
**Petroleum and natural gas
industries — Arctic operations —
Metocean, ice, and seabed data**

*Industries du pétrole et du gaz naturel — Opérations en Arctique
— Données océano-météorologiques et données sur les glaces et les
planchers océaniques*

iTeh STANDARD PREVIEW
(standards.iteh.ai)

[ISO 35106:2017](https://standards.iteh.ai/catalog/standards/sist/a9108c6b-8cf7-4438-bd55-02590c3a0284/iso-35106-2017)

<https://standards.iteh.ai/catalog/standards/sist/a9108c6b-8cf7-4438-bd55-02590c3a0284/iso-35106-2017>



iTeh STANDARD PREVIEW
(standards.iteh.ai)

ISO 35106:2017

<https://standards.iteh.ai/catalog/standards/sist/a9108c6b-8cf7-4438-bd55-02590c3a0284/iso-35106-2017>



COPYRIGHT PROTECTED DOCUMENT

© ISO 2017, 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

Contents

	Page
Foreword	vii
Introduction	viii
1 Scope	1
2 Normative references	1
3 Terms and definitions	1
4 Symbols and abbreviated terms	7
4.1 Symbols.....	7
4.2 Abbreviated terms.....	8
5 General requirements	8
5.1 General.....	8
5.1.1 Physical environmental data requirements.....	8
5.1.2 Relationship with ISO 19901-1 and ISO 19906.....	9
5.1.3 Data sources.....	9
5.1.4 Selection of appropriate parameters.....	9
5.1.5 Physical environmental data monitoring.....	9
5.1.6 Data storage.....	10
5.2 Particular aspects.....	10
5.2.1 Region of interest.....	10
5.2.2 Criticality.....	10
5.2.3 Variability.....	10
5.2.4 Statistical.....	11
5.2.5 Forecasting.....	12
5.2.6 Weather windows.....	12
5.2.7 Climatic trends.....	13
5.2.8 Expertise and experience.....	13
6 Water depth, tides and storm surges	13
6.1 General.....	13
6.2 Bathymetry.....	14
6.3 Tides.....	14
6.4 Storm surges.....	14
7 Wind	15
7.1 General.....	15
7.2 Polar lows.....	15
7.3 Katabatic wind.....	15
7.4 Low level arctic jet.....	15
8 Waves	15
8.1 General.....	15
8.2 Wave-induced ice motions.....	15
8.3 Wave transmission through sea ice.....	15
9 Currents	16
9.1 General.....	16
9.2 Currents for sea ice and iceberg drift prediction.....	16
9.3 Current records.....	16
10 Temperature	16
10.1 General.....	16
10.2 Sea water temperature.....	17
10.3 Air temperature.....	17
11 Atmospheric parameters	17
11.1 General.....	17
11.2 Daylight considerations.....	17

11.3	Visibility and cloud ceiling.....	17
11.4	Precipitation.....	18
12	Sea ice.....	18
12.1	General.....	18
12.2	Sea ice season.....	18
	12.2.1 Operations planning.....	18
	12.2.2 During operations.....	19
	12.2.3 Design.....	19
12.3	Sea ice coverage.....	19
	12.3.1 Operations planning.....	19
	12.3.2 During operations.....	19
	12.3.3 Design.....	20
12.4	Sea ice thickness.....	20
	12.4.1 Operations planning.....	20
	12.4.2 During operations.....	20
	12.4.3 Design.....	20
12.5	Sea ice drift and movement.....	21
	12.5.1 Operations planning.....	21
	12.5.2 During operations.....	21
	12.5.3 Design.....	21
12.6	Sea ice features and conditions.....	22
	12.6.1 General.....	22
	12.6.2 Operations planning.....	22
	12.6.3 During operations.....	22
	12.6.4 Design.....	23
12.7	Physical properties.....	23
13	Icebergs.....	23
13.1	General.....	23
	13.1.1 General data requirements.....	23
	13.1.2 Data collection.....	24
	13.1.3 Data analysis and presentation.....	24
13.2	Iceberg location and areal density.....	25
	13.2.1 Operations planning.....	25
	13.2.2 During operations.....	25
	13.2.3 Design.....	26
13.3	Size, shape and stability.....	26
	13.3.1 Operations planning.....	26
	13.3.2 During operations.....	26
	13.3.3 Design.....	27
13.4	Iceberg drift.....	27
	13.4.1 Operations planning.....	27
	13.4.2 During operations.....	28
	13.4.3 Design.....	28
13.5	Metocean and sea ice context.....	28
	13.5.1 Operations planning.....	28
	13.5.2 During operations.....	28
	13.5.3 Design.....	29
13.6	Physical properties.....	29
14	Snow and ice accretion.....	29
14.1	General.....	29
	14.1.1 Consideration of accretion.....	29
	14.1.2 Accretion data collection.....	29
14.2	Snow accretion.....	30
	14.2.1 Classification.....	30
	14.2.2 Data collection.....	30
	14.2.3 Analysis and presentation.....	31
14.3	Atmospheric ice accretion.....	32

ITeH STANDARD PREVIEW
 (standards.iteh.ai)

14.3.1	Classification	32
14.3.2	Data collection	32
14.3.3	Analysis and presentation	33
14.4	Sea spray ice accretion	33
14.4.1	Classification	33
14.4.2	Data for collection	33
14.4.3	Analysis and presentation	34
15	Seabed considerations	34
15.1	Context	34
15.1.1	General	34
15.1.2	Design issues	35
15.1.3	Operational issues	35
15.2	Ice gouge	35
15.2.1	Requirements for collection	35
15.2.2	Requirements for analysis and interpretation	37
15.2.3	Requirements for documentation	37
15.3	Strudel scours	37
15.3.1	Context	37
15.3.2	Measurements	38
15.3.3	Analysis and interpretation	38
15.4	Submarine permafrost	38
15.4.1	General	38
15.4.2	Design issues	39
15.4.3	Operational issues	39
15.4.4	Site investigations	39
16	Coastal considerations (standards.iteh.ai)	39
16.1	Context	39
16.2	General coastal considerations	40
16.3	Specific coastal considerations	40
16.3.1	Water levels	40
16.3.2	Wind	40
16.3.3	Waves	40
16.3.4	Currents	40
16.3.5	Temperature	40
16.3.6	Visibility	40
16.3.7	Sea ice	40
16.3.8	Icebergs	41
16.3.9	Snow and ice accretion	41
16.3.10	Seabed considerations	41
17	Onshore considerations	41
17.1	Context	41
17.2	Onshore permafrost considerations	42
17.2.1	General	42
17.2.2	Design issues	42
17.2.3	Operational issues	42
17.2.4	Terrain data requirements	43
17.2.5	Permafrost characterization	43
17.3	Land erosion risks	44
17.3.1	General	44
17.3.2	Shoreline and riverine erosion	44
17.3.3	Flooding and drainage risks	44
17.4	Transportation access	45
17.4.1	General	45
17.4.2	Ice road data needs	45
17.5	Inland snow data	45
17.5.1	General	45
17.5.2	Snow measurements	45

Annex A (informative) Additional information and guidance	46
Bibliography	115

iTeh STANDARD PREVIEW
(standards.iteh.ai)

[ISO 35106:2017](https://standards.iteh.ai/catalog/standards/sist/a9108c6b-8cf7-4438-bd55-02590c3a0284/iso-35106-2017)

<https://standards.iteh.ai/catalog/standards/sist/a9108c6b-8cf7-4438-bd55-02590c3a0284/iso-35106-2017>

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 on 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 the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 67, *Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries*, Subcommittee SC 8, *Arctic operations*.

ISO 35106:2017
<https://standards.iteh.ai/catalog/standards/sist/a9108c6b-8cf7-4438-bd55-02590c3a0284/iso-35106-2017>

Introduction

The series of documents on arctic operations (currently ISO 35101 to ISO 35106) addresses operational requirements for use by the petroleum and natural gas industries in arctic and cold regions. Through their application, the intention is to ensure human life safety and to minimize environmental damage. At the same time, the series of documents is intended to provide wide latitude in the choice of operational and design solutions without hindering innovation. Sound engineering judgment is, therefore, necessary in the use of these documents.

This document is developed to provide a coherent and consistent definition of data requirements for operations and designs in arctic and cold regions. With application to offshore, coastal and onshore situations, the document focuses on meteorological, oceanographic, seabed and ice considerations. In addition to the requirements of this document, the requirements of ISO 19901-1 for metocean data, ISO 19906 for ice properties data and ISO 19901-4 and ISO 19901-8 for seabed data also apply.

For many geographical regions, physical environmental data are insufficient for rigorous statistical determination of appropriate extreme and abnormal environmental actions and are insufficiently detailed for the conduct of specialized operations. The determination of relevant operational and design parameters therefore relies on the interpretation of the available data by subject matter experts, together with an assessment of other meteorological, oceanographic, seabed and ice information. In particular, uncertainties can arise from analyses based on limited data sets.

[Annex A](#) provides background to and guidance on the use of this document and it is intended to be read in conjunction with the main body of this document. The clause numbering in [Annex A](#) is the same as in the normative text to facilitate cross-referencing.

ITeH STANDARD PREVIEW

(standards.iteh.ai)

ISO 35106:2017

<https://standards.iteh.ai/catalog/standards/sist/a9108c6b-8cf7-4438-bd55-02590c3a0284/iso-35106-2017>

Petroleum and natural gas industries — Arctic operations — Metocean, ice, and seabed data

1 Scope

This document specifies requirements and provides recommendations and guidance for the collection, analysis and presentation of relevant physical environmental data for activities of the petroleum and natural gas industries in arctic and cold regions. Activities include design and operations, which involve planning and actual execution.

Reference to arctic and cold regions in this document is deemed to include both the Arctic and other locations characterized by low ambient temperatures and the presence or possibility of sea ice, icebergs, shelf ice, glaciers, icing conditions, persistent snow cover, frozen surfaces of lakes and rivers, localized and rapidly changing weather systems and/or permafrost.

This document outlines requirements for a range of different operations that have been or are presently being undertaken and for existing design concepts. This document can also be used for other operations and new design concepts in arctic and cold regions as long as it is recognized that all data requirements are not necessarily addressed.

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 12494, *Atmospheric icing of structures*

ISO 19900, *Petroleum and natural gas industries — General requirements for offshore structures*

ISO 19901-1, *Petroleum and natural gas industries — Specific requirements for offshore structures — Part 1: Metocean design and operating considerations*

ISO 19901-4, *Petroleum and natural gas industries — Specific requirements for offshore structures — Part 4: Geotechnical and foundation design considerations*

ISO 19901-6, *Petroleum and natural gas industries — Specific requirements for offshore structures — Part 6: Marine operations*

ISO 19901-8, *Petroleum and natural gas industries — Specific requirements for offshore structures — Part 8: Marine soil investigations*

ISO 19906, *Petroleum and natural gas industries — Arctic offshore structures*

ISO 35101, *Petroleum and natural gas industries — Arctic operations — Working environment*

ISO 35103, *Petroleum and natural gas industries — Arctic Operations — Environmental monitoring for offshore exploration*

ISO 35104, *Petroleum and natural gas industries — Arctic operations — Ice management*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 35101, ISO 35103, ISO 35104, ISO 19900, ISO 19901-1, ISO 19901-6, ISO 19906 and the following apply.

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

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

3.1

accretion

accumulation of snow, ice and other forms of frozen precipitation on surfaces

3.2

active layer

soil layer above the permafrost that is subjected to annual freeze-thaw cycles

3.3

arctic jet

low-level wind directed parallel to an ice edge or ice lead

3.4

areal density

number of ice features per unit area

Note 1 to entry: Usually averaged over a specific time interval.

3.5

bergy bit

floating glacial ice mass with waterline length between 5 m and 15 m

3.6

calibration

process by which physical parameter values are related to instrument readings

3.7

calving event

break-up of an iceberg or other glacial ice mass into two or more pieces

3.8

coastal region

offshore region adjacent to the coast where the physical environment is influenced by the coast

3.9

data analysis

data interpretation

expert assessment of physical environmental data to satisfy design or operational requirements

Note 1 to entry: Data analysis can include verification with other data sources or physical process models.

3.10

data storage

organization of physical environmental data into an accessible and documented database

3.11

data collection

data measurement

application of human systems or instruments for recording physical environmental data

3.12

data presentation

provision of physical environmental data in a format suitable to the design process or operational decision-making

3.13**downtime**

time interval for which an operation is suspended

Note 1 to entry: Downtime can be planned or unplanned.

3.14**expert**

individual who through training and experience is competent to provide advice specific to the subject in question

3.15**first-year ice****FY ice**

sea ice formed during the current or prior winter that has not survived one summer melt season

[SOURCE: ISO 19906:—¹), 3.16]

3.16**floe size**

waterline dimension of a sea ice floe

Note 1 to entry: Floe size can be defined as either the maximum waterline dimension or the diameter of a circular floe with the same plan area.

3.17**freezing degree days****FDD**

cumulative sum of average freezing daily air temperatures from the start of the winter season

Note 1 to entry: The reference point can be 0 °C or the freezing temperature of sea water.

Note 2 to entry: Usually initiated when the average daily temperature averaged over a specified period, for example, 30 days, falls below 0 °C or the freezing temperature.

3.18**growler**

floating piece of glacial ice with waterline length less than 5 m

3.19**ice action**

external load, displacement, deformation or acceleration applied to a structure as a consequence of an ice scenario

3.20**iceberg draft**

distance between the deepest point in the keel of an iceberg and the water surface

3.21**ice cover**

distribution of ice on the surface of a lake, river or ocean

3.22**ice edge**

line of demarcation between open water and floating *ice cover* ([3.21](#))

Note 1 to entry: Ice edge can be diffuse or compact, depending on the orientation of wind and current actions on the ice cover.

Note 2 to entry: Ice edge is sometimes based on a minimum concentration threshold over a specified averaging area in satellite imagery.

1) To be published. Stage at time of publication ISO/DIS 19906:2017.

Note 3 to entry: The concentration threshold can be dictated by the tolerance of the operation to *ice actions* (3.19).

3.23
ice encroachment

movement of sea ice onto the surface of a platform or man-made island

Note 1 to entry: Ice encroachment can result from ice ride-up, pile-up, and ride-down processes.

Note 2 to entry: Ice encroachment is typically associated with operational or design criteria.

[SOURCE: ISO 19906:—, 3.26]

3.24
ice feature

continuous mass of ice, floating or grounded, having a greater thickness than the surrounding *ice cover* (3.21)

3.25
ice hazard
ice threat

ice feature (3.24) or conditions associated with operational criteria

Note 1 to entry: In this document, referred to without the “ice” qualifier.

3.26
ice length

accumulated distance travelled by the *ice cover* (3.21) past a point regardless of direction

3.27
ice management

processes and activities used to mitigate risks from ice

Note 1 to entry: Ice management can be used to alter icing, sea ice or iceberg environments or accumulations with the intent of reducing *downtime* (3.13) and reducing or avoiding ice action effects.

Note 2 to entry: Ice management can involve ice detection, forecasting, threat assessment, removal, alteration and destruction.

Note 3 to entry: Ice management is often conducted in the context of operating criteria such as alert procedures (see also ISO 19906 and ISO 35104).

3.28
ice ridge

linear feature formed of ice blocks created by the relative motion between ice sheets

Note 1 to entry: Ice pressure ridges are formed when ice sheets are pushed together and a shear ice ridge is formed when ice sheets slide along a common boundary.

[SOURCE: ISO 19906:—, 3.34]

3.29
ice season

period during the year when sea ice exceeds a specified concentration or when *ice features* (3.24) exceed a specified *areal density* (3.4)

Note 1 to entry: Specified criteria can be different for the start and end of season.

3.30
ice shelf

floating ice sheet of considerable thickness attached to the shore

Note 1 to entry: Ice shelf can be determined based on freeboard in excess of 2 m.

3.31**ice scenario**

combination of circumstances involving the presence of ice, resulting in ice events

[SOURCE: ISO 19906:—, 3.35]

3.32**ice thickness**

vertical dimension of ice, measured from the bottom surface to the top surface

Note 1 to entry: Ice thickness can be determined as an average or maximum value over a specified horizontal scale or over the plan area of an *ice feature* (3.24).

3.33**ice type**

ice identified in WMO categorization according to the stage of development

3.34**icing**

ice accretion on the surface of a structure

Note 1 to entry: Icing can involve atmospheric or sea spray processes.

3.35**icing conditions**

combination of metocean, ice and operational conditions under which *icing* (3.34) can occur

3.36**katabatic wind**

gravity-driven flow of dense cold air from higher to lower elevations

Note 1 to entry: Katabatic winds are often associated with glaciers.

3.37**landfast ice****fast ice**

ice that remains attached to a shoreline, island or grounded *ice feature* (3.24)

[SOURCE: ISO 19906:—, 3.37]

3.38**level ice**

ice formed primarily as a result of thermal conduction and radiation processes and excluding mechanical processes

Note 1 to entry: Ice subjected to small amounts of rafting during the initial formation process is generally considered as level ice.

Note 2 to entry: Thicker level ice can vary by several centimetres over distances of several metres.

3.39**marginal ice zone**

sea ice region affected by waves and swell

3.40**multi-year ice****MY ice**

sea ice that has survived at least two summers' melt seasons

[SOURCE: ISO 19906:—, 3.44]

3.41

old ice

sea ice that has survived at least one summer's melt season

Note 1 to entry: Old ice includes both second-year ice and multi-year ice.

[SOURCE: ISO 19906:—, 3.45]

3.42

pack ice

sea ice consisting of discrete floes that is not landfast

[SOURCE: ISO 19906:—, 3.46]

3.43

pack ice pressure

horizontal pressure acting within pack ice

Note 1 to entry: Generally, pack ice pressure is the result of wind and current forcing, but can also result from larger scale mechanics of the *ice cover* (3.21).

Note 2 to entry: Pressure can be measured on an ordinal scale based on the closing rate of icebreaker tracks.

3.44

persistence

duration of a physical environmental parameter with respect to a specified threshold

3.45

rafted ice

ice feature (3.24) formed from the superposition of two or more ice sheet layers

[SOURCE: ISO 19906:—, 3.50]

ISO 35106:2017
<https://standards.iteh.ai/catalog/standards/sist/a9108c6b-8cf7-4438-bd55-02590c3a0284/iso-35106-2017>

3.46

region of interest

<design> geographical region around the facility selected to ensure data accuracy and representativeness

3.47

region of interest

<operation> geographical region over which an operation is undertaken and is influenced by ice and metocean processes

3.48

rolling event

distinct and sudden change in the vertical orientation of an iceberg or other floating glacial ice mass

3.49

second-year ice

SY ice

sea ice that has survived one summer's melt season

[SOURCE: ISO 19906:—, 3.62]

3.50

sea ice

thermally-grown ice formed on the surface of saline water bodies

3.51

season boundary

start or end of the *ice season* (3.29) according to specified criteria

3.52**shelf break**

seaward extent of the continental shelf characterized by a significant increase in slope of seafloor

Note 1 to entry: Shelf break can be used to determine the average seaward extent of sea ice.

Note 2 to entry: Shelf break can be used to determine the seaward limit of potential iceberg contact with the seabed.

3.53**snow cover**

areal distribution of snow on the ground or ice surface

3.54**stability**

state of hydrostatic or hydrodynamic equilibrium with respect to vertical orientation, usually with reference to icebergs

3.55**sub-gouge deformation**

displacement of seabed soil beneath a gouging *ice feature* (3.24)

3.56**waterline length**

maximum dimension of an *ice feature* (3.24) in the plane of the water surface

3.57**waterline width**

maximum dimension of an *ice feature* (3.24) perpendicular to the *waterline length* (3.56) in the plane of the water surface

3.58**wind chill**

perceived temperature due to the combined effect of low ambient temperature and wind

iTeh STANDARD PREVIEW
(standards.iteh.ai)

ISO 35106:2017

<https://standards.iteh.ai/catalog/standards/sist/a9108c6b-8cf7-4438-bd55-02b905a02045/iso-35106-2017>

4 Symbols and abbreviated terms

4.1 Symbols

d	distance from the ice edge
E	wave energy
E_0	wave energy in open water
h	ice thickness
M	ice sample mass
p_t	true precipitation
p_m	measured precipitation
S	salinity
T	air temperature
T_{wc}	wind chill temperature
U_{10}	wind speed at 10 m elevation