
Specification of
Purchasing requirements and methods of test
for fluxes for soft soldering

Spécification et méthodes d'essais des exigences pour les flux pour
les travaux de soudure à l'étain, à convenir avec l'acheteur

Spezifikation und Prüfverfahren für Bestimmungen für Flußmittel
für Weichlotarbeiten, zur Vereinbarung mit dem Käufer

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Foreword

Fluxes for soft soldering assist the molten solder to wet the metal surfaces to be joined and to penetrate the joint. This assistance may depend on several actions, but the essential function of a flux is the removal of oxides and related contaminants from the surfaces, both of the workpieces and of the solder at the soldering temperature, and the preservation of the surfaces from recontamination during the soldering operation. Since the character of the surface contaminants depends on the composition of the workpieces, a range of fluxes is required. Some fluxes leave residues which may promote corrosion of the workpiece; this necessitates careful selection of flux and subsequent treatment of soldered joints to remove these flux residues.

This specification classifies the soft soldering fluxes which

are at present in common usage and provides some guidance for the user on their recommended fields of application.

The standard includes classification tests and routine batch tests. The former are intended to assist the user in selecting an appropriate flux and ensuring its suitability for its intended purpose. Routine batch tests are intended to assist the supplier and the user in checking the consistency of the product from batch to batch. The standard also gives purchasing requirements for fluxes.

Methods of testing flux-cored solder are not covered by this British Standard and reference should be made to BS 441 for guidance on tests for this type of material.

British Standard Specification of

Purchasing requirements and methods of test for fluxes for soft soldering

1. Scope

This British Standard specifies purchasing requirements and appropriate test methods for various types of solid, liquid and paste flux available for soft soldering or 'tinning' operations in which any of the solders listed in BS 219 are used.

The standard classifies soft soldering fluxes according to the nature of their active fluxing ingredients and describes methods of testing their fluxing efficiency and the properties of their residues.

2. References

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

3. Classification of fluxes

Fluxes specified in this standard are divided into seven classes, which are categorized according to their active ingredients. This classification need not be restrictive and a flux may fall within more than one class. The classes are as follows:

- class 1*, inorganic halides with or without inorganic acids
- class 2*, phosphoric acid and derivatives
- class 3*, halides of organic compounds
- class 4*, organic acids
- class 5*, activated rosins, either
 - class 5a*, activators containing halide, or
 - class 5b*, activators not containing halide
- class 6*, non-activated rosins
- class 7*, other organic compounds.

The class of flux selected will depend on the application and on ease of removal of its residues. A guide to the application of each class is given below.

- (a) *Class 1*, soldering and 'tinning' of ferrous and non-ferrous metals in general engineering, in sheet metal work, and in plumbing. Flux residues are normally removed.
- (b) *Class 2*, soldering of stainless steel. In some circumstances the residues from these fluxes need not be removed.
- (c) *Class 3*, soldering and 'tinning' of non-ferrous metals in general engineering and in sheet metal work. Flux residues are less corrosive and less electrically conductive than those of fluxes in class 1 and their removal can often be omitted. On electrical assemblies, their removal is recommended.

(d) *Class 4*, soldering of lead, pewter and copper base alloys.

(e) *Class 5*, soldering and 'tinning' of non-ferrous components in the electrical and electronics industries. Suitable for use with high-speed mechanized soldering systems.

(f) *Class 6*, soldering of copper in the electrical and electronics industries where lowest corrosion liability is essential.

(g) *Class 7*, for general soldering operation, where flux residues should have minimum corrosive action compatible with the application.

4. Physical condition

Fluxes shall be free from foreign matter or impurities deleterious to the fluxing action.

Liquid fluxes shall be homogeneous and free from sediment.

Paste fluxes shall be in a uniform viscous form and of a consistency suitable for application to the surface to be soldered.

5. Packaging and marking

Fluxes supplied to the classifications given in this standard shall be packed in suitable containers and shall have a label bearing the following information.

- (a) The number of this British Standard, the class of flux and nature of the active ingredients present. Where a flux falls within more than one class, this should be presented as shown in the following examples:

BS 5625, class 3/4,

BS 5625, class 5a/5b.

- (b) The name of the manufacturer, the batch number and the date of manufacture.
- (c) Concentration limits, where these have been agreed between the supplier and the purchaser.
- (d) Flash points, if measurable.
- (e) Hazards in handling or in use.

6. Test methods

6.1 Test for fluxing efficiency

6.1.1 Principle. A standard pellet of 60 % tin : 40 % lead solder is melted in contact with the flux on a standard test piece floating on molten solder. The area to which

the solder spreads on the sheet metal is taken as a measure of the fluxing efficiency. The value reported is the mean of 10 such tests.

The composition and preparation of the sheet metal used for testing each class of flux is specified and is representative of the type of basis metal generally soldered with that particular class of flux.

When testing fluxes in classes 1, 3, 4, 5, 6 and 7, both the flux and the solder are placed on the sheet metal before heating is commenced. Fluxes in class 2 tend to dehydrate fairly rapidly when heated and may thus become ineffective under practical soldering conditions. In order to assess the resistance of a flux in class 2 to dehydration it is heated on the sheet metal for a specified time before the solder is placed on the fluxed surface.

6.1.2 Apparatus. The apparatus given in 6.1.2.1 to 6.1.2.4 is required.

6.1.2.1 Heating bath, either round and not less than 120 mm in diameter, or rectangular with dimensions of not less than 100 mm × 75 mm, and containing a tin-lead solder with a liquidus below 200 °C, to a depth of not less than 40 mm, and maintained at the appropriate temperature shown in column 3 of table 1.

6.1.2.2 Jig for holding sheet metal test piece. The design of jig shown in figure 1 has been found to be suitable. Means are provided for carefully lowering the sheet metal test piece, lying on the jig in the horizontal plane, on to the surface of the molten metal in the heating bath and then carefully raising it, again lying in a horizontal plane, on completion of the heating cycle. During the heating cycle, the test piece floats freely on the metal in the bath and is not in contact with any portion of the jig. The jig has a low heat capacity and is preferably made of a thin gauge metal such as stainless steel, anodized aluminium or titanium, which is not wetted by the molten metal in the heating bath.

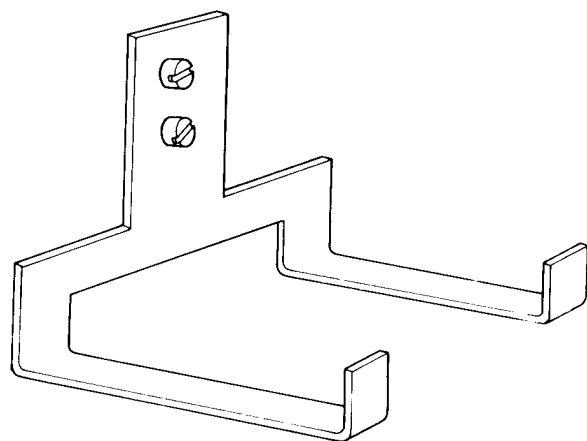


Figure 1. Example of a jig for holding the sheet metal test piece

6.1.2.3 Transparent sheet. A sheet of transparent material, usually perspex, 100 mm × 75 mm × 2 mm inscribed with a series of concentric circles of known diameter.

6.1.2.4 Planimeter, or alternative means to measure the area of solder spread.

6.1.3 Reagents. All reagents shall be of recognized analytical quality and distilled or demineralized water complying with the requirements of BS 3978 shall be used throughout. The reagents given in 6.1.3.1 to 6.1.3.4 are required.

6.1.3.1 Ammonium persulphate (25 % m/V in 0.5 % V/V sulphuric acid). Dissolve 250 g of ammonium persulphate in water and add cautiously 5 ml of sulphuric acid (relative density 1.84). Mix, cool, dilute to 1 litre and mix. This solution should be freshly prepared.

6.1.3.2 Hydrochloric acid (50 % V/V). Dilute 500 ml of hydrochloric acid (relative density 1.16 to 1.18) to 1 litre and mix.

6.1.3.3 Nitric acid (25 % V/V). Dilute 250 ml of nitric acid (relative density 1.42) to 1 litre and mix.

6.1.3.4 Sulphuric acid (5 % V/V). To 400 ml of water add cautiously 50 ml of sulphuric acid (relative density 1.84). Mix, cool, dilute to 1 litre and mix.

6.1.3.5 Acetone, complying with the requirements of BS 509.

6.1.4 Test pieces

6.1.4.1 General. Cut flat squares 40 ± 2 mm in length from sheet metal 0.50 mm to 0.80 mm thick and complying with the specification shown in column 2 of table 1 appropriate to the class of flux.

After degreasing in a neutral organic solvent such as acetone, toluene or petroleum ether, pretreat the test pieces as given in 6.1.4.2 to 6.1.4.5. Clean tongs shall be used to avoid contamination.

Table 1. Test materials and operating temperatures

Flux class	Sheet metal specification	Heating bath temperature, °C
1	Carbon steel, CR4 to BS 1449 : Part 1	235 ± 5
2	Stainless steel, 302S17 to BS 1449 : Part 2	300 ± 5
3	Brass, CZ108 ½ H to BS 2870	235 ± 5
4	Copper, C101 ½ H to BS 2870	235 ± 5
5	Copper, C101 ½ H to BS 2870	235 ± 5
6	Copper, C101 ½ H to BS 2870	235 ± 5
7	Copper, C101 ½ H to BS 2870	235 ± 5

6.1.4.2 Pretreatment of copper test pieces. Pretreat the copper test piece as follows.

- Immerse in sulphuric acid (5 % V/V) at 60 °C to 70 °C for 1 min to remove the film of tarnish.
- Immerse in a solution of ammonium persulphate (25 % m/V in 0.5 % V/V sulphuric acid) at 20 °C to 25 °C for 1 min to etch the surface uniformly.
- Wash in running tap water for a maximum of 5 s.
- Immerse in sulphuric acid (5 % V/V) at a temperature of not greater than 25 °C for 1 min.
- Wash in running tap water for approximately 5 s and then rinse thoroughly in demineralized water.
- Rinse with acetone complying with the requirements of BS 509.
- Allow to dry in clean air.
- Use the test pieces within 15 min of preparation.

6.1.4.3 Pretreatment of brass test piece. Pretreat the brass test piece as follows.

- Immerse in the 'bright' dip acid pickle recommended in method R.2 of CP 3012 : 1972. This is an aqueous solution containing approximately:
 - sulphuric acid (25 % V/V),
 - nitric acid (25 % V/V),
 - sodium chloride (0.1 % m/V) or hydrochloric acid (0.1 % V/V) (optional).

Use the solution at room temperature (approximately 15 °C); cool it if the heat of reaction is excessive. Since the process results in the evolution of highly toxic fumes, efficient fume extraction is essential. Remove the specimen from the pickle immediately vigorous effervescence is observed to be occurring uniformly over the whole of the surface.

- Rinse in running water.
- Rinse with acetone complying with the requirements of BS 509.
- Allow to dry in clean air.
- Use the test piece within 15 min of preparation.

6.1.4.4 Pretreatment of carbon steel test piece. Pretreat the carbon steel test piece as follows.

- Immerse in hydrochloric acid (50 % V/V) for 15 min at room temperature.

(b) Immerse in nitric acid (25 % V/V) for 1 min at room temperature.

(c) Rinse in running tap water.

(d) Rinse with acetone complying with the requirements of BS 509.

(e) Allow to dry in clean air.

(f) Use the test piece within 15 min of preparation.

6.1.4.5 Pretreatment of stainless steel test piece. Manually abrade one surface of each square to a 180 grit finish. Then immerse in a neutral organic solvent, such as acetone, toluene or petroleum ether, to remove any particles of abrasive.

6.1.5 Solder. Use solder in the form of cylindrical pellets, each of minimum thickness 1.5 mm with a mass of 200 ± 10 mg conforming in composition to grade K of BS 219, and previously degreased in a neutral organic solvent such as acetone, toluene or petroleum ether.

6.1.6 Procedure

6.1.6.1 Application of flux. Apply the flux to the central region of the prepared surface of the sheet metal test piece by one of the methods given in 6.1.6.1.1 to 6.1.6.1.3, according to the state of the flux.

6.1.6.1.1 Solid fluxes. Transfer 0.015 g to 0.030 g of the flux to the surface.

6.1.6.1.2 Liquid fluxes. By means of a pipette apply 0.02 ml to 0.03 ml of the flux to the surface.

For liquid flux with a non-volatile matter content of less than 20 %, reduce the volume of approximately 10 ml of the flux to approximately 5 ml by placing the flux in a 50 ml beaker in an air circulating oven at 60 °C. Apply 0.02 ml to 0.03 ml of the concentrated flux to the surface.

6.1.6.1.3 Paste fluxes. Apply a circular layer of the flux, 0.25 mm to 0.50 mm thick and 30 mm in diameter, to the surface. Such a layer is conveniently produced by placing a 0.25 mm thick stainless steel template, with a 30 mm diameter aperture, on the test piece so that it fills the circular cavity with a slight excess of flux, drawing a straight edge (e.g. a razor blade) across the cavity to remove excess flux, then removing the template.

6.1.6.2 Heating

6.1.6.2.1 Flux classes 1, 3, 4, 5, 6 and 7. Place the fluxed sheet metal test piece on the jig and place a solder pellet, as described in 6.1.5, at the centre of the fluxed area. After skimming any dross off the surface of the bath allow the test piece to remain floating on the metal in the bath for a period of 30 s, then raise it to a height sufficient to allow the solder on its upper surface to solidify. Do not remove the test piece from the jig until the solder is completely solid, and avoid any accidental vibration during cooling, otherwise the test is rendered invalid. It is expected that the solder patch will be sufficiently round to enable the measurement described in 6.1.7 to be made.

6.1.6.2.2 Flux class 2. After placing the fluxed test piece on the jig and skimming any dross off the surface of the metal in the heating bath, lower the test piece on to the surface of the bath and allow it to remain floating for 20 s. Place a solder pellet, as described in 6.1.5, at the centre of the fluxed area and, after a further period of 30 s, raise the test piece to a height sufficient to allow the

the solder on its upper surface to solidify. Do not remove the test piece from the jig until the solder is completely solid and avoid any accidental vibration during cooling otherwise the test is rendered invalid. It is expected that the solder patch will be sufficiently round to enable the measurement described in 6.1.7 to be made.

6.1.7 Measurement of area of solder spread. After washing off the flux residues with a suitable solvent, measure the area of the solder by means of a transparent sheet or by alternative means, such as a planimeter.

6.2 Test for corrosion

6.2.1 Principle. A standard pellet of solder complying with grade K of BS 219 is melted in contact with the flux to be tested on a sheet metal test piece. The solder is then exposed to prescribed conditions of humidity and the resulting corrosion, if any, is assessed visually.

This test is applied to classes 4, 5a, 5b, 6 and 7 only.

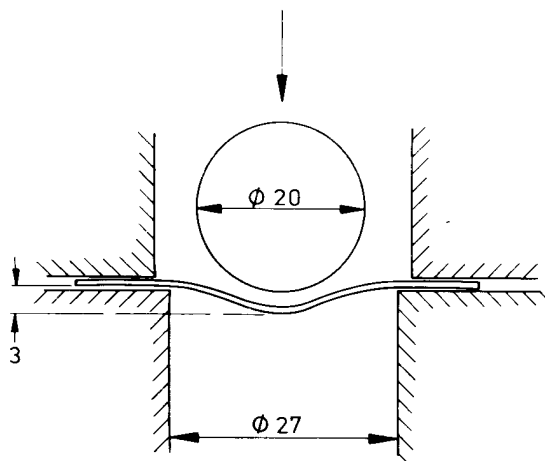
6.2.2 Apparatus. The apparatus given in 6.2.2.1 and 6.2.2.2 is required.

6.2.2.1 Heating bath, either round and not less than 120 mm in diameter, or rectangular with dimensions of not less than 100 mm x 75 mm and containing a tin-lead solder with a liquidus below 200 °C, to a depth of not less than 40 mm.

6.2.2.2 Humidity chamber. If available, use a chamber complying with the requirements of BS 3718, with potassium dihydrogen phosphate as the humidifying salt.

Alternatively, use a chamber made of glass or acrylic resin of about 10 litre capacity, capable of being closed by a gastight cover or door. A conventional 10 litre desiccator vessel is suitable. The internal walls of the test vessel are covered with thick absorbent paper dampened with a saturated solution of potassium dihydrogen phosphate and dipping into at least 100 ml of the same solution placed in the bottom of the vessel and to which some solid crystals of potassium dihydrogen phosphate have been added.

The support for the specimens is made of an inert non-metallic substance such as glass or plastics material. Any suspending medium used is made of glass, synthetic fibre or other inert material. The support, suspension and specimens are prevented from touching the phosphate solution or the paper soaked in it. The whole vessel is maintained at a temperature of 40 ± 2 °C in a suitable oven.



Dimensions are in millimetres.

Figure 2. Dimensions of penetrator, die and blank-holder

6.2.2.3 Erichsen cupping machine, complying with the requirements of BS 3855.

6.2.2.4 Air-circulating oven, as described in BS 2648, of a volume sufficient to contain the test specimen and to permit the free circulation of air.

6.2.2.5 Microscope, of magnification not less than $\times 20$.

6.2.3 Reagents. All reagents shall be of recognized analytical quality and distilled or demineralized water, complying with the requirements of BS 3978, shall be used throughout.

6.2.3.1 Ammonium persulphate (25 % m/V in 0.5 % V/V sulphuric acid). Dissolve 250 g of ammonium persulphate in water and add cautiously 5 ml of sulphuric acid (relative density 1.84). Mix, cool, dilute to 1 litre and mix. This solution should be freshly prepared.

6.2.3.2 Sulphuric acid (5 % V/V). To 400 ml of water add cautiously 50 ml of sulphuric acid (relative density 1.84). Mix, cool, dilute to 1 litre and mix.

6.2.3.3 Acetone, complying with the requirements of BS 509.

6.2.3.4 Toluene, complying with the requirements of BS 805.

6.2.3.5 Petroleum ether.

6.2.4 Test piece

6.2.4.1 General. Cut a flat square 50 mm x 50 mm of approximately 0.5 mm thick copper sheet (half-hard condition) complying with designation C101 of BS 2870.

Make a depression in the centre of the test piece by forcing a 20 mm ball through a 27 mm die to a depth of 3 mm (see figure 2). This can conveniently be done by using the Erichsen cupping machine described in BS 3855. One corner of the test piece may be bent up to facilitate handling with tongs.

6.2.4.2 Pretreatment of test piece. Immediately before use pretreat the test piece in the following manner; handle with clean tongs or with a suitable mechanical device.

- Degrease with a suitable neutral organic solvent such as acetone, toluene or petroleum ether.
- Immerse in sulphuric acid (5 % V/V) at 60 °C to 70 °C for 1 min to remove the tarnish film.
- Immerse in a solution of ammonium persulphate (25 % m/V in 0.5 % V/V sulphuric acid) at 20 °C to 25 °C for 1 min to etch the surface uniformly.
- Wash in running tap water for a maximum of 5 s.
- Immerse in sulphuric acid (5 % V/V) at a temperature of not greater than 25 °C for 1 min.
- Wash for about 5 s in running tap water and rinse thoroughly in demineralized water.
- Rinse with acetone complying with the requirements of BS 509.
- Allow to dry in clean air.
- Use the test piece as soon as possible or store up to 1 h in a closed container.

6.2.5 Procedure

6.2.5.1 Preparation of solder sample. Weigh 1 ± 0.05 g of solder, complying with grade K of BS 219 and previously degreased with a neutral organic solvent such as acetone, toluene or petroleum ether, into the centre