Office for Product
Safety & Standards

SPECIFICATION FOR TESTING EQUIPMENT FOR WEIGHTS – 7130 series

Weights and measures 7000 series

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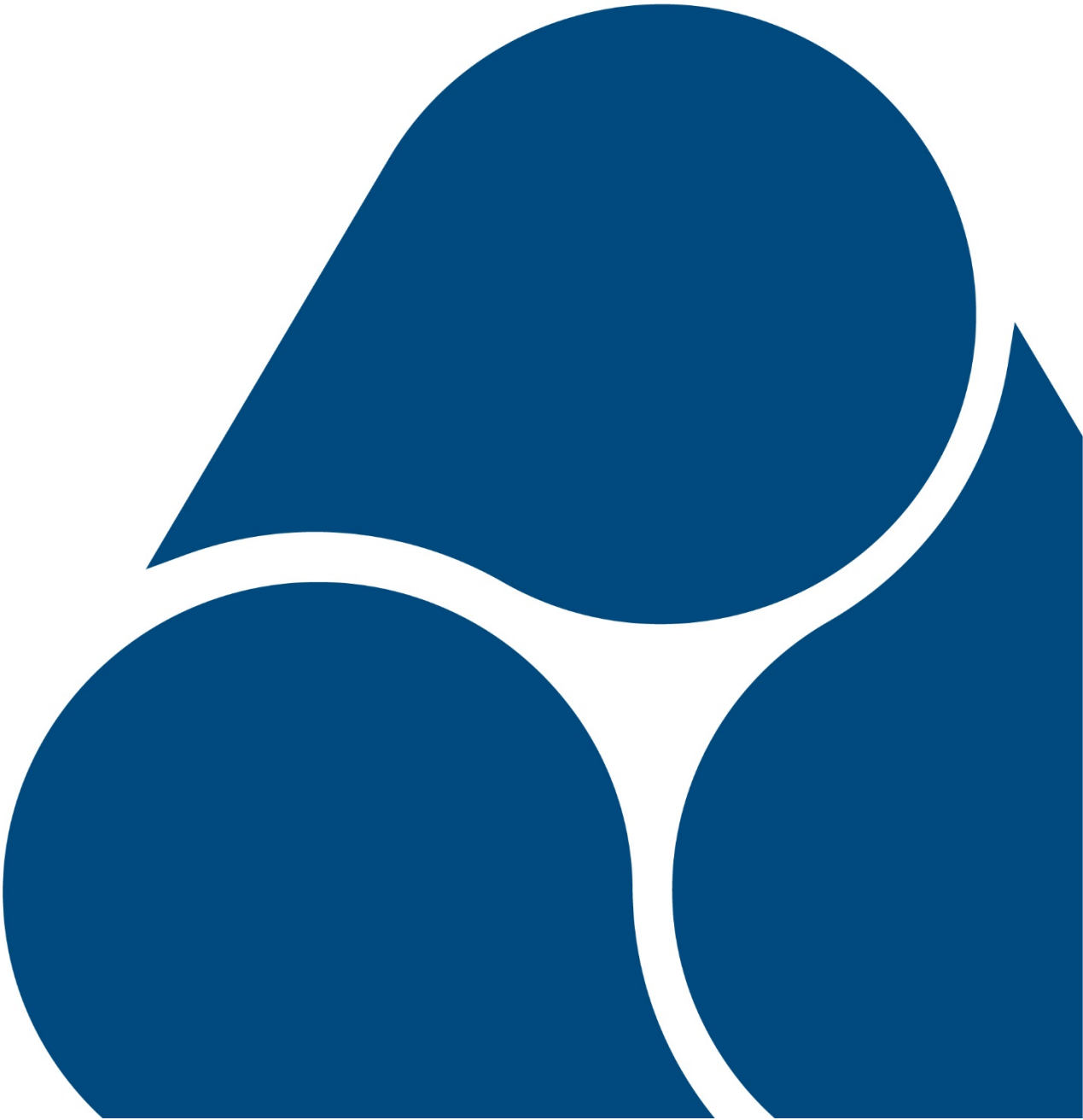

In accordance with the provisions of section 5(5) of the Weights and Measures Act 1985, the Secretary of State hereby approves the material and form of testing equipment consisting of weighing equipment which conforms with this specification.

This specification supersedes the October 1986 version of this specification, reference STD 4514.

SPECIFICATION FOR TESTING EQUIPMENT FOR WEIGHTS

1. The material and form of weighing equipment complying with paragraphs 2 to 7 below are approved.
2. Beams incorporated in balances and beamscales should be sufficiently strong to minimise deflection.
3. Knife edges and bearings should be continuous and of sufficient length and hardness to minimise wear. On precision balances they should be capable of being relieved.
4. Electronic weighing equipment should perform consistently and not be affected by environmental conditions or other external influences.
5. Weighing equipment should be capable of accurately determining the limit of error of the weight being tested. The accuracy of determination depends on two main criteria, both of which must be satisfied:
   a) The equipment must be sufficiently sensitive, and
   b) The equipment must give repeatable readings. These must have been determined within the previous 6 months of use.
6. In the case of analogue equipment, the apparent width of a scale division shall be between four times and ten times the width of the scale mark. The width of the pointer should equal the width of the scale mark.
7. The discrimination threshold and repeatability of weighing equipment must not exceed the figures given in table 1 to 3. These amount to one-fifth of the limit of error of the weight being tested, except when using a beamscale in relation to the obliteration of the stamp. In this case the discrimination thresholds and repeatability must not exceed half the limit of error of the weight being tested.
8. The suitability of the equipment should be easily identifiable. One such method is for a permanent, legible and conspicuous notice to be affixed to the case of the equipment showing the range of weights which may be tested with it.

APPENDIX

NOTES FOR THE GUIDANCE OF INSPECTORS OF WEIGHTS AND MEASURES ON BEAMSCALES, MECHANICAL AND ELECTRONIC BALANCES

LENGTH OF ARM ERROR

1. Working standard weights shall only be tested by substitution (Borda's method). Test weights may be tested by substitution or by direct comparison, in which case, the length of arm error shall be assessed before a balance or beamscale is used. In no case shall the instrument be used if the length of arm error exceeds a value corresponding to one millimetre of apparent pointer movement.
2. The length of arm error shall be determined by testing the balance or beamscale with local or working standard weights and shall be the discrepancy between the rest point with the balance or beamscale unloaded, and the mean value of the rest points obtained before and after the interchange of loads equivalent to the nominal values of the weights to be tested.
3. This test need not be carried out when all the weighing is by substitution (Borda's method).

SENSITIVITY

4. With analogue instruments this has been interpreted traditionally a "value per division". The term "discrimination threshold" has been introduced into regulations to admit the feasibility of estimating to parts of a division in suitable cases.
5. The discrimination threshold is the smallest change in load which produces a perceptible change in indication.
    - With a digital indicator the discrimination threshold is one scale division.
    - With an analogue indicator the discrimination threshold is the load required to produce a movement of 1 mm of the pointer or the scale.
    - Discrimination threshold shall be tested by the addition or subtraction of small weights.
    - The discrimination threshold can be affected by the loading, therefore it should be tested at the load at which the equipment is to be used.
6. EN 45501:2015, clause 3.8 specifies suitable tests for discrimination.

REPEATABILITY

7. The repeatability should be determined in a similar manner in which the balance is to be used. The error of the weight under test is determined by calculating the difference in value displayed between it and the standard being used.
   If a single comparison is made between the standard and the weight being tested then the repeatability can be tested by repeated weighing of the same mass by the following method:
    a. Make 20 repeated weighings of the same mass noting the value displayed and allowing instrument to see zero between each weighing.

b. Calculate the difference between weighing 1 and weighing 2, then weighing 3 and weighing 4, then 5 and 6, and so on to 19 and 20.

c. Calculate the sample standard deviation of the 10 differences.

d. This standard deviation multiplied by the appropriate students t-factor in Table 4 must be no more than the figures in tables 1 to 3.

8. Best practice would be to use an A-B-A weighing scheme, which can be used to minimise drift effects (by averaging the two readings for weight A) and has a check on the balance (comparing the two A readings). The repeatability test can include a check on the linearity of the instrument by the following method:

a. Let A be any weight of the nominal value to be tested, and B be the same weight plus a Local Standard weight of value equal to or greater than twice the mpe of the nominal value of the weight to be tested (‘mg weight’).

b. Exercise the instrument with the weight to be tested, until consecutive readings agree within a few scale divisions, and zero instrument.

c. Place weight A on the load receptor and record reading.

d. Remove weight A, let the instrument see ‘zero value’ (without zeroing) and put on B (weight A plus LS mg weight) and record reading. Remove B, see ‘zero value’.

e. Repeat c & d a further nine times

f. Finally, place weight A on the load receptor and record reading.

g. Calculate the 10 values of B – (average of adjacent As)

h. Calculate the standard deviation for the repeatability of the comparisons. The instrument meets the specification if the standard deviation multiplied by 2.262 is no more than one-fifth the maximum permitted error on the weight.

i. For digital instruments, subtract the certificated value of the mg weight from the average difference between A & B calculated, this can be used for the linearity input in the uncertainty budget. For non-graduated scales, divide the certificated value for the mg weight by the number of scale divisions to obtain the weight per division.

THERMAL PERFORMANCE

9. Some balances, particularly single-pan, can be affected by the temperature of surrounding air, and by localised heating and draughts. Care should be taken to ensure that these factors are minimised.

INTEGRITY OF IN-BUILT WEIGHTS

10. Where in-built tare or calibration weights form part of a weighing instrument, the influence of errors in these weights, which can be considerable, should either be negated by comparison weighings, or the weights should be independently calibrated.

MAGNETISM

11. Some electronic balances are affected by magnetic effects of the weights to be tested. Where balances are so affected the use of a spacer can be used to remove this effect.

PERIODICITY

12. The discrimination threshold shall be determined within six months of use.
13. The repeatability of an electronic balance with digital indication should be tested when the balance has had a sufficient time to warm up. This will normally be several hours and it may be advisable to leave balances switched on permanently.
14. Repeatability shall be tested within six months of use. Each estimate of repeatability, the standard deviation, will be different. It is acceptable to set a limit for each nominal weight value that encompasses the last four values as an acceptance criterion – as long as the 95% confidence interval is less than one-fifth of the limit of error of the weight being tested.
15. There is no need to test the instrument at all nominal weight values if the repeatability is less than one-fifth of the tolerance for weights of lower nominal values.
16. A log of discrimination threshold and repeatability should be maintained and used to monitor trends in performance.

CARE AND USE

17. Bearings should always be relieved slowly and smoothly to avoid shock loading.
18. Beams should always be removed when balances and beamscales are to be transported.
19. Discrimination threshold and repeatability should be determined whenever the instrument is moved.

UNCERTAINTY OF MEASUREMENT

20. For legal metrology there is a shared risk for the uncertainty of measurement, and so it is not normally estimated.
21. A method of estimating the uncertainty of measurement is detailed in the ANNEX.

Table 1

WEIGHING EQUIPMENT FOR TESTING WORKING STANDARDS AND TEST WEIGHTS

Working standard	Limit of error (mg)	1/5th limit of error (mg)
20 kg	1000	200
10 kg	500	100
5 kg	250	50
2 kg	100	20
1 kg	50	10
500 g	25	5
200 g	10	2
100 g	5	1
50 g	3	0.6
20 g	2.5	0.5
15 g	2.2	0.44
10 g	2.0	0.40
5 & 4 g	1.5	0.30
3 & 2 g	1.2	0.24
1 g	1.0	0.20
500, 400 & 300 mg	0.8	0.16
200 & 150 mg	0.6	0.12
100 mg	0.5	0.10
50 mg	0.4	0.08
20 mg	0.3	0.06
10 mg	0.25	0.05
5, 2 & 1 mg	0.20	0.04

Table 2

WEIGHING EQUIPMENT FOR INITIAL VERIFICATION OF TRADER' WEIGHTS

Traders' Weight	Limit of error (mg)	1/5th limit of error (mg)
20 kg	3200	640
10 kg	1600	320
5 kg	800	160
2 kg	400	80
1 kg	200	40
500 g	100	20
200 g	50	10
100 & 50 g	30	6
20, 15 & 10 g	20	4
5 & 4 g	10	2
3, 2 & 1 g	5	1
500 & 400 mg	2.5	0.5
300, 200 & 150 mg	2	0.4
100 mg	1.5	0.3
50 mg	1.2	0.24

Table 3

BEAMSCALES FOR USE IN RELATION TO THE OBLITERATION OF A STAMP

Traders' Weight	Limit of error (mg)	½ limit of error (mg)
20 kg	3200	1600
10 kg	1600	800
5 kg	800	400
2 kg	400	200
1 kg	200	100
500 g	100	50
200 g	50	25
100 & 50 g	30	15
20, 15 & 10 g	20	10
5 & 4 g	10	5
3, 2 & 1 g	5	2.5
500 & 400 mg	2.5	1.25
300, 200 & 150 mg	2	1.00
100 mg	1.5	0.75
50 mg	1.2	0.60

Table 4

No. of comparisons	5	6	7	8	9	10
Students' t-factor	2.776	2.571	2.447	2.365	2.306	2.262

ANNEX: ESTIMATION OF UNCERTAINTY OF MEASUREMENT

Uncertainty budget for the calibration of a weight

Example for calibration of 1 kg working standard against local standard by Borda's method.

The example is based on UKAS document M3003, example K4.

Ref	Source	Value (mg)	Distribution	Divisor	Conversion factor	Standard uncertainty	Degrees of freedom
1	Local standard – value	15.0	Normal	2.0	1.0	7.5	∞
2	Local standard – drift	15.0	Rectangular	1.7	1.0	8.7	∞
3	Rounding error	10.0	Triangular	2.4	1.0	4.1	∞
4	Repeatability	10.0	Normal	1.0	1.0	10.0	9
5	Linearity	1.0	Rectangular	1.7	1.0	0.6	∞
6	Air buoyancy	1.0	Rectangular	1.7	1.0	0.6	∞
	Combined uncertainty					15.8	55.6
	Expanded uncertainty (k = 2)					31.5	

Notes

1) Assumed that value is within the mpe for local standards, if value known then the uncertainty for that value should be used (for 1 kg LS this is 3 mg).
2) Unless data to the contrary are available drift is assumed not to exceed the uncertainty on the weight.
3) This is the scale division 'd' of the balance.
4) In this example this is one-fifth mpe of WS but the actual standard deviation should be used.
5) Usually negligible for digital balances, data needed to demonstrate this.
6) 1 ppm assumes no air buoyancy correction is made, the WS density is between 7.4 and 8.6.
7) As long as the effective degrees of freedom exceeds 30 then k = 2 for 95% confidence.

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