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Determination of the resistance to gas explosions of passive fire protection materials —

Part 3: **Tubular and I-section substrates subject to elastic deformation only**

Détermination de la résistance aux explosions de gaz des matériaux de protection passive contre l'incendie —

Partie 3: Supports tubulaires et de section en I soumis à une déformation élastique uniquement

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Foreword

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

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Determination of the resistance to gas explosions of passive fire protection materials —

Part 3: Tubular and I-section substrates subject to elastic deformation only

1 Scope

This document describes methods for simulating the mechanical loads that can be imparted to passive fire protection (PFP) materials and systems by explosions resulting from releases of flammable gas, pressurized liquefied gas, flashing liquid fuels, or dust that can precede a fire.

These methods can be used to determine the resistance of passive fire protection materials to such events.

This document considers PFP materials applied to substrates that are subject to the combined effects of pressure and drag that occur in the flow path of an explosion. This document excludes specimens in which the substrate is subject to plastic deformation or brittle failure

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 23693-1, *Determination of the resistance to gas explosions 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
congested region
<explosion test rig> region that is occupied by items that provide obstacles to flow ahead of the flame, thereby increasing flame velocity, the rate at which energy is released, and the overpressure produced

3.2
drag load
load on items resulting from the flow of gas generated by a gas explosion

3.3
overpressure
difference between actual pressure and ambient pressure

3.4
pressure load
load on an object resulting from the *overpressure* (3.3) generated by a gas explosion

3.5
projected area
part of the vent area that the instrumented test specimen covers

3.6
rise time
time for the pressure in a blast wave to rise to the peak *overpressure* (3.3)

3.7
side-on overpressure
overpressure (3.3) measured at right angles to the direction of travel of a blast wave

Note 1 to entry: This can also be described as incident or free field overpressure.

3.8
stagnation pressure
pressure at a location perpendicular to and facing the direction of the flow, where the velocity of the explosion gases has been reduced to zero

3.9
streamlined housing
housing that a pressure transducer can be mounted into, which, if aligned with the direction of travel of the blast wave and flow generated by a gas explosion, allows the *side-on overpressure* (3.7) to be measured

3.10
substrate
section to which the passive fire protection (PFP) materials are attached or mounted

4 Explosion loads

Methods for generating explosive loads are described in ISO 23693-1. Due to the nature of the specimen being tested, it will be exposed to a combination of overpressure and drag loads. Pressure loads come from the overpressure generated by the explosion; the drag loads are generated by the high velocity gas flow around the object. To ensure that PFP systems applied to this type of object can survive a gas explosion it is necessary to test them against a combination of pressure and drag loads.

To achieve a combination of pressure and drag loads, the test specimen shall be located in, or near, the vent of a confined gas explosion or at the edge of the congested region of an unconfined gas explosion, where the velocity of the gas flow will produce a drag load.

The pressure load is obtained by measuring the side-on overpressure.

Drag load is characterized either by measuring the stagnation pressure on an instrumented tubular positioned so as to receive the same drag load as the specimen being tested or by instrumenting the specimen being tested. When the instrumented tubular is used, it shall be located in the same position as the specimen during a calibration test conducted under the same test conditions.

The drag load on an object in a flow is given by Formula (1):

$$D_L = C_D \, A \, p_{dyn} \tag{1}$$

where

D_L	is the drag load, in newtons (N);
C_D	is the drag coefficient of object;
A	is the projected area of object normal to flow direction, in square metres (m^2);
p_{dyn}	is the dynamic pressure, in newtons per square metre (N/m^2), and is calculated using Formula (2):

$$p_{dyn} = \rho u^2/2 \tag{2}$$

where

ρ	is the gas density, in kilograms per cubic metre (kg/m^3);
u	is the flow velocity, in metres per second (m/s).

It is difficult to know the actual drag coefficient of an object as it changes with shape, orientation, flow velocity and flow conditions. When computer programs that model the effects of a gas explosion calculate drag load they typically assume a C_D of unity, so drag load is equal to the dynamic pressure.

When conducting gas explosion trials, the dynamic pressure can be calculated from the measured stagnation pressure and side-on pressure using Formula (3):

$$p_{dyn} = p_{stag} - p_{side} \tag{3}$$

where

p_{stag}	is the stagnation pressure, in newtons per square metre, (N/m^2);
p_{side}	side-on pressure, in newtons per square metre, (N/m^2).

NOTE 1 The actual drag load on an object is dependent both on the flow velocity and the drag coefficient of the object. The drag coefficient is dependent on the geometry and orientation of the object being considered.

NOTE 2 This document does not consider bending or deflection of samples. If used for rating PFP performance of bending and deflection, it is necessary to perform additional analysis.

Test laboratories should be aware of the significant potential hazards involved in gas explosion resistance testing and take appropriate steps to ensure the safety of all concerned.

5 Test methods

5.1 General

Two test methods are available, both designed to ensure that the required levels of overpressure and drag load are attained. The two methods are:

a) Method 1: quantifying the drag and pressure loads by direct measurement of the stagnation pressure and side-on overpressure.

b) Method 2: using computational fluid dynamic modelling to simulate the gas explosion such that the drag load and overpressure load on the specimen under test can be calculated.

These methods are described in 5.2 and 5.3.