BS EN 12583:2014

BSI Standards Publication

Gas Infrastructure — Compressor stations — Functional requirements

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National foreword

This British Standard is the UK implementation of EN 12583:2014. It supersedes BS EN 12583:2000 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee GSE/33, Gas supply.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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Infrastructures gazières - Stations de compression - Prescriptions fonctionnelles

Gasinfrastruktur - Verdichterstationen - Funktionale Anforderungen

This European Standard was approved by CEN on 20 December 2013.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels

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Foreword

This document (EN 12583:2014) has been prepared by Technical Committee CEN/TC 234 “Gas Infrastructure”, the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by September 2014, and conflicting national standards shall be withdrawn at the latest by September 2014.

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

This document supersedes EN 12583:2000.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association.

Annex G provides details of significant technical changes between this European Standard and the previous edition.

There is a complete suite of functional standards prepared by CEN/TC 234 "Gas infrastructure" to cover all parts of the gas infrastructure from the input of gas into the on-shore transmission network up to the inlet connection of gas appliances, including transmission, distribution, storage, compression, pressure regulation and metering, installation, injection of non-conventional gases, gas quality issues and others. In preparing this standard a basic understanding of gas infrastructure by the user has been assumed.

The gas infrastructure is complex and the importance on safety of its construction and use has led to the development of very detailed codes of practice and operating manuals in the member countries. These detailed statements embrace recognised standards of gas engineering and the specific requirements imposed by the legal structures of the member countries.

Directive 2009/73/EC concerning common rules for the internal market in natural gas and the related Regulation (EC) No 715/2009 on conditions for access to the natural gas transmission networks also aim at technical safety (security) including technical reliability of the European gas system. These aspects are also in the scope of CEN/TC 234 standardisation. In this respect CEN/TC 234 evaluated the indicated EU legislation and amended this technical standard accordingly, where required and appropriate.

In this edition of EN 12583 environmental aspects relevant to the design, construction and testing, operation and maintenance, decommissioning and disposal of compressor stations in the scope of this standard are covered in accordance with CEN Guide 4 and CEN/TR 16388.

This European Standard supersedes all other European Standards for gas compressor stations in the gas infrastructure above 16 bar and with a total shaft power over 1 MW.

According to the CEN-CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

1 Scope

This European Standard describes the specific functional requirements for the design, construction, operation, maintenance and disposal activities for safe and secure gas compressor stations.

This European Standard applies to new gas compressor stations with a Maximum Operating Pressure (MOP) over 16 bar and with a total shaft power over 1 MW. For existing compressor stations, this European Standard applies to new compressor units. Where changes/modifications to existing installations take place, due account may be taken of the requirements of this European Standard.

This European Standard does not apply to gas compressor stations operating prior to the publication of this European Standard.

The purpose of this European Standard is intended to:

— ensure the health and safety of the public and all site personnel,

— to cover environmental issues and

— to avoid incidental damage to nearby property.

This European Standard specifies common basic principles for the gas infrastructure. Users of this European Standard should be aware that more detailed national standards and/or codes of practice may exist in the CEN member countries.

This European Standard is intended to be applied in association with these national standards and/or codes of practice setting out the above-mentioned basic principles.

In the event of conflicts in terms of more restrictive requirements in national legislation/regulation with the requirements of this European Standard, the national legislation/regulation takes precedence as illustrated in CEN/TR 13737 (all parts). CEN/TR 13737 (all parts) gives:

— clarification of all legislations/regulations applicable in a member state;

— if appropriate, more restrictive national requirements;

— a national contact point for the latest information.

This European Standard does not apply to:

— off-shore gas compressor stations;

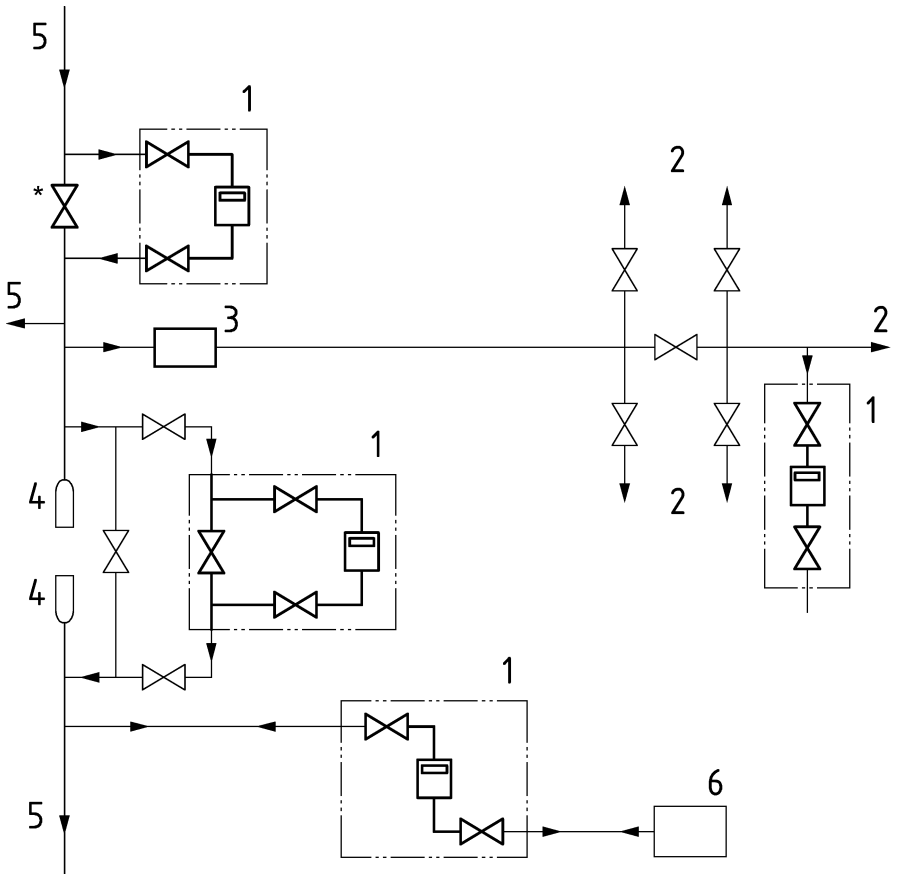
— gas compressor stations for compressed natural gas filling-stations;

— customer installations downstream of the point of custody transfer;

— design and construction of driver packages (see Annex C).

For supplies to utility services such as small central heating boilers reference should be made to EN 1775.

Figure 1 shows a schematic representation of compressor stations in a gas infrastructure.



Key

1	compressor station	4	pig traps
2	distribution system	5	transmission line
3	metering and/or pressure limiting or regulation station	6	storage facility

NOTE Parts indicated in frames by thick lines are within the scope of this European Standard (* part of pipeline but operated by SCS).

Figure 1 — Schematic representation of compressor stations in the gas infrastructure

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 1012-3, *Compressors and vacuum pumps — Safety requirements — Part 3: Process compressors*

EN 1594, *Gas infrastructure — Pipelines for maximum operating pressure over 16 bar — Functional requirements*

EN 12186, *Gas supply systems — Gas pressure regulating stations for transmission and distribution — Functional requirements*

EN 12732, *Gas infrastructure — Welding steel pipework — Functional requirements*

EN 14505, *Cathodic protection of complex structures*

EN 60079-10-1, *Explosive atmospheres — Part 10-1: Classification of areas — Explosive gas atmospheres (IEC 60079-10-1)*

EN 60079-20-1, *Explosive atmospheres — Part 20-1: Material characteristics for gas and vapour classification — Test methods and data (IEC 60079-20-1)*

EN 61000-6-2, *Electromagnetic compatibility (EMC) — Part 6-2: Generic standards — Immunity for industrial environments (IEC 61000-6-2)*

EN 61000-6-4, *Electromagnetic compatibility (EMC) — Part 6-4: Generic standards — Emission standard for industrial environments (IEC 61000-6-4)*

EN 61508 (all parts), *Functional safety of electrical/electronic/programmable electronic safety-related systems (IEC 61508 (all parts))*

EN 61511 (all parts), *Functional safety — Safety instrumented systems for the process industry sector (IEC 61511 (all parts))*

EN ISO 10437, *Petroleum, petrochemical and natural gas industries — Steam turbines — Special-purpose applications (ISO 10437)*

EN ISO 10439, *Petroleum, chemical and gas service industries — Centrifugal compressors (ISO 10439)*

EN ISO 13849-1, *Safety of machinery — Safety-related parts of control systems — Part 1: General principles for design (ISO 13849-1)*

ISO 3977-1, *Gas turbines — Procurement — Part 1: General introduction and definitions*

ISO 3977-2, *Gas turbines — Procurement — Part 2: Standard reference conditions and ratings*

ISO 13707, *Petroleum and natural gas industries — Reciprocating compressors*

3 Terms and definitions

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

3.1
alarm
signal provided to an operator which indicates the approach or the presence of an unwanted event

3.2
availability
ability to be in a state to perform as and when required under given, assuming that the required external resources are provided

Note 1 to entry: This ability depends on the combined aspects of the reliability, the maintainability and recoverability of the item and the maintenance supportability.

Note 2 to entry: Required external resources, other than maintenance resources, do not affect the availability of the item although the item may not be available from the user's viewpoint.

[SOURCE: EN 13306:2010, 4.1, modified − definition altered and original Note 3 not quoted here]

3.3
commissioning
activities required to fill pipework, equipment and assemblies with gas for the first time and to perform test runs to check the system‘s integrity

3.4
compressor surge
flow and/or pressure instability including reverse flow inside a compressor

3.5
compressor unit
set of driver package, gas compressor, control system and their auxiliary equipment which includes unit valves and associated pipework to compress gas

Note 1 to entry: Boundary compressor unit / compressor, see Annex D.

3.6
compressor unit building
structure where one or more drivers with compressors and auxiliary equipment are installed

Note 1 to entry: Operation and maintenance are normally carried out inside the building.

Note 2 to entry: Temporary partitions could be installed to isolate a compressor unit during maintenance (see Figure 2).

3.7
compressor unit housing
structure to contain the compressor unit which can consist of compressor unit building, enclosure or a combination of both

3.8
control room
room housing the control system from which the station personnel can, when necessary, take action on the process

3.9
decommissioning
activities required to take out of service any pipework, stations, equipment or assemblies filled with gas and to disconnect them from the system

3.10
design pressure
DP
pressure on which design calculations are based

3.11
design temperature
DT
temperature on which design calculations are based

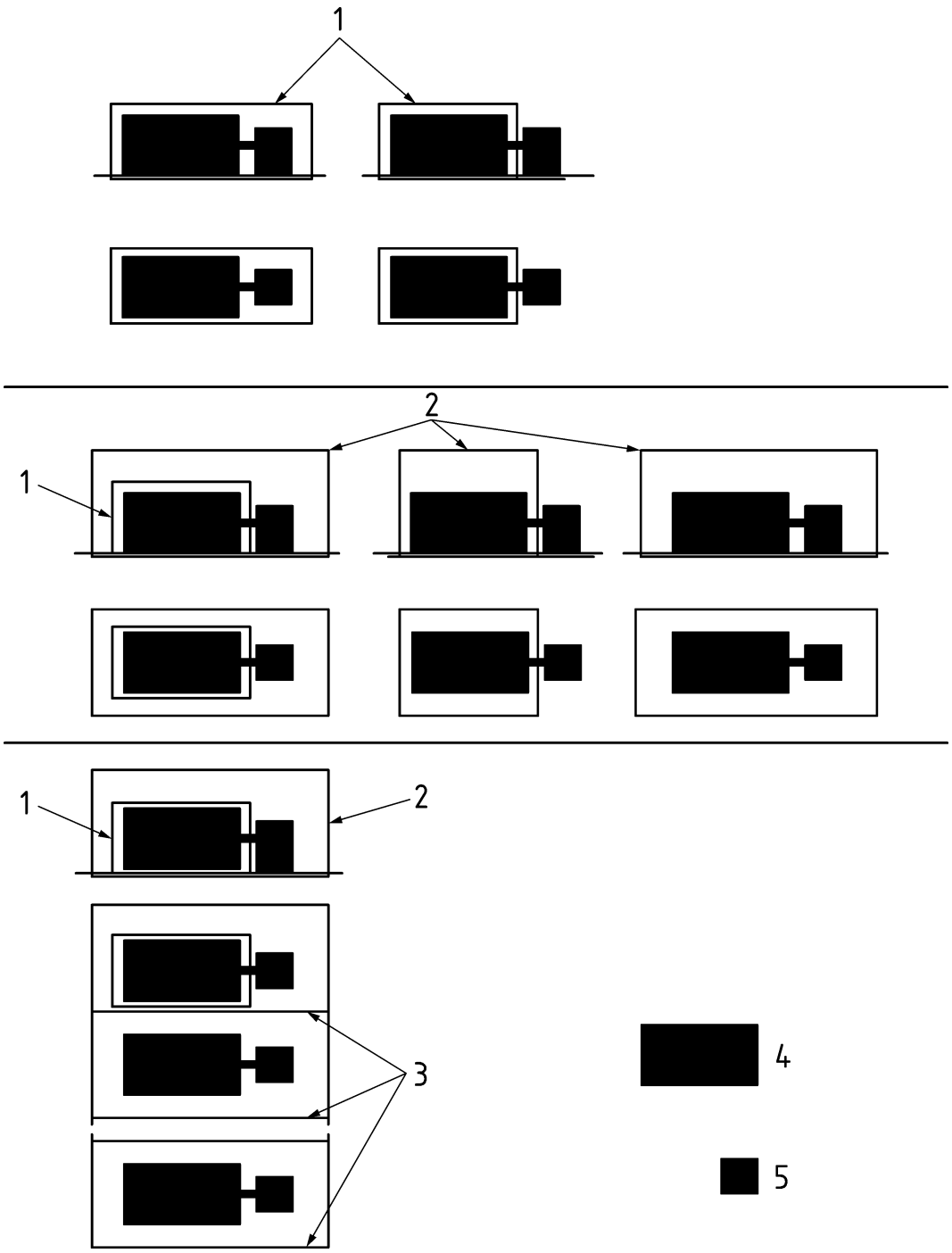
3.12
disposal
activities to be performed after components of a decommissioned gas compressor station have been dismantled

3.13
emergency
situation which could affect the safe operation of the gas infrastructure and/or the safety of the surrounding area, requiring urgent action

3.14
emergency shut down
ESD
actions, in the event of an emergency, to bring the station and/or the compressor unit(s) into a safe condition which requires local manual resetting

3.15
enclosure
structure (a close framework) to surround a driver and/or a compressor and some of their auxiliary equipment in order to protect them from outside influence and avoid possible hazards to personnel

Note 1 to entry: Enclosures could be installed inside the compressor unit building to confine part of a compressor unit (see Figure 2).



Key

1 enclosure

2 building

3 walls or temporary partitions

4 driver

5 compressor

Figure 2 — Compressor unit housing

3.16
fail-safe system
system where loss of power or actuating fluid to any control element, for example an individual relay, valve, actuator, etc. or any failure of these to operate when energized, leads to a safe condition

Note 1 to entry: In particular, all fault shut-down systems operate by de-energizing and not energizing components.

3.17
fuel gas system
system which conditions the fuel gas prior to it entering a gas turbine or gas engine driver package

Note 1 to entry: It can consist of gas filtration, scrubbing, heating, pressure regulating, metering and compression.

3.18
gas
gaseous fuel which is in gaseous state at a temperature of 15 °C under atmospheric pressure (1,013 25 bar absolute)

3.19
gas compressor station
installation used for:

— transporting gas in pipelines;

— compressing gas from a pipeline to a gas storage facility or vice versa

Note 1 to entry: More than one of the above functions could be performed simultaneously or alternately.

3.20
gas infrastructure
pipeline system including pipework and associated stations or plants for the transmission and distribution of gas

3.21
hazardous area
area in which an explosive gas atmosphere is or may be expected to be present, in quantities such as to require special precautions for the construction, installation and use of equipment

[SOURCE: EN 60079-10-1:2008]

3.22
incident
unexpected occurrence which could lead to an emergency situation

3.23
isolation valves
valves which permit isolation of a part or the complete gas compressor station

3.24
maximum incidental pressure
MIP
maximum pressure which a gas system can experience during a short time, limited by the safety devices

3.25
maximum incidental temperature
MIT
maximum temperature which a system can experience during a short time, limited by the safety devices

3.26
maximum operating pressure
MOP
maximum pressure at which a system can be operated continuously under normal conditions

Note 1 to entry: Normal conditions are: no fault in any device or stream.

3.27
maximum operating temperature
MOT
maximum temperature at which a system can be operated continuously under normal conditions

Note 1 to entry: Normal conditions are: no fault in any device or stream.

3.28
occupier
person who manages and controls the work in a compressor station

Note 1 to entry: That person may be a company, an individual manager or the owner.

3.29
operating pressure
OP
pressure which occurs within a system under normal operating conditions

3.30
recycle line
portion of piping to convey gas from the discharge to the suction side of a station or a compressor unit

3.31
redundancy
in an item, existence of more than one means at a given instant of time for performing a required function

[SOURCE: EN 13306:2010, 4.8, modified − second half of the definition altered]

3.32
reliability
ability of an item to perform a required function under given conditions for a given time interval

Note 1 to entry: It is assumed that the item is in a state to perform as required at the beginning of the time interval.

Note 2 to entry: Reliability may be quantified as a probability or performance indicators by using appropriate measures and is then referred to as reliability performance.

[SOURCE: EN 13306:2010, 4.2]

3.33
remote control centre
RCC
continuously manned (24 h) operating centre, from which the gas infrastructure, including stations, are remotely supervised and/or controlled

3.34
services pipework
pipework in which fluids other than the gas are conveyed

EXAMPLE Air, oil, water or steam.

3.35
settling out pressure
SOP
resulting pressure in the pipework and equipment after the compressor station or the compressor unit(s) are turned off or isolated without depressurization

3.36
station auxiliary equipment
plant and equipment which supports the driver package and gas compressor

EXAMPLE Electrical power, lighting, gas treatment systems.

3.37
station control system
SCS
system to monitor, control and protect the compressor station and supervises the Unit Control System (UCS)

Note 1 to entry: In addition it can interface with the Remote Control Centre (RCC).

3.38
shut down
sequence to put out of operation and isolate

Note 1 to entry: System venting may follow.

3.39
shut off
action to put out of operation and isolate devices or parts of a compressor unit or of a compressor station

3.40
suction pipework
pipework upstream of the compressor

3.41
temporary operating pressure
TOP
pressure at which a system can be operated temporarily under control of the regulating devices

3.42
test pressure
TP
pressure at which pressure tests are conducted

3.43
unit control system
UCS
system to start, stop, monitor, control and protect the compressor unit

3.44
vent system
system including pipework, valves, silencer, if any, and stack to convey venting gas to a safe location

4 Safety

The occupier shall have a Safety Management System (SMS) for its gas infrastructure and a Pipeline Integrity Management System (PIMS) for its gas transmission pipelines. Reference should be made to EN 16348.

Safety aspects relating to the specific requirements of gas compressor stations are covered by the present European Standard. For those aspects not covered by the present European Standard, relating to the equipment installed, reference shall be made to the relevant standards in force.

The safety measures shall be based on the prevention of incidents (deterministic approach) or on probability considerations. These measures take into account the safety and environmental conditions existing at the time of construction.

5 Asset management and quality assurance

A management system shall be applied to ensure systematic and coordinated activities and practices through which the organization optimally and sustainably manages its assets and asset systems, their associated performance, risks and expenditures over their life cycle for the purpose of achieving the organisational strategic plan.

A quality system should be applied to all the activities in the application of this European Standard.

EN ISO 9001 and EN ISO 9004 should apply.

6 Environmental constraints

Reference shall be made to applicable regulations.

Methods for emissions reduction should be evaluated. In combustion systems, primary dry methods to avoid pollution production shall be preferred.

Energy conserving approaches should also be considered in order to reduce emissions.

Areas with the potential of leakages or spills of polluting fluids shall be protected with non-penetrating, contamination preventing structures; for instance liquid tight floors and spill basins.

Consideration should be given to the requirements of EN ISO 14001 and EN ISO 50001.

Waste materials (e.g. used oil, filters, chemical waste, packing materials, etc.) shall be separated in accordance with local legislation and be disposed of by certified waste disposal companies or organizations.

7 Design, construction and testing

7.1 General requirements for design

7.1.1 General

Each component of a station shall be capable of performing the function required and shall satisfy the standards according to which it has been designed.

The station design shall consider the technical facilities and procedures together with the environmental, health and safety aspects. The station design shall consider reliability and availability issues.

To ensure the security of supply, gas transportation systems have to be available at the time a transport requirement has to be met.

In accordance with the present boundary conditions of the network and in compliance with the maintenance concept, the requirements in regard to the availability and the minimization of the downtime of the system shall be set by the operator.

Measures to increase the availability can be:

— multiple stream installation of the system;

— redundant design of important system components;

— minimizing common equipment;

— monitoring concept;

— fault management, including spare parts and spare units.

Whichever option is taken will need to form part of the initial design concept.

To meet the required availability, the compressor station shall be designed to provide redundancy of one gas compressor unit (e.g. of the unit with the highest capacity) at the critical transport conditions. This may not be necessary where the gas infrastructure provides adequate level of availability.

7.1.2 Safety and the environment

7.1.2.1 General

In the design and construction of a compressor station safety measures shall be considered. Those requirements appropriate for the particular project shall be incorporated.

7.1.2.2 Environmental impact

The planning of any proposed station shall be systematically approached to identify and record environmental issues which could be affected. Detailed assessments may need to be undertaken to ascertain the impact of the station on environmentally sensitive areas in accordance with national legislation.

The system shall be designed, operated and maintained to ensure that gas venting to the atmosphere is minimized.

7.1.2.3 Ground conditions

Ground conditions shall be investigated and considered in order to establish that they are suitable for the proposed installations.

7.2 Location and station lay-out

7.2.1 Location

The geographical location of a compressor station should be determined by the process requirements taking into account the requirements of 7.1.2.

External structures outside the station shall be far enough away to minimize the possibility of fire propagation into the station.

High voltage overhead power lines shall be outside the station, at least one mast height from the station fence.

Future development of the surrounding area should also be taken into consideration.

7.2.2 Station lay-out

7.2.2.1 General

Each station shall be designed such that it takes account of:

— the surrounding area;

— the requirements of filtering, metering, compression, cooling related to the gas process;

— possibility of isolating the station or parts of the station from the gas transmission system by operating a number of valves;

— weather conditions;

— possible adverse effects due to subsidence, settlement, corrosion or any other likely causes;

— the maintenance needs without interrupting the gas flow;

— the prevention of unauthorized operation.

A particular arrangement of compressor station components on a specific site shall be arrived at by considering aspects which include:

— safety;

— accessibility for operation and maintenance;

— pipework configuration;

— noise emission;

— aesthetics;

— potential growth.

7.2.2.2 Fenced areas

Appropriate measures shall be taken to prevent unauthorized persons entering the station and having access to the station equipment.

To facilitate the evacuation of personnel from a fenced station in case of emergency, there should be at least two quick opening gates in the fence. Alternative arrangements may be made, provided that they offer the same ease of escape.

The main entrance shall be dimensioned and constructed to permit easy access to firefighting equipment.

7.2.2.3 Restricted areas

A compressor station shall be considered as a restricted area where only authorized personnel can enter.

Entry into the station shall only be by persons authorized by the occupier.

Inside the station, certain areas should have limited access.

EXAMPLE Control room, high voltage devices, compressor unit housing.

7.2.2.4 Hazardous areas

Hazardous areas shall be classified in accordance with EN 60079-10-1 or national regulations.

All equipment shall be designed, installed and maintained in accordance with the hazardous area classification.

7.2.2.5 Internal roads and yards

The roads and areas within the compressor station shall be built to provide access to all plant and equipment for operation, maintenance and emergencies. They should be designed for the expected vehicle use.

7.2.2.6 Distances between internal installations

Distances between internal installations shall be designed to:

— allow safe operation and maintenance;

— ensure that one device does not cause malfunctions to any other device;

— allow emergency actions.

7.2.2.7 Electrical systems

Consideration shall be given to the location and separation distances of power lines within the station boundary. The spacing between power systems and other equipment and structures shall be considered.

Buried power lines may cross the internal area only when necessary to supply the station or station components.

7.2.2.8 Signs and signals

As a warning, suitable visual signs shall be posted at the entrance of the station. Appropriate signs and/or signals shall be provided within the station to warn personnel about the possibility of hazards.

7.2.2.9 Hot surfaces

Where the surface temperature exceeds the auto-ignition temperature of any flammable gas, vapour, mist or liquid leak that can impinge on the surface, additional measures shall be taken to prevent such leaks, not readily dispersible by any dilution ventilation airflow from contact with the surface.

Values of auto-ignition temperature from EN 60079-20-1, or otherwise from a verified source, shall be used.

7.3 Pipework

7.3.1 Design considerations

The layout of all pipework shall provide sufficient clearance for operation, maintenance or renewal of any part of the pipework and shall allow the necessary access to the plant and equipment.

Low points where liquids could accumulate shall be recognized during design and provided with suitably valved drain points.

The choice of the pipe diameters shall be made with regard to acceptable pressure loss and allowable noise levels.

Pipework within the station shall be designed in accordance with the relevant standards to ensure the safety and integrity of the system during its design life. Requirements related to pipes, valves, pressure vessels, flanges, gaskets, bolts, nuts and other fittings are indicated in EN 1594.

A flexibility analysis should be made to check that the complete pipework system is not over stressed or subject to excessive deflections and movements during normal operation or testing.

Undue pulsation and vibration shall be avoided in the station gas pipework.

Forces and moments imposed on all components shall be kept within the values defined by the manufacturer.

For compressor unit pipework, see also 7.4.5.9.

7.3.2 Valves

All valves shall be type tested or individually tested by third party.

For buried pipework the choice of valves shall be carefully considered.

When flanged valves are installed underground, a service pit should be provided.

7.3.3 Gas cleaning

If liquid and solid particles, which could disturb the gas process, cannot be ruled out in the gas stream, gas cleaning system such as filter(s), and/or separator(s) shall be installed at least at the entry to the compressor station. Additionally it can be necessary to install separators in the outlet pipework of the station to protect downstream equipment.

The liquid and solid particles recovered in the gas cleaning system shall be collected.

7.3.4 Gas coolers

Gas coolers may be installed to protect downstream pipework so as not to exceed its MOT or to improve gas transmission efficiency.

Gas cooler control shall be provided by UCS or SCS depending on the installation per compressor unit or per station.

7.3.5 Pressure reduction stations

Pressure reduction stations shall be in accordance with EN 12186.

7.3.6 Recycle line

To accommodate particular operating conditions a station recycle line can be provided.

EXAMPLE Flow capacity regulation.

7.3.7 Vent systems

The pipework of the compressor station shall be equipped with vent valves for depressurization.

Vent systems shall terminate in designated safe areas.

Pipework downstream of the vent and pressure relief valves shall be designed based on expected pressure and temperature.

Where several vent systems are joined together in a common manifold, back flow shall be prevented. Pressure relief valve systems on separate compressor units should not have common vent systems.

For automatic venting systems, adequate safety distances shall be provided around the gas vent stack to avoid damage to equipment and personnel in case of the vent gas being ignited.

7.3.8 Station isolation system

The compressor station's gas pipework shall be capable of being isolated from the gas transmission pipeline network.

The isolation system shall be activated in the event of an emergency or for operational/maintenance purposes.

In the event of activation for emergency or maintenance, remote reset shall not be possible.

7.3.9 Corrosion protection

Buried metallic structures and equipment shall be protected against corrosion in accordance with EN 1594, by applying external coating or cathodic protection or a combination of both.

Above ground metallic structures and equipment shall be properly protected.

Where necessary reference shall be made to EN 14505 where compressor stations are described as complex structure.

7.3.10 Services pipework

All services pipework shall be designed and installed taking into account the physical and chemical characteristics of the fluid and the relevant recognized code of practice.

All services pipework shall be protected against corrosion by the choice of suitable material (e.g. stainless steel) or by means of painting, active/passive protection as appropriate.

7.3.11 Standard colour code

Pipe systems should be identified through a standard colour painting code to distinguish different media.

7.4 Compressor unit

7.4.1 General

The gas compressor unit shall be designed for automatic operation.

A failure of the electrical power supply to the auxiliaries for a specified time period should not trip the compressor unit, except during start-up.

The compressor unit should include facilities to permit a test run under the conditions specified by the occupier.

For all equipment complete updated documentation shall be provided.

All machinery, instruments, valves, controllers etc. shall be identified with durable tags, as shown on the relevant drawings and shall be referred to in the operation manuals.

The technical solutions described in the following subclauses (e.g. driver and compressor types) are not intended to be restrictive. However, this standard has been developed with the experience on the solutions mentioned below.

7.4.2 Driver

7.4.2.1 General

The driver and its auxiliaries should be sized for operation with due margins to cover power fluctuations, ageing and fouling.

For gas fired engines an automatic purge of the gas path shall be provided prior to ignition. Purging shall displace at least three times the volume of the entire system (including the stack) before firing the compressor unit. In cases where alternative precautions are taken, this may not be necessary.

The chemical and physical condition of the fuel and process gas shall be agreed between the manufacturer of the driver and the occupier and shall be maintained during any operating conditions.

7.4.2.2 Gas turbines

Gas turbines should have an adequate amount of boroscopic ports for inspection of all critical internal parts. A manual barring device should be installed to rotate the gas turbine shafts.

In addition to the functional requirements stated in this clause, reference shall be made to ISO 3977-1 and ISO 3977-2, for which exceptions may be taken. Exceptions should be agreed between the involved parties.

ISO 21789 should be applied.

7.4.2.3 Gas engines (Reciprocating engines)

Gas engines should be of a proven industrialised design.

The impact of fuel gas methane number should be taken into consideration to avoid the knocking phenomenon.

Purging should not commence until the exhaust system has fallen below 450 °C.

Pressure-relief valve(s) on the crankcase shall be provided with a flame arrester.

The pressure compensating line provided on the gas engine crankcase shall be piped to a safe area and should be provided with an oil separator.

In addition to the functional requirements stated in this clause, reference shall be made to the relevant ISO standards for which exceptions may be taken. Exceptions should be agreed between the involved parties.

7.4.2.4 Electric motors

Electric motors shall be in accordance with the relevant EN standards.

Harmonics limitation systems shall be designed to comply with local regulation.

For integrated electrical compressors specific devices shall be implemented to avoid any gas to migrate through the main electrical power supply cables or any wire crossing the casings.

7.4.2.5 Steam turbines

Reference shall be made to EN ISO 10437 for which exceptions can be taken. Exceptions should be agreed between the involved parties.

7.4.3 Compressor

7.4.3.1 General

Compressors shall be suitable for starting under line pressure conditions defined by the occupier.

The requirements for gas tightness under all working conditions and the allowable gas leakage rate to atmosphere, especially for shaft sealing, shall be specified.

Procedures for alignment, offset values and maximum tolerances for misalignment shall be outlined in the operating manuals.

The relevant gas composition including contamination shall be given to the manufacturer. The compressor material shall be suitable for the given gas composition. If corrosion is to be expected, a corrosion allowance to the material thickness shall be added.

The compressor shall be designed to fulfil the pressure requirements stated in 7.5.6.

EN 1012-3 shall be applied.

In addition to the functional requirements stated in this subclause, reference shall be made to the relevant ISO standards for which exceptions may be taken. Exceptions should be agreed between the involved parties.

7.4.3.2 Centrifugal compressors

The design of the compressor should allow complete inspection and change of rotating parts without the need to remove the suction and discharge pipes.

A performance diagram of the compressor showing the “inlet capacity” vs. “head” shall be given by the manufacturer.

Suction and discharge pressure sensing elements should be as close as possible to the compressor flanges; in any case unstable pressure signals shall be avoided.

Thrust bearings shall be designed to withstand all conditions of loading including starting with the compressor casing pressurized at the maximum incidental pressure (MIP).

Bearings should be replaceable without the need to remove the end caps.

Easy accessibility to bearings and seals for maintenance shall be provided. For integrated electrical compressors, easy access should be considered during compressor design phase.

In addition to the functional requirements stated in this subclause, reference shall be made to EN ISO 10439 for which exceptions may be taken. Exceptions should be agreed between the involved parties.

7.4.3.3 Reciprocating compressors

Reciprocating compressors shall be protected by devices preventing the entry of liquid slugs into the compressor cylinders.

In addition to the functional requirements stated in this subclause, reference shall be made to ISO 13707 for which exceptions can be taken. Exceptions should be agreed between the involved parties.

7.4.4 Unit Control System (UCS)

7.4.4.1 General

The UCS shall control and monitor the compressor unit continuously.

It shall be designed to:

— carry out the automatic sequences for starting, loading, operation, unloading and stopping the compressor unit;

— protect automatically and under all conditions the compressor unit;

— avoid unsafe conditions in case of UCS malfunction;

— prevent the compressor unit going into a hazardous condition in the event of power supply interruption;

— have the features for checking and testing.

In addition:

— the status of all UCS controlled process valves should be shown in the unit control panel. Main steps in any start up and stop sequence should be shown on the unit control panel;

— all field wiring, including that on the compressor unit skid, should be tagged at both ends of every wire section;

— the UCS design shall be insensitive to interference in low voltage cables, data cables, radio, ground loops, rectifiers and other systems. Reference shall be made to EN 61000-6-2 and EN 61000-6-4;

— the UCS shall be located in a non-hazardous area or be designed to fulfil the hazardous area requirements.

The UCS may be integrated in the station control system.

7.4.4.2 Modes of Operation

The UCS should be designed to allow the following modes of operation:

— local operation, in manual or automatic mode;

— automatic operation by station control system (remote control);

— any other operations such as cranking, test, washing;

— off.

By switching the modes, no unsafe conditions shall occur.

Any emergency stop signal shall have priority to all modes.

“Local” mode operation shall have priority over “remote” control operation.

“Off”-mode means that the compressor unit is still monitored by the UCS, but cannot be started.

The various modes of operation shall be clearly described in the manuals.

7.4.4.3 Protective System

The protective system includes the installation from the sensing device to the shut off device on the driver package.

EXAMPLE To the shut off device for the fuel gas line or to the power switch of the electric drive.

The protective system shall be designed in such a way that its functioning is maintained in all modes of operation and ambient conditions.

If the value of one of the process variables exceeds a threshold value the protective system shall automatically shut down the compressor unit.

The protective system shall not be self-resetting.

It shall be possible to check the setting and proper functioning of the protective system.

The response of the protective system shall be transmitted to the remote control centre.

The design of safety related parts of the protective system shall be in accordance with EN ISO 13849-1.

7.4.4.4 Monitoring and Control System

The monitoring and control system shall operate the compressor unit within the design conditions.

The response of the monitoring system shall be transmitted to the remote control centre.

7.4.4.5 Signalling system

Process and equipment status and alarm displays shall be designed to enable operating problems to be quickly located in order to minimize compressor unit shut-down time.

All events triggered by the unit control system influencing the operation of the station should be linked to the SCS.

7.4.4.6 Emergency shutdown system

To ensure a safe shutdown procedure in the event of an emergency, each compressor unit shall be equipped with an emergency shutdown system (ESD) in accordance with EN 61508:

— hardwired or

— consisting of a dedicated fail-safe programmable logic system or

— a combination of both.

In the event of a compressor unit emergency shutdown, the suction and discharge valves of the compressor unit shall be closed automatically, the anti-surge valve shall be opened and the compressor unit and the compressor unit pipework shall be depressurized.

The rate of depressurization shall be carefully considered in respect of environmental constraints and technical requirements.

EXAMPLE 1 Dry gas seal system specification.

If the driver is a gas fuelled driver, the system shall operate directly to cut off the driver fuel supply. In general, the driver primary energy supply shall be cut.

EXAMPLE 2 Steam for steam turbine and power for electric motors.

Manual initiation shall be possible from strategic points including the control room.

7.4.4.7 Over-pressure protection system

See 7.5.6.

7.4.4.8 Over-temperature protection system

See 7.5.7.

7.4.4.9 Anti-surge system

A centrifugal compressor shall have a control and protection system to prevent operation in surge condition.

The following operating conditions shall be taken into account when designing the anti-surge protection system:

— start;

— stop;

— low flow and/ or low suction pressure conditions.

The anti-surge protection system shall be continuously in operation.

A recycle line from discharge to suction with anti-surge valve(s) shall be installed. A fast opening function is required and the response time of the anti-surge valve shall be evaluated.

The anti-surge valve shall be opened quickly in the following cases:

— relevant signal from the anti-surge control system;

— compressor shutdown;

— failure in the anti-surge control system.

The surge control line shall be determined to ensure safe operation and provide optimum performance. This shall be confirmed during compressor unit start-up (see 7.8.3).

7.4.4.10 Over-speed protection system

Should the drive system be able to operate the compressor at speeds unacceptably higher than the maximum speed of the compressor, the compressor unit shall be equipped with a protection system to ensure that the trip speed is not exceeded. With multiple-shaft units, protection shall be provided for each shaft.

The over-speed protection system shall be tested at the manufacturer's works and checked during compressor unit start-up (see 7.8.3).

7.4.4.11 Protection against excessive vibrations

All equipment shall be designed to avoid excessive vibration.

EXAMPLE Rotating elements, foundations, piping and auxiliary equipment.

When compressor unit components are supplied by more than one manufacturer, the responsible compressor unit packager shall obtain an analysis of the lateral and torsional vibration characteristics of the complete rotor system within the range of expected operating conditions.

All rotating elements of a gas compressor unit should be balanced and tested for vibration during a test run at the manufacturer's workshop.

All equipment shall be checked for vibration during construction and commissioning.

The gas compressor and driver shall be monitored continuously for vibration during operation.

The vibration monitoring system installed should provide the possibility of an on-site analysis of the measurements.

Vibration measurements should be made at the most significant locations, i.e. where the highest vibration levels are expected.

Each shaft of the gas compressor unit should be monitored individually.

Vibration alarm and shutdown limits shall be such that equipment operation at excessive vibration levels is prevented. Shutdown limits should be in line with the manufacturer's design criteria and occupier experience.

7.4.4.12 Condition monitoring system

Where fitted, a condition monitoring system can record performance, vibration and other process variables for trend analysis. It can be used to optimize maintenance procedures in order to increase reliability. The system should receive the necessary data from the UCS and shall not affect the operation of the UCS.

7.4.5 Unit auxiliary equipment

7.4.5.1 General

Attention shall be given to the compressor unit auxiliaries regarding the environmental influences which can adversely affect their functioning.

7.4.5.2 Starting system

The starting system of gas turbines shall be adequate to start the compressor unit, including purging, turning, cranking and washing. In the event of consecutive unsuccessful remote starts the compressor unit shall be automatically locked out of operation. The number of unsuccessful starts before lockout occurring should be agreed between the manufacturer and the occupier.

The starting system shall interrupt the energy supply as quickly as possible in the event of a malfunction.

The use of gas starting systems venting to atmosphere should be avoided.

7.4.5.3 Fuel gas system

Each compressor unit shall have two fuel gas shut off valves in series with valve proving, one valve of which is close to the engine.

A compressor unit control valve shall also be installed close to the engine.

During compressor unit start-up, it shall only be possible to supply fuel to the combustion system after the ignition device has been activated.

The fuel supply to each unit shall be provided with a block and bleed system to prevent gas leakage into the combustion system during standstill. Each fuel gas line leading into the compressor unit housing shall have a shut off and a vent valve outside the compressor unit housing.

The chemical and physical condition of the fuel gas shall be agreed between the manufacturer of the driver and the occupier and shall be maintained during any operating conditions.

7.4.5.4 Lubricating oil system

The lubricating oil system shall provide adequate oil supply for all operating conditions including standstill.

A back up powered system should be installed.

Provision shall be made to maintain the lubricating oil at a suitable temperature, such that the unit can be started and run under all specified ambient temperatures.

If this oil is also used for sealing, the system should be designed to minimize gas entrainment from the seal gas/oil interface.

7.4.5.5 Compressor shaft sealing system

The shaft sealing system shall be designed to prevent uncontrolled gas escaping in all operating modes including start-up, shutdown and standstill periods.

The shaft sealing system shall be capable of maintaining the compressor pressure while running or during standstill.

Gas emission from the shaft sealing system to the environment shall be considered during design and operation.

The shaft sealing system shall be designed to accept at least the settling-out pressure SOP to keep the compressor pressurized when stopped.

The settling-out pressure shall be specified to the compressor manufacturer.

With shaft sealing systems based on oil, special attention shall be paid to the increased possibility of fire in the vicinity of hot surfaces. The number of non-welded connections should be minimized and valves and vessels should be arranged outside the area of hot surfaces.

For sealing systems using high pressure liquids the differential pressure between the liquid and the gas shall be monitored.

The seal oil system shall be capable of satisfying the following conditions:

— if the main pump fails, the standby pump shall come on line without initiating an emergency shutdown;

— starting the standby pump shall initiate an alarm;

— the sealing system shall have an emergency rundown capacity;

— sealing during prolonged shutdown periods while the compressor is kept under pressure.

For dry gas sealing, the gas leakage shall be monitored.

Further requirements may be given by EN 1012-3.

7.4.5.6 Air inlet and exhaust systems for gas turbines and gas engines

The air filtration system shall meet the requirements for air cleanliness specified by the driver manufacturer or by the occupier.

Filter pressure loss shall be monitored and when reaching a certain level it shall actuate an alarm and, if necessary, shall cause the compressor unit to shut down.

Blow-in doors in the air inlet duct may be installed depending on environmental circumstances.

The exhaust gas system of a gas engine shall be designed and arranged in such a manner that over-pressure, as a result of defective ignition, causes no damage.

EXAMPLE This can be achieved by using pressure-resistant components and/or pressure-relief devices.

The exhaust duct should be insulated in order to reduce the heat rejection inside the compressor unit housing.

If shut off devices are provided in the inlet/exhaust system, their open position during start up and operation shall be monitored.

7.4.5.7 Gas detection system

The compressor unit housing shall be equipped with a gas detection system.

Gas detectors shall be located at strategic points to monitor gas leakage, and shall be arranged so that their efficiency is not impaired by adverse air flow, i.e. by a high air demand for heat removal.

The gas alarm system shall detect the minimum gas concentration levels to avoid spurious shutdowns with a maximum alarm level of 20 % of lower explosive limit (LEL), this level shall at least initiate an alarm.

The gas alarm system shall initiate the emergency shutdown of the compressor unit/s in the affected compressor unit housing at levels which ensure safety above 20 % LEL but at no time exceeding 40 % LEL (see 7.4.4.6).

All gas supply lines leading into the compressor unit housing shall also be isolated and depressurized.

If a blower supported ventilation of the compressor unit housing is installed, it should be automatically started and latched on, if not yet running, at the alarm level in order to reduce gas concentration.

Due account shall be taken of possible stagnant areas and of highly ventilated areas which reduce the gas detection effectiveness.

NOTE Gas engine and gas turbine gas detection systems may operate at lower alarm and shutdown levels.

7.4.5.8 Fire protection system

The compressor unit housing shall be equipped with a fire detection system.

A fire extinguishing system should also be installed.

Fire detectors shall be located at strategic points and arranged so that their efficiency is not impaired by adverse air flow, i.e. by high air demand for heat removal or oil spray.

The fire alarm system shall initiate the emergency shutdown of the compressor unit/s in the affected compressor unit housing (see 7.4.4.6).

All gas supply lines leading into the compressor unit housing shall also be isolated, depressurized and the air flow through the compressor unit housing ventilation system shall be interrupted.

In addition the electrical supply to the compressor unit not necessary for the safety of the compressor unit itself, should be interrupted.

The fire alarm system shall have priority over the gas alarm system.

If a fire extinguishing system is installed which reduces the oxygen content or is hazardous to personnel, an audible and visible alarm shall be given at least inside the compressor unit housing and a suitable delay shall be provided prior to releasing the extinguishing agent to enable personnel to escape from the housing.

7.4.5.9 Unit pipework design criteria

The process pipework shall be designed so that it does not produce forces and moments exceeding those allowed for the compressor according to manufacturer's specifications.

Gas pipework installed above floor level shall be designed in a way which allows unhampered access to the compressor unit housing and to the gas carrying systems and does not block escape routes.

Flanged joints shall be used only where strictly required for assembly and maintenance. Butt welding and weld neck flanges should be used.

Screwed connections should be avoided.

Equipment shall be provided to prevent the inflow of gas into spaces made accessible when the compressor or parts thereof have to be opened during maintenance.

EXAMPLE This could include double block and bleed systems in the connecting pipes, shut off valves equipped with double seals and a vent valve.

Suitable connections shall be provided in order to purge prior to the opening of the compressor or returning it to service after opening. Suitable purging connections shall also be provided between a check valve and an isolation valve.

The compressor supplier shall approve the joint face alignment between the compressor suction and discharge flanges and the pipework before final connection of the flange faces.

For each compressor unit a check valve shall be installed in order to prevent reverse flow.

In addition to the functional requirements stated in this clause, reference shall be made to EN 1594 and EN ISO 10439. Exceptions from EN ISO 10439 may be taken and should be agreed between the parties.

EN 12732 for welding requirements shall be applied.

7.4.5.10 Shut off and pressure relief system

It shall be possible to shut off and depressurize the compressor between the compressor unit isolation valves.

The system between the compressor unit isolation valves of the compressor shall be designed for the compressor outlet design pressure.

If there are parts of the system which cannot withstand the maximum operating pressure at compressor outlet they shall be protected by their own safety devices.

7.4.5.11 Gas cleaning

In addition to the station gas cleaning system, compressor unit suction strainers should be provided to safeguard the compressor from extraneous solid materials getting inside, particularly during the initial period of operation.

If a strainer is installed in the compressor suction line, the differential pressure should be monitored.

The suction pressure shall be measured downstream of the strainer.

7.4.5.12 Vents and drains

Any gas escaping from piston rod packings, shaft seals, pressure relief devices and seal oil tanks shall be removed in a safe manner.

Gas venting to the atmosphere shall be minimized.

Drains should be routed to collecting systems.

7.4.5.13 Couplings

The compressor and the driver should be directly coupled.

Coupling assemblies and/or torque-meter devices shall be dynamically balanced after the final manufacturing stage and shall be match-marked to prevent later incorrect re-assembly.

7.4.6 Foundations

The foundation and the supporting frame structure of the compressor unit shall be capable of absorbing the static and dynamic loads imposed by the compressor unit as well as the forces transmitted by the connecting gas pipework.

7.4.7 Compressor Unit Housing

7.4.7.1 General

The compressor unit housing should be designed to comply with local requirements and circumstances, climate and operating conditions.

7.4.7.2 Heating and Ventilation

Compressor unit components and/or housing should be heated to enable the compressor unit to be started without extensive pre-warming and prevent damage caused by condensation or freezing.

The compressor unit housing should be ventilated by either a natural or forced ventilation system to remove heat emitted by the installed equipment. The ventilation can also be taken into account when defining the hazardous area classification.

Care shall be taken to ensure that the operating temperatures of the installed equipment are not exceeded, and that the functions of the gas and fire detecting devices are not negatively influenced.

The air inlet openings for the natural ventilation system shall be arranged near the floor at the lowest level of the compressor unit housing and the outlet openings shall be placed at the highest possible level.

7.4.7.3 Maintenance requirements

The compressor unit shall be designed to permit easy disassembly and removal for maintenance.

Additionally easy access to areas for maintenance should be provided.

Major components shall have clearance to permit removal with suitable lifting equipment. This equipment should have at least a slow lift capability.

All special lifting tackle, spreader beams, supports, tools and any other facility required for the maintenance of the compressor, its driver and auxiliaries, shall be specified by the manufacturer.

7.4.7.4 Insulation and cladding

No surface that can be in contact with personnel during operation shall have a temperature higher than 60 °C.

The insulation should be installed in such a manner that disassembly and maintenance are possible without damage to it.

7.5 Station Control and Automation

7.5.1 Station Control System (SCS)

The SCS shall be designed:

— to permit manned or unmanned, manual and automatic operation of the compressor stations by means of communication with the station components;

— to ensure safe and reliable control and monitoring of the whole gas compressor station;

— to communicate with the remote control centre (RCC) if operated remotely.

The SCS should avoid the station operating in a hazardous manner in the event of a power supply failure.

The SCS should be located in a non-hazardous area.

The design of the safety related parts of the protective system shall be in accordance with EN ISO 13849-1 or EN 61511 (all parts).

7.5.2 Station emergency shutdown systems

To ensure a safe shutdown procedure in the event of abnormal conditions, the compressor station shall be equipped with an emergency shutdown system hardwired or consisting of a dedicated programmable logic system.

The station emergency shutdown system shall initiate the compressor unit emergency shutdown system close the station valves in a pre-programmed sequence. Depressurization of the station can follow.

In case of emergency shutdown, remote reset shall not be possible.

Partial shut off of individual machine assemblies or individual station sections is acceptable.

Manual initiation shall be possible from strategic points and from the control room.

The duration of the emergency shutdown depressurization shall be carefully considered.

For the compressor unit see 7.4.4.6.

7.5.3 Gas detection system

In addition to the gas detection systems installed in the compressor unit housings, gas detection systems should be installed in other buildings where gas can be accumulated.

(See also 7.4.5.7)

7.5.4 Fire protection system

The resulting alarms and actions of the fire protection system shall have priority over all other alarms and control actions.

In addition to those installed in the compressor unit housing (see 7.4.5.8), the fire detection system shall be provided in accordance with the regulations in force.

A water supply should be available nearby or in the station for firefighting.

Fire risks from oil, gas and electrical equipment require the provision of appropriate fixed (manual and/or automatic) or portable extinguishers.

7.5.5 Station valve control and supervision

The SCS actuated valves associated with the station sequences shall be capable of manual operation either at the valve or in the local control room. Automatic operation from the local control room or from the RCC may be provided depending on the occupier's operational policy.

The positions of the valves associated with the emergency shutdown system should be indicated on the station control system display.

Actuators can be pneumatic, hydraulic oil, spring, electric powered or a combination of these. The choice of actuator type shall depend on location and function of the valve.

7.5.6 Over-pressure protection system

The station and its components shall be protected against inadmissible over-pressure. Such over-pressure could be caused by the compressor or by a malfunction of a pressure regulator or other devices in other parts of the station or outside the station.

The over-pressure protection system shall comply with the following limits valid for the design pressure (DP) greater than or equal to maximum operating pressure (MOP):

$$OP \leq MOP < TOP < MIP < TP$$

For the pressure margins reference shall be made to EN 1594.

Safety devices shall automatically initiate a shutdown to prevent a higher pressure than the MIP.

On any pressurized gas system, over-pressure protecting devices shall be installed.

On a compressor station the over-pressure protection shall consist of two independent systems:

— the compressor unit protective system (see 7.4.4.3) provided by the UCS;

— the station safety pressure limiting system provided by the SCS.

If the MOP of the station gas pipework and equipment is higher than the MOP of the pipeline taking into account the pressure losses between the compressor discharge and station outlet then the station protective system shall be triggered by the MIP of the pipeline as well as by the MIP of the station.

All station equipment related to the compression process shall be tested at a pressure higher than MIP.

Different pressure level systems with different MIP can be accepted within the station with special precautions.

If the MOP of all gas pressurized vessels is equal or higher than MOP of the relevant station pipework, no special protective installation against over-pressure is required for these vessels.

A settling out pressure could exceed MOP temporarily due to temperature changes, but under no circumstances it shall exceed MIP.

The protective system shall operate as a fail-safe system.

For compressors safety reference shall also be made to EN 1012-3.

7.5.7 Over-temperature protection system

It shall be ensured that a gas temperature rise in any operating mode does not lead to the design temperature limit being exceeded either in a plant section or in the connecting pipeline.

Plant sections, required to operate at different temperatures, shall be allowed for in the design.

Safety devices shall automatically initiate a shutdown to prevent a higher temperature than the MIT.

The protective system shall operate as a fail-safe system.

7.6 Electrical installation and power supply

7.6.1 General

The electrical installation shall be in accordance with the requirements of the relevant EN standards.

7.6.2 Electrical power supply

The electrical power supply system shall be designed to ensure safe operation of the compressor station.

In the event of the main power supply being lost, an uninterruptable power supply system shall be available to ensure that the compressor station remains in a safe condition and to prevent major damage to components.

7.6.3 Electrical installation

In order to protect the built structures and technical equipment against the effects of lightning suitable measures are required. Information on lightning protection is given in EN 62305.

Fire consequences should be considered to design the routing of the interconnecting cables to avoid negative influence between station components.

7.7 General requirements for construction

7.7.1 General

Construction of the station shall be carried out in compliance with the national and local legislation in force.

In addition, compressor unit installation shall be in accordance with both the manufacturer's and occupier's requirements.

7.7.2 Execution of work

Work shall be carried out in such a manner so as to ensure the safety of the workforce and third parties, and protection of property.

The working area shall be marked out and a fence should be installed and any underground and overhead services identified.

If the facilities on a compressor station are to be extended while the station is in operation, then procedures in Clause 8 shall be applied.

7.7.3 Station pipework construction

Station pipework shall be constructed to comply with the relevant clauses of EN 1594 and EN 12732.

7.8 Testing and acceptance

7.8.1 General requirements

A procedure for testing and acceptance activities shall be prepared and agreed between the parties. The procedure should define the sequence of checks and tests to be carried out and their methodology and should contain a general description of the station and its components.

A responsible manager shall be nominated by the parties and be responsible for ensuring that the procedure is carried out.

7.8.2 Pre-commissioning

During pre-commissioning all components and devices necessary for safe and reliable operation shall be calibrated and functionally checked and/or tested and be documented.

Protective system testing shall be recorded and documented. Other testing should also be recorded.

All pipework shall be cleaned and should be flushed, dried and preserved on site before commissioning. The clean condition shall be documented.

The documentation required by the relevant authorities shall be available before commissioning.

7.8.3 Commissioning

Purging of the station pipework and equipment shall be conducted in such a way that any gas/impurity mixtures are removed in a non-hazardous manner. Purge gases shall not be vented inside buildings.

Pressurizing to the operating pressure shall be done in a controlled way with a stop(s) for leakage testing and/or checks.

Following the station pressurization, start-up and shutdown, and any other relevant sequences shall be tested and checked.

Specific safety precautions shall be taken during the introduction of gas, e.g. fire extinguishing equipment, gas detector, warning signs.

The first start-up of the compressor unit shall only be initiated after completing the commissioning of all the involved systems. The protective equipment related to safety shall be tested and be able to operate under the control of UCS and under the control of SCS. The auxiliary systems shall be tested and be able to operate under the control of the UCS and SCS as applicable.

Attention shall be paid on site to determine the surge line to optimize the operating range.

During these tests adjustable parameters and limits should be set.

The station gas pipework should be checked for excessive pulsation and vibration during commissioning.

7.8.4 As built records of the station

An archive containing documents regarding the components installed shall be compiled on completion of the work. The records shall include all risk assessments and details of all hazardous areas.

EXAMPLE The contained documents can be: material and test certificates, declarations of conformity, as built drawings, design calculations, specification, welding log.

These documents shall be kept up to date.

The technical documentation shall always be available to the operator operating the equipment. This may be in electronic form.

7.8.5 Handover

Final handover of the station shall be carried out after successful completion of all commissioning tests and checks and the issue of a final countersigned report. This report shall include archives, construction drawings, specifications and all documents relating to the design and construction, all the documentation required by the Authorities and the instructions for operation and maintenance activities.

Partial handover can be considered only if safety requirements are not compromised.

7.8.6 Responsibility for safety

The point at which the occupier becomes solely responsible for safety shall be agreed between the operator's nominated manager and the contractor. This agreement shall be documented.

At this point all defects shall have been jointly acknowledged as being insignificant for the start-up of operations.

8 Operation

8.1 Introduction and basic requirements

The occupier is responsible for formulating policy with regard to station operation.

Methods and procedures set forth herein serve as a guide and do not relieve the operator from the responsibility for more prudent action. Therefore, each operator having gas compressor stations within the scope of this European Standard shall:

a) set up an operating organization;

b) have written procedures covering normal operation;

c) have written procedures covering failures and emergencies;

d) have specific procedures for planned operational circumstances;

e) manage the procedures;

f) provide training for personnel;

g) nominate a person to be responsible for safety.

8.2 Operating organization

The occupier shall provide trained personnel to ensure correct operation of the plant.

A standby and call out system for operational personnel should be set up to deal with any abnormal operating conditions.

The admission of third parties to the station shall be regulated. Depending on their function, these persons shall be instructed and informed about:

a) dangers or hazards likely to be encountered;

b) site safety procedures;

c) any changing conditions which could affect their work or safety.

8.3 Instruction procedures

8.3.1 General

The occupier shall provide information needed for the safe operation and management of the compressor station. Instruction procedures shall be familiar to all personnel.

8.3.2 Instructions for normal situations

Operating procedures shall include the following information:

a) equipment descriptions, and as built drawings;

b) operating manuals and all other general administrative arrangements;

c) the maximum and minimum operating conditions;

d) instructions for the RCC and local control room including procedures for starting, operating and shutdown of the compressor unit as well as procedures for all other devices on the station;

e) instructions for handling of fluids and materials;

f) instructions for venting procedures considering environmental impact;

g) requirements of relevant legislation or recommendations of regulatory authorities;

h) documentation and information to be submitted to the authorities;

i) procedures to collect and analyse operational data;

j) requirements for permits to work (including operation in hazardous areas).

8.3.3 Instructions for failure or emergency situations

In the event of a major failure or an emergency, all necessary measures shall be taken without delay to rectify the fault.

Potential faults and the procedures to be followed in the event of their occurrence shall be included in the emergency procedures.

The emergency procedures shall contain the following information:

a) procedures defining responsibilities and actions to be taken in the event of a failure or an emergency;

b) procedures for alerting personnel on duty or standby and for mobilising emergency equipment and material;

c) a list of emergency equipment, materials and their location;

d) detailed site emergency drawings showing escape routes and instructions to deal with failures or emergencies in order to enable station personnel to deal with fire, gas leakage and any other relevant occurrences;

e) procedures for limiting the effect of failures or emergencies and for rectifying any damage caused;

f) a list of internal and external personnel, services and agencies which have to be notified in the event of a failure or emergency.

8.3.4 Procedures for specific planned situations

Procedures for specific planned circumstances which refer to facilities presenting hazards due to construction or maintenance requirements should contain the following information:

a) detailed schemes and drawings with instructions to be followed by both the occupier and third parties when the station is pressurized and major construction or maintenance works are in progress;

b) precautions to be taken when operating in or close to hazardous areas.

These procedures should be agreed with the occupier and the involved parties.

When a compressor station or a compressor unit is out of service for a limited period or permanently, specific arrangements should be made to preserve the station components.

For decommissioning, see Clause 10.

8.4 Management of operating procedures

The occupier shall:

a) keep records and retain them to meet operational and legislation requirements;

b) collect and keep up-to-date necessary data to ensure implementation of the procedures;

c) update the procedures from time to time on experience gained;

d) update the procedures following modifications which may affect the procedures.

All instructions should be in writing and may be developed from operating experience, direct use of manufacturer's instruction manuals, or a combination of both.

Following each failure or emergency, personnel activities shall be reviewed to determine whether the procedures were effectively followed by examining the log of events and actions taken.

Consideration should be given to review the need for changes in the written procedures as can be indicated by responses to the emergency.

8.5 Training of personnel

Each occupier shall establish a training program which will provide operating personnel with the necessary skills to carry out safely their job assignments.

The program should include relevant policies, procedures and job methods involved with specific reference to the instruction procedures. It should also include safety courses.

Effectiveness of the training should be verified, and reaction to actual or simulated situations (including emergency) should be tested.

8.6 Safety precautions

8.6.1 Prevention of gas explosion and fire

In areas where a hazardous atmosphere could occur, smoking, use of naked lights, and unprotected engine exhausts shall be prohibited. Appropriate signs shall be displayed.

NOTE Reciprocating engines and gas turbines will require special precautions.

All portable electrical equipment shall comply with the relevant regulations and only be used in locations where the hazardous area classification allows it.

Exceptions are allowed if specific precautions in accordance with 9.7.2 are taken.

8.6.2 Storage of combustible materials

Small quantities of flammable or combustible materials for daily use may be allowed in compressor housing. Larger quantities shall be stored in a separate area or structure located at a sufficient distance away from the compressor housing, so as not to present a fire hazard.

Oil or gasoline storage tanks shall comply with the regulations for the storage of such products.

Storage tanks should be marked with the contents description and the flash point of the contained substances.

8.6.3 Venting

Specific precautions shall be applied when venting flammable gas.

In the event of manual venting, each source of ignition shall be removed from the area and fire extinguishers shall be provided. Manual venting during adverse atmospheric conditions should be avoided.

For automatic venting systems the designated safe area shall be considered as a restricted area.

9 Maintenance

9.1 Introduction and basic requirements

The occupier is responsible for formulating policy with regard to station maintenance.

In particular, the occupier shall:

a) set-up a maintenance organization;

b) have written procedures covering maintenance;

c) maintain facilities in conformance with these procedures;

d) manage the procedures;

e) provide training for personnel;

f) provide appropriate maintenance tools and equipment.

9.2 Maintenance organization

A maintenance organization shall provide safe and reliable operation of the equipment. A planned workload shall be agreed between the occupier and other involved parties.

The occupier should make qualified personnel available and have a spare parts policy to ensure correct maintenance of the station.

9.3 Maintenance procedures

9.3.1 General

The occupier shall provide procedures for maintenance of the compressor station based on the manufacturer‘s recommendations, operational experience and authorities requirements as appropriate.

The procedures shall be made familiar to the maintenance personnel.

Maintenance procedures shall include the following information:

a) description of the maintenance organization showing the responsible person(s);

b) description of the compressor station, including a list of all the equipment;

c) relevant as built drawings;

d) scheduled inspection and maintenance specifications;

e) references to related manuals, documentation and safe working practices;

f) specific instructions that are required for certain repairs;

g) historical records of the results of maintenance carried out on the compressor station main components.

9.3.2 Gas compressor units

The compressor unit shall be periodically checked to:

— verify safety devices;

— ensure compliance with environmental legislation.

Further, the compressor unit should be periodically checked to:

— verify output power and fuel consumption;

— maintain reliability;

— avoid failures, especially major failures which could lead to excessive costs and downtime periods.

9.3.3 Pipework

The condition of the pipework and its components shall be regularly checked and maintained.

9.4 Management of the maintenance procedures

The occupier shall set up an organization to:

a) keep records to administer procedures and training carried out;

b) keep records to administer spare parts and tools;

c) collect and keep up to date necessary information to ensure proper implementation of the procedures;

d) update the procedures from time to time on experience gained;

e) retain records for a period of time to be determined by the occupier or requested by legislation.

9.5 Training of personnel

Each occupier shall establish a training program which will provide the station maintenance personnel with the necessary skills to carry out safely their job assignments.

The training program should be based on the appropriate equipment in use and all relevant information to undertake maintenance tasks in a safe manner.

This program should include maintenance procedures, safe job methods, materials, tools and equipment involved.

Emphasis should be placed on safety precautions related to the potential hazards of gas.

9.6 Maintenance tools and equipment

Appropriate tooling and equipment to perform the maintenance tasks shall be used.

9.7 Safety

9.7.1 General

No maintenance shall be carried out without the prior approval of the occupier.

The occupier shall give his approval for the work to be carried out when he is satisfied that it can be performed safely.

To ensure maximum safety, a permit to work should be issued by the authorized person.

It shall also be the responsibility of the personnel undertaking maintenance work to ensure that it is safe for the work to commence and that it is performed in a safe manner.

9.7.2 Safety precautions

During maintenance activities, the following shall be applied where appropriate:

a) prevent gas from entering isolated equipment by appropriate devices i.e. double block and bleed or spectacle plates (blank plate);

b) prevent back flow to compressor units if a common downstream vent is utilized. Specific precautions could be necessary where relief valves are part of the isolated equipment;

c) prevent the driver from starting while maintenance work is in progress;

d) isolate the power supply to any electric devices.

The equipment shall be returned into service in a safe and orderly manner.

Unless a specific permit to work is given or dedicated control of the atmosphere is taken, the following requirements shall be applied for work in hazardous areas:

e) the use of sparking tools shall not be allowed unless the area is proven to be safe and gas-free;

f) the use of torches, portable flood lights, extension leads and electrically powered tools or equipment unless they are certified for use in hazardous areas shall not be allowed;

g) the operation of internal combustion engines that power trucks, cars, air compressors, pumps, generators and other maintenance equipment in hazardous atmospheres if not provided with special devices for such atmospheres shall not be allowed unless the area is proven to be safe and gas-free;

h) welding or carrying out other works causing sparks shall not be allowed unless the area is proven to be safe and gas-free;

In the above mentioned cases fire extinguishers should be provided.

9.7.3 Safety devices

Instrumentation and equipment associated with the safe operation of the station shall be regularly examined and maintained; also it should be subject to periodic tests to determine that it is:

a) fit for purpose;

b) functioning correctly at the required values;

c) protected from any outside influence that might prevent proper operation.

This includes but is not limited to the following:

— fire and gas detection and protection systems;

— over-pressure and over-temperature protection systems;

— remotely operated shut off equipment;

— emergency shutdown system.

10 Decommissioning and disposal

10.1 Decommissioning

If the station is to be decommissioned, it shall be isolated from the main pipeline by closing and locking the station valves so that they cannot be opened accidentally. It could also be necessary to use isolating blind flanges.

Specific precautions could be required if liquid hydrocarbons are contained in the pipework.

If major works are to be carried out on the station pipework, involving grinding, welding, drilling and any other potentially hazardous activities, the station pipework shall be purged to remove the gas; to avoid purging for minor works, specific procedures and equipment shall be applied.

If a section of the station is to be decommissioned the following safety measures shall be taken:

a) the section shall be isolated from gas-carrying pipelines or other installations on the station. The ends of the pipelines shall be effectively isolated;

b) the section shall be purged to remove gas by an appropriate method.

10.2 Disposal

Compressor stations which are to be disposed shall be decommissioned as stated in 10.1.

All the equipment should be removed.

Attention shall be given to safely isolate any external services into the station.

EXAMPLE These are considered as electrical power, water and drainage.

All work shall comply with the appropriate national and local environmental legislation.

Annex A
(informative)

Boundary of a gas compressor station

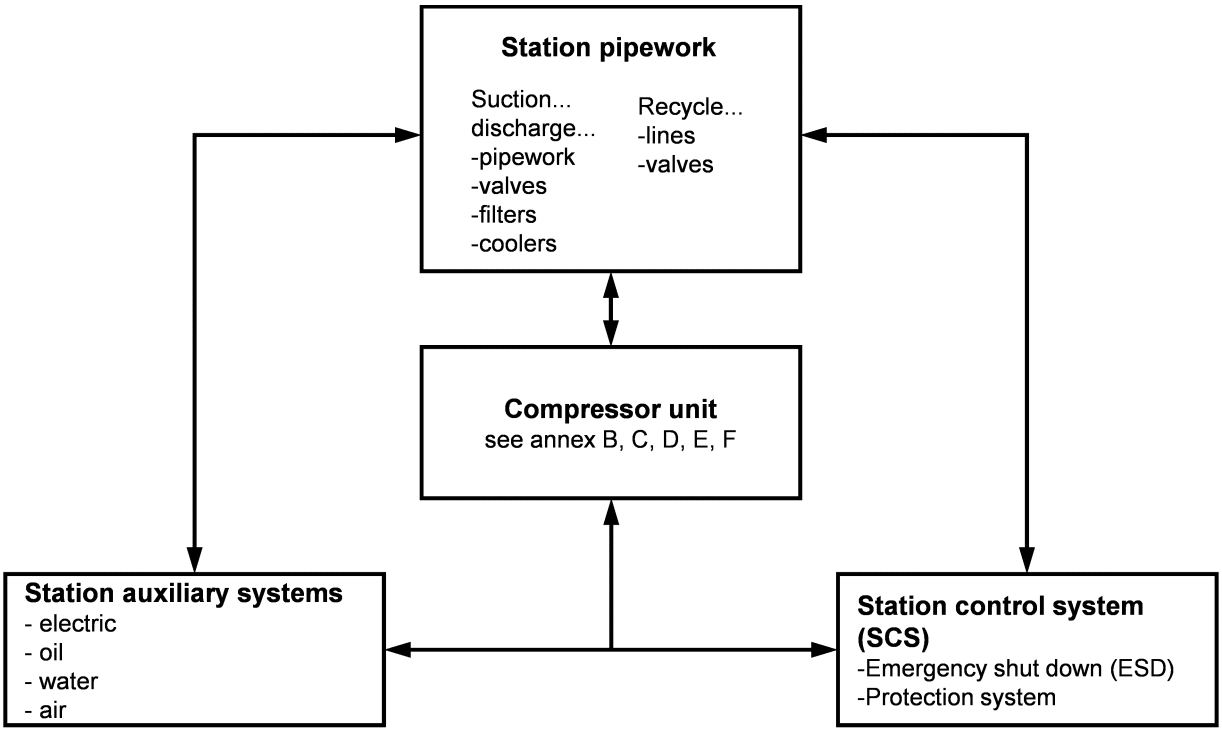


Figure A.1 — Typical elements of a gas compressor station

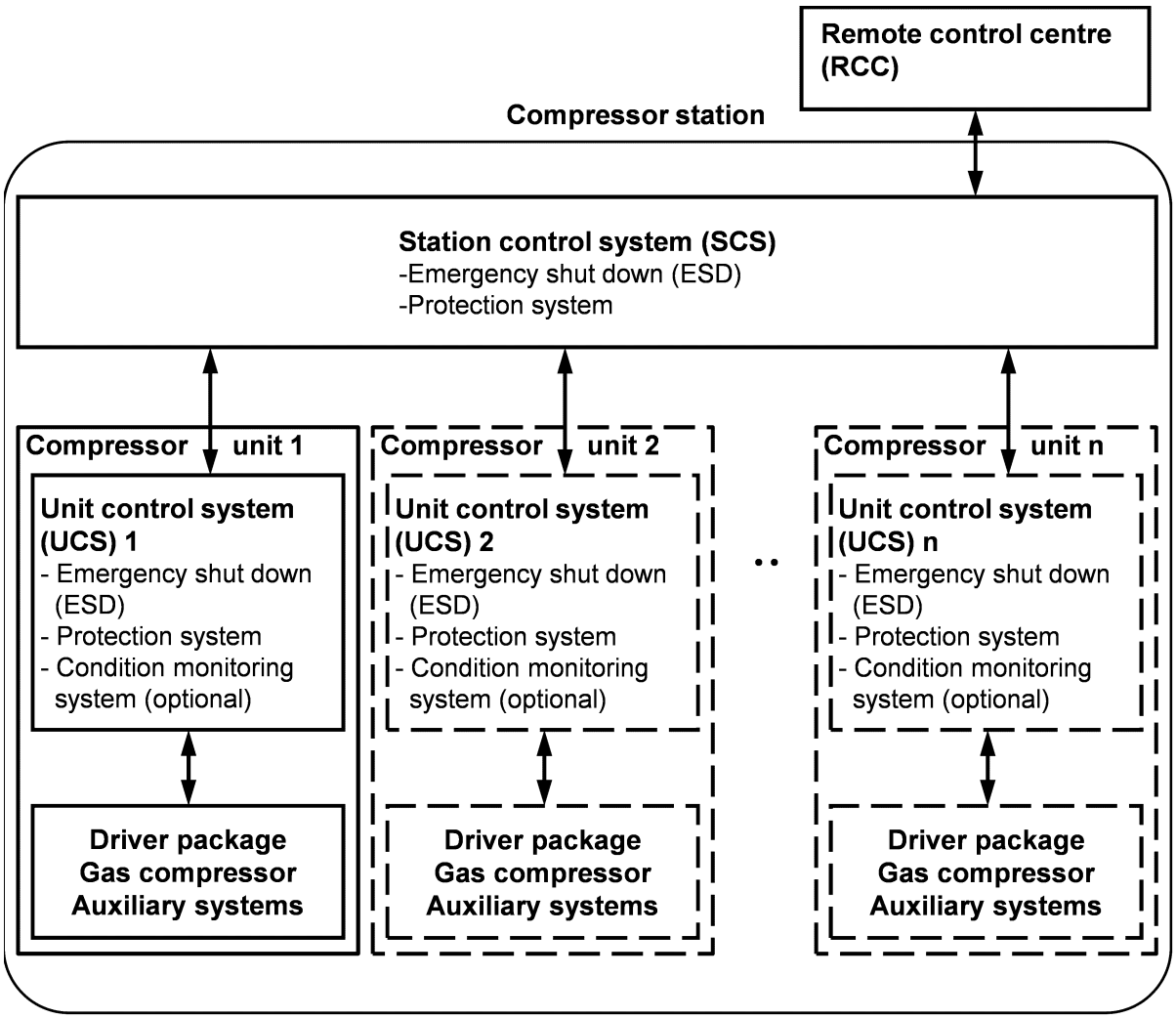


Figure A.2 — Control systems of a gas compressor station

Annex B
(informative)

Parts of a gas compressor unit

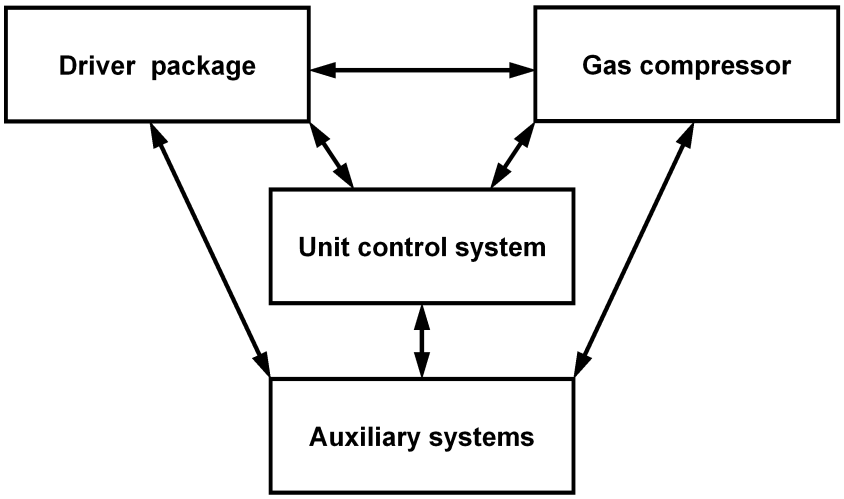
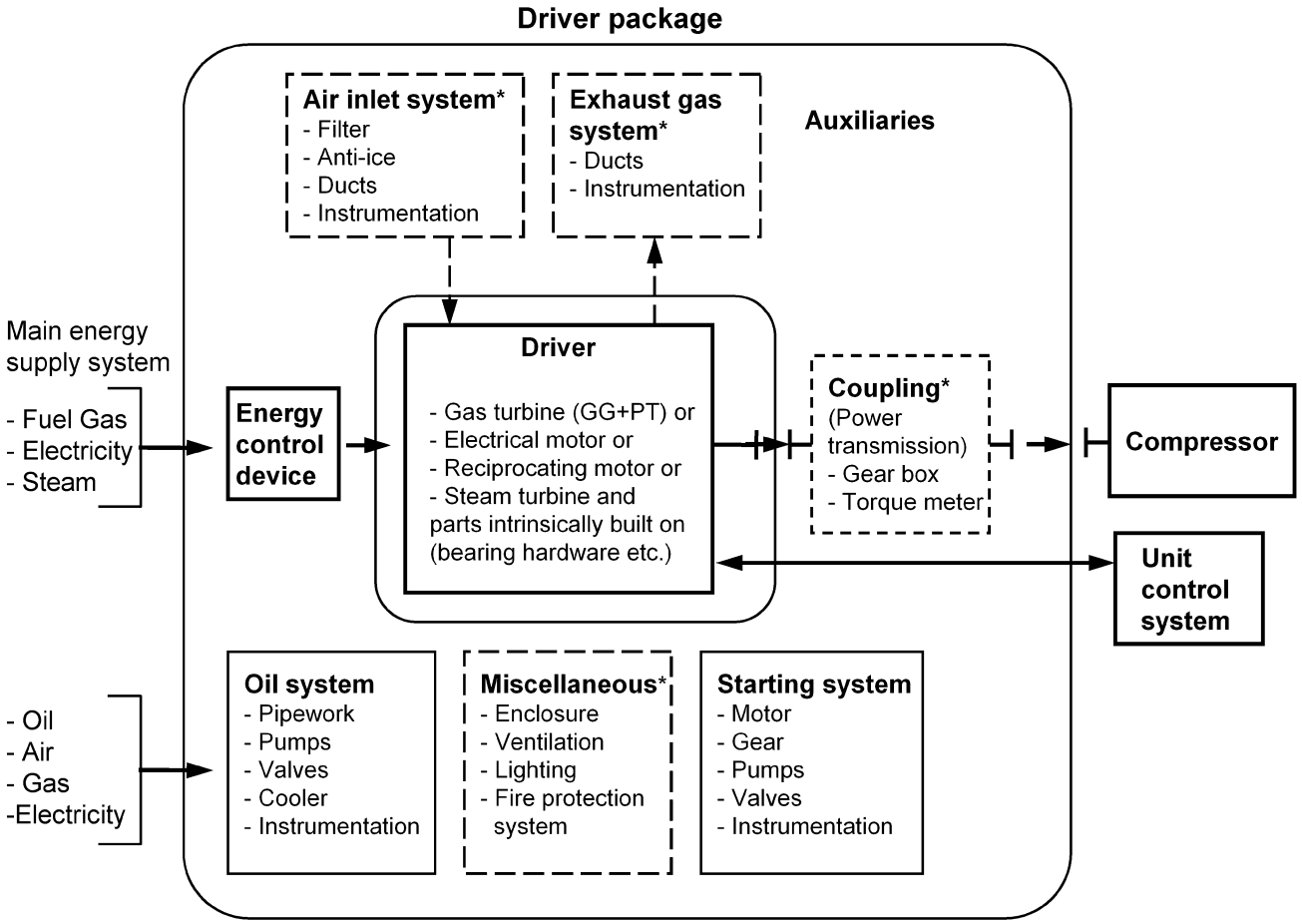


Figure B.1 — Parts of a gas compressor unit

Annex C
(informative)

Boundary Gas compressor unit — Driver package

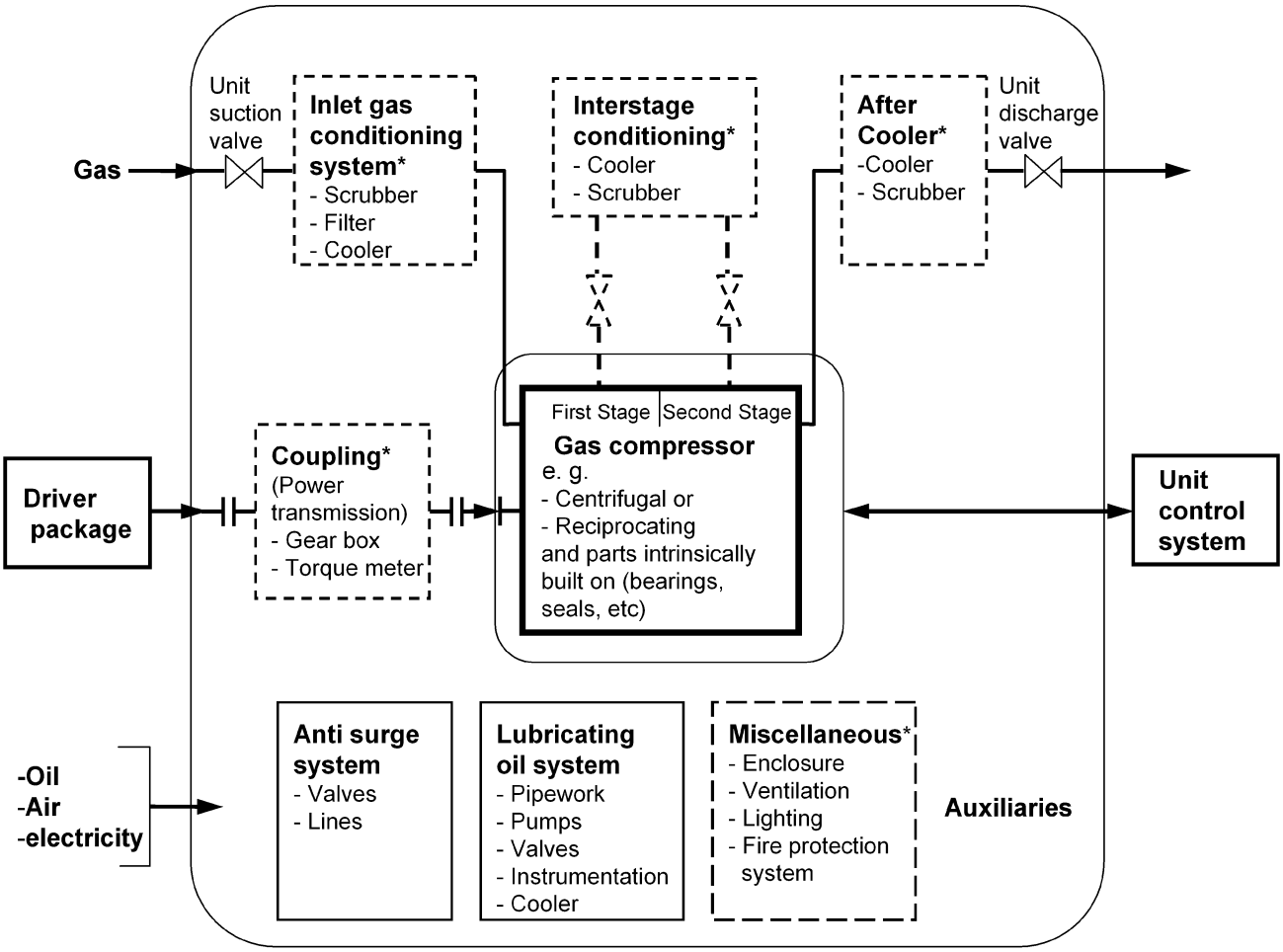


* Parts not required for every kind of driver. If these parts are installed they are to be considered as compressor unit auxiliaries.

Figure C.1 — Boundary gas compressor unit — Driver package

Annex D
(informative)

Boundary Gas compressor unit — Gas compressor

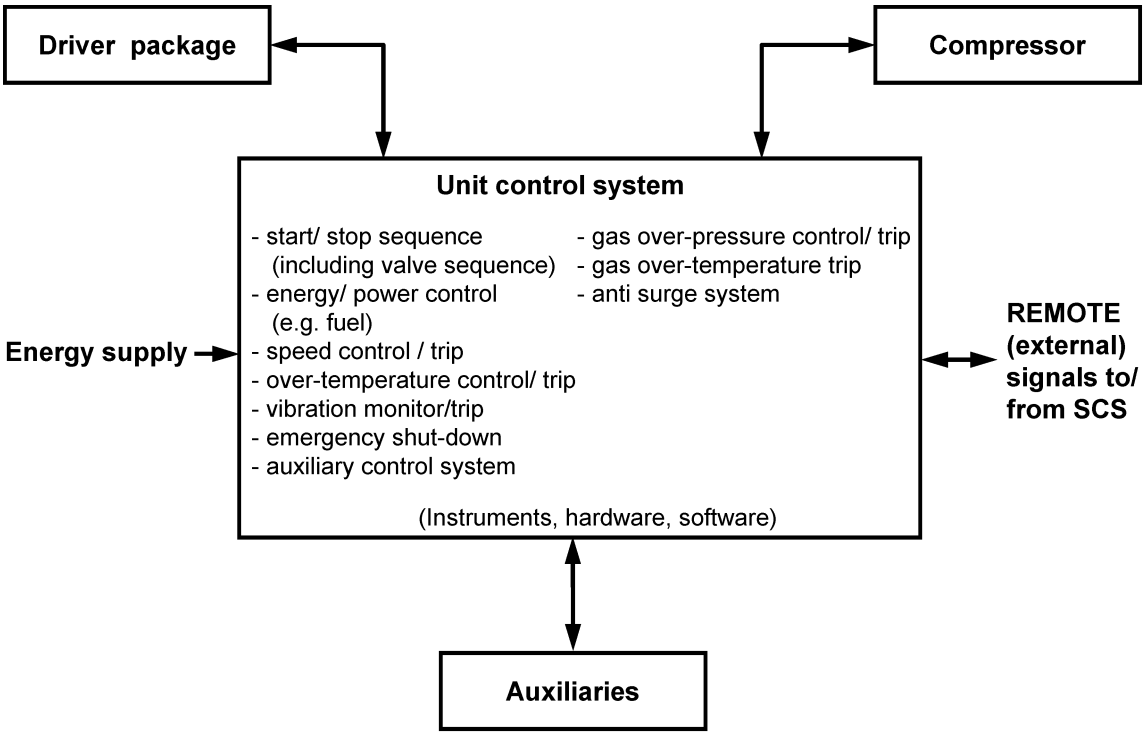


* Parts not required for every kind of driver. If these parts are installed they are to be considered as compressor unit auxiliaries.

Figure D.1 — Boundary gas compressor unit — Gas compressor

Annex E
(informative)

Boundary Gas compressor unit — Unit control system

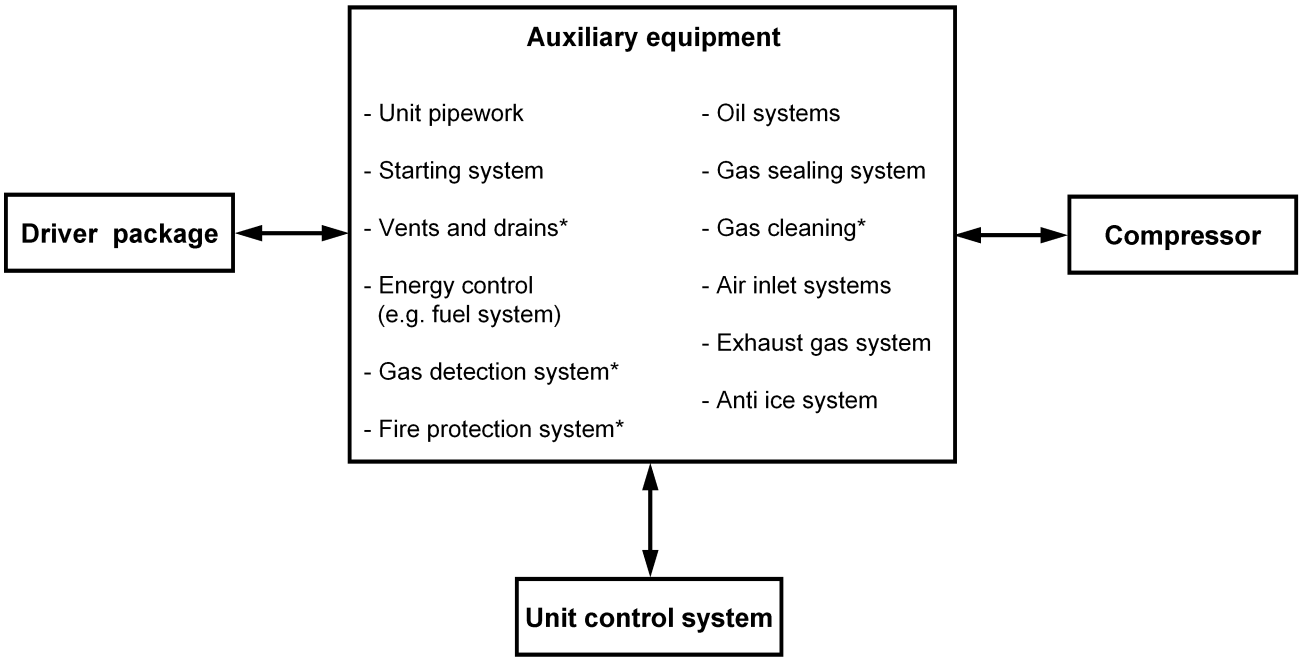


Not every compressor unit requires all the functions listed. If these functions are installed, they are to be considered part of the unit control system.

Figure E.1 — Boundary gas compressor unit — unit control system

Annex F
(informative)

Boundary Gas compressor unit — Auxiliary equipment



* The marked items are considered part of the compressor unit only if they are installed inside the compressor unit. Shut-off valves or are strictly related only to the considered compressor unit.

In case they are common for more than one compressor unit or are related to station equipment they are station auxiliaries.

Figure F.1 — Boundary gas compressor — Auxiliary equipment

Annex G
(informative)

Significant technical changes between this European Standard and the previous edition

Table G.1 — Significant technical changes between this European Standard and the previous edition

Clause/Paragraph/ Table/Figure	Change
Clause 1	Further exclusions from the scope specified: - installations downstream of the point of custody transfer and - design and construction of driver packages.
Clause 4	The requirement of a safety management system and a pipeline integrity management system for the operator was added with a reference to EN 16348.
Clause 5	The requirement of an asset management system was added.
Clause 6	New requirements with regard to environment protection were added.
7.1	In order to ensure the security of supply of the gas transportation system, measures to increase the availability are listed.
7.1.2.2	Requirements regarding the minimization of gas venting to the atmosphere were added.
7.2.2.7	Requirements for electrical systems within the station boundary were reworded.
7.2.2.9	A new clause dealing with the precautions against ignition of flammable substances on hot surfaces was added.
7.3	The title of this clause was changed from “gas pipework” to “pipework”.
7.3.1	The requirement for drains at low points of pipework where liquids could accumulate was added.
7.3.11	A new clause was added with the recommendation that a standard colour painting code is necessary to distinguish different media.
7.4.2	The chemical and physical condition of the fuel and process gas shall be agreed between the manufacturer of the driver and the occupier and shall be maintained during any operating conditions.
7.4.2.3	The purging of the gas path of gas engines should not commence until the exhaust system has fallen below 450 °C.
7.4.2.4	For electric motors a harmonics limitation systems shall be designed to comply with local regulations. Additional design requirements for integrated electrical compressors added.
7.4.3.2	Additional design requirements for integrated electrical compressors added.
7.4.4.6	Details regarding the emergency shutdown system added.
7.4.4.12	Clause “gas turbine flame protection system” was deleted.
7.4.5.7	Setpoints of the gas alarm system for the compressor unit housing modified.

Clause/Paragraph/ Table/Figure	Change
7.8.3	Details on purging of the station pipework and equipment during commissioning added.
7.8.4	The as-build records shall include all risk assessments and details of all hazardous areas.
8.3.2	Instructions for environmental impact precaution during normal operation modified with more details added.
8.6.1	A new note was added regarding the prevention of gas explosion and fire for reciprocating engines and gas turbines.
9.7.2	The safety precautions detailed in item e), g) h) are only required unless the area is proven to be safe and gas-free.
NOTE The technical changes referred include the significant changes from the revised EN; but is not an exhaustive list of all modifications from the previous version.	

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