VENTILATION DUCTS:
FIRE RESISTANCE

1. SCOPE

This NORDTEST method specifies a procedure to determine the fire resistance of ventilation ducts passing from one fire compartment to another without the aid of fire dampers. This method is not applicable for determination of the fire resistance of the fire barrier itself or of the penetration.

2. FIELD OF APPLICATION

The test method described is applicable to ventilation ducts designed to be used either horizontally or vertically and horizontally, taking into account joints as well as suspension devices, etc.

3. REFERENCES

ISO 3261, Fire tests - Vocabulary
ISO 834, Fire-resistance tests - Elements of building construction.

4. DEFINITIONS

For the purposes of this test method, the definitions given in ISO 3261 apply, together with the following:

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4.1 **Ventilation duct**

A duct (including its insulation and suspension devices) for transmission of air for ventilation purposes.

4.2 **Specimen**

A representative piece of the sample prepared to be tested.

5. **SAMPLING**

The sample of the ventilation duct to be tested shall be sufficiently large to be representative.

If a ventilation duct can be supplied in more than one size, the sample shall include the maximum, minimum and an intermediate dimension.

If a ventilation duct can be supplied in more than one geometrical shape (rectangular/circular) each shape shall be tested as a separate ventilation duct.

The materials and standard of workmanship of the test specimens shall be representative of those applying in good practice, as defined by existing national codes and standards.

6. **METHOD OF TEST**

6.1 **Principles**

The test takes into account only the effect of fire exposure from the outside.

The ventilation ducts are attached as is usual to the lower side of a horizontally placed light weight concrete deck construction and are exposed to the standard heating and pressure conditions described in ISO 834.

The test specimens should incorporate the usual joints and be suspended in the same manner as they would be in practice.
The temperature rises on the unexposed side (the free side) of the ventilation ducts are recorded. The ventilation ducts are observed and the time when damages are inflicted on the ducts is noted. After the test, the damages on the ventilation ducts are noted.

During the test a constant air flow is maintained through the ducts.

6.2 **Apparatus**

6.2.1 **Main apparatus**

The main apparatus used for the testing is a horizontal furnace, capable of subjecting the specimen to the heating and pressure conditions specified in ISO 834.

6.2.2 **Additional equipment**

6.2.2.1 **Deck**

A light weight concrete deck construction, see Fig. 1, is used.

6.2.2.2 **Furnace thermocouples**

The furnace thermocouples must be designed according to ISO 834. The thermocouples shall be placed approx. 100 mm from the exposed surfaces of the ducts at a height equal to the centre height of the ducts. The thermocouples shall be at the middle of the exposed length of the ducts.

6.2.2.3 **Surface thermocouples**

The surface thermocouples and the pads to cover them shall be identical to those described in ISO 834.

At least 6 thermocouples shall be used for each duct. The thermocouples shall be arranged in 3 planes on the downstream end of the duct:

a) 50 mm from the unexposed surface of the fire barrier
b) 500 mm from the unexposed surface of the fire barrier
c) on a joint placed 200 mm from the unexposed surface of the fire barrier.
Fig. 1. Arrangement of ducts in horizontal furnace.
Each plane shall contain at least 2 thermocouples. See also Fig. 1.

6.2.2.4 Temperature recorder

The temperatures shall be recorded by suitable equipment, capable of recording the temperatures continuously or at intervals not exceeding 2 minutes.

6.2.2.5 Fans

Fans capable of producing an air velocity in the ducts of 2 m/s, measured at ambient temperature before the test.

6.3 Preparation of test specimens

6.3.1 The specimens shall be as in practice with an exposed length of at least 2,4 m.

6.3.2 The penetration of the duct through the fire barrier shall be arranged in such a way, that the penetration itself will not influence the test result in a positive or negative way.

An appropriate sealed penetration is suggested in Fig. 2.

6.3.3 The mid-section of each duct shall have a length of 1,5 m and shall be carried by its own suspension as shown in Fig. 1. The downstream end-section shall be divided so that a joint is located 200 mm outside the test wall.

6.3.4 The test specimens shall be conditioned in such a way that they correspond as closely as possible, in temperature, moisture content and mechanical strength, to the expected state of a similar element in service.

The conditioning of the test specimen may be by natural or artificial means, but a temperature must not be permitted to rise so high that it could impair the fire-resistance properties of the insulating material. It is recommended that a temperature of 60°C should not be exceeded.
Fig. 2. Detail of sealed penetration.

Mineral wool,
density 20–30 kg/m³

19 mm calcium silicate board

2 x 50 mm mineral wool,
density > 100 kg/m³, tight fit on duct

Dimensions in mm
When possible, the moisture content of the insulating material shall be measured at the time of the test, and the value shall be stated in the test report.

6.4 Procedure

6.4.1 The specimen is placed in the horizontal furnace exposed to the standard heating and pressure conditions specified in ISO 834.

The furnace pressure shall be controlled so that an over-pressure (proportional to the pressure in the laboratory) of 10 Pa can be maintained at a height equal to the centre line of the ducts.

6.4.2 The air velocity in the centers of the ducts shall, at the blow in side of the ducts, be 2.0 m/s measured at ambient temperature just before the start of the test and thereafter the fan velocity must not be adjusted.

6.4.3 During the test, the temperature rise in the furnace and on the ventilation ducts shall be recorded and as well as the pressure in the furnace. The specimens shall be observed during and after the test.

6.4.4 After the test is terminated, the specimens shall be inspected.

6.4.5 During the test the following observations shall be recorded:

- the time when suspension or fixing devices can not longer retain the duct in its intended position or when sections of the duct collaps
- the time at which flames, issuing from the exterior surface of the duct wall sections outside the furnace, can be observed
- the time at which a cotton wool pad is ignited when it is applied 25 mm from any crack or hole along the exterior surface of the duct wall sections outside the furnace.

Throughout the test observations shall be made and recorded of all changes and occurrences which do not effect the performance criteria, but could create hazards in a building, including for example:

- deflections
- the emissions of smoke or noxious fumes from the unexposed face of a duct
- a decrease in cross-sectional area of the ducts (in order to provide information on the ability of the ducts to serve as smoke extraction ducts)
- inside burning in a duct.

6.4.6 After the test the following observations shall be recorded:
- the damages to the ventilation ducts
- the extent of any damage on the suspension or fixing devices.

6.5 Duration of the test

6.5.1 Normally the test shall continue until failure occurs under any one of the relevant performance criteria, namely stability, insulation and integrity.

6.5.2 By prior agreement between the sponsor of the test and the laboratory, testing may be continued after insulation failure and until integrity failure occurs, provided that collapse of the specimen has not already occurred.

6.5.3 Alternatively, the test may be terminated after a period determined by prior agreement between the sponsor of the test and the laboratory, even if no failure under any of the criteria has occurred at the end of that period.

6.5.4 The length of time from the commencement of heating for which the test specimen complies with the relevant requirement(s) shall be expressed in minutes.

6.6 Expression of test results

The furnace- and surface temperature rises shall be reported either as plots or in tabular form. The time difference between tabular values shall not exceed 2 minutes.

The furnace pressure shall be reported either as a plot or in tabular form. The time difference between tabular values shall not exceed 5 minutes.
6.7 **Test report**

The test report shall be as comprehensive as possible. Any observations made during and after the test and comments on any difficulties experienced during testing shall be reported. The following essential information shall also be included in the report:

a) Name and address of the testing laboratory  
b) Date and identification number of the report  
c) Name and address of the sponsor  
d) Purpose of the test  
e) Method of sampling  
f) Name and address of manufacturer or supplier of the product  
g) Name or other identification marks of the product  
h) Weight per linear metre and dimensions for the product  
i) Date of supply of the product  
j) Description of the specimen. This shall include a description of the insulation and of the suspension and fixing devices  
k) Conditioning of specimen  
l) Date of test  
m) Reference to this test method  
n) When not identified in the test method, equipment and instruments used  
o) Deviations from the test method, if any  
p) Test results  
q) The fire-technical classification of the ventilation ducts on the basis of specified performance criteria.
1. VERTICAL DUCTS

For ventilation ducts, which are designed to be used vertically only - and therefore have to be tested in a vertical position - the principles given in this method should be followed as far as possible. Such ventilation ducts shall be tested standing on the furnace floor and penetrating the furnace roof slab, and the air velocity up through the ducts shall be 2 m/s as for ducts tested according to this method.

Special considerations should be given to the way in which the supply of fresh air is established.

The furnace pressure should be controlled so that the furnace pressure is higher than the pressure in the duct above the whole length of the duct.

2. FIRE-TECHNICAL CLASSIFICATION

Ventilation ducts

The following performance criteria are recommended for fire-technical classification of the fire resistance of ventilation ducts tested according to this method.

Stability

Stability failure shall be deemed to have occurred for a duct within the furnace or outside the furnace when the duct collapses in such a manner that the duct no longer fulfills its intended function.

Insulation

Insulation failure for a duct shall be deemed to have occurred when the temperature rise above initial temperature in the laboratory on the unexposed surface of the duct outside the furnace exceeds either
- 140 °C as an average value (excluding any joints) or
- 180 °C as a maximum value read by any of these surface thermocouples.

**Integrity**

Integrity failure for a duct shall be deemed to have occurred when the cotton wool pad, referred to in ISO 834, is ignited along the unexposed face of the duct outside the furnace or when sustained flaming, of duration at least 10 s, appears on the unexposed face of the duct outside the furnace.