PD ISO/TS 16901:2022



BSI Standards Publication

Guidance on performing risk assessment in the design of onshore LNG installations including the ship/shore interface

bsi.

National foreword

This Published Document is the UK implementation of ISO/TS 16901:2022. It supersedes PD ISO/TS 16901:2015, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee PSE/17/-/9, Liquefied Natural Gas (LNG) installations and equipment.

A list of organizations represented on this committee can be obtained on request to its committee manager.

Contractual and legal considerations

This publication has been prepared in good faith, however no representation, warranty, assurance or undertaking (express or implied) is or will be made, and no responsibility or liability is or will be accepted by BSI in relation to the adequacy, accuracy, completeness or reasonableness of this publication. All and any such responsibility and liability is expressly disclaimed to the full extent permitted by the law.

This publication is provided as is, and is to be used at the recipient's own risk.

The recipient is advised to consider seeking professional guidance with respect to its use of this publication.

This publication is not intended to constitute a contract. Users are responsible for its correct application.

This publication is not to be regarded as a British Standard.

© The British Standards Institution 2023
Published by BSI Standards Limited 2023

ISBN 978 0 539 22483 2

ICS 75.180.01

Compliance with a Published Document cannot confer immunity from legal obligations.

This Published Document was published under the authority of the Standards Policy and Strategy Committee on 30 April 2023.

Amendments/corrigenda issued since publication

Date	Text affected

PD ISO/TS 16901:2022

TECHNICAL SPECIFICATION

ISO/TS 16901

Second edition
2022-12-13

Guidance on performing risk assessment in the design of onshore LNG installations including the ship/shore interface

Recommandations sur l'évaluation des risques dans la conception d'installations terrestres pour le GNL en incluant l'interface terre/navire

Reference number
ISO/TS 16901:2022(E)

© ISO 2022



COPYRIGHT PROTECTED DOCUMENT

© ISO 2022, Published in Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org

© ISO 2022 – All rights reserved

Contents

Page

Foreword ..... **v**

1 Scope **1**

2 Normative references **1**

3 Terms and definitions **1**

4 Abbreviated terms **6**

5 Safety risk management **8**
5.1 Decision support framework for risk management 8
5.2 Prescriptive safety or risk performance 8
5.3 Risk assessment in relation to project development 9

6 Risk **11**
6.1 What is risk 11
6.2 Safety philosophy and risk criteria 12
6.3 Risk control strategy 12
6.4 ALARP 12
6.5 Ways to express risk to people 13
6.5.1 General 13
6.5.2 Risk contours (RC) 14
6.5.3 Risk transects (RT) 14
6.5.4 Individual risk (IR) 14
6.5.5 Potential loss of life (PLL) 15
6.5.6 Fatal accident rate (FAR) 15
6.5.7 Cost to avert a fatality (CAF) 15
6.5.8 *F*/*N* curves (FN) 15
6.5.9 Uncertainties in QRA 15

7 Methodologies **16**
7.1 Main steps of risk assessment 16
7.2 Qualitative risk analysis 16
7.2.1 HAZID 16
7.2.2 Failure mode and effect analysis (FMEA) 18
7.2.3 Risk matrix 18
7.2.4 Bow-tie 18
7.2.5 HAZOP 20
7.2.6 SIL analysis 21
7.3 Quantitative analysis: consequence and impact assessment 21
7.3.1 General 21
7.3.2 Consequence assessment 22
7.3.3 Impact assessment 24
7.4 Quantitative analysis: frequency assessment 25
7.4.1 General 25
7.4.2 Failure data 25
7.4.3 Consensus data 25
7.4.4 FAULT tree 25
7.4.5 Event tree analysis (ETA) 26
7.4.6 Exceedance curves based on probabilistic simulations 26
7.5 Risk assessments (consequence*frequency) 27
7.5.1 Risk assessment tools 27
7.5.2 Ad hoc developed risk assessment tools 27
7.5.3 Proprietary risk assessment tools 28

8 Accident scenarios **28**
8.1 Overview accident scenarios 28
8.2 LNG import facilities including SIMOPS 29
8.3 LNG export facilities 31

© ISO 2022 – All rights reserved

9 Standard presentation of risk **33**
Annex A (informative) **Impact criteria** **34**
Annex B (informative) **Chain of events following release scenarios** **53**
Bibliography **57**

© ISO 2022 – All rights reserved

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 67, *Oil and gas industries including lower carbon energy*, Subcommittee SC 9, *Production, transport and storage facilities for cryogenic liquefied gases*.

This second edition cancels and replaces the first edition (ISO/TS 16901:2015), which has been technically revised.

The main changes are as follows:

— reference to IGF code added to the scope;

— references updated in Clause 2 and the bibliography;

— definitions added for HSE critical activity and HSE critical element.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

© ISO 2022 – All rights reserved

TECHNICAL SPECIFICATION **ISO/TS 16901:2022**

Guidance on performing risk assessment in the design of onshore LNG installations including the ship/shore interface

1 Scope

This document provides a common approach and guidance to those undertaking assessment of the major safety hazards as part of the planning, design, and operation of LNG facilities onshore and at shoreline using risk-based methods and standards, to enable a safe design and operation of LNG facilities. The environmental risks associated with an LNG release are not addressed in this document.

This document is applicable both to export and import terminals but can be applicable to other facilities such as satellite and peak shaving plants.

This document is applicable to all facilities inside the perimeter of the terminal and all hazardous materials including LNG and associated products: LPG, pressurized natural gas, odorizers, and other flammable or hazardous products handled within the terminal.

The navigation risks and LNG tanker intrinsic operation risks are recognised, but they are not in the scope of this document. Hazards arising from interfaces between port and facility and ship are addressed and requirements are normally given by port authorities. It is assumed that LNG carriers are designed according to the IGC code, and that LNG fuelled vessels receiving bunker fuel are designed according to IGF code.

Border between port operation and LNG facility is when the ship/shore link (SSL) is established.

This document is not intended to specify acceptable levels of risk; however, examples of tolerable levels of risk are referenced.

See IEC 31010 and ISO 17776 with regard to general risk assessment methods, while this document focuses on the specific needs scenarios and practices within the LNG industry.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

ISO Guide 73, *Risk management — Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO Guide 73 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

© ISO 2022 – All rights reserved