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INTERNATIONAL STANDARDS FOR FIRE EXTINGUISHER CONSTRUCTION AND PERFORMANCE

by

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SUMMARY

The following note compares the existing requirements of the French, German and British Standards for hand fire-extinguishers, and makes suggestions for the requirements of a proposed set of International Standards to replace the equivalent National Standards.

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MINISTRY OF TECHNOLOGY AND FIRE OFFICES' COMMITTEE
JOINT FIRE RESEARCH ORGANIZATION

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INTERNATIONAL STANDARDS FOR FIRE EXTINGUISHER CONSTRUCTION AND PERFORMANCE

1. Introduction

Many European countries have standards for the construction and performance of hand-operated fire extinguishers, and since these appliances are expected to perform a very similar task, regardless of their country of origin, it seems likely that the national standards could be replaced by suitable International Standards without loss of extinguisher quality, but with great advantage in trading facilities and interchangeability. It is the purpose of this note to examine in some detail the French, German and British Standards for the different types of fire extinguisher, and to suggest what would appear to be essential and desirable requirements for a series of International Standards.

2. National Standards

The national standards summarised in this note are as follows:

(a) French: Association Francaise de Normalisation (AFNOR)

(1)	Mobile Fire Extinguishers - General	Standard NF S 61-901 (May 1964)
(2)	Furnace types for testing mobile fire extinguishers	Standard NF S 61-902 (Aug 1965)
(3)	Methods of test for mobile fire extinguishers	Standard NF S 61-903 (Aug 1965)
(4)	"Non-flammable liquid" extinguishers (soda-acid)	Standard NF S 61-911 (Feb 1966)
(5)	Water extinguishers (gas operated)	Standard NF S 61-912 (Feb 1966)
(6)	Foam extinguishers	Standard NF S 61-910 (Oct 1966)
(7)	Liquefied carbon dioxide extinguishers	Standard NF S 61-914 (Jun 1966)
(8)	Powder extinguishers	Standard NF S 61-915 (Oct 1966)
(9)	Halogenated hydrocarbon extinguishers	Standard NF S 61-913 (Jun 1966)

(b) German: Deutsche Normen Ausschuss

Portable extinguishers D.I.N. 14 406 - Sheet 1 (1964)
- Sheet 2 (draft May 1964)

(c) British: British Standards Institution

(1) Portable fire extinguishers of the water type (soda acid) B.S. 138 : 1948

(2) " " " " " " " (gas pressure) B.S. 1382 : 1948

(3) " " " " " " " (stored pressure) B.S. 3709 : 1962

(4) Portable plastics-bodied fire extinguishers of the water type (gas pressure)(draft)

(5) Portable fire extinguishers of the foam type (chemical) B.S. 740:Part 1: 1948 (including amendments up to Mar 1961)

(6) Portable fire extinguishers of the foam type (gas pressure) B.S.740:Part 2:1952 (including amendments up to Oct 1960)

(7) Portable carbon dioxide fire extinguishers B.S. 3326 : 1960

(8) Dry powder portable fire extinguishers B.S. 3465 : 1962

(9) C.T.C. and C.B.M. portable fire extinguishers B.S. 1721 : 1960

(10) Portable fire extinguishers of the halogenated hydrocarbon type (draft revision of B.S. 1721 - Feb 1967)

3) Summary of requirements of National Standards

Each of the national standards has been examined and summarised in Tables 1 - 5, under the following headings:-

Table 1 - Water type extinguishers

Table 2 - Foam extinguishers (Mechanical or air foam, and chemical foam)

Table 3 - Carbon dioxide extinguishers

Table 4 - Dry powder extinguishers

Table 5 - Vaporising liquid (halogenated hydrocarbon) extinguishers.

The tests and specifications summarised in Tables 1 to 5 can be grouped under the following headings for the purpose of comparing and contrasting the standards of the three countries:-

(1) Fire tests.

(2) Extinguisher body design tests.

(3) Extinguisher agent discharge tests.

(4) Environmental tests.

(5) Electrical conductivity tests of extinguishing agent.

(6) Specifications of materials, construction and marking.

(7) Inspection procedures.

Fire tests

The British standards have no fire tests for water, foam and carbon dioxide extinguishers, but have flammable liquid fire tests for dry powder and vaporising liquid (halogenated hydrocarbon) extinguishers.

The French standards have the most comprehensive series of fire tests, and include class B (flammable liquid) tests for all fire extinguishing agents. In addition they cover class A (solid cellulosic materials) fires for water, foam and dry powders (optional). There is also an optional liquefied petroleum gas (LPG) fire test for dry powder extinguishers.

The German standards specify class B fires for carbon dioxide, dry powder and vaporising liquid extinguishers, and a class A fire for water and dry powder (i.e. for "all purpose" powders only). There are also LPG fires for carbon dioxide and dry powders, and a metal fire for dry powder extinguishers when appropriate.

Extinguisher body design tests

All three countries have tests to ensure that the extinguisher body is designed so as to withstand the working pressure developed when it is discharged. Generally there are both working or proof pressure tests, and also burst (ultimate strength) tests of the extinguisher body shell. The British standards for water and foam extinguishers also include a pressure test for operation when the discharge nozzle is completely blocked.

Leakage tests are included by all the countries, with the exception of foam extinguishers in the French standards, and dry powder and vaporising liquids in the German standards.

Corrosion tests are not specified in any of the three countries' standards, except for the single case of the British standard for stored-pressure water-type extinguishers.

Tests for the discharge hose are specified only in the British standards, in the form of an internal pressure test, which is applicable to all five extinguisher types.

Extinguisher agent discharge tests

The duration of discharge of the extinguisher contents is specified in the British and French standards for all five types of agent, but the German standards contain no such requirement.

The "throw" or range required of the agent is given in the British standards for water, foam and vaporising liquids. The French standards describe test procedures for measuring the throw, but give no performance criteria.

The British standards are the only ones to include interrupted discharge tests, which cover carbon dioxide, dry powders, and vaporising liquids. The British are also the only standards which specify that a given proportion of the extinguisher contents shall be discharged (generally 95 per cent at least).

The British standards also include a single test which is not included in the French or German standards. This is a discharge test with an overall extinguisher body, which is included in the draft for plastics-bodied extinguishers containing water.

Environmental tests

In general the standards of all three countries include relatively few environmental tests. The French standards specify a vibration test for all types of extinguishing agent, and there is an impact test on the extinguisher for some types of water and foam extinguishers in the British standards.

There are no tests to study the effects of extremes of ambient temperatures, except a French specification for a high temperature test for dry powder extinguishers, and a German specification for a low temperature test for water extinguishers.

There are no tests to determine the effect of weathering, or the effect of long term storage - under various conditions of temperature and vibration, for example.

Specifications of materials, construction and marking

The marking requirements on extinguisher bodies are specified by the standards of all three countries, for all the five types of extinguishing agent.

Only the British standards lay down specifications for the materials to be used in the construction of the extinguisher, and for the methods to be employed in their construction.

There is generally no specification of the extinguishing materials used, except in the British standards for soda-acid water-type extinguishers and vaporising liquid extinguishers, and for the French vaporising liquid extinguishers.

Electrical conductivity tests of extinguishing agent

Tests are made of the conductivity of the discharge stream from the extinguisher where it may be used on electrical equipment. The French standards cover water, and dry powders, and the German standards require tests for carbon dioxide, dry powders and vaporising liquids which are conducted by the Technical University, Darmstadt.

Inspection procedures

A requirement for the periodic inspection of extinguishers is included in the German standards only, which require examination by competent inspectors of all extinguishers at intervals of not more than 2 years, to ensure that they are still in operational condition.

Although there are no requirements for inspection and maintenance in the British Standards, these matters are covered by British Standard Code of Practice C.P.402 : Part 3 : 1964.

4) Comparison between the requirements of the National Standards

A comparision of the specific National requirements for size, pressure tests, discharge tests and fire tests are shown in Tables 6 - 10, as follows:-

Table 6 - Water type extinguishers

Table 7 - Foam extinguishers

Table 8 - Carbon dioxide extinguishers

Table 9 - Dry powder extinguishers

Table 10 - Vaporising liquid extinguishers

Extinguisher size

The capacities of extinguishers are quoted as volume in some cases, and as weight in others. Since the relevant property of the extinguishers is the fact of their portability, it would be more convenient if "size" was expressed in terms of the weight of agent which the extinguisher contains.

For water and foam extinguishers the French standards cover a number of size ranges up to 25 litres ($5\frac{1}{2}$ gal) and 20 l (4.4 gal) respectively, which represent maximum weights of agent of 25 kg (55 lb) and 20 kg (44 lb). The largest sizes covered seem rather large for hand extinguishers, particularly when it is considered that the weight of the body has to be added to that of the agent. The equivalent British standards cover a range of 4.6 to 11.4 litres (1 to $2\frac{1}{2}$ gal), which is a weight range of 4.6 to 11.4 kg (10 to 25 lb), and the German standard for water extinguishers applies to a single size of 10 litres (2.2 gal), weighing 10 kg (22 lb).

The standards for carbon dioxide extinguishers cover equivalent sizes for the three countries, up to 6 kg (13.2 lb) for France and Germany, and 6.8 kg (15 lb) for Britain. In the case of dry powder extinguishers the sizes are also comparable, ranging up to 13.6 kg (30 lb) in the British standard, and to 11 kg (24.2 lb) and 12 kg (26.4) in the French and German standards respectively.

The vaporising liquid standards give the volumes of liquid with the exception of the draft British standard (revision of B.S.1721) which quotes weights of agent. With vaporising liquids conversion of a volume to weight is complicated by the fact that the densities of the liquids vary, so the density of liquid chlorobromomethane (CBM) (1.95 g/cm^3 at 20°C) has been taken to give the maximum weight of agent for a particular quoted volume. The British standard covers weights of agent up to 11.4 kg (25 lb) in the draft revision of B.S.1721, compared with the French standard which has a maximum size of 5 l (1.1 gal), which represents 9.75 kg (21.5 lb) of CBM. The German standard covers smaller sizes of extinguisher, up to 2 l (3.5 pt), representing 3.9 kg (8.6 lb) of CBM.

Pressure tests

The French standards do not quote specific pressure test requirements, but state that an official test certificate (or proof certificate) is required where the extinguisher is subject to the regulations for pressure vessels. Where this is not the case then the extinguisher prototypes must be subjected to identical tests to those specified in the regulations. No reference is given to the regulations which are relevant, or to what criteria determine whether or not the extinguisher falls within the general requirements for pressure vessels.*

The British and German standards specify, in general, a proof test and an ultimate strength (burst) test. These tests are related to the working pressure developed within the extinguisher body. The working pressure is the maximum pressure developed within the extinguisher when it is operated with a closed nozzle and relief valve (gas operated or by chemical reaction), or the stored pressure.

In general, the requirements of the British standards are more severe than those of the German. Although there are differences of detail in the British standards, in many cases a proof test equal to twice the working pressure is called for, or a pressure of 24.6 kgf/cm^2 (350 lbf/in^2), whichever is the greater. This compares with the German requirement of 1.43 times the working pressure (at 15°C), with minima of 20 kgf/cm^2 (284 lbf/in^2) for cartridge type extinguishers, and 15 kgf/cm^2 (213 lbf/in^2) for stored pressure extinguishers. In the German standard there are tests at an elevated temperature (70°C), but in the British standards such tests are only required for plastics-bodied water-type extinguishers and for vaporising liquid extinguishers (both at 60°C).

The German requirement for the burst test is that the extinguisher should withstand not less than twice the working pressure. In many cases the British standards require the extinguisher to withstand a pressure not less than twice the proof pressure (usually equivalent to 4 times the working pressure) or 49.2 kgf/cm^2 (700 lbf/in^2), whichever is the greater.

In the case of carbon dioxide extinguishers the British standards require them to be manufactured to British Standards 401, 1287, 1288, which cover seamless steel cylinders for the storage and transport of liquefiable gases (B.S.401) and carbon dioxide, nitrous oxide and ethylene (B.S.1287 and 1288).

Discharge tests

The British standards give the most comprehensive specifications for the discharge of the extinguishing agent, and are also the only ones which have a requirement for the discharge of a minimum percentage of the contents during the test (generally 85 or 95 per cent). The German standards have no

*The appropriate regulations are published in the Official Journal of the French Republic (Document No.63-85, May 1963).

specification for discharge performance and the French only specify minimum discharge times. Although the French standards describe a test procedure for determining the range or "throw" of the agent, they give no criteria of performance for acceptance.

For foam and water the British standards require a minimum throw of the agent (6.1 m (20 ft)), to be maintained for a minimum time, dependent on capacity, and also that the contents should be expelled within a specified maximum time. The French standards specify only minimum times for discharge, and these are very much less rigorous than those in the British standards. For carbon dioxide and dry powder extinguishers the British standards specify minimum and maximum discharge times, and for these agents the minima are comparable with the French. For vaporising liquid extinguishers the British standards lay down requirements for minimum range and duration where hand pump operation is used, but for gas container and stored-pressure types a minimum time of discharge is specified, broadly comparable with those of the French standards.

Fire tests

Class A fires. These tests are applicable to fires in the common cellulosic materials, and are generally carried out on burning wood in various configurations. There are no class A fire tests in any of the British standards, and in the case of water-type extinguishers this is a serious omission, since this type of fire will generally be most effectively fought with water.

The French standards for water-type extinguishers specify tests in which wood sticks are laid at random in "furnaces" consisting of wire mesh baskets in the shape of rectangular parallelepipeds. An extinguisher is required to put out the fire in a weight of wood appropriate to its size; the largest size range (10 to 25 l (2.2 to 5.5 gal)) is required to extinguish a fire in 34 kg (75 lb) of wood. The German standard, which applies to a 10 l (2.2 gal) size, requires the extinction of a fire in a wood crib, which contains approximately 39 kg (86 lb) of wood. The fires specified in both standards do not appear to be unduly severe in terms of the extinguisher capacity, and are considerably smaller than specified, for example, in the U.S. National Fire Protection Association Standards (10 and 10a) which have been adopted by the American Standards Association (No. Z 112.1).

For foam extinguishers the French standard specifies class A fire tests, and the fire sizes are similar to those required for water for similar extinguisher capacities.

There are no class A fire tests in any of the standards for carbon dioxide and vaporising liquids.

In the case of dry powder extinguishers there is no British fire test for class A fires, but the French standard has optional tests, and the German standard specifies tests for "all-purpose" powder, i.e. those which are claimed to be suitable for solid fuel fires. In general, the German crib fires contain a greater weight of wood than the French "furnace" fires, particularly for the larger extinguisher capacities. For example, the German wood crib for a 12 kg (26.4 lb) extinguisher, contains 97 kg (214 lb) of wood, compared with only 21 kg (46.4 lb) of wood in the French test for extinguishers in the range 6-11 kg (13.2 to 24.2 lb) of powder.

Class B fires. The tests are applicable to extinguishers which are suitable for extinguishing pool fires in flammable liquids, such as petrol, paraffin, fuel oils, etc..

For water type extinguishers there are no fire tests of this type in either the British or German standards, but the French standards include optional tests for extinguishers which discharge in the form of a spray. These tests are performed on petrol, paraffin or light fuel oil, with fires burning in circular trays. The size of fire (in terms of its surface area) increases with extinguisher capacity, up to a maximum of 1.07 m^2 (11.4 ft^2) for the 10-25 litre size range in petrol or paraffin, and a maximum of 2.79 m^2 (30 ft^2) for fires in light fuel oil.

For the foam type of extinguisher there is no British standard fire test which constitutes an important omission since this type of extinguisher is primarily intended for use against this class of fire. The French test is specified for petrol fires in trays of size appropriate to extinguisher capacity, up to a surface area of 1.07 m^2 for the 10-20 litre size.

There are tests for carbon dioxide extinguishers in the French and German standards, but not in the British. The French requirement for tray fires is more severe than the German, with a requirement ranging from 0.11 to 0.33 m^2/kg (0.54 to 1.61 ft^2/lb) compared with 0.07 m^2/kg (0.34 ft^2/lb), for petrol and benzene fires respectively. The German standard also includes a carburettor fire for the 1.5 kg (3.3 lb) size of extinguisher.

In the case of dry powder and vaporising liquid extinguishers, all three standards specify fire tests. In the French and British tests the fires are in petrol, and in the German standards in benzene. The French tests quote a specific fire size appropriate to a particular range of extinguisher sizes (e.g. 2-4 kg), which means that within a range, the size of fire which has to be extinguished, in terms of area per unit weight of agent, can vary by a factor of up to 2 to 1. Hence the smaller extinguishers in a range have a more exacting requirement than the larger sizes. For dry powder extinguishers the

British and German requirements are comparable, with a minimum extinguishing power of about 0.3 m^2/kg (1.46 ft^2/lb). In general the French requirements are roughly similar at the minimum of a range of extinguisher size, but the maxima are much more severe, with values as high as 0.82 m^2/kg (4 ft^2/lb). The vaporising liquid fire tests in the French and German standards are given in terms of extinguisher capacity in litres. To enable weight comparisons to be made with the British standard a liquid density of 1.83 has been assumed (bromochlorodifluoromethane (BCF) at 20°C). The German requirement is a minimum extinguishing power of 0.27 m^2/kg (1.32 ft^2/lb) compared with the British figure of 0.21 m^2/kg (1 ft^2/lb) (0.10 m^2/kg (0.5 ft^2/lb) for hand pump type). The French specification is generally less severe ranging from 0.11 to 0.27 m^2/kg (0.54 to 1.32 ft^2/lb).

The German standards also include carburettor fires for the 1 kg size of dry powder extinguisher, and for the 0.8 l vaporising liquid extinguisher.

Other types of fire

In addition to the fires discussed above, the French and German standards specify other types of fire test in some cases. These are of three types, liquefied petroleum gas flame, metal fires, and electrical fires. The British tests specify no fires of these types.

There is some confusion because of the fire classification method used. The continental practice is to specify a liquefied petroleum gas fire (e.g. natural gas or propane) as class C, light metal fires (e.g. aluminium, magnesium) as class D, and fires involving live electrical equipment as class E. In the United States and Great Britain a class C fire is one involving live electrical equipment, and class D fires are those involving combustible metals, including the alkali metals. In the discussion below the continental classification is used since only the continental standards include fires other than classes A and B.

Class C fires

This type of fire is specified for dry powder extinguishers in both the French and German standards, and for carbon dioxide in the German standards. In both cases the fire is a flame from liquefied natural gas or propane discharging from a pipe. In the French tests there is a blank flange at the end of the pipe which produces an annulus of flame at right angles to the pipe axis, representing leakage from a pipe flange.

Class D fires

This type of fire test is only specified in the German standard for dry powder extinguishers which are claimed to be suitable for metal fires. The test is performed on 2 kg (4.4 lb) of metal filings (consisting of at least 83-88 per cent magnesium), and applies to the 12 kg (26.4 lb) extinguisher size only.

Class E fires

This type of fire is specified in the French standards for water and dry powder extinguishers only. The test consists of discharging the extinguisher from a distance of 1 m (3.3 ft) on to a charged metal plate (at 50 kV a.c.). The requirement is that the current flow to earth should be not more than 0.5 mA, which compares with the generally accepted minimum of 1 mA for safe operation of fire-fighting equipment(1).

The German standards require tests for carbon dioxide, dry powder and vaporising liquid extinguishers. These tests are carried out by the Institute for High Voltage and Measuring Techniques at the Technical University, Darmstadt. It is stated that the Institute will set up appropriate tests and issue a test certificate, but no indication of the requirements for such a certificate is given in the standard.

6. Conclusions

(a) Range of tests required in a standard

The broad groupings of the tests required for extinguishers are given in Section 3, and the tests which are considered to be essential are discussed under these headings.

Fire tests

These tests are essential for all types of extinguisher in order to provide an assessment of the extinguishing capability of differing capacities.

Class A fires - these are essential for water and foam fires, and for "all purpose" dry powders. They may be specified on an optional basis for carbon dioxide and vaporising liquids. These are most conveniently specified as wood crib fires.

Class B fires - these are essential for foam, carbon dioxide, dry powders, and vaporising liquid extinguishers. They may be specified as optional for water extinguishers which have a spray discharge.

Class C fires (liquified petroleum gas) - tests on this type of fire would be useful for carbon dioxide and dry powders. In the case of vaporising liquids such a test would be appropriate where the boiling point is low enough to be able to fight the fire with the agent in its vapour phase.

Class D fires (metal fires) - tests on this type of fire are appropriate only for the special dry powders intended for the purpose.

Class E fires (electrical fires) - the use of water and foam extinguishers on this class of fire can be dangerous because of the electrical shock hazard[1]. There is information on the use of carbon dioxide, dry powder and vaporising liquid extinguishers[1] which indicates that there is no danger of shock providing the equipment is not approached too closely so that there is a risk of flashover or accidental contact. A simple test for this type of fire, however, may be useful to ensure that such types are safe in use against this class of fire.

Extinguisher body design tests

The purpose of these tests is to ensure that the extinguisher body is capable of withstanding the pressures developed within it during normal use. In addition other tests are necessary to examine, for example, the effect of abnormal conditions such as a blocked discharge nozzle, and to ensure that leakage of the contents does not occur. Tests which are considered necessary in a standard are:-

(1) Pressure tests - (a) a routine "proof" test during manufacture
(b) an ultimate strength or "burst" test
(c) a cycling pressure test

(2) Leakage test - probably by maintaining the proof pressure for a minimum time.

(3) Operation with blocked discharge nozzle.

(4) Operation with overfull body.

(5) Discharge hose and fittings test - proof and burst pressure tests.

(6) Corrosion test.

(7) Test of safety valve efficiency.

Extinguisher agent discharge tests

These tests are conducted to ensure that the agent is discharged over a distance which is practicable, and between time limits which give a rate of discharge which is likely to result in successful extinction of the fire. The type of tests considered necessary are:-

(1) Measurement of range of agent (where appropriate).

(2) Duration of discharge - for a minimum specified percentage of the contents.

(3) Reliable operation with interrupted discharge (where appropriate).

(4) Discharge with overfull body (where appropriate).

Environmental tests

These tests are necessary to make the extinguisher more reliable in use, and cover the kind of conditions which can arise in service.

(1) Vibration - important, for example, when extinguishers are mounted on vehicles or in ships.

(2) Impact.

(3) Weathering.

(4) Operation at high and low ambient temperatures.

(5) Effect of long term storage - e.g. at high and low ambient temperatures and under prolonged vibration.

Specification

These can include the following items:-

(1) Extinguishing agent materials - e.g. chemical composition, physical characteristics, pH value (where appropriate).

(2) Materials to be used for extinguisher bodies.

(3) Methods of construction.

(4) Method of marking.

Inspection procedure

There is a need for some form of inspection procedure so that the extinguisher will function when a fire incident arises. A periodic examination of all extinguishers should be carried out by trained inspectors at intervals of not more than say 2 years, to ensure that the extinguishers are kept in an operational condition.

(b) Comparison of British, French and German standards

Fire tests

The British standards contain no fire tests for water or foam, which is a serious omission. The French and German wood fire tests for these agents do not appear to be unduly severe. The French standard specifies a test for discharge against live electrical equipment for water extinguishers.

There is no British fire test for carbon dioxide. The French and German standards specify flammable liquid tray fires, of which the French is the more severe. The German standards also have a running carburettor fire and a liquefied petroleum gas fire and require a test certificate for electrical fires.

All three countries have flammable liquid tray fire tests for dry powder extinguishers. The French criteria are severe for the smaller extinguishers in a given range of sizes. The French and German standards also include wood fires and liquefied petroleum gas fires. The German standard has, in addition, a carburettor fire (for a small extinguisher) and a light metal (magnesium) fire for the appropriate types of powder. The French standards specify a test for fires involving live electrical equipment; and a test certificate for use on electrical equipment is required for the German standard.

Flammable liquid fire tests are specified by all three countries for vaporising liquid extinguishers. In general the French tests are the least severe and the German tests the most severe. The German standard requires a test certificate for the use of this type of extinguisher on electrical fires.

Extinguisher body

Pressure tests are required by all three countries. The French standard gives no reference to the regulations for pressure vessels which extinguishers must satisfy. The British proof and burst pressure tests are more severe than those of the German standard. In addition, the British standards are the only ones to require pressure tests on the discharge hose. No corrosion tests are specified in any of the standards, with the single exception of the British stored-pressure water-type extinguishers. All three countries include leakage tests.

Discharge tests

There is no specification for the discharge characteristics of extinguishers in the German standard. The British standards are the most comprehensive and specify minimum throw to be maintained for a minimum time (where appropriate) limits of discharge time, interrupted discharge tests, and minimum percentage of contents to be discharged. The French standard does not specify the throw required, and the minimum times of discharge are much less than the British for water and foam extinguishers.

Environmental tests

There are relatively few environmental tests in any of the standards. It would be useful to strengthen this aspect of extinguisher testing since it is important that the effects of the environment should not make it inoperative when required in the event of a fire. Only the French Standards specify tests for vibration, and only the British standards have a resistance to impact test. There are no tests which examine the effects of weathering, or the effect of long term storage at extremes of ambient temperatures or under conditions of prolonged vibration.

Specifications

The British standards lay down fairly detailed requirements for the materials to be used in extinguishers, and for the methods to be used in their construction. The French and German standards do not lay down specific requirements. All three countries have marking specifications including such items as contents of the extinguishers, directions for use, warning of possible dangers arising from its incorrect use, and re-charging instructions.

There are generally no specifications for the agent in the extinguisher, and it would be useful to specify chemical composition and physical properties both from the point of view of safety to the operator, and to ensure reliable functioning.

Inspection

Only the German standards have requirements for the periodic inspection of extinguishers to ensure that they are maintained in an operational condition.

7. Acknowledgments

Mr. P. F. Thorne and Mr. D. W. Fittes assisted in compiling the tabular summaries of the various standards.

8. References

1. O'Dogherty, M. J., The shock hazard associated with the extinction of fires involving electrical equipment, Fire Research Technical Paper No. 13, H.M.S.O., 1965.

Table 1 - Summary of requirements for water type extinguishers

Country	Promul-gating authority	Standard	Sizes covered	Vibration	Solid fire	Liquid fire	LPG fire	Dielectric	Throw	Discharge time	Quantity discharged	Interrupted discharge	Proof pressure	Burst pressure	Leakage	Pressure with blocked hose	Discharge with overfull body	Marking specification	Materials specification	Construction specification	Corrosion	High temperature	Weather	Contents specification	Inspection procedure	Hose	Impact	pH of contents	Low temperature
Great Britain	BSI	B.S. 138 : 1948 (soda-acid)	1 to 2½ gal (4.55 to 11.4 l)						x	x	x		x	x	x	x		x	x	x				x		x			
		B.S. 1382 : 1948 (gas pressure)	1 to 2½ gal						x	x	x		x	x	x	x		x	x	x						x			
		B.S. 3709 : 1964 (stored pressure)	1 to 2½ gal						x	x	x		x	x	x			x	x	x	x					x	x		
		Plastics-bodied (gas pressure) (draft)	1 to 2 gal (4.55 to 9.11)						x	x	x		x	x		x	x	x	x	x						x	x		
France	AFNOR	NF S 61-911 (soda-acid)	⩽1 l (0.22 gal)	x	x	x		x	x	x			x	x	x			x									x		
			1 to 3 l (0.22 to 0.66 gal)																										
			3 to 6 l (0.66 to 1.32 gal)																										
		NF S 61-912 (gas operated)	6 to 10 l (1.32 to 2.20 gal)	x	x	x		x	x	x			x	x	x			x											
			10 to 25 l (2.20 to 5.50 gal)																										
Germany	DNA	14 406 (1964) Sheet 1 and Sheet 2 (1964) (draft)	10 l (2.20 gal)		x								x	x	x			x							x				x

Table 2 - Summary of requirements for foam extinguishers

Country	Promul-gating authority	Standard	Sizes covered	Vibration	Solid fire	Liquid fire	LPG fire	Dielectric	Throw	Discharge time	Quantity discharged	Interrupted discharge	Proof pressure	Burst pressure	Leakage	Pressure with blocked hose	Discharge with overfull body	Marking specification	Materials specification	Construction specification	Corrosion	High temperature	Weather	Contents specification	Inspection procedure	Hose	Impact	pH of contents	Low temperature
Great Britain	BSI	B.S. 740 : Part 1 : 1948 (Foam type. Chemical)	1 to 2½ gal (4.55 to 11.4 l)						x	x	x		x	x	x	x		x	x	x								
		B.S. 740 : Part 2 : 1952 (Foam type. Gas pressure)	1 to 2½ gal						x	x	x		x	x	x	x		x	x	x						x		
France	AFNOR	NF S 61-910 (Oct. 1965) (Chemical and mechanical foam)	≤ 6 l (1.32 gal) 6 l (1.3) to 10 l (2.20 gal) 10 l (2.2) to 20 l (4.40 gal)	x	x	x			x	x			x	x				x										x	
Germany	No tests for foam extinguishers in latest issue of DIN 14406 (1964) but it is understood that another issue is in draft																											

Table 3 - Summary of requirements for carbon dioxide extinguishers

Country	Promul-gating Authority	Standard	Sizes covered	Vibration	Solid fire	Liquid fire	LPG fire	Dielectric	Throw	Discharge time	Quantity discharged	Interrupted discharge	Proof pressure	Burst pressure	Leakage	Discharge with blocked hose	Discharge with overfull body	Marking specification	Materials specification	Construction specification	Corrosion	High temperature	Weather	Contents specification	Inspection procedure	Hose	Impact	pH of contents	Low temperature
Great Britain	BSI	B.S. 3326 : 1960	2 to 15 lb (0.91 to 6.8 kg)							x	x	x	x	x	x			x	x	x						x			
France	AFNOR	NF S 61-914	≤ 2 kg (4.4 lb) 2 to 6 kg (4.4 to 13.2 lb)	x		x		x	x	x			x	x	x			x											
Germany	DNA	14 406 (1964) Sheets 1 and 2 (draft)	1.5 kg (3.3 lb) 6 kg (13.2 lb)			x	x	x					x	x	x			x							x				

Table 4 - Summary of requirements for dry powder extinguishers

Country	Promul-gating Authority	Standard	Sizes covered	Vibration	Solid fire	Liquid fire	LPG fire	Dielectric	Throw	Discharge time	Quantity discharged	Interrupted discharge	Proof pressure	Burst pressure	Leakage	Discharge with blocked hose	Discharge with overfull body	Marking specification	Materials specification	Construction specification	Corrosion	High temperature	Weather	Contents specification	Inspection procedure	Hose	Impact	pH of contents	Low temperature
Great Britain	BSI	B.S. 3465 (1962)	2 lb to 30 lb (0.91 to 13.6 kg)			x				x	x	x	x		x			x	x	x						x			
France	AFNOR	NF S 61-915 (1966)	0.5 kg to 11.0 kg (1.1 to 24.2 lb)	x	x	x	x	x	x	x			x	x	x			x				x							
Germany	DNA	DIN. 14 406 Sheet 1 (1964) and Sheet 2 (draft 1964)	6 kg (13.2 lb) and 12 kg (26.4 lb)		x	x	x	x	x				x	x				x								x			

Table 5 - Summary of requirements for vaporising liquid extinguishers

Country	Promul-gating authority	Standard	Sizes Covered	Vibration	Solid fire	Liquid fire	LPG fire	Dielectric	Throw	Discharge time	Quantity discharged	Interrupted discharge	Proof pressure	Burst pressure	Leakage	Discharge with blocked hose	Discharge with overfull body	Marking specification	Materials specification	Construction specification	Corrosion	High temperature	Weather	Contents specification	Inspection procedure	Hose	Impact	pH of contents	Low temperature
Great Britain	BSI	B.S. 1721 (1960) Revised draft of above (1966).	1 pt to 2 gal (CTC and CBM only). 1.5 lb (0.68 kg) to 25 lb (11.4 kg)			 x			x x	x x	x x	 x	x x	x x	x x			x x	x x	x x				x x		x x			
France	AFNOR	NF S 61-913 (1966)	Up to 5 litres (1.1 gal).	x		x	•		x	x			x	x	x			x						x					
Germany	DNA	DIN. 14 406 Sheet 1 (1964) and Sheet 2 (draft 1964)	0.8 l (1½ pt) and 2 l (3½ pt)			x		x	x				x	x				x							x				

Table 6 - Comparison of National Standard requirements for pressure, discharge and fire tests - water type extinguishers

Country	Standard	Promulgating authority	Sizes covered	Pressure tests	Discharge tests	Fire tests
France	NF S 61-911 (soda-acid) NF S 61-912 (gas operated) see also:- NF S 61-901 (General) NF S 61-902 (Fire tests) NF S 61-903 (Methods of test)	Association Francaise de Normalisation (AFNOR)	⩽ 1 l (0.22 gal) 1 l to 3 l (0.22 to 0.66 gal) 3 l to 6 l (0.66 to 1.32 gal) 6 l to 10 l (1.32 to 2.20 gal) 10 l to 25 l (2.20 to 5.50 gal)	As for those in regulations for pressure vessels. (No reference quoted).	Range - test procedure given but no criterion of performance. Duration - minimum value dependent on extinguisher capacity. ⩽3 kg : 6s 3-6 kg : 9s ⩾6 kg : 12s	Class A fires - solid stream or spray required to extinguish fires in quantities of wood appropriate to capacity up to 34 kg for capacity up to 25 l. Fire consists of loosely piled wood sticks contained in a wire basket. Class B fires - spray required to extinguish tray fires of surface area appropriate to capacity in petrol, paraffin or light fuel oils up to maximum areas of 1.07 m^2 and 2.79 m^2, for maximum sizes of extinguisher up to 25 l. Class E - 1 m sq plate at 50 kV a.c. Test with nozzle at 1 m from plate. Current to earth ⩽ 0.5 mA.
Germany	DIN. 14 406 (1964) (Sheet 1) and Sheet 2 (draft), May 1964	DNA	10 l (2.20 gal)	Proof test 1.1 x test pressure for 3 min to detect leaks or permanent deformation. Burst test 2 x test pressure minimum. Working pressure (P) defined as pressure developed with closed nozzle and pressure relief valve. At 70°C:- Test pressure ⩾ P At 15°C:- Test pressure ⩾ 1.3 P The test pressure must be at least 285 lbf/in^2 (20 kgf/cm^2) for cartridge operated extinguishers, and 213 lbf/in^2 (15 kgf/cm^2) for stored pressure extinguishers.	Non specified	Class A fire - wood crib 60 cm square x 52 cm high with 12 min preburn, with extinguisher at 5 m from fire. Extinction to be achieved with no re-ignition in 3 min. Sticks 4 cm x 4 cm x 60 cm - spacing 4 cm. Trough of petrol for ignition.

/Continued

Table 6 (Continued)

Country	Standard	Promulgating authority	Sizes covered	Pressure tests	Discharge tests	Fire tests
Great Britain	B.S. 138 : 1948 (soda-acid) B.S. 1382 : 1948 (gas pressure) B.S. 3709 : 1964 (stored pressure) Draft for portable plastics-bodied fire extinguishers of the water type (gas pressure)	B.S.I.	1 to $2\frac{1}{2}$ gal (4.55 to 11.4 l)	B.S. 138 and 1382 Proof test - 350 lbf/in^2 for 5 min period. Burst test - must withstand 455 lbf/in^2, and if below 500 lbf/in^2 shall not fail at joint, seam, casting or fitting. Hose test - up to 200 lbf/in^2. (Pressure container tests also specified in 1382 : 1948) B.S. 3709 Routine pressure test - 2 x working pressure or 350 lbf/in^2 whichever is greater. Burst test - not less than 2 x test pressure. Design approval Constant pressure 20°C - 2 x working pressure (150 lbf/in^2) for $\nless$ 30 min. 60°C - $1\frac{1}{4}$ x working pressure (185 lbf/in^2) for $\nless$ $2\frac{1}{2}$ min. Cycling test 20°C - 10,000 reversals to peak of 150 lbf/in^2. 40°C - 1,000 reversals to peak of 185 lbf/in^2.	Discharge shall be maintained at length of 20 ft for 40s for $< 1\frac{1}{2}$ gal capacity and 60s for $> 1\frac{1}{2}$ gal capacity. Maximum discharge period is 80s and 120s for capacities of $< 1\frac{1}{2}$ gal and $> 1\frac{1}{2}$ gal respectively. Not less than 95 per cent of contents shall be discharged. As for above except that max. discharge period is 100 s for capacities $> 1\frac{1}{2}$ gal	None

TABLE 7

Comparison of National Standard requirements for pressure, discharge and fire tests - foam extinguishers

COUNTRY	STANDARD	PROMULGATING AUTHORITY	SIZES COVERED	PRESSURE TESTS	DISCHARGE TESTS		FIRE TESTS	
					Capacity (kg)	Minimum discharge time (sec)	Class A. Wood fires. (Total weight of wood in crib)	Class B. Petrol fires. (Surface area of petrol)
FRANCE	NF S 61 - 910 Oct. 1965. (airfoam or chemical foam)	Association Francaise de Normalisation (AFNOR)	6 l (1.3 gal) 6 l to 10 l (1.3 to 2.2 gal) 10 l to 20 l (2.2 to 4.4 gal)	No limits given, but refers to official test or proof certificate for pressure vessels (no reference given)	≤ 3 3 to 6 ≥ 6 Average range is measured but no limits given.	6 9 12	13 kg (28.6 lb) 21 kg (46.2 lb) 34 kg (75.0 lb) Pieces of wood measuring 100 x 10 x 10 mm to 100 x 20 x 20 mm laid to form pyre.	40.8 dm^2 (4.4 ft^2) 65.9 dm^2 (7.1 ft^2) 106.7 dm^2 (11.5 ft^2) A 3 cm depth of petrol is used in fire tests irrespective of size of fire. Fuel: de-aromatised F essence (petrol) containing no additives.
GERMANY	No tests for foam extinguishers in latest (1964) issue of DIN 14406, but it is understood that another issue is in draft.							
GREAT BRITAIN	B.S. 740 : Pt. 2: 1952. Latest issue. Includes Amendment published Oct., 1960). (Mechanical air foam)	B.S.I.	1 to 2½ gal (4.55 to 11.4 l)	Proof test 350 lb f/in^2 for 5 min. period. Every extinguisher is tested to 350 lb lb f/in^2 for 2½ min. Burst test Must withstand 455 lb f/in^2, and if below 500 lb f/in^2 shall not fail at joint, seam, casting or fitting. Hose test pressure - up to 200 lb f/in^2.	Discharge shall be maintained at length of 20 ft for 20 s mm for ≤ 1½ gal capacity and 30 s mm for > 1½ gal capacity. Maximum discharge period 60 s mm and 90 s mm for ≤ 1½ gal and > 1½ gal capacity respectively. Not less than 95% of liquid contents must be discharged.		NONE	
	B.S. 740 : Pt. 2: 1948. (Latest issue. Includes Amendment published Nov., 1961).		1 to 2½ gal	Proof test 350 lb f/in^2 for 5 min. period. Every extinguisher is tested to 350 lb f/in^2 for 2½ min. Burst test Must withstand 455 lb f/in^2 and if below 500 lb f/in^2 shall not fail at joint, seam, casting or fitting.	As above. (Except condition given in last sentence)		NONE	

TABLE 8

Comparison of National Standard requirements for pressure, discharge and fire tests - carbon dioxide extinguishers

COUNTRY	STANDARD	PROMULGATING AUTHORITY	SIZES COVERED	PRESSURE TESTS	DISCHARGE TESTS	FIRE TESTS
FRANCE	NF S 61 - 914	A.F.N.O.R.	≤2 kg (4.4 lb) 2 to 6 kg (4.4 to 13.2 lb)	As for those in regulations for pressure vessels (no reference quoted)	Range Test procedure given but no criterion of performance. Minimum discharge time given as follows:- ≤ 3 kg : 6 s 3 to 6 kg : 9 s No maximum discharge times given	Class B fire - de-aromatised Pessence fires containing no additives Area of fires to be extinguished are:- (i) ≤ 2 kg capacity : 0.408 m^2 (ii) 2 to 6 kg " : 0.659 m^2
GERMANY	DIN 14406 (1964) Sheet 1 and Sheet 2 (Draft), May, 1964.	D.N.A.	1.5 kg (3.3 lb) 6 kg (13.2 lb)	Proof test 1.1 x test pressure for 3 min. to detect leaks or permanent deformation. Burst test 2 x test pressure minimum. Working pressure (P) defined as pressure developed with closed nozzle and pressure relief valve. At 70°C: Test pressure ≥ P. At 15°C. Test pressure ≥ 1.3 P. The test pressure must be at least 285 lb f/in^2 (20 kg f/cm^2) for cartridge operated extinguishers, and 213 lb f/in^2 (15 kg f/cm^2) for stored pressure extinguishers.	None specified	Class B fires. (a) 1.5 kg - carburettor fire plus ground fire with 30 s preburn. (b) 6 kg - 4 l benzene fire of 0.42 m^2 area 30 s preburn with extinguisher at 3 m initially. Class C fire. Propane gas flame, with extinguisher ≤ 1 m away at 90° to flame. Class E fire. Test for conductivity by Technical University, Darmstadt.
GREAT BRITAIN	B.S. 3326 : 1960	B.S.I.	2 to 15 lb (0.91 to 6.8 kg)	Manufactured to B.S. 401, 1287, and 1288.	At angle of 45° and between 60 and 65°F. shall expel ≥ 95% of contents within specified times depending on capacity. Size — Min. — Max. 2 to 4 lb — 8 — 16 4 to 7 lb — 8 — 18 7 to 10 lb — 10 — 20 10 to 13 lb — 10 — 24 13 to 15 lb — 10 — 30	None

TABLE 9

Comparison of National Standard requirements for pressure, discharge and fire tests - dry powder extinguishers

COUNTRY	STANDARD	PROMULGATING AUTHORITY	SIZES COVERED	PRESSURE TESTS	DISCHARGE TESTS	FIRE TESTS
FRANCE	NF S 61 - 915 (1966) See also NF S 61 - 901 NF S 61 - 902 NF S 61 - 903	A.F.N.O.R.	0.5 to 11 kg (1.1 to 24.2 lb)	As for those in regulations for pressure vessels (no reference quoted)	Range Method given but no limits specified Discharge times Up to 3 Kg (6.6 lb) at least 6 seconds 3 Kg to 6 Kg (13.2 lb) at least 9 seconds More than 6 Kg at least 12 seconds	Class A (optional). Loosely piled wood in wire basket - range of sizes according to capacity up to 21 kg wood for extinguishers in range 6 - 11 kg. Class B. Petrol fires in circular trays, size dependent on extinguisher capacity. Requirement ranges from 0.27 to 0.82 m^2 of fire area per kg of powder. Class C. (optional). 8 cm diameter pipe with natural gas or propane at 220 l/s at flange annulus - 20 s preburn. Class E. 1 m sq plate at 50 kv a.c. Test with nozzle at 1 m from plate. Current to earth $\not>$ 0.5 mA.
GERMANY	DIN 14406 (1964) Sheet 1 and Sheet 2 (Draft), May, 1964.	D.N.A.	1 kg, 6 kg & 12 kg (2.2, 13.2, 26.4 lb)	Proof test 3 min. test at 1.1 x Test Press. Test Press. defined as:- $\not$ Press. at 70°C)$\not$ $\not$ 1.3 x Press. at 15°C)$\not$ $\not$ developed with closed nozzle and pressure relief valve. BUT Must be at least 285 lbf/in^2 (20 kgf/cm^2) for cartridge operated appliances, or at least 213 lbf/in^2 (15 kgf/cm^2) for others. Works certificate accepted in lieu. Burst test Bursting pressure $\geqslant$ 2 x Test Press.	None specified	Class A (all-purpose powder) 1 kg - wood crib, 30 cm sq., 28 cm high- 5.5 kg wood 6 kg - " " , 60 " " , 52 " " -39.0 kg wood 12 kg - " " , 90 " " , 60 " " -97.0 kg wood 12 minutes preburn. Extinction at 5 m (except at 1 kg size when arbitrary) no reignition within 3 minutes. Class B. Benzene tray fire, 30 s preburn 6 kg : 1.68 m^2 fire area 12 kg : 4 m^2 fire area Extinguisher at 3 m initially. Also a carburettor fire for 1 kg size as for carbon dioxide Class C. Propane gas flame with extinguisher $\not<$ 1 m away at 90° to flame. For 6 and 12 kg sizes extinction must be achieved 2 and 4 times respectively Class D (metal fire powder). 2 kg filings ($\not<$ 83-88% Mg) in tray. Extinguish so that some filings remain unburnt (12 kg size only). Class E. Test for conductivity by Technical University, Darmstadt.
GREAT BRITAIN	B.S. 3465 (1962)	B.S.I.	2 to 30 lb (0.91 to 13.6 kg)	Proof test 2.5 min. test at twice working pressure or 350 lb/in^2, whichever is greater. Burst test No test specified but extinguisher must be constructed to withstand twice the "test" pressure or 700 lb f/in^2 whichever is greater.	No throw is specified Discharge times 85% must be discharged at 60°F - 70°F (16°C - 21°C) in the following times:- 2 - 6.9 lb : 8 - 15 secs 7 - 11.9 lb : 10 - 15 secs 12 - 19.9 lb : 10 - 20 secs 20 - 30 lb : 10 - 30 secs	Petrol fire in tray - 2 pts/ft^2 Extinguish not less than 1½ ft^2/lb of powder (0.307 m^2/kg)

TABLE 10

Comparison of National Standard requirements for pressure, discharge and fire tests - vapourizing liquid extinguishers

COUNTRY	STANDARD	PROMULGATING AUTHORITY	SIZES COVERED	PRESSURE TESTS	DISCHARGE TESTS	FIRE TESTS
FRANCE	NF S 61 - 913 (1966) See also NF S 61 - 901 NF S 61 - 902 NF S 61 - 903	A.F.N.O.R.	Up to 5 l (1.1 gal)	As for those in regulations for pressure vessels (no reference quoted)	Range Method given but no limits specified Discharge times Up to 3 kg (6.6 lb) : at least 6 seconds 3 kg to 6 kg (13.2 lb) : at least 9 seconds More than 6 kg : at least 12 seconds	Class B. Petrol fires in circular trays - size dependent on extinguisher capacity. Requirement ranges from 0.11 to 0.27 m^2/kg (taking vapourizing liquid density as 1.83 g/cm^3)
GERMANY	DIN 14406 (1964) Sheet 1 and Sheet 2 (Draft), May, 1964.	D.N.A.	0,8 and 2 l	Proof test 3 min. test at 1.1 x test pressure. Test pressure defined as:- ⩾ Press. at 70°C ⩾ 1.3 x Press. at 15°C) developed with closed nozzle and pressure relief valve. BUT must be at least 285 lb f/in^2 (20 kg f/cm^2) for cartridge operated appliances or 213 lb f/in^2 (15 kg f/cm^2) for others. Works certificate accepted in lieu. Burst test Bursting pressure ⩾ 2 x Test Pressure.	None specified	Class B. 0.8 l size. Carburettor fire plus ground fire with 30 s preburn. 2 l size. Benzene tray fire area 1 m^2 - 30 s preburn. Extinguisher held at 3 m initially. (0.274 m^2/kg taking vapourizing liquid density as 1.83 g/cm^3). Class E. Test for conductivity by Technical University, Darmstadt.
GREAT BRITAIN	B.S. 1721 (1960) Revised draft 1966	B.S.I.	1 pt to 2 gal (CTC and CBM) (0.57 to 9.1 l) 1.5 to 25 lb (0.68 to 11.4 kg)	Proof test Steel + Al: 2 x working Press. at 15°C 1.5 x working Press. at 60°C 350 lb f/in^2 whichever is greatest Copper: 1.5 x working Press. at 15°C 1.125 x working Press. at 60°C 350 lb f/in^2 whichever is greatest 2.5 min. test. Burst test Steel + Al: 4 x test pressure Copper: 4 x working pressure at 15°C or 700 lb f/in^2 whichever is greater.	Range Hand pump type - 20 ft for not less than 25 s. No requirement for other types. Discharge times Hand pump: 95% in not more than 50 secs. Others: 95% in not less than 10 secs. 60°F - 65°F (16°C - 18°C)	Class B. Petrol fire in tray - 2 pts/ft^2, 30 s preburn. Hand pump type : not less than 1 ft^2/2 lb liquid Other types : not less than 1 ft^2/1 lb liquid.