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# Determination of the resistance to jet fires of passive fire protection materials —

## Part 3: Extended test requirements



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# Contents

Page

# Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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This document was prepared by Technical Committee ISO/TC 92, *Fire safety*, Subcommittee SC 2, *Fire Resistance*.

A list of all parts in the ISO 22899 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

# Introduction

The tests and procedures described in ISO 22899-1 are designed to give an indication of how passive fire protection materials and systems will perform in a jet fire. This document provides extended test procedures to meet three objectives:

1) to permit testing of critical process control equipment;

2) to permit an increase in the size and configurations of specimen that can be tested; and

3) to give an indication of how passive fire protection materials and systems will perform in a severe jet fire associated with significant confinement or other severe release scenarios that can generate sustained heat fluxes of 350 kW/m$^2$.

Guidance on the applicability of the test is covered in Reference [9].

Even with the extended test procedures herein, the dimensions of the test specimen can be smaller than typical items of structure and plant and the release of gas can be substantially less than that which might occur in a credible event. However, individual thermal and mechanical loads imparted to the passive fire protection material from the jet fire defined in this document have been shown by simulation to be similar to those imparted by a wide range of large-scale jet fires resulting from high-pressure releases of a range of fuels.

Although the method specified has been designed to simulate some of the conditions that occur in an actual jet fire, it cannot reproduce them all exactly and the thermal and mechanical loads do not necessarily coincide. The results of this test do not guarantee safety but may be used as elements of a fire risk assessment for structures or plants. Such a fire risk assessment should also take into account all the other factors that are pertinent to an assessment of the fire hazard for a particular end use. The test described in this document is not intended to replace the hydrocarbon fire resistance test (EN 1363-2[2]) or the test described in ISO 22899-1. Rather, it is a complementary test.

# Determination of the resistance to jet fires of passive fire protection materials —

# Part 3:
# Extended test requirements

## 1 Scope

This document describes an extended test method determining the resistance to jet fires of passive fire protection (PFP) materials and systems or critical process control equipment. It gives an indication of how PFP material or equipment behaves in a severe jet fire and provides performance data under the specified conditions.

It does not include an assessment of other properties of the passive fire protection material such as weathering, ageing, shock resistance, impact or explosion resistance, or smoke production.

This document is intended to be complementary to ISO 22899-1. It is intended for use in situations when the required fire conditions or limitations on test specimen size or type preclude application of ISO 22899-1.



## 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 834-1:1999, *Fire-resistance tests — Elements of building construction — Part 1: General requirements*

ISO 13702, *Oil and gas industries — Control and mitigation of fires and explosions on offshore production installations — Requirements and guidelines*

ISO 22899-1:2021, *Determination of the resistance to jet fires of passive fire protection materials — Part 1: General requirements*

## 3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

**3.1**
**assembly**
unit or structure composed of a combination of materials or products, or both

**3.2**
**critical process control equipment**
**CPCE**
industrial equipment that performs a safety-critical function by actively changing a hydrocarbon processing routine

Note 1 to entry: This can include valves, actuators, sensors, control panels, transducers, junction boxes, etc.

**3.3**
**critical temperature**
maximum temperature that the equipment, assembly or structure to be protected is allowed to reach

**3.4**
**$\Delta T_{max}$**
maximum temperature rise recorded by any of the installed thermocouples

**3.5**
**fire barrier**
separating element that resists the passage of flame, heat effluents, or a combination of these, for a period of time under specified conditions

**3.6**
**fire resistance**
ability of an item to fulfil, for a stated period of time, the required stability, integrity or thermal insulation, or a combination of these three criteria, along with another expected duty if applicable (such as a restriction from reaching the critical temperature) specified in a standard fire-resistance test



**3.7**
**fire test**
procedure designed to measure or assess the performance of a material, product, structure or system to one or more aspects of fire

**3.8**
**flame compartment**
chamber constructed around the nozzle to contain the test specimen, increasing the size of the fireball and increasing heat fluxes



**3.9**
**flame re-circulation chamber**
mild steel box, open at the front, and as defined in ISO 22899-1, into which the jet fire is directed giving a re-circulating flame resulting in a fireball

Note 1 to entry: Materials other than mild steel may be used when appropriate.

**3.10**
**integrity**
ability of a separating element, when exposed to fire on one side, to prevent the passage of flames and hot gases or the occurrence of flames on the unexposed side, for a stated period of time in a standard fire resistance test

**3.11**
**intermediate-scale test**
test performed on an item of medium dimensions

Note 1 to entry: A test performed on an item of which the maximum dimension is between 1 m and 3 m is usually called “an intermediate-scale test”. This document describes an intermediate-scale jet fire test.

**3.12**
**jet fire**
ignited discharge of propane vapour under pressure

**3.13**
**jet nozzle**
assembly from which the flammable material issues

**3.14**
**outside specimen diameter**
specimen diameter measured to the outer surface of the passive fire protection system on a tubular specimen

**3.15**
**operability**
ability of an item of process control equipment to perform its required function

Note 1 to entry: The required function can be either a change in state (opening or closing) or the activation of a change in state.

**3.16**
**passive fire protection**
**PFP**
coating or cladding arrangement or free-standing system which, in the event of fire, will provide thermal protection to restrict the rate at which heat is transmitted to the object or area being protected

Note 1 to entry: The term "passive" is used to distinguish the systems tested, including those systems that react chemically (e.g. intumescents), from active systems such as water deluge.

**3.17**
**passive fire protection material**
**PFP material**
**PFP system**
material or system, such as a coating, cladding removable jacket or inspection panel, cable transit system, pipe penetration seal or other such system that, in the event of a fire, will provide thermal protection to restrict the rate at which heat is transmitted to the object or area being protected



**3.18**
**penetration seal**
seal used to maintain the fire resistance of a separating element at the position where there is provision for services to pass through the separating element



**3.19**
**protective chamber**
mild steel box, open at the front and back, which is designed to be attached to the rear of the flame re-circulation chamber to shield the rear of the flame re-circulation chamber from environmental influences

Note 1 to entry: A protective chamber is not required for tubular section tests but may be used to provide additional stability to the flame re-circulation chamber, if used.

**3.20**
**temperature rise**
rise in measured temperature above the initial temperature at a given location

**3.21**
**coaming**
raised border around a penetration

**3.22**
**transit sealing system**
cable transit consisting of a metal frame, box or coaming, penetration seal or material and cables

Note 1 to entry: It may be uninsulated, partially insulated or fully insulated.

# 4 Principle

The method provides an indication of how PFP materials or systems or critical process control equipment performs in a severe jet fire that can occur, for example, in petrochemical installations. It aims to simulate the thermal and mechanical loads imparted to passive fire protection material by large-scale jet fires resulting from high-pressure releases of flammable gas, pressure liquefied gas or flashing liquid fuels through use of an intermediate-scale test. Jet fires give rise to high convective and radiative heat fluxes as well as high erosive forces. To generate both types of heat flux in sufficient quantity, a 0,3 kg $s^{-1}$ sonic release of gas is aimed into a partially enclosed compartment, producing an extended fireball. The heat flux to the specimen is increased beyond that of ISO 22899-1 due to an increase in the flame thickness and radiation from the flame compartment. Propane is used as the fuel since it has a greater propensity to form soot than natural gas and can therefore produce a flame of higher luminosity. The high erosive forces generated by the release of the sonic velocity gas jet 1 m from the specimen surface are equivalent to those produced in ISO 22899-1.

# 5 Test configurations

## 5.1 General

There are two basic configurations under which the test can be operated:

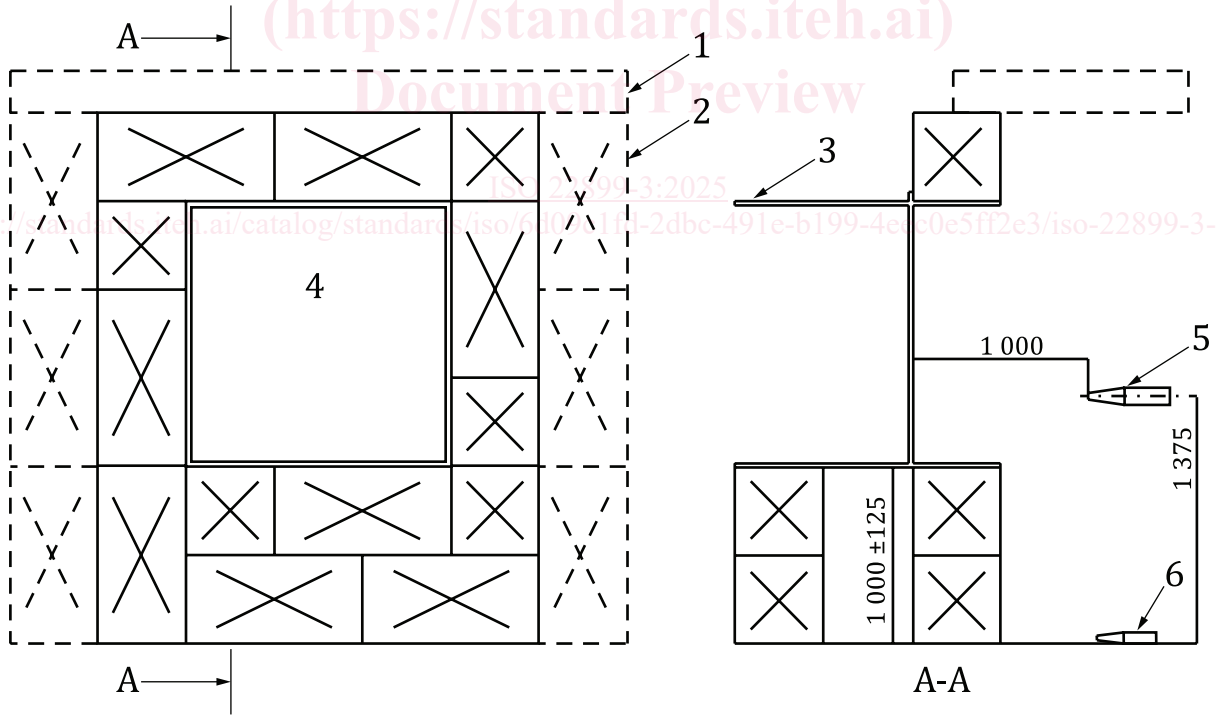
a) a configuration where the rear wall of the flame compartment incorporates the test specimen;

b) a configuration where the test specimen is installed on supports inside the approximate centre of the flame compartment.

These two alternative configurations are shown in Figures 1 and 2.



Dimensions in millimetres




**Key**

1 roof blocks
2 aerated concrete blocks for rear wall and side walls (not shown)
3 protective chamber

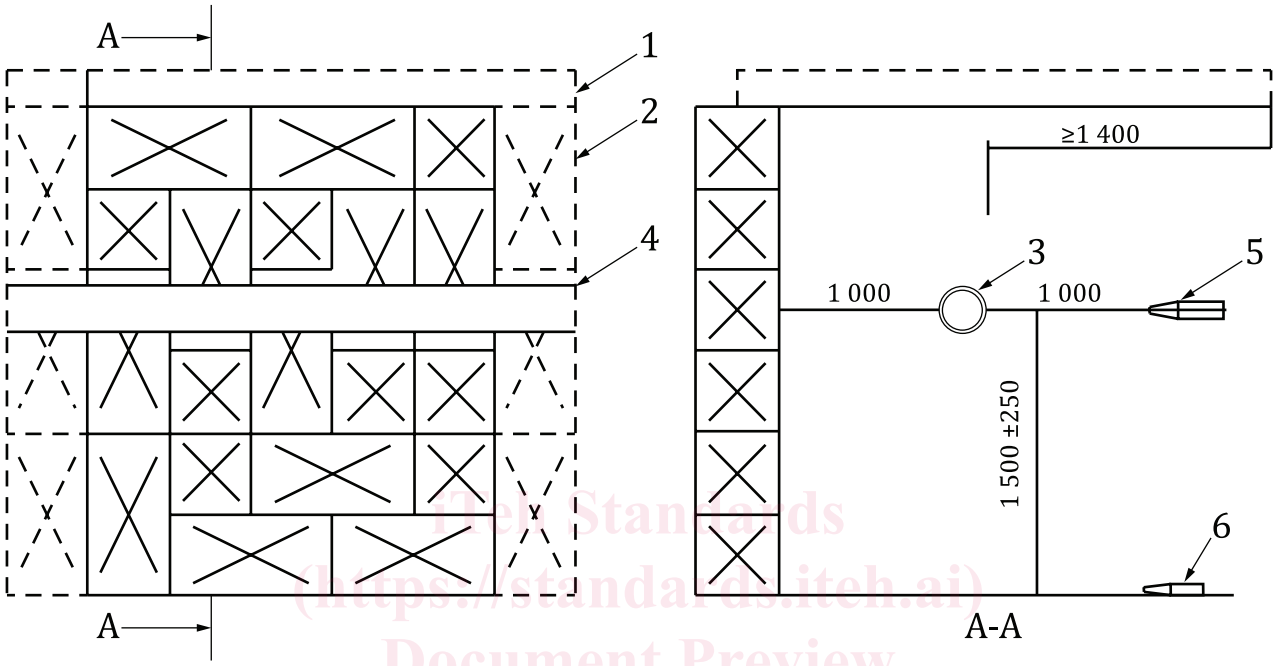
4 test specimen, consisting of a structural box, a panel incorporated within the rear wall, or consisting of an entire construction instead of the rear wall.

5 jet nozzle

6 optional air inlets

**Figure 1 — Layout for configuration incorporating the test specimen in a wall of the flame compartment**

Dimensions in millimetres






**Key**

1 roof blocks

2 aerated concrete blocks for rear wall and side walls (not shown)

3 test specimen

4 test specimen mounted within the wall or on end supports

5 jet nozzle

6 optional air inlets



**Figure 2 — Layout for configuration incorporating the test specimen in the approximate centre of the flame compartment**

## 5.2 Configuration incorporating the test specimen in the rear wall of the flame compartment

The rear wall test configuration is used for determining the jet fire resistance of:

a) protection systems for plane surfaces;

b) protection systems for structural steelwork with an open profile;

c) fire barriers;

d) penetration and transit sealing systems used in conjunction with fire barriers.

### 5.3 Configuration incorporating the test specimen in the approximate centre of the flame compartment

The central test configuration is used for determining the jet fire resistance of:

a) critical process control equipment not used in conjunction with fire barriers;

b) protection systems for structural steelwork with a closed (hollow) profile;

c) PFP systems and assemblies mounted on structural sections with a closed (hollow) profile.

## 6 Construction of the test items and substrates

### 6.1 General

The key items required for the test are the jet release nozzle, the test specimen (which can, but does not necessarily, include a flame re-circulation chamber and a protective chamber) and the flame compartment. These items are required for all configurations of the test. In the configuration of the test where the test specimen is in the approximate centre of the fire compartment, the flame re-circulation chamber and protective chamber is not used.

### 6.2 Flame compartment

The flame compartment shall be constructed of a rear wall, 2 sides walls and a roof. Walls shall be constructed from aerated concrete blocks, or other suitable insulative material, and shall be parallel or perpendicular to each other. The width of the flame compartment shall be 2 500 mm to 3 000 mm, measured across the width of the opening. The depth of the flame compartment shall be greater than or equal to 2 500 mm, measured from the opening to the rear wall. The height of the flame compartment shall be 3 000 mm to 4 000 mm, measured from the floor to the roof.

The roof shall extend from the test specimen to the opening for a minimum distance of 1 400 mm, with the exact distance determined by the requirement to meet the temperature requirements during the test described in 7.4.

The flame compartment may be insulated (in whole or in part) with a fire-resistant board or blanket to ensure rapid temperature rise at the start of the test and to reduce the dependency of the test on wall construction. Retention of the insulation shall be designed to ensure the insulation remains in place for a minimum of 30 minutes, and failure or detachment of the insulation thereafter shall not happen in a manner that impedes heating of the test specimen.

NOTE Failure of any side wall insulation after the temperature requirements in 7.4.1 can affect the validity of the test, as described in 14.3.7.

The flame compartment may be equipped with two air inlets, positioned on the floor symmetrically on either side of the nozzle. Air may be blown into the fire compartment during the test if required to reach the conditions stated in 7.4.

The flame compartment may have a front wall up to the mid-height of the compartment and a vent (or vents), to help achieve the test condition requirements in 7.4.

Test specimens that extend beyond the flame compartment wall or are mounted within the flame compartment wall shall have any openings sealed to prevent loss of hot gases from the flame compartment at the edges of specimens.

### 6.3 Nozzle

The fuel shall be released towards the specimen from a nozzle as defined in ISO 22899-1:2021, 6.3. The tapered, converging nozzle shall be of length 200 mm ± 1 mm, inlet diameter 52 mm ± 0,5 mm and outlet diameter 17,8 mm ± 0,2 mm. Figure 3 shows the details of construction. The nozzle shall be constructed of heat resistant stainless steel. Provisions may be made for fitting a sighting device.