Vehicle Weighing

Compliance & Weighing Systems

Considerations for Waste Facilities

Waste processing facilities are critical to modern life and commerce. They are key contributors to public health, municipal cleanliness, and the management of renewable resources and materials.

Waste material is often collected by a familiar fleet of local vehicles. However, the end destination of this material is typically a considerable distance from its origin. The end destination may be a recycling center, power generation facility, or landfill. Waste processing operations transport, categorize, consolidate, weigh, record, and redistribute waste materials.

In recent decades, population increases have increased the capacity requirements of waste processing facilities. Simultaneously, new and expanded regulations for environmental impact factors, as well as material reprocessing, have imposed further demands. This has made regulatory compliance issues a constant component of waste management operations.

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1 Background in Legislation and Regulations

In the United States, the Resource Conservation and Recovery Act (RCRA) of 1976 defines the federal government involvement in solid waste pollution regulation. Individual states are additionally required to design a solid waste management strategy, and have the ability to enact further regulations beyond the federal standards. One effect of the RCRA has been a drastic decrease in the number of operating landfills in the United States. Total landfills in 1988 numbered 8,000, but just 20 years later only 1,654 remained open.

Mandatory separation of recyclable material has become a popular policy. For example, in 2003 the United Kingdom passed the Household Wastes Recycling Act. This legislation required collection of a minimum of two categories of recyclables, as governed by local authorities, by 2010. Separation of recyclable material is becoming a commonplace requirement to varying extents around the globe.

Additional regulations address a processing facility's impact on the surrounding environment. This often includes water runoff and air quality or emissions standards. Urban locations are often subject to regulations pertaining to the surrounding community. In addition to water and air quality standards, this can include:

- Noise
- Odor
- Dust
- Pests
- Traffic

Some of these factors can be controlled through facility cleanliness. When designing a new facility or upgrading and maintaining an existing operation, the ability to incorporate regular cleaning procedures should be considered. Equipment will need to be able to withstand an entire lifespan of coming in to contact with unpredictable waste materials, as well as the cleaning process to remove them. This is indeed a tall order for nearly any type of equipment.

2 Vehicle Weighing Equipment

Using Weight Information

Weight has long been a primary measure at waste management and transfer facilities. Weight information is typically utilized in numerous ways, for daily operations and ongoing analysis.

- **Transaction Management**
  Many companies use their vehicle scale like a cash register. Incoming trucks are weighed on arrival, and again after unloading to calculate the net weight of the material they have deposited. In small facilities, a single scale can be used to weigh the trucks in both instances. Larger facilities, however, can benefit greatly from having separate incoming and outgoing scales. Using two or more scales can also provide a contingency plan if one scale should experience a problem and become temporarily inoperable. In this situation, one scale could be used for both incoming and outgoing traffic.

- **Transport Operations**
  Vehicles leaving facilities with processed or separated waste materials rely on weight readings to ensure that they are within their maximum weight capacity and do not exceed legal load limits. Axle weight limits are dictated by government entities, such as local transportation authorities. Specific weight limits for bridges or individual roadways should also be considered. These limits are imposed for numerous reasons:
  - Physical safety threshold of the vehicle
  - Type of material being transported
  - Local terrain and environment
  - Long-term road and rail wear factors

  Serious penalties can result from noncompliance with these regulations. Collisions, injuries, and deaths resulting from exceeding weight limits have been litigated with huge financial implications. For these many reasons, highly accurate weighing

equipment can play a role in maximizing the safety, efficiency, and legal status of transport operations.

- **Strategic Analysis**
  Weight information is also used in managing strategic operations. This includes collection route trends, annual reporting, and facility capacity analysis. Capturing data efficiently and effectively aids in these goals. Organizing and storing the right information is critical to utilizing weight data as a strategic metric.

Scale Reliability and System ROI

Reliability is an important and practical consideration for waste facility weighing equipment. Any scale downtime can disrupt daily collection schedules and lead to questionable "guessing" at vehicle weights. Various features of modern scale systems have made strides in increasing reliability in challenging environments. These improvements can be realized in many waste management operations. For example, durable stainless steel enclosures, cable protections, and predictive diagnostics put some new scale systems far beyond conventional systems in terms of reliability.

In operations that process significant volumes of material, avoiding just a seemingly small amount of financially disruptive downtime could, over time, offset the cost of a new vehicle scale system. The elimination of unplanned service events can result in significant savings and productivity increases that continue to add up over the life of a reliable, fully supported vehicle weighing solution.

When considering a new or upgraded vehicle scale, it can be wise to insist on a system offering the features and protections best suited to maximize uptime in your environment and application. The one-time cost of a high-quality scale system can repay itself in dividends by avoiding significant unplanned downtime over its useful life.

Some organizations do not realize what just one day of scale downtime can mean to their business. Either profit can be lost as a direct result of operations being shut down, or multi-scale capacity is diverted to a single scale or overtime, which increases operation costs and lowers profitability.

Downtime effect example #1

Days of downtime:	1
Number of trucks per day:	50
Net load per truck:	30,000 lbs
Price of goods per pound:	$0.02
Profit margin	25%
Profit lost or diverted	**$7,500**

Downtime effect example #2

Days of downtime:	1
Number of trucks per day:	200
Net load per truck:	30,000 lbs
Price of goods per pound:	$0.02
Profit margin	25%
Profit lost or diverted	**$30,000**

Cable Protections

In both indoor and outdoor applications the quality of a system's cables can be critical. Given their location beneath a weighbridge, vehicle scale load cell cables are often the victim of physical damage and chewing rodents. Traditional cables are shielded with plastic insulation and sheathing, providing little protection from physical harm.

Since the failure of a single cable can cripple the entire system, there has recently been an increased focus on cable integrity protections. The premier offerings in this regard are double-shielded stainless steel cables. Beyond physical protection from chewing rodents and other damage, this double shielding can act as a faraday cage against radio frequency interference. Cable protections are important, and should not be overlooked.

Connections are another critical element. Advancements in cable connection hardware has led to some load cell and cables being equipped with IP68 (submersible) quality connections. Some can even be connected and disconnected without the use of tools. Previous load cells had avoided connection problems by integrating the cable and the load cell as a single unit. While this may have helped seal the system,

there were major drawbacks to this configuration. Namely, if a cable became compromised and needed to be replaced, the entire load cell had to be removed and replaced. This process was very time and labor intensive. One major advantage to new cable connection technology is the ability to replace a cable quickly and easily, without removing any load cells.

Scale Cleanliness

The area around a truck scale can be a difficult to clean. Pit-style scales are often designed with limited service access points, and limited drainage for rain and spillage collection from transport vehicle traffic. Over a short time, these substances can collect under or near the scale structure. This creates a haven for buildup leading to mechanical obstructions, rodent problems, and odors.

The ability for equipment to be cleaned, through the use of pressurized spray or other means, can be advantageous. A notable caution is that many conventional truck scales rely on junction boxes to interface with the load cells. These boxes are difficult to seal against outdoor environmental elements, meaning moisture ingress can harm the exposed electronic connections inside. Junction boxes are, in fact, a leading cause of vehicle scale problems.

Some new scale systems, however, no longer rely on junction boxes, and now offer IP68/IP69k waterproof cable connections. These features can be very helpful to waste facilities in adhering to increasing cleanliness guidelines, especially in populated areas where community regulations requiring increased cleanliness are more likely a concern.

Legal for Trade Accuracy Standards

In most cases, when a scale is used as part of business operations, it must conform to legal-for-trade standards. These regulations protect the parties involved in a weight transaction by defining the legal accuracy tolerances for weighing equipment. While these standards do offer a certain level of protection, they can lead to a false sense of security. A vehicle or heavy capacity industrial scale can indeed have significant error, even while meeting the legal requirements for accuracy. This is because calibration standards do not ensure that a scale is completely error-free. For example:

- **OIML** (The International Organization of Legal Metrology) standards are accepted in much of Europe. These standards permit up to 30kg of error on the average truck scale during legal calibrations.

- **NTEP** (The National Conference on Weights and Measures) governs scales in the United States. The average truck scale is permitted to have 60lbs of error during legal calibrations by these standards.

- Similar requirements exist throughout the world.

Once calibrated to these tolerances, influential factors can soon result in even more weighing error. With the combination of legal calibration tolerance error, and typical influential factor error, an average vehicle scale does not weigh with true precise accuracy. For operations that utilize weight as a key transaction measure, such as waste processing, scale error can quickly have a negative effect on the financial bottom line.

Error effect example #1

Number of trucks per day:	50
Net load per truck:	30,000 lbs
Price of goods per pound:	$0.02
Scale error (light):	60 lbs (within legal-for-trade)
Monthly profit lost	**$1200**

Error effect example #2

Number of trucks per day:	200
Net load per truck:	30,000 lbs
Price of goods per pound:	$0.02
Scale error (light):	60 lbs (within legal-for-trade)
Monthly profit lost	**$4800**

System Accuracy Factors

To meet legal requirements, most scales used in industrial applications must be certified and/or calibrated at certain intervals. This ensures accuracy within local regulatory tolerances. These scheduled verifications are standard because scale components can be influenced by a number of factors. Over time, these and other influences can decrease a scale's accuracy:

- Temperature fluctuations
- Moisture / humidity
- Radio frequency interference
- Voltage fluctuations
- Physical damage
- Obstructions
- Duty cycles & fatigue

Some of these factors are particularly influential to analog load cells. Analog systems rely on small microvolt signals which can present more opportunities for disruption and errors. In contrast, digital load cell systems use more powerful signals. Digital systems can also incorporate monitoring systems and compensation algorithms that allow them to maintain accuracy despite large fluctuations in the conditions above. This can result in a dramatic increase in accuracy over analog systems, and an enhanced ability for a scale to meet or exceed regulatory accuracy standards over time.

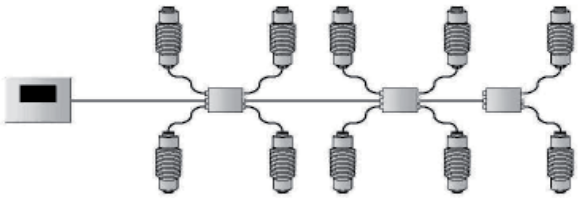
Statistics gathered by field service technicians performing regular maintenance and calibrations have indicated that analog cells are 4 times more likely to have some amount of weighing error than high quality digital load cells. In fact, analog cells are 10 times more likely to have a weighing error of over 60lbs (30kg), than their high-end digital counterparts that utilize compensation algorithms.

Knowing Digital- vs. Analog Systems

Knowing the differences between analog and digital systems can help a facility choose the best system to meet their needs throughout the entire life of the scale. The new features associated with digital weighing system technology can be especially advantageous to meeting the demanding needs of waste processing operations.

Conventional analog load cell systems are comprised of multiple load cells connected to junction boxes, also known as summation boxes, sectional controllers, or similar terminology. One problem with these systems can be a lack of the ability to notice a problem with an individual load cell. A problematic load cell could be outputting large errors, or even no signal at all, but since multiple signals are being combined before reaching the terminal, the problem can be very difficult to notice, confirm, diagnose, and resolve. This can result in extensive troubleshooting for 6-8 hours, simply to determine the source of the error, with the scale inoperable during this time.

In some systems, the analog signals from the load cells are converted to a stronger digital signal within the junction box. This can offer some advantages over completely analog systems. However, the analog output from each load cells is still susceptible to many potentially detrimental factors in the load cell and junction box network interface. Electronics within the junction box are susceptible to a host of environmental elements, as the boxes are notably difficult to seal. To avoid these issues, some new systems offer digital output directly from the load cell, creating a significant benefit in signal accuracy and reliability.



A conventional load cell network with junction boxes

In some digital systems, built-in electronic processing within each load cell produces digital signal output. Microprocessing within each load cell can allow it to be more precise, through the use of digital compensation algorithms for influences such as temperature. The digital signal is also stronger, and can allow for constant monitoring of the performance of each individual load cell. Some digital output systems also introduced the unique ability to eliminate troublesome junction boxes. This can be a significant advantage, especially in harsh applications and demanding en-

vironments, such as the wet environments most truck and rail scales are used in.

Much like modern automobiles have sensory equipment for early detection of operational abnormalities, modern scale systems can also monitor their own performance. Advanced diagnostic systems can immediately alert the user to any inconsistencies, allowing for a high standard of accuracy to be actively maintained. These systems can also make any professional service troubleshooting much more precise, making service more effective and efficient.

A cell-to-cell network, designed to eliminate junction boxes and limit the number of connection points

The features of a system with digital load cell output and predictive diagnostics can mean a dramatic increase in scale accuracy and a noticeable reduction in unplanned downtime. With regular scheduled maintenance, scale owners can be afforded a higher level of predictable performance than ever before.

Hydraulic Scale Systems

Hydraulic systems utilize purely mechanical components within the scale itself, which are connected via numerous fluid lines to a summing unit. This unit may be located near the scale, or even within the scale house. The summing unit contains a load cell which measures the force of the fluid being displaced by the weight on the scale.

The advantages of these systems include their ability to locate most electronic components inside the scale house. They are also known to offer very stable scale platforms. In consistent environments, hydraulic systems can perform well in many applications.

Without the electronic monitoring that digital systems offer, however, it can be much more difficult to notice and diagnose a hydraulic system with weighing error. Systems with automatic zero adjustments that lose small amounts of fluid can create compounding error that can go unnoticed until the next calibration check. Tiny leaks can create "hidden" problems at any time. Breach of fluid system integrity or the vast number of fluid line connections is a constant risk.

Waste facilities should consider the possible difficulty of servicing a hydraulic system. Troubleshooting these systems can be a labor intensive process, and can require access to fluid lines beneath the scale. Some systems can also require periodic purging of fluid systems, or seasonal adjustments to adapt to temperature changes. Waste facilities should be familiar with these procedures and know how the maintenance requirements will affect their operation.

Lightning Strike Protection

A lightning strike can put a vehicle scale out of service in an instant. Even if a warranty or insurance policy covers repair costs, the facility still faces the cost of business lost every day the scale is not operating during the logistics of a repair or replacement. This makes high-quality integrated lightning strike protection a significant long-term value-added feature.

While many manufacturers of vehicle scales offer a warranty that covers the repair of their scale when exposed to lightning, the level of coverage provided under those warranties varies tremendously. Many of these policies are simply referred to as a 5 year warranty. However, it is a recommended best practice to get the details of the warranty in writing from the actual manufacturer of the vehicle scale, not just from the seller or distributor. Specific language in the warranty should address the level of labor, parts, and travel that are covered to address damage resulting from lightning strikes. If labor is not specifically covered, the owner of the scale will likely be responsible for as much as 70% of the cost of the repair with no cap on their financial exposure.

Effective lightning damage prevention systems do exist. Modern lightning protection can shield an entire vehicle scale system including load cells, cables, and terminal. Internal on-board surge protectors redirect voltage surges away from sensitive electronics, creating a barrier of protection. Single-point grounding keeps scales up and running in circumstances where

Laboratory testing of lightning strike protection

electrical damage would previously have knocked a scale out of operation.
The average lightning strike is 30,000 amperes, but can be higher. Ideally, a built-in lightning surge protection system should withstand up to a 40,000 ampere surge.

3 Floor Scales

Although waste material is often handled and weighed in vehicles, some may be weighed in smaller quantities. Forklifts, pallets, and other smaller receptacles may be weighed on floor-level scales. These scales are often installed in pits, leaving the scale platform flush with the floor of the facility. Though smaller, many of the same considerations for performance and reliability can be considered in floor scale equipment.

Beyond maximum load capacity, end loading capability should allow for accurate weighing of concentrated loads. Frames and bumpers should be designed with heavy duty cycles in mind. Additionally, the pit environments can easily harbor buildups of waste material, rodents, and other challenges. Selecting a scale model designed to withstand these elements can mean higher reliability, less downtime, and a longer service life.

4 Peripheral Equipment

Traffic Controls

Regulations for transfer stations often include standard requirements for vehicle traffic controls. This is especially important in and around the scale area, as it may be the initial bottleneck to create a traffic queue during peak times. Ensuring a safe traffic flow pattern, with features like staging areas to keep queuing vehicles from backing up on public roadways, is important. Incorporating sufficient traffic control systems not only ensures procedural and equipment standards, it can also generate an incremental improvement in load processing time.

Traditional traffic control equipment for scale operations has consisted of gates and lights which are manually operated by the operators within the scale house. While sufficient, this may be less than optimal. This is because scale house operators are also tasked with maintaining accurate weight records, data entry, and in many cases, the initial inspection of incoming loads. With the increased regulations pertaining to these initiatives, the ability to streamline traffic flow lets any scale operators focus on these other important tasks.

Automated traffic control systems can be integrated into scale systems. Gates and lights can be programmed with custom criteria to keep trucks flowing in and out the scale area without delays. This can contribute to creating an overall efficient and repeatable processing operation.

Automated Transactions and Components

Unattended, or automated, weighing equipment is designed to let drivers input information and process a weighing transaction without the aid of a scale operator. Waste management operations can be prime candidates to benefit from these systems. In functions where there is high repetition, automated solutions can decrease processing time through various means of automatic identification, such as a scan cards or RFID tags issued to drivers.

Unattended weighing transactions can often collect much of the same data gathered by the scale house. As customizations are common in these applications, software should allow for specialized programming. Traffic controls can also be programmed for automatic operation. Incorporating the right features of these systems can allow for 24-hour accessibility for vehicles, even when a scale house may be closed, all while maintaining compliance with data retention requirements.

Software Systems

Beyond the physical equipment and components of a weighing system, software can play a key role in how information is gathered, organized, stored, and analyzed. Software has been developed that can control weighing transactions on multiple scales, and incorporates other functions with the needs of these facilities in mind. These programs may run on a standalone PC in the scale house or gate house, or be fully integrated into a facility's computer network.

Due to requirements regarding material traceability, some processing facilities have found it helpful to implement specialized or customized software systems. These packages often include standard functions, but may also be customized to fit the organizations specific needs, or requirements of their locality. Specialized software may include multiple databases and tables for material type, generator, origin, destination, permit, and profile. Custom fields for variables such as radioactivity can be implemented where needed. When programmed with sensory equipment, these programs can automatically populate fields in a transaction record. Utilizing specialized software to capture standard and custom information can streamline complex transactions.

In some instances, these programs can integrate directly with other business and operations management programs. This helps facilities capture, organize, and analyze vital information on the materials they process.

Inspection and Load Screening

Pollution monitoring and control guidelines set forth by federal and local authorities has led to an increased focus on inspection of incoming loads. This includes screening for hazardous or otherwise unacceptable items. Visual inspection of a load upon arrival at a facility is often a first step. The scale house has often become the first line of screening operations. Overhead camera systems make this process faster and easier, allowing scale operators and inspectors to view overhead images on monitors in the scale house.

Some operations are utilizing an automatic image capture setting to store pictures of loads as they enter the facility to be weighed. Image files can be digitally attached to transaction records and stored indefinitely. This practice adds a practical historical resource to inspection and traceability systems.

Detection hardware is also being integrated into this initial load assessment. In some waste facilities in France, for example, each incoming load is scanned to measure radioactivity. The readings are stored as part of each transaction record for monitoring and ongoing analysis.

In both of these examples, versatile software plays an instrumental role in collecting, viewing, and storing critical data. Beyond an accurate weight reading, vehicle scale management software has enabled the scale area to become more than just a weighing station.

5 Conclusion

Waste processing operations provide vital services while facing a unique set of challenges. Equipment accuracy and reliability carry importance for transactions and record keeping. Weighing equipment requirements can be further influenced by regulatory compliance needs. This can include the ability to withstand contact with waste materials and the ability to be easily and regularly cleaned and maintained. Modern scale features can be of great aid in allowing vehicle weighing equipment to integrate seamlessly into waste facility operations.

Special tools can help these facilities manage their operations and improve productivity, while still maintaining their required regulatory compliance. Weighing automation, traffic controls, screening equipment, and specialized software can work in tandem with other systems and equipment. Lately, new product features have made a meaningful impact on the real-world performance of this precision equipment in demanding environments. Weighing equipment and integrated accessories can now keep waste facilities compliant, operational, and efficient.

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For more information

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