# International Standard 5388

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION•МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ•ORGANISATION INTERNATIONALE DE NORMALISATION

# Stationary air compressors — Safety rules and code of practice

*Compresseurs d'air fixes — Règles de sécurité et code d'exploitation*

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**Descriptors** : air compressors, construction, installing, operating requirements.

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## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO member bodies). The work of developing International Standards is carried out through ISO technical committees. Every member body interested in a subject for which a technical committee has been set up 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.

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.

International Standard ISO 5388 was developed by Technical Committee ISO/TC 118, *Compressors, pneumatic tools and pneumatic machines*, and was circulated to the member bodies in August 1978.



It has been approved by the member bodies of the following countries :

| | | |
|---|---|---|
| Australia | France | Netherlands |
| Austria | Germany, F.R. | Poland |
| Belgium | India | Romania |
| Brazil | Ireland | Sweden |
| Czechoslovakia | Korea, Dem. P. Rep. of | United Kingdom |
| Finland | Mexico | |

The member bodies of the following countries expressed disapproval of the document on technical grounds :

South Africa, Rep. of
USA



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**Section four : Compressor operation and maintenance**



**Annexes**

# Stationary air compressors — Safety rules and code of practice

## Section one : General

### 1 Scope and field of application

**1.1** This International Standard establishes standards for the safe design, construction, installation and operation of stationary and skid-mounted air compressors for general use. It specifies requirements to help minimize compressor accidents and defines general safety practices for the field. Potential hazards associated with compressors are listed and detailed under the following headings in clause 6 :

a) improper lubrication;

b) inadequate cooling;

c) mechanical failures;

d) personal injury;

e) exposure to noise;

f) fires and explosions in the pressure system;

g) crankcase explosions;

h) incorrect installation, operation or maintenance.

This International Standard does not cover the prime movers, which are dealt with in other International Standards.

**1.2** This International Standard is based on the requirement that the compressor components be designed in accordance with recognized good practice and applicable national standards.

**1.3** This International Standard is intended to apply to stationary and skid-mounted air compressors for general use. However, the following types of compressor are specifically excluded :

a) compressors with a shaft input less than 2 kW;

b) compressors with an effective discharge pressure less than 0,5 bar (50 kPa);

c) compressors with an effective discharge pressure exceeding 50 bar (5 MPa);

d) compressors specifically supplying air for breathing, diving or surgery;

e) compressors used for air brake systems

f) ejectors.



### 2 References

ISO 508, *Identification colours for pipes conveying fluids in liquid or gaseous condition in land installations and on board ships.* [1]

ISO 1000, *SI units and recommendations for the use of their multiples and of certain other units.*

ISO 1996, *Acoustics — Description and measurement of environmental noise — Part 1 : Basic quantities and procedures.* [2]

ISO 1999, *Acoustics — Assessment of occupational noise exposure for hearing conservation purposes.*

ISO 2151, *Measurement of airborne noise emitted by compressor/primemover-units intended for outdoor use.*

ISO 2314, *Gas turbines — Acceptance tests.*

ISO 3046, *Reciprocating internal combustion engines : Performance.*

ISO 3448, *Industrial liquid lubricants — ISO viscosity classification.*

ISO 3864, *Safety colours and safety signs.* [3]

ISO 3977, *Gas turbines — Procurement.*

1) At present at the stage of draft. (Revision of ISO/R 508-1966.)

2) At present at the stage of draft. (Revision of ISO/R 1996-1971.)

3) At present at the stage of draft. (Revision of ISO/R 408-1964 and ISO/R 557-1967.)

ISO 3989, *Acoustics — Measurement of airborne noise emitted by compressor units including primemovers — Engineering method for determination of sound power levels.*[1)]

IEC Publication 34, *Rotating electrical machines.*

IEC Publication 45, *Specification for steam turbines.*

## 3 Unit system

Throughout this International Standard, SI units are used. (See ISO 1000.) However, in accordance with accepted practice in the compressed air industry, the bar is used as the unit of pressure (1 bar = $10^5$ Pa).

NOTE — Unless otherwise stated, the term pressure means effective (gauge) pressure.

## 4 Definitions

**4.1 maximum allowable working pressure :** The maximum operating air pressure which the manufacturer specifies for any service condition specified for the compressor or any part to which the term is referred, such as an individual stage or casing.

**4.2 relief valve or safety valve set pressure :** The pressure on the inlet side of a relief valve or safety valve when opening commences.

**4.3 maximum allowable working temperature :** The maximum compressed air temperature which the manufacturer specifies at any service condition specified for the compressor or any part to which the term is referred.

**4.4 maximum expected outlet temperature :** The highest predicted outlet air temperature resulting from any specified service condition including part-load operation.

**4.5 maximum allowable compressor speed :** The highest rotational frequency at which the manufacturer's design will permit operation, assuming overspeed and governor mechanisms are installed and operating.

**4.6 trip speed :** The rotational frequency at which the primemover is automatically tripped out.

**4.7 surge limit :** The limiting flow below which stable operation of a turbocompressor is not possible.

## 5 Compressor categories

Air compressors can be grouped into the following three categories from a lubrication viewpoint :

a) "Oil-free" compressors in which the air does not come into contact with the oil used to lubricate the machine, for example dynamic compressors, labyrinth compressors, diaphragm compressors or compressors with unlubricated piston rings.

b) Oil-lubricated compressors in which the moving parts in the compression chamber are lubricated with oil which is either specially injected for that purpose by a mechanical lubricator or is carried over from other parts of the machine, as in a single-acting trunk type of reciprocating compressor without a crosshead.

Oil-lubricated compressors can be grouped into any of the four main classes below :

1) Air-cooled reciprocating types with a power input up to 20 kW, usually built as single- or two-stage machines up to about 25 bar (2,5 MPa) and often for intermittent service.

2) Air-cooled reciprocating types with a power input above 20 kW, usually built as single-stage machines up to about 3 bar (0,3 MPa), two-stage up to about 25 bar (2,5 MPa) and more stages for higher pressures.

3) Water-cooled reciprocating types, usually built as single-stage machines up to about 5 bar (0,5 MPa), two-stage up to about 25 bar (2,5 MPa) and more stages for higher pressures.

4) Water- or air-cooled rotary vane types, usually built as single-stage machines up to about 4 bar (0,4 MPa) to 7 bar (0,7 MPa) and two-stage up to about 12 bar (1,2 MPa).

c) Oil-flooded rotary compressors in which relatively large quantities of oil are injected into the compression chamber not only to lubricate the working parts but also to assist in sealing and to absorb the heat of compression.

## 6 Potential hazards

The following sub-clauses do not attempt to identify all the possible hazards associated with running machinery but only those which are specific or particularly applicable to stationary air compressors. (See annexes A to E.)

### 6.1 Improper lubrication

**6.1.1** The more common causes of improper lubrication are :

a) use of improper lubricant;

1) At present at the stage of draft.

b) lack of oil;

c) poor maintenance leading to bearing wear with increased clearances and too low oil pressure;

d) insufficient or excessive cooling;

e) overlubrication.

**6.1.2** Malfunction of the lubrication system may lead to a temperature increase which, with continued operation, may introduce the risk of an oil fire.

## 6.2 Improper cooling

The risks stemming from poor cooling are obvious. However, overcooling is also to be avoided because it gives rise to internal cylinder corrosion as the condensate modifies the lubricant.

## 6.3 Mechanical failures

These usually emanate from one or more of the following causes :

a) excessive pressure;

b) overspeed;

c) secondary phenomena caused by improper lubrication;

d) secondary phenomena caused by improper cooling;

e) poor maintenance;

f) excessive vibrations or external forces.

## 6.4 Personal injury

The more common potential causes of injury are :

a) contact with moving parts;

b) contact with hot parts;

c) falling from elevated positions;

d) slipping (for example caused by oil spillage);

e) electrical hazards;

f) use of incorrect tools during maintenance;

g) bursting or explosion of an apparatus or component under pressure;

h) production of smoke or toxic oil vapour arising from accidental ignition of the oil.

## 6.5 Exposure to noise

Noise, even at reasonable levels, can cause irritation and disturbance which over a long period of time may cause severe injuries to the human nervous system and can take forms such as lack of sleep, irritation, etc. Noise at average sound pressure levels exceeding 90 dB(A) is considered to damage hearing. The effect depends on the level and the duration of the exposure. Reference is made to national regulations.

The noise from a compressor has three main components : intake noise, noise radiated from the surfaces of the machine and noise from pipework. The noise level in a room depends on the noise emission from all noise sources in the room and the acoustic properties of the room itself, i.e. the sound absorption of walls, floors and ceiling. The noise emission from the compressors is not always the most important factor for the total noise level. The noise from the prime movers must also be considered. See also annex A.

## 6.6 Fires and explosions in the pressure system

### 6.6.1 Oil-lubricated compressors

It is generally accepted that the occurrence of fires in oil-lubricated compressor systems is dependent on the build-up of oil degradation (oilcoke) deposits. When the pressure system is designed according to the advice given in annex B and the lubricating oil is chosen according to the advice in annex D, both the compressor and the pressure system should remain clean without any oil degradation, thereby reducing the risk of fire. However, with pressure systems that allow the build-up of oil degradation deposits, the quality of the oil is still more important, as is also a regular cleaning of the pressure system (see annex C).

Four factors that affect coke formation are listed below.

a) Rate of oil feed

Excessive oil feed promotes deposit formation.

b) Air filtration

Solids ingested with the suction air thicken the oil and delay its passage through the hot part of the delivery system, increase the time it is subject to oxidation, and hence increase the rate of deposit formation.

c) Temperature

The temperature at which significant oxidation starts is related to the grade and type of oil used. In the case of compressors with water-cooled cylinders, it is recommended that treated or demineralised water be used to prevent the formation and deposit of scale inside the pipework. A failure of cooling water can result in a sharp rise in temperature above the level appropriate to that particular machine, and is a well-recognized cause of fire initiation when the coke layer in the hot zone is thick enough. Failure of valves can similarly raise the temperature and cause dangerous conditions.

NOTE — In compressors with a very high stage pressure ratio, "dieseling" can occur when the cooling is poor and the lubrication is rich. Such a cylinder "explosion" can, under special circumstances, propagate along the delivery pipe as a detonation.

d) Catalysts present, for example iron oxides.