Lorne Danielson, TD Micronic, Canada, outlines the development of conveyor belt scales in line with continually evolving legal standards that provide new levels of accuracy and commercial certainty.

A DEGREE OF ACCURACY

Since their invention in 1908, belt scales have evolved from mechanical marvels to sophisticated computer-based measuring systems. The convenience and continuous weighing becomes increasingly advantageous for larger quantities of bulk material with flowrates of several thousand tonnes per hour.

Testing requirements and accuracy standards for scales are determined by government authorities within various jurisdictions. Having gone through this process and met the requirements, a scale is said to be 'trade certified' or 'legal for trade', and provides the owner with the legal authority to use the scale as a basis for commercial transactions.

Worldwide, there are three major standards for the approval of scales:

- The International Organisation of Legal Metrology (OIML), for Europe and Australia.
- The National Type Evaluation Program (NTEP), for the USA.
- Measurement Canada, for Canada.

The approval process of 'legal for trade' for scales of all types begins at the government's laboratory with a series of evaluations and tests. These include the verification of scale operations and extensive testing of their sensitivity to external factors. This process is done using static weights and simulated belt speeds. Having passed these tests, the scale is then field-tested according to procedures of the regulatory authority.

Most 'legal for trade' scales are static weighing devices supplied as a complete weighing system. Accuracy verification is carried out by placing certified test weights (or rail test cars) on the scales and verifying the accuracy of the reading. While worldwide standards and verification procedures vary, most static scales for bulk products are certified to about 0.1% accuracy.

Conveyor belt scales that are continuously in motion must simultaneously process weight and belt travel while the material passes by at up to 6 m/sec. They are incorporated into existing conveyor systems of varying lengths, inclines, belt tensions, flowrates and speeds. Furthermore, they are subject to a variety of external factors which scale manufacturers must endeavour to accommodate. The accuracy of such complex devices can only be determined using known quantities of bulk product in test runs replicating actual scale usage.

Unlike more simple static scales, the regulations and standards for 'legal for trade' conveyor belt scales have differed substantially between the three major jurisdictions.

Work by NTEP and Measurement Canada has resulted in significant improvements and this article will focus on these and their impact on automatic weighing of dry bulk commodities.

Changes by the NTEP and Measurement Canada address four areas:

- Accuracy.
- Flowrates for certification.

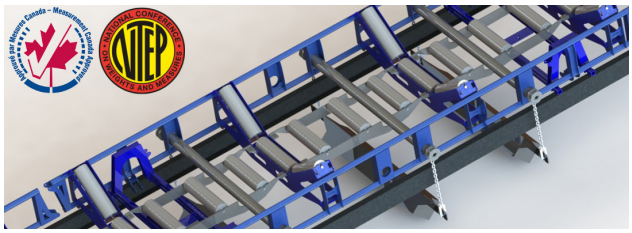

Figure 1. Precision Weighframe design for optimal accuracy.

Figure 2. Conveyor belt scales utilise existing infrastructure for accurate weighing.

- Long-term stability.
- Quantity of test material.

Accuracy

The OIML offers 0.5%, 1.0% or 2.0% accuracy ratings; these are noticeably insufficient to meet most 'legal for trade' requirements.

The NTEP accuracy ratings for conveyor belt scales are 0.25%, which had been the most demanding for belt scales until 2006.

Measurement Canada's 'legal for trade' belt scales are approved to +/- 0.5% accuracy. This restricts their use to cheap materials or to determine the value of freight charges.

The noticeably lower accuracy ratings for belt scales worldwide is indicative of the challenges encountered in automatic weighing. And has also limited their acceptance as 'legal for trade' devices where most would typically be accepted at 0.1%.

In 2006, Measurement Canada allowed belt scales to be approved to 0.1% according to Article R174 of the Act. This was a significant step, requiring certification tests to have a maximum limit of error of +/- 0.075%. No other standard in the world provides such a tight margin of error for conveyor belt scales.

Flowrates for certification

In Canada and the US, material tests have been conducted at a single predetermined flowrate, with significant effort being made to maintain the specified flowrate. Although the intent is to replicate normal production flowrates, the implementation of specified test quantities can result in flowrates not exactly of those in day-to-day use. So, it is possible during normal operation that flowrates may not reflect those of the closely controlled field tests.

It was also generally believed that belt scales were linear and performed 'very well' over wider flowrates. However, this was rarely verified, and the testing of existing approved devices at other flowrates unveiled surprises for most installations.

Real operating conditions vs test conditions resulted in scale discrepancies that were difficult to explain and did not serve to build confidence in belt scales as a 'legal for trade' device. Addressing this, the NTEP revised field-testing to address this by including mandatory testing at varying flowrates and belt speeds (when applicable). Scales certified after 2017 are required to meet the limits of errors at three different flowrates.

Canada adopted similar guidelines in 2014. Belt scales certified through Article 174 of the Measurement Canada Act after 2014 are within 0.1% from lowest to highest flowrates. This is an exceptional performance standard exceeding that of any other standard for conveyor belt scales worldwide.

Verification of belt scale accuracy over a wide range of operating flowrates is a significant step in providing improved accuracy for day-to-day operations.

Long-term stability

At initial certification, the scale must meet regulatory limits of error. This tolerance is lower than the accuracy class so as to provide some allowance for additional factors not present on test day. (i.e. temperature, mechanical wear and electronic drift).

While static scales are also subject to 'drift', the complexity of belt scales makes them more susceptible to changes in calibration. For example, belt scale performance is known to be dependent upon the conveyor belt, which wears and stretches as it ages. It is expected that the belt scale will require some tweaking to correct for these changes in the belt. Most regulatory authorities require the scale be checked/recertified when the belt is changed. However, this does nothing to address the errors in measurement that occurred with normal wear of the belt and previous to recertification.

The NTEP standards have long recognised the importance of scale stability and incorporate a second 'permanence test' as part of the original device approval. This test is a complete repeat of the initial certification and is conducted 6 - 12 months after initial certification. No calibration changes are permitted during this time between initial and permanence certifications. If test results are still within tolerance margins then the conveyor belt scale receives approval.

The NTEP also requires annual certifications for every 'legal for trade' scale. While some adjustment is expected annually if year to year metrological changes are small, there is a reasonable level of certainty that NTEP certified scales have been performing correctly between their certifications.

Measurement Canada has not had a mandatory recertification policy leaving it to the owner to determine test intervals. In 2017, Measurement Canada revised their

Figure 3. Conveyor belt scales provide instantaneous assessment of loaded product and increase port efficiencies.

compliance policy to two years mandatory testing for mining-related conveyor belt scales.

The adoption of regular certification intervals provides confirmation they are performing correctly and can be relied upon as accurate 'legal for trade' scales. Good scales with regular maintenance inspections will pass material certifications with minimal adjustments.

Quantity of test material

As the field certification for conveyor belt scales requires actual product testing, the process requires considerable site planning and outside resources.

Typical site-specific test requirements for a 6000 tph belt scale certification include:

- A reference scale (track scale and certified rail test car or alternative) and a reference scale technician.
- 5000 t of accurately measured product.
- An operations crew and site equipment for the movement of the product.
- Storage of the product (train/ship/trucks to receive product.
- A belt scale technician.
- A government inspector.
- Favourable weather (certifications usually restricted to dry weather).

In Canada and the US, the certification test runs typically require a minimum of six product runs, each lasting a 10 min. duration. If rail cars are used, 5000 t requires the weighing of 50 full rail cars and 50 emptied cars. Accurate measurements require the cars to be decoupled; this is a primary determinant in time and effort required for a certification.

Measurement Canada now allows tests to be as small as 2% of the scale's one hour capacity. While the actual quantity of material requires further site-specific analysis, the result of this is that these new guidelines can reduce the time and effort to less than half previously required.

NTEP has also introduced similar provisions that allow reduced quantities of material for subsequent certifications of belt scales.

Minimising the time and effort required for recertification is a significant plus for the industry where the material certifications may demand significant site resources.

Case study

Canpotex is one of the world's largest exporters of potash. Potash is used worldwide as a crop nutrient and is exported from Canada to approximately 40 countries worldwide. At their Vancouver and Portland terminals, certified belt scales are used to measure the quantity of material shipped.

A port upgrade in 2014 provided a new scale with certification following the NIST's latest requirements highlighted previously. The Initial field (November 2015) and permanence test (October 2016) confirmed maximum limits of error of +0.08% at low, medium and high flowrates.

Subsequent recertification in July 2018 confirmed a maximum error of +0.10%. No calibration adjustments were made during these three years of operation.

Certification at various flowrates and annual certifications has facilitated significant advances in the accuracy and stability of belt scales at Portland. Three years of accurate calibration operations without recalibration represents a very solid level of performance for any 'legal for trade' scale.

Integrity of commercial transaction

Many bulk material transactions are worth tens of millions of dollars and commercial certainty is very important.

Upon shipment the shipper declares the quantity of material shipped. When the shipment is received, the customer may find reason to believe the received quantity is less than the tonnage claimed by a shipper. Such circumstances may result in discussions concerning the functioning of the scale used for that shipment and the appropriate dollar value for that transaction.

As belt scales become a permanent adjunct to a conveyor belt system, they require either additional real estate or time to obtain a measurement of quantity. The use of a second (redundant) 'legal for trade' scale provides a continuous real time cross-check of material shipped.

Canpotex utilises redundant scales for most of their potash exports and they have provided an accurate and reliable measurement for hundreds of millions of tonnes of potash shipped worldwide.

Conclusion

Conveyor belt scales and standards have existed for over a century (NTEP formed in 1901), however they have not traditionally provided accuracy levels associated with 'legal for trade' scales. Conveyor belt scales tested and approved under the newer North American standards now provide accuracy levels previously attainable only with simpler static scales. Furthermore, they provide accuracy levels several times more than commonly used ship's 'draft survey'.

Conveyor belt scales have proven to provide levels of efficiency and performance unmatched by any other method of measuring dry bulk product. The utilisation of 'legal for trade' scales ensures all parties receive a fair and accurate valuation. DB

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