Thermo Scientific Belt conveyor scale handbook

Making a sound choice: Factors that count when it comes to belt scale systems

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Chapter 1
Introduction

A belt conveyor scale is a device that measures the rate at which bulk material is being conveyed and delivered on a moving conveyor belt. It can compute the total mass of material conveyed over a given period of time.

As one of the leading manufacturers of modern belt conveyor scales, we have not only pioneered the latest state-of-the-art technology but have also installed thousands of belt conveyor scales worldwide. This experience has given us special insight into the problems and considerations of applying, operating and maintaining belt conveyor scales. In the following pages, we share that knowledge offering customers and other users of belt conveyor scales a better understanding of applications and limitations.

Yes, belt conveyor scales do have limitations. Unfortunately, it is not as simple as just installing a piece of hardware in a conveyor to have a reliable scale installation. That is not to say the hardware isn't important – it is.

The electronics for belt conveyor scale have progressed from early and simple analog circuits, through such improvements as zero and span calibration assists, electronic calibration and finally to microprocessor-based electronics with a wide array of automatic calibration features and self-diagnostic capabilities. But good hardware alone doesn't ensure a reliable and accurate belt conveyor scale. Of equal importance is how that scale is applied in a given conveyor system and how it is operated, calibrated and maintained.

This handbook covers all factors affecting the reliable and accurate performance of belt conveyor scales of different types. Topics include:

- The theory of operation and components of scale systems
- The concept of weighing accuracy and how it is measured
- Factors that affect weighing accuracy
- Maintenance, calibration and special considerations for certified scale installations

Feel free to contact us if you would like more information or to discuss a specific belt conveyor scale application in this handbook.

Chapter 2

Theory of belt scale operation

Belt conveyor scales provide a means of weighing bulk materials while in motion. The obvious advantage over static weight systems is that the flow of material needs not be interrupted. As in batch weighing, accurate sensing of the weight of material is required. Belt conveyor scales also require accurate sensing of the motion of the bulk material.

The weight on the conveyor belt is measured by sensing the force on one or more conveyor idlers. The motion of the material is measured by sensing travel of the belt with a device which produces an "output" representing a fixed distance of belt travel. Because the measured force represents weight per unit length (i.e., kg/m or lbs/ft), it can be multiplied by the belt travel to acquire total weight. (Example: kg/m x m = kg; lbs/ft x ft = lbs.) This function can be accomplished with an electro-mechanical or electronic integrator.

With proper scaling, total weight may be accumulated in tons, long tons, or metric tons. In addition to displaying total weight passed over the belt conveyor scale, most modern integrators also display instantaneous rate (i.e. kg/ hr or tons/hr) and provide transmitted outputs for remote monitoring and control requirements.

Most viable belt conveyor scale systems operate by the above mentioned method of measuring weight per unit length and multiplying that by belt travel to determine total material weight. To better understand the theory of operation of all belt conveyor scales, the following paragraphs describe the individual components of a scale system in greater detail.

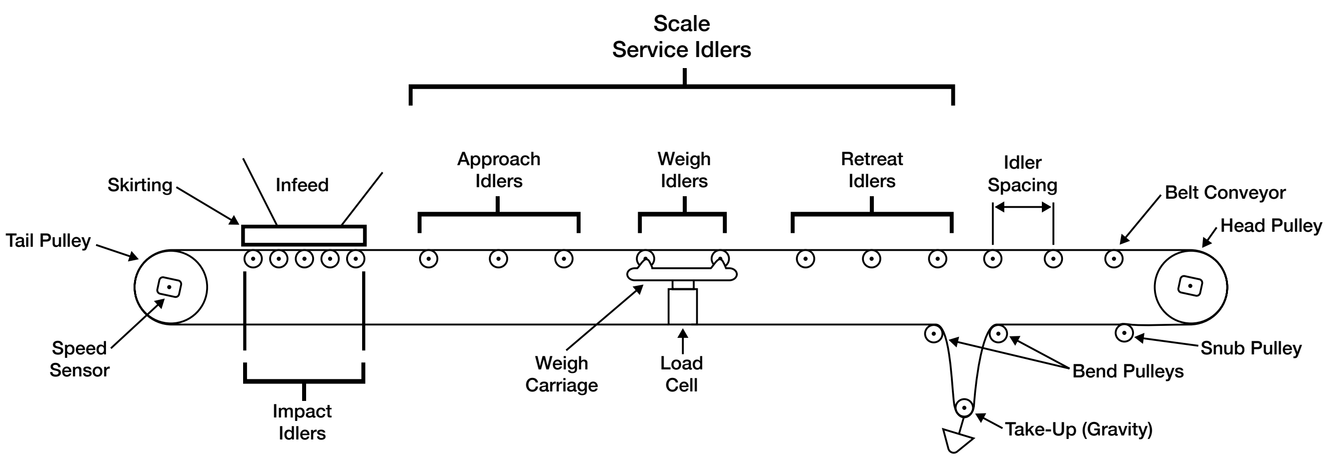


Figure 1: Components of a scale system

Major components of a belt conveyor scale system

The key components of a belt conveyor scale are shown in Figure 1. Their functions are as follows:

- The **scale carriage** (scale suspension) transmits the forces resulting from the belt load and directs those forces to the load sensor(s).
- The **load sensor(s)** transduces the load force to a form acceptable to the mass totalizer.
- The **belt travel (speed) pick-up** contacts the belt and transmits **belt travel (speed)** to the speed sensor.
- The **belt travel (speed) sensor** transduces the **belt travel (speed)** to a form acceptable to the mass totalizer.
- The **mass totalizer (integrator)** computes the total mass that has passed over the belt conveyor scale and then indicates and records that value. Typically, the mass totalizer will also provide a mass flow rate indication.

Various designs and technology can be applied to the components of a belt conveyor scale, but basic design considerations are applicable to all.

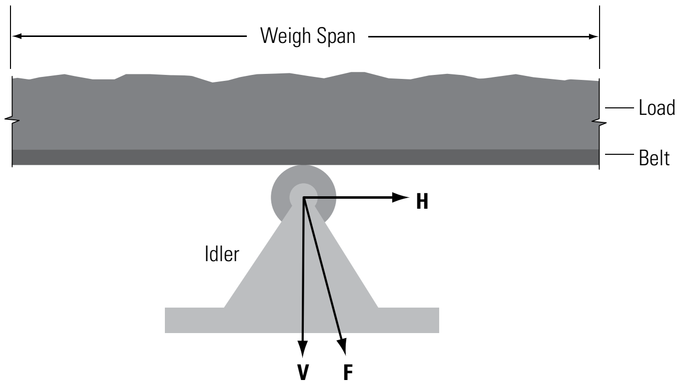
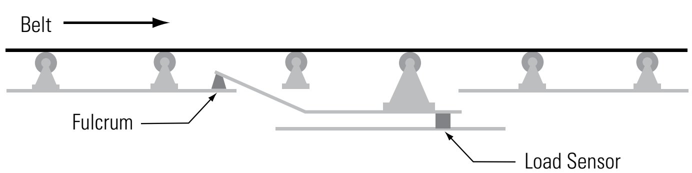
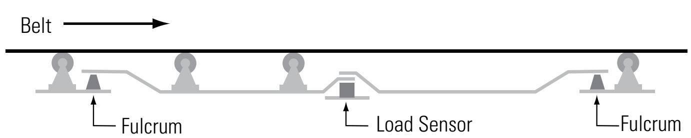


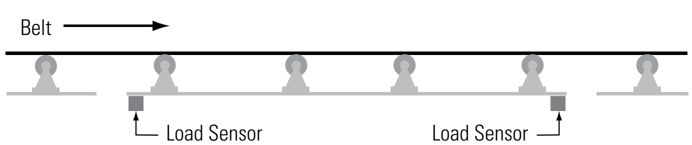
Figure 2: Scale Carriage Operating Principle



Single Pivot Carriage, Single Idler



Dual Pivot Carriage, Multiple Idler



Full-Floating Carriage, Multiple Idler

Figure 3: Common carriage designs

Scale carriage

The scale carriage must transmit the forces resulting from material on the conveyor belt to the load sensor without adding any extraneous forces. It is important that no forces originating from belt travel or belt side travel be converted to a force on the load sensor.

Figure 2 is a sketch of a single weigh idler showing forces in two dimensions. The force F is actually sensed by the idler, but the scale carriage must transmit only force V to the load sensor. Force H (as well as another force H vertical to the plane of the figure) must not be changed to a force acting on the load cell as a false representation of force V.

In general, to accomplish this function, the scale carriage must meet the following criteria:

1. Rigidity, minimal deflection
2. Torsional stability
3. Elimination of the effects of lateral forces
4. Minimized effects of off-center belt loading
5. Alignment provisions
6. Minimized tare weight portion on sensor
7. Maximized belt load portion on sensor
8. Minimized horizontal surface area for dirt collection
9. Unitized construction for easy installation
10. Frictionless pivot points or fulcrums
11. Provisions to accept high temporary overloads without calibration shifts

Several common carriage designs are shown schematically in Figure 3.

Load sensor

The load sensor(s) receive(s) the force transmitted by the scale carriage and converts the force to a signal usable by the mass totalizer (integrator).

Several means of load sensing have been used in belt conveyor weighing, including mass balance, force balance using buoyancy of a displacement float, pneumatic or hydraulic force balance, magnetic force balance, and deflection or spring type transducers which include both strain gauge load cells and linear variable differential transformer (LVDT) load cells.

Each of the above techniques has certain advantages and disadvantages. One important factor for belt conveyor weighing is minimum deflection from no load to full load. Strain gauge load sensors typically have less than .08 mm (.003 inch) deflection as used in conveyor scales and are the most commonly used load sensor. Another important factor is temperature stability. Since most belt conveyor scales are installed outdoors, the load sensor must be able to operate over a wide temperature range without appreciable zero-drift and error due to temperature. Here, again, strain gauge load cells have an advantage over some other types of load sensors.

Belt speed (belt travel) sensors

Belt speed or belt travel sensing (displacement) is equally important to the accurate measurement of load in the computation of total mass passed over a belt conveyor scale. A one percent error in conveyor speed (travel) measurement will produce a one percent error in the totalized value just as surely as a one percent error in load sensing.

Table A

	Advantages	Disadvantages
Tail pulley	1. Large angle of wrap. Low slip. 2. Large diameter – not normally affected by material build-up; small effect from belt thickness variations.	1. If scale is at high tension compared to tail pulley, belt speed will be somewhat higher in scale area.
Underside of load carrying portion of location conveyor speed	Can be mounted near the scale to avoid errors due to tension changes.	1. Very small portion of wrap; has high potential for slip. 2. Often a narrow pulley which can easily be installed incorrectly with an axis not at 90° to belt travel.
Roller mounted to clean side of return portion conveyor	1. Usually a full width roller which can be readily installed at 90° to belt travel. 2. If an extra pulley is installed, adequate angle of wrap can be provided.	1. Has even more tension variation than tail pulley location. 2. Requires installation of special roller or rollers. 3. Smaller diameter is affected by belt thickness variations or material build-up.
Modified conveyor idler	1. Can be mounted at the scale location to avoid speed error due to tension changes.	1. Very small angle of wrap; has high potential for slip. 2. Requires special idler.

Errors in the accurate measurement of belt travel for weighing can occur from a variety of sources:

1. Slip between the belt travel pick-up (roller or pulley) and the conveyor belt.
2. Belt travel pick-up axis not exactly 90° to the direction of belt travel (narrow wheel type pick-ups).
3. Belt speed varies within the conveyor as a function of tension.
4. Inaccuracies within the speed sensor (speed transducer).
5. Material build-up on the belt travel pick-up.
6. Wear or deterioration of the lagging on the belt travel pick-up.

The function of the belt travel pick-up is to provide a rotary motion suitable for the belt travel sensor and representative of the actual conveyor belt travel at the load sensing location. Due to changes in belt tensions, differences along the conveyor of 0.3 to 0.5% have been observed. For this reason, it is preferable that the belt travel pick-up be mounted near the scale location. Note that the return portion of the conveyor does not meet the definition of “near the scale location.”

Some of the most common forms of belt travel (speed) pick-up are as follows:

1. The tail pulley.
2. A pick-up mounted to ride against the underside of the load carrying portion of the conveyor.
3. A roller mounted to ride against the clean surface of the return portion of the conveyor.
4. A conveyor idler modified to provide speed sensing.

Table A provides a summary of some of the advantages and disadvantages for each system.

Belt travel sensors

Devices used for sensing belt travel have included DC generators, AC generators, mechanical belt or chain devices for mechanical integrators, photo-optical segmented disks, and electromagnetic pulse generators. These devices transduce the belt travel to a signal suitable for the mass totalizer.

With the advent of microprocessors, it has become more appropriate to use a device which provides a pulse for each unit length of belt, as described in the section on mass totalizers.

Mass totalizer (integrators)

Outputs from the belt travel (speed) sensor and from the load sensor are combined in the integrator to produce a running total of material passed over the belt conveyor scale. (Both mechanical and electronic integration have been used.) Mathematically, there are two classes of integrators: a weight integrator and a rate integrator.

The weight integrator senses load and belt travel. The device then computes the total weight according to the equation:

$$WT = \int Q dx$$

where

WT = Total Weight

Q = Weight of Material per Unit Length of Belt

dx = Infinitesimal Length Element of the Belt

In the newer digital totalizers, the equation is more correctly stated:

$$WT = N \sum Qi1i$$

where

i = O

WT = Total Weight

Qi = Weight on Scale at Instant i

i = Unit Length of Belt as Unitized by Integrator

The rate integrator multiplies the load by the belt speed to get a weight per unit time signal:

$$WT = \int Qvdt$$

where

WT = Total Weight

Q = Weight per Unit Length v = Belt Speed

To provide accurate total weight and convenient operation, the integrator should contain such features as:

1. Stability of gain and zero over the operating temperature range, typically -30°C to +55°C (-22°F to +131°F). Change across the range should be less than the accuracy statement.
2. Ability to integrate both plus and minus for accurate zeroing.
3. Belt speed compensation.
4. Convenience of operator use for calibration.
5. High resolution for calibration.
6. Non-interacting zero and span adjustments. Digital systems are available with no screwdriver adjustments, only keyboard inputs.
7. Compatibility with instrumentation and control.
8. Auto zeroing capability.
9. For low accuracy installations, a low load cutout may be convenient.

Most present-day conveyor scales use some form of electronic integrator to provide both rate integration and totalizing. Integrators typically also provide signal & alarm outputs, and support various industrial communications as well as all of the functionality listed in the nine points above. Integrators are divided into three categories:

1. Analog mathematics
2. Frequency counting mathematics
3. Microprocessor mathematics

All of the components described above must function accurately with minimal error for a belt conveyor scale system to generate reliable measurements for your processes.

Chapter 3
Weighing accuracy

When using belt conveyor scales, it is important to establish a clear method for determining accuracy. Consider how accuracy is determined as it applies to a platform, truck or hopper scale. The scale is checked for accuracy against a traceable standard weight. For smaller capacities, the weights may be used to full capacity. For larger capacities, a substitution test may be used where standard weights are applied, then removed and material added to that same percent of capacity. In either case, notice the presence of traceable standards of mass which are applied to the scale.

In the case of the belt conveyor scale, the method of using a traceable standard weight to assess accuracy cannot be used. It is certainly possible to apply traceable weights to the belt conveyor scale, but the procedure has little meaning other than to provide greater confidence in the repeatability of the belt scale. The actual mass as seen by the belt scale in operation is affected by the conditions of the conveyor belt as well as by the actual mass passing over the scale. As a result, the only way to prove the accuracy of the belt conveyor scale in a traceable manner is to compare the weight of material weighed over the belt conveyor scale to a reference static scale. This immediately raises several other questions:

1. How much mass should be collected?
2. How accurate is the reference scale?
3. What if it isn't possible to collect the material?

National Institute of Standards and Technology (NIST) Handbook 44 (2020) contains a section covering conveyor scales. Paragraph N.2.3. defines the minimum test load to be collected as not less than the largest of the following values:

> (a) 800 scale divisions for systems not marked with an accuracy class, 800 scale divisions for systems marked Class 0.25, and 2000 scale divisions for systems marked Class 0.1;
>
> (b) the load obtained at maximum flow rate in one revolution of the belt; or
>
> (c) the load obtained during at least one minute of operation.

In addition to defining the minimum mass to be collected, Handbook 44 also requires it to be collected at normal use capacity and at flow rates of no less than 70% of rated capacity. Defined series zero load tests (i.e. tare) must also be done prior to the material test.

The rationale for these requirements is based on the properties of a belt conveyor scale. The requirement of one-minute duration is an acknowledgement that the mass measurement in the conveyor scale contains some process noise, and it is necessary to average this noisy signal over some period of time. For example, Thermo Scientific belt scales average noisy signals 64 or 100 times per second; therefore, the one-minute period is an average of 3,840 to 6,000 observations.

The requirement of a minimum of one circuit of the belt is an acknowledgement that the conveyor belting is not perfectly uniform. Some sections of the conveyor belting will be heavier than others. Therefore, the best test includes an exact unit number of revolutions of the belt.

The requirement for a minimum of 800 scale divisions on the master weight totalizer is to provide a minimum resolution of one part in 800 in the conveyor scale reading.

These requirements can, in some cases, result in a different quantity of material. For example, a conveyor scale operating at 5000 tons per hour will yield 83.3 tons in 1 minute. If loaded into 20-ton rail cars, this requires a minimum of 5 cars. This, in turn, requires 5 gross weights and 5 tare weights, each with some error, to establish the reference weight against which the conveyor scale is to be calibrated. It is always important to verify the accuracy of the reference scale prior to any calibration of the conveyor scale.

Accuracy for a conveyor scale is calculated by:

$$\frac{\text{Reference Scale Value} - \text{Conveyor Scale Value}}{\text{Reference Scale Value}}$$

A weighed material load test is the only way to establish traceable accuracy on a belt conveyor scale.

Other types of tests (referred to as simulated tests) are often used with conveyor scales, such as:

- Test chains applied to the carrying surface of the moving belt ("Roller Chain")
- Known weights applied statically to the conveyor scale ("Static", "On-board Billet" or "Peg" weight)
- Shunt resistors of known value applied to the strain gauge bridge ("R-cal")

None of these simulated tests can establish accuracy. They are useful in determining repeatability and stability of the scale electronics.

Often, a simulated calibration test is the only reasonable way to calibrate a belt scale. It may be very difficult or expensive in some material handling systems to isolate a sample which can be taken to a certified traceable static scale, especially a sample of large size. The location of the nearest certified track or truck scale could also be a considerable distance away, making it very costly and time-consuming to run a material test. One solution is to install a certifiable test weigh bin as part of your material handling system.

Regardless of your installation, it is important to keep in mind what factors contribute to accuracy in a belt scale system. Due to the dynamic effects of weighing-in-motion, a weighed material test is the only way to verify system accuracy, as opposed to simply confirming repeatability.

Table B: Typical belt scale accuracy

Scale model	Number of weigh idlers	Number of load cells	Best accuracy (±%)
10-101 "Idea"	1	1 or 2	1
10-30	1	1 or 2	1
10-20	1	1 or 2	0.5
10-17	2	1 or 2	0.5
10-17	4	2	0.25
10-14	2	4	0.5
10-14	3	4	0.125 (note 1)
10-14	4	4	0.125

1200 mm (48 inch) nominal idler spacing (800 mm min., 1500 mm max.).
Based on 3 lead in and 3 lead out idlers. Derate accuracy if less LILO idlers.

Note 1 – for minimum 64 sample/sec sampling rate and 24 bit ADC. Derate to ±0.25% for lower specification integrators.

Chapter 4
Electro-mechanical belt scales

Chapters 2 and 3 outlined the basic theory of operation, design considerations and concept of weighing accuracy for belt conveyor scales in general. The three basic types of belt conveyor scales in use today are mechanical, nuclear and electro-mechanical.

Mechanical scales are representative of older technology, and their usage is very limited. Nuclear scales measure material density and not weight. Varying density or moisture content will result in significant weighing inaccuracies. Electro-mechanical scales are by far the most widely used type today. Often referred to as electronic belt conveyor scales because data is transmitted and processed electronically, electro-mechanical scales must still mechanically interface with the conveyor itself to measure the mass load on the belt.

Though we refer to an electro-mechanical belt conveyor scale as one type, there is still a great deal of diversity among the various electro-mechanical belt conveyor scales available today. Manufacturers design the components in their systems differently with varying capabilities and features. In addition, a single manufacturer might have significant design differences between models in its own product line. This variation can be seen in all four components that make up a belt conveyor scale system: carriage, load sensor, belt travel (speed) sensor, and integrator.

Carriages, for instance, come in a wide variety of designs, but all generally traceable to the three basic types described earlier in Figure 3. The only generalization that can be made about carriages is that the longer multi-idler versions are usually associated with higher performance systems while single-idler carriages are widely used for most general in-plant control and monitoring applications.

The load sensors used on electro-mechanical scales are electronic transducers, usually either LVDTs or strain gauge load cells, the latter being most widely used.

Speed sensors all generate an electronic signal, but they vary considerably in design and the point at which a given manufacturer usually applies them. Manufacturers generally use the variations discussed earlier in Table A.

Finally, integrators (totalizers) are electronic, but can vary considerably in their design, features, and specifications. Both analog and digital designs are available today; the most current technology is found in microprocessor-based digital units with software that provides simpler calibration and self-diagnostics.

In summary, even within the popular electro-mechanical scale type, a wide selection of product designs and features can be found. Each manufacturer will have an argument supporting its own design and methods. Ideally you will be able to ask key questions and better evaluate the choices available for your processes after reading this handbook and understanding the theory of operation and design considerations for belt scales.

The following chapters on selection, application and maintenance of belt scales are written primarily with the electro-mechanical belt conveyor scale in mind.

Chapter 5

Selecting a belt scale

The process of selecting a belt scale that is best for your particular situation should take into consideration all of the following: (1) intended use, (2) accuracy, (3) belt scale design, (4) conveyor, and (5) calibration.

1. Intended use:

People generally purchase a belt scale for three distinct uses:

a. Fee, trade or custody transfer application.

Typically, these scales require accuracies within ±1/4% (±0.25%) or ±1/8% (±0.125%) and require certified calibration. The scale model or type must have a regulatory agency approval, and the calibration should be performed by an authorized agent of the approving agency.

b. Process management or control application.

These scales are used in process plants to monitor costs, production rates, plant metallurgical account balancing, and precision blending of material. The accuracy levels desired range between ±1/8% and ±1%, depending on the situation. Belt conveyor scales rated for ±¼% or ±1/2% accuracy are the most common for these applications. Typically, the scales do not need regulatory approval. Sometimes a certifiable scale is used because of its high accuracy capability, but it is not calibrated in a traceable manner.

c. Process monitor application.

These scales are used in process plants where a reasonable indication is sufficient, or, for example, to get an alarm when potentially costly or harmful situations exist, such as too much feed to a crusher. The accuracy levels range between ±1/2% and ±3%, depending on the situation. Often repeatability is of equal concern as actual weighing accuracy.

2. Accuracy:

Accuracy statements printed in sales literature from each manufacturer of belt conveyor scales varies widely. Some state the accuracy of the instruments but not the complete system. Others give a repeatability statement, meaning simply that it will repeat performance within certain limits when checked against simulated tests. Still others state that on the installed system, over a specified operating range, the belt conveyor scale system will weigh to a certain accuracy. Traceable accuracy may be established by conducting a material test in accordance with NIST Handbook 44. Other very similar standards are used in other parts of the world, for example, MID in Europe or NMI in Australia.

3. Belt scale design:

The belt scale that comes from the manufacturer has three major components: the electronics, speed sensor, and carriage assembly (which includes the load sensor). Here are some considerations:

a. Electronics – Are they state-of-the-art or current technology? Is the error of the electronics small compared to the whole belt scale system accuracy? Do the electronics feature automated zero and span calibration? Can the electronics assist in diagnosing and displaying warnings or alarms? Are suitable outputs and communications for the control system available? Are output signals isolated? What sort of user interface is required?

b. Speed sensor – Is the speed sensor generating a suitable signal for connection to the electronics? Some speed sensors are designed for direct coupling to the tail pulley; others are non-contact and use a proximity sensor. Speed sensor location should be located close to the scale carriage, protected from damage, and be convenient for maintenance access.

c. Carriage design:

Two basic carriage designs exist: (1) pivoted type, and (2) full-floating platform. (Refer to Figure 3).

(1) Pivoted design – In the pivoted design, the weight applied to the weigh idler(s) results in the torque about the pivot. This torque is measured by the load cell. The torque and weight will have a linear and stable relationship as long as the pivot is perfect. Pivots made from knife edges and ball bearings develop flat spots over time making them far from a perfect pivot. The result is increased weighing errors. Where higher accuracy is required, the use of a dual pivot carriage increases the weighing area so greater accuracy can be achieved.

(2) Full floating design – In this design, there are four load cells to suspend the carriage and sense the weight. Full floating designs have no pivots and no torques – only check rods to hold the weighing platform in place. This results in a direct 1:1 weighing ratio, and is the same principle used in accurate static scales. Full floating scales typically use a greater length of conveyor than a pivoted scale. For high accuracy weighing, microprocessor-based electronics and a full-floating design carriage have proven to be extremely accurate and reliable, resulting in a quick return on investment.

4. Conveyor design:

Chapter 6 on The application of a belt scale provides necessary conveyor considerations. To achieve high accuracy, all suggestions in Chapter 6 should be addressed.

5. Calibration:

The calibration of a belt scale is completely different from a static scale simply because it is a dynamic scale, meaning the material is moving. To calibrate a belt scale involves using a simulated load for initial calibration, followed by a material test in some situations. Subsequent calibration checks are normally done with simulated loads. Consider your requirements for frequency of zero and span calibrations.

Chapter 6

The application of a belt scale

Assuming you have selected good scale hardware, the application and installation of your belt scale now becomes all-important in determining how accurately your belt scale system will perform.

In applying belt scales, one must always consider external influences originating from the material handling system and conveyor belt. Regardless of stated accuracies, these two factors will determine the overall long-term and short-term accuracy of your system. Here are guidelines to help you optimize belt scale performance and weighing accuracy.

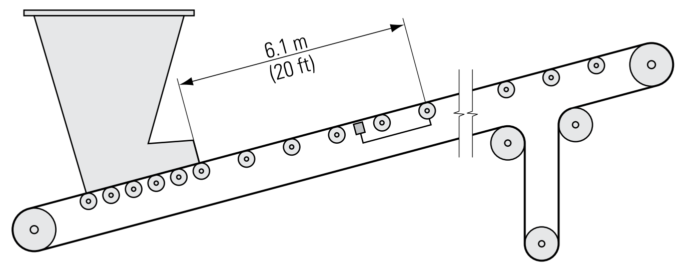


Figure 4: Tension

1. Scale location:

a. Tension

In all installations it is very important that the belt scale be installed in an area where belt tension and tension variations are minimal. For this reason, the belt scale should be installed near the tail section of the conveyor but far enough forward so it is not influenced by infeed skirt boards.

b. Uniform belt loading

Although in most applications the scale system is capable of operating accurately over a 4 to 1 weight range, it is desirable that the belt loading be as uniform as possible. To minimize surges or feed variations, hoppers, if possible, should be equipped with a depth limiting gate or other flow control device, such as a feeder.

c. Single load belt

On high accuracy installations, the loading point should always be at the same location on the conveyor. This assures constant belt tension at the scale during all loading conditions.

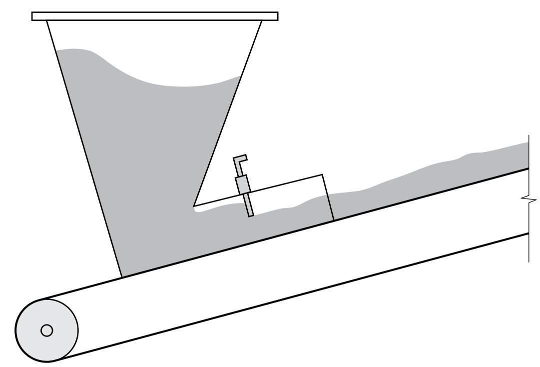


Figure 5: Uniformity of belt loading and flow

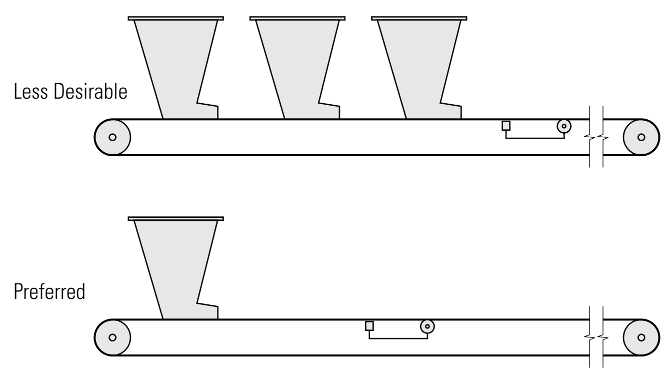


Figure 6: Load point

d. Material slippage

The belt scale system processes belt loading and belt travel to calculate an accurate weight. Product speed must equal belt speed at the scale. For this reason, the conveyor speed and slope should not exceed that at which material slippage occurs.

e. Convex curves

Straight conveyors are preferable to curved conveyors. Curves are not recommended between the loading point and the scale. Convex curves are permissible for accurate readings at a distance of 6 m (20 ft) or a minimum of five idler spaces beyond the scale area idlers.

f. Concave curves

If there is a concave curve in the conveyor before or after the scale, the scale should be installed so that the belt is in contact with all the idler rollers at all times for at least 6 m (20 ft) or 5 idler spaces, whichever is greater, before and after the scale, even without any material on the belt. A concave curve should start no closer than 12 m (40 ft) from the scale to the tangent point of the curve.

g. Trippers

In any installation where weighing accuracy is important, the scale system should not be applied to a conveyor that has a movable tripper. If the scale must be installed on a conveyor with a tripper, then the same rules apply as for an installation in a concave conveyor. The minimum distances outlined in the section on concave conveyors should be adhered to with the tripper in its fully retracted position. It is also of extreme importance that the belt tracks centrally at the scale area for all tripper locations.

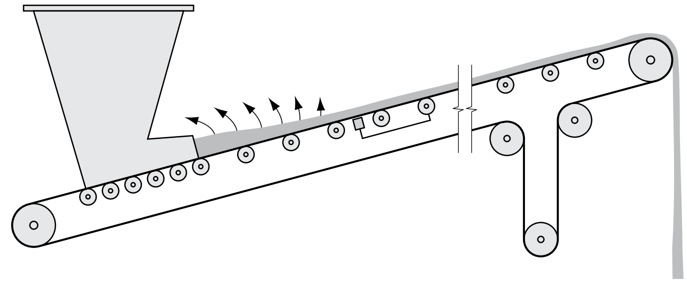


Figure 7: Material slippage

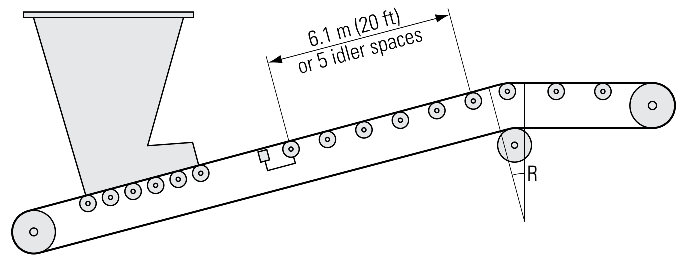


Figure 8: Convex curves

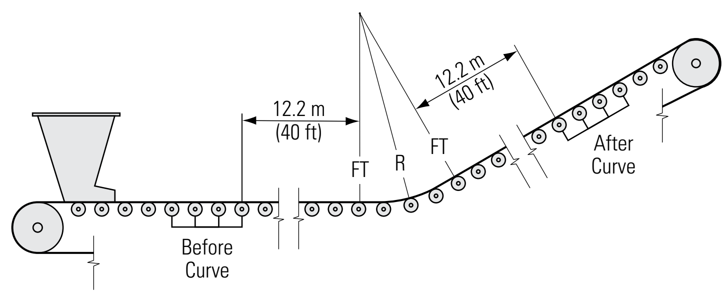


Figure 9: Concave curves

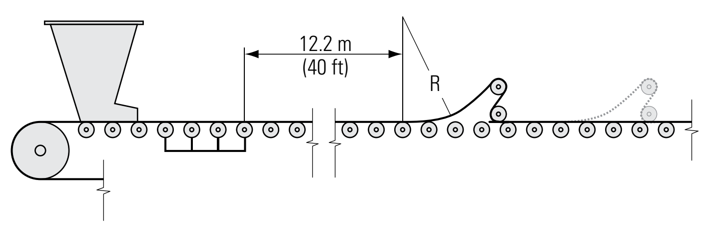


Figure 10: Tripper conveyors

2. Conveyor design:

a. Wind and weather effects

The scale and conveyor at the scale should be protected from wind and weather effects. The magnitude of weighing errors caused by wind is dependent on wind velocity. A minimum of 6 m (20 ft) should be enclosed or shielded on either side of the scale in windy locations.

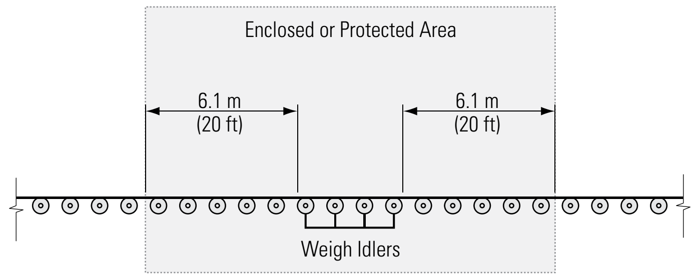


Figure 11: Protection from environmental factors

b. Vibration and deflections

The entire conveyor frame should be isolated from bins, feeders, crushers, and other mechanical equipment. This prevents bin loading from causing conveyor deflections and protects the weighing equipment from vibrations and shocks imposed by mechanical equipment.

c. Conveyor support

In the design of the scale system, two deflections should be taken into consideration. These are the deflection of the load cells, and the deflection of the supporting conveyor structures. It is of utmost importance that these deflections not be excessive. In the manufacture of the scale, the amount of deflection in the load cells and the carriage assembly is controlled. The only variable is the deflection of the conveyor itself. Therefore, the conveyor stringers supporting the scale and idlers to either side of the scale should be designed so that the deflection between any two adjacent idlers within the weigh area does not exceed 0.025 inch (0.6 mm) under load. No conveyor expansion joints should be located in this region of the conveyor.

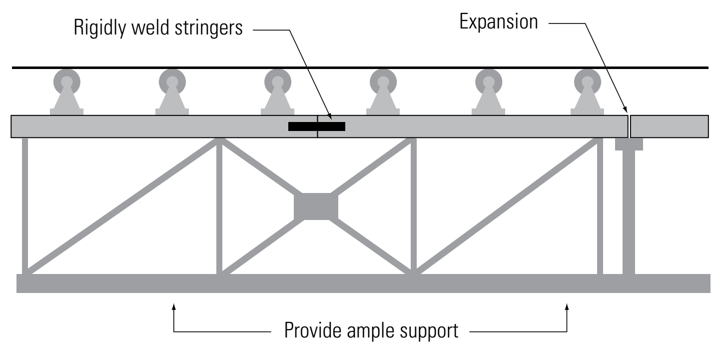


Figure 12: Conveyor support

d. Cable conveyors

Conveyors commonly known as "CABLE" or "ROPE" conveyors are not suitable for electro- mechanical belt conveyor scale weighing unless a rigid conveyor section long enough to support the scale and scale service idlers is added.

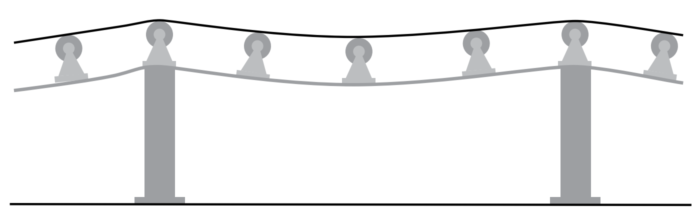


Figure 13: Cable conveyors

e. Stacking conveyors

Avoid cable supported conveyors such as stacking conveyors and conveyors that change the angle of elevation between periods of calibration. This application is possible at the cost of reduced accuracy, and a device that measures the incline is required. The incline measuring device provides an angle signal to the belt scale electronics so they can compensate for the tangential force on the loadcell.

f. Gravity type take-ups

All conveyors over 9 m (30 ft) in length should be equipped with a gravity type take-up.

g. Belt tracking

One problem in attaining optimum belt scale accuracy is the effect of belt tracking from an empty to a fully loaded condition. To enhance belt tracking, the construction of the belting should have the necessary flexibility to ensure contact with all scale area idler rolls when the belt is running empty. In addition, this ensures that the conveyed material is being supported by the weighing idlers rather than by the conveyor belting. In no case should the belt extend beyond the edge of the idler roller over the entire length of the conveyor.

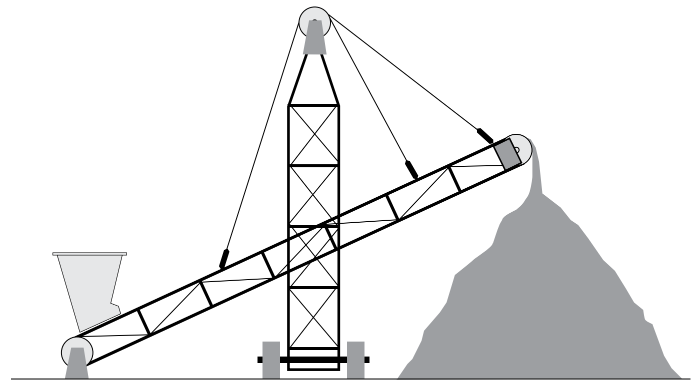


Figure 14: Stacking conveyors

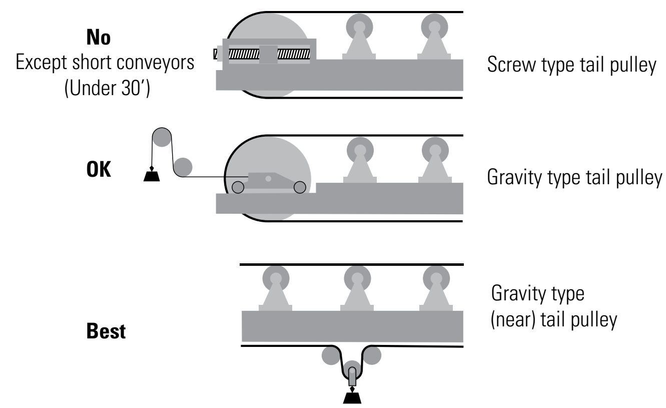


Figure 15: Take-up types

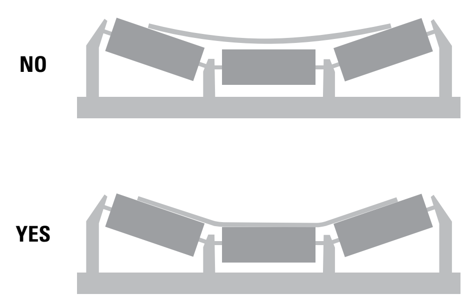


Figure 16: Belt construction and tracking

3. Belt scale area idlers:

a. Idler type

The selection of the idlers used within the scale area is extremely important. Not only is the idler type important, but so is the idler construction itself. Because idler alignment plays an important role in the operation of a belt conveyor scale, it is extremely important that all idlers be manufactured as nearly alike as possible. These are typically referred to as “weigh quality” idlers. It is also important that certain types of idlers be avoided, such as “V” types and rope or cable types. Offset idlers may be installed on full floating carriages but should not be used on single or dual pivoted carriages.

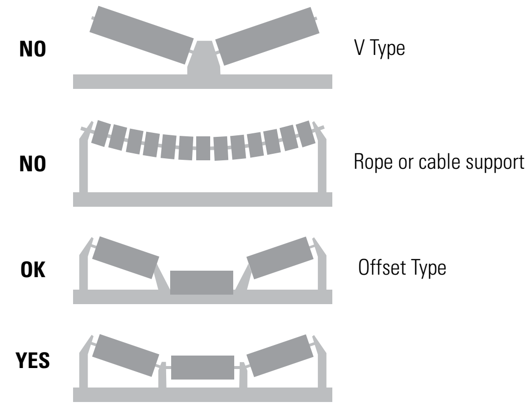


Figure 17: Idler type

b. Scale service idlers

Idlers in the weighing area (up to +4 to -4 idlers in addition to the idlers on the scale) should be round, uniform and of same make, troughing angle and rating. The top grade idler, manufactured by most of the major idler suppliers, under normal conditions is an adequate idler for scale service use. It may be required, however, to select a series of idlers that have similar dimensions and troughing angles for scale service.

c. Idler troughing angles

The use of idlers with steep troughing angles causes many problems. Not only does the beam or catenary effect of the belt become more pronounced as the troughing increases, but the effect of idler misalignment is amplified as well.

One very important function to perform at the time of installation of the scale system is to check out the alignment of all idlers within the weighing area and adjust where necessary.

This is done to help minimize the extraneous forces introduced into the weighing system by changes in belt tension or other external forces as the belt travels across the idlers. Troughing angles of 35º or less are preferred for all high accuracy installations. Troughing angles of 45º are acceptable under certain conditions (check with the manufacturer or contact us for more information).

d. Training idlers

It is extremely important that the belt tracks centrally from no load to full load conditions. Training idlers are normally accepted if located at least 18 m (60 ft) to either side of the scale mounted idlers. Return belt training idlers are acceptable in most applications.

e. Idler alignment

The scale mounted idlers and a minimum of three idlers (up to five idlers for high accuracy systems) to either side should be dimensionally aligned. The installation of these idlers is the most critical to get right. Good idler alignment throughout the entire conveyor is important to ensure adequate and true belt tracking under all load conditions.

The application criteria recommended in this chapter cannot always be followed on every conveyor. On some installations it may be necessary to make a few compromises. On typical process monitoring and control applications, the effect on weighing accuracy may not be of great concern. On certified weighing installations, all criteria must be considered important.

Assuming you have selected good belt conveyor scale hardware and applied according to the guidelines in this handbook, you should have an installation that performs reliably and provides the weighing accuracy you expected. On-going performance is, of course, dependent on continuing maintenance.

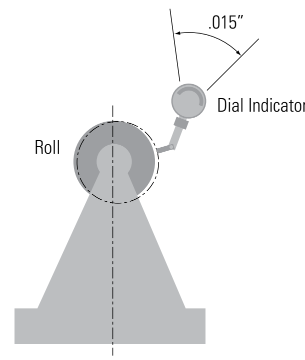


Figure 18: Scale service idlers

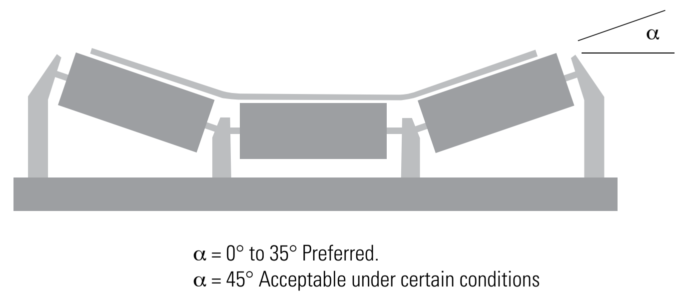


Figure 19: Idler troughing angle

Chapter 7

Continuing maintenance

To achieve the full benefit of the belt conveyor scale, maintenance of the conveyor system and belt conveyor scale area should get adequate attention. Lack of good housekeeping can be a major problem. Keeping the belt conveyor scale area clean should be a primary consideration, particularly in applications where excessive material spillage occurs. The cause of spillage should be investigated and eliminated where possible. Most belt conveyor scale systems are exposed to weather, overloading, etc. Apart from housekeeping, alignment of the troughing rollers should be regularly checked. Normal wear may cause misalignment as might the settling of foundations. Proper functioning of the gravity-type take-up should be checked regularly.

Periodic calibration

Frequent zero calibrations may be impractical although it is recommended to do a daily zero calibration or zero balance. A change in zero balance can be expected over a long period of time due to material buildup on the carriage or belt and idler wear. Zero calibration should only be performed by making a whole number of revolutions. The belt weight variance will be compensated for only if whole number of revolutions are used for zero calibration. Zero shifts in the order of 0.1 to 0.2% of full scale are normally the result of major weather changes, material buildup on the weighbridge, belt tracking, etc. Zero shifts of a larger magnitude normally are conveyor belt related and should be corrected prior to zero calibration. Most belt conveyor scale weighing errors result from improper zero calibration and lack of understanding of factors causing zero calibration shifts or errors.

There are four ways to achieve a span calibration, and the particular scale installation will determine the most practical way of checking and maintaining the span calibration.

- R-Cal
- Billet or static weight
- Calibration roller / matte chain
- Material calibration

The only way to obtain an accurate span setting is to conduct a material test. If a belt scale is calibrated using a material test, for subsequent span checks a span calibration factor will be applied to one or more simulated span calibration methods. Simulated test methods include R-Cal, Billet or Static weight(s) or chain(s). No simulated test is equivalent to a material test. Quite often, a material test is not possible and span calibration can only be performed by using a test chain, test weight, or electronic span R-Cal. Although test chains and/or weights can be expensive and may be difficult to handle, they can provide a better calibration than electronic SPAN (R-Cal) because chains or weights apply actual stresses on to the weighing system. Electronic calibration (R-Cal) is an acceptable alternative for installations with limited access, reduced accuracy requirements or economic limitations.

Accurate record keeping is an important step in any maintenance and calibration program. Without records, severe misalignment and errors due to required mechanical maintenance may go undetected for a long time. A good practice is to record the “as found” and “as left” information. Accurate history via record keeping would reveal a problem during required routine calibrations.

Chapter 8

Special considerations for weight agreement scales

(Trade certifiable / fee for custody transfer belt scale installations)

Overview

There is a significant difference between a Trade Certifiable belt scale and a Trade Certified belt scale.

This chapter provides a basic understanding of the responsibilities for belt scale users that are required by a regulatory agency to be certified or sealed. Approval generally covers the material handling system of which the belt scale is only one component. Rules and regulations pertaining to installation, testing and use of a certified belt scale should be considered prior to the scale actually being tested and approved.

Compliance

Prior to use, the installer should certify to the owner that the scale meets the requirements set forth by the regulatory authority in the geographical region where installed. In the United States this is NIST HB44 and AAR scale HB (Association of American Railroads) when applicable. Similar standards exist in other parts of the world, for example, MID in Europe or NMI in Australia. Material load testing and accuracy verification can only be conducted by an official with statutory authority to determine whether a scale is in compliance.

A complete understanding of the user and testing requirements is a must when designing a belt scale system. The regulatory agency websites are a good source of this information. Knowledgeable belt conveyor scale manufacturers can also help in obtaining this information, and they can advise on particular models or configurations of their belt scales that are trade certifiable.

Testing procedures

All belt scales must be material tested before being used for trade certified (fee for custody transfer) weight agreements. Two, three or more successive material tests may be required to achieve acceptance accuracy and demonstrate repeatability of the belt scale system. Material testing can be a costly item so it is extremely important to consider and plan for this requirement as early in the system design as possible. It is strongly suggested that an on-site material test system be incorporated with the belt scale system design in an effort to reduce excessive cost associated with handling and weighing large amounts of material during material testing. The accuracy of the material test weighing device must be greater than the belt scale being calibrated. Check with your local regulatory agency for any stipulated accuracy requirement of the material test weighing device.

Only once the material calibration is done in accordance with the regulatory requirements by an approved person does a Trade Certifiable belt scale become a Trade Certified belt scale.

Prior to performing a material calibration of a belt scale, a static scale should be available, e.g., a hopper scale or truck weighbridge. The static scale's accuracy should have been verified in a traceable manner prior to performing the material calibration of the belt scale. In-motion track scales and portable scales are not acceptable for most regulatory agencies.

Following a material test, one or more methods of simulated testing is employed to ensure repeatability and maintenance accuracy of the belt scale system until the next material test is required. Material tests are normally required on a semi-annual or annual basis. Refer to the appropriate regulation for the acceptable method of simulated testing where your belt scale is installed.

Commitment and responsibility

Regulations allow for three areas of responsibility:

1. Equipment specifications (manufacturer)
2. Testing procedure and tolerance (regulatory agency)
3. Material handling and belt scale installation (user)

The belt scale manufacturer must assure the user and the regulatory agency that the selected belt scale has been designed to meet the specifications and acceptance tolerance and will maintain the maintenance tolerance, provided that the belt scale is installed, tested and operated in accordance with the manufacturer's written instructions and the regulatory agency's written instructions.

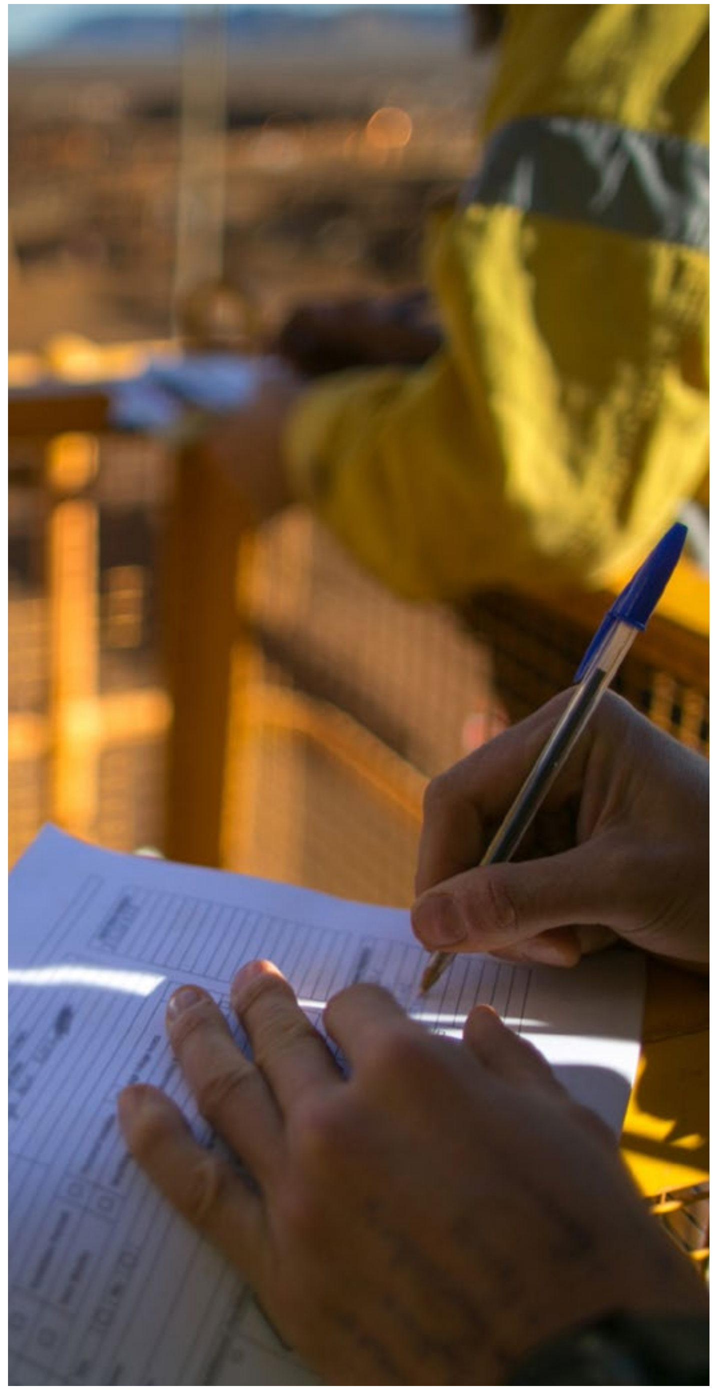
An official with statutory authority can approve the use of belt scales for weight agreements following an accepted material and simulated testing procedure.

The user is responsible for the design, construction, operation, material testing and maintenance of the belt scale system. The ultimate weight agreement is between the user and the regulatory agency. All costs incurred for these requirements are the user's responsibility. Belt scale manufacturers and regulatory agencies will assist the user in any way possible to obtain approval, provided the material handling system is capable of approval.

About Thermo Scientific bulk weighing and monitoring products

The Thermo Scientific line of industrial in-motion weighing, inspection, monitoring and control equipment is used for process control, production monitoring, and automation. Our products are used worldwide in the coal and minerals mining, cement, construction, aggregates for concrete, electric utilities, chemical processing, plastics and food industries, among others.

Our extensive bulk weighing and monitoring product line includes conveyor belt scales, weighbelt feeders, tramp metal detectors, level indicators, and conveyor safety switches, and our manufacturing facilities are ISO 9001 certified.



Service and support

Maintain equipment accuracy and increase longevity with our comprehensive range of service options. We provide premium, customized support with priority response times at a price that meets your budget.

The service team is dedicated to meeting every customer's unique requirements. That is why we offer a choice of service agreements to help you enhance your maintenance and troubleshooting, ranging from quick, convenient telephone support to targeted on-site support. Our experienced customer service organization covers the globe with the help of our channel partners and provides users with technical support, field service, and prompt parts delivery as needed.

We are committed to developing new technologies and creating top-of-the-line parts, accessories, and consumables that enable you to extend the capability of your products, ensure that you keep pace with advancing technology, and achieve the required results. We can retrofit your aging equipment to enhance its performance and functionality, reducing the need to invest in and retrain personnel on new equipment.

Customer satisfaction

We are dedicated to the highest level of customer satisfaction. We pledge to work with you to provide solutions that meet and exceed your specifications, needs, and expectations.

Belt conveyor scale selection guide

Thermo Scientific™ Ramsey™ Series Belt Scales provide vital information that allows you to effectively manage and efficiently operate your business by monitoring production output and inventory or regulating product loadout.

Ramsey Series 10-14 Belt Scale System

High accuracy precision certifiable scale

The Ramsey Series 10-14 scale is specifically designed for high accuracy or basis-of-payment applications requiring certification by government and regulatory agencies. It is extremely accurate to within ±0.125% and is the most widely certified belt scale in the world.

Ramsey Series 10-17 Belt Scale System

High accuracy plant and process scale

The Ramsey Series 10-17 scale is specifically designed for plant and process operations that run at high rates of speed or require the better-than-normal accuracy of ±0.25% with 4 idlers (±0.5% with 2 idlers).

Ramsey Series 10-20 Belt Scale System

Standard plant and process scale

This Ramsey Series 10-20 scale monitors feed to crushers, mills, screens and other processes with an accuracy of ±0.5%, even in the harshest applications.

Ramsey Series 30 Belt Scale System

Basic process control and monitoring scale

The Thermo Scientific™ Ramsey™ Series 30 belt scale system is specifically designed for operations where economy and ease of installation are important considerations.

Ramsey IDEA Belt Scale System

Basic process monitoring scale

The Ramsey Series 10-101-R scale provides basic rate information and totalization functions in processes involving noncritical or lower value materials with an accuracy of ±1%.

Learn more at **thermofisher.com/bulkweighing**