

1 Basic Principles for Quality Assurance and Control of Measuring Equipment

1.1 Quality Assurance is an operational management system and may be summed up in the following slogan:

„Say what you do – and do what you say“.

It has three main goals:

- the prevention of defects during the manufacturing process of a product such that its designated usage is not affected.
- the guarantee of product quality to which two contract partners have agreed.
- the strengthening of the quality consciousness of employees.

1.2 The control of measuring equipment ensures the correct functioning of all measuring equipment of a company within the framework of the quality system.

- This includes both the measuring equipment as test instrument (e.g. Laboratory Balance) and the measurement standard (e.g. Adjusting and Test Weights).
- The control of measuring equipment guarantees its measuring accuracy, reliability and operational capability.
- Well documented control of measuring equipment is significant exonerating evidence in the case of product liability.

2 General Regulations for Control of Measuring Equipment

2.1 The determining factor is the Quality Assurance Manual of the company. ISO 9001, point 4.2 d states in short and binding language with regard to the control of measuring equipment:

„Identification of all demands placed on measurement technology...“

In plain language: The company carries its own responsibility for the scope of the organisation of its operational measurement techniques. It is the company itself which, in conjunction with its customers and suppliers of measurement equipment, sets out the principles.

As manufacturer of weights and weight sets we make some suggestions for **Test Weights in the QA System** in section 3.

2.2 Adjusting and Test Weights are classified as „Measurement Standards“ (Reference Standards as per EN 45001) in relation to control of measuring equipment.

According to ISO 9001 point 4.11 d Measurement Standards must have a known relationship to the National Standard. According to point 4.11 b, a Certification is specified for this purpose. In this case the Test Weight is exactly measured by a Calibration Laboratory accredited for the mass and a Certificate (=Calibration Certificate) is issued.

The DKD Certificate contains:

- General details of the Test Weight, including identification.
- Measured data such as Deviation from Nominal Value and Measuring Uncertainty (See also page 31).

Example:

Test Weight with Nominal Value	1 000.000 g
Measured Weight Value	1 000.015 g
Deviation from Nominal Value	+ 0.015 g
Measuring Uncertainty	± 0.005 g

2.3 A weight, e.g. the external Adjusting Weight of a balance, is transformed into a Test Weight by means of Certification. It is an operating Measurement Standard which serves in control of measuring equipment.

2.4 For balances with inbuilt and motor controlled Adjusting Weights (automatic internal adjusting) section 2.2 is equally valid. Here once again external, independent Test Weights must be used for safety reasons. Indeed the test intervals, that is the periodic control times of the balance, may be extended.

2.5 On request the DKD Laboratory will also suggest the time interval after which the Certificate should be renewed (=Recalibration).

Rule of Thumb: Time interval for Recalibration at least every 2 years, annually or less under conditions of heavy usage. Depends on the usage and environmental conditions.

2.6 Documentation requirements: The proof of regular control of a Test Weight by means of Certification must be documented and recorded. Obligatory storage period:
 For ISO 9000ff 10 years
 for GLP 30 years

3 General about Test Weights

3.1 The seven Classes of Accuracy (=classes of maximum permissible error MPE):

The OIML (Organisation Internationale de Métrologie Légale) classification accredited with the following classes is used practically world-wide:



E_1 is the most accurate and M_3 the coarsest class.

3.2 The Accuracy
 (=max. permissible error MPE)
 It is graduated rigid hierarchy in the ratio 1:3.

Example:

The Accuracy of a weight with Nominal Value 200 g is
 in class $E_2 \pm 0.30$ mg,
 in class $F_1 \pm 1.0$ mg,
 in class $F_2 \pm 3.0$ mg, etc.

Tolerance values see table at page 33.

3.3 Marking of Test Weights according to the OIML

E₁	No marks on the weights On the box is the symbol E_1
E₂	No marks on the weights On the box is the symbol E_2
F₁	Marking only with Nominal Value, e.g. 200
F₂	Nominal Value, e.g. 200 g and letter F
M₁	Nominal Value, e.g. 200 g and letter M
M₂	Nominal Value, e.g. 200 g and letter M_2
M₃	Nominal Value, e.g. 200 g and letter M_3

3.4 Special Test Weight Sets:
 If a company has a number of balances in use an individual set of Test Weights (measurement standard weights) may be worthwhile.

The required individual weights are selected according to operational needs and assembled in a box.

Each weight must be certified.

KERN is a manufacturer of weights. Detailed information is available in our catalogue „Weights“.

We are also happy to provide a bespoke solution to your problem.



4 The suitable Test Weights for your Balances

4.1 Several Test Weights are required to test a balance. These Test Weights must be certified.

The validity of the Certification must be observed.

In the most simple case the external Adjusting Weight belonging to the balance can be used, if it will be certificated afterwards.

With this weight most measurement tests may be undertaken.

When testing the Precision (=Linearity) are additional Test Weights (mostly 3) required.

4.2 The correct Size of Weight (= Nominal Value) for the selection of the suitable Test Weight.

If testing is only conducted with a single Test Weight then either the Maximum Load (Max) or the highest adjusting point of the balance is considered (normally shown on the display of the balance in connection with „CAL“).

If the Precision (=Linearity) of the balance is to be tested then a graduation of Test Weights is recommended as a percentage of the Maximum Load (Max) as follows:

25 / 50 / 75 / 100 % of Max.

4.3 The correct Accuracy (maximum permissible error MPE) for the selection of the suitable test weight.

The basic rule of measurement practice is:

Accuracy (maximum permissible error MPE) of the Measurement Standard 3 times preciser than the measuring Instrument to be tested.

If the Measuring Uncertainty of a balance is unknown, the smallest readable numerical increment „d“ is utilised.

Case 1

Balances with Resolution * $\leq 100\,000\,d$.

Rule of Thumb:

Accuracy of Test Weight according to security requirement $\leq 1\,d$.

Case 2

Balances with Resolution * $> 100\,000\,d$.

Rule of Thumb:

Accuracy of Test Weight according to security requirement $\leq 3\,d$.

If a balance has a number of different weighing ranges, the Resolution of each separate measuring range should be determined individually.

4.4 The correct Class of Accuracy (=class of MPE) for the selection of the suitable Test Weight.

For Test Weights having a Nominal Value close to the Maximum Load is right:

From Size of Weight (=Nominal Value) as per 4.2 and Accuracy (MPE) as per 4.3 will result the correct Class of Accuracy (class of MPE) as per table on page 33.

Minor rounding up or down is allowed. In case of doubt, a more precise Class of Accuracy must be used.

For Test Weights with Nominal Values less than the Maximum Load, e.g. for testing of Precision (=Linearity) of the balance, the same Class of Accuracy as is correct for the Maximum Load is used.

In other words, if the right Class of Accuracy has been chosen for the balance, it will be good for all Test Weights.

* Resolution of balances with only one weighing range:

$$\frac{\text{Maximum Load}}{\text{Smallest readable num. increment } d}$$

4.5 Example:

Test Weight for a Precision Balance
Maximum Load (Max) 500 g and
smallest readable numerical incre-
ment $d = 0.01 \text{ g} = 10 \text{ mg}$

Highest adjusting point of the
balance 500 g, therefore Nominal
Value of Test Weight 500 g.

$$\text{Resolution} * \frac{500 \text{ g}}{0.01 \text{ g}} = 50\,000 \text{ d}$$

Resolution * 50 000 d according
to case 1, see section 4.3. Therefo-
re Accuracy of Test Weight between
 $\pm 0.5 \text{ d}$ and $\pm 1.0 \text{ d}$ e.g. between
 $\pm 5 \text{ mg}$ and $\pm 10 \text{ mg}$.

From the Nominal Value and Accu-
racy the result is class F_2 according
to table page 33 with $\pm 7.5 \text{ mg}$.

Solution:

Certified Test Weight of class F_2 with
Nominal Value of 500 g is required.

To determine the Precision (=Linea-
rity) of the balance the rule as per
section 4.2 is to be used and
calculated:

$$25\% \text{ of } 500 \text{ g} = 125 \text{ g}$$

$$50\% \text{ of } 500 \text{ g} = 250 \text{ g}$$

$$75\% \text{ of } 500 \text{ g} = 375 \text{ g}$$

In practice these values are rounded
down to manage on 4 Test Weights
in Class of Accuracy F_2 .

Solution:

Suitable are 4 certified F_2 Test
Weights with the Nominal Values
50 g, 100 g, 200 g and 500 g.

In practice this is resulting for

$$25\% \quad 100 \text{ g}$$










$$50\% \quad 200 \text{ g} + 50 \text{ g}$$

$$75\% \quad 200 \text{ g} + 100 \text{ g} + 50 \text{ g}$$

$$100\% (=Max) \quad 500 \text{ g}$$

4.6 Control possibilities:

It is possible to check the Test Weight
or Weights according to sections 4.3
and 4.4 from the following table.

Test Weight	Balance	*Resolution
Class	Category	
	 	up to approx. 10 000 d
		up to approx. 50 000 d
		up to approx. 100 000 d
		over 100 000 d

* Resolution of the balance =

$$\frac{\text{Maximum Load}}{\text{Smallest readable numeric. increment d}}$$

The OIML** define for balances
as follows:

 Analytical Balances

 Precision Balances

 Commercial/Industrial
Balances

 Bulk Balances

** Organisation Internationale de
Métrologie Légale

Please take this document as a
Recommendation. In no way do we
wish to encroach upon your QA
Manual.

This subject matter is continuously up-
dated. Our recommendation is based
on the current state of knowledge.

