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

Part 1: General requirements

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

Partie 1: Exigences générales

Reference number
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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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 documents 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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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

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

A list of all parts in the ISO 23693 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.

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

Part 1: General requirements

1 Scope

This document aims to simulate the mechanical loads that could be imparted to passive fire protection (PFP) materials and systems by explosions resulting from releases of flammable gas, pressurised liquefied gas or flashing liquid fuels that may precede a fire. This document can also be applicable to dust explosions. Gas explosions can give rise to pressure and drag forces. Damage to PFP materials in a gas explosion can be caused by the direct effects of pressure and drag loadings and by the deflection of the substrate supporting the PFP material. Other parts of the ISO 23693 series will deal with a range of common types of specimen that could be tested against the mechanical loads generated.

2 Normative references

There are no normative references in this document.

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

3.2
impulse
area under a pressure-time history curve

3.3
overpressure
difference between actual pressure and ambient pressure

3.4
rise time
time for the pressure in a blast wave to rise to the peak overpressure

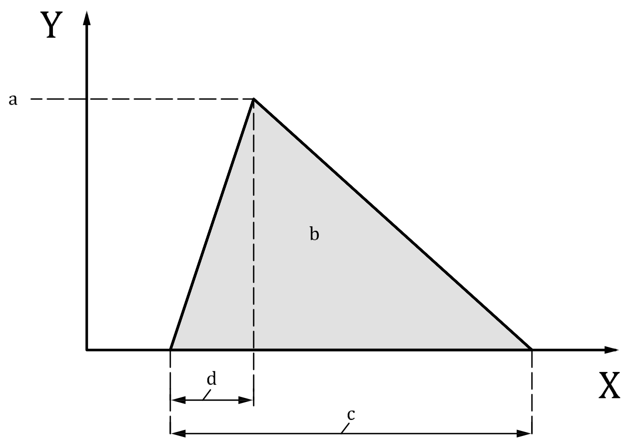
4 Explosion loading

4.1 Overpressure loading

Overpressure loadings shall be characterised as one of two idealised overpressure-time histories that can occur.

4.1.1 Finite rise time

The type of loading that would occur to items close to or inside a gas cloud has a finite rise time. Its characteristics are defined by a peak overpressure, minimum rise time and impulse, as shown in Figure 1.



Key

X time

Y overpressure

a Peak overpressure.

b Impulse.

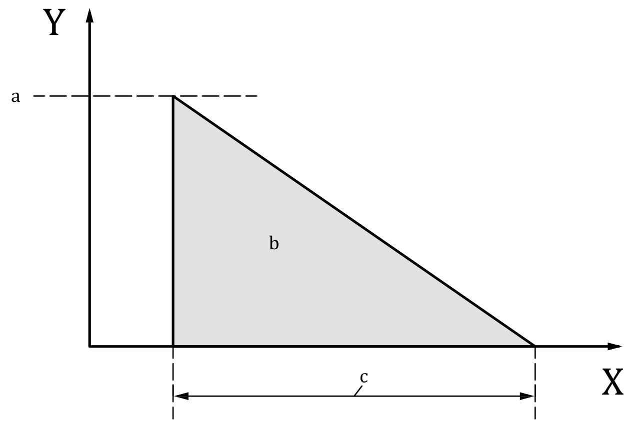
c Duration.

d Rise time.

Figure 1 — Example of overpressure-time plot for a finite rise time

4.1.2 Instantaneous rise time

Shock loading that can occur in the far field of a gas explosion has an instantaneous rise time. Its characteristics are defined by peak overpressure and impulse, see Figure 2.



Key

X time

Y overpressure

a Peak overpressure.

b Impulse.

c Duration.

NOTE These idealised loadings only consider the positive phase loading resulting from a gas explosion; the negative (rarefaction) phase has not been considered. The magnitude and duration of the negative phase will be dependent on the method used to generate the required overpressure-time history.

Figure 2 — Example of overpressure-time plot for an instantaneous time

4.2 Drag loading

PFP materials and systems required to demonstrate resistance to drag loads shall be subject to a drag loading in addition to the test overpressure loading. The drag loading shall be defined as a peak load and optionally a duration. Further details of how the drag loading can be demonstrated on specific configurations of specimen are given in other parts of the ISO 23693 series.

Direct measurement of drag loading is currently impractical and simulation using methods such as computational fluid dynamics is likely to be required to allow drag loading to be inferred from other measurements.

4.3 Means of generating loads

4.3.1 General

The required overpressure-time history shall be generated in one of the following ways.

4.3.2 Confined gas explosion

The overpressure-time history is generated by ignition of flammable gas/air mixtures within a confining structure. The overpressure-time history required would be generated by a combination of confinement and congestion. The location of the sample within or outside the confinement would also affect the overpressure-time history. In addition to overpressure loading, specimens located in the vent path of a confined gas explosion will be exposed to significant drag loads.

4.3.3 Unconfined gas explosion

The overpressure-time history is generated by congestion within the flammable gas cloud. The geometry of the congestion would produce the require overpressure-time history. The location of the sample within or outside the cloud would also affect the overpressure-time history. Samples located close to or within the cloud would be exposed to drag loading.

4.3.4 Shock tube

The overpressure-time histories generated with this type of equipment are normally limited to instantaneous pressure rises.

4.3.5 Solid explosive detonations

The overpressure-time histories generated with this type of equipment are normally limited to instantaneous pressure rises.

The potential duration of the overpressure is limited by the charge size so to generate overpressure-time histories similar to those expected from gas explosions would typically require very large charge sizes.

5 Test specimens

This procedure may be used to test any practical configuration of test specimen. The common types of test specimens that can be part of PFP systems are as follows:

a) divisional elements;

b) structural sections;

c) pipework and fittings;

d) cable, duct and pipe penetration seals;

e) windows and doors.

Further information on specific configuration, installation and instrumentation will be provided in other parts of the ISO 23693 series.

6 Environmental conditions

The ambient temperature shall be recorded immediately prior to the test. When a sample is mounted inside a test chamber the ambient conditions shall be measured inside the test chamber. The ambient humidity shall be recorded immediately prior to the test within the vicinity of the test facility.

7 Instrumentation

7.1 General

The test shall have sufficient and appropriate instrumentation to provide measurements that demonstrate that the performance requirements of the specimen are met.

7.2 Pressure transducers

The overpressure shall be measured using a minimum of three pressure transducers.

All pressure transducers shall be positioned to measure an overpressure representative of the loading on the test specimens.

The pressure transducers shall have a minimum natural frequency of 200 kHz.

Calibration records shall be maintained that demonstrate that the pressure measuring equipment used can measure pressure within an accuracy of ±5 % of the require peak overpressure scale.

7.3 Temperature

PFP materials and systems required to demonstrate performance in specific temperature ranges shall be instrumented with thermocouples that allow the temperature of the sample at the time of test to be reported.

The thermocouples shall be logged for a minimum period of 100 s before the test at a minimum sampling frequency of 1 Hz.

The thermocouples and data acquisition system to be used shall be able to demonstrate an accuracy of ±3 °C.

7.4 Deflection

The dynamic deflection of a sample may be measured using a range of techniques. Any techniques used shall be capable of demonstrating an accuracy of ±5 % of the maximum deflection being measured.

Any permanent deflection of a specimen shall be measured after the test using a measurement technique that can demonstrate an accuracy of ±5 % of the maximum deflection being measured.

7.5 Strain

Where appropriate, strain gauges shall be used to measure the response of a sample. Where used, strain gauges shall be of the appropriate type and installed in areas expected to be subject to maximum strain.

7.6 Data acquisition

The data acquisition system shall consist of a recording system with a sufficient number of channels to accommodate all pressure transducers and any other instruments. The minimum sampling frequency should be 100 kHz unless otherwise stated. No additional pre-filtering shall be used. The data acquisition system shall be set to sample all transducers simultaneously or in rapid burst mode.

7.7 Photography

Photographs shall be taken of the samples prior to the test and after the test. Photography shall show details of damage, joints, fixings, supports, and all other relevant features necessary to record the condition of the specimen before testing and any changes the specimen has undergone during the test.

7.8 Video

Where appropriate, video footage, particularly high-speed video, shall be used. It can be valuable in assessing the response of specimens under test, particularly those mounted externally.

8 Test specification

The test sponsor shall define the overpressure-time history to be tested to in terms of an idealised overpressure-time history as given in 4.1. As a minimum, the peak overpressure, impulse and minimum rise time shall be specified.

The test sponsor shall specify all additional performance requirements that need to be demonstrated and any preconditioning of the specimen that has been, or needs to be, carried out.

In some situations, the test sponsor should obtain guidance in specifying the test conditions. In those cases, it is necessary for the test sponsor to provide details of the operating environment for the material being tested.

9 Data analysis

Overpressure time histories with a duration of 5 ms or greater shall have a 0,5 ms rolling average applied to each signal.

For each time step of the recorded data, the average overpressure over the time period starting 0,25 ms before, and finishing 0,25 ms after this time point is assigned to that time. This process produces a 0,5 ms rolling average and has the effect of smoothing the overpressure trace.

The duration of the overpressure profile shall be determined by considering an idealised overpressure profile in the form of a triangle. The apex of this triangle corresponds to the magnitude and time of the maximum overpressure determined from the 0,5 ms rolling average. The sides of the triangle are formed by lines from this point to the two positions on the actual overpressure profile where the pressure trace passes 10 % of the maximum overpressure.

Overpressure time histories with a duration of less than 5 ms shall have a 0,05 ms rolling average applied to each signal.

For each time step of the recorded data, the average overpressure over the time period starting 0,025 ms before, and finishing 0,025 ms after this time point is assigned to that time. This process produces a 0,05 ms rolling average and has the effect of smoothing the overpressure trace.

The duration of the overpressure profile shall be determined by considering an idealised overpressure profile in the form of a triangle. The apex of this triangle corresponds to the magnitude and time of the maximum overpressure determined from the 0,05 ms rolling average. The sides of the triangle are formed by lines from this point to the two positions on the actual overpressure profile where the pressure trace passes 10 % of the maximum overpressure.

NOTE This process is undertaken because there is the potential for short duration (e.g. <1 ms) variations in the overpressure measurements giving misleading representations of the overpressures recorded. Short duration variations are unlikely to have any importance in terms of structural response and are also unlikely to be represented in any model prediction.

The rise time of the overpressure shall be calculated from the idealised triangular overpressure profile.

The impulse shall be calculated as the area of the idealised triangular overpressure profile.

This process can be appropriate for the analysis of other measurements.

An example of this analysis is illustrated in Figure 3.