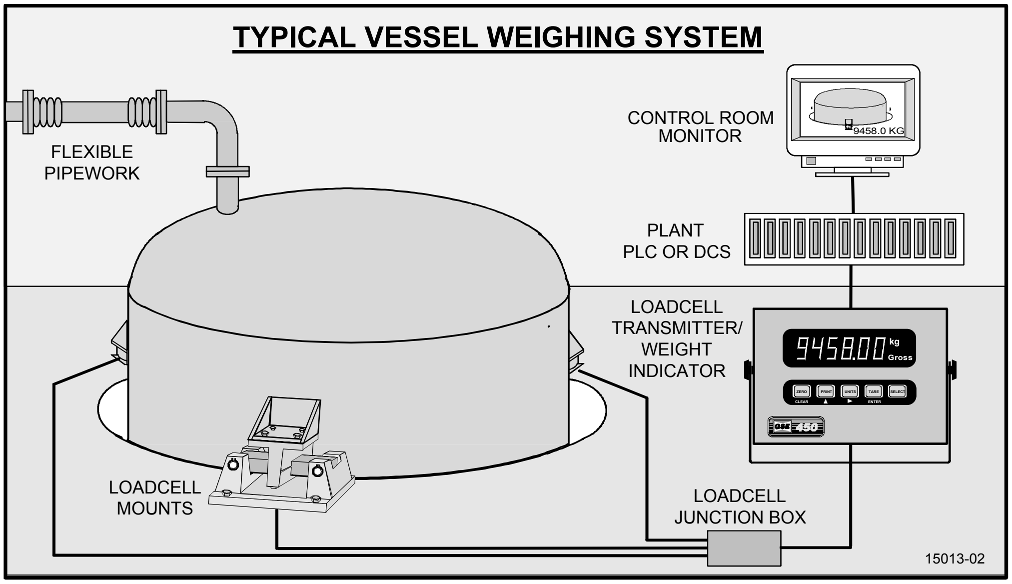
Weighing is a dependable, highly accurate, generally maintenance free, repeatable method of measuring the contents of bins, silos, vessels and tanks.

Pro Weigh loadcell assemblies are designed to provide any easy solution to Tank or Vessel Weighing. At the heart of an Pro Weigh loadcell assembly is of course, a loadcell. This is a strain gauge based transducer. When weight or force is applied to the loadcell, the strain gauges, which are bonded to the loadcell body, change resistance.

When connected to a loadcell transmitter or a weight indicator this change in resistance is converted to a millivolt output which is measured by the instrument. This output can be used to display a weight or converted into a signal to be transmitted to a computer or a PLC. Unfortunately, loadcells by themselves, do not provide a solution to vessel weighing. With compression loadcells, the vessel must be free to rest on a single point on the loadcell. With tension loadcells, the vessel must hang freely from the loadcell. The vessel must also be restrained from swinging or falling over. There are many ways of achieving this including physical stops and horizontal tie rods.

***Our loadcell mounts aim to remove these problems and provide a bolt-in solution*.**

Vessel Weighing: Quick Start



- **Decide on mounting arrangement. (See *Mounting considerations,* page 11)**
- **Calculate capacity of each loadcell. (See *Loadcell capacity,* page 14)**
- **Select the type of loadcell and mount. (See *About Pro Weigh loadcell mounts,* page 17)**
- **Select the type of indicator or transmitter.**
- **Order loadcell mounts, and weight indicator. (Phone Pro Weigh on *09 415 6500*)**
- **Manufacture mounting brackets. (See *Design of the mounting bracket,* page 13)**
- **Fit the loadcell mounts. (See *Installation, Mechanical,* page 17)**
- **Wire the loadcell mounts. (See *Installation, Electrical,* page 27)**
- **Choose a calibration method. (See *Calibration techniques,* page 31)**
- **Calibrate the installation.**

About Vessel Weighing

There are a lot of traps and potential causes of inaccuracies when weighing vessels. Some of these are listed below, along with other considerations to be taken into account when designing a weigh vessel.

Structural support and mounting arrangement

Careful consideration should be given to the support under the loadcell mounts. Poorly designed support structures and interaction with other loads on the structure is one source of weighing errors.

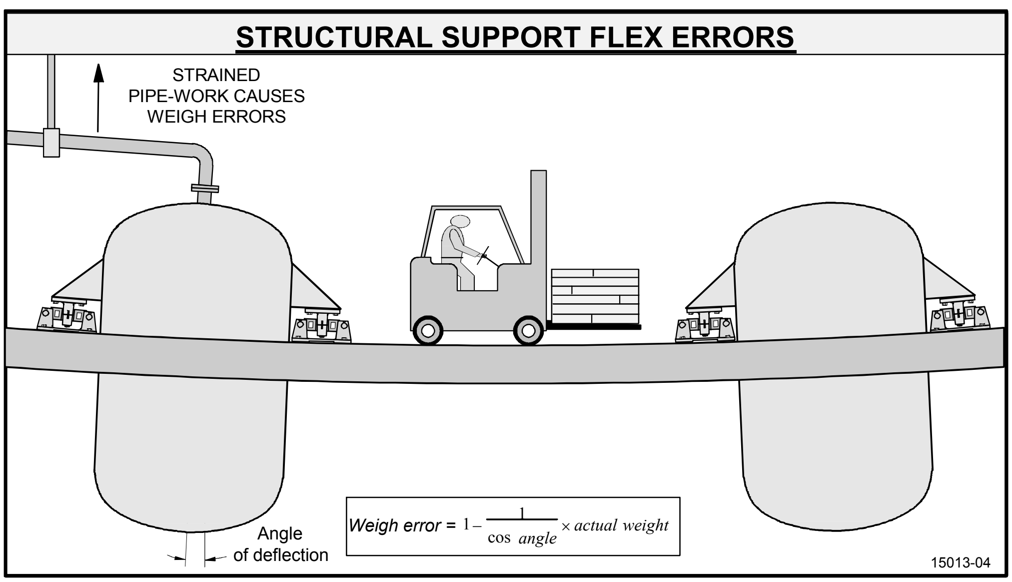
Support structures for weigh vessels

When considering support structures that support a weigh vessel, the following points should be noted:

1. Support structures must be rigid with low deflection. If inherent plant vibration causes low frequency "bouncing" due to a flexible structure, then the weight indicator will show this as a fluctuating display. A general rule is that the vessel supports should not deflect more than 12mm.
2. Structures should not deflect due to interaction with associated loads on the same structure that supports the weigh vessel. Excessive deflection can cause a shift in the weigh vessel's centre of gravity due to the vessel moving away from perpendicular. The weight error will increase with the angle at which the vessel is leaning. Error is equal to:

$$1 - \frac{1}{\cos\ angle} \times actual\ weight$$

(See drawing below) Deflection can also cause errors by putting loads onto attached pipe-work.



3. Structures should not deflect excessively between the full vessel state and the empty vessel state. Interaction with other vessels that cause structural deflection between their empty and full states must also be taken into account. Such deflections will cause similar errors to those in point 2.

4. When the weigh vessel is being mounted on a concrete pad, ensure that the concrete foundation is substantial enough to prevent subsidence, which can cause similar deflection errors as described in point 2 above.
5. Other connections to the weigh vessel can also cause problems. Catwalks, ladders, shared structural supports and mechanical restrictions may cause errors in weighing and must be avoided. These items should be isolated as far as is practically possible.

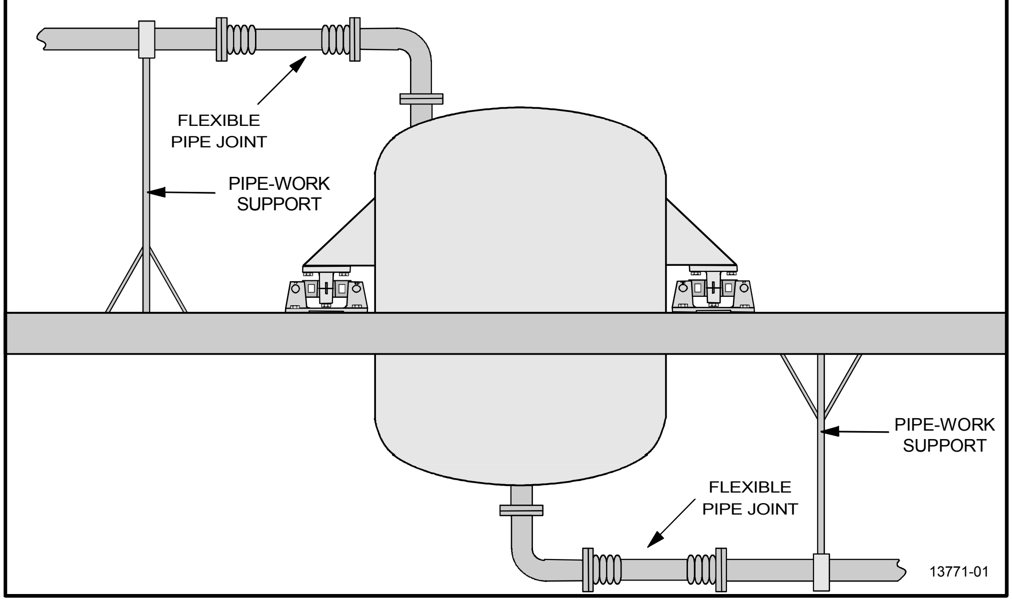
Pipe connections

A free-standing vessel fully supported by loadcells on firm supports has a weigh system accuracy approaching that of the loadcells and instrumentation alone, a value that can easily be below ±0.15%.

Experience has shown that the one major factor that most often compromises a weigh system's accuracy is the mechanical restriction arising from it's pipe-work installation.

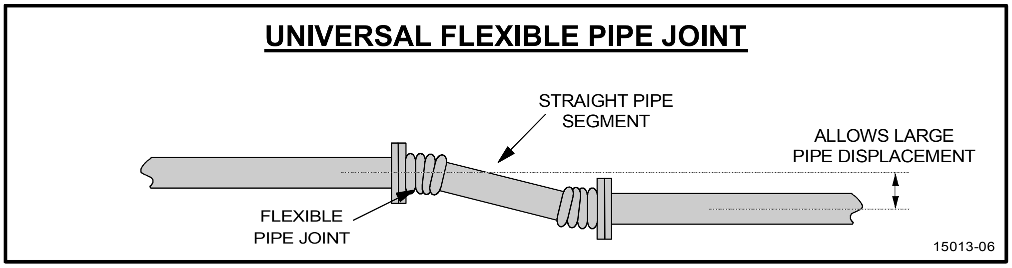
Pipe connections must be very flexible or non-contact. Pipes that are welded to the vessel and secured to a wall, ceiling or other vessel, will be a major cause of inaccuracy in vessel weighing.

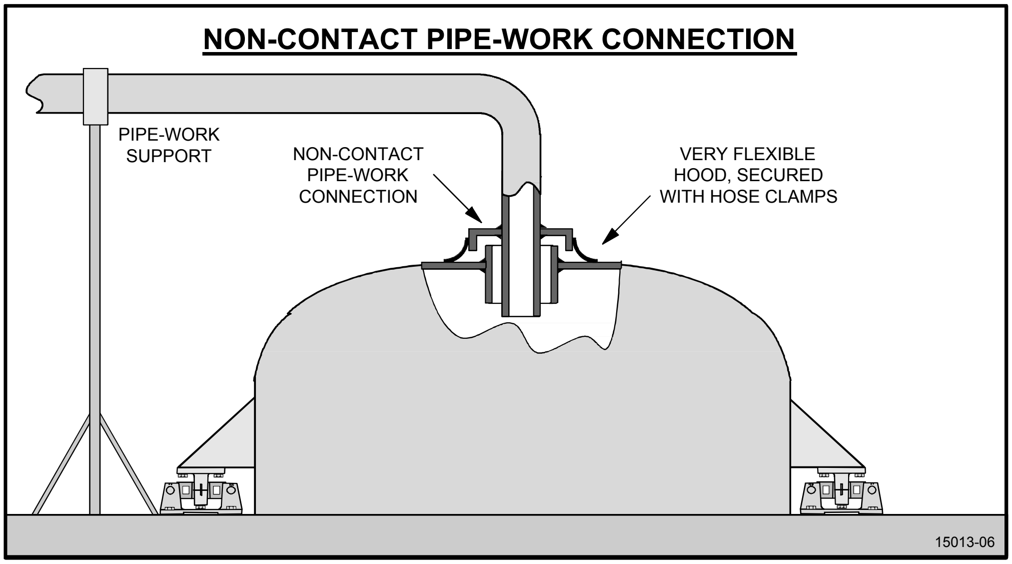
RECOMMENDED PIPE SUPPORT ARRANGEMENT



Pipe-work Tips for Weigh Vessels

- Use flexible joints in pipe-work connected to the vessel.
- Support the pipe-work from the same floor as the vessel rests on.
- Do not insulate flexible joints
- Allow at least 20mm space between pipes. (Remember to allow for lagging)
- Orientate pipe-work runs to the vessel in the horizontal plane to minimise forces created by expansion.
- Do not stretch or compress flexible joints to compensate for poorly aligned pipe-work.
- Do not use the flexible joints as supports when fitting the primary supports.





Mounting considerations

How Many Loadcells?

If possible, 3 loadcell mounts, equally spaced around the vessel, should be used. This automatically distributes the vessel weight evenly. (Apart from offsets caused by uneven vessel weight distribution).

If 4 loadcell mounts are used, the installation will involve shimming of the mounts between the mount and the vessel to ensure even weight distribution between the 4 mounts. This is described in detail under ***Shimming*** on page 12.

To determine the capacity of the loadcells you require please see ***loadcell capacity*** on page 14

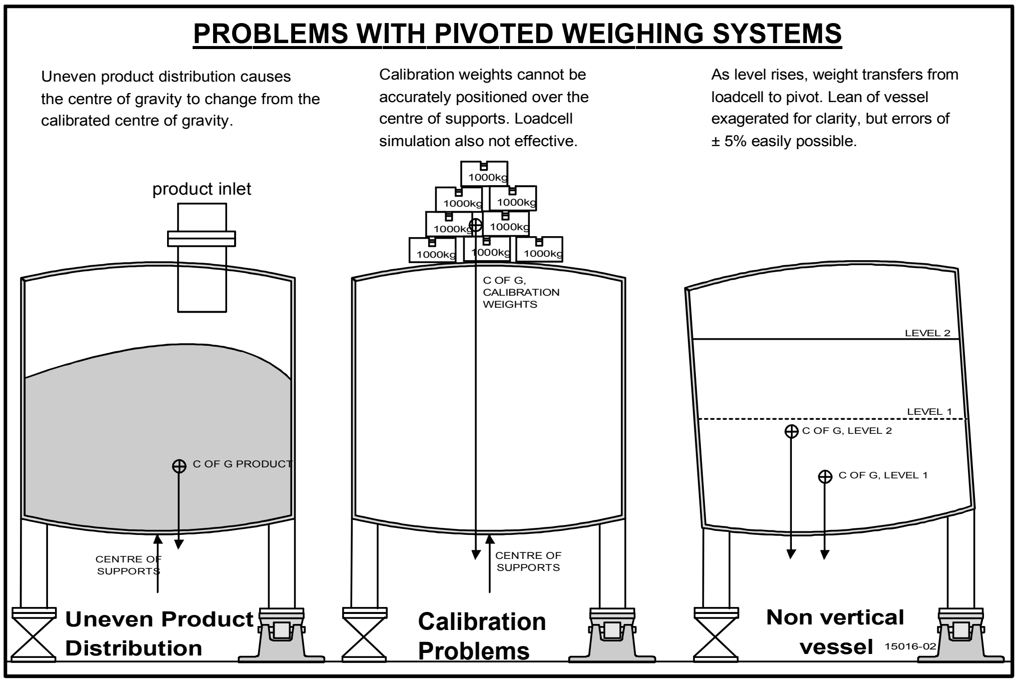
Pivoted Weighing Systems

Due to economic considerations (There are less loadcells involved), pivoted weighing systems, where one end of the vessel is pivoted and the other end is supported by loadcells, are popular in some industries. There are quite severe restrictions associated with these systems however, and an installation that gives reasonable accuracy with one product, may not necessarily provide it with another. The pivot point can be either a bearing, or a fixed structure that is designed to bend in one axis only, and provide restraint in the other direction.

Pivoted weighing systems can provide an economic method of low accuracy (say ±1%) weighing where:

- The vessel contents are self leveling.
- The vessel is symmetrical around a vertical line through the content's centre of gravity.
- The vessel is level and the ends are identical in shape.
- The vessel is inside and not subject to wind forces.

These restrictions ensure that as the vessel fills, the centre of gravity of the contents rises along a vertical line, whose location is fixed relative to the support points. These restrictions also practically limit this sort of application to liquid contents.



Other problems are:

- Wind forces are not compensated for, ie the wind does not add force to one leg and subtract from the other, as only one leg is weighed.
- The only satisfactory methods of calibration will be by measured weight transfer of product, or by filling the vessel with water through a certified flow-meter.

It is Pro Weigh's opinion, that the potential problems of this sort of system outweigh most benefits a weighing system offers.

Uneven vessel weight distribution

If the vessel weight or product weight is unevenly distributed, it means that one loadcell assembly will take more weight than the others. This must be taken into account when sizing the loadcell assemblies, so that the loadcell is not overloaded. Small amounts of uneven weight distribution (say 10% to 20%) are not usually a problem.

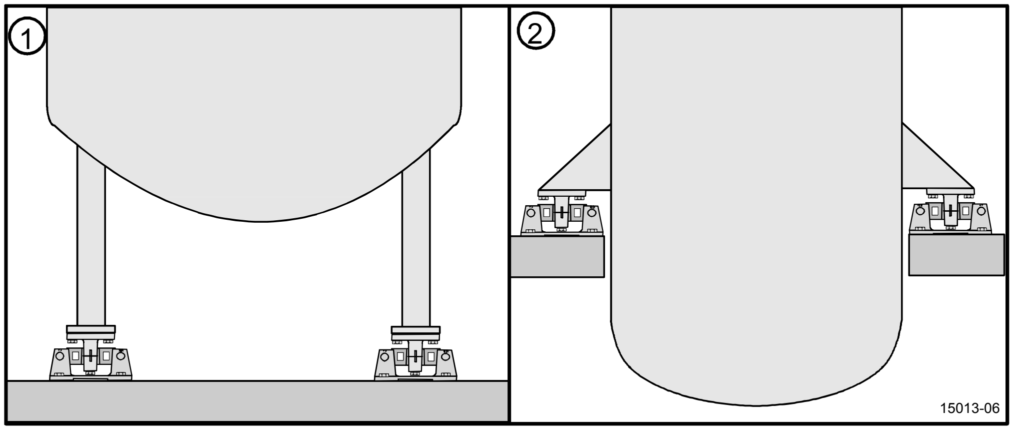
Beware of 4 loadcell installations where 2 of the loadcells take all the weight, and the other 2 take very little (ie the vessel is "rocking" across 2 loadcells). If the vessel structure is stiff enough, the 2 loadcells taking the weight can easily be overloaded. This can be overcome by shimming under the 2 low loadcells. (see *Mechanical installation, shimming*, P25)

Where to locate the loadcell mounts

The 2 most common places that loadcell assemblies are mounted, are:

1 Under the vessel's legs.

2 Between a gusseted bracket and a mezzanine floor.

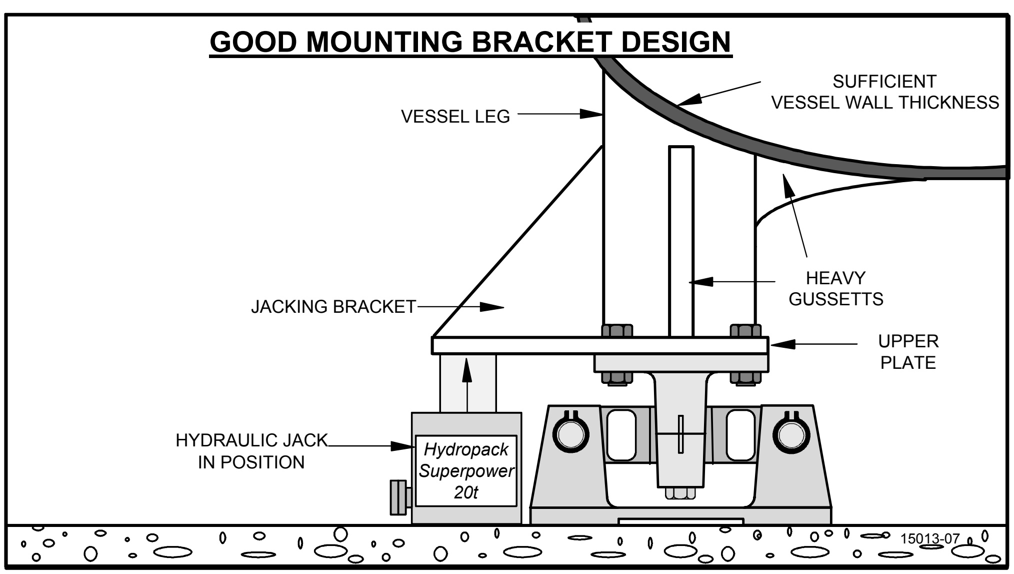


The second case is the best one, due to the natural stability offered by a low centre of gravity. Mounting the assemblies under the legs however, is perfectly acceptable.

Design of the mounting bracket

Some consideration should be given to the design of the mounting bracket where the loadcell mount is attached to the vessel. This may be at the bottom of a leg, or a bracket welded to the side of the vessel. If the bracket or leg is attached to the side of the vessel, ensure the vessel wall is sufficiently strong enough to withstand any bending force that may be exerted on it.

It is often a good idea to include a ***jacking point*** in the mounting bracket, to aid installation, and make any future maintenance an easier job. One suggested design is shown below.



Loadcell Capacity

To calculate the capacity of the loadcells required for the weigh vessel:

1. Determine the empty weight of the vessel. This is the weight of the tank when empty plus any piping, agitators, motors or any other permanent equipment If the vessel is jacketed, be sure to include the weight of any fluids introduced to the jacket.
2. Determine the live load of the vessel. This is the maximum capacity of the vessel with the heaviest product it accepts. It is not the “normal” or “usual” working weight.
3. Add these 2 figures to obtain the ***Gross Weight***.
4. Divide the gross weight by the number of structural support points. The resultant number is the required capacity for your loadcells.
5. If this capacity falls between 2 sizes of loadcell, (it almost always does) choose the greater capacity loadcell. This allows for any unequal weight distribution, or shock loadings which may result in one loadcell taking more weight than the others.

Example:

A vessel has an empty weight of 1500 kg, a live load of 12,200 kg and has 3 support legs. Maximum accuracy is required. The vessel is not heavily agitated, and is inside.

1500 + 12,200 = 13,700 kg. ÷ 3 = 4,566 kg capacity.

Solution: Use 3, 5000kg DSM Loadcell mounts.

Accuracy

Often, very high, and often unreasonable accuracy demands are placed on a weighing installation. The loadcells in a weighing system are sized to weigh the entire structure (dead weight) and the contents (live weight) and then have a small amount of emergency capacity left.

When accuracies are quoted for a loadcell, they refer to the capacity of the loadcell. When they are quoted for a system, they refer to the capacity of that system. For example, say a weighing system consists of three compression loadcell assemblies (type DSM) each of capacity 2272kg. Their quoted repeatability is ±0.03% FS. The total system capacity is 6816kg, so expected BEST CASE accuracies should be in the region of ±2kg.

Many users, think that these accuracy figures refer to their live load of their batch load. They do not. ***Accuracy figures with loadcells apply to overall capacity***.

These figures do not take into account any system inaccuracies. These may be caused by attached pipe-work, poor installation, dynamic forces and a myriad of other factors.

The biggest causes of system inaccuracies are:

1. Attached, rigid pipe-work.
2. Attached structures, such as ladders and catwalks.
3. Over-capacity loadcells.
4. Non-vertical vessels, and/or loadcell mounts.
5. The use of pivots on vessels with powders and granular products as contents.
6. Poor calibration procedure.

Welding

Extreme care must be taken when welding to a vessel fitted with loadcells. If even small currents pass through the loadcell, then it is possible to destroy the delicate strain gauges bonded to the loadcell body.

If the vessel must be welded on, it is best to remove the loadcell assembly. Blank or dummy assemblies are available from Pro Weigh to replace the loadcell assembly while welding is taking place.

If it is likely that the vessel is to be welded on frequently, then a heavy duty bypass cable may be fitted to the loadcell assembly. Contact Pro Weigh for details.

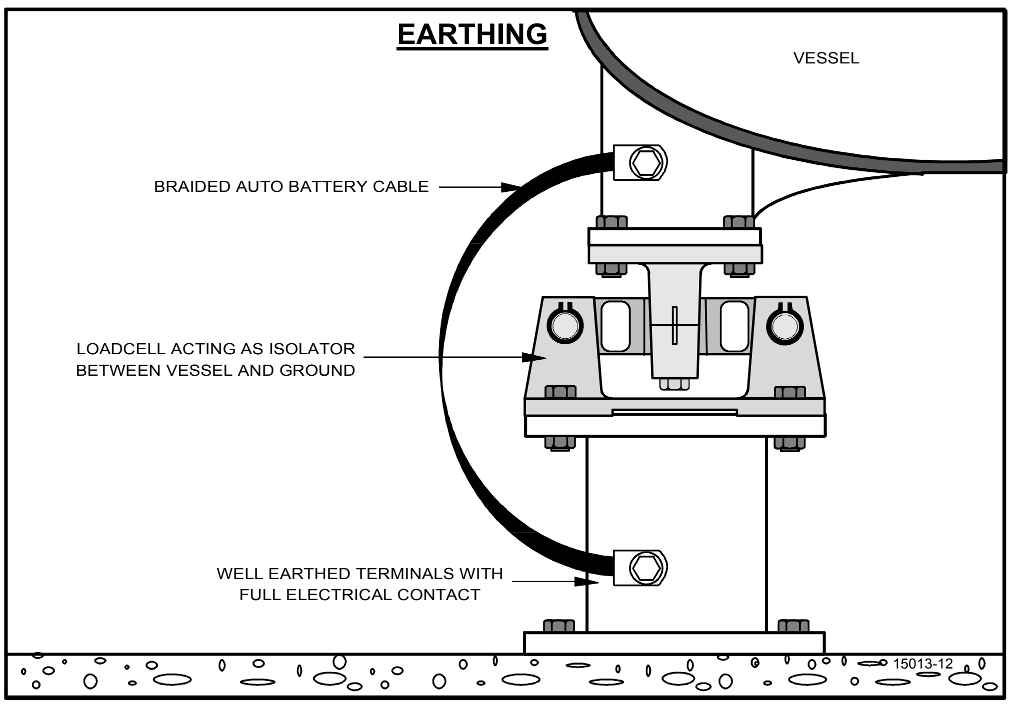
If the loadcell assemblies cannot be removed, then the welder earth clamp should be attached as close as possible to where the actual welding is taking place and as far away from the loadcell as possible.

Under no circumstances should welding be done where the welding current is passing through the loadcell

Earthing

Because the loadcells often form the only electrical path to earth for the vessel being weighed, earth discharge through the loadcells can be a common cause of damage to the loadcell for the same reasons as explained in the previous section. Although there may be no other electrical equipment on the vessel, just the action of filling and discharging the vessel, can build up a large amount of stored static electrical charge. If this discharges through the loadcell, expensive damage can result).

Heavy gauge, but flexible earth cabling should be used to electrically by-pass the loadcell. Auto-battery braided earth strapping is ideal.



The use of restraints

Where the vessel is subject to severe out of balance type forces, restraining rods may be required. Examples of vessels that would need restraints are:

- A vessel with a stirrer and high viscosity contents.
- A tall silo located outside and subject to high velocity winds.

With most vessel weighing applications, restraints are not required if using Pro Weigh DSM loadcell mounts. If in doubt, please talk to an Pro Weigh engineer.

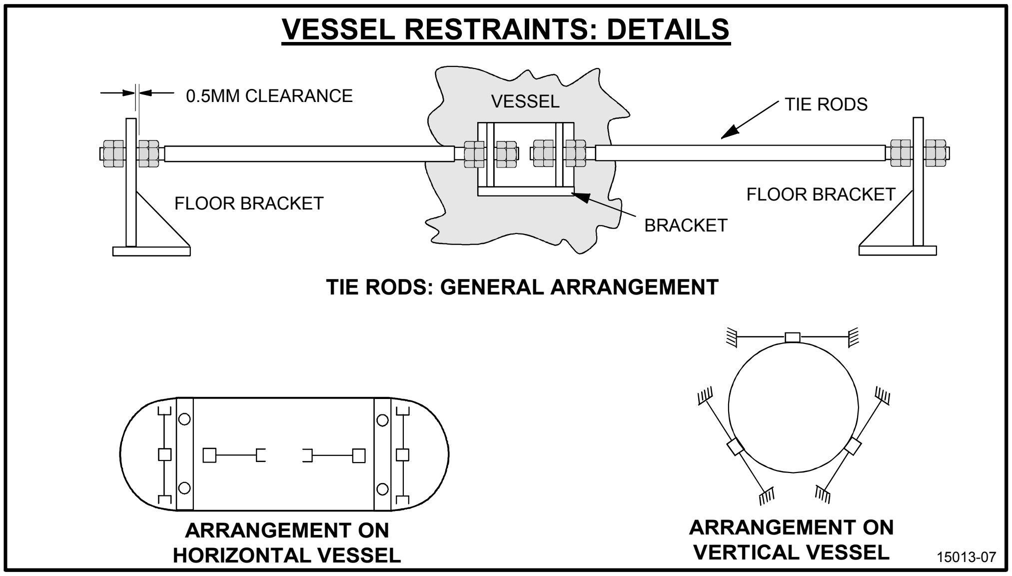
Restraints, in any form, must have 2 important features:

1. They must restrain the vessel from moving.
2. They must not interfere with the weighing of the vessel

Weigh vessel restraints generally come in the form of horizontally mounted tie rods that restrict the vessel's movement in the horizontal plane. Vertical restraints are also common, but are not required when using Pro Weigh loadcell mounts, which have in-built vertical restraints.

Generally, threaded tie rods are used to restrain weigh vessels. These should be sized according to the gross weight of the vessel.

The most important test with tie rods is that the tie rods must also be free to turn when the vessel is fully loaded. The 0.5mm gap between the nuts and the bracket (as shown below) is a guide only.

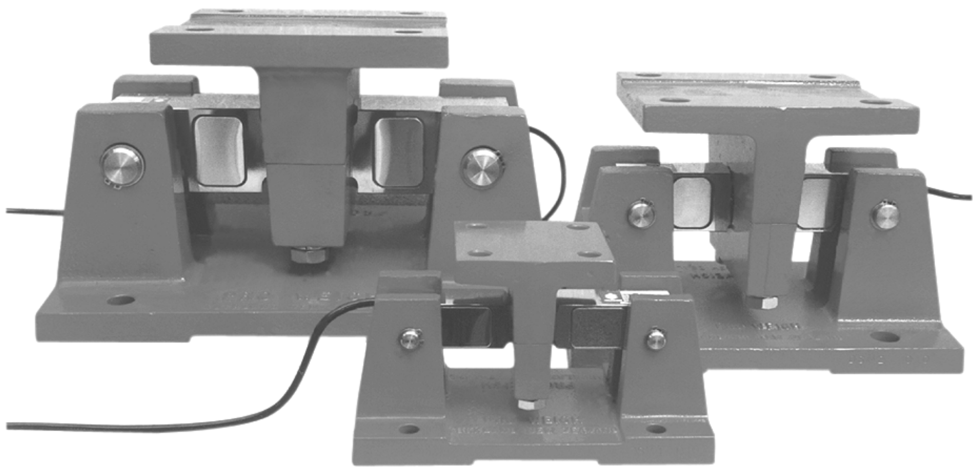


About Pro Weigh Loadcell Mounts

DSM type

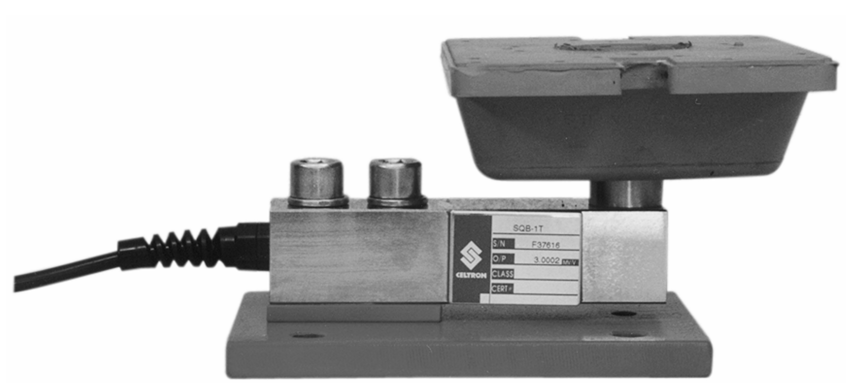
The DSM type loadcell mount is Pro Weigh's most accurate loadcell mount, and also has the widest range of loadcell capacities. The DSM mounts, which come in 3 different sizes, use a state of the art double ended shear beam loadcell in a cast iron or cast stainless steel mount. Capacities range from 450 kg to 34,000 kg.

The DSM mounts are used where high accuracy combined with heavy duty restraint is required.



SQB Type

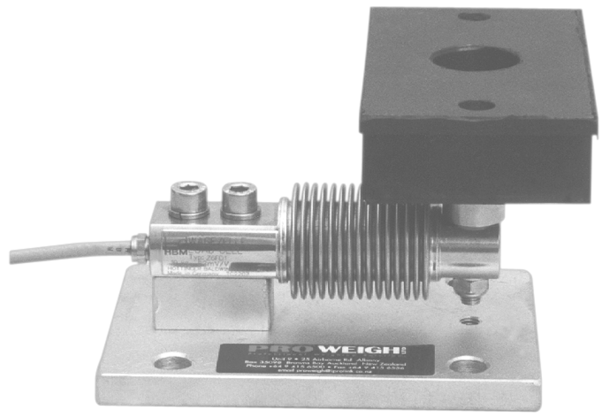
The Pro Weigh SQB loadcell assembly provides an accurate weighing solution for light duty installations. Capacities of 250kg, 500kg, and 1000kg are available. While the SQB mounts are not as rugged as the DSM mounts, they are less costly, and highly suitable for light duty, indoor weighing. They are suitable for weighing small hoppers and batch vessels, conveyors, intermediate bulk containers (IBCs), bulk bag weighing and so on. The flexible neoprene mounting pad allows for minor misalignment, thermal expansion and shock absorption. They are available in standard form with a nickel plated cell and powder-coated base, or with an optional IP67 welded seal stainless steel loadcell, stainless base and bolts, for wash down applications.



Z6M type

These mounts are Pro Weigh's light duty versions with capacities from 50kg to 500kg. They are all stainless steel wash-down type and utilise HBM Germany's legendary Z6 bellows type bending beam. These loadcells are hermetically sealed with welded seals. They are fitted with mechanical overload stops, and all stainless steel fittings.

Applications include light vessel weighing, conveyor weighing, batching applications bulk bag weighing and so on. They are ideal mounts for the food industry.



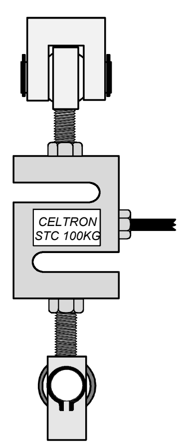
STC type loadcell assembly

Pro Weigh's STC loadcell assemblies provide a budget method of weighing smaller tanks and vessels by suspending them from *S type* loadcells.

The STC type loadcell assembly is designed to turn a standard Celtron STC *S type* loadcell into a self–contained vessel suspension weighing assembly. All too often *S type* loadcells are mounted incorrectly using threaded rod, or even bolting the loadcells solidly to beams. This sort of mounting arrangement will severely effect the performance of the loadcells, and they WILL NOT weigh accurately.

STC loadcell assemblies are not suitable for heavily agitated vessels, and should be used in conjunction with vertical and horizontal restraints.

STC LOADCELL MOUNT



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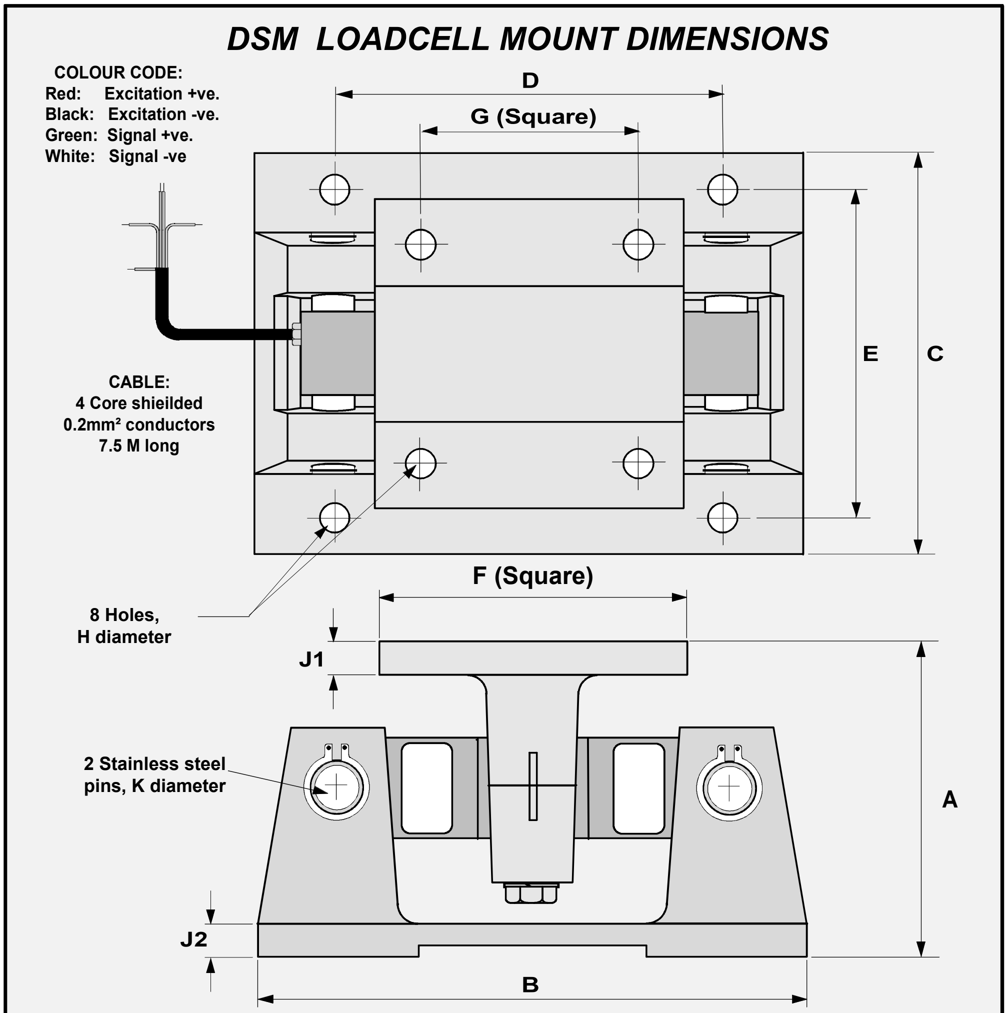
Installation : Mechanical

Installing DSM style loadcell Mounts

Your DSM loadcell mount is supplied with the top mounting plate free to move. When fitting the mount, ensure that the top plate is sitting in the middle of the loadcell and the loadcell is sitting in the centre of the horizontal pins. This allows maximum movement for expansion.

Upper Plates

Separate upper plates that have matching hole centres to the loadcell mounts must be welded to the vessel leg or support bracket. These can be fabricated by the end user, or can be supplied by Pro Weigh. These plates must be parallel and directly above the lower plate or floor. Dimensions of the DSM mounts are shown below



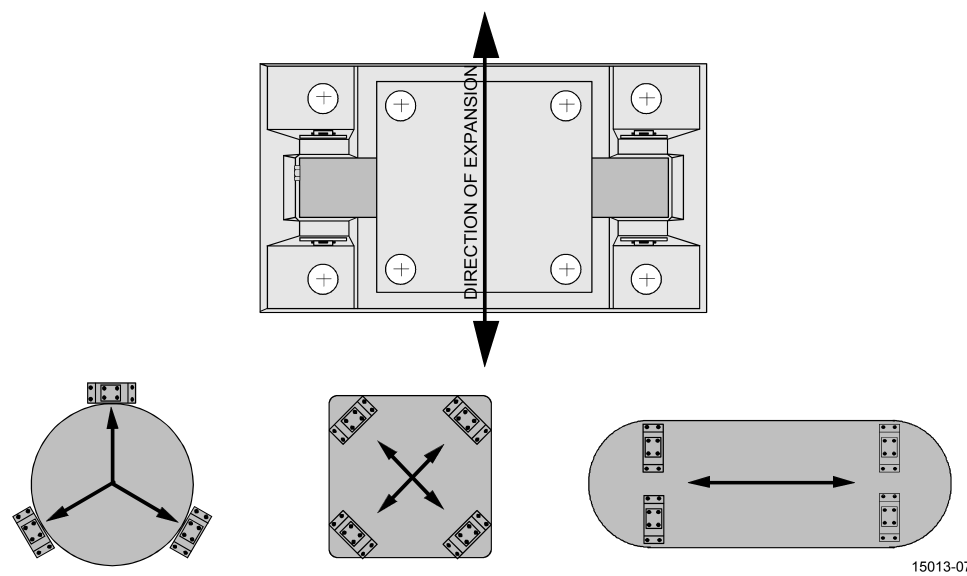
MODEL	A	B	C	D	E	F	G	H	J1	J2	K	CAPACITIES
DSM 1	130	235	125	160	100	100	70	13	16	20	12	450, 680, 900, 1130, 1360, 2270 kg
DSM 2	200	300	200	190	150	200	150	22	20	20	20	4500, 6800, 11300 kg
DSM 3	236	410	300	290	245	230	165	22	25	25	32	22700, 34000 kg

As an aid to welding the loadcell mount in place, Pro Weigh can provide a “dummy” loadcell mount (returnable) for a small deposit. This enables the top plate to be accurately positioned and the bottom holes to be accurately marked. Top and base plates that are pre drilled and tapped are also available from Pro Weigh.

Orientation of DSM loadcell mounts under the Vessel

The DSM loadcell mounts have the ability to expand and contract with the vessel. With this in mind, it is important that the DSM mounts are orientated correctly according to the type of vessel they are fitted to. The diagram below shows the correct orientation for a variety of vessels. If the vessel is heated, or is known to expand during normal process operation, install the loadcell mount when the vessel is cold and position the loadcell as far to the inside of the mount as possible by sliding it on its mounting pins.

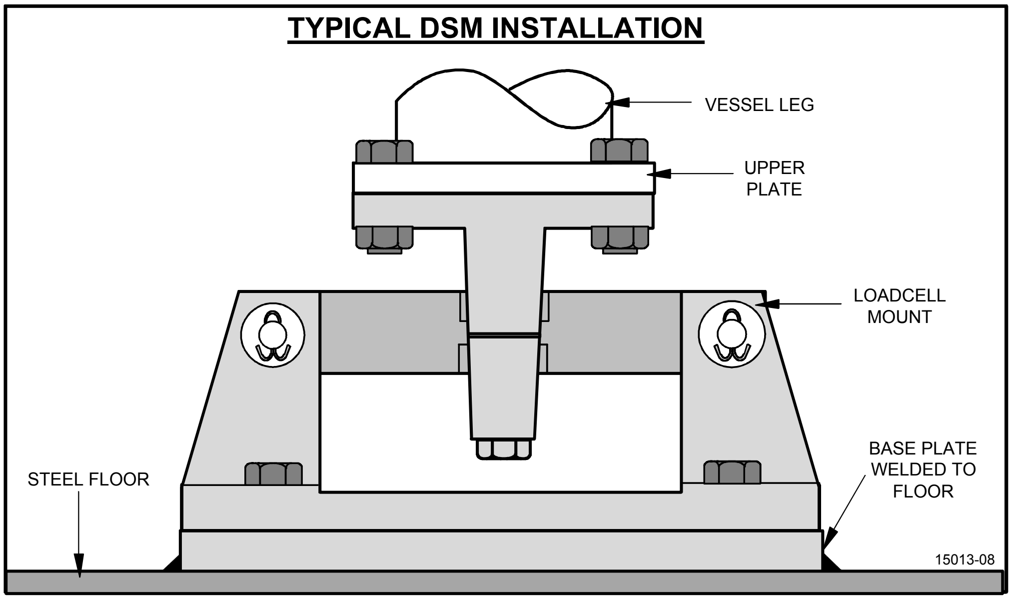
ORIENTATION OF DSM MOUNTS



Using the dummy loadcell mount

1. Bolt the upper plate and (if used) lower plate to the dummy mount.
2. Raise or jack the vessel evenly so that the dummy mount supports the leg or mounting bracket. The other legs or brackets should be supported to keep the vessel level.
3. Weld the upper and lower plates into position. If the mount is being positioned onto a concrete floor, carefully mark the hole positions.
4. Remove the dummy mount and support the leg or bracket with a timber block cut to the same height. If using multiple dummy mounts, leave the first dummy mount bolted in position and repeat process with other legs.
5. Fit the real loadcell mounts only when all welding is completed. A typical installation is shown on the next page.

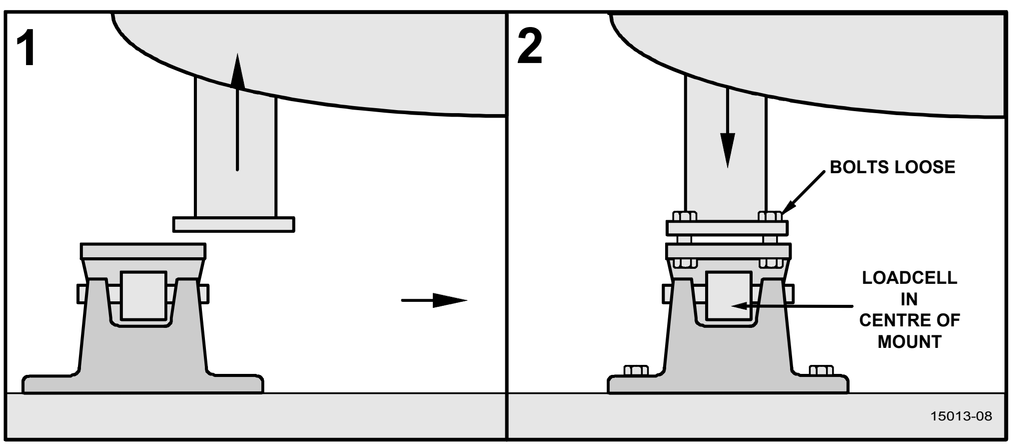
NOTE:	Any welding on the supported vessel or structure after the loadcell assemblies have been installed may cause irreparable damage to the loadcells. **DO NOT USE THE LOADCELL MOUNT AS A WELDING JIG**

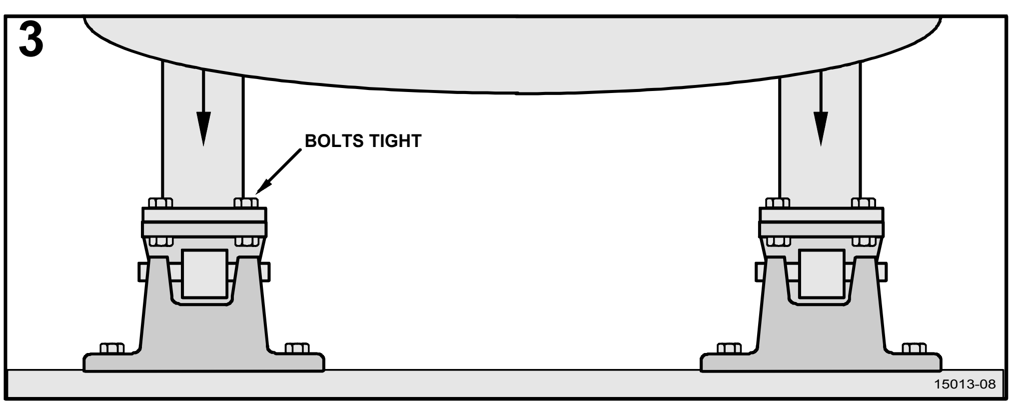


Installing The Loadcell Mount

This section assumes that the upper plates have been fitted and the lower plate (if used) is fitted. If a lower plate is not fitted then the concrete will have been drilled and fitted with dynabolts or similar. It is also assumed that the loadcell mounts are being bolted to a solid level surface. If the surface is not level please read the section on ***shimming***, page 25

1. Using a crane or jacks, raise the vessel sufficiently to fit the loadcell mount underneath the leg or bracket.





2. Place the loadcell mount in position, orientating the loadcell to account for vessel expansion. Install all the bolts and concrete fasteners. **DO NOT TIGHTEN YET**
3. Carefully lower the vessel <u>evenly</u> until all the loadcell mounts are supporting the weight. Tighten all the mounting bolts, checking that the loadcell is in the centre of the mount, and the top plate of the mount is square to the base.

Your weighing system is now ready for wiring.

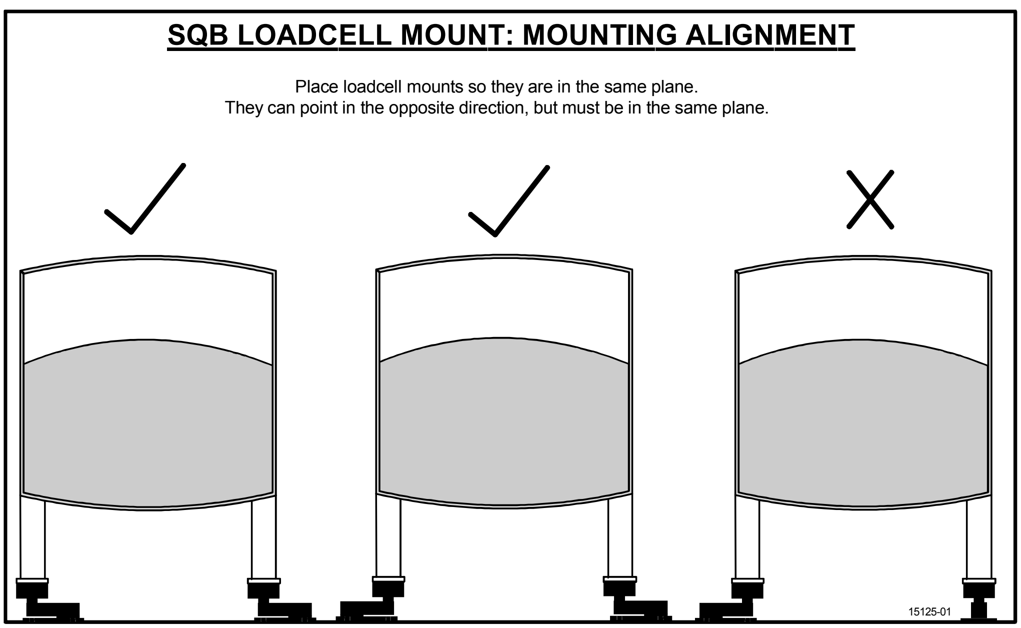
NOTE	Extreme care must be taken with the loadcell cable when completing an installation. It is easy to “nip” the cable between the loadcell mount and the mounting plates. This can cause major problems if water gets into the cable through the cut, or worse, the internal wires are severed.

Installing SQB and Z6M style loadcell Mounts

SQB and Z6M loadcell mounts have a flexible neoprene mounting pad that allows the loadcell to bend without restriction. It also compresses under load, so provision for movement with all process fittings must be allowed. This movement allows for expansion, and also gives some resistance to shock loadings

The SQB mounts should be installed in such a way that when they are bolted up, no extra stress is introduced into the mount. This means the mounting plate attached to the tank must be parallel to the ground surface.

The mounts should be arranged so that they are all in the same plane. (see below).



This means that the loadcells have equal pressure placed on them when load is applied.

Some thought should be given to weight distribution when mounting position is calculated. Although it is not necessary to have equal weight distribution, the weight placed on each loadcell should not exceed the stated capacity of the individual cell.

Any welding should be carried out before the loadcells are installed. Stray welding currents can destroy the strain gauge circuitry.

Ideally the loadcells should be positioned so that the loadcell cable points inwards, under the vessel. This leaves the cable area less exposed to mechanical damage.

Electrical Installation.

The loadcells should be connected in parallel to the supplied 4 loadcell junction card. Please refer to the circuit diagram #15124 located under section 3 of this folder.

The loadcell leads should not be cut to length as this changes the individual loadcell resistance, which can lead to corner errors. Coil the loadcell cables near the junction box.

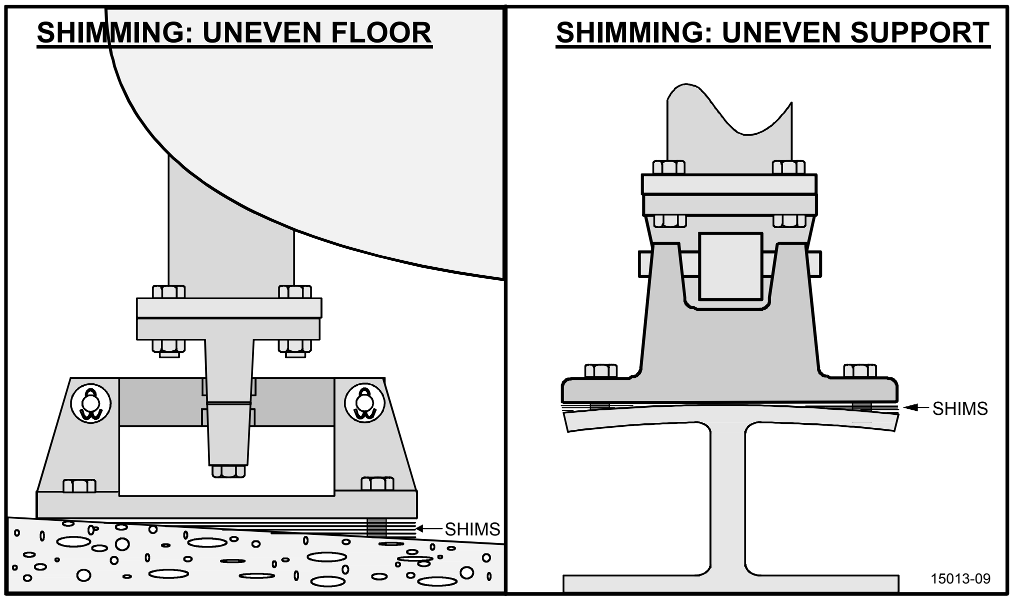
From the junction box to the GSE M350, 4 wire shielded cable should be used. The shield should be earthed at the indicator end only.

Shimming

Shimming for level

If the floor or steel-work that the loadcell mounts are bolted to is not level or flat, then shimming will be required. Flat steel or stainless steel sheet metal shims of 0.5mm, 1.0mm and 2.0mm thickness are good sizes to begin with.

The loadcell mounts should be shimmed so that they are level to ± 0.5°. The vessel itself should also be perpendicular to ± 1.0° to ensure equal weight distribution of the live load (contents) to the loadcell mounts.



Shimming for equal weight distribution

This applies mainly to vessels with 4 or more loadcell mounts. Vessels with 3 loadcell mounts that have been levelled, should provide automatic weight distribution. The aim is to get each loadcell mount bearing the same amount of weight.

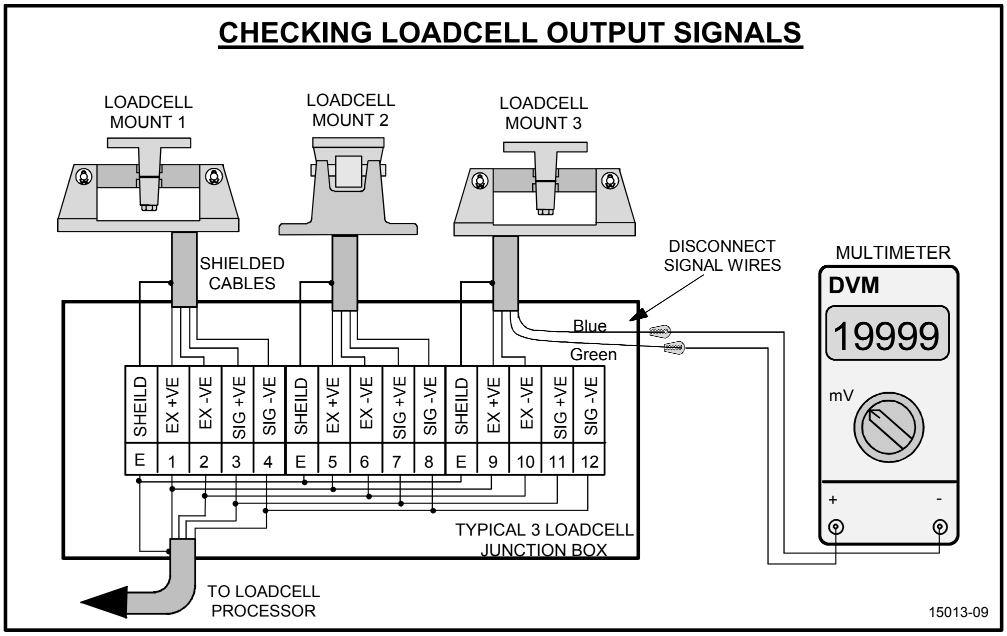
The loadcell mounts should be shimmed until the signal output from each individual loadcell varies less than 25% of each.

Common sense must prevail however. If the vessel has a large offset load (such as a mixer gearbox and motor) then the loadcell nearest to this will have a higher output. As long as the loadcell is not overloaded when the vessel is full, this situation is acceptable.

Method:

1. Excite the loadcells from the loadcell transmitter/indicator (see ***Electrical Installation***, page 10) or a stable DC source.
2. Disconnect all loadcell signal wires from the junction box. The excitation wires should remain connected. The colour codes are shown in the table on the next page.
3. Shim underneath the loadcell mounts to equalise weight distribution.
4. Measure each loadcell signal output with an accurate digital multimeter that reads to at least 0.01 mV. Write the readings down.
5. Shim under the loadcell mount with the lowest reading. The amount of shimming required will vary widely with different installations, so some experimentation is required.
6. Repeat steps 4 & 5 until the loadcell output readings vary by less than ±25% of each other.

Pro Weigh Loadcell Mounts: Wiring Colour Codes.			
Signal	***DSM Colour code***	***STC Colour Code***	
Excitation +ve	Red	Red	
Excitation -ve	Black	Black	
Signal +ve	Green	Green	
Signal -ve	White	White	
Shield	Silver	Silver	

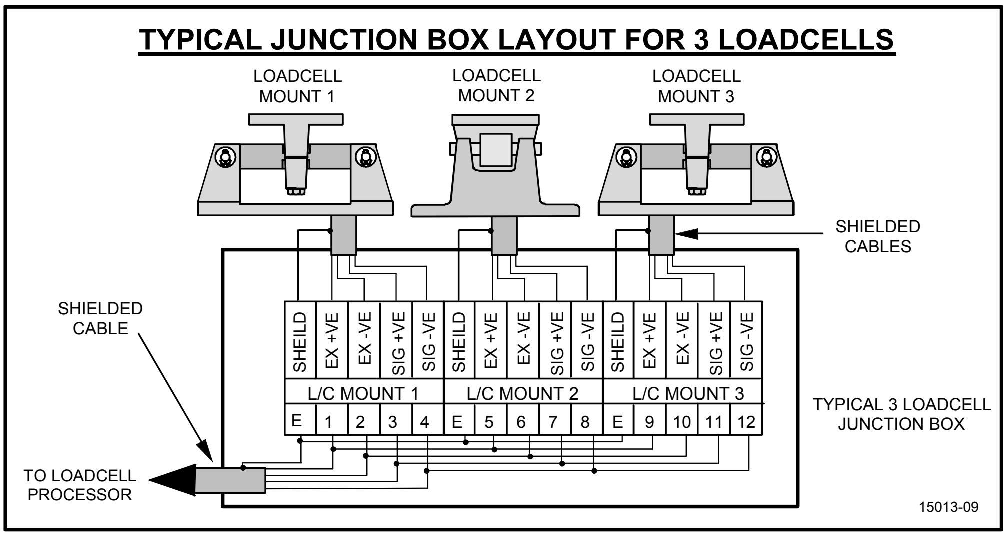


Installation: Electrical

The junction box

A suitable junction box is required to connect the loadcell cables together in parallel and run them to the weight indicator or loadcell transmitter. Suitable junction boxes are available from Pro Weigh. Junction boxes must be:

1. Accessible for calibration purposes.
2. Located where they are unlikely to be damaged.
3. Waterproof (IP65) if they are outside or in a wash-down environment.
4. Labeled clearly with loadcell identification.



Wiring runs

The wires that run from the loadcells to the transmitter or indicator are another source of inaccuracies and problems if they are not installed correctly. If multiple loadcells are used, the loadcell cables should run to a junction box close to the vessel and be connected together in parallel. A single 4-core or 6-core wire should then run from the junction box to the transmitter or indicator. This should be kept as short as possible. Tips for wiring runs are laid out below.

1. Keep the run as short as possible.
2. Do not shorten the loadcell cable. Coil up excess cable neatly next to the junction box or loadcell mount. This keeps the loadcell input and output resistances the same for each loadcell.
3. For longer runs, increase the wire cross sectional area size. (Over 20 metres use 0.5mm² conductors)
4. Do not run near mains cables, or other sources of electrical interference. If mains cables must be crossed, cross them at right-angles.
5. Physically protect the cable runs from mechanical or chemical damage. Many loadcell cables will quickly degrade in chemical wash-down areas and should be protected by suitable conduit, or a flexible tube covering.
6. Use “drip loops” in the cables to ensure that water runs away from the loadcell and junction box glands.
7. Use weatherproof junction boxes (IP 65).

8. Only earth the cable screen wire at the instrument end. Do not earth the screen at the junction box.

Circuit

When multiple loadcells are connected together in parallel the amount of current required to drive the excitation supplies for these loadcells can often exceed the maximum output of the loadcell transmitter or indicator. Often these indicators will have a reduced voltage option to use in these types of installations.

To calculate the required current output for a given installation, use the following formula:

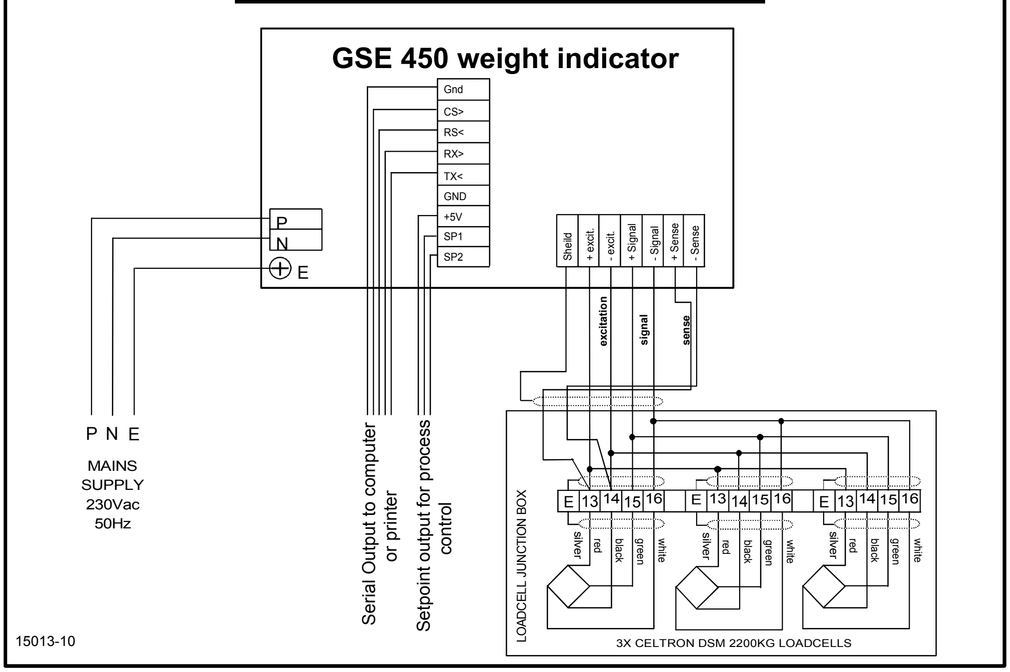
$$Current\ required = V \times \left[\frac{1}{Loadcell\ input\ resistance}\right] \times No\ of\ loadcells$$

For example: A vessel is being weighed with 4 350Ω loadcells. What will be the current requirements if the required excitation voltage is 10V?

$$Current\ required = 10 \times \left[\frac{1}{350}\right] \times 3 = 0.0857A\ or\ 85.7mA$$

Check the loadcell excitation rating of the loadcell transmitter to verify that it can supply this amount of current. A typical circuit is shown below.

TYPICAL VESSEL WEIGHING CIRCUIT



Hazardous areas

Certain areas are classified as hazardous due to the presence of gases, flammable vapours or combustible dusts. When vessel weighing installations are required in these areas, an ***intrinsically safe*** electrical installation must be used. Intrinsic safety is a technique that limits thermal and electrical energy below a level required to ignite a specific hazardous mixture.

The most common way of dealing with hazardous areas is to mount the loadcell transmitter or weight indicator in a ***safe area*** where the explosive mixture is not present, and connect the loadcells to the loadcell transmitter via suitable ***safety barriers***. These barriers use either shunt diodes or galvanic isolation to limit the amount of energy present in the loadcell cables.

Intrinsically safe installations require considerable expertise, of which Pro Weigh has in-depth experience. If in doubt, please contact Pro Weigh.

Calibration

Calibration Techniques.

In order to calibrate a weigh vessel, the loadcell transmitter or weight indicator needs to be “told” what loadcell output is equivalent to an empty vessel (***zero***) and what loadcell output is equivalent to a known weight (***span***). Most loadcell transmitters “draw” a straight line between these 2 values and assume that the signal output from the loadcells increases in a linear fashion with weight. Some “smart” loadcell transmitters and indicators can “linearise” the signal by having multiple span inputs. What you are doing in this case is saying (for example) “for 1000 kg indicated weight output display 1050 kg”. This may be done at a number of points if the weighing system is not linear.

Obviously the zero calibration is straight forward; simply empty the vessel and adjust the indicator to read zero. To span the indicator however requires the addition of a known quantity of weight which can prove to be a little difficult, especially with large capacity vessels. Pro Weigh recommends a minimum of 15% of the total live weight value to be used as a span value. The larger the span value the better.

There are 4 main methods used to span weigh vessels:

1. By placing certified calibration weights onto the vessel. This is called ***Dead weight calibration***.
2. By placing calibration weights onto the vessel in conjunction with an amount of product. This is called ***Dead weight calibration with material substitution.***
3. By filling the vessel with product or water that has been accurately measured by a flowmeter or another weighing system. This is called ***Calibrated material transfer***
4. By using an accurate loadcell simulator that simulates the loadcell’s output for a known weight. This is called ***Loadcell simulation***.

NOTE: Pro Weigh have loadcell simulators, certified calibration weights, and a certified flowmeter for the calibration of weigh vessels.

Dead weight calibration with certified calibration weights

This method is usually limited to small capacity weigh vessels in the range of up to 5000kg, due to the difficulty of handling large amounts of calibration weights, and finding a place on the vessel to hang or place them

Method:

1. Empty the vessel, ensure there is no interference with the vessel.
2. Zero the weighing instrument as detailed in the operating manual of that instrument.
3. Hang or rest the calibration weights on the vessel.
4. Span the weighing instrument as detailed in the operating manual of that instrument, so that it reads the same as the weight applied.
5. Remove the calibration weights and check for return to zero.
6. If you have sufficient weight, add the weights to the vessel one by one and check the linearity of the system. If the system is badly non-linear, (say worse than ± 0.1%) check for mechanical interference.

Material Substitution

This method of calibration is used where high accuracy is required, and uses addition of product to aid calibration. Ideally the calibration weights should be at least 5% of the system's capacity, and should be easy to move around as they will be required to be lifted on and off the vessel numerous times. This method has the advantage of producing an accurate calibration with only a small quantity of weights.

Method:

1. Empty the vessel, ensure there is no interference with the vessel.
2. Zero the weighing instrument as detailed in the operating manual of that instrument.
3. Add the calibration weights to the vessel.
4. Span the weighing instrument as detailed in the operating manual of that instrument, so that it reads the same as the weight applied.
5. Remove the calibration weights.
6. Add exactly the same amount of material to the vessel as the weight of the calibration weights by watching the weight indicator display.
7. Add the calibration weights again. Record the new weight reading on the weight indicator.
8. Remove the weights.
9. Add material until the display reads the recorded weight figure from step 7.
10. Repeat steps 7, 8 and 9 until the weight (test weights and added material) is filled to 80% to 100% of system capacity.
11. The weight now applied to the scale is the weight of certified test weights plus the material multiple. (For example, if the test weights total 1000kg, and 5 material substitutions were made, then the total weight on the vessel = 1000 + (5 x 1000) = 6000kg. Span the weighing instrument again using this weight figure.
12. Remove the calibration weights and material and check for return to zero.

Calibrated material transfer

This method uses another measuring instrument to measure the weight of a set amount of material, and then uses this material as the span weight. The most common methods are using a volumetric flowmeter to measure water flowing into the vessel, or using trucked-in material and measuring the weights of the truck before and after delivery on a certified weigh-bridge. (The weight of the water can be calculated using temperature vrs water density tables. Usually a figure of 1kg per litre of water is used).

Other methods use mass flowmeters, or platform scales.

This method often presents a simple way to calibrate a weigh vessel, but the accuracy of the weigh vessel will only ever be as good as the accuracy of the measuring instrument.

Method:

1. Empty the vessel, ensure there is no interference with the vessel.
2. Zero the weighing instrument as detailed in the operating manual of that instrument.
3. Add the measured amount of material to the vessel.
4. Span the weighing instrument as detailed in the operating manual of that instrument so that it reads the same as the weight applied.
5. Remove the material and check for return to zero.

Loadcell simulation

This method uses an accurate loadcell simulator which replaces the loadcells in the weighing circuit. It removes many of the difficulties in calibrating large vessels, and removes the requirement of moving large amounts of material and/or calibration weights around. It is the quickest method of calibration for large weigh vessels.

The main disadvantage of the loadcell simulator is that it does not simulate the effect of having the full amount of material in the vessel and the associated variations caused by misalignments or mechanical connections to the weighing system.

Method:

1. Connect the loadcell simulator to the weighing instrument with the output set to zero by following the manufacturer's instructions. The loadcell simulator should replace all loadcells in the circuit.
2. Zero the weighing instrument as detailed in the operating manual of that instrument.
3. Adjust the simulator to produce an output equivalent to the output of the weighing system. For example ; if 3 x 5,000kg loadcells were used with a sensitivity of 2mV/V, the simulator would be set to 2mV/V and the span weight would be 15,000kg.
4. Span the weighing instrument as detailed in the operating manual of that instrument.

Disconnect the simulator, reconnect the loadcells and Zero the weighing instrument as detailed in the operating manual of that instrument.

Troubleshooting

Troubleshooting - General

Troubleshooting any problem involves skill. The main skill required is logic. When tackling the troubleshooting of a weighing system problem, move through your investigation in a logical sequence. Do not assume anything. Write your findings down. If changes are made, change one thing at a time and note the effect of these changes.

Order

- Begin by checking the loadcell connections, one by one.
- Measure the loadcell signal outputs one by one. Are they what you would expect?
- Re-check the configuration of the indicator - following the manufacturer's instructions step-by-step.
- Check for mechanical problems.

Vessel weighing problems and inaccuracies can generally be divided into 3 categories:

1 Loadcells

2 Processor

3 Mechanical

Loadcells

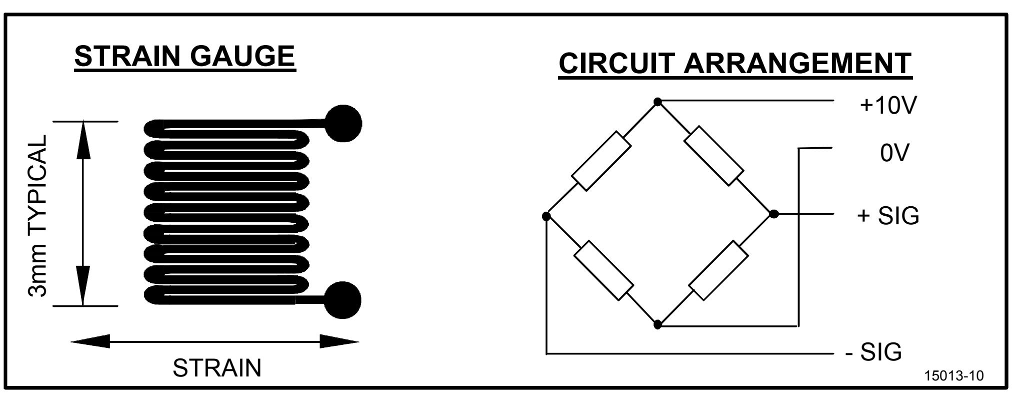
Strain gauges were invented in 1938 by two very clever guys; Dr Arthur C Ruge of MIT and E Simmons of Cal Tech.

Strain gauges themselves consist of thin wire or foil elements that are glued to the loadcell body. Strain gauges are cunningly shaped so that even very small movements or "stretching" of the gauge results in comparatively large changes in resistance.

The relationship between strain and change in resistance is almost perfectly linear. Accuracies of ±0.01% are not uncommon for a high accuracy loadcell.

Certain extreme conditions can cause one or more of the strain gauges to become "un-bonded" from the loadcell base material. These conditions can include:

- Severe shock.
- Welding currents passing through the loadcell.
- Water ingress to the sealed gauge area.

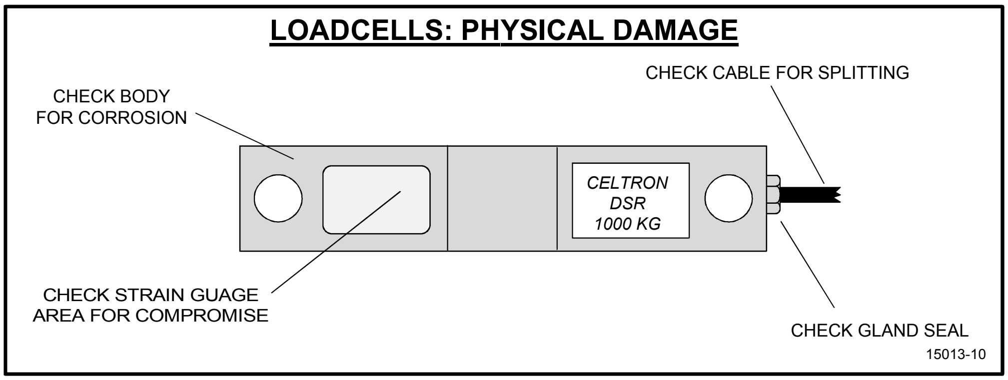


Testing Loadcells

Physical Condition

- Firstly check the loadcell for signs of physical damage.
- Is the loadcell surface badly rusted or corroded?
- Have the strain gauge areas become compromised?
- Is there any physical damage to the loadcell? Is the body bent or twisted? (With single point loadcell, use a steel rule to check the body for straightness).
- What is the condition of the loadcell cable? Does it have any cuts, splits or tears?

If the answer to any of the above is YES, there is a good chance the loadcell is faulty. Proceed with the electrical checks.



Electrical Tests

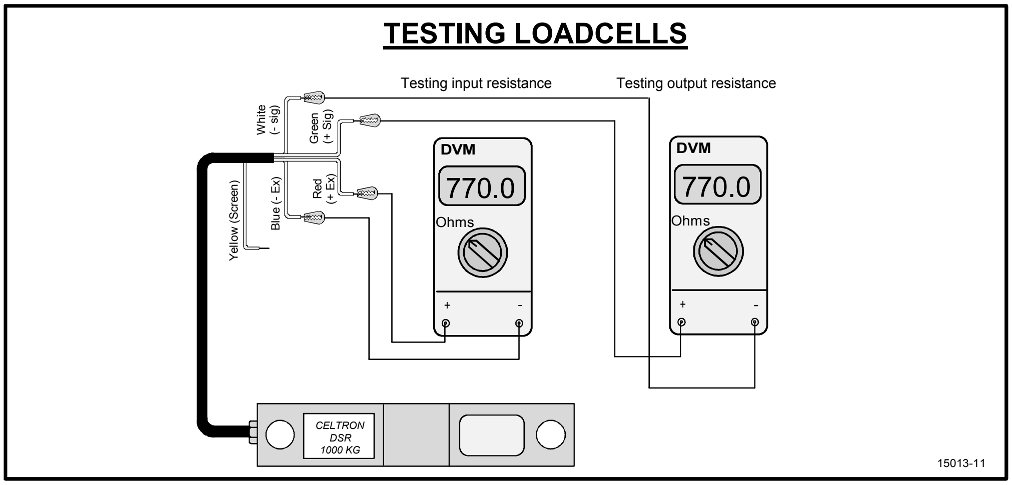
For these tests you will need an accurate 3½ digit (or better) multimeter with a low voltage MΩ range and a millivolt range. You will also need a DC source to excite the loadcell - a 12V battery the weight indicator or a DC power supply will do. You will also need to obtain a data sheet for the model of loadcell you are testing. Alternatively Pro Weigh can supply a loadcell testing instrument with all the functions required to test the loadcells.

The chart below lists the colour codes for Pro Weigh supplied loadcell mounts.

Pro Weigh Loadcell Mounts: Wiring Colour Codes.			
Signal	***DSM Colour code***	***SQB Colour Code***	***STC Colour Code***
Excitation +ve	Red	Red	Red
Excitation -ve	Black	Black	Black
Signal +ve	Green	Green	Green
Signal -ve	White	White	White
Shield	Silver	Silver	Silver

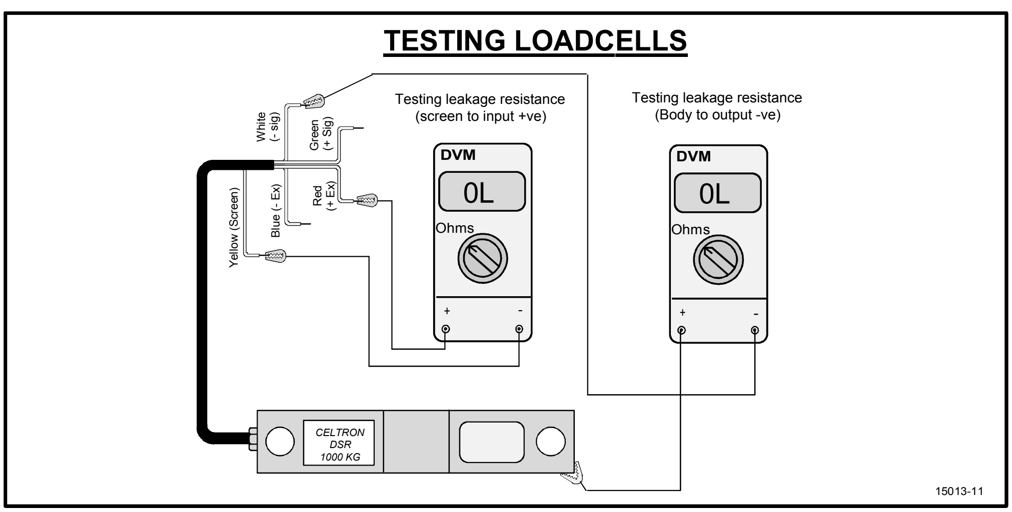
Bridge Resistance

Obtain the data sheet which provides input and output resistances for the loadcell you are checking. Switch your multimeter to the ohm range and measure the input resistance (across the excitation wires). Next measure the output resistance (across the signal wires) compare these values to the data sheet. They should be with the tolerance stated. If they are different, the loadcell has been damaged and will require replacement. Typical values for input and output resistance are 350Ω and 800Ω.



Leakage Resistance

Set your multimeter to ohms and measure from each of the loadcell wires (4 or 6 wires) to the loadcell cable screen. Next measure from each loadcell wire to the loadcell body. These readings should be greater than 1000mΩ. (This may read OL on some meters). If a reading of less than 1000mΩ is encountered, then the loadcell has "leakage" between the internal circuit and the loadcell body or cable screen. This is usually caused by moisture ingress to the loadcell body or cable. Sometimes the cable can be repaired, but if the loadcell has moisture in it, it usually requires replacement.

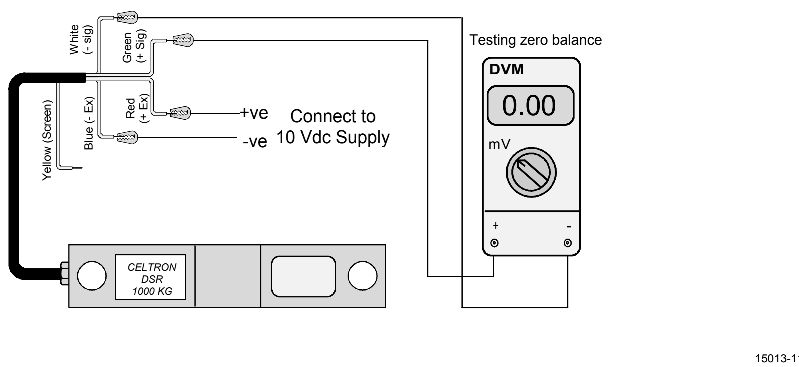


Zero Balance

This test checks for mechanical overload, where the body of the loadcell has been stretched beyond it's elastic limit. This is a common cause of loadcell failure especially in low capacity loadcells (100kg or less).

Connect the loadcell to a stable DC source of between 5 and 15 volts. Switch the multimeter to mV and connect to the loadcell signal wires. The meter should read 0.00mV ± approximately 1% of full load. Small overloads can generally be tolerated although they may effect the linearity of the loadcell. If the output reads greater than ±10% of full scale, then the loadcell will require replacement. This indicates severe overload.

TESTING LOADCELLS



Processor

Microprocessor based weight indicators are usually very reliable instruments with few faults. Often if they do have a fault, it will be very obvious, such as the display locking up or an error message. There can be occasional problems however and following are some quick checks:

- Check the loadcell excitation voltage. Is it as specified? (Usually 5, 10 or 15 Vdc).
- If the display is fluctuating or there is no reading, check the loadcell input signal. Is there a signal (mV) present? Is it fluctuating? If the display is fluctuating but the loadcell signal is not, then the processor is probably faulty. If the processor display shows no weight, but there is a loadcell signal, then again, the processor is probably faulty. (Check that the processor has not been tared).
- If you have a loadcell simulator, connect it to the indicator. Loadcell simulators are an excellent method of checking digital weight indicators. Pro Weigh can provide a range of loadcell simulators.
- Faulty processors should be returned to the manufacturer for repair.

Mechanical

Very often, (in fact, most often) weigh errors are caused by a poor installation or mechanical interference. If the weight reading is not returning to zero. When the tank is empty, then almost certainly, the problem is related to mechanical interference. Among the points to check are;

- Pipework Connections: Are they flexible? Have new connections been made to the vessel? (See ***Pipework*** Page 10).

- Structures: Have new structures (such as ladders or stairways) been added to the vessel. Are they rigidly mounted to the ground or another vessel? (See ***Structures*** Page 9).
- Loadcell Mounts: Are they being mechanically interfered with? Have guards been installed that are touching them?
- If restraints are fitted, are they free to move in a vertical plane? If they are tie rods, are they free to turn when the vessel is fully loaded?
- Is anything other than the loadcell supporting the weight?
- When the vessel is loaded, does it move substantially? Does surrounding support structure flex considerably from no-load to full load?
- Does the Vessel share a support structure with another vessel or container that causes the structure to flex considerably when it is loaded?

If you are still having problems and cannot locate the cause, please contact one of our Pro Weigh weighing engineers:

Ph (09) 415 6500

Fax (09) 415 6556