

## Sec. 2.21. Belt-Conveyor Scale Systems

### A. Application

**A.1.** This code applies to belt-conveyor scale systems used for the weighing of bulk materials.

**A.2.** The code does not apply to:

- (a) devices used for discrete weighing while moving on conveyors;
- (b) devices that measure quantity on a time basis;
- (c) check-weighers; or
- (d) controllers or other auxiliary devices except as they may affect the weighing performance of the belt-conveyor scale.

**A.3.** See also General Code requirements.

### S. Specifications

#### S.1. Design of Indicating and Recording Elements.

**S.1.1. General.** - A belt-conveyor scale shall be equipped with a primary indicating element in the form of a master weight totalizer *and shall also be equipped with a recording element, and a rate of flow indicator and recorder (which may be analog).* \* An auxiliary indicator shall not be considered part of the master weight totalizer.

*\*[Nonretroactive as of January 1, 1986]*

(Amended 1986)

**S.1.2. Units.** - A belt-conveyor scale shall indicate and record weight units in terms of pounds, tons, long tons, metric tons, or kilograms. The value of a scale division (d) expressed in a unit of weight shall be equal to:

- (a) 2, or 5, or
- (b) a decimal multiple or submultiples of 1, 2, or 5.

#### S.1.3. Value of the Scale Division.

**S.1.3.1. For Scales Installed After January 1, 1986.** - *The value of the scale division shall not be greater than 0.1 percent (1/1000) of the minimum totalized load.*

*[Nonretroactive as of January 1, 1986]*

**S.1.3.2. For Scales Installed Before January 1, 1986.** - The value of the scale division shall not be greater than 1/1200 of the rated capacity of the device. However, provision shall be made so that compliance with the requirements of the zero-load test as prescribed in N.3.1. may be readily and accurately determined in 20 minutes of operation.

**S.1.4. Recording Elements and Recorded Representations.** - *The value of the scale division of the recording element shall be the same as that of the indicating element. The belt-conveyor scale system shall record the initial indication and the final indication of the master weight totalizer\*, the quantity delivered\*, the unit of measurement (i.e., kilograms, tonnes, pounds, tons, etc.), the date, and time. This information shall be recorded for each delivery.\**

*[Nonretroactive as of January 1, 1986]*

*[\*Nonretroactive as of January 1, 1994]*

(Amended 1993)

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**S.1.4.1.** *The belt-conveyor scale system shall be capable of recording the results of automatic or semi-automatic zero load tests. \*\**

*[\*\*Nonretroactive as of January 1, 2004]*

(Added 2002)

**S.1.5. Rate of Flow Indicators and Recorders.** - *A belt-conveyor scale shall be equipped with a rate of flow indicator and an analog or digital recorder. Permanent means shall be provided to produce an audio or visual signal when the rate of flow is equal to or less than 35 percent and when the rate of flow is equal to or greater than 98 percent of the rated capacity of the scale. The type of alarm (audio or visual) shall be determined by the individual installation.*

*[Nonretroactive as of January 1, 1986]*

(Amended 1989)

**S.1.6. Advancement of Primary Indicating or Recording Elements.** - The master weight totalizer shall advance only when the belt conveyor is in operation and under load.

(Amended 1989)

**S.1.7. Master Weight Totalizer.** - *The master weight totalizer shall not be resettable without breaking a security means.*

*[Nonretroactive as of January 1, 1986]*

**S.1.8. Power Loss.** - *In the event of a power failure of up to 24 hours, the accumulated measured quantity on the master weight totalizer of an electronic digital indicator shall be retained in memory during the power loss.*

*[Nonretroactive as of January 1, 1986]*

(Amended 1989)

**S.2. Design of Weighing Elements.** - A belt-conveyor scale system shall be designed to combine automatically belt travel with belt load to provide a determination of the weight of the material that has passed over the scale.

**S.2.1. Speed Measurement.** - A belt-conveyor scale shall be equipped with a belt speed or travel sensor that will accurately sense the belt speed or travel whether the belt is empty or loaded.

**S.2.2. Adjustable Components.** - An adjustable component that can affect the performance of the device (except as prescribed in S.3.1.) shall be held securely in adjustment.

(Amended 1998)

**S.2.3. Overload Protection.** - The load-receiving elements shall be equipped with means for overload protection of not less than 150 percent of rated capacity. The accuracy of the scale in its normal loading range shall not be affected by overloading.

### S.3. Zero Setting.

**S.3.1. Design of Zero-Setting Mechanism.** - Automatic and semiautomatic zero-setting mechanisms shall be so constructed that the resetting operation is carried out only after a whole number of belt revolutions and the completion of the setting or the whole operation is indicated. *An audio or visual signal shall be given when the automatic and semiautomatic zero-setting mechanisms reach the limit of adjustment of the zero-setting mechanism.\**

(Amended 1999 and 2002)

*Except for systems that do not record the zero load reference at the beginning and end of a delivery, the range of the zero-setting mechanism shall not be greater than  $\pm 2$  percent of the rated capacity of the scale without breaking the security means. For systems that record the zero load reference at the beginning and end of a delivery, the range of zero-setting mechanism shall not be greater than  $\pm 5$  percent without breaking the security means.\*\**

*[\*Nonretroactive as of January 1, 1990]*

*[\*\*Nonretroactive as of January 1, 2004]*

(Amended 1989 and 2002)

**S.3.2. Sensitivity at Zero Load (For Type Evaluation).** - *When a system is operated for a time period equal to the time required to deliver the minimum test load and with a test load calculated to indicate two scale divisions applied directly to the weighing element, the totalizer shall advance not less than one or more than three scale divisions. An alternative test of equivalent sensitivity, as specified by the manufacturer, shall also be acceptable.*  
 [Nonretroactive as of January 1, 1986]

**S.4. Marking Requirements.** - A belt-conveyor scale shall be marked with the following: (Also see G-S.1.)

- (a) the rated capacity in units of weight per hour (minimum and maximum);
- (b) the value of the scale division;
- (c) the belt speed in terms of feet (or meters) per minute at which the belt will deliver the rated capacity;
- (d) the load in terms of pounds per foot or kilograms per meter (determined by materials tests);
- (e) the operational temperature range if other than -10 °C to 40 °C (14 °F to 104 °F).

[Nonretroactive as of January 1, 1986]

**S.5. Provision for Sealing.** - *A device shall be designed using the format set forth in Table S.5. with provision(s) for applying a security seal that must be broken, or for using other approved means of providing security (e.g. data change audit trail available at the time of inspection), before any change that affects the metrological integrity of the device can be made to any electronic mechanism.*

[Nonretroactive as of January 1, 1999]

(Added 1998)

<b>Table S.5. Categories of Device and Methods of Sealing</b>	
<i>Categories of Devices</i>	<i>Method of Sealing</i>
<i>Category 1: No remote configuration capability.</i>	<i>Seal by physical seal or two event counters: one for calibration parameters and one for configuration parameters.</i>
<i>Category 3: Remote configuration capability.</i>	<i>An event logger is required in the device; it must include an event counter (000 to 999), the parameter ID, the date and time of the change, and the new value of the parameter. A printed copy of the information must be available through the device or through another on-site device. The event logger shall have a capacity to retain records equal to ten times the number of sealable parameters in the device, but not more than 1000 records are required. (Note: Does not require 1000 changes to be stored for each parameter.)</i>

[Nonretroactive as of January 1, 1998] (Table Added 1998)

## N. Notes

**N.1. General.** - Belt-conveyor scales are capable of weighing bulk material accurately. (See Tolerances.) However, their performance can be detrimentally affected by the conditions of the installation. (See User Requirements.) The performance of the equipment is not to be determined by averaging the results of the individual tests. The results of all tests shall be within the tolerance limits.

(Amended 2002)

**N.1.1. Official Test.** - An official test of a belt-conveyor scale system shall be a materials test.

**N.1.2. Simulated Test.** - Simulated loading conditions as recommended by the manufacturer and approved by the official with statutory authority may be used to properly monitor the system operational performance between official tests, but shall not be used for official certification.

(Amended 1991)

**N.2. Conditions of Tests.** - A belt-conveyor scale shall be tested after it is installed on the conveyor system with which it is to be used and under such environmental conditions as may normally be expected. It shall be tested at normal use

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capacity and may also be tested at any other rate of flow that may be used at the installation. Each test shall be conducted for:

- (a) not less than 1000 scale divisions,
- (b) at least three revolutions of the belt, and
- (c) at least 10 minutes of operation, or for a normal weighment.

(Amended 1986)

### N.3. Test Procedures.

**N.3.1. Zero Load Tests.** - A zero-load test shall be conducted to establish that the belt scale system (including the conveyor) is capable of holding a stable, in-service zero.

(Amended 1989 and 2002)

**N.3.1.1. Determination of Zero.** - A "Zero-Load Test" is a determination of the error in zero, expressed as an internal reference, a percentage of the full-scale capacity, or a change in a totalized load over a whole number of complete belt revolutions. For belt-conveyor scales with electronic integrators, the test must be performed over a period of at least 3 minutes and with a whole number of complete belt revolutions. For belt-conveyor scales with mechanical integrators, the test shall be performed with no less than three complete revolutions or 10 minutes operation, whichever is greater.

(Added 2002)

**N.3.1.2. Initial Stable Zero.** - The conveyor system shall be run to warm up the belt and the belt scale shall be zero adjusted as required. A series of zero-load tests shall be carried out until three consecutive zero-load tests each indicate an error which does not exceed " 0.06 % of the full-scale capacity or " 1 division, whichever is less. No adjustments can be made during the three consecutive zero-load test readings.

(Added 2002)

**N.3.1.3. Test of Zero Stability.** - The conveyor system shall be run to warm up the belt and the belt scale shall be zero adjusted as required. A series of zero-load tests shall be carried out immediately before the simulated or materials test until the three consecutive zero-load tests each indicate an error which does not exceed " 0.06 % of the full-scale capacity or " 1 division, whichever is less. No adjustments can be made during the three consecutive zero-load test readings.

Immediately after material has been weighed over the belt-conveyor scale during the conduct of the materials test, the zero-load test shall be repeated. The zero error from this test shall not exceed " 0.12 % of the full-scale capacity or " 2 divisions, whichever is less.

(Added 2002)

**N.3.1.4. Check For Consistency of the Conveyor Belt Along Its Entire Length.** - After a zero-load test with flow rate filtering disabled, the totalizer shall not change more than three scale divisions from its initial indication during one complete belt revolution.

(Added 2002)

**N.3.2. Material Tests.** - Material tests should be conducted using actual belt loading conditions. These belt loading conditions shall include, but are not limited to conducting materials tests using different belt loading points, all types and sizes of products weighed on the scale, at least one other belt speed, and in both directions of weighing.

On initial verification, at least three individual tests shall be conducted. On subsequent verifications, at least two individual tests shall be conducted. The results of all these tests shall be within the tolerance limits.

Either pass a quantity of pre-weighed material over the belt-conveyor scale in a manner as similar as feasible to actual loading conditions, or weigh all material that has passed over the belt-conveyor scale. Means for weighing the material test load will depend on the capacity of the belt-conveyor scale and availability of a suitable scale for the test. To assure that the test load is accurately weighed and determined, the following precautions shall be observed:

(Amended 2002)

- (a) The containers, whether railroad cars, trucks, or boxes, must not leak, and shall not be overloaded to the point that material will be lost.
- (b) The actual empty or tare weight of the containers shall be determined at the time of the test. Stenciled tare weight of railway cars or trucks shall not be used. Gross and tare weights shall be determined on the same scale.
- (c) When a pre-weighed test load is passed over the scale, the belt-loading hopper shall be examined before and after the test to assure that the hopper is empty and that only the material of the test load has passed over the scale.
- (d) Where practicable, a reference scale should be tested within 24 hours preceding the determination of the weight of the test load used for a belt-conveyor scale material test.

A reference scale which is not "as found" within maintenance tolerance should have its accuracy re-verified after the belt-conveyor test with a suitable known weight load if the "as found" error of the belt-conveyor scale material test exceeds maintenance tolerance values.

- (e) If any suitable known weight load other than a certified test weight load is used for re-verification of the reference scale accuracy, its weight shall be determined on the reference scale after the reference scale certification and before commencing the belt scale material test.

**Note:** Even if the reference scale is within maintenance tolerance it may require adjusting to be able to meet paragraph N.3.2.1.

- (f) The test shall not be conducted if the weight of the test load has been affected by environmental conditions. (Amended 1986, 1989, 1998, 2000, and 2002)

**N.3.2.1. Accuracy of Material.** - The quantity of material used to conduct a material test shall be weighed on a reference scale to an accuracy within 0.1 percent. Scales typically used for this purpose include Class III and III L scales or a scale without a class designation as described in Handbook 44, Section 2.20., Table T.1.1. (Added 1989) (Amended 1991, 1993, 1998 and 2000)

### **N.3.3. Simulated Load Tests. -**

- (a) As required by the official with statutory authority, simulated load tests as recommended by the manufacturer are to be conducted between material tests to monitor the system's operational performance, but shall not be used for official certification. (Amended 1991)
- (b) A simulated load test consisting of at least three consecutive test runs shall be conducted as soon as possible, but not more than 12 hours after the completion of the material test, to establish the factor to relate the results of the simulated load test to the results of the material tests. (Added 1990)
- (c) The results of the simulated load test shall repeat within 0.1 percent. (Added 1990) (Amended 1989 and 1990)

## **T. Tolerances**

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**T.1. Tolerance Values<sup>1</sup>.** - Maintenance and acceptance tolerances on materials tests, relative to the weight of the material, shall be  $\pm 0.25$  percent of the test load.  
(Amended 1993)

**T.2. Tolerance Values, Repeatability Tests.** - The variation in the values obtained during the conduct of materials tests shall not be greater than 0.25 percent (1/400).

**T.3. Influence Factors.** - The following factors are applicable to tests conducted under controlled conditions only, provided that:

- (a) types of devices approved prior to January 1, 1986, and manufactured prior to January 1, 1988, need not meet the requirements of this Section; and
- (b) new types of devices submitted for approval after January 1, 1986, shall comply with the requirements of the Section; and
- (c) all devices manufactured after January 1, 1988, shall comply with the requirements of this Section.

**T.3.1. Temperature.** - Devices shall satisfy the tolerance requirements at temperatures from  $-10^{\circ}\text{C}$  to  $40^{\circ}\text{C}$  ( $14^{\circ}\text{F}$  to  $104^{\circ}\text{F}$ ).

**T.3.1.1. Effect on Zero-Load Balance.** - The zero-load indication shall not change by more than 0.07 percent of the rated capacity of the scale (without the belt) for a change in temperature of  $10^{\circ}\text{C}$  ( $18^{\circ}\text{F}$ ) at a rate not to exceed  $5^{\circ}\text{C}$  ( $9^{\circ}\text{F}$ ) per hour.

**T.3.1.2. Temperature Limits.** - *If a temperature range other than  $-10^{\circ}\text{C}$  to  $40^{\circ}\text{C}$  ( $14^{\circ}\text{F}$  to  $104^{\circ}\text{F}$ ) is specified for the device, the range shall be at least  $30^{\circ}\text{C}$  ( $54^{\circ}\text{F}$ ).*  
*[Nonretroactive as of January 1, 1990] (Added 1989)*

**T.3.2. Power Supply, Voltage, and Frequency.** - A belt-conveyor scale system shall satisfy the tolerance requirements over a range of 100 V to 130 V or 200 V to 250 V as appropriate and over a frequency range of 59.5 Hz to 60.5 Hz.

## UR. User Requirements

**UR.1. Use Requirements.** - A belt-conveyor scale system shall be operated between 35 percent and 98 percent of its rated capacity.

**UR.1.1. Minimum Totalized Load.** - Delivered quantities of less than the minimum test load shall not be considered a valid weighment.

**UR.1.2. Security Means.** - When a security means has been broken, it shall be reported to the official with statutory authority.  
(Amended 1991)

**UR.2. Installation Requirements.**

**UR.2.1. Protection from Environmental Factors.** - The indicating elements, the lever system or load cells, and the load-receiving element of a belt-conveyor scale shall be adequately protected from environmental factors such as wind, moisture, dust, weather, and radio frequency interference (RFI) and electromagnetic interference (EMI) that may adversely affect the operation or performance of the device.

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<sup>1</sup> The variables and uncertainties included in the relative tolerance represent only part of the variables that affect the accuracy of the material weighed on belt-conveyor scales. If this tolerance was based on an error analysis beginning with mass standards through all of the test processes and following the principle expressed in Section 3.2. of the Fundamental Considerations in Appendix A, the tolerance would be 0.5 percent.  
(Added 1993)

**UR.2.2. Conveyor Installation.** - The design and installation of the conveyor leading to and from the belt-conveyor scale is critical with respect to scale performance. The conveyor may be horizontal or inclined, but if inclined, the angle shall be such that slippage of material along the belt does not occur. Installation shall be in accordance with the scale manufacturer's instructions and the following:

(Amended 2002)

- (a) **Installation - General.** - A belt-conveyor scale shall be so installed that neither its performance nor operation will be adversely affected by any characteristic of the installation, including but not limited to, the foundation, supports, covers, or any other equipment.  
(Amended 2002)
- (b) **Live Portions of Scale.** - All live portions of the scale shall be protected by appropriate guard devices to prevent accidental interference with the weighing operation.
- (c) **Storage of Simulated Load Equipment.** - Suitable protection shall be provided for storage of any simulated load equipment.
- (d) **Take-up Device.** - If the belt length is such that a take-up device is required, this device shall be of the counter-weighted type for either vertical or horizontal travel.
- (e) **Scale Location and Training Idlers.** - The scale shall be so installed that the first weigh idler of the scale is at least 6 m (20 ft) or 5 idler spaces, whichever is greater, from loading point, skirting, head or tail pulley, or convex curve in the conveyor. Any training idler shall be located at least 18 m (60 ft) from the centerline of the weigh span of the scale. Training idlers shall not be restrained at any time in order to force belt alignment.  
(Amended 1998)
- (f) **Concave Curve.** - If there is a concave curve in the conveyor, before or after the scale, the scale shall 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.<sup>2</sup> A concave curve shall start no closer than 12 m (40 ft) from the scale to the tangent point of the concave curve.  
(Amended 1998)
- (g) **Tripper and Movable Pulleys.** - There shall be no tripper or movable head pulleys in the conveyor.
- (h) **Conveyor Length.** - *The conveyor shall be no longer than 300 m (1000 ft) nor shorter than 12 m (40 ft) from head to tail pulley.*  
*[Nonretroactive as of January 1, 1986]*
- (i) **Conveyor Orientation.** - The conveyor may be horizontal or inclined, but, if inclined, the angle shall be such that slippage of material along the belt does not occur.
- (j) **Conveyor Stringers.** - Conveyor stringers at the scale and for not less than 6 m (20 ft) before and beyond the scale shall be continuous or securely joined and of sufficient size and so supported as to eliminate relative deflection between the scale and adjacent idlers when under load. The conveyor stringers should be so designed that the deflection between any two adjacent idlers within the weigh area does not exceed 0.6 mm (0.025 in) under load.
- (k) **Identification of Scale Area.** - The scale area and 5 idlers on both ends of the scale shall be of a contrasting color, or other suitable means shall be used to distinguish the scale from the remainder of the conveyor installation, and the scale shall be readily accessible.

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<sup>2</sup> Installing the belt scale 5 idler spaces from the tail pulley or the infeed skirting will be in the area of least belt tension on the conveyor and should produce the best accuracy. The performance of a belt-conveyor scale may be adversely affected by a concave curve in the conveyor that is located between the loading point and the scale. Therefore, whenever possible, a belt-conveyor scale should not be installed with a concave curve in the conveyor between the loading point and the scale.

(Amended 1995 and 1998)

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(Amended 1998)

- (l) **Belt Composition and Maintenance.** - Conveyor belting shall be no heavier than is required for normal use. In a loaded or unloaded condition, the belt shall make constant contact with horizontal and wing rollers of the idlers in the scale area. Splices shall not cause any undue disturbance in scale operation (see N.3.).  
(Amended 1998, 2000, and 2001)
- (m) **Uniformity of Belt Loading and Flow.** - The conveyor loading mechanism shall be designed to provide uniform belt loading. The distance from the loading point to the scale shall allow for adequate settling time of the material on the belt before it is weighed. Feeding mechanisms shall have a positive closing or stopping action so that material leakage does not occur. Feeders shall provide an even flow over the scale through the full range of scale operation. Sufficient impact idlers shall be provided in the conveyor under each loading point to prevent deflection of the belt during the time material is being loaded.
- (n) **Belt Alignment.** - The belt shall not extend beyond the edge of the idler roller in any area of the conveyor.  
(Amended 1998)

**UR.2.3. Material Test.** - *A belt-conveyor scale shall be installed so that a material test can be conveniently conducted.*

*[Nonretroactive as of January 1, 1981]*

**UR.2.4. Belt Travel (Speed or Velocity).** - The belt travel sensor shall be so positioned that it accurately represents the travel of the belt over the scale for all flow rates between the maximum and minimum values. The belt travel sensor shall be so designed and installed that there is no slip.

### UR.3. Use Requirements.

**UR.3.1. Loading.** - The feed of material to the scale shall be controlled to assure that, during normal operation, the material flow is in accordance with manufacturer's recommendation for rated capacity.

**UR.3.2. Maintenance.** - Belt-conveyor scales and idlers shall be maintained and serviced in accordance with manufacturer's instructions and the following:

- (a) The scale and area surrounding the scale shall be kept clean of debris or other foreign material that can detrimentally affect the performance of the system.
- (b) Simulated load tests or material tests, and zero load tests shall be conducted at periodic intervals between official tests in order to provide reasonable assurance that the device is performing correctly.

The action to be taken as a result of the material tests or simulated load tests is as follows:

(Amended 2002)

- if the error is less than 0.25 percent, no adjustment is to be made;
- if the error is at least 0.25 percent but not more than 0.6 percent, adjustment may be made if the official with statutory authority is notified;  
(Amended 1991)
- if the error is greater than 0.6 percent but does not exceed 0.75 percent, adjustments shall be made only by a competent service person and the official with statutory authority shall be notified. After such an adjustment, if the results of a subsequent test require adjustment in the same direction, an official test shall be conducted;  
(Amended 1991)
- if the error is greater than 0.75 percent, an official test is required.  
(Amended 1987)



- (c) Scale Alignment. - Alignment checks shall be conducted in accordance with the manufacturer's recommendation when conveyor work is performed in the scale area. A material test is required after any realignment.  
(Amended 1986 and 2000)
- (d) Simulated Load Equipment. - Simulated load equipment shall be clean and properly maintained.
- (e) Zero Load Reference Information. – When zero load reference information is recorded for a delivery, the information must be based upon zero load tests performed as a minimum both immediately before and immediately after the totalized load.  
(Added 2002)  
(Amended 2002)

**UR.3.3. Retention of Maintenance, Test, and Analog or Digital Recorder Information.** - Records of calibration and maintenance, including conveyor alignment, analog or digital recorder, zero-load test, and material test data shall be maintained on site for at least the three concurrent years as a history of scale performance. Copies of any report as a result of a test or repair shall be mailed to the official with statutory authority as required. The current date and correction factor(s) for simulated load equipment shall be recorded and maintained in the scale cabinet.  
(Added 2002)

**UR.4. Compliance.** - Prior to initial verification, the scale manufacturer or installer shall certify to the owner that the scale meets code requirements. Prior to initial verification and each subsequent verification, the scale owner or his agent shall notify the official with statutory authority in writing that the belt-conveyor scale system is in compliance with this specification and ready for material testing.  
(Amended 1991)

