



# SLOVENSKI STANDARD SIST EN 1473:2007

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

Anlagen und Ausrüstung für Flüssigerdgas - Auslegung von landseitigen Anlagen

**ITeh STANDARD PREVIEW**

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

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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 25 November 2006.

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. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN Management Centre has the same status as the official versions.

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EUROPEAN COMMITTEE FOR STANDARDIZATION  
COMITÉ EUROPÉEN DE NORMALISATION  
EUROPÄISCHES KOMITEE FÜR NORMUNG

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## Foreword

This document (EN 1473:2007) 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of an identical text or by endorsement, at the latest by July 2007, and conflicting national standards shall be withdrawn at the latest by July 2007.

This document supersedes EN 1473:1997.

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

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## Introduction

The objective of this European Standard is to give functional guidelines for LNG installations. It recommends procedures and practices that 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.

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## 1 Scope

This European Standard gives guidelines for the design, construction and operation of all onshore liquefied natural gas (LNG) installations including those for the liquefaction, storage, vaporisation, transfer and handling of LNG.

This European Standard is valid for the following plant types:

- LNG export installations (plant), between the designated gas inlet boundary limit, and the ship manifold;
- LNG receiving installations (plant), between the ship manifold and the designated gas outlet boundary limit;
- peak-shaving plants, between designated gas inlet and outlet boundary limits.

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

Satellite plants are excluded from this European Standard. Satellite plants with storage capacity of less than 200 t are covered by EN 13645.

## 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.

EN 287-1, *Qualification test of welders — Fusion welding — Part 1: Steels*

EN 473, *Non destructive testing — Qualification and certification of NDT personnel — General principles*

EN 571-1, *Non destructive testing — Penetrant testing — Part 1: General principles*

EN 809, *Pumps and pump units for liquids — Common safety requirements*

EN 970, *Non-destructive examination of fusion welds — Visual examination*

EN 1092-1, *Flanges and their joints — Circular flanges for pipes, valves, fittings and accessories, PN-designated — Part 1: Steel flanges*

EN 1127-1, *Explosive atmospheres — Explosion prevention and protection — Part 1: Basic concepts and methodology*

EN 1160, *Installations and equipment for liquefied natural gas — General characteristics of liquefied natural gas*

EN 1435, *Non-destructive examination of welds — Radiographic examination of welded joints*

EN 1474, *Installation and equipment for liquefied natural gas — Design and testing of loading/unloading arms*

EN 1514-1, *Flanges and their joints — Dimensions of gaskets for PN-designated flanges — Part 1: Non-metallic flat gaskets with or without inserts*

EN 1532, *Installation and equipment for liquefied natural gas — Ship to shore interface*

EN 1714, *Non-destructive examination of welds — Ultrasonic examination of welded joints*

## EN 1473:2007 (E)

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

EN 1991-1-2, *Eurocode 1 — Actions on structures — Part 1-2: General actions - Actions on structures exposed to fire*

EN 1992-1-1, *Eurocode 2 : Design of concrete structures — Part 1-1: General rules and rules for buildings*

EN 1992-1-2, *Eurocode 2 : Design of concrete structures — Part 1-2: General rules - Structural fire design*

EN 1993-1-1, *Eurocode 3 : Design of steel structures — Part 1-1: General rules and rules for buildings*

EN 1993-1-2, *Eurocode 3 : Design of steel structures — Part 1-2: General rules — Structural fire design*

EN 1994-1-1, *Eurocode 4 — Design of composite steel and concrete structures — Part 1-1: General rules and rules for buildings*

EN 1994-1-2, *Eurocode 4 — Design of composite steel and concrete structures — Part 1-2: General rules — Structural fire design*

EN 1998-1, *Eurocode 8 : Design of structures for earthquake resistance — Part 1: General rules, seismic actions and rules for buildings*

EN 1998-5, *Eurocode 8: Design of structures for earthquake resistance — Part 5: Foundations, retaining structures and geotechnical aspects*

EN 10204, *Metallic products — Types of inspection documents*

EN 12065, *Installations and equipment for liquefied natural gas — Testing of foam concentrates designed for generation of medium and high expansion foam and of extinguishing powders used on liquefied natural gas fires*

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EN 12066, *Installations and equipment for liquefied natural gas — Testing of insulating linings for liquefied natural gas impounding areas*

EN 12162, *Liquid pumps — Safety requirements — Procedure for hydrostatic testing*

EN 12308, *Installation and equipment for LNG — Suitability testing of gaskets designed for flanged joints used on LNG piping*

EN 12434, *Cryogenic vessels — Cryogenic flexible hoses*

EN 12567, *Industrial valves — Isolating valves for LNG — Specification for suitability and appropriate verification tests*

EN 13445 (all parts), *Unfired pressure vessels*

EN 13480 (all parts), *Metallic industrial piping*

EN 14620-1:2006, *Design and manufacture of site built, vertical, cylindrical, flat-bottomed steel tanks for the storage of refrigerated, liquefied gases with operating temperatures between 0°C and -165°C – Part 1: General*

EN 14620 (all parts), *Design and manufacture of site built, vertical, cylindrical, flat-bottomed steel tanks for the storage of refrigerated, liquefied gases with operating temperatures between 0 °C and – 165 °C*

EN 60034-5, *Rotating electrical machines — Part 5: Degrees of protection provided by the integral design of rotating electrical machines (IP code) — Classification (IEC 60034-5:2000)*



- EN 60079-0, *Electrical apparatus for explosive gas atmospheres — Part 0: General requirements (IEC 60079-0:2004)*
- EN 60079-1, *Electrical apparatus for explosive gas atmospheres — Part 1: Flameproof enclosures "d" (IEC 60079-1:2003)*
- EN 60079-2, *Electrical apparatus for explosive gas atmospheres — Part 2: Pressurized enclosures "p" (IEC 60079-2:2001)*
- EN 60079-7, *Electrical apparatus for explosive gas atmospheres — Part 7: Increased safety "e" (IEC 60079-7:2003)*
- EN 60079-10, *Electrical apparatus for explosive gas atmospheres — Part 10: Classification of hazardous areas (IEC 60079-10:2002)*
- EN 60079-14, *Electrical apparatus for explosive gas atmospheres — Part 14: Electrical installations in hazardous areas (other than mines) (IEC 60079-14:2002)*
- EN 60079-17, *Electrical apparatus for explosive gas atmospheres — Part 17: Inspection and maintenance of electrical installations in hazardous areas (other than mines) (IEC 60079-17:2002)*
- EN 60079-18, *Electrical apparatus for explosive gas atmospheres — Part 18: Construction, test and marking of type of protection encapsulation "m" electrical apparatus (IEC 60079-18:2004)*
- EN 60079-25, *Electrical apparatus for explosive gas atmospheres — Part 25: Intrinsically safe systems (IEC 60079-25:2003)*
- EN 60079-26, *Electrical apparatus for explosive gas atmospheres — Part 26: Construction, test and marking of group II category 1 G electrical apparatus*
- EN 60529, *Degrees of protection provided by enclosures (IP Code) (IEC 60529:1989)*
- EN 61508-1, *Functional safety of electrical/electronic/programmable electronic safety-related systems — Part 1: General requirements (IEC 61508-1:1998 + Corrigendum 1999)*
- EN ISO 1460, *Metallic coatings — Hot dip galvanized coatings on ferrous materials — Gravimetric determination of the mass per unit area (ISO 1460:1992)*
- EN ISO 1461, *Hot dip galvanized coatings on fabricated iron and steel articles — Specifications and test methods (ISO 1461:1999)*
- EN ISO 9001, *Quality management systems — Requirements (ISO 9001:2000)*
- EN ISO 10456, *Building materials and products — Procedures for determining declared and design thermal values (ISO 10456:1999)*
- EN ISO 10497, *Testing of valves — Fire type-testing requirements (ISO 10497:2004)*
- EN ISO 12241, *Thermal insulation for building equipment and industrial installations — Calculation rules (ISO 12241:1998)*
- EN ISO 12944 (all parts), *Paints and varnishes — Corrosion protection of steel structures by protective paint systems (ISO 12944:1998)*
- EN ISO 13709, *Centrifugal pumps for petroleum, petrochemical and natural gas industries (ISO 13709:2003)*
- EN ISO 15607, *Specification and qualification of welding procedures for metallic materials — General rules (ISO 15607:2003)*

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EN ISO 15609-1, *Specification and qualification of welding procedures for metallic materials — Welding procedure specification - Part 1: Arc welding (ISO 15609-1:2004)*

EN ISO 15614-1, *Specification and qualification of welding procedures for metallic materials — Welding procedure test - Part 1: Arc and gas welding of steels and arc welding of nickel and nickel alloys (ISO 15614-1:2004)*

IEC 60079-4, *Electrical apparatus for explosive gas atmospheres — Part 4: Method of test for ignition temperature*

IEC 60079-5, *Electrical apparatus for explosive gas atmospheres — Part 5: Powder filling "q"*

IEC 60079-6, *Electrical apparatus for explosive gas atmospheres — Part 6: Oil-immersion "o"*

IEC 60079-11, *Explosive atmospheres — Part 11: Equipment protection by intrinsic safety "i"*

IEC 60079-13, *Electrical apparatus for explosive gas atmospheres — Part 13: Construction and use of rooms or buildings protected by pressurization*

IEC 60079-15, *Electrical apparatus for explosive gas atmospheres — Part 15: Construction, test and marking of type of protection "n" electrical apparatus*

IEC/TR 60079-16, *Electrical apparatus for explosive gas atmospheres — Part 16: Artificial ventilation for the protection of analyzer(s) houses*

IEC 60079-19, *Electrical apparatus for explosive gas atmospheres — Part 19: Repair and overhaul for apparatus used in explosive atmospheres (other than mines or explosives)*

IEC/TR3 60079-20, *Electrical apparatus for explosive gas atmospheres — Part 20: Data for flammable gases and vapours, relating to the use of electrical apparatus*

IEC 60079-27, *Electrical apparatus for explosive gas atmospheres — Part 27: Fieldbus intrinsically safe concept (FISCO) and Fieldbus non-incendive concept (FNICO)*

IEC 60364-5-54, *Electrical installations of buildings — Part 5-54: Selection and erection of electrical equipment — Earthing arrangements, protective conductors and protective bonding conductors*

### 3 Terms and definitions

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

**3.1 abnormal operation**  
plant operation such as plant trip, the production and disposal of off-spec products and also operation with production equipment failed or on maintenance are modes of abnormal operation and are not accidental events

**3.2 accidental event**  
event that arises from an uncontrolled or unplanned situation with safety and/or environmental consequences

**3.3 boundary**  
property line on land or water inside which the operator/owner has full control and authority, or exclusive use

**3.4****bund or bund wall**

raised impermeable structure, able to withstand the static pressure and temperature of the spilled liquid, around the perimeter of an impounding area for the confinement of hydrocarbon spills, usually associated with storage areas

**3.5****condensate**

hydrocarbon liquids produced from primary separation of natural gas from a reservoir

NOTE Natural gas condensates consist primarily of pentanes and heavier components, although quantities of propane and butane may be dissolved within the mixture

**3.6****container - primary container**

container in continuous contact with LNG i.e.:

- 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

**3.7****container - secondary container (standards.iteh.ai)**

container in contact with LNG only in the event of a failure of the primary container i.e.:

- the bund walls for single and double containment tanks and spherical tanks;
- the outer container of full containment tanks or cryogenic concrete tanks;
- the concrete envelope of membrane tanks

**3.8****conventional onshore LNG terminal**

LNG export or receiving terminal that is located on-shore and has a marine transfer facility for the loading or unloading of LNG carriers

NOTE The transfer facility is located in a harbour or other sheltered coastal location and consists of a fixed structure, or wharf, capable of withstanding the berthing loads of a fully laden LNG carrier of a given specification and mooring the vessel safely alongside. The structure is connected to the shore by a trestle, tunnel or other means, facilitating the LNG transfer and ancillary services and providing safe access and egress for personnel performing maintenance or operational duties

**3.9****earthquake - OBE (Operating Basis Earthquake)**

maximum earthquake for which no damage is sustained and restart and safe operation can continue

NOTE This higher probability event would result in no commercial loss to the installation and public safety is assured

**3.10****earthquake - SSE (Safe Shutdown Earthquake)**

maximum earthquake event for which the essential fail-safe functions and mechanisms are designed to be preserved.

NOTE 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

**3.11  
ESD (Emergency Shut Down) system**

system that safely and effectively stops the whole plant or individual units to minimise incident escalation

**3.12  
flammable gases**

gas or vapour which, when mixed with air in certain proportions, will form a combustible gas mixture

**3.13  
frequency**

number of occurrences per unit of time

**3.14  
golden weld**

weld that cannot be pressure tested due to its nature or location and that consequently will be subjected to a high level of non-destructive examination to prove that it is safe

**3.15  
hazard**

property of a dangerous substance or physical situation with a potential for creating damage to human health and/or to environment<sup>1)</sup>

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**3.16  
impounding area**

area where spills from liquid hydrocarbon storage containers may be confined or controlled, close to the source of leakage

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**3.17  
impounding basin**

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container within or connected to an impounding area or spill collection area where liquid hydrocarbon spills can be collected and safely confined and controlled

**3.18  
limit states**

two categories of limit states are 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  
LNG (Liquefied Natural Gas)**

LNG (Liquefied Natural Gas) is defined in EN 1160

**3.20  
LNG export terminal**

site at which natural gas coming by pipe from one or several gas producing fields is liquefied then stored for subsequent transport, normally by sea, to other destinations.

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<sup>1)</sup> Refer to European Directive [Council Directive 96/82/EC of 9 December 1996 on the control of major-accident hazards involving dangerous substances].

NOTE It has marine facilities for the transfer of LNG and can have loading stations for road, rail, barge or small LNG carriers

### 3.21

#### LNG peak-shaving plant

LNG peak-shaving plants are connected to a gas network.

NOTE During the period of the year when gas demand is low, natural gas is liquefied and stored. LNG may be vaporised for short periods, when gas demand is high

### 3.22

#### LNG receiving terminal

site where LNG carriers (ships) are unloaded, and where LNG is stored in tanks, vaporised and sent to the gas networks or gas consumers.

NOTE It has marine facilities for the transfer of LNG and can have loading stations for road, rail, barge or small LNG carriers

### 3.23

#### 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

### 3.24

#### NGL (Natural Gas Liquid)

liquid composed of light hydrocarbons (typically ethane through hexane plus) condensed from the natural gas prior to its liquefaction

### 3.25

#### normal operation

operation including intermittent operation such as ship loading or unloading, start-up, maintenance, planned shutdown and commissioning

### 3.26

#### operator/occupier

company responsible for the operation of the installation

### 3.27

#### owner

company responsible for the safe design and construction of the installation

### 3.28

#### PASQUILL atmospheric stability factors

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

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

**3.29**

**probability**

number in a scale from 0 to 1 which expresses the likelihood of an event occurrence

**3.30**

**PSD (Process Shut Down) system**

system that safely and effectively stops individual units within the plant for process reasons

**3.31**

**risk**

combination of the consequence and the frequency of a specific hazard occurring within a specified period under specified circumstances

**3.32**

**Safety Management System**

management process which defines and monitors the organisational structure, responsibilities, procedures, processes and resources for determining and implementing the major accident prevention policy<sup>2)</sup>

**3.33**

**SIL**

Safety Integrity Level required of a safety related system in terms of EN 61508

**3.34**

**spill collection area**

area at LNG production or transfer areas where leakages can be confined or controlled, often by the use of kerbing and/or controlled sloping of paved areas

**3.35**

**tank**

equipment item in its entirety for the storage of LNG

**NOTE**

The different types of tank are described in Annex H

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**3.36**

**transfer area**

area containing a piping system where flammable liquids or gases are introduced into or removed from the plant or where piping connections are connected or disconnected routinely

**3.37**

**validated model**

mathematical model, the scientific basis of which is accepted to be sound and is proven to provide mathematical outputs to the relevant mathematical problem, and is shown to cover the full range of usage of the model and which has been calibrated or checked using realistic test data or results

## 4 Safety and environment

### 4.1 General

The design, procurement, construction and operation phases should all be implemented in accordance with the requirements of the Quality, Health, Safety and Environment management systems as described in EN ISO 9000 and EN ISO 14000 series.

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

<sup>2)</sup> Refer to European Directive [Council Directive 96/82/EC of 9 December 1996 on the control of major-accident hazards involving dangerous substances].

## 4.2 Environmental impact

### 4.2.1 Environmental Impact Assessment

During the feasibility study phase of the project, a preliminary Environmental Impact Assessment (EIA) shall be carried out for the proposed location in accordance with local regulations. Consideration should be given to formally recording the base line site environmental characteristics.

When the site has been selected, a detailed EIA shall be carried out.

All emissions from the plant, that is, solid, liquid (including water), and gaseous (including noxious odours) shall be identified and measures taken to ensure they will not be harmful to persons, property, animals or vegetation. This applies not only to normal, but also to accidental emissions.

During or prior to operation an effluent management procedure shall be established. The precautions for handling toxic materials shall be identified and be regularly updated by the operator/occupier.

The environmental impact due to construction and operation shall also be assessed and undesirable levels of activities shall be eliminated or minimised and restricted. The following checklist covers the main items:

- increased population, permanent and temporary;
- increased road, rail and ship traffic;
- increased noise levels, sudden and intermittent noise;
- increased vibration levels, sudden and intermittent;
- increased night working, effect of lights and their intermittent use;
- flaring, intermittent and/or continuous;
- warming or cooling of water.

### 4.2.2 Plant emissions

During the design plans shall be developed to eliminate, minimise or render harmless emissions resulting from commissioning tests, operations and maintenance activities, and shall set targets for quantities and concentrations of pollutants in emissions.

### 4.2.3 Emission control

The following shall be safely controlled:

- combustion products;
- normal or accidental venting of gas;
- normal or accidental flaring of gas;
- disposal of acid gas removal solvent;
- disposal of spent mercury removal reactant (as the demercurisation process is not regenerative, it is necessary to store and then treat the used absorbent mass or have it removed by a licensed waste disposal contractor);
- oily water condensed during dryer regeneration or from machines;