INTERNATIONAL STANDARD

ISO 23251

First edition
2006-08-15

Corrected version
2006-10-01

Petroleum, petrochemical and natural gas industries — Pressure-relieving and depressuring systems

Industries du pétrole, de la pétrochimie et du gaz naturel — Systèmes de dépressurisation et de protection contre les surpressions

Reference number
ISO 23251:2006(E)

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Published in Switzerland

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Foreword

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The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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ISO 23251 was prepared by Technical Committee ISO/TC 67, *Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries*, Subcommittee SC 6, *Processing equipment and systems*.

This corrected version of ISO 23251:2006 incorporates corrections to Table 4, column 2, second row under the header, and the five rows of data in column 3.

Introduction

This International Standard is based on the draft 5th edition of API RP 521, with the intent that the 6th edition of API RP 521 will be identical to this International Standard.

The portions of this International Standard dealing with flares and flare systems are an adjunct to API Std 537 [10], which addresses mechanical design, operation and maintenance of flare equipment. It is important for all parties involved in the design and use of a flare system to have an effective means of communicating and preserving design information about the flare system. To this end, API has developed a set of flare data sheets, which can be found in of API Std 537, Appendix A. The use of these data sheets is both recommended and encouraged as a concise, uniform means of recording and communicating design information.

Petroleum, petrochemical and natural gas industries — Pressure-relieving and depressuring systems

1 Scope

This International Standard is applicable to pressure-relieving and vapour-depressuring systems. Although intended for use primarily in oil refineries, it is also applicable to petrochemical facilities, gas plants, liquefied natural gas (LNG) facilities and oil and gas production facilities. The information provided is designed to aid in the selection of the system that is most appropriate for the risks and circumstances involved in various installations. This International Standard is intended to supplement the practices set forth in ISO 4126 or API RP 520-I for establishing a basis of design.

This International Standard specifies requirements and gives guidelines for examining the principal causes of overpressure; and determining individual relieving rates; and selecting and designing disposal systems, including such component parts as piping, vessels, flares, and vent stacks. This International Standard does not apply to direct-fired steam boilers.

Piping information pertinent to pressure-relieving systems is presented in 7.3.1.

2 Normative references

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

ISO 4126 (all parts), *Safety devices for protection against excessive pressure*

API RP 520-I:2000, *Sizing, Selection and Installation of Pressure-Relieving Devices in Refineries — Part I: Sizing and Selection* [1)]

3 Terms and definitions

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

3.1
accumulation
pressure increase over the maximum allowable working pressure of the vessel allowed during discharge through the pressure-relief device

NOTE Accumulation is expressed in units of pressure or as a percentage of MAWP or design pressure. Maximum allowable accumulations are established by pressure-design codes for emergency operating and fire contingencies.

1) American Petroleum Institute, 1220 L Street, N.W., Washington, D.C., 20005-4070, USA.

3.2
administrative controls
procedures intended to ensure that personnel actions do not compromise the overpressure protection of the equipment

3.3
assist gas
combustible gas that is added to relief gas prior to the flare burner or at the point of combustion in order to raise the heating value

3.4
atmospheric discharge
release of vapours and gases from pressure-relieving and depressuring devices to the atmosphere

3.5
back pressure
pressure that exists at the outlet of a pressure-relief device as a result of the pressure in the discharge system

NOTE The back pressure is the sum of the superimposed and built-up back pressures.

3.6
balanced pressure-relief valve
spring-loaded pressure-relief valve that incorporates a bellows or other means for minimizing the effect of back pressure on the operational characteristics of the valve

3.7
blowdown
depressurization of a plant or part of a plant and equipment

NOTE Not to be confused with the difference between the set pressure and the closing pressure of a pressure-relief valve.

3.8
blow-off
loss of a stable flame where the flame is lifted above the burner, occurring if the fuel velocity exceeds the flame velocity

3.9
breaking-pin device
pressure-relief device actuated by static differential or static inlet pressure and designed to function by the breakage of a load-carrying section of a pin that supports a pressure-containing member

3.10
buckling pin device
pressure-relief device actuated by static differential or static inlet pressure and designed to function by the buckling of an axially-loaded compressive pin that supports a pressure-containing member

3.11
built-up back pressure
increase in pressure at the outlet of a pressure-relief device that develops as a result of flow after the pressure-relief device opens

3.12
buoyancy seal
dry vapour seal that minimizes the amount of purge gas needed to protect against air infiltration

NOTE The buoyancy seal functions by trapping a volume of light gas in an internal inverted compartment; this prevents air from displacing buoyant light gas in the flare.

3.13
burnback
internal burning within the flare tip

NOTE Burnback can result from air backing down the flare burner at purge or low flaring rates.

3.14
burning velocity
flame velocity
speed at which a flame front travels into an unburned combustible mixture

3.15
burn-pit flare
open excavation, normally equipped with a horizontal flare burner that can handle liquid as well as vapour hydrocarbons

3.16
burst pressure
value of the upstream static pressure minus the value of the downstream static pressure just before a rupture disk bursts

NOTE If the downstream pressure is atmospheric, the burst pressure is the upstream static gauge pressure.

3.17
closed disposal system
disposal system capable of containing pressures that are different from atmospheric pressure

3.18
cold differential test pressure
CDTP
pressure at which a pressure-relief valve is adjusted to open on the test stand

NOTE The cold differential test pressure includes corrections for the service conditions of back pressure or temperature or both.

3.19
combustion air
air required to combust the flare gases

3.20
conventional pressure-relief valve
spring-loaded pressure-relief valve whose operational characteristics are directly affected by changes in the back pressure

3.21
corrected hydrotest pressure
hydrostatic test pressure multiplied by the ratio of stress value at design temperature to the stress value at test temperature

NOTE See 4.3.2.

3.22
deflagration
explosion in which the flame-front of a combustible medium is advancing at less than the speed of sound

cf. **detonation** (3.25)

3.23
design pressure
pressure, together with the design temperature, used to determine the minimum permissible thickness or physical characteristic of each component, as determined by the design rules of the pressure-design code

NOTE The design pressure is selected by the user to provide a suitable margin above the most severe pressure expected during normal operation at a coincident temperature, and it is the pressure specified on the purchase order. The design pressure is equal to or less than the MAWP (the design pressure can be used as the MAWP in cases where the MAWP has not been established).

3.24
destruction efficiency
mass fraction of the fluid vapour that can be oxidized or partially oxidized

NOTE For a hydrocarbon, this is the mass fraction of carbon in the fluid vapour that oxidizes to CO or CO_2.

3.25
detonation
explosion in which the flame-front of a combustible medium is advancing at or above the speed of sound

cf. **deflagration** (3.22)

3.26
dispersion
dilution of a vent stream or products of combustion as the fluids move through the atmosphere

3.27
elevated flare
flare where the burner is raised high above ground level to reduce radiation intensity and to aid in dispersion

3.28
enclosed flare
enclosure with one or more burners arranged in such a manner that the flame is not directly visible

3.29
enrichment
process of adding assist gas to the relief gas

3.30
flame-retention device
device used to prevent flame blow off from a flare burner

3.31
flare
device or system used to safely dispose of relief gases in an environmentally compliant manner through the use of combustion

3.32
flare burner
flare tip
part of the flare where fuel and air are mixed at the velocities, turbulence and concentration required to establish and maintain proper ignition and stable combustion

3.33
flare header
piping system that collects and delivers the relief gases to the flare

3.34
flashback
phenomenon occurring in a flammable mixture of air and gas when the local velocity of the combustible mixture becomes less than the flame velocity, causing the flame to travel back to the point of mixture

3.35
ground flare
non-elevated flare

NOTE A ground flare is normally an enclosed flare but can also be a ground multi-burner flare or a burnpit.

3.36
heat release
total heat liberated by combustion of the relief gases based on the lower heating value

3.37
huddling chamber
annular chamber located downstream of the seat of a pressure-relief valve, which assists the valve to lift

3.38
hydrate
solid, crystalline compound of water and a low-boiling-point gas (e.g. methane and propane), in which the water combines with the gas molecule to form a solid

3.39
jet fire

fire created when a leak from a pressurized system ignites and forms a burning jet

NOTE A jet fire can impinge on other equipment, causing damage.

3.40
knockout drum
vessel in the effluent handling system designed to remove and store liquids

3.41
lateral
section of pipe from outlet flange(s) of single-source relief device(s) downstream of a header connection where relief devices from other sources are tied in

NOTE The relief flow in a lateral is always from a single source, whereas the relief flow in a header can be from either single or multiple sources simultaneously.

3.42
lift
actual travel of the disc from the closed position when a valve is relieving

3.43
liquid seal
water seal
device that directs the flow of relief gases through a liquid (normally water) on the path to the flare burner, used to protect the flare header from air infiltration or flashback, to divert flow, or to create back pressure for the flare header

3.44
Mach number
ratio of a fluid's velocity, measured relative to some obstacle or geometric figure, divided by the speed at which sound waves propagate through the fluid

3.45
manifold
piping system for the collection and/or distribution of a fluid to or from multiple flow paths

3.46
marked burst pressure
rated burst pressure
⟨rupture disk⟩ burst pressure, established by tests for the specified temperature and marked on the disk tag by the manufacturer

NOTE The marked burst pressure can be any pressure within the manufacturing design range unless otherwise specified by the customer. The marked burst pressure is applied to all of the rupture disks of the same lot.

3.47
maximum allowable working pressure
MAWP
maximum gauge pressure permissible at the top of a completed vessel in its normal operating position at the designated coincident temperature specified for that pressure

cf. **design pressure** (3.23)

NOTE The MAWP is the least of the values for the internal or external pressure as determined by the vessel design rules for each element of the vessel using actual nominal thickness, exclusive of additional metal thickness allowed for corrosion and loadings other than pressure. The MAWP is the basis for the pressure setting of the pressure-relief devices that protect the vessel.

3.48
non-condensable gas
gas or vapour that remains in the gaseous state at the temperature and pressure expected

3.49
operating pressure
pressure the process system experiences during normal operation, including normal variations

3.50
overpressure
⟨general⟩ condition where the MAWP, or other specified pressure, is exceeded

⟨relieving device⟩ pressure increase over the set pressure of a relieving device

NOTE In the latter context, overpressure is the same as **accumulation** (3.1) only when the relieving device is set to open at the MAWP of the vessel.

3.51
pilot burner
small, continuously operating burner that provides ignition energy to light the flared gases

3.52
pilot-operated pressure-relief valve
pressure-relief valve in which the major relieving device or main valve is combined with and controlled by a self-actuated auxiliary pressure-relief valve (pilot)

3.53
pin device
non-reclosing pressure-relief device actuated by static pressure and designed to function by buckling or breaking a pin that holds a piston or a plug in place; upon buckling or breaking of the pin, the piston or plug instantly moves to the fully open position

3.54
pool fire
burning pool of liquid

3.55
pressure-design code
standard to which the equipment is designed and constructed

EXAMPLE ASME Section VIII, Division 1 [20].

3.56
pressure-relief valve
valve designed to open and relieve excess pressure and to reclose and prevent the further flow of fluid after normal conditions have been restored

NOTE In ISO 4126-1, this is termed a safety valve.

3.57
process tank
process vessel
tank or vessel used for an integrated operation in petrochemical facilities, refineries, gas plants, oil and gas production facilities, and other facilities

cf. **storage tank** (3.74)

NOTE A process tank or vessel used for an integrated operation can involve, but is not limited to, preparation, separation, reaction, surge control, blending, purification, change in state, energy content, or composition of a material.

3.58
purge gas
fuel gas or non-condensable inert gas added to the flare header to mitigate air ingress and burnback

3.59
quenching
cooling of a fluid by mixing it with another fluid of a lower temperature

3.60
radiation intensity
local radiant heat transfer rate from the flare flame, usually considered at grade level

3.61
rated relieving capacity
relieving capacity used as the basis for the application of a pressure-relief device, determined in accordance with the pressure-design code or regulation and supplied by the manufacturer

NOTE The capacity marked on the device is the rated capacity on steam, air, gas or water as required by the applicable code.

3.62
relief gas
flared gas
waste gas
waste vapour
gas or vapour vented or relieved into a flare header for conveyance to a flare

3.63
relief valve
spring-loaded pressure-relief valve actuated by the static pressure upstream of the valve, due to which the valve normally opens in proportion to the pressure increase over the opening pressure

NOTE A relief valve is normally used with incompressible fluids.

3.64
relieving conditions
inlet pressure and temperature on a pressure-relief device during an overpressure condition

NOTE The relieving pressure is equal to the valve set pressure (or rupture disk burst pressure) plus the overpressure. The temperature of the flowing fluid at relieving conditions can be higher or lower than the operating temperature.

3.65
rupture-disk device
non-reclosing pressure-relief device actuated by static differential pressure between the inlet and outlet of the device and designed to function by the bursting of a rupture disk

NOTE 1 A rupture disk device includes a rupture disk and a rupture disk holder.

NOTE 2 In ISO 4126-2, this is termed a bursting-disc safety device.

3.66
safety instrumented system
SIS
emergency shutdown system
ESD, ESS
high-integrity protection system
HIPS
high-integrity pressure-protection system
HIPPS
safety-shutdown system
SSD
safety-interlock system
system composed of sensors, logic solvers and final control elements for the purpose of taking the process to a safe state when predetermined conditions are violated

3.67
safety-integrity level
SIL
discrete integrity level of a safety instrumented function in a safety instrumented system

NOTE SILs are categorized in terms of probability of failure; see Annex E.

3.68
safety relief valve
spring-loaded pressure-relief valve that can be used as either a safety valve or a relief valve depending on the application

3.69
safety valve
spring-loaded pressure-relief valve actuated by the static pressure upstream of the valve and characterized by rapid opening or pop action

NOTE 1 A safety valve is normally used with compressible fluids.

NOTE 2 This definition is different than that in ISO 4126-1; see 3.56.

3.70
set pressure
inlet gauge pressure at which a pressure-relief device is set to open under service conditions

3.71
shear pin device
non-reclosing pressure-relief device actuated by static differential or static inlet pressure and designed to function by the shearing of a load-carrying member that supports a pressure-containing member

3.72
staged flare
group of two or more flares or burners that are controlled so that the number of flares or burners in operation is proportional to the relief gas flow

3.73
stoichiometric air
chemically correct ratio of fuel to air capable of perfect combustion with no unused fuel or air

3.74
storage tank
storage vessel
fixed tank or vessel that is not part of the processing unit in petrochemical facilities, refineries, gas plants, oil and gas production facilities, and other facilities

cf. **process tank** (3.57)

NOTE These tanks or vessels are often located in tank farms.

3.75
superimposed back pressure
static pressure that exists at the outlet of a pressure-relief device at the time the device is required to operate

NOTE It is the result of pressure in the discharge system coming from other sources and can be constant or variable.

3.76
vapour depressuring system
protective arrangement of valves and piping intended to provide for rapid reduction of pressure in equipment by releasing vapours

NOTE The actuation of the system can be automatic or manual.

3.77
velocity seal
dry vapour seal that minimizes the required purge gas needed to protect against air infiltration into the flare burner exit

3.78
vent header
piping system that collects and delivers the relief gases to the vent stack

3.79
vent stack
elevated vertical termination of a disposal system that discharges vapours into the atmosphere without combustion or conversion of the relieved fluid

3.80
vessel
container or structural envelope in which materials are processed, treated or stored

EXAMPLES Pressure vessels, reactor vessels and storage vessels (tanks).

3.81
windshield
device used to protect the outside of a flare burner from direct flame impingement

NOTE The windshield is so named because external flame impingement occurs on the downwind side of an elevated flare burner.