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Procedure for utilizing statistical control techniques to monitor the tare weight of a run of boxes

Scope

Tare weight, i.e. the weight of an empty corrugated box, can be an important property in industries where the product and box are weighed together in the packaging operation and the predetermined tare weight of the box is subtracted to obtain the weight of the product being sold.

It is essential in these industries that the tare weight is within specified limits to ensure that the weight of the product sold is within acceptable commercial tolerances.

Safety Precautions

There are no safety precautions

Content

Test methods

Two test methods for monitoring the tare weight of a run of boxes are given in this Technical Information Paper.

The first requires the use of an accurate balance capable of weighing individual boxes. The second method uses a scale to weigh bundles or groups of boxes.

Method I

Equipment: A balance capable of weighing to an accuracy of 1 g (0.05 oz.)

Procedure: Select five random boxes at the take-off of a flexo folder gluer, curtain coater, or other finishing machine. (The tare weight must be determined on the finished box).

Weigh each box individually and record on an $\bar{X}$ and R chart (see Fig. 1).

Repeat at intervals throughout the run so that approximately 20 sets of samples are taken. (Once control limits have been established for a specific box, checks can be reduced to beginning, middle, and end of run, and the control chart is then kept over several orders.)

Recording and calculation of control limits:

1. Add the weights that have been recorded in each column, and record sum and average.
2. Determine the range between the highest and lowest weight in each column, and record in the range (*R*) box.
3. Select a suitable scale and record the averages and ranges on the control chart.
4. Using the factors in Table 1 and the worksheets in Fig. 2, calculate upper and lower control limits.

NOTE: The example (Fig. 1) shows measurements in grams. The chart would look exactly the same if the measurements were recorded in ounces.

Method II

Equipment: A scale capable of weighing up to 50 lb in 2 oz units (25 kg in 50 g units).

Procedure: Select bundles or groups of boxes weighing approximately 25 lb (11.34 kg) at the machine take-off (if bundles are selected, check the count before weighing). In any case, the group or bundle count must be the same for all data points within a given chart.

Weigh the bundle and record on an *X* and *MR* chart (see Fig. 3).

NOTE: To avoid confusion with the mathematics, both the individual measurement and the moving range should be expressed in the same units of measure, e.g., pounds for the individual reading, along with tenths of pounds for the moving range; or ounces for both points; or kilograms for the individual reading, along with tenths of kgs. for the moving range.

When setting up control limits, sample boxes at regular intervals to obtain approximately 20 – 25 readings.

Once control limits for a specific box have been set up, sampling can be conducted at the beginning, middle, and end of run.

Recording and calculation of control limits:

1. Use the individual and moving range (*X* and *MR*) chart.

The moving range is calculated as the difference between the current reading and the previous reading. Ranges are always expressed as positive numbers. There will always be one less moving range than the number of individual readings.

2. Select a suitable scale and record individual measurements and moving ranges on the control chart (Fig. 3).
3. Using the factors from Table 1, calculate the upper and lower control limits as shown on the worksheet in Fig. 4.

Process Capability

To determine if you are in compliance with a customer's specification, it is necessary to calculate (standard deviation) using the formula $\bar{R}/d_2$. Adding and subtracting 3σ from the process centerline ($\bar{X}$ for $\bar{X}$ and *R* charts or $\bar{X}$ for *X* and *MR* charts) will give you the variability (natural limits) of individual measurements (single boxes from the $\bar{X}$ and *R* process or groups of boxes from *X* and *MR* process). The upper and lower natural limits and process centerline can be matched with the customer target and specification limits. You will then know if you are in compliance or must narrow the variation, shift the centerline, or do both. ($\sigma = \bar{R}/d_2$ is calculated at the bottom of each worksheet in Fig. 2 and Fig. 4).

Keywords

Statistical methods, Tare weight, Weight

Additional information

Effective date of issue: December 19, 2003.

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Table 1. Factors for computing control limits

Sample Size n	Averages	Ranges		Standard Deviation	Sample Size n
	A ₂	D ₃	D ₄	d ₂	
2	1.800	.0	3.268	1.128	2
3	1.023	.0	2.574	1.693	3
4	.729	.0	2.282	2.059	4
5	.577	.0	2.115	2.326	5
6	.483	.0	2.004	2.534	6
7	.419	.076	1.924	2.704	7
8	.373	.136	1.864	2.847	8
9	.337	.184	1.816	2.970	9
10	.308	.223	1.777	3.078	10
11	.285	.256	1.744	3.173	11
12	.266	.284	1.717	3.258	12
13	.249	.308	1.692	3.336	13
14	.235	.329	1.671	3.407	14
15	.223	.348	1.652	3.472	15