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Fireworks —

Part 3: Methods of test for fireworks

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Committees responsible for this British Standard

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Chief and Assistant Chief Fire Officers' Association
Child Accident Prevention Trust
Confederation of British Industry
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Health and Safety Executive
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Loss Prevention Council
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National Association of Toy Retailers
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Scout Association

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Foreword

This Part of BS 7114 has been prepared under the direction of the Chemicals Standards Committee.

BS 7114 has been prepared in order to specify certain basic requirements for the construction and performance of fireworks (as well as describing an associated classification system and methods of test) which will help to ensure that the risks of injury to users, onlookers and the public in general and of damage to property are minimized. It also includes requirements for labelling in order to encourage the proper use of fireworks. Prior to the publication of BS 7114 there had been no comprehensive document published in the United Kingdom concerned with the quality of fireworks, although fireworks are subject to certain legislation, notably the Explosives Act 1875 and the Fireworks Act 1951, and to voluntary agreements between Government departments and the industry.

BS 7114 is issued in three Parts as follows:

— *Part 1: Classification of fireworks;*

— *Part 2: Specification for fireworks;*

— *Part 3: Methods of test for fireworks.*

The main purpose of this Part of BS 7114 is to provide the test methods for assessment of compliance with the requirements of Part 2. If testing is carried out at the place of manufacture it is advisable to condition the fireworks so as to simulate the effects of temperature, humidity and, vibration during storage and transportation.

A test for the presence of a mixture of sulphur and sodium or potassium chlorate is described in Appendix C, although there is no requirement in BS 7114-2 concerning such mixtures[1)].

WARNING. The testing of fireworks can be very dangerous and should only be carried out by suitably qualified personnel, taking all appropriate safety precautions. Such safety precautions are not described in this British Standard. It is essential, however, that suitable screens, clothing and other equipment are provided to protect test operators. If possible, tests should be initiated remotely. All personnel should be kept a safe distance from a functioning firework.

The dismantling of fireworks is a particularly hazardous operation which can be carried out legally only in a factory licensed for that purpose.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations. In particular, attention is drawn to the Explosives Act 1875 and Order in Council 15[1)], the Explosives Act 1923, the Fireworks Act 1951, the Health and Safety at Work etc. Act 1974 and the Consumer Protection Act, 1987.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 26, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

[1)] Order in Council 15 made under the Explosives Act 1875 is concerned with whether an explosive composition contains a mixture of sulphur and of potassium chlorate or other chlorates.

1 Scope

This Part of BS 7114 describes methods for testing fireworks and certain items of ancillary equipment. It is applicable to fireworks for sale to the general public, for indoor and outdoor use (i.e. categories 1, 2 and 3 as classified in BS 7114-1). Category 4 fireworks, i.e. fireworks which are incomplete and/or which are not intended for sale to the general public, are excluded. Category 3 shells supplied without a mortar tube are also excluded.

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

2 Definitions

For the purposes of this Part of BS 7114 the definitions given in BS 7114-1 apply.

3 Caps (type 1A fireworks)[2)]

3.1 Reagents

3.1.1 *General.* During the test use only reagents of recognized analytical grade and water complying with grade 3 of BS 3978.

3.1.2 *Nitric acid solution, dilute.* Dilute concentrated nitric acid solution, ρ approximately 1.42 g/mL, about 70 % (m/m), 1 + 1 with water.

3.2 Test area for communication testing

The test area for communication testing, as described in **3.5.4** to **3.5.6**, shall be swept and washed clean, shall contain only the apparatus used during the testing and shall be provided with a means of extracting fumes.

3.3 Apparatus

Ordinary laboratory apparatus together with the following.

3.3.1 *Analytical balance,* capable of weighing to an accuracy of 0.0001 g.

3.3.2 *Hard, smooth, horizontal metal surface.*

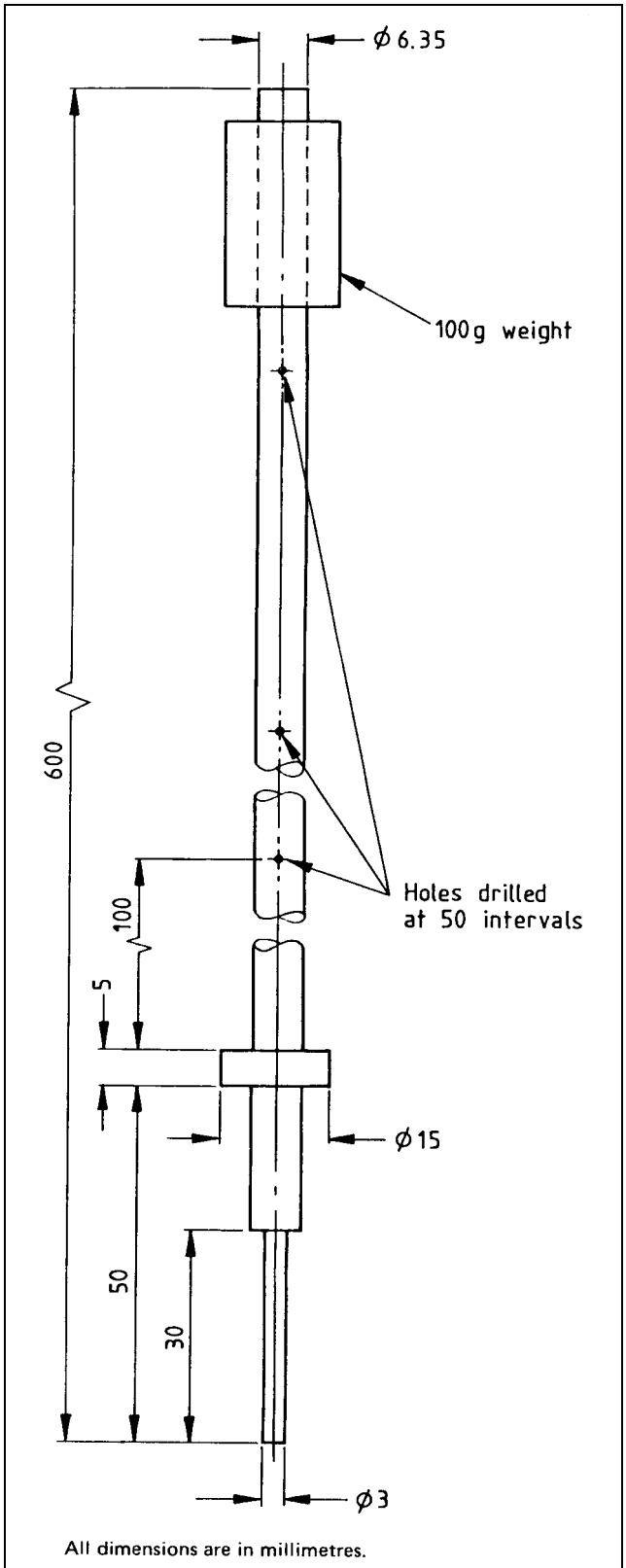


Figure 1 — Rod for communication testing

[2)] See BS 7114-1 for the classification of fireworks.

3.3.3 *Stainless steel rod,* of length 600 mm and diameter 6.35 mm, as shown in Figure 1. One end is machined so that the diameter is reduced to 3.00 mm over a length of 30 mm with a flat tip perpendicular to the axis of the rod. A stainless steel collar, of thickness 5 mm and outside diameter 15 mm, is firmly attached to the rod at a distance of 50 mm from the end with the reduced diameter. The rod is also fitted with an annular weight, of mass 100 g and internal diameter such that it is just able to move freely along the 6.35 mm diameter section of the rod. The rod is drilled with a hole, into which a pin can be inserted, at a distance of 100 mm from the collar and with similar holes at intervals of 50 mm along the remaining length.

3.3.4 *Means of clamping the rod in a vertical position.*

3.3.5 *Vacuum desiccator.*

3.3.6 *Magnetic stirrer*, with a bar coated in polytetrafluoroethylene.

3.3.7 *Wooden cocktail sticks.*

3.3.8 *Small pair of copper-beryllium pliers.*

3.4 Test specimen

Use one primary pack for each complete test.

3.5 Procedure

3.5.1 *Examination of primary pack.* Examine the outside of the primary pack (**3.4**) visually and record the occurrence of any holes or splits.

Open the pack. Tap out any loose composition, collect it and weigh it to an accuracy of 0.0001 g.

3.5.2 *Examination of amorces.* Carefully remove the contents of the primary pack and examine each roll visually before unwinding it. Record any instances of the leading tape being shorter than one circumference of the roll (i.e. if one or more caps are visible or partially visible).

Unwind each roll, examine it visually and record the number of caps on the roll and the number of patches of exposed composition (i.e. caps without a complete cover and other areas where composition is adhered to the tape).

3.5.3 *Examination of plastics encapsulated caps and plastics cup type caps.* Remove the contents of the primary pack, taking care to avoid unnecessary damage to the pack, and examine each ring or strip visually. Record the total number of caps in the pack and the number of patches of exposed composition (i.e. caps without covers, caps with loose or incomplete covers and other areas where composition is adhered to the ring or strip).

3.5.4 *Determination of drop-height for communication testing.* Determine the lowest position on the rod (**3.3.3**) from which the weight can be dropped in order to fire a cap as follows, using caps similar to those actually under test.

Place an individual cap on the metal surface (**3.3.2**), within the test area (**3.2**), and clamp the rod in a vertical position so that the tip of the rod rests on the cap. Raise the weight and insert a pin in the lowest hole so as to support the weight. Attach a piece of string to the pin. Remove the pin remotely by pulling the string. If the cap fails to fire, replace it with a further cap and drop the weight from the next position upwards along the rod. Repeat the process until each of five caps is successfully fired when dropping the weight from the same height.

3.5.5 *Communication testing of amorces.* Unwind a roll and lay it flat, with the caps uppermost, on the metal surface (**3.3.2**), within the test area (**3.2**). Clamp the rod (**3.3.3**) in a vertical position so that the tip of the rod rests centrally on the fourth cap from one end of the roll. Raise the weight to the drop-height, determined in accordance with **3.5.4**, and insert a pin to support it. Attach a piece of string to the pin. Remove the pin remotely by pulling the string, thus causing the "donor cap" to be fired. Initiate further donor caps by repositioning the rod on every tenth cap and dropping the weight in the same manner. If an intended donor cap fails to fire when the weight is dropped, record this fact and move on to the next position. Count the total number of caps which have been fired, including donor caps.

Repeat the above process for each roll.

3.5.6 *Communication testing of plastics encapsulated caps and plastics cup type caps.* Drill or punch a 5 mm diameter hole through the wall of the empty pack so that when the contents are returned the rod (**3.3.3**) can be inserted so that its tip will rest centrally on a cap in the middle of the bottom layer after the caps immediately above this donor cap have been removed. Cut out the caps to be removed and count those remaining. Return those caps to the pack and close it. Place the pack on the metal surface (**3.3.2**), within the test area (**3.2**). Insert the rod as described and clamp it in position. Raise the weight to the drop-height determined in accordance with **3.5.4** and insert a pin to support it. Attach a piece of string to the pin. Remove the pin remotely by pulling the string, thus causing the donor cap to be fired.

If the intended donor cap fails to fire when the weight is dropped: open the pack; rearrange the contents and reassemble it so that another cap, at least two removed from the original cap, is aligned underneath the rod; then drop the weight again. If the second cap fails to fire, repeat this process once more, using a cap at least two removed from the others. If the third intended donor cap fails to fire, record this fact and discontinue the communication testing.

Remove the contents of the pack and count the total number of caps which have been fired, including the (eventual) donor cap.

3.5.7 *Determination of the net explosive content of amorces.* Select at random 10 sections each containing a single cap, which had remained intact after communication testing, and cut them from the rolls. Place the sections in the vacuum desiccator (**3.3.5**) for 24 h. Remove the sections and immediately weigh them collectively to an accuracy of 0.0001 g.

Place the sections in a beaker of water and leave to soak for about 1 h. Remove the sections from the beaker and gently wash off the top layer of paper (covering the composition) using water from a wash bottle. Retain the paper removed in this manner. Using more water from the wash bottle, gently rinse away all the composition, taking care not to lose any paper fibres.

Collect all the paper and dry it in the vacuum desiccator for 24 h. Remove the paper and immediately weigh it to an accuracy of 0.0001 g.

3.5.8 *Determination of the net explosive content of plastics encapsulated caps.* Select at random 10 sections each containing a single cap, which has remained intact after communication testing, and cut them out from the rings or strips. Weigh the sections collectively to an accuracy of 0.0001 g.

Cut each section down the centre of the cap using a sharp scalpel. Place the sections in a 100 mL beaker and add about 20 mL of the nitric acid solution (**3.1.2**). Insert the bar of the magnetic stirrer (**3.3.6**) and cover the beaker with a watch glass. Put the beaker on the stirrer inside a fume cupboard. Stir continuously for at least 30 min.

Carefully remove the sections and wash them with the water (**3.1.1**), discarding the washings. Examine each section to check that all the composition has been removed. If some composition remains, remove it by using a wooden cocktail stick (**3.3.7**) and by further washing.

Collect all the pieces of plastics and dry them to constant mass at a temperature not exceeding 50 °C. Allow to cool to ambient temperature and then weigh the pieces to an accuracy of 0.0001 g.

3.5.9 *Determination of the net explosive content of plastics cup type caps.* Select at random 10 sections each containing a single cap, which has remained intact after communication testing, and cut them out from the rings or strips. Weigh the sections collectively to an accuracy of 0.0001 g.

Carefully remove the sealing disc from each cap and retain. Remove and discard the composition from each cap by tapping it, then, if necessary, by squeezing the cup using the pliers (**3.3.8**) and finally by using a wooden cocktail stick (**3.3.7**).

Collect all the empty sections and sealing discs and weigh them to an accuracy of 0.0001 g.

3.6 Expression of results

3.6.1 *Communication of amorces.* For each roll, the proportion of caps fired by communication C, expressed as a percentage, is given by the equation:

$$C = \frac{F-D}{A-D} \times 100$$

where

A is the total number of caps on the roll;

D is the number of donor caps;

F is the total number of caps which are fired.

3.6.2 *Communication of plastics encapsulated caps and plastics cup type caps.* The proportion of caps fired by communication C, expressed as a percentage, is given by the equation:

$$C = \frac{F-1}{B-1} \times 100$$

where

B is the number of caps in the pack, excluding those removed to enable the rod to be inserted;

F is the total number of caps which are fired.

3.6.3 *Net explosive content.* The net explosive content E, expressed in milligrams per cap, is given by the equation:

$$E = \frac{m_1 - m_2}{10} \times 1\,000$$

i.e.

$$E = 100\,(m_1 - m_2)$$

where

m_1 is the mass (in g) of the 10 sections before the composition has been removed;

m_2 is the mass (in g) of the paper and/or plastics remaining after the composition has been removed.

3.7 Test report

The test report shall include the following information:

a) a reference to the method used, i.e. clause **3** of BS 7114-3:1988;

b) the complete identification of the sample under test;

c) the date of test;

d) whether there were any holes or splits in the primary pack;

e) the mass, in mg, of any loose composition in the primary pack;

f) for amorces, whether the leading tape of any roll was shorter than one circumference;

g) for amorces, the number of rolls in the primary pack and the number of caps on each roll;

h) for plastics encapsulated caps and plastics cup type caps, the total number of caps in the primary pack;

i) the total number of patches of exposed composition on the rolls, rings or strips;

j) the drop-height for the communication testing, in mm;

k) for amorces, whether any intended donor caps failed to fire during communication testing;

l) for plastics encapsulated caps and plastics cup type caps, whether three intended donor caps each failed to fire during communication testing;

m) the percentage of caps fired by communication for each roll of amorces or for the primary pack of plastics encapsulated caps and plastics cup type caps;

n) the net explosive content, in milligrams per cap.

4 Smoke devices (type 1B fireworks)

4.1 Material

4.1.1 *Sheet of paper,* 1 m × 1 m, complying with Appendix A.

4.2 Test area for performance testing

The test area for performance testing, as described in **4.5.3**, shall be swept and washed clean, shall contain only the apparatus and material used during the testing and shall be provided with a means of extracting fumes.

4.3 Apparatus

4.3.1 *Analytical balance,* capable of weighing to an accuracy of 0.0001 g.

4.3.2 *Flat, non-flammable plate,* diameter 200 mm.

4.4 Test specimen

Use one primary pack for each complete test.

4.5 Procedure

4.5.1 *Examination of primary pack.* Examine the outside of the primary pack (**4.4**) visually and record the occurrence of any holes or splits.

Open the pack. Tap out any loose composition, collect it and weigh it to an accuracy of 0.0001 g.

4.5.2 *Determination of the net explosive content.* Remove the contents of the primary pack and select two smoke devices at random. Remove any wrapping from these devices and weigh the composition from each device separately to an accuracy of 0.0001 g.

4.5.3 *Performance testing.* Place the plate (**4.3.2**) in the centre of the sheet of paper (**4.1.1**), within the test area (**4.2**).

Select at random two smoke devices which have not been unwrapped (see **4.5.2**). Place one of these devices in the centre of the plate and ignite it using a wax taper. If the device fails to ignite after the ignition source has been applied continuously for 60 s, record this fact and discard the device. If the device is successfully ignited, observe it until the emission of smoke ceases. Record whether the device produces a flame or explodes during this period. Remove the debris and then repeat the process for the other device.

Examine the paper for any holes burnt through it.

4.6 Test report

The test report shall include the following information:

a) a reference to the method used, i.e. clause **4** of BS 7114-3:1988;

b) the complete identification of the sample under test;

c) the date of test;

d) whether there were any holes or splits in the primary pack;

e) the mass, in g, of any loose composition in the primary pack;

f) the net explosive content, in g, of each of the two devices tested;

g) whether either device failed to ignite during the performance testing;

h) whether either device produced a flame during the performance testing;

i) whether either device exploded during the performance testing;

j) whether there were any holes burnt in the paper after the performance testing.

5 Party poppers (type 1C fireworks)

5.1 Material

5.1.1 *Two sheets of paper,* each 750 mm × 750 mm, complying with Appendix A.

5.2 Test area for performance testing

The test area for performance testing, as described in **5.5.2**, shall be swept and washed clean, shall contain only the apparatus and material used during the testing and shall be provided with a means of extracting fumes.

5.3 Apparatus

5.3.1 *Means of clamping a party popper in a horizontal position.*

5.3.2 *Means of holding a sheet of paper in a vertical plane.*

5.4 Test specimen

Use one party popper for each complete test.

5.5 Procedure

5.5.1 *Initial examination of party popper.* Examine the device (**5.4**) visually and determine whether there are any holes or splits in the body, whether the end closure, or either end closure if the device is designed to incorporate two end closures, is loose or missing and whether any composition is exposed in some other way. If any such fault is found, record the fact and do not proceed with the performance testing.

5.5.2 *Performance testing.* Place one sheet of the paper (**5.1.1**) horizontally, within the test area (**5.2**), and clamp the party popper in a horizontal position, in the centre of the paper, so that its axis is 200 mm above the paper. Arrange the second sheet of paper so that it is held vertically, in a plane that is perpendicular to the axis of the party popper, opposite the base of the device and at a distance of 300 mm from it. Pull the string in order to fire the device.

If the device fails to fire when the string is pulled, record the fact and discontinue the test.

If the device is successfully fired, observe and record whether streamers are ejected and whether the test paper catches fire. Examine the body of the party popper and record whether it has any splits or holes. Examine both sheets of paper and record whether they have any holes burnt through them and whether they have any holes caused by objects ejected from the party popper.

5.6 Test report

The test report shall include the following information:

a) a reference to the method used, i.e. clause **5** of BS 7114-3:1988;

b) the complete identification of the sample under test;

c) the date of test;

d) whether any holes or splits were found in the body of the device during the initial examination;

e) whether the (either) end closure was loose or missing;

f) whether any composition was exposed in some other way;

g) whether the device failed to eject streamers;

h) whether the test paper caught fire during the performance testing;

i) whether there were any holes or splits in the body of the device after the performance testing;

j) whether there were any holes burnt in the paper, or caused by objects ejected from the device, after the performance testing.

6 Table bombs (type 1D fireworks)

6.1 Materials

6.1.1 *Sheet of paper,* 1 m × 1 m, complying with Appendix A.

6.1.2 *Sheet of paper,* 750 mm × 750 mm, complying with Appendix A.

6.2 Test area for performance testing

The test area for performance testing, as described in **6.5.2**, shall be swept and washed clean, shall contain only the apparatus and material used during the testing and shall be provided with a means of extracting fumes.

6.3 Apparatus

6.3.1 *Flat, non-flammable plate,* diameter 200 mm.

6.3.2 *Means of holding a sheet of paper in a horizontal plane.*

6.3.3 *Timing device,* accurate to within 0.1 s.

6.4 Test specimen

Use one table bomb for each complete test.

6.5 Procedure

6.5.1 *Initial examination of table bomb.* Examine the device (**6.4**) visually and determine whether there are any holes or splits in the body, whether the end closure, or either end closure if the device is designed to incorporate two end closures, is loose or missing, and whether any composition is exposed in some other way. If any such fault is found, record the fact and do not proceed with the performance testing.

6.5.2 *Performance testing.* Place the plate (**6.3.1**) in the centre of the larger sheet of the paper (**6.1.1**) within the test area (**6.2**). Arrange the second sheet of paper (**6.1.2**) so that it is held in a horizontal plane, 1.2 m above the top of the table bomb.

Place the table bomb in the centre of the plate. Ignite the table bomb, in accordance with the instructions on the label, and start the timing device (**6.3.3**) immediately. Observe and record whether the table bomb explodes and, if it does, the time, to the nearest 0.1 s, of this occurrence, whether streamers or novelties are ejected and whether the test paper catches fire.

If the table bomb has exploded, examine its body and record whether it has any splits or holes. Examine both sheets of paper and record whether they have any holes burnt through them and whether they have any holes caused by objects ejected from the table bomb.

6.6 Test report

The test report shall include the following information:

a) a reference to the method used, i.e. clause **6** of BS 7114-3:1988;

b) the complete identification of the sample under test;

c) the date of test;

d) whether any holes or splits were found in the body of the table bomb during the initial examination;

e) whether the (either) end closure was loose or missing;

f) whether any composition was exposed in some other way;

g) whether the table bomb exploded and, if so, the time, in s, of the explosion;

h) whether the table bomb failed to eject streamers or novelties;

i) whether the test paper caught fire during the performance testing;

j) whether there were any holes or splits in the body of the table bomb after the performance testing;

k) whether there were any holes burnt in the paper, or caused by objects ejected from the table bomb, after the performance testing.

7 Throwdowns (type 1E fireworks)

7.1 Reagents

7.1.1 *General.* During the test use only reagents of recognized analytical grade, unless otherwise specified, and only water complying with grade 3 of BS 3978.

7.1.2 *Divanadium pentaoxide,* ordinary laboratory grade.

7.1.3 *Hydrochloric acid solution, concentrated,* ρ approximately 1.18 g/mL, about 35.5 % (*m*/*m*) solution.

7.1.4 *Nitric acid solution, concentrated,* ρ approximately 1.42 g/mL, about 70 % (*m*/*m*) solution.

7.1.5 *Nitric acid solution, dilute.* Dilute the concentrated nitric acid solution (**7.1.4**) 1 + 6 with water.

7.1.6 *Pyridine*

7.1.7 *Ammonium peroxodisulphate,* saturated solution.

7.1.8 *Hydrochloric acid,* standard volumetric solution, c(HCl) = 0.1 mol/L.

7.1.9 *Sodium hydroxide solution,* c(NaOH) = 80 g/L.

7.1.10 *Acetic acid solution,* $c(CH_3COOH)$ = 60 g/L.

7.1.11 *Indicator solution,* suitable for indicating a pH of 4.4 to 6.0.

7.1.12 *Reagents for determination of chloride ions.* See Appendix B.

7.2 Test area for communication testing

The test area for communication testing, as described in **7.5.2** and **7.5.3**, shall be swept and washed clean, shall contain only the apparatus used during the testing and shall be provided with a means of extracting fumes.

7.3 Apparatus

Ordinary laboratory apparatus together with the following.

7.3.1 *Analytical balance,* capable of weighing to an accuracy of 0.0001 g.

7.3.2 *Hard, smooth, horizontal metal surface.*

7.3.3 *Stainless steel rod,* as specified in **3.3.3**.

7.3.4 *Means of clamping the rod in a vertical position.*

7.3.5 *Apparatus for determination of chloride ions.* See Appendix B.

7.4 Test specimen

Use one primary pack for each complete test.

7.5 Procedure

7.5.1 *Examination of primary pack.* Examine the primary pack (**7.4**) visually and record the occurrence of any holes or splits in the layer of packaging immediately surrounding the throwdowns. If any such fault is found, record the fact and omit the communication testing (**7.5.2** and **7.5.3**).

7.5.2 *Determination of drop-height for communication testing.* Determine the lowest position on the rod (**7.3.3**) from which the weight (see **3.3.3**) can be dropped in order to fire a throwdown as follows, using throwdowns similar to those actually under test.

Place a throwdown on the metal surface (**7.3.2**), within the test area (**7.2**), and clamp the rod in a vertical position so that the tip of the rod rests on the throwdown. Raise the weight and insert a pin in the lowest hole so as to support the weight. Attach a piece of string to the pin. Remove the pin remotely by pulling the string. If the throwdown fails to fire, replace it with a further device and drop the weight from the next position upwards along the rod. Repeat the process until each of five throwdowns is successfully fired when dropping the weight from the same height.

7.5.3 *Communication testing.* Remove the contents of the primary pack, taking care to avoid unnecessary damage to the pack, and count the number of throwdowns. Drill or punch a 5 mm diameter hole through the wall of the empty pack so that when the contents are returned the rod (**7.3.3**) can be inserted in a vertical position, with its tip resting centrally on a throwdown. Return the throwdowns and packing material to the pack and close it. Place the pack on the metal surface (**7.3.2**) within the test area (**7.2**). Insert the rod as described and clamp it in position. Raise the weight to the drop-height determined in accordance with **7.5.2** and insert a pin to support it. Attach a piece of string to the pin. Remove the pin remotely by pulling the string, thus causing the donor throwdown to be fired.

If the intended donor throwdown fails to fire when the weight is dropped, open the pack, rearrange the contents and reassemble it so that another throwdown is aligned underneath the rod, then drop the weight again. If the second throwdown fails to fire, repeat this process once more. If the third intended donor throwdown fails to fire, record this fact and discontinue the communication testing.

If a donor throwdown is successfully fired, observe and record whether the primary pack catches fire. Then examine the pack visually and record the occurrence of any holes or splits in the layer of packaging immediately surrounding the throwdowns. Remove the contents of the pack and determine the total number of throwdowns which have been fired, including the (eventual) donor throwdown.

7.5.4 *Qualitative testing of explosive composition.* Select at randon two throwdowns which have remained intact after communication testing. Empty their contents and carefully mix them with 25 mg of the *di*vanadium pentaoxide (**7.1.2**). Add one drop of the concentrated hydrochloric acid solution (**7.1.3**) and observe whether a purple colour is obtained, indicating the presence of fulminate.

Select a further four intact throwdowns at random. Carefully empty their contents and dissolve them in 2 mL of the dilute nitric acid solution(**7.1.5**). Take 0.3 mL of the solution, add one drop of the pyridine (**7.1.6**) and two drops of the ammonium peroxodisulphate solution (**7.1.7**). After 2 min, observe whether a yellow colour is obtained, indicating the presence of silver.

7.5.5 *Determination of net explosive content.* Select 10 throwdowns at random and empty their contents carefully into a 100 mL beaker containing 10 mL of water. Add 2 mL of the concentrated nitric acid solution (**7.1.4**) from a dropping pipette. Cover the beaker with a watch glass, place it on a hotplate, gradually bring the contents to the boil and then evaporate just to dryness.

Allow to cool, add 10 mL of the concentrated nitric acid solution and boil just to dryness again. Repeat these operations using a further 10 mL of the acid solution.

Allow the beaker to cool and then transfer its contents quantitatively, using three portions of water, each of about 10 mL, to a filter funnel. Filter the washings into a 100 mL one-mark volumetric flask. Transfer 2 mL of the hydrochloric acid standard volumetric solution (**7.1.8**) to the flask by means of a pipette and add six to eight drops of the indicator solution (**7.1.11**). Adjust the pH of the solution to between 4.4 and 6.0 using the sodium hydroxide solution (**7.1.9**) and the acetic acid solution (**7.1.10**) and then make up to the mark with water.

Prepare a blank solution at the same time as the test solution by following the above procedure but omitting the contents of the throwdowns.

Determine the mass of chloride in the test solution and in the blank solution in accordance with Appendix B.

7.6 Expression of results

7.6.1 *Communication.* The proportion of throwdowns fired by communication C, expressed as a percentage, is given by the equation:

$$C = \frac{F-1}{T-1} \times 100$$

where

F is the total number of throwdowns which are fired;

T is the number of throwdowns in the pack.

7.6.2 *Net explosive content.* The net explosive content E, expressed in milligrams per device, is given by the equation:

$$E = \frac{(m_2 - m_1) \times 149.9}{35.5 \times 10}$$

i.e.

$$E = 0.422\ (m_2 - m_1)$$

where

m_1 is the mass (in mg) of chloride found in the test solution;

m_2 is the mass (in mg) of chloride found in the blank solution;

149.9 is the molar mass (in g) of silver fulminate;

35.5 is the atomic mass (in g) of chlorine.

7.7 Test report

The test report shall include the following information:

a) a reference to the method used, i.e. clause **7** of BS 7114-3:1988;

b) the complete identification of the sample under test;

c) the date of test;

d) whether there were any holes or splits in the layer of packaging immediately surrounding the throwdowns before the communication testing;

e) the drop-height for the communication testing, in mm;

f) whether three intended donor throwdowns each failed to fire during communication testing;

g) whether the primary pack caught fire during the communication testing;

h) whether there were any holes or splits in the layer of packaging immediately surrounding the throwdowns after the communication testing;

i) the percentage of throwdowns fired by communication;

j) whether both fulminate and silver were indicated in the qualitative testing of the explosive composition;

k) the net explosive content, in milligrams per throwdown.

8 Novelty matches (type 1F fireworks)

8.1 Material

8.1.1 *Sheet of paper,* 1 m × 1 m, complying with Appendix A.

8.2 Test area for performance testing

The test area for performance testing, as described in **8.5.2**, shall be swept and washed clean and shall contain only the apparatus and material used during the testing. It shall be provided with a means of extracting fumes and a flat, horizontal non-flammable surface, at least 1 m × 1 m.

8.3 Apparatus

8.3.1 *Analytical balance,* capable of weighing to an accuracy of 0.0001 g.

8.3.2 *Means of clamping a match in a horizontal position.*

8.4 Test specimen

Use one primary pack for each complete test.

8.5 Procedure

8.5.1 *Examination of primary pack.* Examine the outside of the primary pack (**8.4**) visually and record the occurrence of any holes or splits.

Open the pack. Tap out any loose composition, collect it and weigh it to an accuracy of 0.0001 g.

8.5.2 *Performance testing.* Place the sheet of paper (**8.1.1**) on the flat, horizontal non-flammable surface in the test area (**8.2**).

Select at random 10 matches. Clamp one of these matches horizontally, so that the head and half the uncoated length of the stick are exposed, 200 mm above the centre of the sheet of paper. Ignite the match by striking it with the abrasive surface provided as part of the primary pack and observe the match until it ceases to function. Record the principal effect(s) produced by the match and whether the paper catches fire. Remove the debris and then repeat the process for each of the other nine matches. If a match fails to ignite after three attempts, record this fact and proceed with the testing of the next match.

Examine the paper for any holes burnt through it.

8.6 Test report

The test report shall include the following information:

a) a reference to the method used, i.e. clause **8** of BS 7114-3:1988;

b) the complete identification of the sample under test;

c) the date of test;

d) whether there were any holes or splits in the primary pack;

e) the mass, in g, of any loose composition in the primary pack;

f) whether any match failed to ignite during the performance testing;

g) whether any match exploded during the performance testing;

h) whether the paper caught fire during the performance testing;

i) whether there were any holes burnt in the paper after the performance testing.

9 Non-hand-held sparklers for indoor use (type 1G fireworks)

9.1 Material

9.1.1 *Sheet of paper,* 1 m × 1 m, complying with Appendix A.

9.2 Test area for performance testing

The test area for performance testing, as described in **9.5.2**, shall be swept and washed clean, shall contain only the apparatus and material used during the testing and shall be provided with a means of extracting fumes.

9.3 Apparatus

9.3.1 *Laboratory balance,* capable of weighing to an accuracy of 0.1 g.

9.3.2 *Flat, non-flammable plate,* diameter 200 mm.

9.3.3 *Means of supporting a sparkler,* if the devices are not free-standing and are not supplied with a base in the primary pack.

9.4 Test specimen

Use one primary pack for each complete test.

9.5 Procedure

9.5.1 *Initial weighing.* Weigh the sparklers individually to an accuracy of 0.1 g.

9.5.2 *Performance testing.* Place the plate (**9.3.2**) in the centre of the sheet of paper (**9.1.1**), within the test area (**9.2**).

Place one of the sparklers, supported as necessary, in the centre of the plate, ignite it using a wax taper. If the sparkler fails to ignite after the ignition source has been applied continuously for 30 s, record this fact and replace it with the next sparkler. Observe the sparkler until it ceases to function. Record whether the sparkler explodes during this period, whether it burns along the entire composition length and whether the paper catches fire. Remove and retain the spent sparkler. Repeat the process for each of the other sparklers from the primary pack.

Examine the paper for any holes burnt through it.

9.5.3 *Weighing of sparkler wires.* Allow the spent sparklers to cool and discard any on which the composition has not burnt along its entire length. Remove the residue from the remaining sparklers by tapping each one gently with a hammer. Weigh the wires collectively to an accuracy of 0.1 g.

9.6 Expression of results for determination of net explosive content

The net explosive content E, expressed in grams per sparkler, is given by the equation:

$$E = \frac{m_1 - m_2}{n}$$

where

m_1 is the total initial mass (in g) of those sparklers which burnt completely;

m_2 is the mass (in g) of the wires;

n is the number of wires weighed.

9.7 Test report

The test report shall include the following information:

a) a reference to the method used, i.e. clause **9** of BS 7114-3:1988;

b) the complete identification of the sample under test;

c) the date of test;

d) whether any sparkler failed to ignite during the performance testing;

e) whether any sparkler exploded during the performance testing;

f) whether any sparkler failed to burn along its entire composition length during the performance testing;

g) whether the paper caught fire during the performance testing;

h) whether there were any holes burnt in the paper after the performance testing;

i) the net explosive content, in grams per sparkler.

10 Hand-held sparklers for indoor use (type 1H fireworks)

10.1 Material

10.1.1 *Sheet of paper,* 1 m × 1 m, complying with Appendix A.

10.2 Test area for performance testing

The test area for performance testing, as described in **10.5.3**, shall be swept and washed clean and shall contain only the apparatus and material used during the testing. It shall be provided with a means of extracting fumes and a flat, horizontal non-flammable surface, at least 1 m × 1 m.

10.3 Apparatus

10.3.1 *Laboratory balance,* capable of weighing to an accuracy of 0.1 g.

10.3.2 *Means of clamping a sparkler in a horizontal position.*

10.4 Test specimen

Use one primary pack for each complete test.

10.5 Procedure

10.5.1 *Initial weighing.* Weigh the sparklers individually to an accuracy of 0.1 g.

10.5.2 *Measurement of sparklers.* Measure the total length and the length of the handle (i.e. the section of wire which is not coated with composition) of each sparkler.

10.5.3 *Performance testing.* Place the sheet of paper (**10.1.1**) on the flat, horizontal non-flammable surface in the test area (**10.2**).

Clamp the handle of one of the sparklers so that the sparkler is horizontal, 200 mm above the centre of the sheet of paper. Ignite the sparkler using a wax taper. If the sparkler fails to ignite after the ignition source has been applied continuously for 30 s, record this fact and replace it with the next sparkler. Observe the sparkler until it ceases to function. Record whether the sparkler explodes during this period, whether it burns along the entire composition length and whether the paper catches fire. Remove and retain the spent sparkler. Repeat the process for each of the other sparklers from the primary pack.

Examine the paper for any holes burnt through it.

10.5.4 *Weighing of sparkler wires.* Allow the spent sparklers to cool and discard any on which the composition has not burnt along its entire length. Remove the residue from the remaining sparklers by tapping each one gently with a hammer. Weigh the wires collectively to an accuracy of 0.1 g.

10.6 Expression of results for determination of net explosive content

The net explosive content E, expressed in grams per sparkler, is given by the equation:

$$E = \frac{m_1 - m_2}{n}$$

where

m_1 is the total initial mass (in g) of those sparklers which burnt completely;

m_2 is the mass (in g) of the wires;

n is the number of wires weighed.

10.7 Test report

The test report shall include the following information:

a) a reference to the method used, i.e. clause **10** of BS 7114-3:1988;

b) the complete identification of the sample under test;

c) the date of test;

d) the total length, in mm, of each sparkler;

e) the length, in mm, of the handle of each sparkler;

f) whether any sparkler failed to ignite during the performance testing;

g) whether any sparkler exploded during the performance testing;

h) whether any sparkler failed to burn along its entire composition length during the performance testing;

i) whether the paper caught fire during the performance testing;

j) whether there were any holes burnt in the paper after the performance testing;

k) the net explosive content, in grams per sparkler.

11 Cracker snaps (type 1J fireworks)

11.1 Reagents

Use the reagents specified in **7.1**.

11.2 Apparatus

Ordinary laboratory apparatus together with the following.

11.2.1 *Analytical balance,* capable of weighing to an accuracy of 0.0001 g.

11.2.2 *Apparatus for determination of chloride ions.* See Appendix B.

11.3 Test specimen

Use one primary pack for each complete test.

11.4 Procedure

11.4.1 *Examination of primary pack.* Examine the outside of the primary pack (**11.3**) visually and record the occurrence of any holes or splits.

Open the pack. Tap out any loose powder, collect it and weigh it to an accuracy of 0.0001 g.

11.4.2 *Communication testing.* Select seven cracker snaps at random. Place the snaps one on top of another so that the central portions, coated with the composition, are adjacent to each other. Hold the snaps in this position by means of two paper clips, one on either side of the midpoint at a distance of 50 mm from the midpoint. Pull the central snap and if it fails to fire, record this fact. If the central snap is successfully fired, observe and record whether any of the other snaps are ignited.

11.4.3 *Qualitative testing of explosive composition.* Select five cracker snaps at random and carefully cut away the card or paper to expose the portions coated with composition. Cover the composition on one section with 25 mg of the *di*vanadium pentaoxide (**7.1.2**), add one drop of the concentrated hydrochloric acid solution (**7.1.3**) and observe whether a purple colour is obtained, indicating the presence of fulminate.

Cut out the portions of the other snaps which are coated with composition and soak them in 1 mL of the dilute nitric acid solution (**7.1.5**) for 5 min, while agitating. Cut out a portion without any composition from each snap, of the same length as the coated portion, and prepare a blank solution by treating the uncoated portions in the same manner as the coated portions. Continue by treating the blank solution in the same manner as the test solution. Place two drops of the test solution on a spotting plate and add two drops of the pyridine (**7.1.6**) and two drops of the ammonium peroxodisulphate solution (**7.1.7**). After 2 min, observe whether a yellow colour is obtained with the test solution, much more intense than any yellow colour that may be obtained with the blank solution, indicating the presence of silver.

11.4.4 *Determination of net explosive content.* Select 10 cracker snaps at random. Carefully cut out the portion of each snap which is coated with composition and place these portions into a 100 mL beaker containing 10 mL of water. Proceed as described in **7.5.5** but include a portion without any composition from each snap, of the same length as the coated portion, in the preparation of the blank solution.

11.5 Expression of results for determination of net explosive content

Express the results for the net explosive content in accordance with **7.6.2**.

11.6 Test report

The test report shall include the following information:

a) a reference to the method used, i.e. clause **11** of BS 7114-3:1988;

b) the complete identification of the sample under test;

c) the date of test;

d) whether there were any holes or splits in the primary pack;

e) the mass, in mg, of any loose composition in the primary pack;

f) whether the central snap failed to fire during the communication testing;

g) whether any snap, other than the central one, was ignited during the communication testing;

h) whether both fulminate and silver were indicated in the qualitative testing of the explosive composition;

i) the net explosive content, in milligrams per cracker snap.

12 Serpents (type 1K fireworks)

12.1 Material

12.1.1 *Sheet of paper,* 1 m × 1 m, complying with Appendix A.

12.2 Test area for performance testing

The test area for performance testing, as described in **12.5.2**, shall be swept and washed clean, shall contain only the apparatus and material used during the testing and shall be provided with a means of extracting fumes.

12.3 Apparatus

12.3.1 *Analytical balance,* capable of weighing to an accuracy of 0.0001 g.

12.3.2 *Flat, non-flammable plate,* diameter 200 mm.

12.4 Test specimen

Use one primary pack for each complete test.

12.5 Procedure

12.5.1 *Examination of primary pack.* Examine the outside of the primary pack (**12.4**) visually and record the occurrence of any holes or splits.

Open the pack. Tap out any loose composition, collect it and weigh it to an accuracy of 0.0001 g.

12.5.2 *Performance testing.* Place the plate (**12.3.2**) in the centre of the sheet of paper (**12.1.1**), within the test area (**12.2**).

Remove the contents of the primary pack and select at random two serpents. Place one serpent in the centre of the plate and ignite it using a wax taper. If the serpent fails to ignite after the ignition source has been applied continuously for 60 s, record this fact and discard the serpent. If the serpent is successfully ignited, observe it until it ceases to function. Record whether the serpent produces a flame or explodes during this period. Remove the debris and then repeat the process for the other serpent.

Examine the paper for any holes burnt through it.

12.6 Test report

The test report shall include the following information:

a) a reference to the method used, i.e. clause **12** of BS 7114-3:1988;

b) the complete identification of the sample under test;

c) the date of test;

d) whether there were any holes or splits in the primary pack;

e) the mass, in g, of any loose composition in the primary pack;

f) whether any serpent failed to ignite during the performance testing;

g) whether either serpent produced a flame during the performance testing;

h) whether either serpent exploded during the performance testing;

i) whether there were any holes burnt in the paper after the performance testing.

13 Performance testing of category 2 and category 3 fireworks (general)

13.1 Test environment

13.1.1 *Test area for category 2 fireworks.* The test area shall be an outdoor site, on level ground, with a radius of at least 10 m. A smooth, hard horizontal surface and an area of soft soil or sand shall be provided at the centre of the test area. A circle, radius 3 m, shall be marked around the centre of the test area. In the space between this circle and the perimeter of the test area, posts shall be provided in order to indicate a height of 3 m above the ground. The test area shall be clear of any other obstructions.

13.1.2 *Test area for category 3 fireworks.* The test area shall be an outdoor site, on level ground, with a radius of at least 30 m. A smooth, hard horizontal surface and an area of soft soil or sand shall be provided at the centre of the test area. A circle, radius 20 m, shall be marked around the centre of the test area. In the space between this circle and the perimeter of the test area, posts shall be provided in order to indicate heights of 3 m and 5 m above the ground. The test area shall be clear of any other obstructions.

13.1.3 *Wind speed.* A means of measuring the wind speed at a height of 2 m above the ground shall be provided. No performance testing shall be carried out if the wind speed exceeds 24 km/h.

13.2 Apparatus

13.2.1 *Timing device,* accurate to within 0.1 s.

13.2.2 *Laboratory balance,* capable of weighing to an accuracy of 0.1 g.

13.3 Procedure

Measure the wind speed.

Position the firework, in accordance with the instructions on the label, in the centre of the test area. Remove the fuse cover, if any. Straighten the fuse (except for fireworks with electrical contacts). Ignite the firework and start the timing device (**13.2.1**) immediately.

Record the durations of the initial fuse burning and any period of invisible burning. Observe and record what principal effects are produced by the firework. Observe whether the firework explodes and, if so, record the number of explosions and the time of the first occurrence. Observe whether any burning or incandescent matter falls outside a distance of 3 m, for category 2 fireworks, or 20 m, for category 3 fireworks, from the functioning point without being extinguished before descending to a height of 3 m above the ground. Observe whether any debris is projected laterally beyond 3 m, for category 2 fireworks, or 20 m, for category 3 fireworks, from the functioning point.

After the firework has ceased to function, collect any debris which was observed to have been projected laterally beyond 3 m, for category 2 fireworks, or 20 m, for category 3 fireworks, from the functioning point. Examine this debris and discard any piece of paper, cardboard, felt or plastics foam. Weigh individually any of the remaining particles which might exceed a mass of 1 g.

14 Category 2 bangers (type 2A fireworks)

14.1 Test environment for performance testing

The test environment shall be as specified in **13.1.1** and **13.1.3**.

14.2 Apparatus

14.2.1 *Timing device,* accurate to within 0.1 s.

14.2.2 *Laboratory balance,* capable of weighing to an accuracy of 0.01 g.

14.3 Test specimen

Use one primary pack for each complete test.

14.4 Procedure

14.4.1 *Examination of bangers.* Examine each banger visually and determine whether there are any holes, splits, dents or bulges in the body of the firework case, whether the end closure is loose or missing and whether the initial fuse is loose. If any such fault is found in a banger, record the fact and do not use that banger for further testing.

14.4.2 *Determination of net explosive content.* Select at random one banger, carefully dismantle it and remove and weigh the composition (including that contained in the fuse) to an accuracy of 0.01 g.

14.4.3 *Performance testing.* Using the remaining bangers from the primary pack (**14.3**) one at a time, carry out the performance testing as described in **13.3**.

14.5 Test report

The test report shall include the following information:

a) a reference to the method used, i.e. clause **14** of BS 7114-3:1988;

b) the complete identification of the sample under test;

c) the date of test;

d) whether there were any holes, splits, dents or bulges in the body of the firework case of any banger;

e) whether the end closure of any banger was loose or missing;

f) whether the initial fuse of any banger was loose;

g) the net explosive content, in grams per banger;

h) the wind speed, in km/h, at the time of the performance testing;

i) the duration, in s, of the initial fuse burning of each banger tested;

j) the duration, in s, of each period of invisible burning, if any;

k) the number of explosions and, if any, the time, in s, of the first occurrence, for each banger tested;

l) whether any burning or incandescent matter fell more than 3 m away from the functioning point without being extinguished before descending to a height of 3 m above the ground;

m) whether any particle of debris, excluding paper, cardboard, felt or plastics foam, which was observed to be projected laterally beyond 3 m from the functioning point, had a mass exceeding 1.0 g.

15 Visual examination and performance testing of category 3 bangers (type 3A fireworks)

15.1 Test environment and apparatus for performance testing

The test environment shall be as specified in **13.1.2** and **13.1.3** and the apparatus shall be as specified in **13.2**.

15.2 Test specimen

Use one banger for each complete test.

15.3 Procedure

15.3.1 *Examination of banger.* Examine the banger (**15.2**) visually and determine whether there are any holes, splits, dents or bulges in the body of the firework case, whether the end closure, or either end closure if the banger is designed to incorporate two end closures, is loose or missing and whether the initial fuse is loose. If any such fault is found, record the fact and do not proceed with the performance testing.

15.3.2 *Performance testing.* Carry out performance testing as described in **13.3**.

15.4 Test report

The test report shall include the following information:

a) a reference to the method used, i.e. clause **15** of BS 7114-3:1988;

b) the complete identification of the sample under test;

c) the date of test;

d) whether there were any holes, splits, dents or bulges in the body of the firework case;

e) whether the (either) end closure was loose or missing;

f) whether the initial fuse was loose;

g) the wind speed, in km/h, at the time of performance testing;

h) the duration, in s, of the initial fuse burning;

i) the duration, in s, of each period of invisible burning, if any;

j) the number of explosions and, if any, the time, in s, of the first occurrence;

k) whether any burning or incandescent matter fell more than 20 m away from the functioning point without being extinguished before descending to a height of 3 m above the ground;

l) whether any particle of debris, excluding paper, cardboard, felt or plastics foam, which was observed to be projected beyond 20 m from the functioning point, had a mass exceeding 1.0 g.

16 Determination of net explosive content of category 3 bangers (type 3A fireworks)

16.1 Test specimen

Use one banger for each test.

16.2 Apparatus

16.2.1 *Laboratory balance,* capable of weighing to an accuracy of 0.1 g.

16.3 Procedure

Carefully dismantle the banger (**16.1**) and remove and weigh the composition (including that contained in the fuse) to an accuracy of 0.1 g.

16.4 Test report

The test report shall include the following information:

a) a reference to the method used, i.e. clause **16** of BS 7114-3:1988;

b) the complete identification of the sample under test;

c) the date of test;

d) the net explosive content, in g.

17 Fountains (type 2B and type 3B fireworks)

17.1 Test environment and apparatus for performance testing

The test environment and the apparatus shall be as specified in **13.1** and **13.2**, respectively.

17.2 Test specimen

Use one fountain for each complete test.

17.3 Procedure

17.3.1 *Examination of fountain.* Examine the fountain (**17.2**) visually and determine whether there are any holes, splits, dents or bulges in the body of the firework case, whether the end closure, or either end closure if the fountain is designed to incorporate two end closures, is loose or missing and whether the initial fuse is loose. If any such fault is found, record the fact and do not proceed with the performance testing.

17.3.2 *Performance testing.* Carry out performance testing as described in **13.3**.

17.4 Test report

The test report shall include the following information:

a) a reference to the method used, i.e. clause **17** of BS 7114-3:1988;

b) the complete identification of the sample under test;

c) the date of test;

d) whether there were any holes, splits, dents or bulges in the body of the firework case;

e) whether the (either) end closure was loose or missing;

f) whether the initial fuse was loose;

g) the wind speed, in km/h, at the time of performance testing;

h) the duration, in s, of the initial fuse burning;

i) the duration, in s, of each period of invisible burning, if any;

j) the principal effects produced by the fountain;

k) the number of explosions and, if any, the time, in s, of the first occurrence;

l) whether any burning or incandescent matter fell more than 3 m, for category 2 fireworks, or 20 m, for category 3 fireworks, away from the functioning point without being extinguished before descending to a height of 3 m above the ground;

m) whether any particle of debris, excluding paper, cardboard, felt or plastics foam, which was observed to be projected laterally beyond 3 m, for category 2 fireworks, or 20 m, for category 3 fireworks, from the functioning point, had a mass exceeding 1.0 g.

18 Roman candles (type 2C and type 3C fireworks)

18.1 Test environment for performance testing

The test environment shall be as specified in **13.1**.

18.2 Apparatus

The apparatus shall be as specified in **13.2** together with the following when testing category 3 fireworks.

18.2.1 *Dip-stick,* graduated in mm, suitable for insertion inside the firework case.

18.3 Test specimen

Use one firework for each complete test.

18.4 Procedure

18.4.1 *Examination of firework.* Examine the firework (**18.3**) visually and determine whether there are any holes, splits, dents or bulges in the body of the firework case, whether the end closure, or either end closure if the firework is designed to incorporate two end closures, is loose or missing and whether the initial fuse is loose. If any such fault is found, record the fact and do not proceed with the performance testing.

For category 2 fireworks, measure the outside diameter of the body.

For category 3 fireworks, measure the length of the body (i.e. the outside length of the tube only).

18.4.2 *Performance testing.* Carry out the performance testing as described in **13.3** with the following modifications.

Ensure that the firework is vertical before igniting it. Immediately after the firework ceases to function, observe whether it has remained upright and record this fact.

For category 3 fireworks, within 10 min of the firework ceasing to function, determine whether the dip-stick (**18.2.1**) can be inserted to a depth of at least 80 % of the original length of the tube.

18.5 Test report

The test report shall include the following information:

a) a reference to the method used, i.e. clause **18** of BS 7114-3:1988;

b) the complete identification of the sample under test;

c) the date of test;

d) whether there were any holes, splits, dents or bulges in the body of the firework case;

e) whether the (either) end closure was loose or missing;

f) whether the initial fuse was loose;

g) the outside diameter, in mm, of the body (category 2 fireworks only);

h) the wind speed, in km/h, at the time of performance testing;

i) the duration, in s, of the initial fuse burning;

j) the duration, in s, of each period of invisible burning, if any;

k) the principal effects produced by the firework;

l) the time, in s, of the explosion, if any;

m) whether any burning or incandescent matter fell more than 3 m, for category 2 fireworks, or 20 m, for category 3 fireworks, away from the functioning point without being extinguished before descending to a height of 3 m above the ground;

n) whether any particle of debris, excluding paper, cardboard, felt or plastics foam, which was observed to be projected laterally beyond 3 m, for category 2 fireworks, or 20 m, for category 3 fireworks, from the functioning point, had a mass exceeding 1.0 g;

o) whether the firework remained upright whilst functioning;

p) whether the dip-stick could be inserted to a depth of at least 80 % of the original length of the tube after the firework had functioned (category 3 fireworks only).

19 Mines (type 2D and type 3D fireworks)

19.1 Test environment and apparatus for performance testing

The test environment and the apparatus shall be as specified in **13.1** and **13.2**, respectively.

19.2 Test specimen

Use one mine for each complete test.

19.3 Procedure

19.3.1 *Examination of the mine.* Examine the mine (**19.2**) visually and determine whether there are any holes, splits, dents or bulges in the body of the firework case, whether (either) end closure is loose or missing and whether the initial fuse is loose. If any such fault is found, record the fact and do not proceed with the performance testing.

Weigh the mine to an accuracy of ± 0.1 g.

For category 3 mines, measure the maximum width of the body (excluding the base).

19.3.2 *Performance testing.* Carry out the performance testing as described in **13.3** with the following modifications.

Ensure that the firework is vertical before igniting it. Immediately after the firework ceases to function, observe whether it has remained upright and record this fact.

19.4 Test report

The test report shall include the following information:

a) a reference to the method used, i.e. clause **19** of BS 7114-3:1988;

b) the complete identification of the sample under test;

c) the date of test;

d) whether there were any holes, splits, dents or bulges in the body of the firework case;

e) whether either end closure was loose or missing;

f) whether the initial fuse was loose;

g) the mass, in g, of the mine;

h) the maximum width, in mm, of the body (category 3 only);

i) the wind speed, in km/h, at the time of performance testing;

j) the duration, in s, of the initial fuse burning;

k) the duration, in s, of each period of invisible burning, if any;

l) the principal effects produced by the mine;

m) the number of explosions and, if any, the time, in s, of the first occurrence;

n) whether any burning or incandescent matter fell more than 3 m, for category 2 fireworks, or 20 m, for category 3 fireworks, away from the functioning point without being extinguished before descending to a height of 3 m above the ground;

o) whether any particle of debris, excluding paper, cardboard, felt or plastics foam, which was observed to be projected laterally beyond 3 m, for category 2 fireworks, or 20 m, for category 3 fireworks, from the functioning point, had a mass exceeding 1.0 g;

p) whether the firework remained upright whilst functioning.

20 Wheels (type 2E and type 3E fireworks)

20.1 Test environment for performance testing

The test environment shall be as specified in **13.1** and a horizontal or vertical wooden surface, as required, to which the spindle of the wheel can be secured at a height above the ground of 1.7 m (for category 2 wheels) or 3.0 m (for category 3 wheels), shall be provided at the centre of the test area.

20.2 Apparatus

The apparatus shall be as specified in **13.2**.

20.3 Test specimen

Use one wheel for each complete test.

20.4 Procedure

20.4.1 *Examination of wheel.* Examine the wheel (**20.3**) visually and determine whether there are any holes, splits, dents or bulges in the firework case and whether the initial fuse is loose. If any such fault is found, record the fact and do not proceed with the performance testing.

20.4.2 *Performance testing.* Carry out performance testing as described in **13.3** with the following modifications.

Secure the spindle of the wheel, so that the wheel is free to rotate, at a height of 1.7 m, for category 2 wheels, or 3.0 m, for category 3 wheels, above the ground. In addition to the other observations, after it ceases to function record whether the wheel has remained attached to the wooden surface.

20.5 Test report

The test report shall include the following information:

a) a reference to the method used, i.e. clause **20** of BS 7114-3:1988;

b) the complete identification of the sample under test;

c) the date of test;

d) whether there were any holes, splits, dents or bulges in the firework case;

e) whether the initial fuse was loose;

f) the wind speed, in km/h, at the time of performance testing;

g) the duration, in s, of the initial fuse burning;

h) the duration, in s, of each period of invisible burning, if any;

i) the principal effects produced by the wheel;

j) the number of explosions and, if any, the time, in s, of the first occurrence;

k) whether any burning or incandescent matter fell more than 3 m, for category 2 fireworks, or 20 m, for category 3 fireworks, away from the functioning point without being extinguished before descending to a height of 3 m above the ground;

l) whether any particle of debris, excluding paper, cardboard, felt or plastics foam, which was observed to be projected laterally beyond 3 m, for category 2 fireworks, or 20 m, for category 3 fireworks, from the functioning point, had a mass exceeding 1.0 g;

m) whether the wheel remained attached to the wooden surface whilst functioning.

21 Rockets (type 2F and type 3F fireworks) supplied without a rocket launcher

21.1 Test environment for performance testing

The test environment shall be as specified in **13.1** except that the test area for category 2 rockets shall be provided with posts to indicate heights of 3 m and 5 m above the ground.

21.2 Apparatus

The apparatus shall be as specified in **13.2** together with the following.

21.2.1 *Rocket launcher,* for rockets with sticks, suitable for holding the stick(s) of the rocket so that the rocket is vertical and is free to move upwards.

21.2.2 *Equipment for monitoring the flight of the rocket.* This shall comprise either:

a) two sighting devices, as shown in Figure 2 and Figure 3, each of which enables an observer to determine whether a rocket travels outside a prescribed triangle, which has a height of 25 m, an apex at the functioning point and two sides at 30° to the vertical; or

b) two video cameras and equipment for recording and playing back pictures on a television screen, or two television screens, on which projections of the same triangles are displayed or marked.

21.3 Test specimen

Use one rocket for each complete test.

21.4 Procedure

21.4.1 *Examination of rocket.* Examine the rocket (**21.3**) visually and determine whether there are any holes, splits, dents or bulges in the firework case and whether the initial fuse is loose. If any such fault is found, record the fact and do not proceed with the performance testing.

If the rocket is designed to have one or more sticks, check that a stick is fitted securely in each socket or that a stick for each socket which will fit securely is provided. If the rocket has one or more fins, check that each is securely attached. If a stick is missing or will not fit securely in the socket, or a fin is loose or missing, record the fact and do not proceed with the performance testing.

For category 2 rockets, weigh the rocket and stick(s), if any, together to an accuracy of 0.1 g.

21.4.2 *Performance testing.* Measure the wind speed (see **13.1.3**).

Fit the stick(s), if any and if not already fitted, to the rocket. Place the rocket in the rocket launcher (**21.2.1**) or on the smooth, hard horizontal surface, as appropriate, in the centre of the test area. Set up the equipment for monitoring the flight of the rocket (**21.2.2**) in two positions on the ground, at 90° to each other in relation to the rocket and in the same horizontal plane as the rocket.

Ensure that the rocket is vertical and that it is free to move upwards. Remove the fuse cover, if any, and straighten the fuse. Ignite the rocket and start the timing device (**13.2.1**) immediately.

Record the duration of the initial fuse burning. Observe whether the rocket explodes and, if so, record the time of the first explosion and whether it occurs before the rocket has ascended beyond a height of 3 m, for category 2 fireworks, or 5 m, for category 3 fireworks. Record whether the rocket ascends beyond a height of 5 m (for both categories) above the ground. Monitor the upward flight of the rocket, up to a height of 25 m, and determine whether the angle of flight, as viewed from either position, is greater than 30° to the vertical. Observe and record what other principal effects (in addition to ascent) are produced by the rocket. Observe whether any burning or incandescent matter falls outside a distance of 3 m, for category 2 fireworks, or 20 m, for category 3 fireworks, from the functioning point without being extinguished before descending to a height of 3 m above the ground. Observe any large pieces of debris which fall beyond 3 m, for category 2 fireworks, or 20 m, for category 3 fireworks, from the functioning point and note the places where they land.

After the firework has ceased to function, collect any large pieces of debris within the 3 m (category 2) or 20 m (category 3) radius circle and any large pieces of debris which were observed to have fallen outside this circle. Weigh individually any piece of debris which might exceed a mass of 100 g.

21.5 Test report

The test report shall include the following information:

a) a reference to the method used, i.e. clause **21** of BS 7114-3:1988;

b) the complete identification of the sample under test;

c) the date of test;

d) whether there were any holes, splits, dents or bulges in the firework case;

e) whether the initial fuse was loose;

f) whether the rocket was fitted securely with a stick or provided with a stick that would fit securely in each socket, if any, and whether each fin, if any, is securely attached;

g) the mass, in g, of the rocket with any stick(s);

h) the wind speed, in km/h, at the time of performance testing;

i) the duration, in s, of the initial fuse burning;

j) the time, in s, of the first explosion, if any;

k) whether the first explosion occurred before the rocket had ascended beyond a height of 3 m, for category 2 fireworks, or 5 m, for category 3 fireworks;

l) whether the rocket ascended beyond 5 m;

m) whether the angle of flight, viewed from either position, was greater than 30° to the vertical;

n) the principal effects (other than ascent) produced by the rocket;

o) whether any burning or incandescent matter fell more than 3 m, for category 2 fireworks, or 20 m, for category 3 fireworks, away from the functioning point without being extinguished before descending to a height of 3 m above the ground;

p) the mass, in g, of each piece of debris weighed.

22 Rockets (type 2F and type 3F fireworks) supplied with a rocket launcher

22.1 Test environment for performance testing

The test environment shall be as specified in **13.1** except that the test area for category 2 rockets shall be provided with posts to indicate heights of 3 m and 5 m above the ground.

22.2 Apparatus

The apparatus shall be as specified in **13.2** and **21.2.2**.

22.3 Test specimen

Use one primary pack for each complete test.

22.4 Procedure

22.4.1 *Examination of rockets.* Examine each rocket as described in **21.4.1**.

22.4.2 *Performance testing.* Set up the rocket launcher in accordance with the instructions on the label, but ensure that it is aligned so that the rocket will be vertical, in the centre of the test area. Carry out performance testing, using one rocket at a time, as described in **21.4.2**.

Record the observations for each rocket separately. Before firing each rocket check that the rocket launcher is not damaged to such an extent that it can no longer support the rocket in a vertical position or that the rocket is not free to move upwards. If any such fault is found, record the fact and do not continue with the testing. Otherwise continue until all the rockets have been fired.

22.5 Test report

The test report shall include the following information:

a) a reference to the method used, i.e. clause **22** of BS 7114-3:1988;

b) the complete identification of the sample under test;

c) the date of test;

d) items d) to g) in **21.5**, for each rocket;

e) the wind speed, in km/h, at the time of performance testing;

f) items i) to p) in **21.5**, for each rocket;

g) whether the rocket launcher was damaged to such an extent that it could no longer support a rocket in a vertical position or that a rocket supported by it was not free to move upwards.

23 Non-hand-held sparklers for outdoor use (type 2G and type 3G fireworks)

23.1 Test environment for performance testing

The test environment shall be as specified in **13.1** and a vertical post, to which a sparkler can be secured, shall be provided at the centre of the test area.

23.2 Apparatus

The apparatus shall be as specified in **13.2** except that either the timing device shall be capable of being restarted instantaneously or two such devices shall be provided: one for timing the period up to ignition, accurate to within 1 s, and one for timing the period after ignition, accurate to within 0.1 s.

23.3 Test specimen

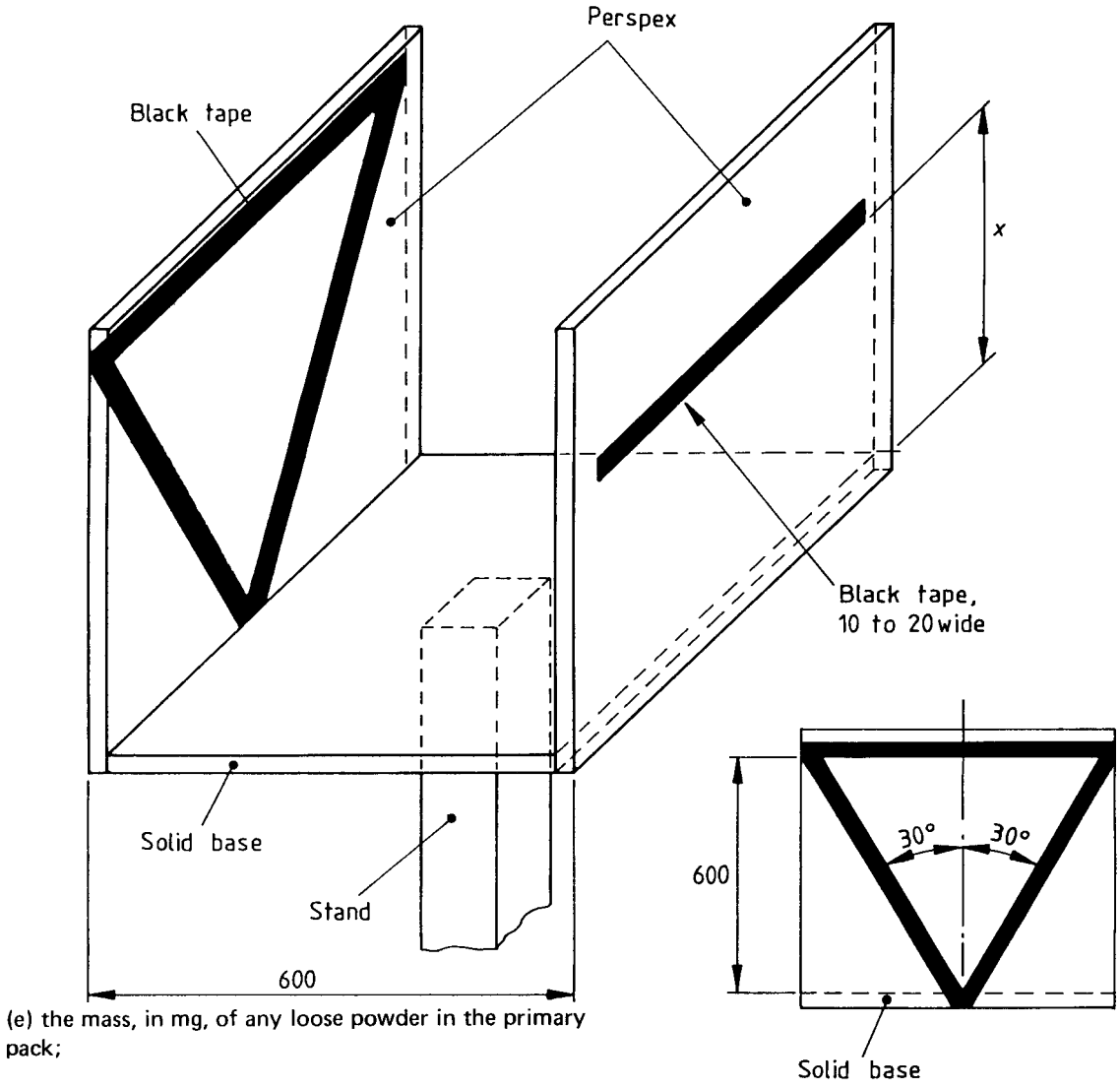
Use one primary pack for each complete test.

23.4 Procedure

23.4.1 *Measurement of sparklers (category 2 only).* Measure the total length of each sparkler.

23.4.2 *Performance testing.* Measure the wind speed (see **13.1.3**).

Attach one of the sparklers securely to the post in the centre of the test area and ignite it using a portfire. If the sparkler fails to ignite after the ignition source has been applied continuously for 30 s, record this fact and replace it with the next sparkler. If the sparkler is successfully ignited, restart the timing device or start the second timing device (see **23.2**), immediately.



(e) the mass, in mg, of any loose powder in the primary pack;

Distance x is given, in mm, by the equation:

$$x = 600 - \left(\frac{24.4 \times 600}{y}\right)$$

where y is the distance, in m, from the viewing point to the functioning point (see Figure 3).

The observer is positioned so that the bottom of the triangle on the front screen coincides with the base of the rocker and the bottom edge of the tape on the back screen coincides with the bottom edge of the horizontal tape on the front screen.

All dimensions are in millimetres.

Figure 2 — Sighting device for rockets

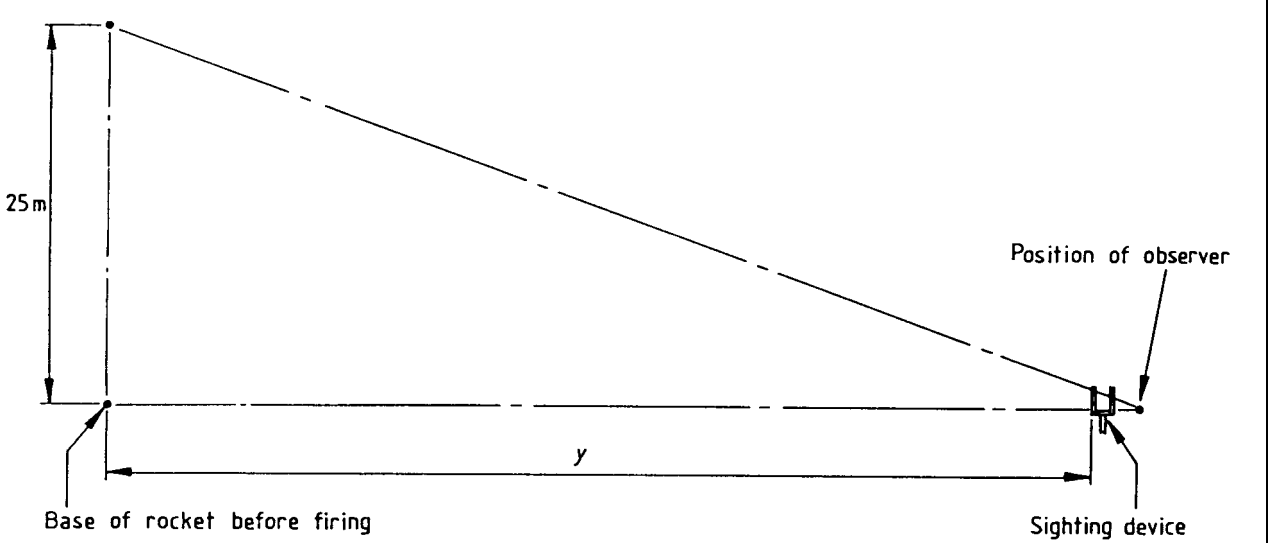


Figure 3 — Location of a sighting device

Observe whether the sparkler explodes and, if so, record the time of each occurrence. Observe and record whether any burning or incandescent matter falls outside a distance of 3 m, for category 2 sparklers, or 20 m, for category 3 sparklers, from the functioning point without being extinguished before descending to a height of 3 m above the ground. Observe whether any debris is projected laterally beyond 3 m, for category 2 sparklers, or 20 m, for category 3 sparklers, from the functioning point. Observe and record whether the sparkler burns along the entire composition length.

After the sparkler has ceased to function, collect any debris which was observed to have been projected laterally beyond 3 m, for category 2 sparklers, or 20 m, for category 3 sparklers, from the functioning point. Weigh individually any particles which might exceed a mass of 1 g.

Repeat the above operations for each of the other sparklers from the primary pack.

23.5 Test report

The test report shall include the following information:

a) a reference to the method used, i.e. clause **23** of BS 7114-3:1988;

b) the complete identification of the sample under test;

c) the date of test;

d) the total length, in mm, of each sparkler (category 2 only);

e) the wind speed, in km/h, at the time of performance testing;

f) whether any sparkler failed to ignite during the performance testing;

g) the number of explosions and, if any, the time, in s, of the first occurrence for each sparkler tested;

h) whether any burning or incandescent matter fell more than 3 m, for category 2 sparklers, or 20 m, for category 3 sparklers, away from the functioning point without being extinguished before descending to a height of 3 m above the ground;

i) whether any particle of debris, excluding paper, cardboard, felt or plastics foam, which was observed to be projected laterally beyond 3 m, for category 2 sparklers, or 20 m, for category 3 sparklers, from the functioning point, had a mass exceeding 1.0 g;

j) whether any sparkler failed to burn along its entire composition length during the performance testing.

24 Category 2 hand-held sparklers (type 2H fireworks)

24.1 Material

24.1.1 *Sheet of paper,* 1 m × 1 m, complying with Appendix A.

24.2 Test area for performance testing and apparatus

The test area for the performance testing and the apparatus shall be as specified in **10.2** and **10.3**, respectively.

24.3 Test specimen

Use one primary pack for each complete test.

24.4 Procedure

24.4.1 *Initial weighing.* Weigh all the sparklers individually to an accuracy of 0.1 g.

24.4.2 *Measurement of sparklers.* Measure the total length and the length of the handle (i.e. the section of wire which is not coated with composition) of each sparkler.

24.4.3 *Performance testing.* Place the sheet of paper (**24.1.1**) on the flat, horizontal non-flammable surface in the test area (**10.2**).

Clamp the handle of one of the sparklers so that the sparkler is horizontal, 1 200 mm above the centre of the sheet of paper. Ignite the sparkler using a wax taper. If the sparkler fails to ignite after the ignition source has been applied continuously for 30 s, record this fact and replace it with the next sparkler. Observe the sparkler until it ceases to function. Record whether the sparkler explodes during this period, whether it burns along the entire composition length and whether the paper catches fire. Remove and retain the spent sparkler. Repeat the process for each of the other sparklers from the primary pack.

Allow each sparkler to cool and then measure the deflection, x, of the unsupported tip from the horizontal (see Figure 4).

24.4.4 *Weighing of sparkler wires.* Discard any of the spent sparklers on which the composition has not burnt along its entire length. Remove the residue from the remaining sparklers by tapping each one gently with a hammer. Weigh the wires collectively to an accuracy of 0.1 g.

24.5 Expression of results

24.5.1 *Vertical droop.* The vertical droop, D, expressed as a percentage of the composition length of the sparkler, is given by the equation:

$$D = \frac{100x}{(l-h)}$$

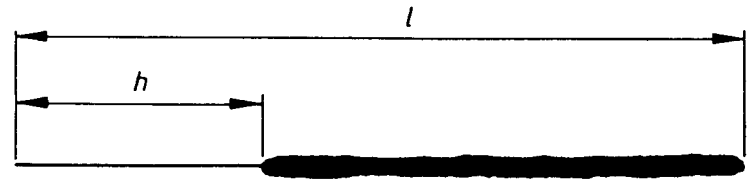
where

x is the deflection (in mm) of the tip of the sparkler;

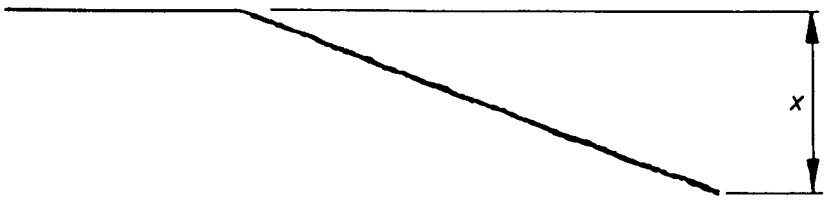
l is the total length (in mm) of the sparkler;

h is the length (in mm) of the handle.

24.5.2 *Net explosive content.* Express the results for the net explosive content in accordance with **10.6**.



(a) Unburnt sparkler



(b) Spent sparkler

Figure 4 — Hand-held sparkler, before and after performance testing

24.6 Test report

The test report shall include the following information:

a) a reference to the method used, i.e. clause **24** of BS 7114-3:1988;

b) the complete identification of the sample under test;

c) the date of test;

d) the total length, in mm, of each sparkler;

e) the length, in mm, of the handle of each sparkler;

f) whether any sparkler failed to ignite during the performance testing;

g) whether any sparkler exploded during the performance testing;

h) whether any sparkler failed to burn along its entire composition length during the performance testing;

i) whether the paper caught fire during the performance testing;

j) the vertical droop, in %, of each sparkler;

k) the net explosive content, in grams per sparkler.

25 Shells (type 3H fireworks)

25.1 Test environment for performance testing and apparatus

The test environment and the apparatus shall be as specified in **13.1** and **13.2**, respectively.

25.2 Test specimen

Use one primary pack (containing a mortar tube and one or more shells) for each complete test.

25.3 Procedure

25.3.1 *Initial examination of mortar tube.* Examine the mortar tube visually and determine whether there are any holes or splits in the wall of the tube and whether the base is loose or missing. If any such fault is found, record the fact and do not proceed with the performance testing.

Measure the inside depth (from the rim to the base) of the mortar tube.

25.3.2 *Examination of shell(s).* Examine each shell visually and determine whether there are any holes, splits, dents or bulges in the firework case and whether the initial fuse is loose or missing. If any such fault is found in a shell, record the fact and do not use that shell for the performance testing.

Weigh each shell and measure its diameter. Check that each initial fuse is fitted with an orange cover. Pull each initial fuse gently taut and measure the distance from the base of the shell to the tip of the fuse. Determine the length of each fuse which would be outside the mortar tube if the shell were loaded, by subtracting the depth of the mortar tube.

25.3.3 *Performance testing.* Measure the wind speed (see **13.1.3**).

Bury the mortar tube in accordance with the instructions on the label, but ensure that it is vertical, in the centre of the test area. Straighten the initial fuse of the first shell and lower the shell, with the fuse end uppermost, to the bottom of the mortar tube. Remove the fuse cover. Ignite the fuse and start the timing device (**13.2.1**) immediately.

Observe and record the time when the shell is projected from the mortar tube (if at all) and whether the shell explodes at a height greater than 5 m above the ground. Observe and record what other principal effects (in addition to projection and explosion) are produced by the shell. Observe whether any burning or incandescent matter falls outside a distance of 20 m from the functioning point without being extinguished before descending to a height of 3 m above the ground. Observe any large pieces of debris which fall beyond 20 m from the functioning point and note the places where they land.

After the shell has ceased to function, collect any large pieces of debris within the 20 m radius circle and any large pieces of debris which were observed to have fallen outside this circle. Weigh individually any piece of debris which might exceed a mass of 100 g.

If the shell fails to be projected from the mortar tube, do not continue with the testing.

Before loading the next shell (if any), extinguish and remove any debris in the mortar tube and examine the mortar tube visually, without disturbing it, to determine whether there are any holes or splits in the wall of the tube or any constrictions which would prevent the next shell being lowered to the bottom. If any such fault is found, record the fact and do not continue with the testing.

Unless the test is halted (under the conditions stated in this clause), repeat the above operations for each of the remaining shells (if any).

25.4 Test report

The test report shall include the following information, items g) to q) being given for each shell tested:

a) a reference to the method used, i.e. clause **25** of BS 7114-3:1988;

b) the complete identification of the sample under test;

c) the date of test;

d) whether there were any holes or splits in the wall of the mortar tube and whether the base was loose or missing before the performance testing;

e) whether there were any holes or splits in the wall of the mortar tube, or any constrictions which prevented the next shell being lowered to the bottom, after firing any of the shells;

f) the wind speed, in km/h, at the time of performance testing;

g) whether there were any holes, splits, dents or bulges in the firework case;

h) whether the initial fuse was loose or missing;

i) the mass, in g, of the shell;

j) the diameter, in mm, of the shell;

k) whether the initial fuse was fitted with an orange cover;

l) the length, in mm, of fuse which would have been outside the mortar tube when the shell was loaded;

m) the time, in s, when the shell was projected from the mortar tube;

n) whether the shell exploded at a height greater than 5 m above the ground;

o) the principal effects (other than projection and explosion) produced by the shell;

p) whether any burning or incandescent matter fell more than 20 m away from the functioning point without being extinguished before descending to a height of 3 m above the ground;

q) the mass, in g, of each piece of debris weighed.

26 Shell-in-mortars (type 3J fireworks)

26.1 Test environment and apparatus for performance testing

The test environment and the apparatus shall be as specified in **13.1** and **13.2**, respectively.

26.2 Test specimen

Use one firework for each complete test.

26.3 Procedure

26.3.1 *Examination of the firework.* Examine the firework (**26.2**) visually and determine whether there are any holes, splits, dents or bulges in the outer tube, whether the end closure, or either end closure if the firework is designed to incorporate two end closures, is loose or missing, and whether the initial fuse is loose or missing. If any such fault is found, record the fact and do not proceed with the performance testing.

Measure the outside diameter of the tube. Check that the initial fuse is fitted with an orange cover.

26.3.2 *Performance testing.* Measure the wind speed (see **13.1.3**).

Bury the firework in accordance with the instructions on the label, but ensure that it is vertical, in the centre of the test area. Straighten the initial fuse and remove the fuse cover. Ignite the fuse and start the timing device (**13.2.1**) immediately.

Observe and record the time when the shell is projected from the tube (if at all) and whether the shell explodes at a height greater than 5 m above the ground. Observe and record what other principal effects (in addition to projection and explosion) are produced by the firework.

Observe whether any burning or incandescent matter falls outside a distance of 20 m from the functioning point without being extinguished before descending to a height of 3 m above the ground. Observe any large pieces of debris which fall beyond 20 m from the functioning point and note the places where they land.

After the firework has ceased to function, collect any large pieces of debris within the 20 m radius circle, excluding the remains of the tube which are still at the functioning point, and any large pieces of debris which were observed to have fallen outside this circle. Weigh individually any piece of debris which might exceed a mass of 100 g.

26.4 Test report

The test report shall include the following information:

a) a reference to the method used, i.e. clause **26** of BS 7114-3:1988;

b) the complete identification of the sample under test;

c) the date of test;

d) whether there were any holes, splits, dents or bulges in the outer tube;

e) whether the (either) end closure was loose or missing;

f) whether the initial fuse was loose or missing;

g) the outside diameter, in mm, of the firework;

h) whether the initial fuse was fitted with an orange cover;

i) the wind speed, in km/h, at the time of performance testing;

j) the time, in s, when the shell was projected from the tube;

k) whether the shell exploded at a height greater than 5 m above the ground;

l) the principal effects (other than projection of the shell and explosion of the shell) produced by the firework;

m) whether any burning or incandescent matter fell more than 20 m away from the functioning point without being extinguished before descending to a height of 3 m above the ground;

n) the mass, in g, of each piece of debris weighed.

27 Combinations (type 2X and type 3X fireworks)

Testing other than performance testing shall be carried out as described for the fireworks which correspond to the individual elements of the combination.

For performance testing, the combination shall be assembled and positioned in the centre of the test area, in accordance with the instructions on the label. Performance testing shall be carried out as described in **13.3**. In addition to the other observations, record whether the combination has remained upright after it ceases to function and, if the combination includes a wheel, rocket and launcher or shell-in-mortar, make the necessary observations specified in the procedure for testing that type of firework.

Appendix A Test paper

A.1 Physical properties

The paper[3)] shall comply with the requirements of Table 1.

Table 1 — Physical properties of test paper

Property	Test method	Requirement
Thickness	BS 3983-2	0.075 ± 0.005 mm
Grammage	BS 3432	55 ± 3 g/m^2
Bursting strength	BS 3137	100 kN/m^2, minimum
Tensile strength, in the cross direction	BS 4415-2	1.4 kN/m, minimum
Elongation at break, in the cross direction	BS 4415-2	2 %, maximum

A.2 Conditioning

The paper shall be conditioned at 20 ± 4 °C and 65 ± 5 % relative humidity for at least 24 h immediately prior to use.

Appendix B Determination of chloride ions

B.1 General

Any suitable apparatus and procedure may be used providing the accuracy and precision of the method comply with **B.3**.

B.2 Standard reference solution

Dissolve 32.97 mg of analytical grade sodium chloride in water, complying with grade 3 of BS 3978, in a 100 mL volumetric flask and dilute to the mark.

B.3 Accuracy and precision

The mean of five determinations of the chloride content of the standard reference solution (**B.2**) shall be in the range 19.85 mg of chloride ions (Cl^-) to 20.15 mg of Cl^-. Each individual result shall be within ± 0.30 mg of Cl^- from the mean.

Appendix C Test for the presence of a mixture of sulphur and sodium or potassium chlorate

C.1 Reagents and material

C.1.1 *General.* During the test use only reagents of recognized analytical grade, unless otherwise specified, and water complying with grade 3 of BS 3978.

C.1.2 *Anilinium chloride, acidified solution.* Dissolve 5 g of anilinium chloride (aniline hydrochloride), ordinary laboratory grade, in 100 mL of hydrochloric acid solution, c(HCl) = 8 mol/L.

C.1.3 *Silver nitrate, acidified solution.* Dissolve 5 g of silver nitrate in 100 mL of nitric acid solution, $c(HNO_3)$ = 2 mol/L.

C.1.4 *Sodium nitrite,* 50 g/L solution.

C.1.5 *Benzoin,* ordinary laboratory grade.

C.1.6 *Lead di(acetate) test paper.*

C.1.7 *Piperidine,* ordinary laboratory grade.

C.2 Test specimen

Use one firework for each complete test.

C.3 Procedure

C.3.1 Carefully dismantle the firework (**C.2**) and separate out each component containing explosive composition (e.g. fuse, pyrotechnic unit, burster).

Repeat the sequence of operations described in **C.3.2** to **C.3.6** for each component.

[3)] For information on the availability of the test paper, apply to Enquiry Section, BSI, Linford Wood, Milton Keynes MK14 6LE, enclosing a stamped addressed envelope for reply.

C.3.2 Place about 5 mg of the explosive composition on a spotting plate and add two drops of the anilinium chloride solution (**C.1.2**). Observe whether a green/blue colour is formed, indicating the presence of an oxidizing agent: if this does not show up, the testing of that particular component may be discontinued.

C.3.3 Dissolve 10 mg of the explosive composition in 1 mL of water and add 1 mL of the silver nitrate solution (**C.1.3**). If a white precipitate is formed, add a further 1 mL of silver nitrate solution and filter off the precipitate before proceeding.

C.3.4 To the solution obtained as described in **C.3.3** (filtered if necessary) add 0.5 mL of the sodium nitrite solution (**C.1.4**) and warm the solution over a small flame. Add a further 1 mL of silver nitrate solution. Observe whether a white precipitate is formed, indicating the presence of a chlorate: if there is no precipitate, the testing of that particular component may be discontinued.

C.3.5 Put 0.3 g of the benzoin (**C.1.5**) in a test tube and add 2 mg to 5 mg of the explosive composition. Moisten a strip of about 20 mm length of the lead di(acetate) test paper (**C.1.6**) and place it in the mouth of the test tube. Heat the test tube very gently over a small flame. When the benzoin melts, ensure that the liquid covers the explosive composition. Observe whether a black/brown coloration of the test paper is obtained, indicating the presence of elemental sulphur.

C.3.6 Place about 5 mg of the explosive composition on a spotting plate and add one drop (about 0.03 mL) of the piperidine (**C.1.7**). Observe whether a yellow/brown colour is obtained, indicating the presence of sulphur.

C.4 Test report

The test report shall include the following information:

a) a reference to the method used, i.e. Appendix C of BS 7114-3:1988;

b) the complete identification of the sample under test;

c) the date of test;

d) whether the presences of both a chlorate and elemental sulphur were indicated, for each component of the firework.

Publications referred to

BS 3137, *Methods for determining the bursting strength of paper and board.*

BS 3432, *Method for determination of grammage of paper and board.*

BS 3978, *Specification for water for laboratory use.*

BS 3983, *Thickness and apparent density of paper and board.*

BS 3983-2, *Method for determining the single sheet thickness of paper and board and apparent density of board.*

BS 4415, *Determination of the tensile properties of paper and board.*

BS 4415-2, *Constant rate of elongation method.*

BS 7114, *Fireworks.*

BS 7114-1, *Classification of fireworks.*

BS 7114-2, *Specification for fireworks*[4)].

[4)] Referred to in the foreword only.

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