SIST

SLOVENSKI STANDARD
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Napeljave in oprema za utekoļ injeni zemeljski plin ï Naļ rtovanje in preskuġanje rok za polnjenje in praznjenje

Installation and equipment for liquefied natural gas - Design and testing of loading/unloading arms

Anlagen und Ausrüstung für Flüssigerdgas - Auslegung und Prüfung von Ladearmen

Installations et équipements relatifs au gaz naturel liquéfié - Conception et essais des bras de chargement/déchargement

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Installation and equipment for liquefied natural gas - Design and testing of loading/unloading arms

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CEN

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Foreword

This European Standard has been prepared by Technical Committee CEN/TC 282 "Installation and equipment for LNG", the secretariat of which is held by AFNOR.

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of an identical text or by endorsement, at the latest by January 1998 and conflicting national standards shall be withdrawn at the latest by January 1998

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

1 Scope

This European Standard specifies the design, material selection, minimum safety requirements and inspection and testing procedures for liquefied natural gas (LNG) loading and unloading arms. It also covers the minimum requirements for safe LNG transfer between ship and shore.

Although the requirements for remote control power systems are covered, the standard does not include all the details for the design and fabrication of standard parts and fittings associated with loading/unloading arms.

The content of this standard is supplementary to local or national standards and regulations and is additional to the requirements of prEN 1532.

2 Normative references

This European Standard incorporates, by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

EN 287-1	Approval testing of welders - Fusion welding - Part 1 : Steels
EN 288-1	Specification and qualification of welding procedures for metallic materials - Part 1 : General rules for fusion welding
EN 288-2	Specification and approval of welding procedures for metallic materials - Part 2 : Welding procedure specification for arc welding
EN 288-3	Specification and approval of welding procedures for metallic materials - Part 3 : Welding procedure tests for the arc welding of steels
prEN 571-1	Non destructive testing - Penetrant testing - Part 1 : General principles
EN 875	Destructive tests on welds in metallic materials - Impact tests - Test specimen location, notch orientation and examination
EN 910	Destructive tests on welds in metallic materials - Bend tests
EN 1160	Installation and equipment for liquefied natural gas - General characteristics of liquefied natural gas
prEN 1435	Non destructive examination of welds - Radiographic examination of welded joints
prEN 1473	Installation and equipment for liquefied natural gas - Design of onshore installations
EN 10088-2	Stainless steels - Part 2 : Technical delivery conditions for sheet/plate and strip for general purposes

EN 10088-3	Stainless steels - Part 3 : Technical delivery conditions for semi-finished products, bars, rods and sections for general purposes
EN 50014	Electrical apparatus for potentially explosive atmospheres - General requirements
EN 50015	Electrical apparatus for potentially explosive atmospheres - Oil immersion "o"
EN 50016	Electrical apparatus for potentially explosive atmospheres - Pressurized apparatus "p"
EN 50017	Electrical apparatus for potentially explosive atmospheres - Powder filling "q"
EN 50018	Electrical apparatus for potentially explosive atmospheres - Flameproof enclosure "d"
EN 50019	Electrical apparatus for potentially explosive atmospheres - Increased safety "e"
EN 50020	Electrical apparatus for potentially explosive atmospheres - Intrinsic safety "i"
ISO 10497	Testing of valves - Fire type-testing requirements

3 Definitions and abbreviations

For the purposes of this European Standard the following definitions apply :

3.1 ship/shore transfer facilities : A jetty including all the ship/shore interface equipment for receiving or exporting LNG.

3.2 apex swivel : The articulated, fluid-carrying joint located between the inboard and outboard arms.

3.3 arm : The articulated piping, including the base riser, that is fixed on the jetty and its supporting structure plus all its accessories.

3.4 arm, inboard : The fluid-carrying pipe and/or structural members contained between the apex swivel and the trunnion swivel.

3.5 arm, outboard : The fluid-carrying pipe contained between the apex swivel and the triple swivel assembly.

3.6 attitude : The various modes of use and/or location of the arm (i.e. manoeuvring, stored, connected, washing, hydrostatic test, and maintenance). The arm may take several positions for each attitude.

3.7 bank of arms : All the arms on the same jetty.

3.8 base riser : See riser (see 3.48).

3.9 brinelling : Any permanent indentation in the swivel raceways caused by excessive loading of the swivel balls.

NOTE : For swivel test purposes, brinelling is said to occur when the width of the indentation is equal to or greater than eight percent of the ball diameter.

3.10 cantilever length : The distance from the ship's manifold flange face (including spool pieces), to the first permanent manifold support point on the ship's cargo line.

3.11 cavitation : The formation of low pressure zones at the inner radius of elbows. Cavitation is caused by the collapse of bubbles which are formed at excessively high flow rates. The collapse releases energy, sometimes with an audible sound and vibration.

3.12 centreline of arm group : The line equidistant between the two outside arms of those loading arms in simultaneous service. It is used as the line for spotting the centreline of the manifold group to be serviced by the loading arm group.

3.13 centreline of manifold group : The line equidistant between the two outside manifolds (nozzles) of the group of manifolds to be connected to the loading arms.

3.14 clash : Any contact :

- between adjacent loading arms while both arms are operating or one arm is operating and the other arm is stored ;

- between adjacent sections of the same arm (e.g. the triple swivel and outboard arm) ;

- between the arm and any loading platform equipment.

3.15 contact angle (α) : The angle between the plane of the swivel joint balls and the centre of contact at the ball raceway interface.

3.16 CPMS : Constant position monitoring system.

3.17 counterweight, primary : The mass located on the opposite side of the riser from the inboard arm and affixed to an extension of the inboard arm. It balances the self-weight of the inboard arm and the self-weight of the outboard arm and triple swivel assembly as if they were suspended from the apex swivel.

3.18 counterweight, secondary : The mass used to balance the self-weight of the outboard arm and triple swivel assembly.

3.19 coupler : The manual or hydraulic mechanical device used to connect the arm to the ship's manifold without employing bolts. This device is often also referred to as QCDC i.e. quick connect disconnect coupler (see 3.46).

3.20 drift : Longitudinal and/or lateral displacement of the ship (see annex A).

3.21 emergency release coupling (ERC) : This is a device to provide a means of quickly disconnecting the loading/unloading arms when such action is required only as an emergency measure.

3.22 emergency release system (ERS) : A system that provides a positive means of quick release of loading/unloading arms and safe isolation of ship and shore.

3.23 emergency shut down (ESD) : A method that safely and effectively stops the transfer of LNG between the ship and shore or vice versa.

3.24 envelope, composite : That volume in space which a single arm is required to service.

NOTE : A composite envelope is developed by the supplier for each arm in the bank based on the following: the reference envelope, single and simultaneous service requirements, and the minimum/maximum manifold spacings specified. The composite envelope for each arm should be included in the loading arm design specification.

3.25 envelope, reference (or basic) : That volume in space which contains all of the locations of the centreline of the manifold group(s) based on :

- elevation changes for tide and draft ;
- changes in horizontal position due to tanker sway and surge ;
- differences in the set back and elevation above deck of the vessel's manifolds.

3.26 freewheel : The ability of a hydraulically operated loading arm to freely follow without hydraulic restraint the motion of the ship's manifold due to tide and draft changes and sway and surge motions.

3.27 heave : Vertical motion of the ship due to wave action (see annex A).

3.28 included angle : The angle formed between the inboard and outboard arm. This angle varies with the position of the arm and ranges from between 10 ° and 15 ° in the stored attitude to 150 ° in the connected attitude.

3.29 insulating flange : An electrical insulating system which is installed in the lower end of the outboard arm or within the middle swivel of the triple swivel assembly. Its purpose is to prevent stray currents from causing an arc at the ship's flange as the loading arm is connected or disconnected.

3.30 jack : A permanent, adjustable load-carrying mechanism installed in the triple swivel assembly to transfer a portion of the arm fluid weight to the deck instead of the ship's manifold.

3.31 jetty control centre : A control centre situated on or adjacent to the jetty primarily to control the loading/unloading arms.

3.32 LNG : Liquefied Natural Gas.

3.33 LN_2 : Liquefied Nitrogen Gas.

3.34 main control room : A control room situated in the terminal from which central control is directed.

3.35 ship's cargo manifold : The flanged, pipe assembly mounted onboard ship to which the outboard flange of the loading arm is connected.

3.36 manifold spacing : The horizontal distance between the centreline of adjacent manifolds.

NOTE : The designer should clarify whether the data refers to straight manifolds or wyes and it is the spacing between manifolds to which arms will connect at the same time that is important.

3.37 MOV : Motor Operated Valve.

3.38 N_2 : Nitrogen gas.

3.39 NG : Natural gas.

3.40 nozzle : See 3.35.

3.41 offset : The horizontal projected distance between any two assemblies of the arm (e.g. the apex offset is between the inboard and outboard arm ; the heel offset is between the riser and the inboard arm).

3.42 operating envelope : The volume in space in which the arm can be connected to the ship (see annex B).

3.43 pantograph : The assembly of linkages and pinned connections used to transmit the secondary counterweight forces and moments to the outboard arm. In a wider sense where a cable and sheaves system is used for the same purpose we also refer to "Pantograph Cables and Pantograph Sheaves".

3.44 pitch(ing) : Rotation of the ship around transversal horizontal axis (see annex A).

3.45 product : Fluid transferred using loading arms (LNG, NG or LN_2).

3.46 QCDC : Quick connect disconnect coupler (see 3.19).

3.47 remote pendant control : A device to facilitate the flanging/unflanging operation of the loading/unloading arms from a remote location (e.g. ship's cargo manifold area).

3.48 riser ; base riser ; standpost : The vertical assembly which bolts to the loading platform and supports the articulated assembly of the loading arm.

3.49 riser assembly : The fluid carrying system of elbow(s) and vertical riser swivel mounted on top of the riser.

3.50 riser swivel : The swing joint in the riser assembly which permits the inboard arm to rotate around the base riser.

3.51 roll(ing) : Rotation of ship around longitudinal horizontal axis.

3.52 sheaves : The large pulleys mounted at the riser and apex assemblies of some loading arms. Cables are strung around the sheaves to transmit the secondary counterweight force to the outboard arm.

3.53 ship : LNG carrier to be connected to arm for LNG loading or unloading.

3.54 ship cargo control room : A control room situated on board the ship from which the control of the ship's transfer operation is directed.

3.55 simultaneous service : The use of two or more loading arms.

3.56 slew(ing) : Horizontal, rotary motion of the loading arm around the riser.

3.57 spool (piece) : The reducers or enlargers bolted to the ships permanent manifold for the purpose of matching the ship's and loading arm flanges. Sometimes also referred to as adaptors.

3.58 standpost : See riser (see 3.48).

3.59 stress analysis : A detailed calculation of the structural loading in the arm and manifold for various positions and attitudes to check integrity of the arm for the service intended.

NOTE : Best accomplished by use of especially designed computer programs.

3.60 surge : Longitudinal ship motion, also referred to as drift (see annex A).

3.61 surge pressure : The rapid change in pressure as a consequence of a change in flow rate in a pipeline.

3.62 sway : Transverse ship motion, also referred to as drift (see annex A).

3.63 swivel : Swing joint contained in the loading arm to permit the arm to freely follow the motion of the vessel. Swivels are composed of male and female housings containing ball raceways and balls (or similar systems) to permit rotation and to carry loads. Liquid seals are placed between the two housings to prevent leakage.

3.64 tanker : The LNG carrier.

3.65 terminal : An LNG plant with loading/unloading facilities.

3.66 lean-back : The position of the arm in the connected mode when the inboard arm is to the rear of the riser.

3.67 trailing wire : The unsupported electrical multi-core cable strung between the jetty control console and the remote pendant control. See also remote pendant control in 3.47.

3.68 transfer : Loading or unloading operation.

3.69 triple swivel assembly (TSA) : The group of three swivel and elbows located at the end of the outboard arm.

3.70 trunnion assembly : The fluid carrying system of elbow(s) and horizontal trunnion swivel on top of the riser assembly.

3.71 trunnion swivel : The swing joint in the trunnion assembly which permits the inboard arm to rotate around horizontal.

3.72 UPS : Uninterrupted Power Supply.

3.73 wind velocity : Wind velocity to be used as design wind speed at 10 m above lowest low water, and is given as a three seconds gust speed in metres per second.

3.74 Yaw : Rotation of the ship around vertical axis (see annex A).

4 Design of the arms

4.1 Definition of the length and the configuration of the arms

The length and the configuration of the arms shall allow for the connection of the on-shore piping to the ship's cargo manifold. The connection shall allow for free movement in the whole operating envelope of the installation (see annex B).

The connection of the arms to the ship shall take into account the manifold arrangement of the different types of ship, the low low and high high water levels, the ship freeboard changes, the ship's drift allowance and the combination of the arms to be connected.

The design shall cater for the following minimum clearances:

- 0,15 m minimum clearance between any part of an operating arm and a stored arm ;

- 0,3 m minimum clearance between any part of an operating arm and any adjacent structures, piping, equipment, etc. ;

- 0,3 m minimum clearance between any part of adjacent operating arms, except for counterweights. The minimum clearance between counterweights of operating arms shall be 0,15 m.

4.2 Description

The arms are normally composed of :

- a triple swivel assembly (TSA) ;

- an outboard arm ;

- an inboard arm ;

- an apex swivel assembly between the outboard and inboard arm ;

- a base riser ;

- a double swivel assembly between the inboard arm and the base riser.

Within the operating envelope, the design of the arms shall include six degrees of freedom to accommodate the ship's movements (refer to annex A).

The product piping subject to low temperature shall be free to expand or contract within the structure. The structure itself shall not be subjected to low temperature.

All piping supports shall be adequately designed so that stresses in the piping and the structure are within allowable limits for all attitudes and positions.

The complete TSA and outboard arm shall be balanced in the empty condition without ice. It shall be balanced around the apex swivel joint and bearing by means of a counterweight and pantograph arrangement.

The complete, articulated assembly shall be balanced, in empty condition without ice. It shall be balanced around the trunnion swivel joint and bearing by means of a counterweight.

The design of the arm shall take into account the design of the ship's cargo manifold connections without overstressing the manifold piping and the ship's deck.

The design of the loading/unloading arms shall consider, in addition to the normal operation, the emergency release of the arms in both the empty and full condition. There should be no clash of the arms with the ship or the jetty.

4.3 Swivel joints

4.3.1 General

The swivel joints used on the arm shall allow for the rotation of two piping or structure components in the same plane. The maximum amplitude of the swivel joint shall be adequate to satisfy the connecting, the manoeuvring, the stored and the maintenance conditions.

Two types of swivel joint are used namely, the product swivel joint and the structure bearing.

4.3.2 Design of the product swivel joint

The product swivel joint is made up of a product sealing arrangement, a bearing system and an external sealing arrangement.

4.3.2.1 Product sealing arrangement

The arrangement shall comprise of two seals, one primary and one secondary. The secondary seal is to avoid external leakage or leakage into the bearing in case of primary seal failure.

A detection port shall be provided in the annular space between the primary and secondary seal.

4.3.2.2 Bearing

The swivel bearing shall permit the rotation of the swivel under internal and external loads in all design conditions.

The bearing which is subjected to low temperature shall be either adequately lubricated or kept dry with nitrogen gas circulation. The selected means shall prevent ice formation inside the bearing.

4.3.2.3 External sealing arrangement

This arrangement shall prevent water penetration into the bearing which could freeze. It shall also ensure a seal for the re-circulating nitrogen or lubricant inside the bearing.

4.3.2.4 Design

The swivel joints shall be designed for a minimum :

- safety factor of four against structural failure ;
- safety factor of two against leakage ;
- safety factor of 1,5 against brinelling.

The safety factor is the ratio of the maximum equivalent axial load at which the event occurs and the calculated maximum equivalent axial load.

The equivalent axial load (P_{CA}) is calculated by the formula :

$$P_{CA} = F_A + 5\frac{M_T}{d} + 2{,}3\,F_R \tan\alpha$$

where :

F_A is the total axial load equal to the axial fluid pressure load plus externally applied axial load (newtons) ;

M_T is the externally applied bending moment (newton metres) ;

d is the raceway diameter (metres) ;

F_R is the externally applied radial load (newtons) ;

α is the contact angle (the angle between the plane of the balls and the centre of contact at the ball raceway interface).

Maximum acceptable leakage rate is 1 050 cm³/h of gas (0 °C, 101 325 Pa) per centimetre of seal diameter ; or four cm³/h of liquid per cm of seal diameter.

Brinelling occurs when the width of permanent indentation is equal to or greater than 8 % of the ball diameter.

4.3.3 Structure bearings

The structure bearing joints shall be capable of withstanding the external loads in all design conditions of the arm.

The bearing shall be protected from penetration of water, solid particles and against sea atmosphere corrosion.

The swivel joint shall be designed for a minimum :

- safety factor of 3,5 against structural failure ;
- safety factor of 1,5 against brinelling.

The safety factor is the ratio of the maximum equivalent axial load at which the event occurs and the calculated maximum equivalent axial load.

The equivalent axial load (P_{CA}) is calculated by the formula :

$$P_{CA} = F + 5\frac{M_T}{d} + 2{,}3\,F_R \tan\alpha$$

where :

F is the external axial load (newtons) ;

M_T is the externally applied bending moment (newton metres) ;

d is the raceway diameter (metres) ;

F_R is the externally applied radial load (newtons) ;

α is the contact angle (the angle between the plane of the balls and the centre of contact at the ball raceway interface).

4.4 Accessories

4.4.1 Adjustable support (Jack)

If required, the arm shall be equipped with a support device at the TSA. The support shall be made of two adjustable legs to rest on the deck after connection of the arm to the ship.

Its function is to take up part of the load due to the weight of the product and to reduce stresses in the manifold of the ship. These loads are transmitted to the ship's deck through the feet of the support.

The height of the support shall be adjustable from 450 mm to 1 400 mm, and it shall be designed to prevent overloading the deck and the manifold.

The design of the support on the loading arm shall not interfere with free movement of the arm with the pitching of the ship.