BSI

BS 1181 : 1989

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British Standard Specification for

Clay flue linings and flue terminals

British Standards Institution

Foreword

This British Standard, prepared under the direction of the Clay Products Standards Policy Committee, is a revision of BS 1181 : 1971 which is withdrawn.

The 1971 edition has proved to be a useful and adequate specification but has been revised in respect of testing and inspection procedures to facilitate quality control and to enable certification to be applied. The inspection schedules are consistent with BS 6001 : Part 1, at an acceptable quality level (AQL) of 10 % and inspection level S2.

Whilst amendments have been made to the heat resistance test, further research is to be carried out to define the necessary parameters and test procedures. The findings will be incorporated into this standard by an amendment in due course.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Contents

Section one. General

1 Scope

This British Standard specifies requirements for the following.

(a) Clay flue linings and terminals for use with domestic appliances as detailed in BS 6461 : Part 1*.

(b) Clay flue linings for use with gas appliances not exceeding 60 KW as detailed in BS 5440 : Part 1.

(c) Clay flue terminals for use where flue linings are not involved.

(d) Clay flue linings for ventilation.

This standard applies to both glazed and unglazed products and specifies certain dimensions and tolerances, physical and performance characteristics, marking, sampling, and testing and inspection procedures to verify compliance and to facilitate quality control.

NOTE. The titles of the publications referred to in this standard are listed on the inside back cover.

2 Definitions

For the purpose of this British Standard the following definitions apply.

2.1 flue linings. Flue linings comprise the following two types:

(a) Type 1. Circular in cross section with rebated or spigot and socket ends;

(b) Type 2. Square in cross section with rebated ends and rounded internal and external corners.

2.2 flue terminals. Flue terminals comprise the following two types:

(a) Type A. For use with flue linings;

(b) Type B. For use with systems where flue linings are not involved.

2.3 nominal height. A numerical designation of the height of a straight flue lining which is a convenient round number approximately equal to a manufacturing dimension.

2.4 nominal size. A numerical designation of the bore or internal width of a unit which is a convenient round number approximately equal to a manufacturing dimension.

2.5 curvature. The angle subtended by a curved flue lining at the centre of the curve (see figure 1).

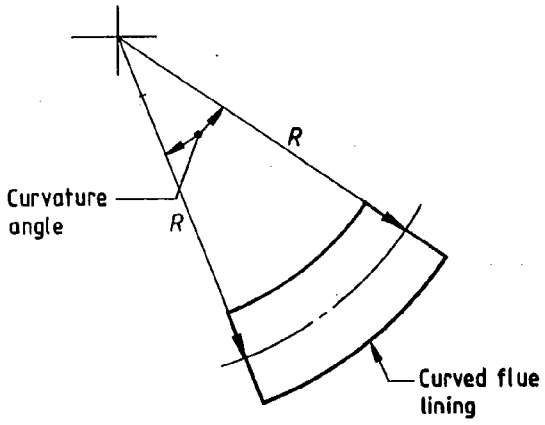


Figure 1. Definition of curvature

3 Materials and manufacture

3.1 Flue linings and flue terminals

Flue linings and flue terminals shall be manufactured from suitable clays.

NOTE. The suitability of clays is assessed by chemical and other tests carried out by the manufacturer.

3.2 Flue lining joint

The design and dimensions of the rebates and sockets shall be such that the male end shall be capable of entering the female end of another lining of the same type, made by the same manufacturer, leaving a jointing space. The width of the top of the rebate shall be not less than 4 mm, and the height/depth of the rebate shall be not less than 6 mm.

*Clay flue blocks and terminals for use with domestic gas appliances are specified in BS 1289 : Part 2.

Section two. Flue linings

4 Dimensions and tolerances

4.1 Cross-sectional dimensions

The limits of bore (for type 1) and internal width (for type 2) and maximum dimensions of flue linings shall be as given in table 1.

Table 1. Cross-sectional dimensions of linings

Type	Nominal size (DN)	Limits of bore or internal width		Maximum external diameter or width
		min.	max.	
		mm	mm	mm
1	125	119	135	175
	150	145	160	200
	175	169	186	230
	185	179	198	242
	210	200	220	268
	225	219	239	287
	250	242	266	314
	300	292	317	385
	350	342	366	424
2	175 x 175	169	186	240
	185 x 185	179	198	250
	200 x 200	193	213	260
	225 x 225	219	239	295
	250 x 250	242	266	320
	300 x 300	292	317	400

4.2 Nominal height

The nominal height of straight flue linings shall be not less than 180 mm and not greater than 600 mm.

The limits of tolerance on the stated nominal height shall be −2 % +5 % subject to a minimum value of ± 10 mm.

4.3 Curvature and radius

Flue lining bends shall have a nominal radius of 550 mm and a curvature of either 11.25, 22.5 or 37.5 degrees.

The tolerances shall be ± 55 mm on radius and ± 5 degrees on curvature.

4.4 Straightness

The permissible deviations from straightness of type 1 and type 2 straight flue linings of nominal height equal to or greater than 450 mm, when tested in accordance with appendix A, shall be not greater than the values given in table 2.

For intermediate nominal heights the permissible deviation from straightness shall be interpolated linearly.

Table 2. Straightness

Nominal height	Maximum permissible deviation
mm	mm
450	5
600	7

4.5 Squareness of ends

The permissible deviation from square of the ends of type 1 and type 2 straight flue linings, when tested in accordance with appendix B, shall not be greater than an angle of slope 30 mm/m.

4.6 Deviation from shape of cross section

The permissible deviation from square of the angles of, and flatness of walls for type 2 straight flue linings, when tested in accordance with appendix C, shall not be greater than the values given in table 3.

Table 3. Deviations from shape of cross section

Nominal size	Maximum permissible deviation
mm	mm
175 x 175	7
185 x 185	7
200 x 200	8
225 x 225	9
250 x 250	10
300 x 300	11

5 Performance requirements for flue linings

5.1 Crushing strength

When tested in accordance with appendix D, straight flue linings shall withstand an intensity of loading of 3.5 MN/m^2.

Where curved flue linings are fired in a plant alongside straight flue linings, using the same materials and firing process, the crushing strength of these curved flue linings is deemed to be that of the straight flue linings when tested in accordance with appendix D.

If curved flue linings are not normally fired alongside straight flue linings, straight flue linings or short lengths of straight flue linings made for test purposes, using the same materials and firing process as for curved flue linings, shall be type-tested (see **8.5**) for compliance with the requirements of this clause.

5.2 Impermeability

When subjected to the air pressure test described in appendix E, straight flue linings, and flue lining bends, excluding any rebates, shall withstand an initial internal air pressure of 100 mm water gauge, and this shall not drop below 75 mm water gauge in 5 min.

5.3 Heat resistance

When subjected to the heat resistance test described in appendix F, no test piece shall blister, powder, crack or change in such a way as would impair performance.

5.4 Acid resistance

When subjected to the acid resistance test described in appendix G, the mass loss from any test piece shall not exceed 0.25 %.

Section three. Flue terminals

6 Dimensions and tolerances

6.1 Cross-sectional dimensions

The limits of bore/internal width and maximum dimensions of flue terminals shall be as given in table 4.

6.2 Nominal height

The limits of tolerance on the stated nominal height shall be −2 % +5 % subject to a minimum value of ± 10 mm.

7 Performance requirements for flue terminals

7.1 Heat resistance

When subjected to the heat resistance test described in appendix F, no test piece shall show any of the faults specified in **5.3.**

Table 4. Cross-sectional dimensions of terminals

Nominal size	Type A		Maximum external diameter/width	Type B	
	Limits of bore/internal width			Limits of bore/internal width	
	min.	max.		min.	max.
mm	mm	mm	mm	mm	mm
Circular					
125	119	135	175	116	137
150	145	160	200	143	163
175	169	186	230	167	189
185	179	198	242	177	202
210	200	220	268	200	229
225	219	239	287	216	245
250	242	266	314	239	270
300	292	317	385	288	323
Square					
175 x 175	169	186	240	167	189
185 x 185	179	198	250	177	202
200 x 200	193	213	260	191	218
225 x 225	219	239	295	216	245
250 x 250	242	266	320	240	270
300 x 300	292	317	400	288	323

NOTE. No part of a type A flue terminal for use with solid fuel should be less than 210 mm circular nominal size or 185 X 185 mm square nominal size. These limitations should not apply to the size of any side entries which could be incorporated in the design of type A flue terminals.

The main inlet and outlet(s) to type B flue terminals can be of different nominal sizes but should not deviate beyond the appropriate limits given in table 4. These limitations do not apply to the size of any side entries which may be incorporated in the design of type B flue terminals.

7.2 Acid resistance

When subjected to the acid resistance test described in appendix G, the mass loss of any test piece shall not exceed 0.25 %.

7.3 Accelerated weathering test

When subjected to the accelerated weathering test described in appendix H, no test piece shall:

(a) show any new cracks;

(b) show any change in minor acceptable defects;

(c) show spalling or similar structural failure.

Section four. Sampling and testing

8 Sampling for flue linings and flue terminals

8.1 Sampling and testing

The relevant sampling procedures and test clauses are given in table 5.

8.2 Sampling for quality control at the manufacturer's works

Sampling and testing in respect of any batch shall be completed prior to removal from the works and shall be in accordance with tables 5, and 6 to 9 of appendix J and their switching rules, which are consistent with BS 6001 : Part 1, at an AQL of 10 % and inspection level S.2. Isolated batches of units shall be assessed in accordance with table 10 of appendix J with a maximum batch size of 1200.

8.3 Sampling for resubmitted rejected batches

Batches rejected under the sampling procedure specified in **8.2**, may be resubmitted once, after removal of units with previously undetected visible defects, under the tightened inspection procedures given in table 10 of appendix J, in respect only of the defect that caused initial rejection.

8.4 Sampling for material composition and manufacturing method

Sampling and tests relating to material composition and method of manufacture, i.e. regarding strength, permeability, heat resistance, acid resistance and weathering, shall be performed initially and whenever a change is made in material composition or method of manufacture.

8.5 Type tests

For the purposes of **5.1**, straight flue linings or short lengths of straight flue linings shall be tested at a frequency of at least one sample per month.

Table 5. Sampling procedures

Item	Relevant test clauses		
	Sampling procedure	Sampling procedure	Sampling procedure
	8.2	8.3	8.4
Type 1 and type 2 straight flue linings	5.1, 5.2	In respect only of the defect that caused initial rejection	5.1, 5.2, 5.3, 5.4
Type 1 and type 2 flue lining bends	5.2		5.1, 5.2, 5.3, 5.4
Type A and type B flue terminals			7.1, 7.2, 7.3

Section five. Marking

9 Marking

9.1 A company trade mark or the name of the manufacturer, and a means of identifying the date of manufacture shall either be impressed, preferably before firing, or, shall be marked indelibly on each flue lining and flue terminal after firing.

9.2 All flue linings and flue terminals shall be clearly and indelibly marked before dispatch with the number of this British Standard, i.e. 'BS 1181'*.

9.3 In addition type A flue terminals shall be marked 'A', and type B flue terminals marked 'B'.

*Marking BS 1181 on or in relation to a product represents a manufacturer's declaration of conformity, i.e. a claim by or on behalf of the manufacturer that the product meets the requirements of the standard. The accuracy of the claim is therefore solely the responsibility of the person making the claim. Such a declaration is not to be confused with third party certification of conformity, which may also be desirable.

Appendices

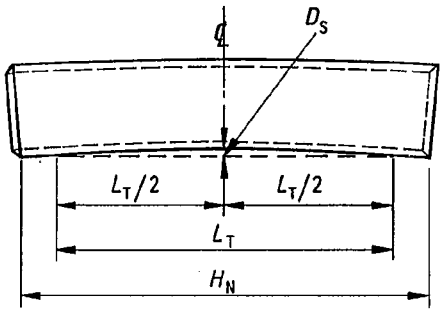
Appendix A. Straightness test

Test for straightness using any apparatus capable of measuring deviation from straightness to within ± 5 % of the specified values in 4.4. An example is shown in figure 3.

The test length shall be 150 mm less than the nominal height of the flue lining to allow for clearance at the shoulder of any socket.

The deviation from straightness of a flue lining is the maximum distance from the mid-point of a straight line equal to the test length spanning the concave curves on the outside of a flue lining to the flue lining surface (D_s) as shown in figure 2.

If both ends of this testing apparatus come into contact simultaneously with the flue lining then the permissible deviation from straightness is exceeded.



H_N is the nominal height of the flue lining in mm
L_T is the test length in mm
D_s is the deviation from straightness in mm
$H_N - L_T = 150$ mm

Figure 2. Terms for deviation from straightness

Appendix B. Squareness of end test

The test gauge as shown in figure 4 with one arm set at a slope of 30 mm/m to the other shall be provided with two pairs of supports at 50 ± 5 mm centres. The end support shall be positioned so that there is a recess of 30 ± 5 mm from the inside of the angled arm. The slope of the supports shall be such as to provide a clearance of at least 5 mm under the test gauge. The angled arm shall be of such a length as to span the outside diameter/width of the flue lining.

Place the gauge on the end of the flue lining and note whether the slope of the end exceeds that of the gauge, i.e. whether there is a gap at 'G'.

Appendix C. Squareness of angles and flatness of walls test

A test gauge as shown in figure 5 has one arm set at an angle of 90 ± 0.5 degrees to the other and both arms of the test gauge of such a length as to span the outside width of the flue lining under test.

Place the gauge against two adjoining walls of type 2 straight flue lining, and measure the distances x_1 and x_2 between the inner edge of the test gauge and the outside of the flue lining, excluding the rounded external corners, to an accuracy of ± 0.5 mm.

Appendix D. Crushing strength test

D.1 Test specimen

The test specimen of flue linings shall be not less than 150 mm high with flat and parallel ends on the full cross section of the flue lining.

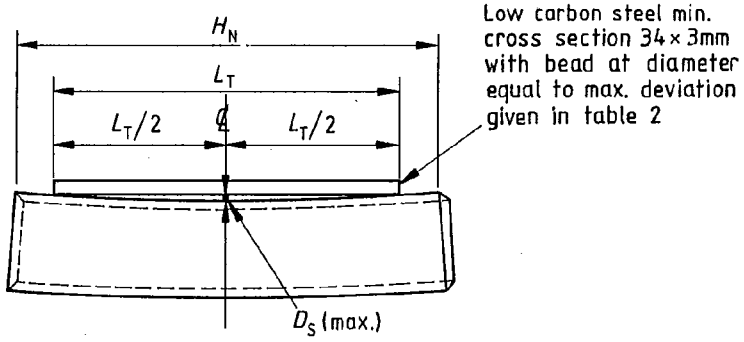


Figure 3. Straightness test

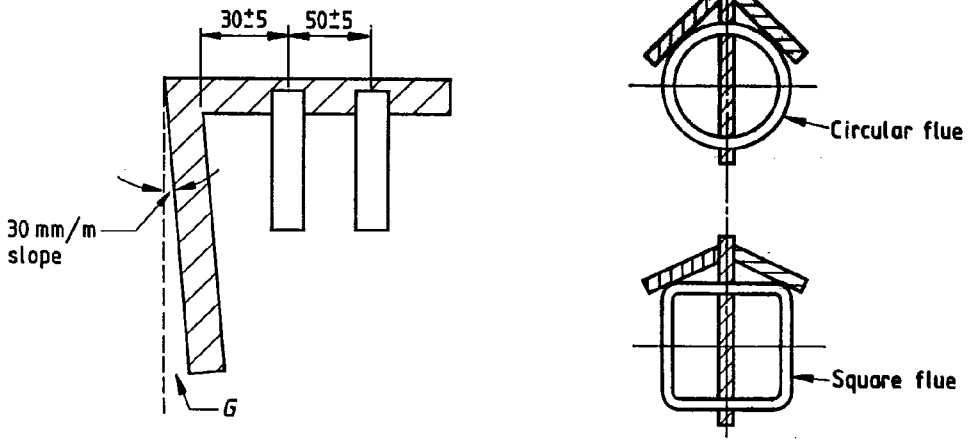
D.2 Testing machine

The testing machine shall be substantial and rigid throughout so that the distribution of load will not be affected appreciably by the deformation or yielding of any part. The machine shall be capable of applying the load at the rate specified in **D.3** and its accuracy shall be verified by the means detailed in BS 1610.

The specimen together with a thrust packer at each end shall be placed between thrust plates. The bearing faces of both the thrust packers and the thrust plates shall be larger than the outside dimensions of the flue lining under test. The thrust packers shall consist of 18 mm thick type II/III (moisture resistant) flooring grade chipboard to BS 5669 and be concentric to the thrust plates.

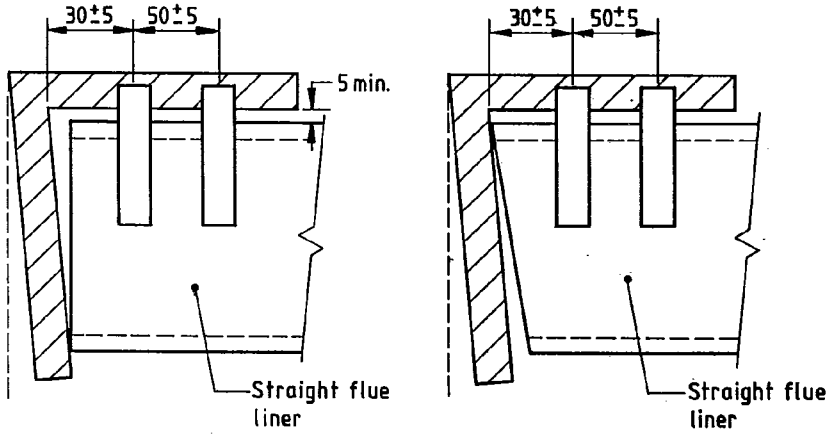
The thrust plates shall consist of metal, free from warping or twisting and be centrally loaded and of sufficient dimensions so as not to distort under load. One thrust plate shall be free to tilt in any direction so that it can align with the surface of its associated thrust packer.

Ensure that the bearing surfaces of the machine and specimen are clean and free from any loose particles. Place the test specimen in the machine so that the load is applied through its longitudinal axis.



Longitudinal section of gauge

Cross section of gauge



Liner passing test

Liner failing test

All dimensions are in millimetres.

Figure 4. Squareness test for ends

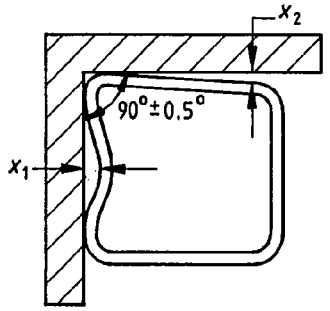


Figure 5. Squareness test for angles and flatness of walls

D.3 Loading

Apply the load to the specimen without shock and increase it at a rate of 14 MN/m^2 per minute until either the required load as specified in **5.1** is reached or the specimen falls.

The loading is produced by the following loads:

(a) For type 1 flue linings 2.75 $(D_1^2 - D_2^2)$ N

where

D_1 = actual mean external diameter of the test piece (in mm).

D_2 = actual mean internal diameter of the test piece (in mm).

(b) For type 2 flue linings 3.5 $(L_1^2 - L_2^2)$ N

where

L_1 = actual mean external width of test piece (excluding rounded corners) (in mm).

L_2 = actual mean internal width of test piece (excluding rounded corners) (in mm).

Appendix E. Impermeability (air pressure test)

Close the ends of the flue lining with airtight seals. Connect a clear plastic or glass 'U' tube (manometer) to one of the airtight seals and a means of applying the air pressure to the other airtight seal.

Apply pressure to achieve a value of 105 ± 2 mm water gauge and allow not less than 5 min for stabilization of the air temperature. Adjust air pressure to 100 ± 2 mm water gauge at the commencement of the test.

During stabilization and testing the ambient temperature and atmospheric conditions of the test should, as far as possible, remain constant.

Appendix F. Heat resistance test

Test units shall be straight flue linings not less than 300 mm in height and of 210 mm nominal circular or 185 mm by 185 mm nominal square section. If neither section is normally produced, units for testing shall be selected from the nearest nominal section normally produced.

Place the test unit in a kiln or oven capable of holding the unit without it touching the sides. Raise the temperature inside the kiln or oven steadily at a rate not exceeding 200 °C/h to a maximum temperature of 1000 °C. Maintain this temperature for a period of not less than 1 h. Cool the oven slowly, i.e. at a rate of not more than 100 °C/h.

Appendix G. Acid resistance test

Test pieces shall be freshly broken pieces of flue lining or flue terminal as appropriate, about 65 × 10^4 mm^3 in volume, free from cracks or shattered edges. The test pieces may be those already subjected to the heat resistance test given in appendix F. Clean and dry them at a temperature of not less than 150 °C until no further loss of mass (correct to 0.01 g) is noted on successive weighings. Immerse the test pieces for 48 h in 500 mL of each of the test solutions at a temperature of 15 ± 5 °C.

The test solutions shall be as follows.

(a) Hydrochloric acid solution, c (HCl) = 1 mol/L (d = 1.18).

(b) Nitric acid solution, c (HNO_3) = 1 mol/L (d = 1.42).

(c) Sulphuric acid solution, c (H_2SO_4) = 0.5 mol/L (d = 1.84).

The weighing machine shall be accurate to within 0.01 g when loaded with 200 g.

On removal from the solution, carefully and thoroughly wash each test piece with hot distilled water and then boil in 500 mL of distilled water for 0.5 h. Dry the test piece at a temperature of not less than 150 °C until no further loss of mass can be noted on successive weighings. Calculate the loss of acid soluble matter in the test piece as a percentage of the dry mass as follows:

$$\text{percentage loss in dry mass} = \frac{(M_1 - M_2 \times 100)}{M_1}$$

where

M_1 = mass of the test piece before treatment (g);

M_2 = mass of the test piece after treatment (g).

Appendix H. Accelerated weathering test

A test specimen shall be made using the same materials and method of manufacture as the flue terminal. It shall be not less than 150 mm high and of such a nominal size and wall thickness as to be typical of the range of flue terminals produced.

Examine the test specimen prior to the test, and mark any defects which are already present.

Place the test specimen in an airtight box and evacuate it to at least 300 mm of mercury, taking care to place it in such a position as to permit gradual immersion during the next operation.

Maintain the vacuum for 2 h; introduce water into the box by suction, in such a way that complete immersion of the specimen is obtained in about 30 min.

Then subject the test specimen to the following sequence of freezing and thawing.

(a) Place the test specimen in a tank filled with water which is itself located in the centre of a refrigerator and cool this water to a temperature of not greater than 5 °C.

(b) Draw out the water and continue the freezing until the test specimen reaches a temperature of − 15 ± 5 °C. During this stage of the test agitate the air in the surrounding refrigerator by fans.

(c) Introduce water into the tank at a temperature of 15 ± 5 °C until the test specimen is completely immersed. Keep the specimen for not less than 30 min in the water maintained at this temperature by heating and stirring so that the temperature in the test specimen reaches 15 ± 5 °C at the end of the period.

Repeat the freezing and thawing operation 25 times.

Remove the test specimen and examine it to determine if:

(1) any new cracks have appeared;

(2) there has been any change in defects noted prior to the test;

(3) there has been any spalling or similar structural failure.

Appendix J. Inspection procedures

J.1 Acceptability determination

NOTE. Single or double sampling may be used.

J.1.1 Single sampling

If the number of defectives found in the sample is equal to or less than the acceptance number, the batch shall be accepted. If the number of defectives is equal to or greater than the rejection number, the batch shall be rejected.

When reduced inspection is in effect and the acceptance number has been exceeded, but the rejection number has not been reached, the batch shall be accepted and normal inspection reinstated. If the rejection number has been reached or exceeded, the batch shall be rejected and normal inspection reinstated.

J.1.2 Double sampling

The number of sample units shall be equal to the first sample size in the plan. If the number of defectives found in the first sample is equal to or less than the first acceptance number, the batch shall be accepted. If the number of defectives found in the first sample is equal to or greater than the first rejection number, the batch shall be rejected. If the number of defectives found in the first sample is between the first acceptance and rejection numbers, the second sample of the size given in the plan shall be inspected.

The number of defectives found in the first and second samples shall be accumulated. If the cumulative number of defectives is equal to or less than the second acceptance number, the batch shall be accepted. If the cumulative number of defectives is equal to or greater than the second rejection number, the batch shall be rejected. If this occurs on reduced inspection, normal inspection shall be reinstated for the next batch.

When reduced inspection is in effect and, after the second sample, the acceptance number has been exceeded but the rejection number has not yet been reached, the batch shall be accepted and normal inspection reinstated.

J.2 Normal inspection

The sample size appropriate to the batch size and the acceptance and rejection values for numbers of defectives shall be in accordance with table 6. Sample units shall be selected at random.

J.3 Normal to reduced inspection

A reduced inspection level as shown in table 7 shall be used when normal inspection is in effect, provided that the following conditions are satisfied:

(a) the preceding ten batches have been on normal inspection, and none has been rejected on original inspection;

Table 6. Sampling plans for normal inspection

Batch size	Single sampling			Double sampling					
	Sample size	Accept number	Reject number	First sample size	Accept number	Reject number	Second sample size	Accept number	Reject number
2 to 1200	5	1	2	3	0	2	3	1	2
1201 to 20000	8	2	3	5	0	3	5	3	4

Table 7. Sampling plan for normal to reduced inspection

Batch size	Single sampling			Double sampling					
	Sample size	Accept number	Reject number	First sample size	Accept number	Reject number	Second sample size	Accept number	Reject number
2 to 1200	2	0	2	Not applicable					
1201 to 20000	3	1	3	2	0	3	2	0	4

(b) the total number of defectives in the samples from the ten preceding batches (or such other number required by table 8) is equal to or less than the limit number given in table 8.

When double sampling is in use, all samples inspected should be included, not first samples only.

Table 8. Limit number of defectives for normal to reduced inspection

Number of samples from last ten batches	Limit number of defectives
20 to 29	0
30 to 49	0
50 to 79	2
80 to 129	4

J.4 Reduced to normal inspection

When reduced inspection is in effect, normal inspection shall be reinstated if a batch is rejected, or if a batch is accepted without either acceptance or rejection criteria having been met (see **J.1.1** and **J.1.2**).

J.5 Tightened inspection

Tightened inspection as shown in table 9 shall be used either when inspecting a new product or when two or more batches have been rejected in any five consecutive batches of normal inspection.

J.6 Tightened to normal inspection

Tightened inspection shall continue until five consecutive batches are accepted when normal inspection shall be resumed.

J.7 Discontinuation of inspection

If ten consecutive batches remain on tightened inspection, the provision of these sampling plans shall be discontinued pending action to improve the quality of the submitted batches.

J.8 Tightened inspection for rejected batches

Tightened inspection as shown in table 10 shall be used when inspecting a batch which has previously been rejected, after removal of units with previously undetected visible defects.

Table 10. Sampling plan for tightened inspection for rejected batches

Batch size	Single sampling		
	Sample size	Accept number	Reject number
2 to 150	3	0	1
151 to 20000	13	1	2

Table 9. Sampling plan for tightened inspection

Batch size	Single sampling			Double sampling					
	Sample size	Accept number	Reject number	First sample size	Accept number	Reject number	Second sample size	Accept number	Reject number
8 to 20000	8	1	2	5	0	2	5	1	2

Publications referred to

BS 1289	Flue blocks and masonry terminals for gas appliances Part 1 Specification for precast concrete flue blocks and terminals Part 2 Specification for clay flue blocks and terminals
BS 1610	Materials testing machines and force verification equipment
BS 5440	Code of practice for flues and air supply for gas appliances of rated input not exceeding 60 kW (1st and 2nd family gases) Part 1 Flues
BS 5669	Specification for wood chipboard and methods of test for particle board
BS 6001	Sampling procedures for inspection by attributes Part 1 Specification for sampling plans indexed by acceptable quality level (AQL) for lot-by-lot inspection
BS 6461	Installation of chimneys and flues for domestic appliances burning solid fuel (including wood and peat) Part 1 Code of practice for masonry chimneys and flue pipes

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