


















Principles of Checkweighing Building an Effective Programme

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METTLER TOLEDO

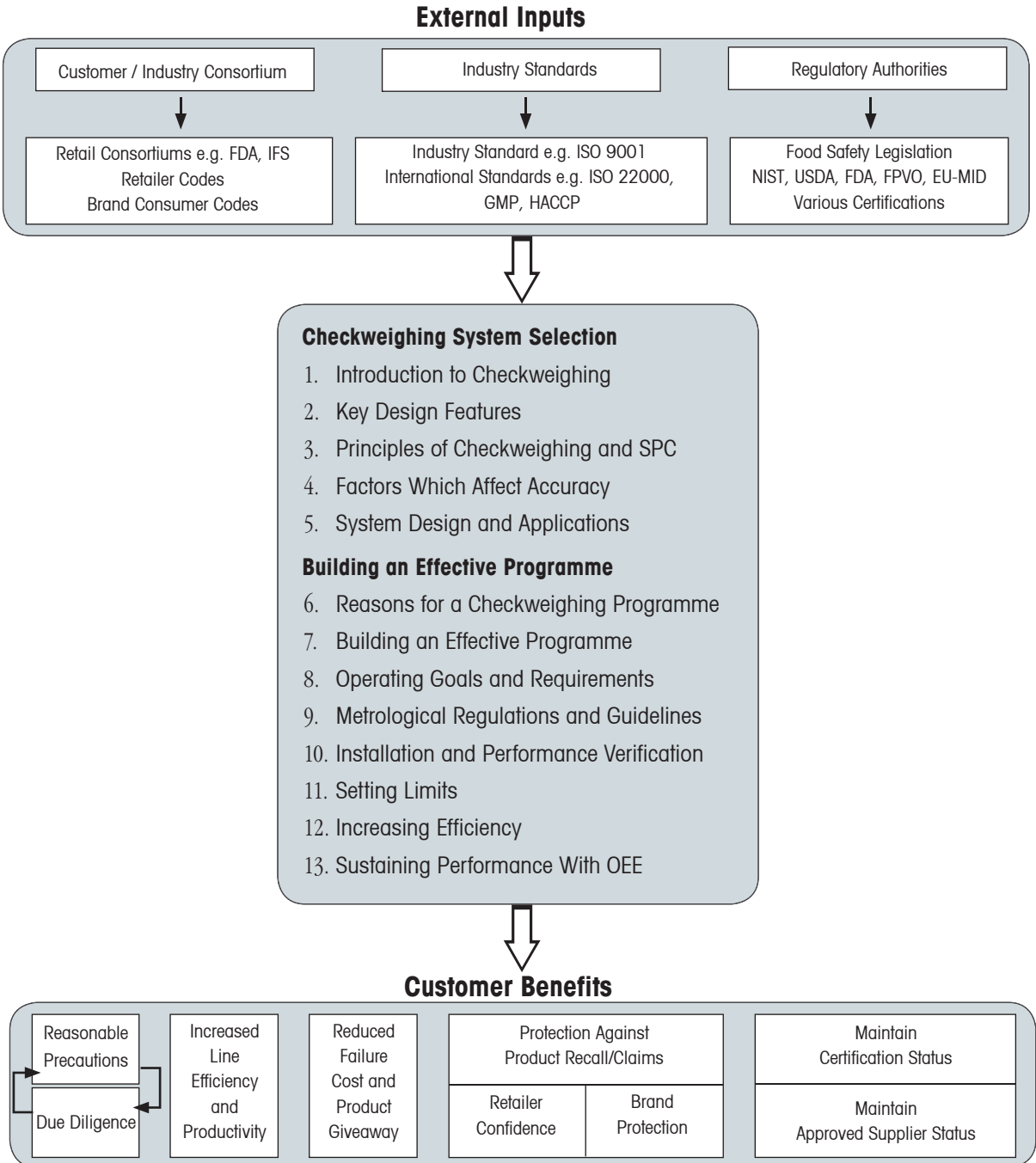
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Introduction

The need for checkweighers in the food, pharmaceutical, cosmetics, beverage and transport/logistics industries as well as in chemical, automotive and metal industries is recognised by most manufacturers and processors as a key element to an effective quality assurance regime. Checkweighers are instrumental in an increasingly competitive marketplace in fulfilling ever-changing customer needs and in complying with local Weights and Measures standards and regulations.




Installation of a checkweigher will not guarantee that a good product is produced unless it is executed as a part of an overall checkweighing programme containing specific goals, anticipated results, and well defined measurement metrics. This guide has been written to assist manufacturers in the setting up of such a programme.

An effective checkweighing programme can provide protection against product failure and recalls, help to comply with local Weights and Measures guidelines and reduce overall operating costs. The programme can also support the ability to prove that reasonable precautions and due diligence have been applied in the manufacturing process in the event of a legal claim or audit. The requirements for and the benefits of adopting a programme are summarised in the diagram below.



This guide serves as the definitive reference point for those involved in the packaging industry, providing an insight into all aspects of checkweighing from basic principles to implementation of a comprehensive programme. The first part of this guide "Checkweighing System Selection" covers all aspects of checkweigher design and functionality. Part two is entitled "Building an Effective Programme" which guides process planners and plant designers through the process of programme configuration and administration. This section ends with an important discussion on how to sustain the programme over the long term.

The following symbols are used throughout this guide to draw your attention to particular points of interest.

Symbol	Description
	Warning – An operating practice that could result in the incorrect operation or use of the checkweigher.
	Best Practice – An operating practice that is considered as best practice at the time of publication.
	Record – Highlights pertinent records that should be generated and maintained in order to demonstrate the effective operation of the checkweigher.

Chapter 1

Introduction to Checkweighing

In order to make informed decisions about a checkweighing system, it is important to understand the principles of operation. This chapter is designed to provide a basic overview which will be built upon in subsequent chapters to gain a greater understanding of checkweighing technology, equipment capabilities and performance.

1.1 Quality Control

Checkweighers are used as part of overall quality control programmes and to provide protection to both the manufacturer and consumer:

- Manufacturers are assured that they are offering products which fully comply with national regulations, contain the correct quantity of ingredients or parts and are making the most out of their raw materials.
- Consumers are assured that they are receiving a high quality product which has been verified to include all the ingredients or parts specified on the label.

The use of checkweighers builds trust between manufacturers and consumers ensuring that strict quality standards are both met and adhered to over the entire production cycle.

By definition, a checkweigher is a system that weighs items as they pass through a production line, classifies the items by preset weight zones and sorts or rejects the items based on their classification. Checkweighers weigh **100%** of the items on a production line and provide a 100% overview of production data such as production counts, batch tracking, total weights, good weights and rejected weights.

“In simple terms, a checkweigher weighs, classifies and segregates items by weight”

In addition, checkweighers are used to increase product quality and to optimise processes in order to keep costs under control, eliminate waste and thereby increase profits. Manufacturers can use the data and metrics produced by checkweighers to ensure that overfilling is minimised keeping production costs to targeted levels.

1.1.1 Typical Uses of a Checkweigher

Checkweighers are used for a variety of applications some of which include:

- Checking for under and/or overweight packages
- Ensuring compliance with net contents laws for pre-packaged goods
- Checking for missing components in a package including labels, instructions, lids, leaflets or products
- Verifying count by weight by checking for a missing carton, bottle, bag or can in a case
- Checking package mixes against weight limits to keep the solid to liquid ratio within established standards
- Reducing product giveaway by using checkweigher totals to determine filler adjustments
- Classifying products into weight zones for grading or portioning
- Ensuring product compliance with customer, association or agency specifications
- Pure net weighing with tare/gross systems



- Weighing before and after a process to check process performance
- Fulfilling USDA, FDA, OIML, FPVO and other reporting standards
- Measuring and reporting production line efficiency
- Keeping production printouts as a record of settings for management and regulatory agencies
- Analysing filler head performance for both single and multihead fillers

1.1.2 Statistical Uses of a Checkweigher

Today's technology makes checkweighers more reliable and accurate than ever before. The information that a quality team would have previously collected manually can now be collected in a fraction of the time by the checkweigher.

Example: Consider a line with a throughput of 100 packages per minute. If you sample 15 packages every hour, what percentage of the total production is that sample? In 60 minutes, $60 \times 100 = 6000$ packages pass through the line. 15 packages represent only $15/6000 = 0.25\%$. With a sample size that small there is a little statistical significance and over 99.75% are not inspected. A checkweigher automatically weighs 100% of all packages on the line and can react immediately if it senses a negative tendency or problem.

The primary value of checkweighing is to achieve "100% sampling" compared with random off-line sampling.

Statistical uses of a checkweigher include:

- Analysing production by weight zone or classification
- Using 3 or more zones to gain detailed fill weight information
- Monitoring overall production efficiency through total count and total weight (Figure 1.1)
- Monitoring overall production speed efficiency (packages per minute)
- Monitoring standard deviation to alert operator or filler of an out of tolerance condition or trend
- Printing or accumulating individual production weights or totals for a day, shift, hour, batch or collecting and printing a production run
- Monitoring short, long-term or individual weights and filler performance through statistics
- Providing Statistical Process Control (SPC) charts for manual feedback and process adjustments
- Providing SPC for closed loop control, feedback and automatic process adjustments
- Linking packaging line data to upstream control and information systems
- Interfacing with business systems, Programmable Logic Controllers (PLC) and SCADA systems to link the checkweigher to the production process, including controlling the checkweigher by a remote device
- Reducing quality control labour
- Important information source for quality control departments

The primary value of checkweighing is "100% inspection"

1.1.3 Inspection

Checkweighers are used for additional inspection purposes, beyond those stated above. The checkweigher is increasingly becoming a quality assurance station and also integrates other automated inspection devices to check:

- Open flaps on a carton or case
- Missing caps
- Bar code labels and RFID tags
- Package orientation and skew detection
- Printed information on the package such as batch number, expiry or best before date
- Contaminants such as metal, stone or glass
- Traceability and serialisation

Integration of other inspection devices such as cameras, scanners, marking systems, sensors, metal detectors and X-ray devices makes the checkweigher a high performance product inspection solution. Primary benefits of combin-



Figure 1.1: Monitoring Production Data

ing these other devices may include consolidation of multiple user interfaces into one to simplify operator training, and reduce the time it takes for package set-up and line changeovers. Further consolidation of the various inspection technologies on a single product handling platform can be optimised to save valuable production space. Finally, rejected products can be quarantined in one area for convenient and error-free management of non-conforming products.

1.2 Consumer Protection

Packaging and processing companies generally refer to the checkweigher as a “policeman” on the packaging line placed there to protect consumers. In this role it is the weight control centre on a production line ensuring that unacceptable under or overweight packages never reach the consumer.

Net content laws and regulations differ from country to country. As an example, in the United States of America the Department of Commerce, National Institute of Standards and Technology’s (NIST¹) Handbook 133 on prepackaged goods defines the specific net contents laws on packages for processors, wholesalers and retailers. It specifies the number of underweight packages permitted, as well as the weight of packages allowed to be underweight, but not exceeding the Maximum Allowable Variation (MAV). For prepackaged items commonly weighed by checkweighers, the MAV value varies according to the label weight of the package.

As another example, the OIML² R87 (International Organisation of Legal Metrology) standard which is used by most European and many other countries around the world defines the tolerable deficiencies in actual content for prepackaged products. National Weights and Measures authorities regulate and enforce the local net content laws applicable in the respective country. Official action resulting from package checking can take the form of spoken recommendations, instructions, warnings or legal action.

A discussion between the local Weights and Measures inspector and the person in charge of packaging regulatory compliance within the operation is extremely important to confirm general compliance with laws and regulations. Consultation with your local inspector can also be beneficial to help identify any inconsistencies in weighing patterns, precision or variations.

¹ <http://ts.nist.gov/WeightsAndMeasures/upload/Complete-HB133-05-Z-2.doc>

² <http://www.oiml.org/publications/R/R087-e04.pdf>

1.2.1 Regulations on Net Contents

As discussed in the prior section specific Weights and Measures regulations vary from country to country. In general non-conformance to the regulatory standard would typically take the form of:

- One or more packages with unreasonably large minus (underweight) errors
- An average minus (underweight) error for the entire batch of packages
- Significant errors in selling price calculations of one or more packages (for weigh price labelling)

1.2.2 Legal Action Against Non-Conforming Organisations

Legal action stemming from a violation may take several forms depending on the specific jurisdiction.

- “Stop sale” or “off sale” orders, which normally mean that the batch cannot be offered for sale until officially released
- Re-weighing or re-marking orders, which means that an entire batch cannot be offered for sale until the content or labelling has been corrected
- Prosecution, in which case the inspector purchases or confiscates samples as evidence of violation

Deployment of an effective checkweigher programme including active integration for continuous weight control can minimise the risk of non-conformance thereby eliminating legal entanglements and consumer complaints about underweight packages. Well designed and maintained checkweigher systems also protects the manufacturer by reducing product giveaway costs by tuning the average fill weight of the product through active feedback to the filling process, whilst complying with regulatory standards.

1.3 What Kind of Items do Checkweighers Typically Weigh?

A checkweigher can be used to weigh almost any item produced on a production line ranging in weight from below one gramme to several hundred kilogrammes. Below are a few examples of items which organisations weigh on checkweighers:

- Raw or unwrapped food products prior to the packaging process

- Pre-packed food products such as cans, glasses, wrapped products, trays and other food packaging
- Boxes, cartons or tubs of products to determine if papers, components, instructions or other items are missing
- Weight-based counting of contents in bottles, bags, packaged parts, cases of batteries, nappies or drink bottles in a case
- Checking volume or density of a mixture, such as bread, yoghurt, or volatile products such as airbag charges
- Weighing items of varying weights for future reference or billing for a warehouse or delivery service
- Checking for missing leaflets or instructions, blister packs of products or single tablets and capsules

1.4 Where Should a Checkweigher be Used?

Checkweighers are typically used in four areas of production.

In the industrial world, checkweighers are often used for product integrity checking and to determine whether products meet manufacturing and quality tolerances. For instance, in metal casting checkweighing is often used to determine whether the casting has an air void. In a bearing production line checkweighers are commonly used to determine whether all steel balls are present. Further checkweighers are employed to inspect raw materials to ensure they are the correct size, using weight for further processing.

Figure 1.2 shows four distinct areas where checkweighers are typically used in a manufacturing operation.

1. Checkweighers can be used prior to the packaging line, such as handling raw dough prior to freezing and pack-

aging. In this application the checkweigher would also send a feedback signal to the divider or former to maintain product consistency and reduce product giveaway.

2. Checkweighers are used in the primary packaging process. This may be to checkweigh tubes of personal care products prior to the cartoner in order to help keep a filler in tune and to prevent any non-conforming product reaching the next stage of the process. Checkweighing prior to the secondary packaging process eliminates rework and costly waste when non-conforming product is combined with other components or packaging materials.
3. The secondary packaging process combines various components into a common package. This could include checking ready-to-serve meal kits to ensure that all components have been included in the package. Another example is when a checkweigher is placed at the outfeed of the cartoner and ensures that the inserter has placed the dosage instructions into the carton.
4. Caseweighers are another type of checkweigher and are normally located after the case packer. Caseweighers determine whether the case contains the correct number of packages, ensuring that no short cases are shipped. In addition they may also transmit the case weight data to a manifesting system for shipping purposes. This type of checkweigher is also used for large bulk bags of products such as 25kg bags of dry dog food, bags of flour or sacks of chemicals for net weight control.

There are many opportunities for using checkweighers. They are not only used as the aforementioned “police-man” checkweigher, but provide weights that can help deliver consistently high quality, reduce waste and increase profitability.

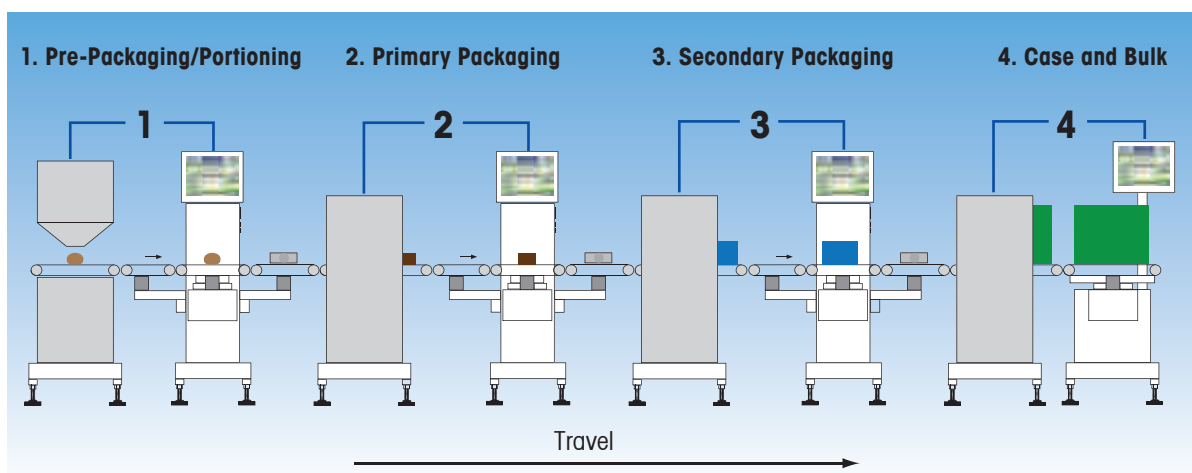


Figure 1.2: Checkweigher Usage in Manufacturing Operations

1.5 What is the Difference Between a Static Checkweigher and a Dynamic Checkweigher?

The main difference between a static scale used for checkweighing and a dynamic checkweigher is that static scales measure the weight of objects that stand still whereas a dynamic checkweigher automatically weighs objects (products) in motion. This yields a traditional result where static scales are used for sample spot checking of product whereas dynamic checkweighers check 100% of the product produced. Additionally static scales used for checkweighing are a manual operation requiring a person to take the product, weigh, record the result, and then remove the product for the next weightment to occur. Dynamic checkweighing is an automatic process which is typically performed without manual intervention or a dedicated operator.

There are dynamic checkweighers which can be used for static weight measurements in a continuous production line. Traditionally used where extreme accuracies approaching those found in the laboratory are required in a production environment, this type of checkweigher normally has a rotary stepping action or start/stop operation mode where the product is stationary for the small amount of time in which it is being weighed. Commonly referred to as an intermittent motion dynamic checkweigher these systems should not be confused with hybrid checkweighers that will be described later.



Note: This guide focuses on dynamic checkweighers as described in Chapter 2.

Static scales used for checkweighing and dynamic checkweighers work hand in hand when used on production lines for quality control and Weights and Measures compliance. Both systems are used for sampling weights; the static scale for sampling a set percentage of product weights and the dynamic checkweigher for sampling 100% of all weights. In many countries static scales must be used to sample product for completion of net contents and package tare weight verification reports for Weights and Measures. Application requirements and processes in combination with financial and economic factors usually dictate which system should be used on a production line.

The main application, process and economic factors which need to be considered are listed below. This list also forms

the basis of a more detailed difference between using static and dynamic checkweighers on production lines:

- Initial investment cost
- Running costs
- Production line throughput
- Manpower efficiency and costs
- Product characteristics
- Product security
- Product weight fluctuation potential
- Local laws and regulations governing sampling rates
- Safety at work regulations
- Customer requirements

For each of these points there are sound arguments when considering which system to use. It is clear to see that there are many differences and each of these have advantages and disadvantages when looking at specific production line requirements.

Hybrid or component systems are sometimes offered as an alternative to a dynamic checkweigher. These systems use a static scale, an averaging indicator with a fast update rate, a photoeye and a conveyor. While this type of system may serve an immediate purpose, most static scales are not designed for in-motion weighing, just as most dynamic checkweighers are not designed to deliver the same performance as a static scale. The constant vibration and dynamic loading of a package being moved onto the scale causes the load cell to oscillate violently. This movement can cause inaccurate and non-repeatable weighing results, plus it can lead to deterioration of the load cell and other active scale components which are not designed to withstand the rigours of in-motion processes.

In most production environments both static scales and dynamic checkweighers are used. Static scales are commonly used to determine target weights for dynamic checkweighers and to perform the sample tests for net weight and tare weight reports for Weights and Measures compliance.

Typically the absolute weighing results produced by a good quality static scale for a single package will be more repeatable and have a far lower standard deviation than those of a dynamic checkweigher. The reasons for this are explained in detail in Chapter 3.

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