



SLOVENSKI STANDARD SIST EN 1473:1999

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Installation and equipment for liquefied natural gas - Design of onshore installations

Anlagen und Ausrüstung für Flüssigerdgas - Auslegung von landseitigen Anlagen

Installations et équipements de gaz naturel liquéfié - Conception des installations
terrestres

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ICS:

75.200

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Petroleum products and
natural gas handling
equipment

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English version

Installation and equipment for liquefied natural gas - Design of onshore installations

Installations et équipements de gaz naturel
liquéfié - Conception des installations
terrestres

Anlagen und Ausrüstung für Flüssigerdgas -
Auslegung von landseitigen Anlagen

This European Standard was approved by CEN on 1997-01-09. CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

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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of an identical text or by endorsement, at the latest by November 1997, and conflicting national standards shall be withdrawn at the latest by November 1997.

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.

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0 Introduction

The objective of this European Standard is to give functional guidelines for LNG installations. It recommends procedures and practices which will result in safe and environmentally acceptable design, construction and operation of LNG plants. It need not be applied retrospectively, but application is recommended when major modifications of existing installations are being considered.

1 Scope

This European Standard gives guidelines for the design, construction and operation of all onshore stationary liquefied natural gas (LNG) installations including those for the liquefaction, storage, vaporisation, transfer and handling of LNG. Satellite plants with total storage capacity of less than 200 t are excluded from this European Standard.

This European Standard is valid for the following plant types :

- export terminals, between the designated gas inlet boundary limit, and the ship manifold ;
- receiving terminals, between the ship manifold and the designated gas outlet boundary limit ;
- peak-shaving plants, between designated gas inlet and outlet boundary limits ;
- LNG satellite plants with total storage capacity above 200 t, including the loading station up to the designated gas outlet boundary limit.

A short description of each of these installations is given in annex G.

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 approval 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
EN 473	Qualification and certification of NDT personnel - General principles

EN 571-1	Non destructive testing - Penetrant testing - Part 1: General principles
prEN 823	Thermal insulating products for building applications - Determination of thickness
prEN 970	Non-destructive examination of fusion welds- Visual examination
prEN 1050	Safety of machinery - Principles for risk assessment
prEN 1092-1	Flanges and their joints- Circular flanges for pipes, valves and fittings - Part 1 : Steel flanges - PN designated
prEN 1127-1	Safety of machinery - Fire and explosions - Part 1 : Explosion prevention and protection
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 1474	Installation and equipment for liquefied natural gas - Design and testing of loading/unloading arms
prEN 1514-1	Flanges and their joints - Dimensions of gaskets for PN-designated flanges - Part 1 : Non-metallic flat gaskets with or without inserts
prEN 1532	Installation and equipment for liquefied natural gas - Ship to shore interface for liquefied natural gas
prEN 1594	Gas supply systems - Pipelines - Maximum operating pressure over 16 bar - Functional requirements
prEN 1714	
prEN 1759-1	Flanges and their joints - Circular flanges for pipes, valves, fittings and accessories - Part 1 : Steel flanges, NPS ½ to 24
prEN 1776	Gas supply - Natural gas measuring systems - Functional requirements
EN ISO 9001	Quality systems - Model for quality assurance in design, development, production, installation and servicing (ISO 9001 : 1994)
EN ISO 9002	Quality systems - Model for quality assurance in production, installation and servicing (ISO 9002 : 1994)
prEN ISO 9906	Rotodynamic pumps- Code for hydraulic performance tests for acceptance- Grades 1 and 2 (ISO/DIS 9906 : 1995)

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EN 10204	Metallic products - Types of inspection documents
prEN ISO 10456	Building materials and products - Procedures for determining declared and design thermal values (ISO/DIS 10456:1995)
prEN 12008-1	Specific functional requirements for the materials, design, construction, operation, maintenance and renovation of gas supply systems up to and including 16 bar - Part 1 : Polyethylene systems up to and including 10 bar
prEN 12008-2	Specific functional requirements for the materials, design, construction, operation, maintenance and renovation of gas supply systems up to and including 16 bar - Part 2 : Steel-systems up to and including 16 bar MOP
prEN 12065	Installation and equipment for liquefied natural gas - Suitability testing of foam concentrates designed for generation of medium and high expansion foam and of extinguishing powders used on liquefied natural gas fires
prEN 12066	Installation and equipment for liquefied natural gas - Testing of insulation linings for liquefied natural gas retention bunds
prEN ISO 12241	Calculation rules for the thermal insulation of pipes, ducts and other equipment in building and industrial installations (ISO/DIS 12241:1995)
prEN 12308	Installation and equipment for liquefied natural gas - Suitability testing of gaskets designed for flanged joints used on LNG piping
EN 25199	Technical specifications for centrifugal pumps- class II (ISO 5199 : 1986)
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 - Pressurised 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"

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EN 50020	Electrical apparatus for potentially explosive atmospheres - Intrinsic safety "i"
EN 50028	Electrical apparatus for potentially explosive atmospheres - Encapsulate "M"
EN 50039	Electrical apparatus for potentially explosive atmospheres - Intrinsic electrical systems "i"
EN 50054	Electrical apparatus for the detection and measurement of combustible gases - General requirements and test methods
EN 50057	Electrical apparatus for the detection and measurement of combustible gases - Performance requirements for group II apparatus indicating up to 100% lower explosive limit
prEN 50145	Electrical apparatus for potentially explosive gas atmospheres- Classification of hazardous areas
ISO 2548	Centrifugal, mixed flow and axial pumps - Code for acceptance tests - Class C
ENV 1991-2-2	Eurocode1 - Basis design and actions on structures - Part 2-2 : Actions on structures exposed to fire
ENV 1992-1-1	Eurocode 2 - Design of concrete structures - Part 1-1: General rules and rules for buildings
ENV 1992- 1- 2	Eurocode 2 - Design of concrete structures - Part 1-2 : Structural fire design
ENV 1993-1-1	Eurocode 3 - Design of steel structures - Part 1-1: General - General rules and rules for buildings
ENV 1993-1-2	Eurocode 3 - Design of steel structures - Part 1- 2 : General rules- Structural fire design
ENV 1994-1-1	Eurocode 4 - Design of composite steel and concrete structures - Part 1-1: General rules and rules for buildings
ENV 1994-1-2	Eurocode 4 - Design of composite steel and concrete structures - Part 1-2 : General rules- Structural fire design
ENV 1998-1-1	Eurocode 8 - Design provisions for earthquake resistance of structures - Part 1-1 : General rules - Seismic actions and general requirements for structures
ENV 1998-1-2	Eurocode 8 - Design provisions for earthquake resistance of structures - Part 1 -2 : General rules - General rules for buildings

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ENV 1998-5 Eurocode 8 - Design provisions for earthquake resistance of structures - part 5 : foundations, retaining structures and geotechnical aspects

3 Terms and definitions

For the purpose of this standard, the following definitions apply.

3.1 LNG (Liquefied Natural Gas) : LNG (Liquefied Natural Gas) is defined in EN 1160.

3.2 LNG export terminal : in an LNG export terminal, the natural gas coming by pipe from one or several gas fields is liquefied then stored for subsequent transport to other destinations.

3.3 LNG receiving terminal : in LNG receiving terminals, LNG carriers (ships) are unloaded, LNG is stored in tanks, vaporised and sent to the gas networks or gas consumers. LNG receiving terminals can have loading stations for road, rail, barge or small LNG carriers.

3.4 LNG peak-shaving plant : LNG Peak-shaving plants are connected to a gas network. During the period of the year when gas demand is low, natural gas is liquefied and LNG is stored. LNG is vaporised during short periods, when gas demand is high.

3.5 LNG satellite plant : LNG satellite plants are connected to a gas network or gas consumers. LNG is supplied by road tankers, rail, barge or small LNG carriers. LNG is stored in insulated pressure vessels, vaporised and sent to the network.

3.6 actions : "Actions" (sometimes referred to as loads) are forces and couples of forces due to the loads and deformations which are imposed on an item of equipment.

3.7 combined actions : actions are classified in three categories :

- "permanent actions" for which intensity is constant or does not vary very much or always varies in the same direction while tending to a limit ;

- "variable actions" for which intensity is not constant. Variations are due essentially to actions during construction, testing, commissioning and normal operation of the installations, atmospheric conditions and operating basis earthquake (OBE) ;

- "accidental actions" for which intensity is not constant. Its variations are due essentially to accidental internal or external actions including the safe shutdown earthquake (SSE).

Actions are combined to obtain two types of combined actions :

- "normal actions" are combinations of actions which are permanent and variable ;

- "augmented actions" are the combination of normal actions and a single accidental action. Unless otherwise stated, accidental actions in combination need not be considered.

3.8 hazards : a physical situation which has the potential for human injury, damage to property, damage to the environment or some combination of these.

3.9 tank : the word "Tank" used in this standard corresponds to the equipment item in its entirety for the retention of LNG. The different types of tank are described in annex H.

3.10 OBE (Operating Basis Earthquake) : an OBE, defined for any installation, is the maximum earthquake for which no damage is sustained and restart and safe operation can continue. This higher probability event would result in no commercial loss to the installation and public safety is assured. An OBE event shall require a structural assessment to be carried out at the serviceability limit state.

3.11 SSE (Safe Shutdown Earthquake) : an SSE, defined for any installation, is the maximum earthquake event for which the essential fail-safe functions and mechanisms are designed to be preserved. Permanent damage can be expected of this lower probability event, but without the loss of overall integrity and containment. The installation would not remain in continuous service without a detailed examination and structural assessment at the ultimate limit state.

3.12 level of risks : the combination of the consequence and the probability of a specific hazard occurring within a specified period under specified circumstances.

3.13 impounding area and bund wall : the impounding area is formed by the bund walls around the LNG storage tank which is a low construction of earth or concrete surrounding the storage tank, at a distance greater than 6 m from the tank, to contain spilled liquid.

3.14 primary container : the primary container is :

- the cryogenic container of the single containment tank ;
- the cryogenic container of the spherical tank ;
- the inner cryogenic container of the double containment tank, full containment tank or cryogenic concrete tank ;
- the cryogenic membrane of the membrane tanks.

3.15 secondary container : the secondary container is :

- the bund wall of the single containment tank and the spherical tank ;
- the outer container of double or full containment tanks ;
- the concrete outer envelope of membrane tanks or cryogenic concrete tanks.

3.16 PASQUILL atmospheric stability factors : PASQUILL atmospheric stability factors are determined as a function of the wind speed and solar radiation (see P.1). The six factors are :

- A : extremely unstable ;
- B : moderately unstable ;
- C : lightly unstable ;
- D : neutral ;
- E : lightly stable ;
- F : moderately stable.

3.17 NGL (natural gas liquid) : the NGL (Natural Gas Liquid) is composed of light hydrocarbons (typically ethane through hexane plus) condensed from the natural gas prior to its liquefaction.

3.18 limit states : two categories of limit states shall be used in the design of the load bearing structures :

- the serviceability limit state (SLS), which is determined on the basis of criteria applicable to functional capability or to durability properties under normal actions ;
- the ultimate limit state (ULS), which is determined on the basis of the risk of failure, large plastic displacements or strains comparable to failure under augmented actions.

3.19 impounding basin : impounding basin is a special pit to collect LNG spillage.

3.20 flammable gases : gas or vapour which, when mixed with air in certain proportions, will form an explosive gas mixture.

3.21 owner : the company responsible for the safe design, construction and operation of the installation as defined in 3.2 to 3.5.

3.22 ESD (Emergency Shut Down) : ESD is a system that safely and effectively stops the whole plant or individual units before an unrecoverable incident occurs.

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3.23 PSD (Process Shut Down) : PSD is a system that safely and effectively stops individual units within the plant for process reasons.

3.24 safety management system : a formal system¹⁾ consisting for example in a series of checklists which are monitored and signed off as the project progresses to show that all safety concerns have been addressed.

¹⁾ Standardisation work is in progress

4 Safety and environment

4.1 General

The design, procurement, construction and operation phases shall all be implemented in accordance with the requirements of the Quality management system described in EN ISO 9001.

Furthermore each phase shall be controlled by an acceptable Safety Management System.

LNG installations shall be designed to minimise the risk to property and life outside and inside the battery limits. In particular, hazard assessments shall be carried out and all the safety measures defined in 4.5 shall be taken into account.

A hazard assessment, as defined in 4.4, shall be carried out where the inventory of LNG and natural gas on the site exceeds the threshold specified in the relevant local regulation. The assessment shall be carried out during the design of the plant and it is recommended if a major change takes place.

4.2 Installation and its environment

4.2.1 Description of the installation

A description of the installation shall be written by plant area and/or by process function.

4.2.2 Site study

The site study shall include, where appropriate :

- a soil survey ;
- a study of terrain to enable the dispersion of liquid and gas clouds to be assessed ;
- a study of vegetation to enable, in particular, vegetation fire risks to be identified ;
- a study of ground water tables ;
- a study of the marine aquatic environment and marine access ;
- a study of sea water quality and temperature ;
- a study of tidal conditions ;
- a study of shock waves and flooding (tsunami, failure of dams, etc.) ;
- a survey of the surrounding infrastructure (e. g. industrial sites, built up areas, communications).

The soil survey shall include :

- the geotechnical survey that will enable the geomechanical characteristics of the subsoil to be defined ;
- the geological and tectonic investigation.