

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

EESTI STANDARDI EESSÕNA

NATIONAL FOREWORD

See Eesti standard EVS-EN 1473:2016 sisaldab Euroopa standardi EN 1473:2016 ingliskeelset teksti.	This Estonian standard EVS-EN 1473:2016 consists of the English text of the European standard EN 1473:2016.
Standard on jõustunud sellekohase teate avaldamisega EVS Teatajas.	This standard has been endorsed with a notification published in the official bulletin of the Estonian Centre for Standardisation.
Euroopa standardimisorganisatsioonid on teinud Euroopa standardi rahvuslikele liikmetele kättesaadavaks 18.05.2016.	Date of Availability of the European standard is 18.05.2016.
Standard on kättesaadav Eesti Standardikeskusest.	The standard is available from the Estonian Centre for Standardisation.

Tagasisidet standardi sisu kohta on võimalik edastada, kasutades EVS-i veebilehel asuvat tagasiside vormi või saates e-kirja meiliaadressile standardiosakond@evs.ee.

ICS 75.200

Standardite reprodutseerimise ja levitamise õigus kuulub Eesti Standardikeskusele

Andmete paljundamine, taastekitamine, kopeerimine, salvestamine elektroonsesse süsteemi või edastamine ükskõik millises vormis või millisel teel ilma Eesti Standardikeskuse kirjaliku loata on keelatud.

Kui Teil on küsimusi standardite autorikaitse kohta, võtke palun ühendust Eesti Standardikeskusega:

Aru 10, 10317 Tallinn, Eesti; koduleht www.evs.ee; telefon 605 5050; e-post info@evs.ee

The right to reproduce and distribute standards belongs to the Estonian Centre for Standardisation

No part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying, without a written permission from the Estonian Centre for Standardisation.

If you have any questions about copyright, please contact Estonian Centre for Standardisation:

Aru 10, 10317 Tallinn, Estonia; homepage www.evs.ee; phone +372 605 5050; e-mail info@evs.ee

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 4 March 2016.

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-CENELEC 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-CENELEC Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and United Kingdom.



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

CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels

Contents

Page

European foreword.....	7
Introduction	8
1 Scope.....	9
2 Normative references	9
3 Terms and definitions	13
4 Safety and environment.....	18
4.1 General.....	18
4.2 Environmental impact.....	19
4.3 Safety general.....	20
4.4 Hazard assessment.....	24
4.5 Safety engineering during design and construction.....	30
4.6 Safety during operation	33
5 Jetties and marine facilities.....	34
5.1 General.....	34
5.2 Siting	34
5.3 Engineering design	34
5.4 Safety	35
6 Storage and retention systems.....	35
6.1 General.....	35
6.2 Types of tank.....	35
6.3 Types of containment	36
6.4 Design principles.....	37
6.5 General design rules	39
6.6 Foundations	40
6.7 Operating instruments.....	40
6.8 Pressure and vacuum protection	42
6.9 Bund walls and impounding area for single and double containment.....	43
6.10 Safety equipment.....	45
6.11 Tank piping	46
6.12 Distance between tanks.....	46
6.13 Commissioning and decommissioning.....	47
6.14 Testing.....	47
7 LNG pumps.....	47
7.1 General.....	47
7.2 Materials.....	48
7.3 Specific requirements.....	48
7.4 Inspection and testing	48
8 Vaporization of LNG	48
8.1 General requirements	48
8.2 Design conditions.....	50
8.3 Vaporiser requirements	50
9 Pipe-work.....	50
9.1 General.....	50
9.2 Piping systems.....	50

9.3	Rules for design.....	52
9.4	Pressure tests.....	53
9.5	Piping components.....	53
9.6	Valves.....	56
9.7	Relief valves.....	56
9.8	Thermal insulation.....	57
9.9	Pipe rack/pipe way.....	61
9.10	Corrosion.....	61
10	Reception/send out of natural gas.....	61
10.1	Metering.....	61
10.2	Gas quality.....	62
10.3	Odourizing.....	62
11	Boil off recovery and treatment plants.....	62
11.1	General.....	62
11.2	Boil off collection system.....	63
11.3	System of gas return to tanker(s) or to export terminal.....	63
11.4	Boil off gas recovery.....	64
11.5	Gas compressor.....	64
11.6	Flare/vent.....	64
12	Auxiliary circuits and buildings.....	66
12.1	Electrical equipment.....	66
12.2	Lightning and earthing.....	67
12.3	Cathodic protection.....	68
12.4	Warning lights.....	68
12.5	Sea water supply.....	68
12.6	Gas contaminant removal plant.....	68
12.7	Instrument air.....	68
12.8	Fuel (utility) gas.....	69
12.9	Nitrogen system.....	69
12.10	Buildings.....	70
13	Hazard management.....	70
13.1	Inherent safety.....	70
13.2	Passive protection.....	72
13.3	Security.....	73
13.4	Incident detection and signalling.....	74
13.5	Emergency Shutdown System.....	75
13.6	Active protection.....	76
13.7	Other requirements.....	80
14	Control and monitoring systems.....	81
14.1	General description.....	81
14.2	Process control system.....	81
14.3	Safety control system.....	82
14.4	Access control system.....	84
14.5	Anti-intrusion system.....	84
14.6	CCTV.....	84
14.7	Jetty and marine monitoring and control.....	84
14.8	Communications.....	85
14.9	Environmental monitoring and control.....	85
15	Construction, commissioning and turnaround.....	85
15.1	Quality assurance and quality control.....	85

15.2	Acceptance tests	85
15.3	Preparation at start-up and shutdown.....	85
16	Preservation and corrosion protection	86
16.1	Painting.....	86
16.2	Cathodic protection	87
17	Training for operations	87
18	Pre-operational marine training.....	87
Annex A (normative) Thermal radiation threshold values.....		88
A.1	Heat radiation from LNG fires.....	88
A.2	Heat radiation from flare or ignited vent stack	89
Annex B (normative) Definitions of reference flow rates.....		91
B.1	General.....	91
B.2	V_T (heat input)	91
B.3	V_L (fluid input).....	91
B.4	V_O (over filling).....	91
B.5	V_F (flash at filling).....	91
B.6	V_R (LNG recirculation by a submersible pump).....	92
B.7	V_A (variation in atmospheric pressure)	92
B.8	V_V (control valve failure)	93
B.9	V_I (heat input in the course of a fire).....	93
B.10	V_D (fluid suction)	93
B.11	V_C (compressors suction)	93
B.12	V_B (roll-over).....	94
Annex C (informative) Seismic classification		95
C.1	Introduction	95
C.2	Some basic principles	95
C.3	Example of safety approach after SSE.....	95
C.4	Example of classification for SSE	96
Annex D (normative) Specific requirements for LNG pumps.....		97
D.1	Introduction	97
D.2	Design	97
D.3	Inspection	97
D.4	Testing.....	98
D.5	Declared values.....	100
D.6	Marking.....	100
D.7	Particular requirements for submerged pumps and related cables.....	101
D.8	Vertical external motor pumps.....	102

Annex E (normative) Specific requirements for LNG vaporizers	103
E.1 Operating parameters/declared performance.....	103
E.2 Water stream vaporizers: Open rack type (ORV)	103
E.3 Water stream vaporizers : Closed type (STV).....	105
E.4 Intermediate fluid vaporizers (IFV).....	106
E.5 Submerged combustion type vaporizers (SCV)	106
E.6 Ambient air vaporizers (AAV).....	108
Annex F (normative) Criteria for the design of pipes	109
Annex G (informative) Description of the different types of onshore LNG installations.....	111
G.1 LNG liquefaction plant	111
G.2 LNG receiving terminals.....	111
G.3 LNG peak shaving plants	112
G.4 LNG satellite plants	112
G.5 LNG bunkering stations	112
Annex H (informative) Definition of different types of LNG tanks.....	113
H.1 General	113
H.2 Spherical storage tank	113
H.3 Cryogenic concrete tank.....	113
Annex I (informative) Frequency ranges	116
Annex J (informative) Classes of consequence.....	117
Annex K (informative) Levels of risk	118
K.1 General	118
K.2 Acceptability criteria.....	118
Annex L (informative) Typical process steps of liquefaction	120
L.1 Introduction.....	120
L.2 Treatment of natural gas/extraction of acid gases	120
L.3 Natural gas treatment/dehydration	122
L.4 Treatment of natural gas/removal of mercury	123
L.5 Natural gas liquefaction unit.....	124
Annex M (informative) Odourant systems	129
M.1 Odourants in general.....	129
M.2 Odourant systems requirements.....	129
M.3 Odourant handling.....	130
M.4 Odourant injection	130
M.5 Odourant leakage	131
M.6 Safety of personnel.....	131

Bibliography..... 132

This document is a preview generated by EVS

European foreword

This document (EN 1473:2016) 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 2016, and conflicting national standards shall be withdrawn at the latest by November 2016.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 1473:2007.

In comparison with EN 1473:2007, the following changes have been made:

- the scope definition has been modified to cover interfaces and limits with floating solutions, plants refurbishing, renovation and expansion, and to better complement EN 14620;
- some requirements were revisited, such as tank containment types, new air vaporizer and sections that were subject to questions from the 2007 version;
- terms and definitions were adjusted to cope with new market development;
- the normative references were updated.

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, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

The objective of this European Standard is to give functional guidelines for on-shore 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.

This standard is also recommended for debottlenecking, revamping and plant life extension in the limits that will be defined by the local Authorities. The appliance of the European Directives to the existing facilities is part of the limits to be defined together with the local Authorities.

In case of plant expansion, this European Standard is applicable for the new facilities. The application of these recommendations for the tie-ins and connections to the existing facilities will be defined by the local Authorities. The limits of such application should consider the practicality of such appliance. In the same way the limits of the European Directives appliance will be accurately defined with the local Authorities.

1 Scope

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

This European Standard is valid for plants with LNG storage at pressure lower than 0,5 barg and capacity above 200 t and for the following plant types:

- LNG liquefaction installations (plant), between the designated gas inlet boundary limit, and the outlet boundary limit which is usually the ship manifold and/or truck delivery station when applicable; feed gas can be from gas field, associated gas from oil field, piped gas from transportation grid or from renewables;
- LNG regasification installations (plant), between the ship manifold and the designated gas outlet boundary limit;
- peak-shaving plants, between designated gas inlet and outlet boundary limits;
- the fixed part of LNG bunkering station.

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

Floating solutions (FPSO, FSRU, SRV), whether off-shore or nearby shore, are not covered by this European Standard even if some concepts, principles or recommendations could be applied. However, in case of berthed FSRU with LNG transfer across the jetty, the following recommendations apply for the jetty and topside facilities if the jetty is located within 3 000 m from the shore line.

In case of FSU type solution, the on-shore part is covered by these standard recommendations.

This standard is not applicable for installations specifically referred or covered by other standards, e.g. LNG fuelling stations, LNG road or rail tankers and LNG bunkering vessels.

The plants with a storage inventory from 50 t up to 200 t with tanks at a pressure higher than 0,5 barg are covered by EN 13645.

2 Normative references

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

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

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 1474 (all parts) *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 1591 (all parts), *Flanges and their joints — Design rules for gasketed circular flange connections*

- EN 1776, *Gas infrastructure — Gas measuring systems — 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 1997 (all parts), *Eurocode 7: Geotechnical 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*
- 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, *Installations 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 60079-0, *Explosive atmospheres — Part 0: Equipment — General requirements (IEC 60079-0)*

EN 60079-1, *Explosive atmospheres — Part 1: Equipment protection by flameproof enclosures "d" (IEC 60079-1)*

EN 60079-2, *Explosive atmospheres — Part 2: Equipment protection by pressurized enclosure "p" (IEC 60079-2)*

EN 60079-5, *Explosive atmospheres — Part 5: Equipment protection by powder filling "q" (IEC 60079-5)*

EN 60079-6, *Explosive atmospheres — Part 6: Equipment protection by liquid immersion "o" (IEC 60079-6)*

EN 60079-7, *Explosive atmospheres — Part 7: Equipment protection by increased safety "e" (IEC 60079-7)*

EN 60079-10-1, *Explosive atmospheres — Part 10-1: Classification of areas — Explosive gas atmospheres (IEC 60079-10-1)*

EN 60079-10-2, *Explosive atmospheres — Part 10-2: Classification of areas — Explosive dust atmospheres (IEC 60079-10-2)*

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

EN 60079-13, *Explosive atmospheres — Part 13: Equipment protection by pressurized room "p" (IEC 60079-13)*

EN 60079-14, *Explosive atmospheres — Part 14: Electrical installations design, selection and erection (IEC 60079-14)*

EN 60079-15, *Explosive atmospheres — Part 15: Equipment protection by type of protection "n" (IEC 60079-15)*

EN 60079-17, *Explosive atmospheres — Part 17: Electrical installations inspection and maintenance (IEC 60079-17)*

EN 60079-18, *Explosive atmospheres — Part 18: Equipment protection by encapsulation "m" (IEC 60079-18)*

EN 60079-19, *Explosive atmospheres — Part 19: Equipment repair, overhaul and reclamation (IEC 60079-19)*

EN 60079-20-1, *Explosive atmospheres — Part 20-1: Material characteristics for gas and vapour classification - Test methods and data (IEC 60079-20-1)*

EN 60079-25, *Explosive atmospheres — Part 25: Intrinsically safe electrical systems (IEC 60079-25)*

EN 60079-26, *Explosive atmospheres — Part 26: Equipment with Equipment Protection Level (EPL) Ga (IEC 60079-26)*

EN 60079-27, *Explosive atmospheres — Part 27: Fieldbus intrinsically safe concept (FISCO) (IEC 60079-27)*

EN 61508-1, *Functional safety of electrical/electronic/programmable electronic safety-related systems — Part 1: General requirements (IEC 61508-1)*

EN 62305 (all parts), *Protection against lightning (IEC 62305)*

EN ISO 1460, *Metallic coatings — Hot dip galvanized coatings on ferrous materials — Gravimetric determination of the mass per unit area (ISO 1460)*

EN ISO 1461, *Hot dip galvanized coatings on fabricated iron and steel articles — Specifications and test methods (ISO 1461)*

EN ISO 3452-1, *Non-destructive testing — Penetrant testing — Part 1: General principles (ISO 3452-1)*

EN ISO 9606-1, *Qualification testing of welders — Fusion welding — Part 1: Steels (ISO 9606-1)*

EN ISO 9712, *Non-destructive testing — Qualification and certification of NDT personnel (ISO 9712)*

EN ISO 10456, *Building materials and products — Hygrothermal properties — Tabulated design values and procedures for determining declared and design thermal values (ISO 10456)*

EN ISO 10497, *Testing of valves — Fire type-testing requirements (ISO 10497)*

EN ISO 12944 (all parts), *Paints and varnishes — Corrosion protection of steel structures by protective paint systems (ISO 12944)*

EN ISO 13709, *Centrifugal pumps for petroleum, petrochemical and natural gas industries (ISO 13709)*

EN ISO 15607, *Specification and qualification of welding procedures for metallic materials — General rules (ISO 15607)*

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

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)*

EN ISO 16903, *Petroleum and natural gas industries — Characteristics of LNG, influencing the design, and material selection (ISO 16903)*

EN ISO 17636-1, *Non-destructive testing of welds — Radiographic testing — Part 1: X- and gamma-ray techniques with film (ISO 17636-1)*

EN ISO 17636-2, *Non-destructive testing of welds — Radiographic testing — Part 2: X- and gamma-ray techniques with digital detectors (ISO 17636-2)*

EN ISO 17637, *Non-destructive testing of welds — Visual testing of fusion-welded joints (ISO 17637)*

EN ISO 17640, *Non-destructive testing of welds — Ultrasonic testing — Techniques, testing levels, and assessment (ISO 17640)*

EN ISO 28460, *Petroleum and natural gas industries — Installation and equipment for liquefied natural gas — Ship-to-shore interface and port operations (ISO 28460)*

HD 60364-5-54, *Low-voltage electrical installations — Part 5-54: Selection and erection of electrical equipment — Earthing arrangements and protective conductors (IEC 60364-5-54)*

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

3 Terms and definitions

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

3.1

abnormal operation

operating conditions 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 (liquid state at standard conditions) produced from primary separation of natural gas from a reservoir

Note 1 to entry: Natural gas condensates consist primarily of pentanes and heavier components, although quantities of propane and butane may be dissolved within the mixture.

3.6

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 cryogenic container of the double containment tank;
- the 9% Ni-steel self-supporting container;