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Fixed fire protection systems – Industrial and commercial watermist systems

Part 6: Fire performance tests and requirements for watermist systems for the protection of industrial oil cookers

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Summary of pages

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Foreword

Publishing information

This part of BS 8489 is published by BSI Standards Limited, under licence from The British Standards Institution, and came into effect on 31 May 2016. It was prepared by Subcommittee FSH/18/5, *Watermist systems*, under the authority of Technical Committee FSH/18, *Fixed fire fighting systems*. A list of organizations represented on these committees can be obtained on request to their secretary.

Supersession

This part of BS 8489 supersedes DD 8489-6:2011, which is withdrawn.

Relationship with other publications

BS 8489 is published in a series of parts:

- Part 1: *Code of practice for design and installation*;
- Part 4: *Tests and requirements for watermist systems for local applications involving flammable liquid fires*;
- Part 5: *Tests and requirements for watermist systems for the protection of combustion turbines and machinery spaces with volumes up to and including 80 m^3*;
- Part 6: *Tests and requirements for watermist systems for the protection of industrial oil cookers*;
- Part 7: *Tests and requirements for watermist systems for the protection of low hazard occupancies*.

BS 8489-6 is intended to be read in conjunction with BS 8489-1.

Information about this document

This document converts DD 8489-6 into a full British Standard.

Third-party testing/certification. Users of this British Standard are advised to consider the desirability of third-party testing/certification of conformity with this British Standard.

Use of this document

This British Standard is intended for use by manufacturers, designers and installers of watermist systems, and for authorities having jurisdiction.

It has been assumed in the preparation of this British Standard that the execution of its provisions will be entrusted to appropriately qualified and experienced people, for whose use it has been produced.

Presentational conventions

The provisions of this standard are presented in roman (i.e. upright) type. Its methods are expressed as a set of instructions, a description, or in sentences in which the principal auxiliary verb is "shall". Its requirements are expressed in sentences in which the principal auxiliary verb is "shall".

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

Where words have alternative spellings, the preferred spelling of the Shorter Oxford English Dictionary is used (e.g. "organization" rather than "organisation").

Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

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0 Introduction

Industrial oil cookers are typically non-insulated conveyorized fryers, or occasional batch kettles, used in food processing plants for chicken, fish, potato products (e.g. fries/chips), doughnuts and many other food products. These cookers are extremely different in size, configuration and construction from standard kitchen or restaurant oil cookers or fryers, and require a different type of extinguishment system.

Industrial oil cookers normally have large cooking surfaces; from 4.6 square metres to several hundred square metres. They contain from a few hundred litres up to approximately 18 900 litres of cooking oil. Industrial oil cookers (except for some batch kettles) typically have moveable covers, or hoods, that can be hydraulically operated. The hood is generally in a closed position in a normal operation period; however, the hood might be open from time to time as part of a routine maintenance. There are also exhaust stacks connected on top of the hood.

The most severe fire incident involving industrial oil cookers is a fire caused by overheating the cooking oil until it reaches its auto-ignition temperature (AIT). Even though installing an interlocking system to prevent the oil from reaching its AIT is a normal practice in the industry, an AIT fire can happen as a result of a system malfunction or simple human error. Thus, all the performance tests proposed in this part of BS 8489 require extinguishment of an AIT fire. The AIT fire is particularly challenging because of its rapid spread of flame over the oil surface and its difficulty in extinguishment, as it requires flame extinction over the entire surface with simultaneous rapid cooling to prevent re-ignition. Exhaust air fans need to be interlocked to shut down automatically upon fire detection or operation of the watermist system.

Whilst this fire test protocol specifically relates to the oil cooker itself, the overall oil cooker watermist fire protection system is also expected to provide protection of the adjacent conveyors, fines boxes and exhaust air duct (see Figure 1).

1 Scope

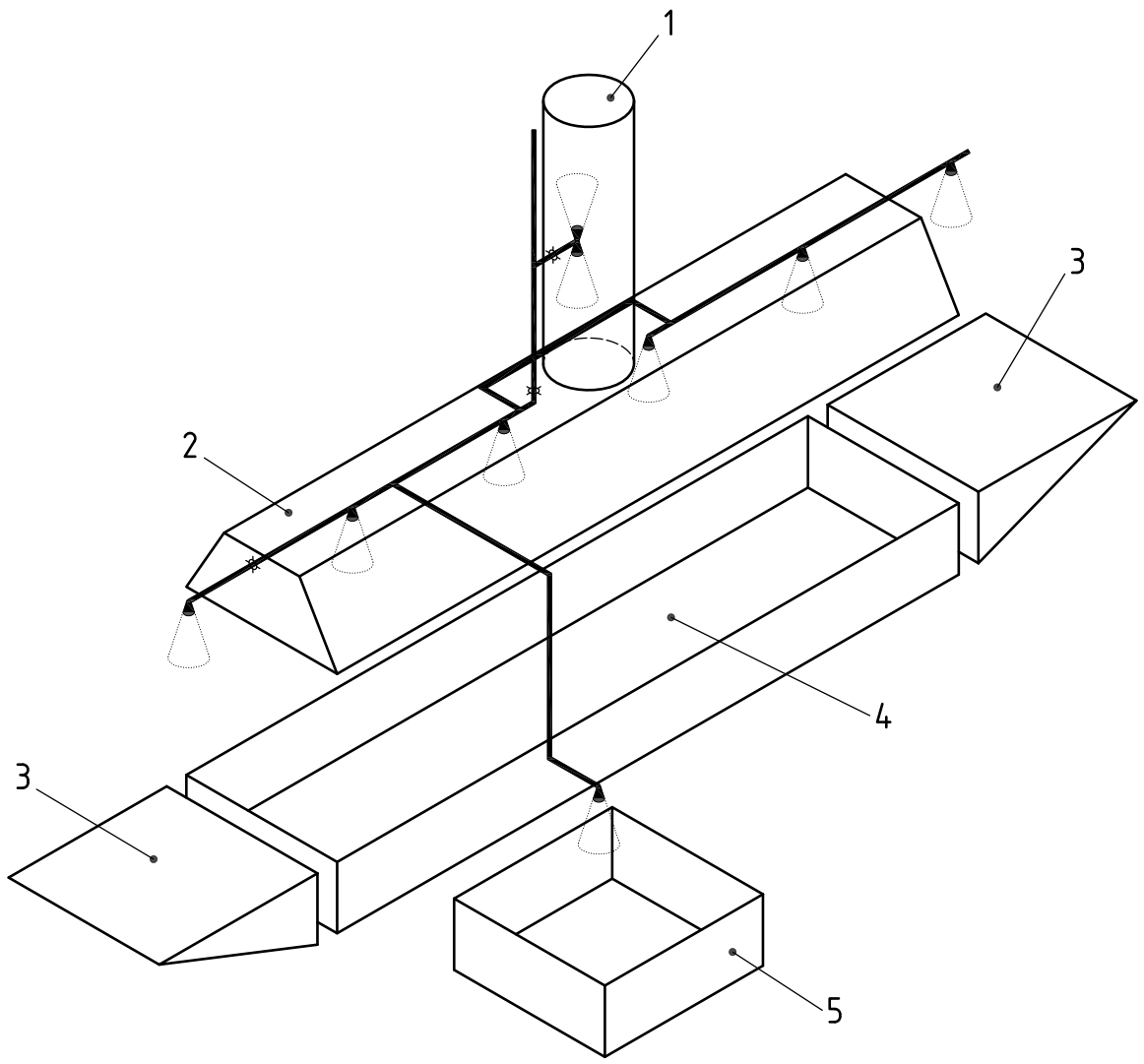
This part of BS 8489 describes tests and specifies requirements for industrial and commercial watermist systems for the protection of industrial oil cookers.

This part of BS 8489 does not cover external conveyors, fines boxes, oil transfer equipment or supplementary exhaust duct protection.

The tests and requirements given in this part of BS 8489 apply only to the specific fire scenarios described, i.e. with no obstructions between the watermist nozzles and the oil surface when the hood is in either the raised or lowered position. Configurations with obstructions are not covered in this part of BS 8489.

This part of BS 8489 is applicable to the protection of the industrial oil cookers only, and does not include the protection of other equipment such as exhaust ducts, heaters, heat exchangers and food processing areas.

Figure 1 **Diagrammatic arrangement of watermist fire protection for industrial oil cookers**



Key

1 Stack
2 Hood
3 Conveyor
4 Oil bath
5 Fines box

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS 8489-1, *Fixed fire protection systems – Industrial and commercial watermist systems – Part 1: Code of practice for design and installation*

BS EN ISO/IEC 17025:2005, *General requirements for the competence of testing and calibration laboratories*

3 Terms and definitions

For the purposes of this part of BS 8489, the terms and definitions given in BS 8489-1 apply.

4 Apparatus

NOTE Unless otherwise stated, the following tolerances apply:

- *length: ±2%;*
- *volume: ±5%;*
- *pressure: ±3%;*
- *temperature: ±5%.*

4.1 *Test hall* of appropriate size to accommodate the largest test rig (**4.4**), with natural or minimal ventilation that will not interfere with the fire testing within the enclosure or test rig.

NOTE Since exhaust air fans are required to be interlocked with the detection system to shut down the ventilation, and given the expectation that a watermist system might not prevent a fire from entering the exhaust duct if the fans remain on, power ventilated exhaust tests are not conducted as part of this part of BS 8489.

4.2 *Industrial oil cooker test rig A*, fabricated from nominal 11 mm thick steel and comprising a pan and a hood, conforming to Figure 2. The inside dimensions of the pan shall be X mm wide × Y mm long × 345 mm deep, where X and Y are specified by the watermist system manufacturer, and $Y \geq X$. The inside dimensions of the hood shall be (X + 50) mm wide × (Y + 50) mm long × 760 mm deep. Both ends of the hood shall be open. There shall be a 510 mm diameter vent on top of the hood simulating the exhaust duct. The distance from the centreline of the vent to either end of the hood shall be (Y/2 + 25.4) mm. Legs shall be attached along the length of the hood so that the hood position can be adjusted vertically before each test. Thermocouples (**4.6**) shall be placed inside the pan as shown in Figure 2. Several evenly spaced gas burners (see Note) shall be placed under the pan, to heat the oil to its auto-ignition temperature.

NOTE The number of gas burners is immaterial, provided that they are evenly spaced and that the oil reaches auto-ignition temperature.

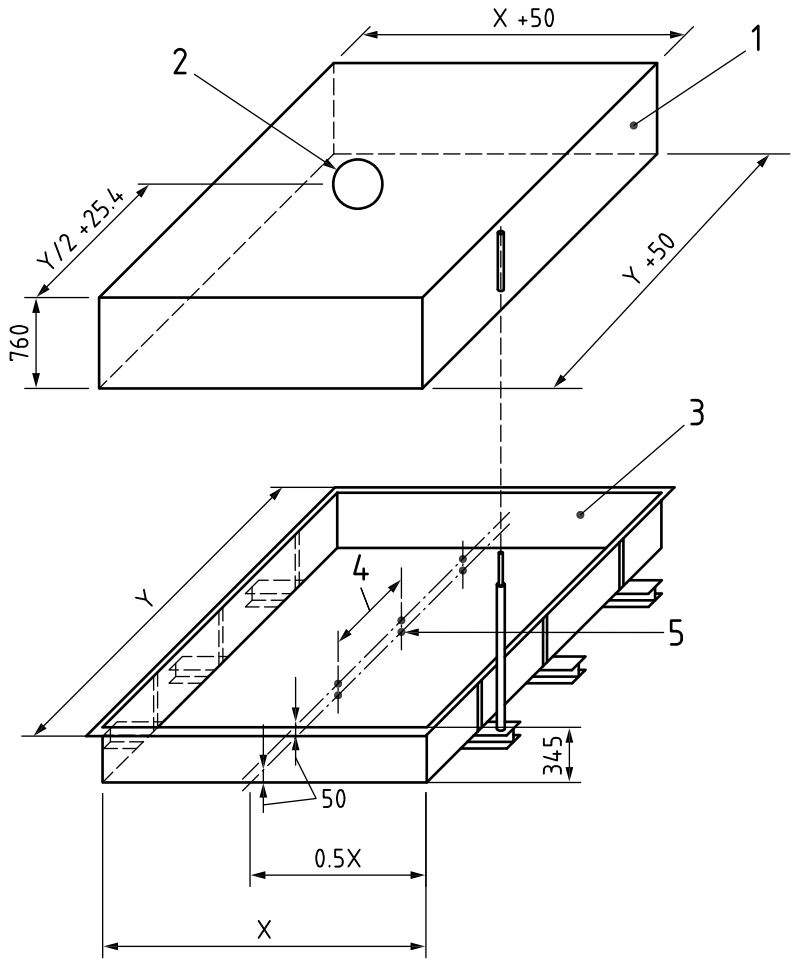
4.3 *Industrial oil cooker test rig B*, fabricated from nominal 11 mm thick steel and comprising a pan and a hood, conforming to Figure 3. The inside dimensions of the pan shall be X mm wide × 2Y mm long × 345 mm deep, where X and Y are specified by the watermist system manufacturer, and $Y \geq X$. The inside dimensions of the hood shall be (X + 50) mm wide × (2Y + 50) mm long × 760 mm deep. Both ends of the hood shall be open. There shall be two 510 mm diameter vents on top of the hood simulating the exhaust ducts. The distance from the centreline of the vents to the closest respective end of the hood shall be (0.7Y + 20) mm. Legs shall be attached, and gas burners supplied, as specified in **4.2**. Thermocouples (**4.6**) shall be placed inside the pan as shown in Figure 3.

4.4 *Industrial oil cooker test rig C*, fabricated from nominal 11 mm thick steel and comprising a pan and a hood, conforming to Figure 4. The inside dimensions of the pan shall be X mm wide × 3Y mm long × 345 mm deep, where X and Y are specified by the watermist system manufacturer, and $Y \geq X$. The inside dimensions of the hood shall be (X + 50) mm wide, (3Y + 50) mm long and 760 mm deep. Both ends of the hood shall be open. There shall be three 510 mm diameter holes on top of the hood simulating the exhaust ducts. The distance between the centreline of the vents shall be (0.75Y + 12.5) mm,

and the distance from the centreline of the two vents closest to the ends of the hood shall be (0.75*Y* + 12.5) mm to the closest respective end of the hood. Legs shall be attached, and gas burners supplied, as specified in **4.2**. Thermocouples (**4.6**) shall be placed inside the pan as shown in Figure 3.

Figure 2 **Configuration of test rig A**

All dimensions are in millimetres and are inside dimensions. Drawing is not to scale.

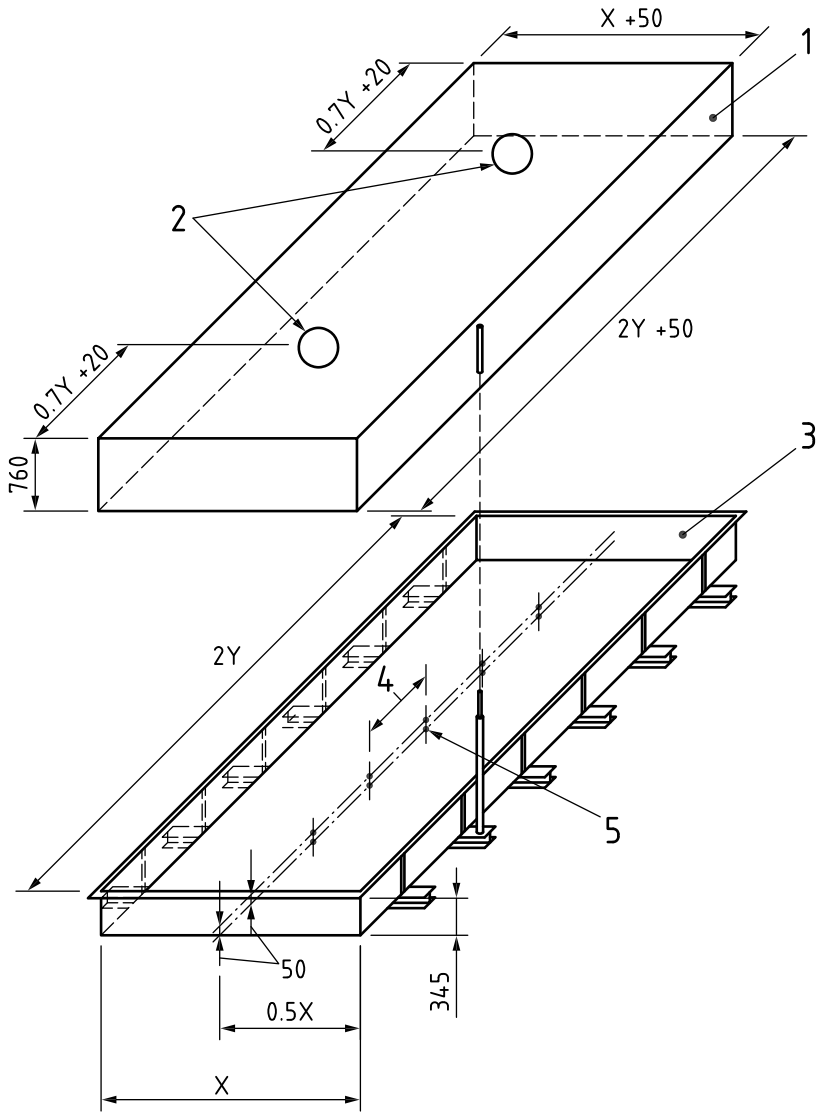


Key

1 Hood
2 Vent, 510 mm diameter
3 Pan
4 Distance between thermocouples, 610 mm (typical)
5 Thermocouples
X Dimensions as specified by the manufacturer (see **4.2**)
Y Dimensions as specified by the manufacturer (see **4.2**)

Figure 3 **Configuration of test rig B**

All dimensions are in millimetres and are inside dimensions. Drawing is not to scale.

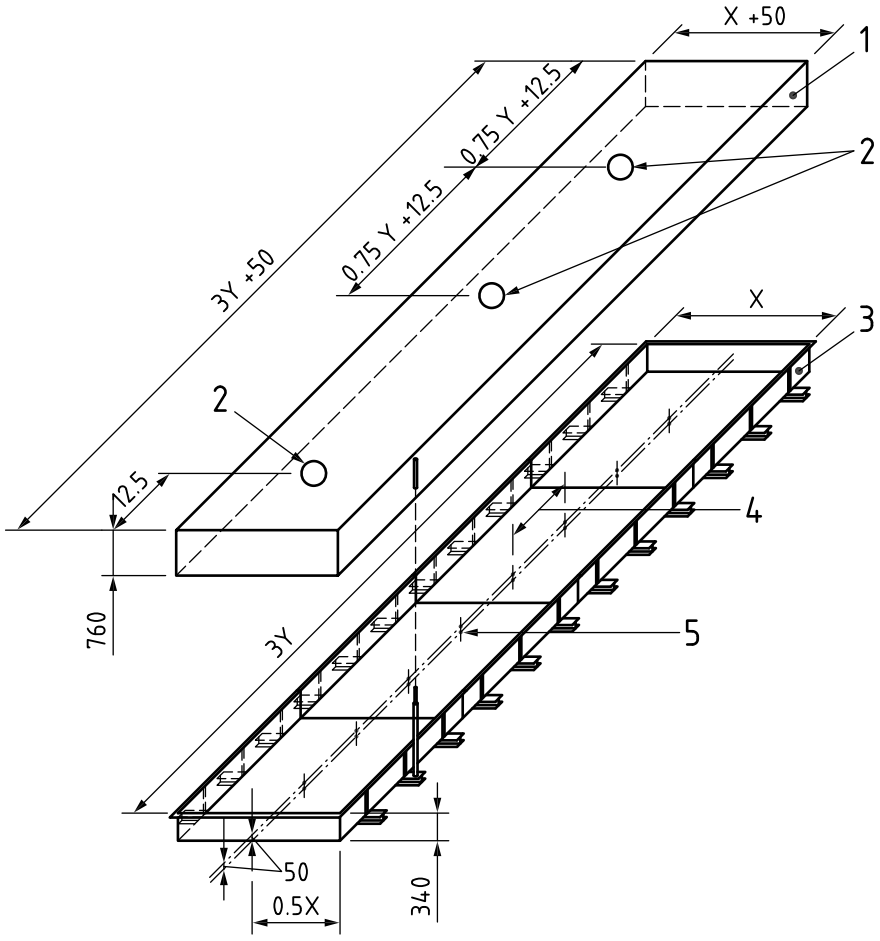


Key

1 Hood
2 Vent, 510 mm diameter
3 Pan
4 Distance between thermocouples, 610 mm (typical)
5 Thermocouples
X Dimensions as specified by the manufacturer (see **4.3**)
Y Dimensions as specified by the manufacturer (see **4.3**)

Figure 4 **Configuration of test rig C**

All dimensions are in millimetres and are inside dimensions. Drawing is not to scale.



Key

1 Hood
2 Vent, 510 mm diameter
3 Pan
4 Distance between thermocouples, 610 mm (typical)
5 Thermocouples
X Dimensions as specified by the manufacturer (see **4.4**)
Y Dimensions as specified by the manufacturer (see **4.4**)

4.5 *Cooking oil*, as specified by the manufacturer, based on the manufacturer's intended application for protection.

NOTE Commonly used cooking oils are listed in Annex A.

4.6 *Thermocouples*, placed inside the pan to measure oil temperatures. One row of thermocouples shall be located 50 mm above the bottom of the industrial oil cooker test rig, and a second row shall be located 100 mm above the bottom of the test rig. The thermocouples shall be placed along the centreline of the test rig at 610 mm intervals, starting 610 mm from the end of the test rig.

4.7 *Instrumentation*, to measure and record the following parameters, as appropriate to the type of test:

a) temperature of fuel in pools;

b) test enclosure temperatures;

c) pool fire flame temperatures;

d) extinguishing agent flow and pressure in the extinguishing system;

e) water supply pressure (including tank pressure if applicable) and nozzle discharge pressures;

f) extinguishing agent pressure at the most remote nozzle branch line;

g) gas pressure at its storage outlet and distribution sources;

h) consumption of foam concentrate or other additive, recorded by means of a load cell on which the concentrate/additive tank is placed during the tests;

i) gas consumption, measured by means of pressure or load cell on which the gas tank is placed during the tests, or mass flow measurement.

4.8 *Additional baffles or obstructions*, if needed, to prevent the direct impact of mist on the fire.

4.9 *Stopwatch*.

5 Test conditions

5.1 The minimum operating nozzle pressure (as specified by the manufacturer) shall be used for all tests. System operating pressures shall be maintained to within ±5%. For decaying pressure systems, the starting pressure shall be within ±5% of the manufacturer's designated starting pressure. For systems designed to cycle between two pressure limits, both the higher and lower pressures shall be within ±5% of the manufacturer's designated pressures, and the periods pertaining to the higher and lower pressure in each cycle shall be within ±3 s of the manufacturer's designated duration.

5.2 The nozzles shall be placed inside or outside the industrial oil cooker and shall be located in accordance with the watermist manufacturer's design manual.

5.3 Where nozzle protection caps are used to prevent or reduce the amount of nozzle contamination, the use of such caps shall be included in the test.

5.4 The nozzle arrangement shall have uniform spacing. The nozzle spacing from the wall shall be uniform.

NOTE The nozzle spacing from the wall should preferably be one-half the main spacing.

5.5 For all fire tests, the ceiling, floor and walls shall be dry. The relative humidity in the test enclosure prior to the start of the test shall not differ from that of the ambient relative humidity by more than 20%.

5.6 All fuels shall be at an ambient temperature of (20 ±10) °C, measured with the thermocouple located in the approximate centre of the initial fuel layer.

5.7 The test hall shall have an ambient temperature of (20 ±10) °C prior to the start of the test, measured in the central area of the test hall at one-third, two-thirds and ceiling heights. The test hall shall be at as uniform an ambient temperature as reasonably practicable, with no localized hot or cold spots. All non-fire-induced draughts shall be eliminated.

5.8 The extinguishing agent flow and pressure in the extinguishing system shall be measured continuously on the high pressure side of the pump, cylinder or equivalent equipment.

5.9 The water supply and nozzle discharge pressures shall be monitored at the source (pump and/or cylinder) and at the distribution piping manifold.

6 Principle

The industrial oil cooker test comprises three stages, each of which uses a different size test rig (**4.2**, **4.3** and **4.4**). At each stage, there are two tests; one to evaluate the fire extinguishment and cooling performance with the hood down and one with the hood up. The watermist system needs to pass all six tests.

7 Procedure

7.1 The tests shall be performed in the following order. Each individual test shall be successfully completed, according to the pass criteria specified in Clause **8**, before the next test is performed.

a) *Test rig A with hood up*. The bottom of the lip of the hood of test rig A (**4.2**) shall be positioned 455 mm above the top of the pan of the test rig (see Figure 5).

b) *Test rig A with hood down*. The bottom of the lip of the hood of test rig A (**4.2**) shall be positioned 50 mm above the top of the pan of the test rig (see Figure 5).

c) *Test rig B with hood up*. The bottom of the lip of the hood of test rig B (**4.3**) shall be positioned 455 mm above the top of the pan of the test rig (see Figure 5).

d) *Test rig B with hood down*. The bottom of the lip of the hood of test rig B (**4.3**) shall be positioned 50 mm above the top of the pan of the test rig (see Figure 5).

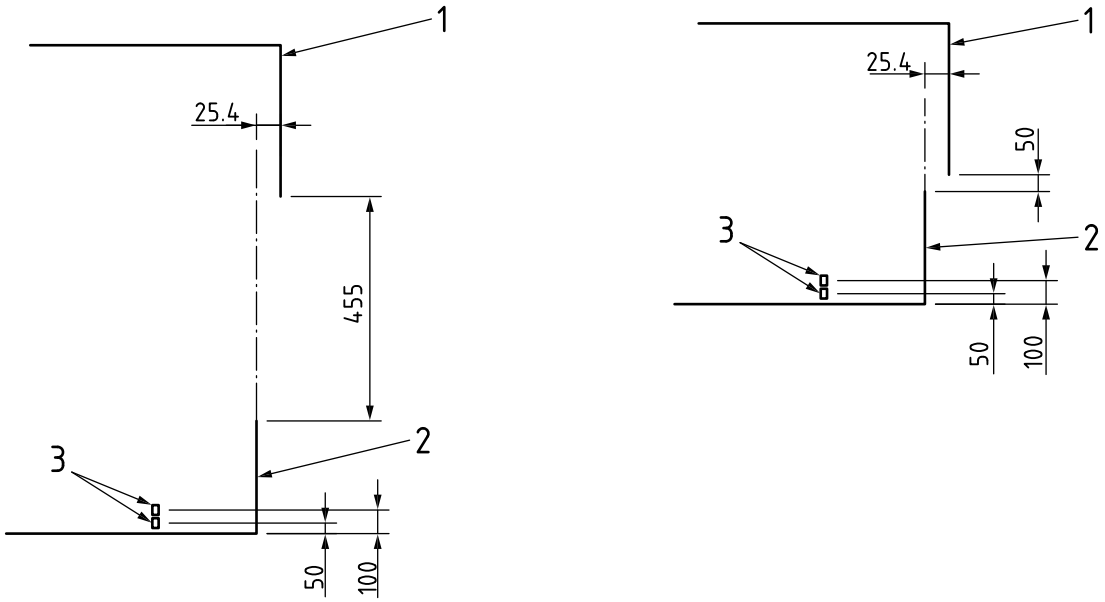
e) *Test rig C with hood up*. The bottom of the lip of the hood of test rig C (**4.4**) shall be positioned 455 mm above the top of the pan of the test rig (see Figure 5).

f) *Test rig C with hood down*. The bottom of the lip of the hood of test rig C (**4.4**) shall be positioned 50 mm above the top of the pan of the test rig (see Figure 5).

7.2 At the start of each test, the oil inside the pan shall be heated to its auto-ignition temperature by the gas burners under the pan. At the end of each test, the burned oil shall be completely drained, and fresh oil used for the next test. The depth of the oil for each test shall be 125 mm (216 mm freeboard).

Figure 5 **Hood positions**

All dimensions are in millimetres. Drawings are not to scale.



a) Hood up position

b) Hood down position

Key

1 Hood

2 Pan

3 Thermocouples (typical)

7.3 For each test, once the oil temperatures inside the pan indicate that the oil has reached its auto-ignition temperature (at all thermocouple locations) and the oil surface is completely involved in orange/yellow flame, the gas burners shall be shut off. The watermist system shall be activated manually 30 s after shutting off the gas burners.

7.4 For watermist systems designed to operate at constant pressures, the system pressures shall be automatically controlled by the watermist system to within ±5%. If the system pressures cannot be controlled within the specified tolerance, the tests shall be conducted at both the minimum and the maximum pressures for each test by using external means to control the system pressure.
For watermist systems designed to operate with decaying pressures, the starting pressures shall be within ±5% of the designated starting pressures.
For watermist systems designed to cycle between two pressure limits, both the higher and lower pressures shall be within ±5% of their respective designated pressures, and the periods pertaining to the higher and lower pressure in each cycle shall be within ±3 s of their designated durations.

7.5 The tests shall be conducted for 30 min (unless otherwise specified) or until the fire is extinguished or the length of time to discharge 50% of the water agent, whichever is shorter.

NOTE There is no minimum extinguishing agent discharge time.

7.6 The following times shall be recorded during testing:

a) start of ignition procedure;

b) start of test fuel ignition;

c) time when the extinguishing system is activated with watermist discharging from the nozzles;

d) time when the fire(s) is extinguished;

NOTE Use of a thermal imaging camera is recommended.

e) time when the extinguishing system is shut off;

f) time when the test is finished.

7.7 The following parameters shall be recorded during testing:

a) temperature of test enclosure;

b) temperature of fuel in pool fires;

c) temperature of flame above the fuel after auto-ignition;

d) extinguishing agent flow and pressure in the extinguishing system;

e) water supply pressure (including tank pressure if applicable) and nozzle discharge pressure;

f) extinguishing agent pressure at the most remote nozzle branch line;

g) gas pressure at its storage outlet and distribution sources;

h) consumption of foam concentrate or other additive;

i) gas consumption.

7.8 The results of the test shall be documented in a test report prepared in accordance with BS EN ISO/IEC 17025:2005, **5.10**. The test report shall contain at least the following information:

a) a title;

b) the name and address of the laboratory, and the location where the tests were carried out, if different from the address of the laboratory;

c) unique identification of the test report (such as the serial number), an identification on each page in order to ensure that the page is recognized as a part of the test report, and a clear identification of the end of the test report;

d) the name and address of the client;

e) a description of the method used, including details of the test apparatus and a reference to the standard against which the system was tested, i.e. BS 8489-6;

f) a description of, the condition of, and unambiguous identification of the item(s) tested;

g) the date of receipt of the test item(s) where this is critical to the validity and application of the results, and the date(s) of performance of the test;

h) reference to the sampling plan and procedures used by the laboratory or other bodies where these are relevant to the validity or application of the results;

i) the test results, with units of measurement where appropriate, including the percentage of any damage to the system components, test rig, or test enclosure, together with the times and parameters recorded during each test;

j) a statement of compliance/non-compliance with the pass/fail criteria specified in Clause **8**;

k) confirmation of system design parameters relevant to the specific application, including, but not limited to, the following:

   1) the extinguishing time, system duration and discharge duration;

   2) nozzle designation;

   3) permitted location in the protected volume;

   4) minimum and maximum installation height limitation;

   5) maximum dimensional and area coverage, including spacing between the nozzles;

   6) operating flow rates of the nozzle;

   7) distance between the ceiling and nozzle orifice;

   8) maximum and minimum design pressure over the duration of the test;

   9) type of detection/actuation method;

   10) additives, propellants and atomizing media used;

   11) details of the test hall geometry;

   12) ventilation conditions during the test;

   13) environmental conditions during the test;

l) the name(s), function(s) and signature(s) or equivalent identification of person(s) authorizing the test report;

m) where relevant, a statement to the effect that the results relate only to the items tested.

8 Pass/fail criteria

When tested in accordance with Clause **7**, the watermist system shall be deemed to have passed the test if all of the following criteria are met:

a) the watermist system extinguishes any auto-ignition fire inside the industrial oil cooker mock-up, regardless of its hood position;

b) all visible open flames are extinguished within 1 min from the discharge of mist from any nozzle;

c) the watermist system prevents, and does not cause, any significant thermal damage to the industrial oil cooker by ensuring that, at the completion of system discharge, the average oil temperature inside the pan, using all thermocouples, is below the oil's flash point;

d) the available extinguishing agent duration is double that needed to extinguish the worst case fire scenario and subsequently cool the oil to a temperature below its flash point, or 10 min, whichever is greater;

e) the watermist system discharge time does not exceed 30 min;

f) during the discharge of the watermist system, there are no repeated fire flare-ups, micro-explosions of oil reacting with water, or splashing of the burning oil outside the pan.

Annex A (informative)

Commonly used cooking oils

A list of commonly used cooking oils, together with their flash points and auto-ignition temperatures, is shown in Table A.1.

Table A.1 **Commonly used cooking oils**

Cooking oil	Flash point °C	Auto-ignition temperature °C
Canola	338	363
Corn	342	362
Cotton seed	334	366
Peanut	348	370
Soybean (Soya)	333	377
Sunflower	340	359
Palm	328	377

Bibliography

For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS 8489-4, *Fixed fire protection systems – Industrial and commercial watermist systems – Part 4: Tests and requirements for watermist systems for local applications involving flammable liquid fires*

BS 8489-5, *Fixed fire protection systems – Industrial and commercial watermist systems – Part 5: Tests and requirements for watermist systems for the protection of combustion turbines and machinery spaces with volumes up to and including 80 m^3*

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