II

(Acts whose publication is not obligatory)

COUNCIL

COUNCIL DIRECTIVE

of 5 December 1978

on the approximation of the laws of the Member States relating to automatic checkweighing and weight grading machines

(78/1031/EEC)

THE COUNCIL OF THE EUROPEAN COMMUNITIES,

Having regard to the Treaty establishing the European Economic Community, and in particular Article 100 thereof,

Having regard to the proposal from the Commission (1),

Having regard to the opinion of the European Parliament (2),

Having regard to the opinion of the Economic and Social Committee (3),

Whereas in the various Member States construction and methods of control of checkweighing and weight grading machines are subject to mandatory provisions which differ from one Member State to another and consequently hinder trade in such instruments; whereas it is therefore necessary to approximate these provisions;

Whereas Council Directive 71/316/EEC of 26 July 1971 on the approximation of the laws of the Member States relating to common provisions for both measuring instruments and methods of metrological control (4), as last amended by Directive 72/427/EEC (5), has laid down the EEC pattern approval and EEC initial verification procedures; whereas, in accordance with that Directive, it is necessary to lay down the technical requirements which the manufacture and operation of checkweighing and weight grading machines must satisfy in order to be imported, marketed and freely used after having undergone the requisite inspections and having been provided with the required marks and signs,

HAS ADOPTED THIS DIRECTIVE:

Article 1

This Directive applies to automatic checkweighing and weight grading machines. These instruments are defined in Section 1 of the Annex.

Article 2

Those checkweighing and weight grading machines which may bear EEC marks and signs are described in the Annex.

They shall be subject to EEC pattern approval and shall be submitted for EEC initial verification.

Article 3

No Member State may prevent, prohibit or restrict the placing on the market or entry into service of automatic

(1) OJ No C 54, 8. 3. 1976, p. 44.
(2) OJ No C 125, 8. 6. 1976, p. 43.
(3) OJ No C 197, 23. 8. 1976, p. 13.
(4) OJ No L 202, 6. 9. 1971, p. 1.
(5) OJ No L 291, 28. 12. 1972, p. 156.

checkweighing and weight grading machines bearing the EEC pattern approval sign or EEC initial verification mark on grounds concerning their metrological characteristics.

Article 4

1. Member States shall bring into force the laws, regulations and administrative provisions needed in order to comply with this Directive within 18 months of its notification and shall forthwith inform the Commission thereof.

2. Member States shall communicate to the Commission the text of the main provisions of national law which they adopt in the field covered by this Directive.

Article 5

This Directive is addressed to the Member States.

Done at Brussels, 5 December 1978.

For the Council

The President

M. LAHNSTEIN

ANNEX

CHAPTER I

DEFINITIONS AND TERMINOLOGY

1. GENERAL DEFINITIONS

Automatic checkweighing machines and weight grading machines subdivide articles into two or more subgroups according to the mass of these articles.

1.1. **Checkweighing machines**

Machines which subdivide articles the mass of which varies on either side of a pre-determined value called the nominal mass.

The function of a checkweighing machine is to subdivide the articles into two or more subgroups according to the value of the difference between their mass and the nominal mass.

1.2. **Weight grading machines**

Machines which subdivide articles of different mass for which there is no predetermined nominal mass.

The function of the weight grading machine, hereinafter called 'grading machine', is to classify the articles into several subgroups, each characterized by a given mass range.

1.3. This Directive does not apply to automatic price-computing and ticket-printing weighing machines and egg grading machines.

Additional provisions will be drawn up later for automatic checkweighing machines fitted with electronic devices, which for the time being are ineligible for EEC pattern approval.

2. TERMINOLOGY

2.1. **Classification according to method of checkweighing or weight grading**

2.1.1. Machines which subdivide the articles into distinct groups separately leaving the machine.

2.1.2. Machines which subdivide the articles by applying to each article a distinctive mark which identifies the group to which it belongs.

2.1.3. Machines which count the articles in each group without separation.

2.1.4. Machines which give a visual or audible signal for each article in a group without separation.

2.2. **Classification according to method of operation**

2.2.1. Continuous checkweighing and grading machines.

Machines with continuous movement of the loads.

The movement of the loads on to the load receptor is continuous and the information regarding mass is provided during this movement.

2.2.2. Discontinuous checkweighing and grading machines.

Machines with discontinuous movement of the loads.

The movement of the loads on to the load receptor is discontinuous and the information regarding mass is provided when the load is at rest.

2.3. **Component devices**

2.3.1. Measuring system.

2.3.1.1. Weighing unit.

Device providing information on the mass of the load to be checkweighed or graded. This device may consist of all or part of a non-automatic weighing machine.

It comprises a load receptor, an equilibrium mechanism, and possibly an indicating device showing for instance the value of the mass of the load or the difference between this value and a reference value, in units of mass.

2.3.1.2. Triggering device.

Device which gives the order to provide the information regarding mass.

2.3.1.3. Processing device.

Device which converts the data from the weighing unit into a signal and processes this signal to give a checkweighing or grading order.

2.3.1.4. Indicating device.

Device which gives at least one of the following items of information:

— the mass of the checkweighed or graded load,

— the difference between this mass and a reference value,

— the subgroup to which the checkweighed or graded load belongs.

2.3.2. Load conveyor.

Device to move the loads on to and off the load receptor.

It may form part of the weighing unit.

2.3.3. Setting device.

Device for fixing the limits of mass of the subgroups.

2.3.4. Sorting device.

Device by means of which the loads are automatically divided into physically separate subgroups. This device need not form part of the machine.

2.3.5. Correction device (servo feed-back device).

Device which, in the light of the checkweighing results, automatically corrects the setting of the machine making up the loads upstream from the checkweighing machine.

2.3.6. Counter.

Device indicating the number of loads which have moved on to the load receptor (movement counter) or indicating the number of the loads in each of the subgroups (division counters).

2.4. **Standard test load**

Standard test load is the load by means of which the standard zone of indecision (U_s) is tested under the conditions laid down in 7.2.1.1.

2.5. **Metrological characteristics**

2.5.1. Nominal set point.

Value expressed in units of mass, preset by the operator by means of the setting device in order to establish the limit between consecutive subgroups.

2.5.2. Actual set point.

Value in units of mass in respect of which two different decisions may be taken for the same load, each having the same probability.

2.5.3. Setting range.

Range within which a nominal set point can be adjusted for a given nominal value of mass of the loads.

2.5.4. Setting interval (width of a subgroup).

Interval, expressed in units of mass, between consecutive nominal set points.

2.5.5. Setting error.

Difference between the value of the nominal and the actual set point.

2.5.6. Weight category.

Subgroup of loads which fall within a given range of mass. With 'n' set points the whole range of loads, from zero to infinity, is divided into (n + 1) weight categories.

2.5.7. Minimum capacity.

Value of load below which the machine may not be able to identify and classify the load correctly in the subgroup to which it belongs.

2.5.8. Zone of indecision.

Range, expressed in units of mass, in which the decision of the machine is indeterminate.

2.5.8.1. Standard zone of indecision (U_s).

Range claimed by the manufacturer and expressed in units of mass, within which the machine may make two different decisions for a standard test load and a given speed of operation.

2.5.8.2. Nominal zone of indecision (U_n).

Range claimed by the manufacturer and expressed in units of mass, within which the machine may make two different decisions for a given product and speed of operation.

2.5.8.3. Actual zone of indecision (U_a).

Range ascertained by the metrological service and expressed in units of mass, within which the machine may make two different decisions for a standard test load or a given product and speed of operation.

Its conventional value is equal to 6σ (from -3 to $+3\sigma$), σ being equal to the standard deviation.

2.5.9. Checkweighing or grading rate (speed of operation).

Number of loads checkweighed or graded per unit of time.

2.5.10. Load length.

Length of load measured in the direction in which it is moving.

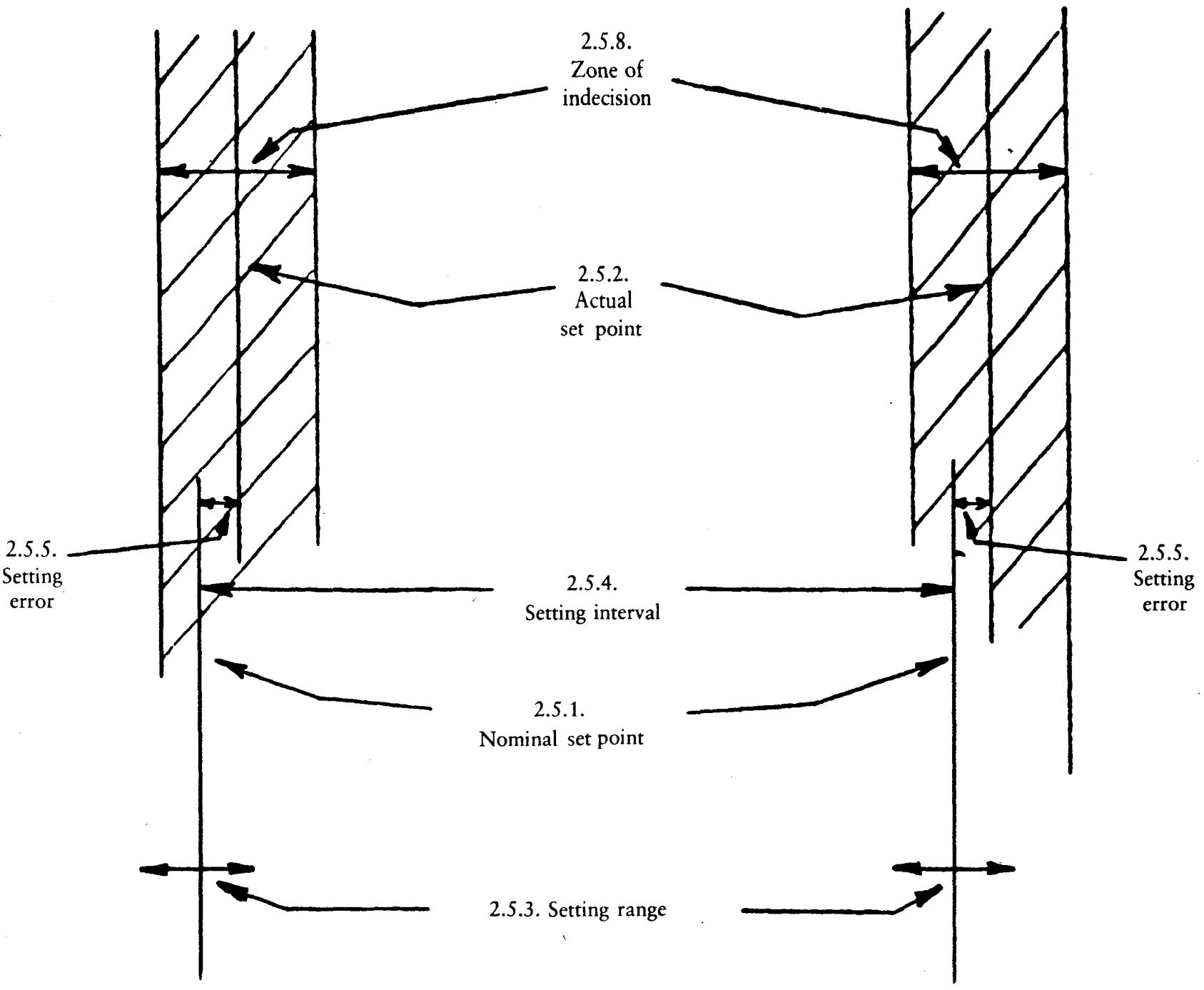
2.5.11. Weighing time.

Time elapsed between the moment when the load is completely on the load receptor and the moment when the information regarding the mass is provided.

2.5.12. Response time.

Time elapsed between the moment when the load is completely on the load receptor and the moment at which the instantaneous response of the weighing unit differs from the final response by less than U_n.

METROLOGICAL CHARACTERISTICS



CHAPTER II

METROLOGICAL REQUIREMENTS

3. GENERAL

3.1. **Scale interval of the weighing unit**

When the weighing unit has an indicating device with a scale subdivided into units of mass, its scale interval and its verification scale interval must comply with the Community requirements for non-automatic weighing machines.

3.2. **Maximum standard zone of indecision**

Without prejudice to the requirements of 5.1.2 the standard zone of indecision (U_s) must be no more than:

— 1 g for loads of nominal mass up to and including 100 g,

— 1 % for loads of nominal mass above 100 g.

3.3. **Relationship between nominal and standard zones of indecision**

The nominal zone of indecision (U_n) must not be less than the standard zone of indecision (U_s).

4. MAXIMUM PERMISSIBLE ERRORS

4.1. **Maximum permissible errors on EEC pattern approval**

4.1.1. Weighing unit.

When the weighing unit has an indicating device with a scale subdivided into units of mass, it is regarded as a non-automatic weighing machine and must comply, by static testing, with the Community requirements concerning the maximum permissible errors for such machines.

4.1.2. Actual zone of indecision (U_a).

The actual zone or zones of indecision determined during tests carried out in accordance with Chapter V, must not exceed 0·8 times the standard zone of indecision (U_s).

4.1.3. Setting error.

The setting error must not exceed 0·5 times the standard zone of indecision (U_s).

4.1.4. Variation of the actual set point with time.

The variation of the actual set point must not exceed 0·5 times the standard zone of indecision (U_s) during a period of eight hours of operation.

4.1.5. Variation of the actual set point with temperature.

The variation of the actual set point must not exceed 0·5 times the standard zone of indecision (U_s) for a temperature difference of 5 °C.

4.1.6. Effect of eccentric loading.

If it is possible to place loads eccentrically, the maximum difference between the values of the masses required to obtain the equilibrium position at a load equal to the minimum capacity must not exceed 0·5 times the standard zone of indecision (U_s) wherever the loads are placed on the load receptor.

4.2. **Maximum permissible errors on EEC initial verification**

4.2.1. Weighing unit.

When the weighing unit has an indicating device with a scale subdivided into units of mass, it is regarded as a non-automatic weighing machine and must comply, by static testing, with the Community requirements concerning the maximum permissible errors for such machines.

4.2.2. Actual zone of indecision (U_a).

The actual zone or zones of indecision determined during tests carried out in accordance with Chapter V must not exceed 0·8 times the nominal zone of indecision (U_n).

4.2.3. Setting error.

The setting error must not exceed 0·8 times the nominal zone of indecision (U_n).

4.2.4. Variation of the actual set point with time.

The variation of the actual set point must not exceed 0·5 times the nominal zone of indecision (U_n) during a period of eight hours of operation.

4.2.5. Variation of the actual set point with temperature.

The variation of the actual set point must not exceed 0·5 times the nominal zone of indecision (U_n) for a temperature difference of 5 °C.

4.3. **Maximum permissible errors in service**

4.3.1. Weighing unit.

When the weighing unit has an indicating device with a scale subdivided into units of mass, it is regarded as a non-automatic weighing machine and must comply, by static testing, with the Community requirements concerning the maximum permissible errors for such machines.

4.3.2. Actual zone of indecision (U_a).

The zone of indecision determined during tests carried out in accordance with Chapter V must not exceed the nominal zone of indecision (U_n).

4.3.3. Setting error.

The setting error must not exceed 0·5 times the nominal zone of indecision (U_n).

5. CONDITIONS FOR THE APPLICATION OF THE MAXIMUM PERMISSIBLE ERRORS

5.1. Normal conditions of use

5.1.1. Mass of loads.

The mass of the loads must be within a range between the maximum and minimum capacity of the machine.

5.1.2. Minimum capacity.

The minimum capacity must not be less than:

$25\ U_n$ for $U_n \leq 200$ mg,

$50\ U_n$ for $200\ mg < U_n \leq 500$ mg,

$100\ U_n$ for $500\ mg < U_n$.

5.1.3. Weighing time.

The weighing time must be greater than or equal to the response time and less than or equal to the time during which the load is completely on the load receptor.

However the competent authority may dispense with this requirement if the principles of construction and/or operation of the machine so permit.

For all speeds less than or equal to the maximum speed of operation, the setting error and the zone of indecision must remain less than or equal to the values specified in Section 4.

5.2. Influence factors

5.2.1. Temperature.

The machines must comply with the requirements of Section 4 at all virtually constant temperatures within a range of at least 25 °C.

When the machine is intended to operate in temperature controlled conditions, the temperature range may be reduced to 10 °C.

The temperature is considered to be virtually constant if the following two conditions are complied with:

— the difference between the extreme temperatures as recorded during a test does not exceed 5 °C,

— the variation of temperature does not exceed 1 °C in five minutes.

5.2.2. Power supply.

The actual set point and the actual zone of indecision (U_a) must comply with the requirements of Section 4 for the following variations of the power supply:

from — 15% to + 10% of the nominal voltage and

from — 2% to + 2% of the nominal frequency.

5.2.3. Other influence factors.

Machines must comply with the requirements of Section 4 when they are submitted to the effects of influence factors other than those referred to in 5.2.1 and 5.2.2 and resulting from the conditions of their installation and intended use.

CHAPTER III

TECHNICAL REQUIREMENTS

6. GENERAL

6.1. Suitability for use

Machines must be designed to suit their intended use and must be of careful and robust construction.

6.2. Accidental maladjustments

Machines must be so constructed that maladjustments likely to disturb their operation cannot normally take place without the effect being readily detectable.

6.3. Oscillation damper (dashpot)

Oscillation dampers whose characteristics are affected by temperature change to a degree that machine performance and accuracy are beyond the prescribed tolerances must be fitted with an automatic compensating device.

A signal must indicate when the device is at the correct temperature.

The oscillation damper must not be readily accessible to unauthorized persons.

6.4. Conveyor

If a conveyor comprises belts, tapes, or chains, intended to pass loads on to the load receptor, and if the belts, tapes, or chains are fitted with tension-regulating devices, the devices must not be readily accessible if adjustment of the tension can affect the information regarding mass provided by the weighing unit.

6.5. Levelling

6.5.1. Machines must be maintained in a level position.

6.5.2. If the machines are movable, they must be fitted with a levelling device and a level indicator or comply with the requirements in Section 4 when tilted lengthwise or transversely up to 5%.

6.5.3. Where a level indicator is supplied to comply with 6.5.2, the sensitivity of the level indicator must be such that its moving indicating part shows a displacement of at least 2 mm for tilt of 0·5%.

6.6. Equilibrium adjusting device and setting device

It must be possible to adjust the controls of both the equilibrium adjusting device and the setting device to within at least a quarter of the nominal zone of indecision, whether the machine is loaded or not, according to its method of operation.

6.7. Detachable masses

Detachable masses must either be weights of the medium or higher accuracy classes in accordance with Community requirements or purpose-designed masses distinguishable by shape from such weights and identified with the machine.

6.8. Descriptive markings

6.8.1. Mandatory markings.

Machines must bear the following markings:

— identification mark of the manufacturer,

— identification mark of the importer, if applicable,

— serial number and type designation of machine,

— EEC pattern approval sign,

— maximum capacity: max. .....

— minimum capacity: min. .....

— nominal zone of indecision: U_n .....

— speed of operation: ..... number of loads per minute

— response time: t ..... s

— verification scale interval of the weighing unit in accordance with the Community requirements for non-automatic weighing machines

— temperature limits: .....°C/ .....°C

— electrical supply voltage: V

— electrical supply frequency: ..... Hz

— identification mark on parts of the machine not directly attached to the main unit.

6.8.2. Supplementary markings.

Depending upon the particular use of the machine, one or more supplementary markings may be required on EEC pattern approval by the metrological service issuing the EEC pattern approval certificate.

6.8.3. Presentation of descriptive markings.

Descriptive markings must be indelible and have a size, shape and clarity allowing easy reading under the normal conditions of use of the machine.

They must be grouped together in a readily visible location on the machine, either on a descriptive plate fixed near the indicating device or on the indicating device itself.

It must be possible to seal the plate bearing the markings, unless it cannot be removed without being destroyed.

6.8.4. Stamping.

The descriptive plate may include a space for stamping. If it does not include a space for stamping, a device designed for this purpose must be provided in its vicinity.

CHAPTER IV

METROLOGICAL CONTROLS

EEC pattern approval and EEC initial verification of automatic checkweighing and weight grading machines must be carried out in accordance with Directive 71/316/EEC. Certain of these requirements are specified in this Chapter.

7. EEC PATTERN APPROVAL

7.1. Application for EEC pattern approval

The application must be accompanied by a machine of the pattern concerned and by the following information and documents:

7.1.1. Metrological characteristics:

— special characteristics of the weighing unit,

— maximum speed of operation in keeping with the load conveyor speed and the load length,

— electrical characteristics of the components of the measuring system.

7.1.2. Descriptive documents:

— general arrangement drawings,

— photographs and if necessary, drawings or models of details of metrological interest,

— schematic diagrams illustrating the method of operation and a technical description of the machine.

7.2. **EEC pattern approval examination**

7.2.1. EEC pattern approval tests.

Machines must comply with the metrological requirements specified in Sections 3, 4.1 and 5 with reference to the standard zone of indecision (U_s) for standard test loads within their range of operation, i.e. between the minimum and maximum capacity and the minimum and maximum speeds.

Machines which may have several nominal set points must be tested with at least two nominal set points.

Standard test load.

When testing is carried out for EEC pattern approval, a standard test load must be used.

The standard test load must comply with the following conditions:

— mass 'm' = max, min. and $^1/_2$ (max. + min.)

— length 'L' (cm) = $\sqrt[3]{m}$ (grams) ± 20 %

— height 'h' = $\frac{L}{2}$

— constant mass,
— solid material,
— non-hygroscopic material,
— non-electrostatic material,
— metal-to-metal contact to be avoided.

7.2.1.1. Static tests.

7.2.1.1.1. Tests with eccentric loads.

If it is possible to place loads eccentrically on the load receptor, a test must be carried out with a load equal to the minimum capacity and placed successively at any position on the load receptor. The maximum permissible errors are specified in 4.1.6.

7.2.1.1.2. Special tests for a machine with a weighing unit consisting of a self-contained non-automatic weighing machine.

The weighing unit of the machine must undergo the sensitivity, mobility and accuracy tests specified in the Community requirements for non-automatic weighing machines.

The maximum permissible errors must be the same as those for non-automatic weighing machines in keeping with their verification scale interval and accuracy class.

7.2.1.2. Measurement of response time.

The response time must be measured under stable test conditions free from effects of undue influence factors. The values obtained must not be greater than the values shown in the descriptive markings.

The data referred to in 7.1.1 concerning the maximum operating speed as a function of the load conveyor speed and the load length must be compatible with the values obtained for the response time.

7.2.1.3. Tests under normal conditions of use.

7.2.1.3.1. Zone of indecision and setting error.

The tests must be carried out in accordance with method C as described in 10.3 of Chapter V.

7.2.1.3.2. Variation of the actual set point with time.

These tests must be carried out with standard test loads without altering the machine settings and without varying the influence factors, and must be repeated several times during a period of eight hours of operation. Electrical methods of measurement may be used during these tests to obtain the results.

7.2.1.3.3. Variation of the actual set point with temperature.

These tests must be carried out with standard test loads without altering the machine settings and without varying the influence factors other than the temperature; they must be repeated several times over the temperature range indicated by the manufactuer. Electrical methods of measurement may be used during these tests to obtain the results.

7.2.2. Tests for compliance with technical requirements.

It must be possible from these tests to establish that machines comply with the technical requirements specified in Chapter III.

7.2.3. Provision of means of testing.

For the purpose of testing, the metrological service may require from the applicant the standard test loads, the handling equipment, the appropriate qualified personnel and the required control machines.

7.2.4. Place of testing.

Machines submitted for pattern approval may be tested:

— either on the premises of the metrological service to which the application has been submitted, or

— in any other suitable place agreed between the metrological service concerned and the applicant.

8. EEC INITIAL VERIFICATION

8.1. EEC initial verification tests

Machines must comply with the requirements specified in Sections 3, 4.2, 5 and 6 with reference to the nominal zone of indecision (U_n) for a given product or products within the range of operation, i.e. between the minimum and maximum capacity and the minimum and maximum speeds.

EEC initial verification is carried out by the competent metrological service in one or two stages.

8.1.1. First stage tests.

Static tests are carried out in accordance with 7.2.1.1.

8.1.2. Second stage tests.

The zone of indecision and the setting error must be verified using one of the methods described in Chapter V with the products for which the machine is intended. In all cases, one of the tests at least must be at minimum capacity.

Method C will be the reference method in the event of a dispute.

8.2. Provision of means of testing

For the purpose of testing, the metrological service may require from the applicant the test loads, the handling equipment, the appropriate qualified personnel and the required control machines.

8.3. Place of EEC initial verification

The first stage may be carried out in the workshop or any other suitable place agreed with the metrological service concerned; the second stage must be carried out at the place of installation.

If EEC initial verification is completed in one stage, it must be carried out at the place of installation.

9. IN-SERVICE INSPECTION

9.1. In-service tests

If it is intended to carry out in-service tests, 4.3 is applicable.

CHAPTER V

TEST METHODS

10.1. INCREMENTAL METHOD (METHOD A)

10.1.1. Procedure

10.1.1.1. A test load is used, equal to the desired load.

10.1.1.2. Adjust the set point to be tested so that a 'reject' signal always appears during 'n' weighings.

Where a machine has two or more set points and if the setting interval of the machine is small, the set point or points not in use must be set well clear of the set point which is being tested to avoid the possibility of interference during the tests.

10.1.1.3. Increase the load by an increment of approximately one tenth of the nominal zone of indecision (U_n) as shown on the machine and pass the test load across the machine 'n' times.

10.1.1.4. Continue the test by increasing the test load by single increments until the 'accept' signal appears at least once during 'n' weighings.

10.1.1.5. Continue the test by increasing the test load by single increments until the 'accept' signal is always obtained in the course of 'n' weighings.

10.1.1.6. Continue for several weight increments beyond this point.

10.1.1.7. Tabulate the results.

10.1.1.8. Repeat the test procedure with the same test loads by decreasing the loads by single increments or by using the loads at random.

If the random procedure is used, a test load will be required for each increment.

10.1.1.9. Tabulate the results.

10.1.2. Calculations

10.1.2.1. From the results obtained calculate, as a percentage, the number of rejections and acceptances.

10.1.2.2. Plot on arithmetical probability paper the relationship between the incremental loads and the percentage rejected.

10.1.2.3. From the straight line which should result choose a convenient interval on either side of the 50 % point (the values of the intervals 2·275 % — 50 % and 50 % — 97·725 % correspond to 2σ).

10.1.2.4. Read off the weight interval corresponding to these points.

10.1.2.5. A weight interval divided by two gives a value of σ.

10.1.2.6. The conventional value of the zone of indecision (6σ) can now be estimated.

10.1.2.7. The value at the 50 % point (mid-point of the zone of indecision) is the value of the actual set point.

10.1.2.8. The setting error is the difference between the nominal set point and the value of the actual set point obtained.

10.2. UP AND DOWN METHOD (METHOD B)

10.2.1. **Procedure**

10.2.1.1. A test load is selected. Its value should be less than that of the set point by approximately five times the nominal zone of indecision (U_n).

10.2.1.2. A value of the basic load increment 'd' is chosen. This should be of the order of $U_n/4$, where U_n is the nominal zone of indecision as shown on the descriptive plate of the machine. (This load should be of suitable value to allow the use of standard weights and to simplify calculation, e.g. 10, 20, 50, 100, 200, 500.)

10.2.1.3. The test load is then passed and re-passed on the machine, after being suitably increased incrementally between passes so that the test load plus the added load, having a total mass Mo, falls within the zone of indecision with the chosen set point. The machine is now ready for recording of results to commence.

10.2.1.4. The testing is continued as follows:

The load Mo is passed over the checkweigher. If a 'reject' signal appears the second test will be to repeat the process with a load of Mo + d; if however an 'accept' signal appears, the second test will consist of passing the load Mo — d.

This method of testing by the value of 'd' being added or subtracted according to the checkweighing result is repeated until the required number of passes has been achieved.

10.2.1.5. The results obtained must be recorded on a test chart in the form shown in 10.2.3.

Each horizontal line on the table corresponds to a particular value of load Mo ± id, the total number of lines covering the width of the zone of indecision. The results of each pass made is entered on the chart in the form of a code; it is suggested an 'X' be used where the load is rejected and an 'O' where it is accepted.

10.2.2. **Calculations**

10.2.2.1. Zone of indecision.

																O	X	i
Mo — 2d			X													0	1	— 2
Mo — d		O		X		X										1	2	— 1
Mo	O				O		X								X	2	2	0
Mo + d								X		X		X		O		1	3	+ 1
Mo + 2d									O		O		O			3	0	+ 2
																7	8	
																No	Nx	

The 'X's and 'O's on each line Mo ± id are totalled: the number 'Nx' of 'X's and the number 'No' of 'O's are for all the lines likewise totalled.

In making the calculations the set with the numerically smaller total is used, either the X results or the O results, since either set of results yields approximately the same statistical information.

The zone of indecision is calculated using the following formula:

$$U_a = 9{\cdot}72d \left(\frac{NB - A^2}{N^2} + 0{\cdot}029 \right)$$

where:

d = load increment of step ($U_n/4$, see 10.2.1.2),

i = number of load increments,

n_i = number of results taken into account on a line i,

N = total number of results used (No or Nx whichever is the smaller),

A = $\sum i \cdot n_i$,

B = $\sum i^2 \cdot n_i$.

10.2.2.2. Set point (2.5.2).

The set point is calculated using the following formula:

$$m = Mo + d\left(\frac{A}{N} \pm \frac{1}{2}\right)$$

The plus sign must be used where the calculation is based on rejections (X) and the minus sign where the calculation is based on acceptances (O).

The setting error is then worked out as the difference between the actual set point m (obtained by calculation above) and the nominal set point.

10.2.2.3. Standard deviation of the calculated values.

10.2.2.3.1. Zone of indecision (U_a).

The standard deviation of the variable U_a (as obtained in 10.2.2.1) can be estimated from the formula:

$$S_{U_a} = \frac{H\,U_a}{\sqrt{N}}$$

The value of the coefficient H varies as a function of the ratio $\frac{d}{U_a}$ in accordance with the table shown in 10.2.2.3.1.1.

The mathematical method of calculating the zone of indecision is valid only for:

$$\frac{d}{U_a} \leq \frac{1}{3}$$

10.2.2.3.1.1. The values of H as a function of $\frac{d}{U_a}$ are:

d/U_a:	0·1	0·13	0·17	0·20	0·23	0·27	0·30	0·33;
H:	1·6	1·47	1·38	1·32	1·30	1·25	1·25	1·25.

10.2.2.3.2. Setting error.

The standard deviation of the variable m (as obtained in 10.2.2.2.) can be estimated from the formula:

$$S_m = \frac{G\,U_a}{\sqrt{N}}$$

The value of the coefficient G varies as a function of the ratio $\frac{d}{U_a}$ in accordance with the table shown in 10.2.2.3.2.1.

The mathematical method of calculating the set point is valid only for:

$$\frac{d}{U_a} \leq \frac{1}{3}$$

10.2.2.3.2.1. The values of G as a function of $\frac{d}{U_a}$ are:

d/U_a:	0·1	0·13	0·17	0·20	0·23	0·27	0·30	0·33;
G:	0·95	0·98	1	1·02	1·05	1·08	1·1	1·12.

10.2.3. Test chart

Mo — 5d				— 5
Mo — 4d				— 4
Mo — 3d				— 3
Mo — 2d				— 2
Mo — d				— 1
Mo				0
Mo + d				+ 1
Mo + 2d				+ 2
Mo + 3d				+ 3
Mo + 4d				+ 4
Mo + 5d				+ 5
	Totals	X	O	i

d = ... Mo = ...

Nominal set point = ...

N = ...

A = $\Sigma i \cdot n_i$ = ...

B = $\Sigma i^2 \cdot n_i$ = ...

$U_a = 9{\cdot}72d\left(\frac{NB - A^2}{N^2} + 0{\cdot}029\right)$ = ...

$m = Mo + d\left(\frac{A}{N} \pm \frac{1}{2}\right)$ (*) = ...

Setting error = ...

(*) (+) if the 'X's are used, (—) if the 'O's are used.

10.3. QUANTAL ASSAY METHOD (METHOD C)

If this method is used for EEC pattern approval, the machine must operate with standard loads simulating a production line. For practical reasons, the metrological service concerned may as an exception carry out this test on a production line with the products for which the machine is intended.

10.3.1. **Procedure**

10.3.1.1. Take the value of the nominal zone of indecision (U_n) as shown on the machine.

10.3.1.2. Calculate the mass of the test loads (seven in number) to be used in spanning the zone of indecision; the mass of the test loads is obtained as follows:

$$m_{1\cdot7} = A \pm 1\cdot645\frac{B}{6} \quad \Big| \quad m_{2\cdot6} = A \pm 1\cdot282\frac{B}{6} \quad \Big| \quad m_{3\cdot5} = A \pm 0\cdot842\frac{B}{6} \quad \Big| \quad m_4 = A$$

where:

$$A = \frac{H + L}{2}$$

$$B = H - L$$

H and L are the approximate values of the mass at the limits of the zone of indecision, for a given set point.

10.3.1.3. Ensure that the test loads span the zone of indecision for the set point being tested.

10.3.1.4. Pass each test load over the machine 50 times and continue in the case of the two lightest and two heaviest test loads until 200 passes have been completed.

The test loads must be passed in random order. However, the test loads at the opposite extremes of the zone of indecision should follow each other consecutively, separated by a time interval which corresponds to the speed of operation used during the test.

10.3.2. **Tabulate the results**

10.3.2.1. Summarize the results and set out as shown in Table 1.

10.3.2.2. Obtain the values of nw and nwy from Tables 2 and 3 for $n = 50$ and $r = 200$ respectively. Summarize columns 5 and 6.

10.3.2.3. Calculate the values of $n_i w_i x_i$, $n_i w_i x_i^2$ and $n_i w_i x_i y_i$ and summarize columns 7, 8 and 9.

10.3.2.4. From the totals in Table 1 calculate the values for the estimate of the set point ($\hat{M}$) and the estimate of the zone of indecision ($\hat{U}_a$) as shown in 10.3.3.

TABLE 1

10.3.2.5.

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8	Column 9
x	n	r	i	nw	nwy	nwx	nwx^2	nwxy
x_1	n_1	r_1	1	$n_1 w_1$	$n_1 w_1 y_1$	$n_1 w_1 x_1$	$n_1 w_1 x_1^2$	$n_1 w_1 x_1 y_1$
.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.
x_i	n_i	r_i	i	$n_i w_i$	$n_i w_i y_i$	$n_i w_i x_i$	$n_i w_i x_i^2$	$n_i w_i x_i y_i$
.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.
x_k	n_k	r_k	k	$n_k w_k$	$n_k w_k y_k$	$n_k w_k x_k$	$n_k w_k x_k^2$	$n_k w_k x_k y_k$
	.			$\sum_1^k n_i w_i$	$\sum_1^k n_i w_i y_i$	$\sum_1^k n_i w_i x_i$	$\sum_1^k n_i w_i x_i^2$	$\sum_1^k n_i w_i x_i y_i$

where:
x_i = incremental mass,
n_i = number of passes made (50 or 200),
r_i = number of times x_i is accepted.

10.3.3. The following quantities are calculated from the totals given in Table 1:

$$\bar{x} = \frac{\sum n_i w_i x_i}{\sum n_i w_i}$$

$$\bar{y} = \frac{\sum n_i w_i y_i}{\sum n_i w_i}$$

$$S(nwxx) = \sum n_i w_i x_i^2 - \frac{(\sum n_i w_i x_i)^2}{\sum n_i w_i}$$

$$S(nwxy) = \sum n_i w_i x_i y_i - \frac{(\sum n_i w_i x_i)\ (\sum n_i w_i y_i)}{\sum n_i w_i}$$

and $$b = \frac{S(nwxy)}{S(nwxx)}$$

Then the estimate $\hat{M}$ of the set point M is given by:

$$M = Mo + \hat{m} \text{ where } \hat{m} = \bar{x} - \frac{1}{b}\bar{y}$$

The estimate $\hat{U}_a$ of the zone of indecision U_a is given by:

$$\hat{U}_a = \frac{6}{b}$$

TABLE 2

n = 50

r	nw	nwy	r	nw	nwy
0 (1)	3·588	— 8·346	26	31·802	1·595
1	5·981	— 12·282	27	31·715	3·185
2	9·669	— 16·928	28	31·569	4·766
3	12·580	— 19·559	29	31·363	6·332
4	15·015	— 21·097	30	31·096	7·878
5	17·111	— 21·929	31	30·767	9·399
6	18·947	— 22·263	32	30·374	10·888
7	20·574	— 22·226	33	29·915	12·339
8	22·024	— 21·902	34	29·386	13·744
9	23·325	— 21·351	35	28·784	15·094
10	24·494	— 20·614	36	28·104	16·380
11	25·546	— 19·726	37	27·342	17·591
12	26·492	— 18·711	38	26·492	18·711
13	27·342	— 17.591	39	25·546	19·726
14	28·104	— 16·380	40	24·494	20·614
15	28·784	— 15·094	41	23·325	21·351
16	29·386	— 13·744	42	22·024	21·902
17	29·915	— 12·339	43	20·574	22·226
18	30·374	— 10·888	44	18·947	22·263
19	30·767	— 9·399	45	17·111	21·929
20	31·096	— 7·878	46	15·015	21·097
21	31·363	— 6·332	47	12·580	19·559
22	31·569	— 4·766	48	9·669	16·928
23	31·715	— 3·185	49	5·981	12·282
24	31·802	— 1·595	50 (1)	3·588	8·346
25	31·831	0			

(1) The values of nw and nwy in this line must only be used for the highest value of x when r = 0 or the lowest value of x when r = 50.

TABLE 3

n = 200

r	nw	nwy	r	nw	nwy
0 (1)	4·831	— 13·560	18	64·398	— 86·342
1	8·406	— 21·650	19	66·454	— 87·094
2	14·350	— 33·384	20	68·444	— 87·714
3	19·414	— 42·128	21	70·368	— 88·212
4	23·922	— 49·128	22	72·232	— 88·594
5	28·028	— 54·932	23	74·038	— 88·872
6	31·820	— 59·846	24	75·788	— 89·050
7	35·356	— 64·062	25	77·486	— 89·138
8	38·676	— 67·710	26	79·136	— 89·138
9	41·812	— 70·890	27	80·738	— 89·058
10	44·788	— 73·668	28	82·294	— 88·902
11	47·618	— 76·102	29	83·806	— 88·676
12	50·320	— 78·236	30	85·276	— 88·382
13	52·906	— 80·104	31	86·706	— 88·024
14	55·386	— 81·736	32	88·096	— 87·608
15	57·768	— 83·158	33	89·450	— 87·134
16	60·058	— 84·386	34	90·766	— 86·606
17	62·268	— 85·444	35	92·050	— 86·028

r	nw	nwy	r	nw	nwy
36	93·298	— 85·402	101	127·316	1·596
37	94·514	— 84·728	102	127·294	3·192
38	95·698	— 84·012	103	127·258	4·786
39	96·850	— 83·254	104	127·208	6·380
40	97·974	— 82·456	105	127·142	7·972
41	99·086	— 81·620	106	127·062	9·564
42	100·132	— 80·750	107	126·968	11·154
43	101·170	— 79·842	108	126·858	12·740
44	102·182	— 78·904	109	126·734	14·326
45	103·166	— 77·932	110	126·596	15·908
46	104·124	— 76·932	111	126·442	17·488
47	105·058	— 75·902	112	126·274	19·064
48	105·968	— 74·844	113	126·090	20·636
49	106·852	— 73·762	114	125·892	22·040
50	107·714	— 72·652	115	125·678	23·768
51	108·552	— 71·518	116	125·450	25·328
52	109·368	— 70·362	117	125·206	26·882
53	110·162	— 69·182	118	124·948	28·432
54	110·936	— 67·982	119	124·674	29·974
55	111·686	— 66·762	120	124·384	31·512
56	112·416	— 65·520	121	124·078	33·044
57	113·126	— 64·262	122	123·758	34·568
58	113·814	— 62·984	123	123·422	36·086
59	114·484	— 61·688	124	123·068	37·596
60	115·134	— 60·376	125	122·700	39·098
61	115·764	— 59·048	126	122·316	40·590
62	116·376	— 57·704	127	121·914	42·076
63	116·968	— 56·346	128	121·496	43·552
64	117·542	— 54·974	129	121·062	45·018
65	118·098	— 53·588	130	120·612	46·474
66	118·636	— 52·190	131	120·144	47·920
67	119·156	— 50·778	132	119·658	49·354
68	119·658	— 49·354	133	119·156	50·778
69	120·144	— 47·920	134	118·636	52·190
70	120·612	— 46·474	135	118·098	53·588
71	121·062	— 45·018	136	117·542	54·974
72	121·496	— 43·552	137	116·968	56·346
73	121·914	— 42·076	138	116·376	57·704
74	122·316	— 40·590	139	115·764	59·048
75	122·700	— 39·098	140	115·135	60·376
76	123·068	— 37·596	141	114·484	61·688
77	123·422	— 36·086	142	113·814	62·984
78	123·758	— 34·568	143	113·126	64·262
79	124·078	— 33·044	144	112·416	65·520
80	124·384	— 31·512	145	111·686	66·762
81	124·674	— 29·974	146	110·936	67·982
82	124·948	— 28·432	147	110·162	69·182
83	125·206	— 26·882	148	109·368	70·382
84	125·450	— 25·328	149	108·552	71·518
85	125·678	— 23·768	150	107·714	72·652
86	125·892	— 22·040	151	106·852	73·762
87	126·090	— 20·636	152	105·968	74·844
88	126·274	— 19·064	153	105·058	75·902
89	126·442	— 17·488	154	104·124	76·932
90	126·596	— 15·908	155	103·166	77·932
91	126·734	— 14·326	156	102·182	78·904
92	126·858	— 12·740	157	101·170	79·842
93	126·968	— 11·154	158	100·132	80·750
94	127·062	— 9·564	159	99·086	81·620
95	127·142	— 7·972	160	97·974	82·456
96	127·208	— 6·380	161	96·850	83·254
97	127·258	— 4·786	162	95·698	84·012
98	127·294	— 3·192	163	94·514	84·728
99	127·316	— 1·596	164	93·298	85·402
100	127·324	0	165	92·050	86·028

r	nw	nwy	r	nw	nwy
166	90·766	86·606	184	60·058	84·386
167	89·450	87·134	185	57·768	83·158
168	88·096	87·608	186	55·386	81·736
169	86·706	88·024	187	52·906	80·104
170	85·276	88·382	188	50·320	78·236
171	83·806	88·676	189	47·618	76·102
172	82·294	88·902	190	44·788	73·668
173	80·738	89·058	191	41·812	70·890
174	79·136	89·138	192	38·676	67·710
175	77·486	89·138	193	35·356	64·062
176	75·788	89·050	194	31·820	59·846
177	74·038	88·872	195	28·028	54·932
178	72·232	88·594	196	23·922	49·128
179	70·368	88·212	197	19·414	42·128
180	68·444	87·714	198	14·350	33·384
181	66·454	87·094	199	8·406	21·560
182	64·398	86·342	200 (1)	4·831	13·560
183	62·268	85·444			

(1) The values of nw and nwy in this line must only be used for the highest value of x when r = 0 or the lowest value of x when r = 200.