PD CEN/TR 16395:2012

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Gas Infrastructure — CEN/TC 234 Pressure Definitions — Guideline Document

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National foreword

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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.

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ISBN 978 0 580 77705 9

ICS 01.040.23; 01.040.91; 23.040

Compliance with a British Standard cannot confer immunity from legal obligations.

This Published Document was published under the authority of the Standards Policy and Strategy Committee on 31 October 2012.

Amendments issued since publication

Date	Text affected

TECHNICAL REPORT

RAPPORT TECHNIQUE

TECHNISCHER BERICHT

CEN/TR 16395

October 2012

ICS 01.040.23; 01.040.91; 23.040.01; 91.140.40

English Version

Gas Infrastructure - CEN/TC 234 Pressure Definitions - Guideline Document

Infrastructures gazières - Définitions des pressions du CEN/TC 234 - Lignes directrices

Gasinfrastruktur - CEN/TC 234 Druckdefinitionen - Leitliniendokument

This Technical Report was approved by CEN on 24 June 2012. It has been drawn up by the Technical Committee CEN/TC 234.

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Ref. No. CEN/TR 16395:2012: E

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Foreword

This document (CEN/TR 16395:2012) has been prepared by Technical Committee CEN/TC 234 “Gas Infrastructure”, the secretariat of which is held by DIN.

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Operating pressure levels of gas infrastructure differ from one country to another in the European Union. This is due to many different factors, such as the history of gas systems, technologies and materials used and technical constraints.

When beginning to draft the functional standards on gas infrastructure, CEN/TC 234 recognised various pressure levels and ranges in the European member countries, which are to some extent laid down in national laws.

To form a consensus for the standardisation work, all pressure levels used in Europe have been brought together and classified in ranges. This subdivision in pressure levels should permit the manufacturers of components to focus on a limited number of designs in order to reduce the costs.

Introduction

Background

The standards issued by CEN/TC 234 "Gas Infrastructure" contain a large number of definitions used for the design, testing and operation of the different parts of the gas infrastructure.

This document clarifies the CEN/TC 234 concept behind the definitions and advises how to use the definitions correctly and consistently. In order to further that goal, an inventory of existing definitions is compiled and the primary definitions are identified.

This document also gives guidance for the selection of components falling into the scope of the European Pressure Equipment Directive (PED) [15] and used in the gas infrastructure.

Apart from the issue of the consistency of the pressure definition in the standards, there is also the issue of the pressure rating of equipment and systems. Other classifications (e.g. PN or class) do not necessarily completely coincide with the classification as defined in the CEN/TC 234 standards.

Concept of pressure conditions

On one hand, three different sets of pressure conditions are to be considered:

— conditions during testing and commissioning (P_1);

— conditions during exceptional operating circumstances (P_2);

— conditions during normal operation (P_3).

where:

$P_1 > P_2 > P_3$

The maximum pressure levels related to these conditions are the topic of the primary definitions.

On the other hand, two other pressure conditions are used for specifying the system:

— pressure on which design calculations are based (p_A);

— pressure rating of the system (p_B).

where

$p_A > p_B$.

The relationship between p_A and P_2 or P_3 is not uniform in the different CEN/TC 234 standards. This situation is confusing and undesirable. The recommended practice is stated in chapter 4.4 and 4.5 below and should be considered when revising standards or developing new standards.

Piping versus pressure regulating installations

Only two out of the three aforementioned conditions apply when specifying piping:

— conditions during testing and commissioning;

— operating conditions.

Normally for piping no distinction is made between normal operating conditions and exceptional operating conditions, as piping is a passive component. However, in gas infrastructure piping and pressure regulating installations both are present. This necessitates identification of the “normal operating conditions” and “exceptional operating conditions” of the pressure regulating installations and the “operating conditions” of the piping.

1 Scope

This Technical Report gives explanation on the pressure definitions used by the gas network operators with regard to the standards of CEN/TC 234 "Gas Infrastructure".

The European Standards of CEN/TC 234 comprise the functional requirements in the field of 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.

2 Normative references

Not applicable.

3 Terms and definitions

3.1 Key pressure definitions used in CEN/TC 234 standards

3.1.1
design pressure
DP
pressure on which design calculations are based

Note 1 to entry: A system designed for a design pressure (DP) can comprise components designed for a different maximum allowable pressure (PS).

3.1.2
maximum operating pressure
MOP
maximum pressure at which a system can be operated continuously under normal operating conditions

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

Note 2 to entry: The set point of the regulator does not exceed MOP.

3.1.3
maximum incidental pressure
MIP
maximum pressure which a system can experience during a short time, limited by the safety devices

3.2 Derived pressure definitions used in CEN/TC 234 standards

3.2.1
operating pressure
OP
nominal pressure on which the system is operated

3.2.2
temporary operating pressure
TOP
pressure at which a system can be operated temporarily under control of regulating devices

3.2.3
test pressure
TP
pressure at which pressure tests are conducted

3.2.4
strength test pressure
STP
pressure applied to a system during strength testing

3.2.5
tightness test pressure
TTP
pressure applied to a system during tightness testing

3.2.6
combined test pressure
CTP
pressure applied to a system during combined testing, i.e. tightness and strength testing

3.3 Commonly used pressure definitions in European product standards

3.3.1
maximum allowable pressure
PS
maximum pressure for which the equipment is designed, as specified by the manufacturer

Note 1 to entry: Definition and requirements according Directive 97/23/EC (Pressure Equipment Directive - PED).

3.3.2
nominal pressure
PN xx
alphanumeric designation used for reference purposes related to a combination of mechanical and dimensional characteristics of a component of a pipework system

Note 1 to entry: It comprises the letters PN followed by a dimensionless number.

[SOURCE: EN 1333, modified]

3.3.3
class xxx
alphanumeric designation used for reference purposes related to a combination of mechanical and dimensional characteristics of a component of a pipework system

Note 1 to entry: It comprises the word "Class" followed by a dimensionless whole number.

[SOURCE: EN 1759-1, modified]

4 Explanation of Gas pressure definitions for gas transport and distribution systems

4.1 General

The pressure levels in the system MOP, TOP and MIP are to be chosen by the network operator when designing and operating its network according to its constraints and national regulations.

4.2 Pressure demarcation

For a pipeline system, the maximum pressure values will occur at the entrance of a pipeline section. However, in case the gas stream is interrupted for any reason, the whole pipeline section will be subjected to the same pressure level.

The demarcation line for different pressure levels are, in the case of gas pressure regulating stations, at the exit flange of the gas pressure regulator[1)] [EN 12186] and for compressor stations, at the entrance of the compressor [EN 12583].

4.3 Operating conditions

4.3.1 Normal operating conditions

4.3.1.1 MOP – Maximum operating pressure

The most relevant information related to the pressure in a network is the maximum pressure at which the system can be operated under normal conditions. This value is defined as the maximum operation pressure (MOP).

The maximum set point of the operating pressure is MOP, considering the available accuracy classes and the lock-up pressure of gas pressure regulators [EN 334] or other regulating devices. The instantaneous pressure (peak level OP) in the system can be occasionally higher than MOP even under normal operating conditions.

4.3.1.2 OP – Operating pressure

OP is the pressure which occurs within a system under normal operating conditions, being the set point of the pressure regulating system at the entry of a pipeline.

4.3.1.3 Peak level OP

For pipelines with MOP > 16 bar, the peak level OP is limited to 1,025 $\times$ MOP [EN 1594]. For pipelines with a MOP up to and including 16 bars, no limit is given in EN 12007. However, for gas pressure regulating stations for transport and transmission and gas pressure regulating installations on service lines, the allowed limits for this peak level OP is given in EN 12186 and EN 12279; see Table 1.

4.3.2 Gas pressure under incidental operating conditions

4.3.2.1 General

In case of a fault in the pressure regulator or compressor, the safety system will ensure that the pressure in the downstream system will not exceed a stated maximum value under any circumstance.

4.3.2.2 MIP – Maximum incidental pressure

The pressure value that may not be exceeded in the gas infrastructure, even under fault conditions, is called MIP – maximum incidental pressure. The pressure safety system has to ensure that MIP is never exceeded, also considering the dynamic behaviour of the system [EN 12186]. The accuracy class of the safety device is to be taken into account.

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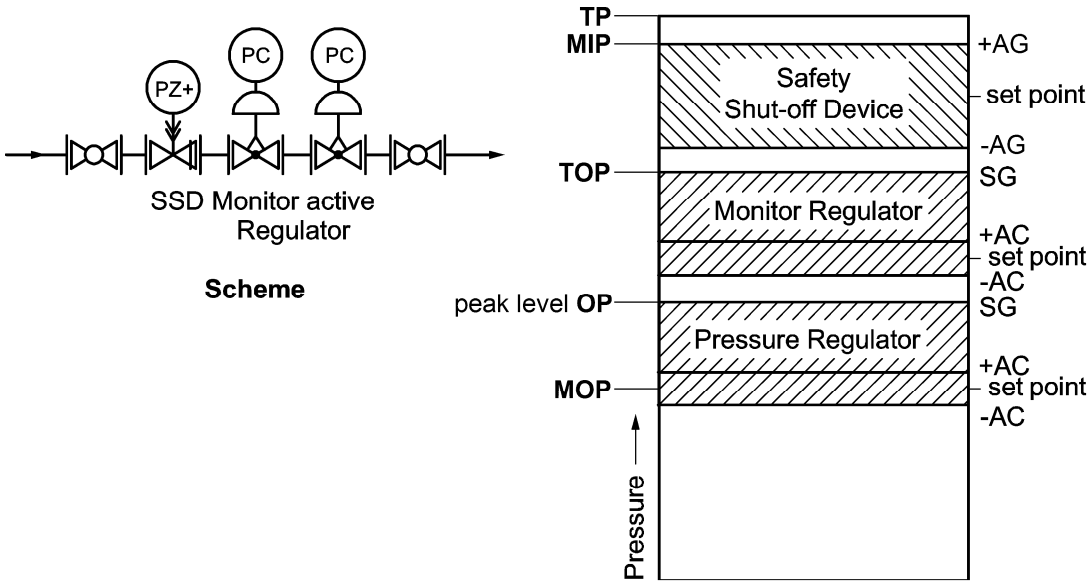
1) For details regarding the pressure demarcation in gas pressure regulating stations see EN 12186.

Figure 1 below illustrates the maximum set values for a possible pressure control system.



Key

AC: Accuracy class [EN 334]
SG: Lock-up pressure class [EN 334]
AG: Accuracy group [EN 14382]

Figure 1 — Example: Pressure staggering for a single stream pressure control system with a Safety shut-off device (SSD) and a monitor as safety devices

NOTE Detailed information with regard to the calculation of pressure values from the parameters AC, SG and AG is given in EN 334 and EN 14382.

4.4 Design pressure

Regarding the wall thickness calculations for systems of gas infrastructure, the design pressure is given in the related standards. This value can be derived from MOP, MIP or another value as stated in the aforesaid standards.

Pipelines and systems have to be capable to withstand at least the MIP. The relation between MIP and MOP depends on the pressure of the system as given in Clause 5.

4.5 Test pressures

Test pressures (STP, CTP) are indicated Table 1. The requirements for the tightness test pressures are given in the relevant CEN/TC 234 standards.

4.6 Equipment in the scope of the European Pressure Equipment Directive

The design approach laid down in the PED considers only the maximum allowed pressure PS at which the equipment may be operated. To allow the operation of the equipment up to PS it is considered that the functional behaviour of the safety system may lead to a maximum overpressure of 1,1 $\times$ PS. For standard pressure equipment used in the gas infrastructure the following condition shall be fulfilled:

$$PS \geq \frac{MIP}{1{,}1}$$

NOTE 1 An additional tightness test for components designed under PED may be required according to the relevant standards.

NOTE 2 In EN 15001-1 DP is considered as equivalent to PS.

NOTE 3 Information on industrial installations according EN 15001 is given in Annex B.

In some countries MIP may be limited to PS of the standard pressure equipment according national regulations or standards. In this case standard pressure equipment for installation in the gas infrastructure has to be selected with $PS \geq MIP$.

5 Relationships between MOP, TOP and MIP and test pressures

The figures given in the following table are maximum values which can be reduced by the decision of the network operator.

Table 1 — Relationships between MOP, TOP and MIP and test pressures

MOP [1)] **(bar)**	**peak level OP ≤**	**TOP ≤**	**MIP ≤**	**STP/CTP >**
MOP > 40	1,025 MOP	1,1 MOP	1,15 MOP	MIP
16 < MOP ≤ 40	1,025 MOP	1,1 MOP	1,20 MOP	MIP
5 < MOP ≤ 16	1,050 MOP	1,2 MOP	1,30 MOP	MIP
2 < MOP ≤ 5	1,075 MOP	1,3 MOP	1,40 MOP	MIP
0,1 < MOP ≤ 2	1,125 MOP	1,5 MOP	1,75 MOP	MIP
MOP ≤ 0,1	1,125 MOP	1,5 MOP	2,50 MOP[2)]	MIP

NOTE When no safety device is required, TOP and MIP downstream of the regulator are not relevant for installation pipework supplied by systems with MOP upstream of the regulator up to and including 100 mbar.

[1)] These relations are only valid when DP=MOP.

[2)] When gas appliances, tightness tested at 150 mbar, are directly connected to an installation pipework, the MIP downstream of the final regulator shall be limited to 150 mbar.

In case MOP is less than DP, the relation factors may be higher. MOP shall not exceed DP and MIP shall not exceed STP/CTP.

Annex A
(informative)

Examples of relationships between pressure designations

The examples in Tables A.1 to A.3 below support the purchasing of equipment and components to be used in the gas infrastructure.

Table A.1 — Example 1: Components with PS 16 bar in a network operating at MOP 16 bar

Network Characteristics	Components PS 16 bar according to EN 334, EN 14382
MOP = 16 bar TOP = 1,2 × MOP = 19,2 bar MIP = 1,3 × MOP = 20,8 bar TTP and STP shall be greater than 20,8 bar	PS = 16 bar $p_{t,\ tightness}$ = 1,1 × PS = 17,6 bar[a] $p_{t,\ strength}$ = 1,5 × PS = 24 bar*
PS x 1,1 < MIP and MIP and TTP > $p_{t,\ tightness}$, this equipment does not fit in the pressure scheme, equipment with PS 25 bar tested at $p_{t,\ tightness}$ = 27,5 bar should be used.	
[a] Subscripts: t – test. * By manufacturer.	

Table A.2 — Example 2: Regulating station downstream of the network

Network characteristics upstream as stated by the network operator	Standard equipment in the regulating station upstream of the regulator
MOP_u = 5 bar [a] TOP_u = 5,9 bar MIP_u = 6,4 bar TTP_u = 7,5 bar	PS = p_{umax} = 6 bar Requirements fulfilled: MOP_u < PS TOP_u < PS MIP_u < 1,1 × PS TTP_u < PT = 1,43 × PS
Since TOP_u (5,9 bar) < PS (6 bar) and MIP_u (6,4 bar) ≤ 1,1 × PS (6,6 bar), the requirements are fulfilled. The standard equipment mentioned includes valves, filter, shut off device and the regulator.	
[a] Subscripts: u – upstream.	

Table A.3 — Example 3: Components PN 10 in a network operating at MOP 8 bar

Network Characteristics	Components PN 10[a] (assuming tightness test at 1,1 PN and strength test at 1,5 PN)
MOP = 8 bar TOP = 1,2 × MOP = 9,6 bar MIP = 1,3 × MOP = 10,4 bar	PN = 10 bar $p_{t,\ tightness}$ = 1,1 × PN = 11 bar[b] $p_{t,\ strength}$ = 1,5 × PN = 15 bar
Since MIP, TTP and STP are less than $p_{t,\ tightness}$, this equipment fulfils the network pressure requirements.	
[a] In this example PN is considered to be equal to the maximum allowable pressure of the component. In some product standards, PN refers to dimensions (e. g. for flanges) and does not give information about the pressure strength of the related component [EN 334, EN 14382]. [b] Subscripts: t – test.	

Annex B
(informative)

Industrial installations according to EN 15001

EN 15001-1 and EN 15001-2 give detailed functional requirements for industrial gas pipework including its components, e.g. the gas pressure regulating and safety systems in these installations.

This type of gas pipework is located on an industrial plant and can be situated inside buildings, in ducts, outside and buried. From a safety point of view, industrial pipework can be exposed to:

— mechanical damage due to insufficient protection;

— decrement of integrity caused by:

  — insufficient maintenance;

  — aggressive environment;

  — corrosion;

  — vibration;

  — strong ambient temperature changes;

  — strong operational pressure changes.

For these reasons the design and commissioning of industrial pipework is based on:

— a design pressure DP which is equivalent to the maximum allowable pressure PS and MIP $\leq 1{,}1 \times$ DP at the point of delivery;

— a design factor of 0,45 for the whole pressure range;

— a slightly deviant pressure range and strength test pressure for strength testing.

Gas transmission and distribution pipelines are excluded from the PED. If industrial gas pipework is designed, constructed and commissioned by the owner of the gas pipework himself, this pipework is also excluded from the PED, unless National Legislation makes compliance to the PED mandatory. For example, EPC projects and turn key projects are not excluded from the PED.

When compliance with the PED is Mandatory, EN 15001-1 is a convenient standard because this standard is harmonised under the PED. Therefore, application of this standard for design, construction and testing industrial gas pipework gives the presumption of compliance with the PED.

Bibliography

CEN/TC 234 Standards

[1] EN 1594, *Gas supply systems — Pipelines for maximum operating pressure over 16 bar — Functional requirements*

[2] EN 1775, *Gas supply — Gas pipework for buildings — Maximum operating pressure less than or equal to 5 bar — Functional recommendations*

[3] EN 1776, *Gas supply systems — Natural gas measuring stations — Functional requirements*

[4] EN 12007-1, *Gas infrastructure — Pipelines for maximum operating pressure up to and including 16 bar — Part 1: General functional recommendations*

[5] EN 12007-2, *Gas infrastructure — Pipelines for maximum operating pressure up to and including 16 bar — Part 2: Specific functional recommendations for polyethylene (MOP up to and including 10 bar)*

[6] EN 12007-3, *Gas supply systems — Pipelines for maximum operating pressure up to and including 16 bar — Part 3: Specific functional recommendations for steel*

[7] EN 12007-4, *Gas infrastructure — Pipelines for maximum operating pressure up to and including 16 bar — Part 4: Specific functional recommendations for renovation*

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

[9] EN 12279, *Gas supply systems — Gas pressure regulating installations on service lines — Functional requirements*

[10] EN 12327, *Gas infrastructure — Pressure testing, commissioning and decommissioning procedures — Functional requirements*

[11] EN 12583, *Gas supply systems — Compressor stations — Functional requirements*

[12] EN 12732, *Gas supply systems — Welding steel pipework — Functional requirements*

[13] EN 15001-1, *Gas Infrastructure — Gas installation pipework with an operating pressure greater than 0, 5 bar for industrial installations and greater than 5 bar for industrial and non-industrial installations — Part 1: Detailed functional requirements for design, materials, construction, inspection and testing*

[14] EN 15001-2, *Gas infrastructure — Gas installation pipework with an operating pressure greater than 0, 5 bar for industrial installations and greater than 5 bar for industrial and non-industrial installations — Part 2: Detailed functional requirements for commissioning, operation and maintenance*

Other documents

[15] Directive 97/23/EC of the European Parliament and of the Council of 29 May 1997 on the approximation of the laws of the Member States concerning pressure equipment (Pressure Equipment Directive – PED)

[16] EN 334, *Gas pressure regulators for inlet pressures up to 100 bar*

[17] EN 1333, *Flanges and their joints — Pipework components — Definition and selection of PN*

[18] EN 1759-1, *Flanges and their joints — Circular flanges for pipes, valves, fittings and accessories, Class designated — Part 1: Steel flanges, NPS 1/2 to 24*

[19] EN 14382, *Safety devices for gas pressure regulating stations and installations — Gas safety shut-off devices for inlet pressures up to 100 bar*

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