



BSI Standards Publication

Transportation of CO₂ by ship

National foreword

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Transportation of CO₂ by ship

Transport de CO₂ par bateau

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Contents

Page

Foreword	v
Introduction	vi
1 Scope	1
2 Normative references	1
3 Terms and definitions	1
4 Abbreviations	3
5 Regulatory regime for maritime and inland waterways for CO₂ transportation	3
5.1 General	3
5.2 Maritime governance	4
5.3 Technical safety regime for maritime transportation of liquid CO ₂	5
5.4 Greenhouse gas emissions	6
5.5 Trading and cross-border transportation	6
6 Ship transport of CO₂	7
6.1 General	7
6.2 CO ₂ cargo transport conditions	7
6.2.1 General	7
6.2.2 Low pressure	8
6.2.3 Medium pressure	8
6.2.4 Elevated pressure	8
6.2.5 Density effects	9
6.2.6 Solid state CO ₂ (dry ice)	9
6.3 Cargo tank design	9
6.3.1 Cargo tank design considerations	9
6.3.2 Tank material	10
6.3.3 Novel materials	10
6.3.4 Design pressure	11
6.3.5 Insulation	11
6.4 CCS ship transport concepts	11
6.4.1 General	11
6.4.2 Ship terminal to terminal	12
6.4.3 Barge terminal to terminal (inland waterways)	12
6.4.4 Offshore floating storage and injection unit (FSIU)	12
6.4.5 Offshore injection unit	12
6.4.6 Offshore direct injection	13
6.5 Multi Gas and dedicated carriers	13
6.5.1 General	13
6.5.2 Existing ship conversion	13
6.6 Ship design	13
7 Properties of CO₂, CO₂ streams and mixing of CO₂ streams influencing the ship transportation	13
7.1 Thermodynamic properties of CO ₂ and CO ₂ composition	13
7.2 CO ₂ impurities and trace components	15
7.2.1 Common impurities	15
7.3 Flexibility and mixing of CO ₂ streams from different sources	16
8 Ship operation	17
8.1 Ship and terminal modes of operation	17
8.2 Compatibility and interface	17
8.3 Cargo operations	18
8.3.1 Responsibilities	18
8.3.2 Manifold operations	18
8.3.3 Loading operations	18
8.3.4 Offloading operations	19

8.4	Cargo management.....	19
8.4.1	General.....	19
8.4.2	Cargo tank preparation.....	19
8.4.3	Cargo voyage management.....	19
8.4.4	Cargo losses.....	20
9	Technical gaps and development.....	20
9.1	Applicability and precision of existing requirements.....	20
9.2	Identification of additional relevant requirements such as practices onshore.....	20
9.3	Qualification and process for new technology.....	21
9.4	Gaps and need for development.....	21
10	Safety and risks.....	21
10.1	Health, safety and environment (HSE).....	21
10.1.1	Toxicity and asphyxiation.....	21
10.1.2	Hazards of liquid CO ₂	22
10.2	Measures to mitigate risks.....	22
10.2.1	Gas detection.....	22
10.2.2	Emergency shut down.....	22
10.2.3	Emergency release system.....	22
10.3	Special risks with liquid CO ₂ as ship cargo.....	22
10.3.1	Solid formation.....	22
10.3.2	Material integrity.....	22
10.3.3	Electrostatic charge.....	23
11	Quantification and verification of CO₂ cargo.....	23
11.1	General.....	23
11.2	Quantification and measurement.....	23
11.2.1	General.....	23
11.2.2	Cargo measurement.....	23
11.2.3	CO ₂ quality.....	24
11.2.4	Co-mingling.....	24
11.2.5	Onboard carbon capture.....	24
11.3	Verification.....	24
12	Summary status and development needs for CO₂ ship transportation for CCS value chains.....	24
	Bibliography.....	26

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 document 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).

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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 265, *Carbon dioxide capture, transportation, and geological storage*.

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.

Introduction

In a carbon dioxide capture and storage (CCS) value chain, the main means for transportation of CO₂ from an emitter to storage are by ships or by pipelines. Transportation of gas in liquid state is well established in the shipping industry and has been done for decades. However, liquid CO₂ is different from other gases carried by ships and poses new challenges for both ship design and ship operation. Compatibility along the value chain is an essential element in the development of CCS. It is important to have a common understanding of how different aspects, such as cargo temperature and pressure, can influence the ship design and ship operation.

The purpose of this document is to support consistency and compatibility in the design of CCS value chains and address important areas where future development and standardization can add value. This document will discuss CO₂ ship types, ship logistics and interface-specific aspects related to the safe and reliable design and operation of CO₂ ships.

Transportation of liquified gas on ships is governed by the regulations, codes and conventions drawn up under the International Maritime Organization (IMO) which is referred to under United Nations Convention on the Laws of the Sea (UNCLOS). Ships carrying CO₂ are regulated by the IMO International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code), which serves as the main technical regulation for CO₂ carriers under the International Convention for the Safety of Life at Sea (SOLAS).

Ship transportation of CO₂ is currently limited to commercial trade for small-scale use in industries such as the food or beverage industries and is served by a handful of small ships. However, the evolving industry around CCS will demand transportation volumes of a different magnitude and involve development of new ship designs and ship logistics concepts. These are introducing a need for knowledge-sharing related to type of transportation concepts, CCS value chain compatibility, technical and operational reliability and the safety of CO₂ carriers.

Quantification, verification and reporting along the different elements in the CCS value chain will become important. This document describes limitations and challenges to them and how they can be done onboard the ship.

In this document, CO₂ means a captured CO₂ stream, including potential impurities following the capture process, if not otherwise explicitly referred to as pure CO₂.

Transportation of CO₂ by ship

1 Scope

This document provides insights into the essential aspects of CO₂ shipping and provides basic descriptions of how the CO₂ carrier and technology therein is technically integrated with the CCS value chain. It also includes a description of specific challenges of transporting CO₂ as cargo, how this differs from other gases transported by ships today, and how this influences the ship design and operation. Finally, this document introduces how CO₂ ships are regulated within the existing international maritime regulatory framework. This document's main focus is on the technical aspects of CO₂ shipping. Commercial, liability and financial aspects are intentionally kept out of this document. However, general reference to commercial impact is made where relevant.

This document focuses on the ship transportation of CO₂ between loading and offloading facilities where the system boundaries are at the ship manifold equipment that connects the ship to the other components in the value chain. In the document, the basis for the description of ship operation is transportation between two shore-based terminals. A high-level description of other relevant interfaces is given on a conceptual level as this has impact on the ship design. However, any further description of potential solutions upstream and downstream from the CO₂ carrier is outside the scope. This document also gives a high-level description of the physical properties of CO₂ streams at the conditions relevant for shipping and how relevant impurities can impact the ship and ship operation.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions 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/>

3.1 barge

floating unit carrying freight on canals, rivers and in ports, either under its own power or towed by another

3.2 cargo containment system

arrangement for containment of the cargo including, where fitted, a primary and secondary barrier, associated insulation and any intervening spaces, and adjacent structure, if necessary, for the support of these elements

Note 1 to entry: See Reference [9].

3.3 convention

written agreement between countries

Note 1 to entry: Conventions form a major part of maritime affairs governed by the International Maritime Organization (IMO).

3.4

CO₂ carrier

cargo ship or barge constructed or adapted and used for the carriage of CO₂ as cargo

3.5

CO₂ stream

stream consisting overwhelmingly of carbon dioxide

[SOURCE: ISO 27917: 2017, 3.2.10]

3.6

dynamic positioning system

equipment and system that is used for keeping a vessel at a given position using the thruster and propulsion of the vessel to compensate for the environmental loads, including waves, wind, current, etc.

3.7

export location

location where the ship loads the CO₂ for transport to the import location

3.8

flag state

jurisdiction under whose laws the ship is registered

3.9

heat ingress

transfer of heat from the surroundings into the cargo

3.10

heel

liquid cargo maintained at the bottom of the tank on the return voyage to maintain cargo tank temperature

3.11

import location

location where the ship offloads the CO₂ that is transported from the export location

3.12

inland waterway

natural or artificial navigable inland body of water, or system of interconnected bodies of water, used for transport, such as lakes, rivers or canals

3.13

intermediate storage

storage of CO₂ volumes before being loaded to a ship and storage after being offloaded from the ship

3.14

multi-lobe

bi-lobe

tri-lobe

cargo tanks which consist of two (bi-lobe) or three (tri-lobe) lobes where lobes represent cylinder segments partly merged and connected by a common bulkhead

3.15

muster area

location where the crew assemble in the event of an emergency

3.16

riser

flexible pipe that connects an offshore well to a ship or floating offshore unit

3.17

ship master

person in charge of the ship, its crew and any passengers or cargo it is carrying, on the water and in port

3.18**territorial seas**

areas which extend up to 12 nautical miles from the baseline of a country's coastal line

3.19**triple point**

temperature and pressure at which three phases (gas, liquid and solid) of a substance coexist in thermodynamic equilibrium

3.20**two-phase flow**

simultaneous flow of gas and liquid

3.21**vapour return**

connection between ship and terminal for vapour exchange to ensure pressure equilibrium between the shore storage tanks and the ship cargo tanks

3.22**vapour-liquid equilibrium**

state where a substance's liquid and vapour phases are in equilibrium

4 Abbreviations

CO ₂	carbon dioxide
CCS	carbon dioxide capture and storage
ESD	emergency shut down
FSIU	floating storage and injection unit
IGC Code	International Code of the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk
IMO	International Maritime Organization
LNG	liquified natural gas
LPG	liquefied petroleum gas
NIST	National Institute of Standards and Technology
OCIMF	Oil Companies International Maritime Forum
SIGTTO	Society of International Gas Tanker and Terminal Operators
SOLAS	International Convention for the Safety of Life at Sea
UNCLOS	United Nations Convention on the Law of the Sea
IACS	International Association of Classification Societies
ES-TRIN	European Standard — Technical Requirements for Inland Navigation vessels

5 Regulatory regime for maritime and inland waterways for CO₂ transportation**5.1 General**

International and national shipping are subject to an extensive and stringent set of laws and regulations which are enforced by international, regional and national regulatory bodies. Considering the large number