TECHNICAL SPECIFICATION

ISO/TS 27469

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Petroleum, petrochemical and natural gas industries — Method of test for fire dampers

Industries du pétrole, de la pétrochimie et du gaz naturel — Méthode d'essai des clapets coupe-feu

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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

In other circumstances, particularly when there is an urgent market requirement for such documents, a technical committee may decide to publish other types of document:

— an ISO Publicly Available Specification (ISO/PAS) represents an agreement between technical experts in an ISO working group and is accepted for publication if it is approved by more than 50 % of the members of the parent committee casting a vote;

— an ISO Technical Specification (ISO/TS) represents an agreement between the members of a technical committee and is accepted for publication if it is approved by 2/3 of the members of the committee casting a vote.

An ISO/PAS or ISO/TS is reviewed after three years in order to decide whether it will be confirmed for a further three years, revised to become an International Standard, or withdrawn. If the ISO/PAS or ISO/TS is confirmed, it is reviewed again after a further three years, at which time it must either be transformed into an International Standard or be withdrawn.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO/TS 27469 was prepared by Technical Committee ISO/TC 67, *Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries*, Subcommittee SC 6, *Processing equipment and systems*.

Introduction

The purpose of this International Technical Specification is to enable evaluation of the ability of a fire damper installation to maintain the integrity of fire rated barriers. Typical fire barrier ratings are given in ISO 13702:1999, Table C.5.

The following performance criteria are evaluated by this Technical Specification:

a) fire integrity and insulation: to limit/control the spread of radiated and conducted heat at the protected side of a fire damper installation; it is necessary to determine the distance from the damper's blades, in free air or along a duct, where temperatures do not exceed requirements;

b) ability to provide protection from both hydrocarbon pool fires and jet fires;

c) leakage past closed blades;

d) ability to withstand overpressure that can arise from an explosion.

This Technical Specification is based on the use of existing approved fire research and testing facilities. Specially constructed facilities can be required for testing blast pressure withstand capability. It is important that test dampers be installed in a manner that represents their design installation.

In carrying out the tests described in this Technical Specification, it is necessary to refer to other standards connected with the fire-testing of materials and application in the petroleum and natural gas industries. The test methods simulate thermal and overpressure conditions that can result from fire and explosion. The conditions in a real incident can be different, so the test results and resultant damper designations do not guarantee safety but can be used as elements of a fire and explosion risk assessment that takes into account all other pertinent factors.

NOTE It is planned to determine some aspects of this Technical Specification during the development and testing stage.

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CAUTION - Attention is drawn to the fact that fire testing is hazardous and that there is a possibility that toxic fumes, smoke and/or gases can be evolved during tests. Mechanical and operational hazards can also occur during construction of the test elements or structures, their testing and disposal of test residues.

It is essential that an assessment of all potential hazards and risks to health be made and safety precautions identified and provided, including appropriate training to relevant personnel.

1 Scope

This Technical Specification specifies a method for determining the following:

a) ability of fire dampers installed in ventilation systems to prevent the spread of fire and heat through designated fire divisions; typical ratings are given in ISO 13702:1999, Table C.5.

b) fire damper operational reliability in the petroleum, petrochemical and natural gas industries, particularly offshore installations;

NOTE It is planned to determine the methodology during the testing and development phase.

c) ability of fire dampers installed in ventilation systems to withstand blast overpressures that may result from the explosion of a flammable gas.

This Technical Specification applies to different start-up operations for different types of furnace and, therefore, tolerances in test conditions at the beginning of the test are not described in detail. The fire test enables only a limited assessment of the actuating mechanism being carried out and additional tests can be necessary to fully evaluate its operational reliability.

2 Normative references

The following referenced documents are indispensable for the application 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, *Fire-resistance tests — Elements of building construction — Part 1: General requirements*

ISO 13702:1999, *Petroleum and natural gas industries — Control and mitigation of fires and explosions on offshore production installations — Requirements and guidelines*

ISO 15138, *Petroleum and natural gas industries — Offshore production installations — Heating, ventilation and air-conditioning*

ISO 22899-1:2007, *Determination of the resistance to jet fires of passive fire protection materials — Part 1: General requirements*

EN 1363-1, *Fire resistance tests — Part 1: General requirements*

EN 1363-2:1999, *Fire resistance tests — Part 2: Alternative and additional procedures*

3 Terms and definitions

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

3.1
fire damper
mechanical device designed to close off an air duct or aperture and prevent the passage of fire

3.2
connecting duct
duct section between the fire damper and supporting construction

3.3
extension duct
duct section on the unexposed side of the fire damper and on which the test temperature sensors are located

3.4
test specimen
fire damper, connecting duct, extension duct, insulation and (as applicable) the perimeter penetration sealing system

3.5
test construction
complete assembly of the test specimen and the supporting construction

3.6
fire-damper actuating mechanism
mechanism, integral or directly associated with the fire damper that when initiated by the thermal release device, causes the movable components of the damper to change from the “open” to the “closed” position

3.7
thermal release mechanism
thermally actuated device designed to respond to a rise in temperature and release the fire-damper actuating mechanism/blades at a predetermined temperature

NOTE It can interface with mechanically, electrically, electronically, or pneumatically operated mechanisms that are positioned integrally or remotely from the device

3.8
pool fire
combustion of flammable or combustible hydrocarbon liquid spilled and retained on the surface

3.9
jet fire
ignited discharge of flammable material under pressure

3.10
exposed
facing the fire

3.11
unexposed
facing away from the fire

4 Testing

4.1 Test types

The following different types of test shall be required:

a) hydrocarbon pool fire;

b) jet fire;

NOTE Procedure details will be defined during the development and testing stage.

c) blast pressure.

4.2 Hydrocarbon pool fire test

4.2.1 General test procedure

The test shall be carried out in accordance with ISO 834-1, except where amended by this Technical Specification. The time-temperature curve shall be in accordance with EN 1363-2:1999, 4.1 and Figure 1.

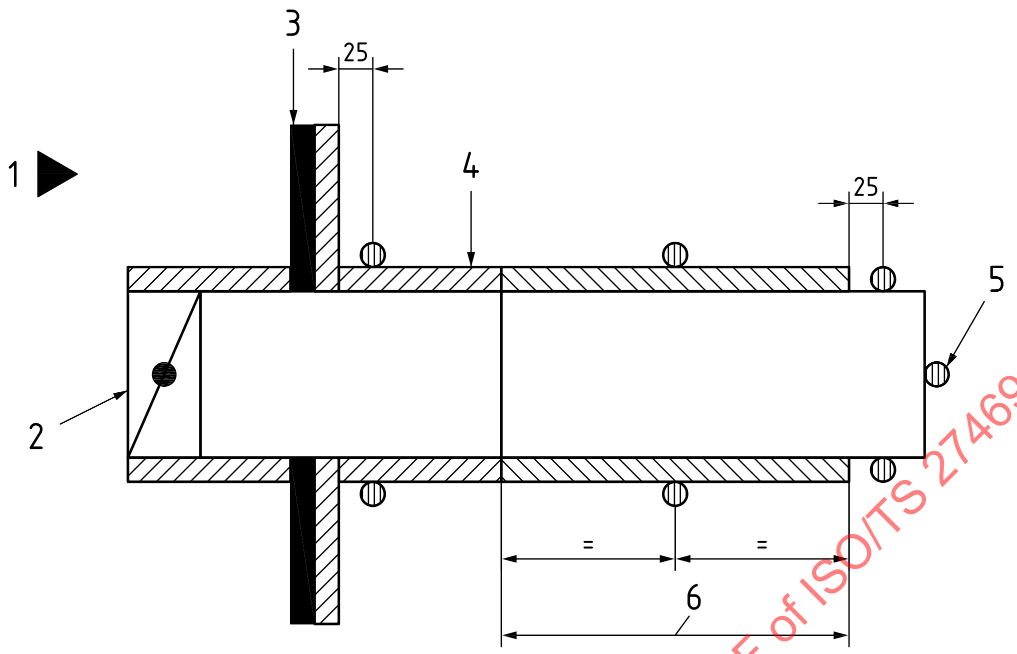
4.2.2 Test environment

The test shall be carried out in an environment in which the effects of weather do not significantly affect the test. The test specimen should be shielded from the effects of a high wind and testing should not be carried out if wind speed in the immediate vicinity exceeds 3 m/s. The ambient temperature range for the test is −10 °C to +40 °C.

4.2.3 Specimen mounting

The test specimen comprised of the damper assembly, ducting sections and supporting structure shall be constructed in accordance with an approved "H" rating design and insulated to a H120 rating on the stiffened external face of the furnace. Vertical and horizontal arrangements should be of similar construction. The fire damper should be fixed in position in the same manner as intended for a design installation and should be as close to the fire barrier division as possible. Extension ducts and insulation shall be provided as required to meet thermal performance criteria and to enable measurement of temperatures arising from radiated, conducted and convected heat on the unexposed side of the fire damper. Typical arrangements are shown in Figures 1, 2, 3 and 4.

Dimensions in millimetres



Key

1 furnace

2 fire damper

3 structural steel core

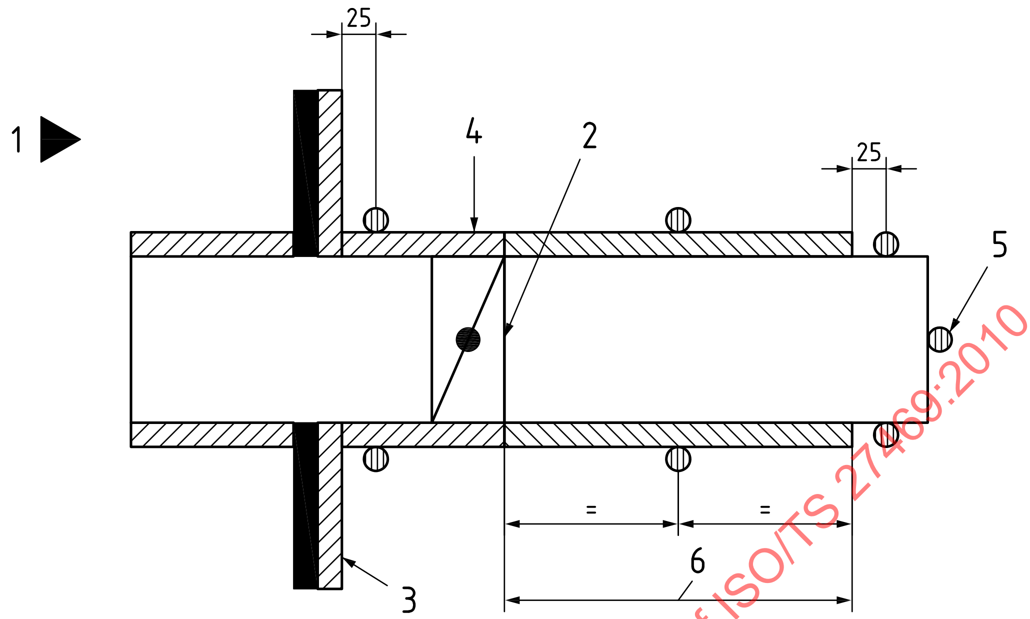
4 insulation material

5 temperature sensing device

6 define by testing

Figure 1 — Fire damper installed inside the furnace

Dimensions in millimetres



Key

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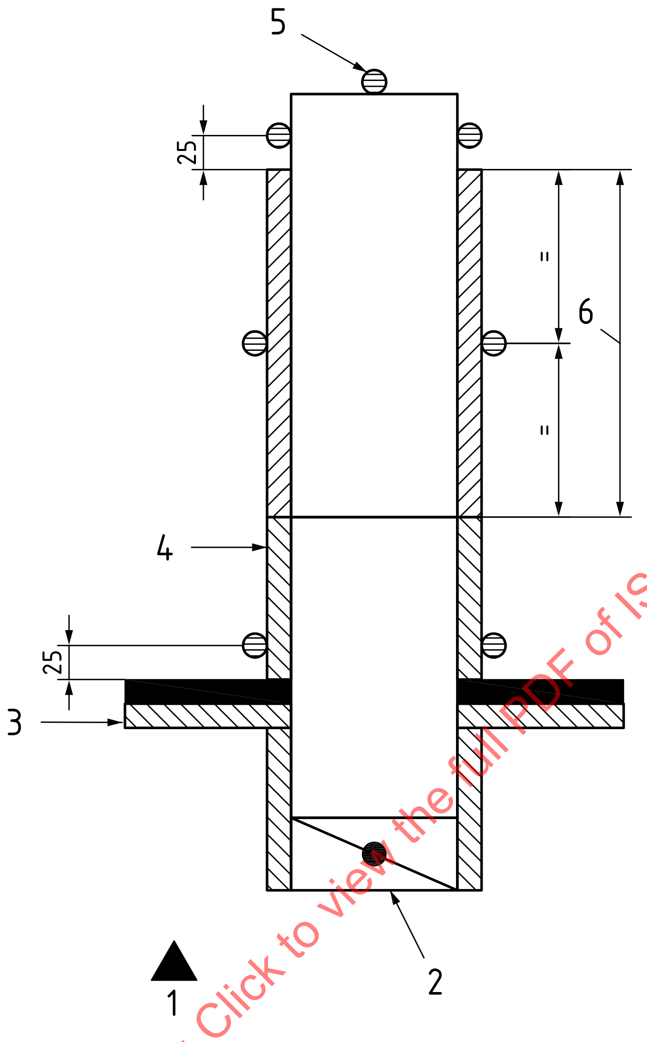
Figure 2 — Fire damper installed outside the furnace

Dimensions in millimetres



Key

1 furnace

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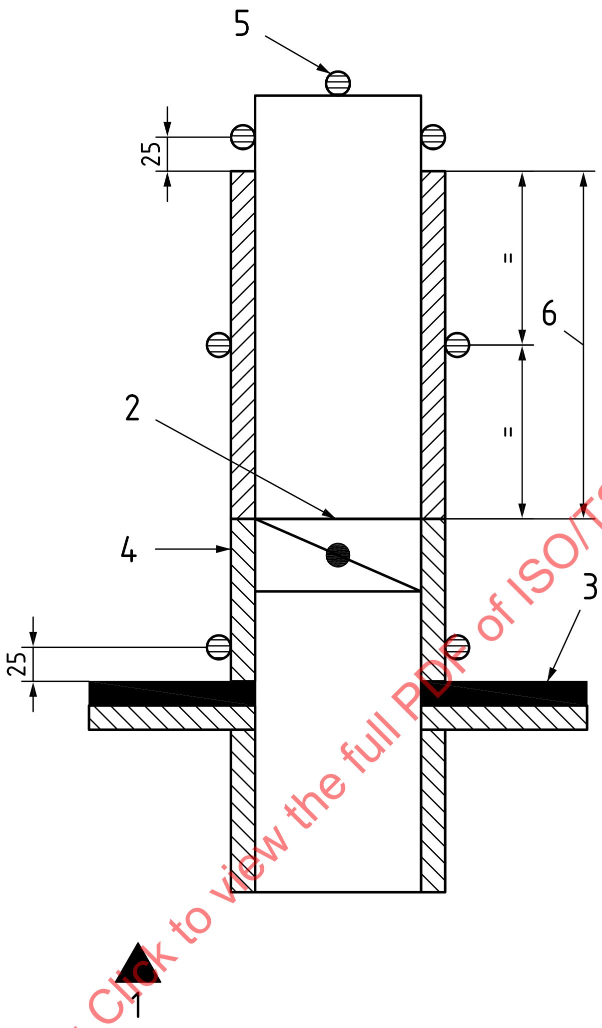
6 define by testing

Figure 3 — Horizontal fire damper installed inside the furnace

Dimensions in millimetres



Key

1 furnace

2 fire damper

3 structural steel core

4 insulation material

5 temperature sensing device

6 define by testing

Figure 4 — Horizontal fire damper installed outside the furnace

4.2.4 Fire damper sizes and orientation

Fire dampers of the following sizes should be tested:

a) maximum size: the maximum that can be accommodated by the test facilities or the maximum size available for the type of damper being tested;

b) minimum size: the smallest version of the type of fire damper being tested.

Fire dampers shall be tested in both the horizontal and vertical orientations indicated in Figures 1, 2, 3 and 4.

4.2.5 Fire dampers installed onto a steel structural opening

A test result obtained for a fire damper installed within a structural opening is only applicable to fire dampers installed in the same orientation as that tested.

4.2.6 Test instruments

4.2.6.1 Test specimen temperature sensors

For each test specimen, temperature sensors should be in accordance with EN 1363-1 and fixed to surfaces at the following locations and as indicated in Figures 1, 2, 3, and 4:

— on the surface of the extension-duct insulation at a distance of 25 mm from the unexposed face of the division;

— on the surface of the extension duct at a distance of 25 mm from where the insulation terminates;

— along the insulated length of the extension duct to record the conducted temperature.

4.2.6.2 Furnace thermocouples

The positions of unexposed surface thermocouples shall be in accordance with ISO 834-1.

4.2.6.3 Furnace pressure

The position of the furnace pressure-measuring probe to measure the difference in pressure between inside and outside (ambient) the furnace shall be in accordance with EN 1363-1.

4.2.7 Test procedure

Connect all instrumentation, set the fire damper into its open position and ignite the furnace. Then use either a local or simulated remote signal to close the damper. The time to close by means of a simulated signal shall be determined during preliminary testing.

Start the timing device and switch on all measuring devices. The test shall be deemed to have commenced at this time.

Carry out the following during the test.

a) Control and record the furnace temperature and pressure. The furnace pressure at the horizontal centre-line of a vertical fire damper shall be maintained at 20 Pa ± 3 Pa;

b) Record the temperature on the external surface of the connecting and extension ducts at the locations specified in Figures 1, 2, 3 and 4.

c) Observe whether any gaps develop at the junction between the supporting construction and the connecting duct. Observe the effects of any such gaps and check for any sustained flaming.

d) Record, where practical, any observations of the general behaviour of the fire-damper assembly during the test. In practice, this is limited to observations of what can be seen externally, which can be restricted for tests where the fire damper is inside the furnace.

4.3 Jet fire test

4.3.1 Test conditions

Heating conditions shall be in accordance with ISO 22899-1:2007, Clause 9. The fuel should be commercial propane supplied to the specified nozzle as a vapour without a liquid fraction at a steady rate of 0,30 kg·s^{-1} ± 0,05 kg·s^{-1}. The total amount of fuel used should be recorded and should be 0,3 times the duration of test, expressed in seconds, ± 5 %. The nozzle shall be in accordance with ISO 22899-1:2007, Clause 6.

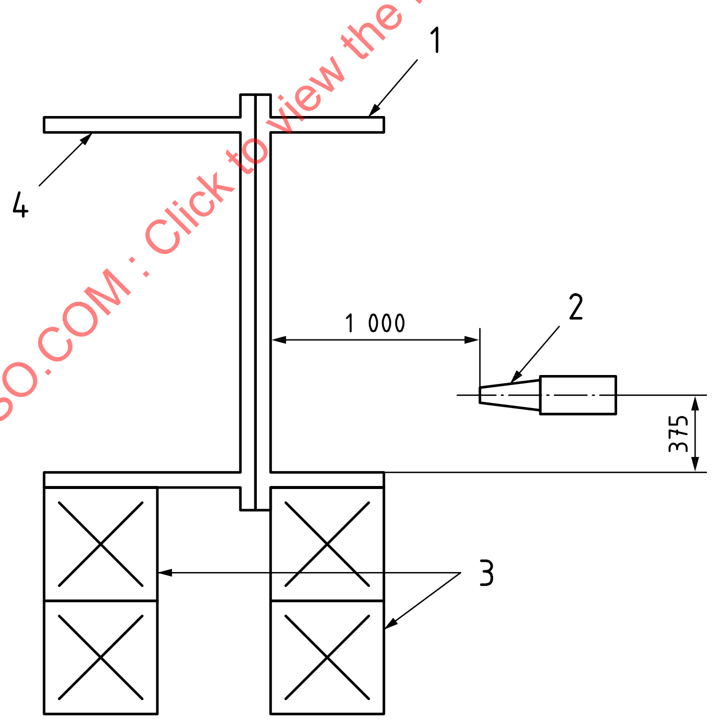
4.3.2 Test environment

The test should be carried out in an environment in which the effects of weather do not significantly affect the test. The specimen should be shielded from the effects of a high wind and testing should not be carried out if wind speed in the immediate vicinity exceeds 3 ms^{-1}.The test can be carried out in rain providing it does not blow directly into the flame recirculation chamber. The ambient test temperature range is between –10 °C and +40 °C.

4.3.3 Specimen mounting

The test specimen, comprised of the mounting duct and the damper assembly, shall be mounted centrally in the flame recirculation chamber shown in Figure 5. The mounting duct cannot project beyond the front of the flame recirculation chamber. The damper assembly can then be recessed a distance along the duct corresponding to that of the configuration under test. The position of the jet nozzle is shown in Figure 5.

Dimensions in millimetres



Key

1 flame re-circulation chamber with either coated inner surfaces or with the rear face replaced by a panel to form the test construction

2 jet nozzle

3 supports

4 protective chamber

Figure 5 — Position of the jet nozzle

The jet-fire flame recirculation and protective chambers into which the duct and damper test specimen shall be mounted in accordance with those given in ISO 22899-1:2007.

4.3.4 Fire damper sizes

The maximum size of test fire damper shall be 1 100 mm × 1 100 mm. If the fire damper type is available in larger sizes, the test damper shall include the key features of the full-size damper.

The side, top and bottom walls of the flame re-circulation chamber shall be protected by insulation or other suitable passive fire protection material.

4.3.5 Test procedure

The following apply.

a) The sponsor determines the test duration, which may be changed during the test depending on how the specimen performs.

b) The sponsor shall provide the specimen for the test in a condition representative of its design application.

c) Measure the environmental conditions immediately before the test and record any significant changes during the test. Measurements taken shall include ambient temperature and, for tests conducted outdoors, wind speed and direction, and whether there is any precipitation.

d) The test shall commence when the jet fire first impinges on the specimen. Recordings shall be made of time, fuel flow rate, temperature and pressure. Readings of the instruments shall be taken at least once every 30 s. The test shall continue until either the time or the temperature selected prior to the test is exceeded.

e) Record any observations of the behaviour and appearance of the test specimen during the test and after the jet fire is extinguished. This should include any details of damper deformation and continuation of flaming.

f) Make continuous visual records of the test.

4.3.6 Recorded temperatures

The temperature-time profiles at each measurement position should be used to determine the maximum temperature reached at each position during the test. The mean substrate temperature shall not be used in the evaluation because the jet fire is not applied uniformly over the specimen. The position and time of any sudden increase in the rate of temperature rise, if any, should be recorded because it can indicate possible failure of the system/assembly at that point.

4.4 Performance evaluation

4.4.1 Use of test results

It is not the purpose of this Technical Specification to provide guidance on the acceptability of a particular assembly. The acceptance process should be left to the appropriate authority, whether regulatory or advisory, which takes into consideration the proposed usage and safety requirements. The method specified has been designed to simulate some of the conditions that occur in a jet fire but these might not be the same as those for a particular incident. The results of this test do not guarantee safety but may be used as elements of a fire-risk assessment that takes account of all pertinent factors.

The main criterion of performance is the minimum time required to reach the critical temperature associated with the fire barrier requirements. Factors in 4.4.2 to 4.4.5 should also be considered when assessing performance.

4.4.2 Integrity

The integrity around the perimeter and internal face of the fire damper shall be judged in accordance with the following criteria.

- There should be no flaming on the exposed face.

  NOTE It is planned to determine the methodology during the testing and development phase.

- It should not be possible to insert gap gauges into any opening in the specimen.
- There should be no penetration of flames or hot gasses through any cracks, holes or breeches in joints.
- The condition of any flexible material (e.g. insulation) and fixings should be evaluated.

The result of the fire test shall be stated in terms of the time elapsed, to the whole minute, from the commencement of heating to the time when the fire damper failed to conform to the criteria for integrity, insulation or leakage, or the termination of the heating, whichever is the shortest.

4.4.3 Loss of integrity

The amount of penetration and condition of the method of fixing may be evaluated in terms of

a) evidence of the passage of flames through the system or the fixing system being ineffective;

b) evidence of the passage of hot gases/smoke through the system with the fixing system being effective;

c) no passage of hot gases through the system and with the fixing system being effective.

If the temperature criterion is met, then a specimen meeting criterion c) clearly provides a wider safety margin than a specimen meeting criterion a). A statement of the criterion that is most appropriate should be included in the report.

4.4.4 Critical temperature

The critical temperature, $T_{critical}$, is the maximum acceptable temperature at the unexposed side of a fire-damper installation before either the fire barrier criterion is exceeded or other system failure is likely to occur. Examples of typical critical temperatures are given in ISO 13702:1999, Annex C. For fire barriers, the critical temperature is typically a rise of 140 °C but for other situations the critical temperature may be the temperature at which a safety-critical piece of equipment can fail. In practice, the critical temperature is treated as a temperature rise above the initial substrate temperature. A 5 °C temperature tolerance, $T_{tolerance}$, is acceptable in measuring the temperature rise.

4.4.5 Fire resistance duration

The fire-resistance duration of a fire damper is the time from the start of the test to when the temperature criterion is exceeded. The period of resistance should be rounded down to the nearest 5 min. The most common periods of resistance used for fire barriers are 15 min, 30 min, 60 min, 90 min and 120 min. Other increments may be used.

4.4.6 Test report

The test report shall be in accordance with EN 1363-1 with the following additions:

a) details of the distance from the exposed face of the supporting construction to the centreline of the plane of operation of the fire damper, with a clear statement as to whether that distance is in the direction of the furnace or away from it;

details of insulation and dimensions of the extension duct;

description of the method and materials used to seal the fire damper into the test construction;

description of the partition used for the test, including its thickness and density;

record of the following temperatures obtained from the tests:

— temperature at the exit of the extension duct,

— temperature along the length of the duct;

b) time at which the fire damper closed after the start of the test and the test duration;

c) any observations which were made during the course of the test, particularly with respect to the loss of integrity at the joints between the fire damper and its connecting duct and between the fire damper assembly and its supporting construction.

4.5 Fire damper classification

4.5.1 Fire designation

Fire designations shall be in accordance with ISO 13702, which refers to cellulosic fires (CF), hydrocarbon pool fires (HC) and jet fires (JF). Some fire scenarios may be comprised of both a jet fire and a hydrocarbon pool fire.

If it is not feasible to perform combined jet-fire and furnace tests on the same specimen, the classification shall be based on the results of the separate tests with reference to the type of fire and tested duration. Hence, for a fire barrier with a critical temperature rise of 140 °C that is required to withstand a 15 min jet fire followed by a 30 min hydrocarbon pool fire, the rating would be as follows:

(JF + HC) / Fire barrier / 140 °C / ($15_{JF} + 30_{HC}$)

Where necessary an optional classification may be made for the intended use. The classification should be related to the type of application and based on the maximum temperature rise observed during the test and the period of exposure to the jet fire. The procedure used is based on that proposed in ISO 13702:1999.

4.5.2 Example of application of the rating

The following example illustrates the classification procedure for jet-fire capability for a fire barrier with a critical temperature rise of 140 °C and minimum time of 60 min.

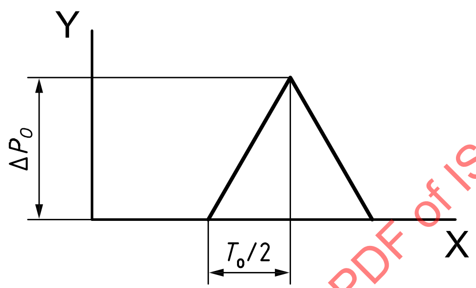
— Test criterion specified in terms of critical temperature rise:	$T_{critical}$ = 140 °C;
— Average initial substrate temperature:	$T_{initial}$ = 10 °C;
— Temperature measurement tolerance:	$T_{tolerance}$ = 5 °C;
— Allowable actual substrate temperature:	$T_{ambient} + T_{critical} + T_{tolerance}$ = (10 + 140 + 5) °C = 155 °C;
— Time to reach 155 °C:	57,5 min;
— Fire rating:	55 minutes (rounded down to nearest 5 min);
— Rating:	JF / Fire barrier / 140 °C / 55 min.

5 Blast pressure

5.1 Blast pressure test

The purpose of the blast pressure test is to establish the level of overpressure that the damper is capable of withstanding in the closed position without impairment to its fire barrier function. A fire damper's blast pressure withstand capability should not be confused with the functions necessary to provide blast protection, for which a different type of damper is required.

The pressure load can be tested in steady state conditions or in dynamic conditions resembling a triangular pressure pulse of minimum 300 ms duration, see Figure 6. A typical gas explosion pressure wave will have a duration of 100 ms to 300 ms. For a steady state test the test pressure shall be maintained for a minimum of 1 second (1 s).



Key

X time, expressed in milliseconds

Y pressure, expressed in kilopascals (bar)

Figure 6 — Design explosion pulse of duration T_o ($T_o/2 + T_o/2 = T_o$)

A fire damper's blast pressure rating is the maximum overpressure to which it can be subjected without losing its ability to provide protection as a fire barrier. It is recommended that dampers should be classified as follows:

— Class 1: Blast pressure class 20 kPa (0,2 bar);

— Class 2: Blast pressure class 30 kPa (0,3 bar);

— Class 3: Blast pressure class 40 kPa (0,4 bar).

Gas dampers shall also be leakage tested in accordance with ISO 15138.

5.2 Design blast pressure

The design pressure can be significantly higher than the side-on pressure depending on the orientation of the opening; see Figure 7. Dampers are normally mounted inside a duct or an air intake. Normally, intake volumes are too small to provide a pressure damping effect due to the long duration of the blast pulse (typically 100 ms to 300 ms). The reflection effects at a closed damper can, therefore, be considerable. As a rule-of-thumb, the design blast pressure should be 1,5 times (50 % higher) than the local blast pressure if detailed simulations do not indicate otherwise. For openings facing the blast wave directly, the design blast pressure should be increased another 50 %, i.e. approximately 2 times the local blast pressure.

Reference is made to NORSOK Z-013:2001, Annex G.

