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Petroleum and natural gas industries — Piping

Industries du pétrole et du gaz naturel — Tuyauterie

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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

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.

Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 15649 was prepared by Technical Committee ISO/TC 67, *Materials, equipment and offshore structures for petroleum and natural gas industries*, Subcommittee SC 6, *Processing equipment and systems*.

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

Introduction

This International Standard makes normative reference to ANSI/ASME B31.3, which is presently the worldwide basis for current standards and practices for piping systems for the petroleum and natural gas industries. It should be noted that ANSI/ASME B 31.3 itself does allow supplementary requirements if necessary for the particular application or service intended.

Users of this International Standard should be aware that further or differing requirements may be needed for individual applications. This International Standard is not intended to inhibit a vendor from offering, or the purchaser from accepting alternative equipment or engineering solutions for the individual application. This may be particularly appropriate where there is innovative or developing technology. Where an alternative is offered, the vendor should identify any variations from this International Standard and provide details.

Petroleum and natural gas industries — Piping

1 Scope

1.1 This International Standard specifies the requirements for design and construction of piping for the petroleum and natural gas industries, including associated inspection and testing.

1.2 This International Standard is applicable to all piping within facilities engaged in the processing or handling of chemical, petroleum, natural gas or related products.

EXAMPLE Petroleum refinery, loading terminal, natural gas processing plant (including liquefied natural gas facilities), offshore oil and gas production platforms, chemical plant, bulk plant, compounding plant, tank farm.

1.3 This International Standard is also applicable to packaged equipment piping which interconnects individual pieces or stages of equipment within a packaged equipment assembly for use within facilities engaged in the processing or handling of chemical, petroleum, natural gas or related products.

1.4 This International Standard is not applicable to transportation pipelines and associated plant.

EXAMPLE Pipeline pump station, pipeline compressor station, pipeline tank farm, offshore platform risers up to and including pig launching facility.

2 Normative reference

The following normative document contains provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent edition of the normative document indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ANSI/ASME B31.3, *Process Piping*.

3 Terms and definitions

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

3.1
ambient temperature
temperature of the surrounding atmosphere in the immediate vicinity of the piping system

3.2
chemical plant
industrial plant for the manufacture or processing of chemicals, or of raw materials or intermediates for such chemicals

NOTE A chemical plant may include supporting and service facilities such as storage, utility and waste treatment units.

3.3
design minimum temperature
lowest temperature, at the mid-thickness of the piping wall, expected in service

3.4
design pressure
pressure used in calculating the thickness and the rating of piping components

3.5
design temperature
maximum temperature likely to be reached in operation, at the mid-thickness of the nominal piping wall, at design pressure

3.6
designer
individual or organization that takes responsibility for the engineering design of piping in accordance with any requirements established by the owner and in accordance with this International Standard

3.7
fabricator and/or erector
individual or organization that takes responsibility for the fabrication and/or installation of piping in accordance with the engineering design and in accordance with the requirements of this International Standard

3.8
fluid service category
category concerning the application of a piping system, considering the combination of fluid properties, operating conditions and other factors which establish the basis for design of the piping system

3.9
manufacturer
individual or organization that takes responsibility for the manufacture of piping in accordance with the engineering design and in accordance with the requirements of this International Standard

NOTE If a manufacturer employs subcontractors or fabricators and/or erectors for certain items, he has full control over their work.

3.10
mechanical joint
joint for the purpose of mechanical strength or leak resistance or both, in which the mechanical strength is developed by threaded, grooved, rolled, flared or flanged pipe ends, or by bolts, pins, toggles or rings, and the leak resistance is developed by threads and compounds, gaskets, rolled ends, caulking, or machined and mated surfaces

3.11
owner
individual or organization responsible for establishing the requirements for design, construction, examination, inspection and testing which govern the entire fluid handling or process facility of which the piping is part

NOTE The owner is normally the individual or organization that purchases the piping system and/or is responsible for operating the facility.

3.12
packaged equipment
assembly of individual pieces or stages of equipment, complete with interconnecting piping and connections for external piping

NOTE The assembly may be mounted on a skid or other structure prior to delivery.

3.13
petroleum refinery
industrial plant for the processing or handling of petroleum and products derived directly from petroleum

NOTE A petroleum refinery may be an individual gasoline recovery plant, a treating plant, a gas processing plant (including liquefaction) or an integrated refinery having various process units and attendant facilities, and may include supporting and service facilities such as storage, utility and waste treatment units.

3.14
pipe
pressure-tight cylinder used to convey a fluid or to transmit a fluid pressure

NOTE Pipe is ordinarily designated "pipe" in applicable material specifications. Materials designated "tube" or "tubing" in the specifications are treated as pipe when intended for pressure service.

3.15
piping
assemblies of piping components used to convey, distribute, mix, separate, discharge, meter, control or snub fluid flows

NOTE Piping also includes pipe-supporting elements, but does not include support structures such as building frames, bents or foundations.

3.16
piping component
mechanical element suitable for joining together or assembly into pressure-tight fluid-containing piping systems

EXAMPLE Pipe, tubing, fittings, flanges, gaskets, bolting, valves and devices such as expansion joints, flexible joints, pressure hoses, traps, strainers, in-line portions of instruments, and separators.

3.17
piping system
interconnected piping subject to the same set or sets of design conditions

4 Metallic industrial piping

4.1 General

4.1.1 Piping shall be designed, manufactured, fabricated, erected, inspected and tested in accordance with ANSI/ASME B31.3 and in accordance with the further requirements of this International Standard. Where ANSI/ASME B31.3 specifies requirements by reference to standards, the requirements of other standards may be substituted where determined to be appropriate by the designer and if agreed by the owner.

4.1.2 Any substitute requirements shall be mutually consistent and coherent, and it shall be demonstrated that these will achieve at least the same fitness for purpose in the context of their application. ANSI/ASME B31.3 requirements of unlisted components and unlisted materials may be used for guidance in determining fitness for purpose. This may often be achieved by substituting the set of standards referenced by ANSI/ASME B31.3 with an alternative coherent set of standards that has been developed for the same subject areas. This may not be easy to demonstrate if substitute standards are selected from a variety of origins.

4.1.3 Provision shall be made to safely contain or relieve any pressure to which the piping may be subjected. Piping not protected by a pressure-relieving device, or that can be isolated from a pressure-relieving device, shall be designed for at least the highest pressure that can be developed. It shall be ensured that all such measures remain adequate for the as-built condition.

NOTE Modifications to the measures necessary for adequate pressure resistance or relief may be required due to changes made during procurement of piping components, or during manufacture, fabrication and erection.

4.2 Responsibilities

4.2.1 Owner

The owner is normally responsible for the operation of a fluid handling or process facility such as a petroleum refinery or a chemical plant where the piping will be installed and operated. The owner shall establish the requirements for design, construction, examination, inspection and testing which govern the entire facility of which the piping and piping systems are part. The owner shall ensure that any special service requirements are designated for the piping. The owner shall define the boundary for application of this International Standard, noting 1.4.

4.2.2 Designer

The designer is responsible to the owner for assurance that the engineering design of piping meets the owner's requirements and is in accordance with this International Standard. The engineering design shall specify any unusual requirements for a particular service and shall specify any special measures necessary due to service requirements.

4.2.3 Manufacturer

The manufacturer of piping shall manufacture pipe, piping and piping components including any mechanical joints in accordance with the material specifications and in accordance with the requirements of this International Standard.

4.2.4 Fabricator and/or erector

The fabricator and/or erector shall fabricate and/or install pipes, piping, piping components and piping systems including mechanical joints in accordance with the engineering design and in accordance with the requirements of this International Standard.

4.3 Materials

4.3.1 General

The designer shall take appropriate measures to ensure that the material used for piping is suitable for the application. The piping manufacturer shall take appropriate measures to ensure that the material used for piping conforms to the required material specification.

4.3.2 Materials for pressurized parts

When selecting materials for pressure-containing piping components, the designer shall consider the following:

a) suitability of the materials for all operating and test conditions;

b) materials shall have sufficient ductility and toughness. Due care should be exercised in selecting materials in order to prevent brittle-type fracture where necessary; where for specific reasons brittle material has to be used, appropriate measures shall be taken. The requirements of ANSI/ASME B31.3 shall be the minimum requirements. Any additional requirements shall be specified in the engineering design;

c) materials shall be suitable for the fluid service. Materials shall be sufficiently chemically resistant to the fluid contained in the piping; the chemical and physical properties necessary for operational safety shall not fall below the minimum required within the planned lifetime of the equipment;

d) material performance due to ageing shall not fall below the minimum requirements;

e) materials shall be selected in order to avoid undesirable effects when the various materials are put together (e.g. galvanic corrosion);

f) materials shall be suitable for the intended processing procedures.

EXAMPLE Procedures that may be applicable are: regeneration, decoking, steam-out, auto-refrigeration, startup, shutdown or an interruption in normal operation of the process.

4.3.3 Traceability

When specified in the engineering design, material certificates or test reports shall be provided for all piping components.

When material certificates or test reports are requested, suitable procedures should be established and maintained for identifying the material making up the pressure-containing components of the piping, from receipt, through production, up to the final test of the manufactured piping. For components such as commodity valves the material certificate should be provided when the component is delivered.

4.4 Measures against misuse

Where the potential for misuse is known or can be clearly foreseen, the piping shall be designed to minimize danger from such misuse. If that is not possible, adequate warning shall be given that the piping shall not be used in that way. The limitation of the piping system shall be clearly established and made known to the user.

Take-off points shall be clearly marked on the permanent side, indicating the fluid contained, in order to ensure that the risk of inadvertent discharge is minimized.

For dangerous fluids, a risk assessment shall be performed in order to determine isolation requirements for take-off pipes the size of which may represent a risk arising from the fluids contained in the piping.

4.5 Draining and venting

Adequate means shall be provided for the draining and venting of piping where necessary, to minimize harmful effects such as water hammer, vacuum collapse, corrosion and uncontrolled chemical reactions. All stages of operation and testing, particularly pressure testing, shall be considered, to permit cleaning, inspection and maintenance in a safe manner.

4.6 Design conditions

4.6.1 Design conditions shall be based on the temperatures, pressures and loads applicable to the operation of piping, with due consideration of various effects and their consequent loadings.

4.6.2 The design pressure shall be not less than the pressure at the most severe condition of coincident internal or external pressure and temperature expected during service, that results in the greatest required component thickness and the highest component rating.

NOTE By reference to ANSI/ASME B31.3 this International Standard permits occasional variations above design conditions for a limited period of time, subject to certain criteria, and with owner approval.

4.6.3 Design conditions shall be determined with due consideration of the following:

a) design pressure and required pressure containment or relief;

b) design temperature and design minimum temperature, including consideration of internal or external insulation (if any), solar radiation and heating or cooling, e.g. by tracing or jacketing;

c) ambient effects, including fluid cooling effects, fluid expansion effects, atmospheric icing, and low ambient temperature;

d) dynamic effects, including impact, wind, earthquake, vibration and forces due to let-down or discharge of fluids;

e) weight effects, including live loads and dead loads;

f) thermal expansion and contraction effects, including thermal loads due to restraints, loads due to temperature gradients and loads due to differences in expansion characteristics;

g) effects of support, anchor and terminal movements;

h) reduced ductility effects;

i) cyclic effects;

j) air condensation effects.

4.7 Layout of piping

Layout of piping shall consider safety, environmental effects, economy, construction, operations and maintenance.

In particular, adequate provisions shall be made for maintenance, including maintenance *in situ* and removal or replacement of piping components as appropriate.

Annex A provides information and good practice for the layout of piping.

NOTE Layout of piping is part of the engineering design, for which the designer is responsible to the owner.

4.8 Buried piping

4.8.1 General

Buried piping within an industrial site presents a potential hazard to site personnel and equipment. Buried piping shall be subject to the general provisions of this International Standard and to the additional requirements and considerations of this subclause 4.8.

This subclause 4.8 and annex B provide guidance as to how the hazard presented by the piping may be assessed, and the integrity of the piping system maintained.

Annex B also provides information and good practice for buried piping.

4.8.2 Design requirements

The main factors that shall be considered are as follows:

a) design, including routing, layout, interaction with connecting systems;

b) materials and construction specification and quality control;

c) operating procedures and control;

d) corrosion protection;

e) external impact protection and mitigation.

All of these factors interact. It is recommended that all buried piping be subjected to a formal hazard identification and risk assessment procedure.

Safety requirements additional to appropriate national or local regulations may be specified by the owner for hazardous fluid services, including automated means of isolating buried sections of piping.

4.8.3 Design conditions

4.8.3.1 A simple model linking buried pipes and the surrounding ground may be sufficient for piping designed in accordance with this International Standard. More comprehensive analysis of pipe-to-soil interaction may be used where sufficient accurate geomechanical data is available, or where the conditions of this International Standard cannot be met.

4.8.3.2 If the piping is laid on an even bed of sand or similar material, the longitudinal bending stress due to its own weight may be discounted.

4.8.3.3 The designer shall include in the calculations the weight of soil or backfill above the pipe and the maximum predicted value of traffic or other static and dynamic loads imposed on the ground above the pipe.

4.8.3.4 In addition to calculations at the design pressure, the loading on the unpressurized system shall be calculated.

4.8.3.5 Pipe movement is significantly restrained by the frictional force at the interface with the surrounding soil, and may be effectively prevented at buried bends and large branches. Unless specific measures are incorporated to permit relative movement, buried pipes shall be considered as fully restrained axially for calculation purposes.

4.8.3.6 If no detailed analysis is undertaken, the maximum temperature range (including the installation temperature) shall not exceed 35 K (e.g. from 20 K to 55 K), and restraining features such as buried bends and tees shall have a separation of not less than 5 nominal pipe diameters.

4.8.3.7 If seismic events are to be considered, the pipe shall be treated as if rigidly connected to the ground and following the imposed displacements. Dynamic amplification may be ignored.

4.8.3.8 The designer shall consider the interface between buried and above-ground sections of the piping for all design conditions. For static analysis, the buried section shall be treated as if anchored, and the designer shall ensure sufficient flexibility in the above-ground section to limit loads at the interface to the allowable limit. The designer shall analyse the effects of any anticipated settlement of the buried piping relative to the connected piping above ground or in ducts, and shall ensure compliance with the requirements of this International Standard.

4.9 Erosion and abrasion

4.9.1 If the piping is subjected to severe conditions of erosion or abrasion, at the design stage adequate consideration shall be given to:

a) providing additional material thickness to allow an acceptable operating period before retirement due to erosion or abrasion;

b) use of lining and cladding materials in the piping to minimize or eliminate erosion or abrasion;

c) ensuring that the design considers the maintenance of the piping at locations where erosion or abrasion is most likely to occur, in order to allow replacement of damaged items.

4.9.2 The in-service inspection strategy for such piping shall take into account the following:

a) the minimum allowable pipe wall thickness for continued safe operation or, where this method is not practical, the results of a more detailed fitness-for-purpose assessment may be considered;

b) the need to inspect the piping before the wall thickness becomes less than the minimum allowable or before any other defined criteria are exceeded.

5 Non-metallic piping and piping lined with non-metals

5.1 General

5.1.1 Non-metallic piping and piping lined with non-metals shall be designed, manufactured, fabricated, erected, inspected and tested in accordance with ANSI/ASME B31.3 and in accordance with the further requirements of this International Standard. Consideration should be given as to whether glass-reinforced-plastics piping in accordance with ISO 14692 should be specified.

5.1.2 Non-metallic piping shall comply with the requirements of 4.1.2 for the safe containment and relief of pressure.

5.1.3 Metallic piping which provides the pressure containment for a non-metallic lining shall conform to the requirements of clause 4 and to those in this clause 5 where not limited to non-metals.

5.2 Design conditions

5.2.1 Design conditions shall be determined in accordance with 4.6 as supplemented by 5.2.2.

5.2.2 For uninsulated components, the component design temperature shall be the fluid temperature, unless a higher temperature will result from solar radiation or other external heat sources.

Annex A
(informative)

Layout of piping

A.1 General

This annex provides guidance and good practice for layout of piping, primarily for onshore plant. The information in this annex A supports the requirements of 4.7 of this International Standard. Similar issues should be considered offshore (see ISO 13703 for further guidance).

A.2 Terms and definitions

Terms used in this annex are defined, for information only, in A.2.1 through A.2.3.

A.2.1
accessway
designated zone or corridor providing access for operation or maintenance of piping

A.2.2
clearway
designated zone or corridor, left free of all services and equipment, allowing future access or expansion

A.2.3
pipetrack
dedicated buried or above-ground structure containing one or more pipes and associated piping components

A.3 General considerations

A.3.1 Specific attention should be given to commissioning where piping is required to be steam-blown, etc. Adequate allowance should be made for siting steam headers and trapping stations at the plant layout stage.

A.3.2 Piping and platforms around columns should, where necessary, leave clear space for lowering equipment to the ground. Pipe tracks should not encircle equipment.

A.3.3 Space should be left around equipment and instruments to facilitate maintenance (tube bundle withdrawal, cleaning, level instrument bridles, etc.).

A.3.4 Piping layout should ensure that valves are readily accessible, easily operated and provide proper access to allow maintenance of valves *in situ*. Valves for emergency isolation of equipment and process-area limit valves should be accessible from ground level, or from permanent accessway. Valves should be approachable from two sides with easy, readily available escape routes. A single ladder up to an emergency shut-off valve is not acceptable.

A.3.5 Valves should not be installed with their stems below horizontal. Flare and relief line battery limit valves should be installed with their stems horizontal. Valves in ground-level pipe tracks should be suitably grouped. Drain valves for level gauges on vessels should be located so that the liquid level can be seen easily from the drain valve position. Sufficient clearance should be provided for satisfactory operation of lever valves. Allowance for insulation boxes should be made. Where valves are secured in position by clamping between pipe flanges, the effect of removing the adjoining pipe should be taken into account.

A.3.6 The use of extended spindle- or chain-operated valves should be minimized. Where they are used, they should not cause obstruction.

A.3.7 Piping layout should allow for protection of piping systems, where necessary, to prevent freezing or to prevent difficulties resulting from high viscosities or wax formation. Methods of protection may include:

a) heating by external or internal tracing, jacketing, impedance heating or grouping with adjacent hot lines;

b) insulation;

c) grading or sloping to permit complete draining;

d) burying below frost level;

e) circulation of flow.

A.3.8 Generally, lines should be run horizontally. Underground lines should be provided with a means for emptying. Where lines need to be drained completely, the piping should be sloped and be provided with drainage points. Examples of lines requiring complete drainage are:

a) multi-purpose lines;

b) where hazardous or valuable liquids can be spilt during dismantling of pipework;

c) where there may be polymerization or settling of solids from liquids in the piping;

d) where there may be contamination of pure products due to liquids standing in lines subject to intermittent use;

e) where condensation of gas or vapour streams may occur;

f) where two-phase flow lines could give rise to residual quantities of liquid.

A.3.9 Lines to be sloped should be indicated on the engineering line diagram. Typical slopes for sloped lines are as follows:

a) drain lines: minimum 1:100;

b) service (i.e. non-process) lines: between 1:240 and 1:200;

c) process lines generally: 1:120;

d) process lines on pipetracks: 1:240.

A.3.10 Branch connections from horizontal steam and air mains should be taken from the top of the main.

A.3.11 Spading (line blanks) positions or other means of positive isolation requiring access during routine operation should be accessible without the use of scaffolding.

A.3.12 Piping on overhead structures, in tracks or in permanent trenches, should permit removal of any pipe, fitting, or valve without disturbing adjacent piping. Pipes entering or leaving pipe racks should do so at common intermediate elevations, either above or below the main rack levels.

A.3.13 For plants containing stainless steel piping operating at temperatures above 400 °C, the risk of zinc embrittlement due to the proximity of any galvanized structural steelwork should be considered.

A.3.14 Sufficient space should be allowed between adjacent lines at changes of direction to prevent damage of one line by another due to expansion or contraction.

A.3.15 Flare lines and other essential utilities should not be run directly above special Fire Risk Areas as determined by the owner.

A.4 Clearances

A.4.1 Piping should be laid out to provide access by mobile equipment. Accessways should be planned accordingly and, unless specified otherwise, the minimum headroom clearances for this purpose should be considered as follows:

a) 4,5 m over railways (top of rail) and clearways for mobile equipment;

b) 5 m over the crown of access roads and, where specified, over clearways for heavy equipment;

c) 2,1 m over walkways and platforms.

A.4.2 Minimum clearance for walkways around pumps, motors, compressors, etc. should be 1,0 m measured from the furthest projection on the equipment, including associated piping with flanges and insulation boxes, filters, valves in their open position, drains, cabling, instruments, etc. between grade and 2,0 m above grade.

A.4.3 Minimum clearance between the nearest edge of a pipetrack and the toe of a bund should be 1,0 m.

A.4.4 Flanges in parallel pipelines should be staggered, with a minimum of 150 mm longitudinal clearance between the flanges or insulation boxes.

A.4.5 Overground lines running side by side should have a minimum clearance of 25 mm between a pipe and an adjacent flange, after allowing for insulation and deflections. Attention should be given to pipe movement caused by thermal changes.

A.4.6 Lines crossing each other should have a minimum clearance of 25 mm pipe-to-pipe, after allowing for insulation and deflection.

A.5 Inside process areas — Additional considerations

A.5.1 Piping should be overhead wherever practicable, and accessways provided where necessary to allow operation of cranes and other mobile equipment. Overhead racks may contain more than one level of piping, subject to the owner's approval. In multi-level racks, cable trays should normally be on the highest level, with utilities and process piping on the lower levels.

A.5.2 Fire-water lines should not normally be laid inside process area limits.

A.5.3 Where main trunk lines for steam, water and other common systems run through a number of process units, off-takes to the users in any one unit should not be taken directly from the main trunk lines. Off-takes should be from a header or headers supplying each unit and should be provided with a valve at their junction with the main trunk lines. Where the main trunk lines run in offsite pipetracks, off-takes into each unit should be fitted with a valve at the plot limit of each unit.

A.5.4 Pipe trenches close to process equipment should be avoided. Where it is not practicable to run pipe overhead and trenches below paving level are unavoidable, the trenches should be in accordance with local regulations, and should be approved by the owner. In all areas handling flammable fluid, such trenches should be divided by firebreaks into sections about 10 m in length.

A.5.5 Individual lines not exceeding DN 25, such as lines for drains, may be run in chases in paving if no suitable alternative is available.

A.6 Outside process areas — Additional considerations

A.6.1 Piping should preferably run at ground level. Only in exceptional circumstances should trenches be used, or should lines be buried. The spacing of any firebreak walls is specified by the owner. Piping should be sufficiently above ground to prevent corrosion of underside by contact with soil and wind-blown materials.

A.6.2 Lines at ground level should be grouped together to form pipetracks and run on supports to give the same bottom-of-pipe elevation.

A.6.3 Above-ground lines should not be laid directly over the underground lines where running parallel.

A.6.4 Piping passing under roads and railways should be protected against mechanical damage and corrosion. Additional earth cover (e.g. haunching, terracing) or sleeves extending at least 1 m on either side of the road shoulders should be used as protection against damage.

A.6.5 Pipes in sleeves should be sealed to the sleeve where:

a) it is necessary to provide a firebreak;

b) it is necessary to exclude moisture and avoid corrosion of the internal surface of the sleeve;

c) the sleeve might become a channel for underground drainage;

d) it is advisable to prevent ingress of solids which might block the sleeve against any future addition of another pipe;

e) it is desirable to exclude rodents, particularly where the end of the sleeve is above ground, e.g. a thrust bore has been made;

Sealing may be by sheet metal covers with packing or proprietary synthetic rubber cappings.

Pipe sleeves should be galvanised or otherwise protected against corrosion.

A.6.6 Hot lines in pipetracks should be grouped together and expansion loops nested. The number of expansion loops should be minimized, consistent with the flexibility requirements.

A.6.7 Take-offs from pipetrack to process areas should rise from track level, run low, and rise at the battery limit to the elevation of the piping within the process area. Battery limit valves, spades and drains should be located in the vertical risers, except those specified by the owner.

A.7 Tankage areas — Additional considerations

A.7.1 Forces and moments imposed on connections on tanks should be minimised by providing flexibility in the connecting lines.

A.7.2 Where piping design and layout cannot accommodate differential settlement between tank and piping, flexible joints should be provided subject to the approval of the owner. Such joints should incorporate fire-safe seals.

A.7.3 Lines passing through bunds should be protected to minimize corrosion.

A.7.4 The annular space between any sleeves and piping should be large enough to avoid clogging and should be properly sealed.

A.7.5 At storage tanks, a by-pass between the water drain branch and the suction piping should be installed only when it will be necessary to use the suction piping to empty the tank completely. Such by-pass connections should be the same size as the water drain.

Annex B
(informative)

Buried piping

B.1 General

This annex provides guidance and good practice for buried piping. The information in this annex supports the requirements of 4.8 of this International Standard.

B.2 Design considerations

B.2.1 Routes

All routes for buried piping should be agreed with the owner and operator of the site. The site owner should be required to furnish details of all other actual or planned buried services (including cables) and all roadways or other surface loads within the construction working width or zone of the proposed pipe.

B.2.2 Depth of installation

In the absence of special protection (e.g. concrete slabs), buried piping should be provided with a minimum cover of 0,8. m. The designer should consider increasing the extent of cover above the minimum where penetrating cold or frost heave of the ground is likely, or where damage from excavation activities is a possibility.

B.2.3 Pipe marking and recording

Buried pipes should be marked by a continuous tape or other agreed means placed no closer than 0,3 m directly above the pipe.

All buried pipes should be identified on as-installed drawings which accurately locate the route relative to structures or other permanent features. The site owner may require the route to be physically marked by the use of identification posts or cover slabs at appropriate intervals.

B.2.4 Internal inspection

Where periodic internal inspection of buried piping is anticipated, and the specification identifies the method proposed, the designer should incorporate appropriate means of introducing and removing the inspection devices. Such closures, nozzles or chambers should be designed in accordance with the rules set out in this International Standard.

Where travelling pigs are to be employed, the designer should ensure that the piping arrangement is suitable for the equipment specified. In particular, the position and design of branches, radius of bends, out-of-roundness due to manufacture and operations and restriction of the internal diameter should be considered.

B.2.5 Contents removal

The design of the piping system should make allowance for the safe filling and removal of the contents. This should include vent and drain points or falls as required, and the selection of appropriate bends and fittings. See also A.3.8.

B.2.6 Trench drainage

The designer should recognize that pipe trenches for buried piping can act as channels for ground water. Appropriate means should be employed to ensure that the bottom of the trench has sufficient slope to soak-aways or sumps to prevent accumulation of water around the piping. If such measures are not possible, the designer should include the possibility of flotation in the design calculations.

In addition, the disposal of hydraulic test water should be considered in the arrangement of drainage. Care should be exercised during this operation to ensure that washout of bedding material does not occur.

B.3 Installation in trenches

B.3.1 The normal method of installation should be by the excavation of trenches. Sections of buried pipe installed by thrust boring or similar trenchless methods should be set in casings.

B.3.2 The bottom of the trench should be consolidated and free from sharp objects, rocks or stones. The trench should be made with sufficient slope to provide drainage for the pipe to minimize flotation and corrosion. Where necessary, soak-aways or sumps should be provided.

B.3.3 A bedding base of free-flowing material such as rounded sand or fine gravel should be provided, with sufficient depth to support the pipe and assist drainage.

B.4 Pipe laying

B.4.1 The trench should be substantially free of water before the pipe is placed in position.

B.4.2 Provision should be made for sufficient access to joints to permit proper examination during hydrostatic or other testing operations, and to wrap or otherwise protect pipe joints in the trench. Adequate means should be provided for removing the test water from the pipe and trench.

B.4.3 The bore of the piping should be clean to the required standard before laying in the trench.

B.4.4 All practical means should be taken to prevent damage to the pipe and its coatings in storage and during pipe laying. Wire ropes and chains should not be used for lifting. Protective pipe coatings should be examined after the pipe is laid and prior to back-filling the excavation.

B.5 Back-filling

B.5.1 All tie and examination operations should be completed before any back-filling is undertaken.

B.5.2 The first cover of the piping should be made using free-flowing materials to a minimum depth of 0,2 m, ensuring that the whole circumference of the pipe is in contact with the filling.

B.5.3 The remaining back-filling should be the same material that was excavated to form the trench or of similar characteristics. No vegetable or waste matter should be incorporated.

B.6 Sleeves or casings

B.6.1 Where buried piping is subjected to frequent overhead traffic or occasional heavy loads, consideration should be given to providing the pipe with an external protective sleeve or casing. These should also be employed for sections installed by thrust boring or similar means.

B.6.2 Casings should be of steel, concrete or plastic composition with a diameter providing a minimum of 100 mm clearance from the carrier pipe. They should be constructed to carry all likely external loads, without consideration of the carrier pipe and any internal supports.

B.6.3 Casings should be sealed at their ends to prevent the ingress of water or other foreign matter. If the annulus between carrier and sleeve pipes is to be filled with a fluid, the seal need only be sufficient to withstand the pressure of the filler, unless otherwise specified by the purchaser.

B.7 Corrosion protection

B.7.1 General

B.7.1.1 Buried piping should be protected from external corrosion which can arise from water and ground contaminants, and the effects of stray earth electrical currents. Protection should be provided by a combination of pipe surface coating and cathodic electrical protection.

B.7.1.2 The piping specification should identify the necessary requirements for corrosion protection of buried pipes. These should be in the form of preparation, coating and cathodic protection specifications.

B.7.1.3 The owner should furnish all appropriate information in respect of the corrosion hazards likely to be encountered on site.

B.7.2 Coatings

B.7.2.1 All coatings should be suitable for the underground environment and have mechanical and electrical properties to suit the specified conditions.

B.7.2.2 In the absence of any other specification, the manufacturer should consider the relevant International Standards for the selection of suitable coatings.

B.7.2.3 Coatings should bond strongly to the pipe surface and be resistant to loss of bonding at discontinuities and imperfections.

B.7.2.4 Offsite coating should be maximized to ensure application under the most favourable conditions. Site coating may use alternative methods to achieve the requisite protection, e.g. tape-wrapping of joints or similar small areas. Care should be taken to select a method which will bond adequately with the coating of the main pipe body and is appropriate for the installation conditions.

B.7.3 Cathodic protection

B.7.3.1 Cathodic protection of buried piping should be applied to reduce the risk of aggressive localized corrosion at points where the protective coating is or could become defective.

B.7.3.2 Protection should be either by the connection of sacrificial anodes or the use of an impressed current. Protection should be applied as soon as practicable after installation.

B.7.3.3 Attention should be given to the risks of pick-up from stray earth currents in complex industrial sites, and the designer of the protection system should consider the possible interaction with other local electrical networks.

B.7.3.4 The designer should ensure that electrical continuity is in place for all buried piping.

B.7.3.5 Buried piping should be electrically isolated from above-ground sections through the use of isolating flanges or similar arrangements.

B.8 Pressure testing

Wherever practical, buried sections of piping should be pressure-tested prior to laying in the trench, and all final connections subjected to other approved non-destructive testing methods. Where this is not practical, the final leak test should be performed when the piping is in the trench prior to burial.

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