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Shipbuilding — Engine-room ventilation in diesel-engined ships — Design requirements and basis of calculations

Construction navale — Ventilation du compartiment machines des navires à moteurs diesel — Exigences de conception et bases de calcul

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.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 8861 was prepared by Technical Committee ISO/TC 8, *Shipbuilding and marine structures.*

Annexes A and B of this International Standard are for information only.

Shipbuilding — Engine-room ventilation in diesel-engined ships — Design requirements and basis of calculations

1 Scope

This International Standard specifies design requirements and suitable calculation methods for the ventilation of the engine-room in merchant seagoing diesel-engined ships, for normal conditions in all waters.

Annex A gives graphical estimates of total airflow in the engine-room in ships, divided into

— the airflow for combustion and evacuation of heat emission in the engine-room, excluding the boiler(s), based on the brake power of the diesel engine(s) for propulsion;

— the airflow for evacuation of heat emission from the boiler(s), based on the calculated steam consumption at sea.

Annex B provides guidance and good practice in the design of ventilation systems for ships' engine-rooms.

NOTE — Users of this International Standard should note that, while observing the requirements of the standard, they should at the same time ensure compliance with such statutory requirements, rules and regulations as may be applicable to the individual ship concerned.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards listed below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 31-1 : 1978, *Quantities and units of space and time.*

ISO 31-3 : 1978, *Quantities and units of mechanics.*

ISO 31-4 : 1978, *Quantities and units of heat.*

ISO 3258 : 1976, *Air distribution and air diffusion — Vocabulary.*

3 Definitions

For the purposes of this International Standard, the definitions given below, together with those in ISO 31-1, ISO 31-3, ISO 31-4 and ISO 3258, apply.

3.1 engine-room : Space containing propulsion machinery, auxiliary diesel engines, boilers, generators and major electric machinery, etc.

3.2 ventilation : Provision of air to an enclosed space to meet the needs of the occupants and/or the requirements of the equipment therein.

4 Design conditions

The outside ambient air temperature shall be taken as + 35 °C.

5 Airflow calculation

5.1 Total airflow

The total airflow shall be based on the maximum operation load, taking into consideration the sum of the airflow for combustion air to diesel engines and boilers in accordance with 5.2 and the sum of the airflow necessary for evacuation of heat emission from the installations in the engine-room in accordance with 5.3.

For rating purposes, the simultaneous operation of two auxiliary diesel engines for driving the generators shall be included, unless shaft-driven generators or equivalent values from the electrical load analysis are already included in the total calculation.

Combustion air for, and heat emission from, all stand-by plant, boilers and other installations situated within the engine-room casing but not included in the total operating load shall be ignored.

Spaces separated from the engine-room, such as individual auxiliary machinery-rooms and boiler-rooms shall be calculated separately.

5.2 Airflow for combustion

5.2.1 Sum of airflow for combustion

The sum of the airflow for combustion, q_c, shall be calculated, in cubic metres per second, as follows :

$$q_c = q_{dp} + q_{dg} + q_b$$

where

q_{dp} *is the airflow for propulsion diesel engine combustion,* in cubic metres per second (see 5.2.2);

q_{dg} is the airflow for generator diesel engine(s) combustion, in cubic metres per second (see 5.2.3);

q_b is the airflow for boiler combustion, in cubic metres per second (see 5.2.4).

5.2.2 Airflow for combustion for diesel engine(s) for propulsion

The airflow for combustion of the diesel engine(s) used for propulsion, q_{dp}, shall be calculated, in cubic metres per second, as follows :

$$q_{dp} = \frac{P_{dp} \times m_{ad}}{\varrho}$$

where

P_{dp} is the brake shaft power of the diesel engine(s) for propulsion at maximum power output, in kilowatts;

m_{ad} is the air requirement for diesel engine combustion, in kilograms per kilowatt second.

NOTE — Where specific data for m_{ad} are not available, the following values may be used for calculation :

m_{ad} = 0,002 5 kg/(kW·s) for 2-stroke engines,
0,002 0 kg/(kW·s) for 4-stroke engines.

ϱ = 1,13 kg/m^3 (i.e. the density of air, at + 35 °C, 70 % RH and 101,3 kPa).

5.2.3 Airflow for combustion for diesel engine(s) for generator(s)

The airflow for combustion for diesel engine(s) for generator(s), q_{dg}, shall be calculated, in cubic metres per second, as follows:

$$q_{dg} = \frac{P_{dg} \times m_{ad}}{\varrho}$$

where

P_{dg} is the brake shaft power of the generator diesel engine(s) at maximum power output, in kilowatts (see 5.1);

m_{ad} is the air requirement for diesel engine combustion, in kilograms per kilowatt second.

NOTE — Where specific data for m_{ad} are not available, the following values may be used for calculation :

m_{ad} = 0,002 5 kg/(kW·s) for 2-stroke engines,
0,002 0 kg/(kW·s) for 4-stroke engines.

ϱ = 1,13 kg/m^3 (i.e. the density of air, at + 35 °C, 70 % RH and 101,3 kPa).

5.2.4 Airflow for combustion for boiler(s)

The airflow for combustion for boiler(s), q_b, shall be calculated, in cubic metres per second, as follows :

$$q_b = \frac{m_s \times m_{fs} \times m_{af}}{\varrho}$$

where

m_s is the total steam consumption, in kilograms per second (see 5.1);

m_{fs} is the fuel consumption, in kilograms of fuel per kilogram of steam.

NOTE — Where specific data are not available, m_{fs} = 0,079 kg/kg may be used for calculation.

m_{af} is the air requirement for combustion, in kilograms of air per kilogram of fuel.

NOTE — Where specific data are not available, m_{af} = 16,8 kg/kg may be used for calculation.

ϱ = 1,13 kg/m^3 (i.e. the density of air, at + 35 °C, 70 % RH and 101,3 kPa).

5.3 Airflow for evacuation of heat emission

The sum of the airflow to be evacuated, q_h, shall be calculated, in cubic metres per second, as follows :

$$q_h = \frac{\phi_{dp} + \phi_{dg} + \phi_{tp} + \phi_p + \phi_g + \phi_{el} + \phi_{ep} + \phi_t + \phi_o}{\varrho \times c \times \Delta T} - 0,4\,(q_{dp} + q_{dg}) - q_b$$

where

ϕ_{dp} is the heat emission from diesel engine(s) for propulsion, in kilowatts (see 6.1);

ϕ_{dg} is the heat emission from diesel engine(s) for generator(s), in kilowatts (see 6.2);

ϕ_{tp} is the heat emission from boilers and other heat exchangers, in kilowatts (see 6.3);

ϕ_p is the heat emission from steam and condensate pipes, in kilowatts (see 6.4);

ϕ_g is the heat emission from electrical air-cooled alternator(s), in kilowatts (see 6.5);

ϕ_{el} is the heat emission from electrical installations, in kilowatts (see 6.6);

ϕ_{ep} is the heat emission from exhaust pipes, in kilowatts (see 6.7);

ϕ_t is the heat emission from hot tanks, in kilowatts (see 6.8);

ϕ_o is the heat emission from other components, in kilowatts (see 6.9);

q_{dp} is the airflow for propulsion diesel engine combustion, in cubic metres per second (see 5.2.2);

q_{dg} is the airflow for generator diesel engine combustion, in cubic metres per second (see 5.2.3);

q_b is the airflow for boiler combustion, in cubic metres per second (see 5.2.4);

ϱ = 1,13 kg/m³ (i.e. the density of air, at + 35 °C, 70 % RH and 101,3 kPa);

c = 1,01 kJ/(kg·K) (the specific heat capacity of the air);

ΔT = 12,5 K (the increase of the mean temperature in the engine-room).

6 Calculation of heat emission

6.1 Heat emission from diesel engine(s) for propulsion

The heat emission from diesel engine(s) for propulsion, ϕ_{dp}, shall be calculated, in kilowatts, as follows :

$$\phi_{dp} = P_{dp} \times \frac{\Delta h_d}{100}$$

where

P_{dp} is the brake power of the diesel engine(s) for propulsion at maximum power output, in kilowatts;

Δh_d is the heat loss from the diesel engine(s), in percentage.

NOTE — Where specific data are not available, data according to 7.1 may be used for calculation.

6.2 Heat emission from diesel engine(s) for generator(s)

The heat emission from diesel engine(s) for generator(s), ϕ_{dg}, shall be calculated, in kilowatts, as follows :

$$\phi_{dg} = P_{dg} \times \frac{\Delta h_d}{100}$$

where

P_{dg} is the brake power of the generator diesel engine(s) at maximum power output, in kilowatts (see 5.1);

Δh_d is the heat loss from the diesel engine(s), in percentage.

NOTE — Where specific data are not available, data according to 7.1 may be used for calculation.

6.3 Heat emission from boilers and other heat exchangers

The heat emission from heat transfer plants, ϕ_{tp}, shall be calculated in kilowatts, as follows :

$$\phi_{tp} = m_s \times m_{fs} \times h \times \frac{\Delta h_{tp}}{100} \times B_1$$

where

m_s is the total steam consumption, in kilograms per second (see 5.1);

m_{fs} is the fuel consumption, in kilograms of fuel per kilogram of steam.

NOTE — Where specific data are not available, m_{fs} = 0,079 kg/kg may be used for calculation.

h is the specific enthalpy of the fuel, in kilojoules per kilogram.

NOTE — Where specific data are not available, h = 42 000 kJ/kg may be used for calculation.

Δh_{tp} is the heat loss in percentage of the steam consumption at sea, including 50 % load of the steam transfer plants.

NOTE — Where specific data are not available, data according to 7.2 may be used for calculation.

B_1 is a constant that applies to the location of the boiler(s) and other heat exchangers in the engine room.

NOTE — B_1 = 0,1 for boiler(s) located directly below exposed casing.

6.4 Heat emission from steam and condensate pipes

The heat emission from steam and condensate pipes, ϕ_p, shall be calculated, in kilowatts, as follows :

$$\phi_p = m_s \times m_{fs} \times h \times \frac{\Delta h_p}{100}$$

where

m_s is the total steam consumption, in kilograms per second (see 5.1);

m_{fs} is the fuel consumption, in kilograms of fuel per kilogram of steam.

NOTE — Where specific data are not available, m_{fs} = 0,079 kg/kg may be used for calculation.

h is the specific enthalpy of the fuel, in kilojoules per kilogram.

NOTE — Where specific data are not available, h = 42 000 kJ/kg may be used for calculation.

Δh_p is the heat loss from steam and condensate pipes, in percentage of the energy supplied to the boiler.

NOTE — Where specific data are not available, 0,15 % may be used for calculation.

6.5 Heat emission from electrical alternator(s)

The heat emission from air-cooled alternator(s), ϕ_g, shall be calculated, in kilowatts, as follows :

$$\phi_g = P_g \left(1 - \frac{\eta}{100}\right)$$

where

P_g is the power of installed aircooled alternator(s), in kilowatts (stand-by sets shall be ignored);

η is the alternator efficiency, in percentage.

NOTE — Where specific data are not available, η = 94 % may be used for calculation.

6.6 Heat emission from electrical installations

The heat emission from electrical installations, ϕ_{el}, shall be calculated, in kilowatts, in accordance with one of the following three alternative methods in descending order of preference :

a) where full details of the electrical installations are known, the heat emission shall be taken as the sum of the simultaneous heat emission; or

b) for conventional ships where full details of the electrical installations are not known, the heat emission is taken as 20 % of the rated power of the electrical apparatus and lighting that are in use at sea; or

c) for conventional ships where details of the electrical installations are not known, the heat emission is taken as 10 % of the power of generator(s) installed, and ϕ_{el} is calculated, in kilowatts, as follows :

$$\phi_{el} = P_g \times \frac{10}{100}$$

where P_g is the power of generator(s) installed, in kilowatts (stand-by sets shall be ignored).

6.7 Heat emission from exhaust pipes

The heat emission from exhaust pipes, ϕ_{ep}, shall be calculated in kilowatts, on the basis of a temperature difference of 350 K and thermal conductivity values appropriate to the insulation material used.

NOTE — ϕ_{ep} may be determined from 7.3, in kilowatts per metre of pipe.

6.8 Heat emission from hot tanks

The heat emission from hot tanks, ϕ_t, in kilowatts, shall be based on the sum of the hot tank surfaces contiguous with the engine-room using values as given in table 1.

Table 1 — Heat emission and tank temperature for insulated and uninsulated surfaces

Tank surface	Heat emission ϕ_t, in kW/m^2, at a tank temperature of				
	60 °C	70 °C	80 °C	90 °C	100 °C
Uninsulated	0,14	0,234	0,328	0,42	0,515
Insulation 30 mm	0,02	0,035	0,05	0,06	0,08
Insulation 50 mm	0,01	0,02	0,03	0,04	0,05

6.9 Heat emission from other components

The heat emission from other components, ϕ_o, in kilowatts, e.g. compressors and steam turbines, shall be included when calculating the sum of the airflow for evacuation of heat emission.

7 Graphs

7.1 Heat loss in percentage from diesel engine based on brake power of engine

See figure 1.

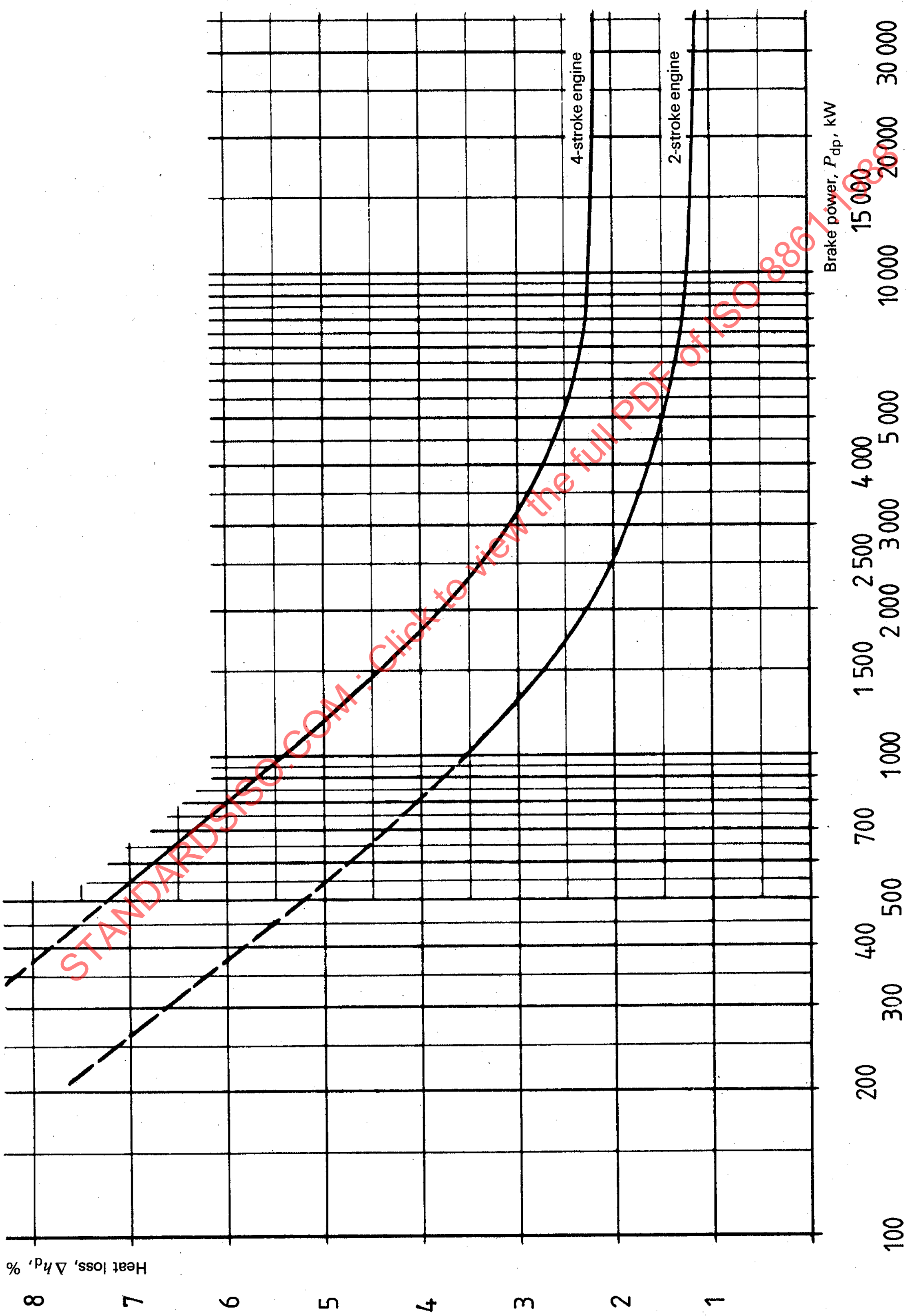

Figure 1

7.2 Heat loss in percentage of steam consumption at sea, including 50 % load of boiler(s) and other heat transfer plants

See figure 2.

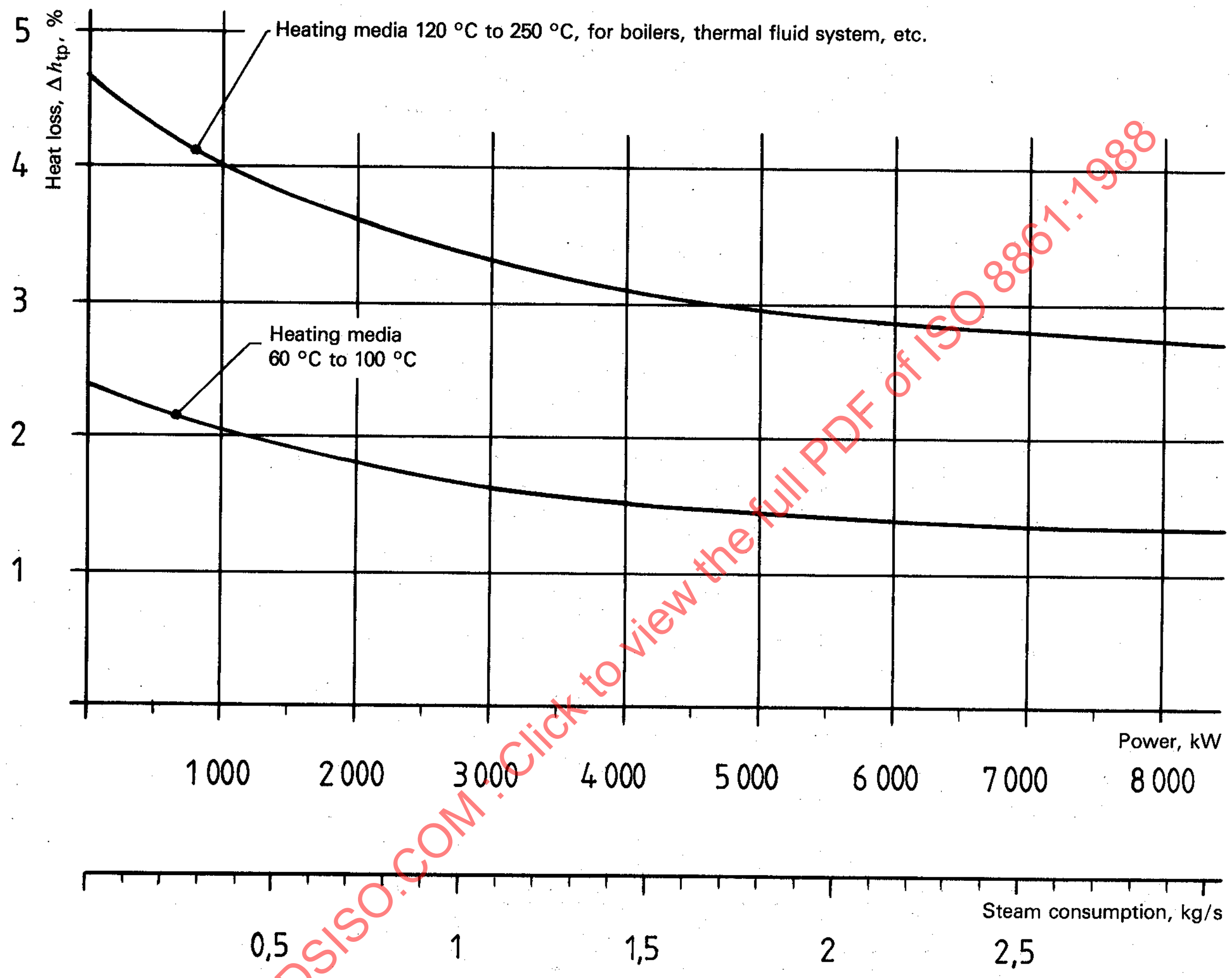

Figure 2

7.3 Heat emission from exhaust pipes

The curve is plotted for a temperature difference, ΔT, of 350 K and insulation thickness between 40 mm and 70 mm. See figure 3.

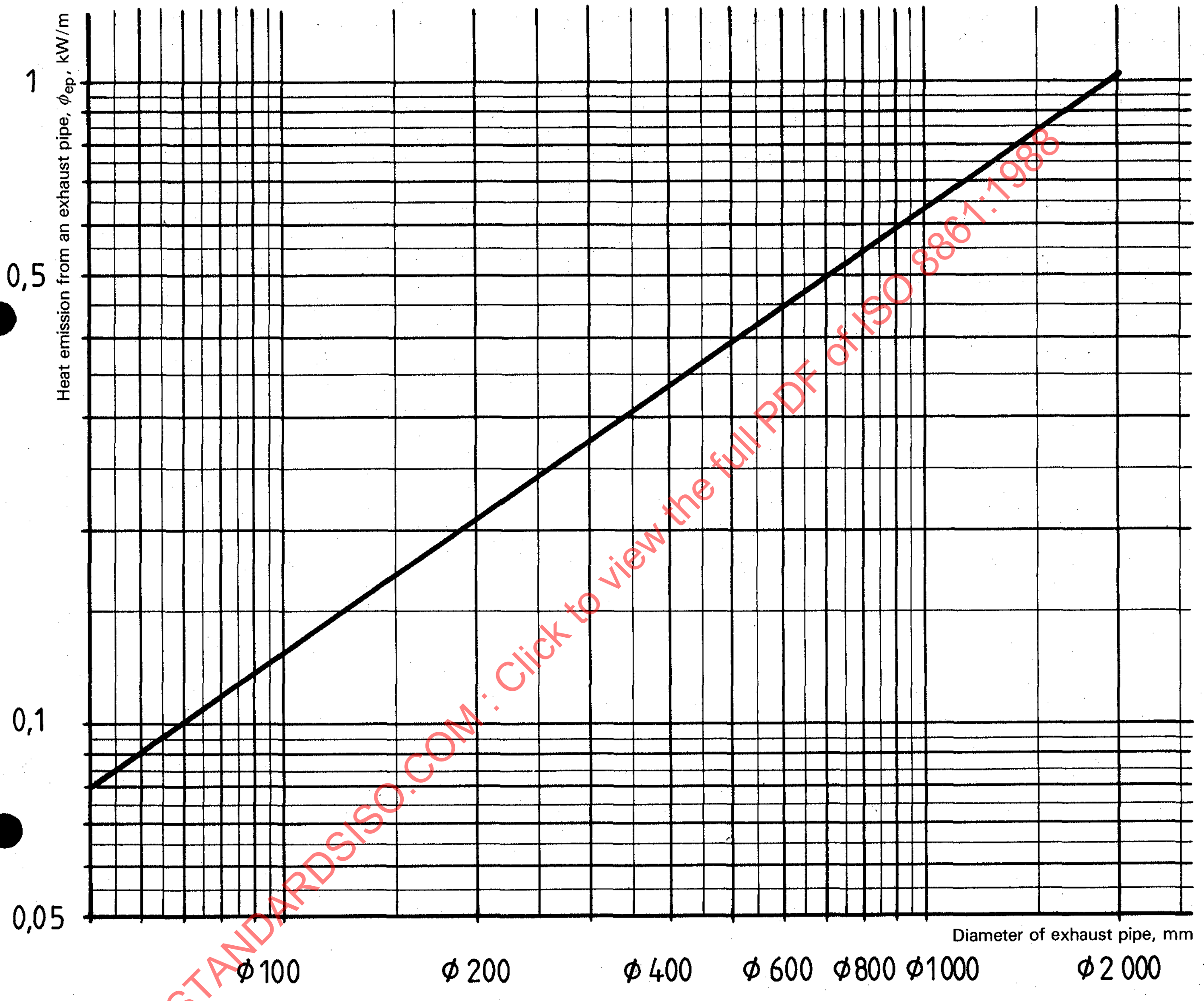

Figure 3