BS ISO 19901-10:2021

BSI Standards Publication

Petroleum and natural gas industries — Specific requirements for offshore structures

Part 10: Marine geophysical investigations

Documents
Document Sharing Hub

Full document details: BS ISO 19901-10:2021

National foreword

This British Standard is the UK implementation of ISO 19901-10:2021.

The UK participation in its preparation was entrusted to Technical Committee B/525/12, Design of offshore structures.

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.

© The British Standards Institution 2021
Published by BSI Standards Limited 2021

ISBN 978 0 539 02733 4

ICS 75.180.10

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 March 2021.

Amendments/corrigenda issued since publication

Date	Text affected

Documents
Document Sharing Hub

Full document details: BS ISO 19901-10:2021

INTERNATIONAL STANDARD

ISO 19901-10

First edition
2021-03

Petroleum and natural gas industries — Specific requirements for offshore structures —

Part 10: Marine geophysical investigations

Industries du pétrole et du gaz naturel — Exigences spécifiques relatives aux structures en mer —

Partie 10: Enquêtes géophysiques marines

Reference number
ISO 19901-10:2021(E)

Documents
Document Sharing Hub

© ISO 2021

Full document details: BS ISO 19901-10:2021

COPYRIGHT PROTECTED DOCUMENT

© ISO 2021

All rights reserved. Unless otherwise specified, or required in the context of its implementation, 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
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

© ISO 2021 – All rights reserved

Documents
Document Sharing Hub

Full document details: BS ISO 19901-10:2021

Contents

Page

Foreword ... **v**

Introduction ... **vi**

1 Scope ... **1**

2 Normative references ... **2**

3 Terms and definitions ... **2**

4 Symbols and abbreviated terms ... **12**
4.1 Symbols ... 12
4.2 Abbreviated terms ... 13

5 Objectives, planning, and quality management ... **14**
5.1 General ... 14
5.1.1 Objectives and project specifications ... 14
5.1.2 Georeferencing and GIS ... 15
5.1.3 Ground model ... 15
5.2 Desk study ... 16
5.2.1 General ... 16
5.2.2 Use of exploration 2D and 3D seismic data in a desk study ... 17
5.2.3 Desk study for pre-drilling well-site investigations ... 17
5.3 Scoping and planning ... 17
5.3.1 General ... 17
5.3.2 Scoping of seafloor mapping and sub-seafloor mapping ... 19
5.4 Operations planning and data quality management ... 22
5.4.1 Quality plan ... 22
5.4.2 Effects of attenuation ... 23
5.4.3 Data quality management ... 23

6 Positioning ... **23**
6.1 General ... 23
6.2 Coordinate reference systems ... 24
6.2.1 Horizontal coordinate reference system ... 24
6.2.2 Vertical coordinate reference system ... 24
6.3 Surface positioning requirements ... 25
6.4 Vessel heading ... 25
6.4.1 General ... 25
6.4.2 Gyro compass ... 25
6.4.3 GNSS based heading reference ... 26
6.4.4 Alignment ... 26
6.5 Sub-sea positioning — Ultra-short baseline system ... 26
6.6 Inertial navigation system ... 27
6.7 Auxiliary sensor: doppler velocity log ... 27
6.8 Auxiliary sensor: altimeter ... 27
6.9 Auxiliary sensor: pressure-depth sensor ... 28

7 Seafloor mapping ... **28**
7.1 General ... 28
7.2 Instrumentation and acquisition parameters ... 29
7.2.1 Multi-beam echo sounder ... 29
7.2.2 Side scan sonar ... 31
7.2.3 Auxiliary sensor: velocity of sound in seawater ... 31
7.3 Data acquisition methods ... 32
7.3.1 General ... 32
7.3.2 Reconnaissance seafloor mapping ... 32
7.3.3 Engineering seafloor mapping ... 33
7.3.4 Detailed engineering seafloor mapping ... 33
7.4 Seafloor mapping deliverables ... 33

© ISO 2021 – All rights reserved

AVA Documents
Document Sharing Hub

Full document details: BS ISO 19901-10:2021

8 Sub-seafloor mapping ... **34**
8.1 General ... 34
8.1.1 Resolution and signal penetration ... 34
8.1.2 Equipment selection for sub-seafloor mapping methods ... 35
8.1.3 Assessment of data quality ... 35
8.1.4 Deliverables ... 36
8.2 Acquisition equipment and parameters for seismic data ... 36
8.2.1 Equipment performance ... 36
8.2.2 Acquisition and processing parameters ... 37
8.2.3 High resolution seismic reflection ... 40
8.2.4 Ultra-high-resolution seismic reflection ... 44
8.2.5 Ultra-ultra-high resolution seismic reflection ... 44
8.2.6 Sub-bottom profiling ... 45
8.3 Non-seismic reflection methods ... 46
8.3.1 Seismic refraction ... 46
8.3.2 Magnetometer and magnetic gradiometer ... 47
8.3.3 Marine shear waves ... 47
8.3.4 Marine surface waves ... 48
8.3.5 Electrical resistivity imaging ... 48
8.3.6 Electromagnetic imaging ... 48

9 Reporting of seafloor mapping and sub-seafloor mapping ... **48**
9.1 General ... 48
9.2 Record of data acquisition operations ... 48
9.3 Record of data processing ... 49
9.4 Results report ... 49

10 Data integration, interpretation and investigation of geohazards ... **50**
10.1 General ... 50
10.2 Horizons, isopachs and isochores ... 50
10.3 Mapping stratigraphic units and defining geochronology ... 50
10.4 Time-to-depth conversion ... 51
10.5 Borehole geophysical logging ... 51
10.6 Investigation of geohazards ... 52
10.7 Integrated studies ... 52

Annex A (informative) **Additional information and guidance** ... **53**

Bibliography ... **78**

© ISO 2021 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS ISO 19901-10:2021

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, *Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries*, Subcommittee SC 7, *Offshore structures*.

A list of all parts in the ISO 19901 series can be found on the ISO website.

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 2021 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS ISO 19901-10:2021

Introduction

The general objective of a marine site investigation is to provide information about the seafloor, the sub-seafloor and geological processes affecting both, geohazards, and human-made objects at or below the seafloor. Marine site investigations can encompass both marine soil investigations and marine geophysical investigations, as shown in Figure 1. This document provides requirements for marine geophysical investigations to support oil and gas developments offshore, is complementary to ISO 19901-8 on marine soil investigations, and provides guidance on the integration of both types of investigations.

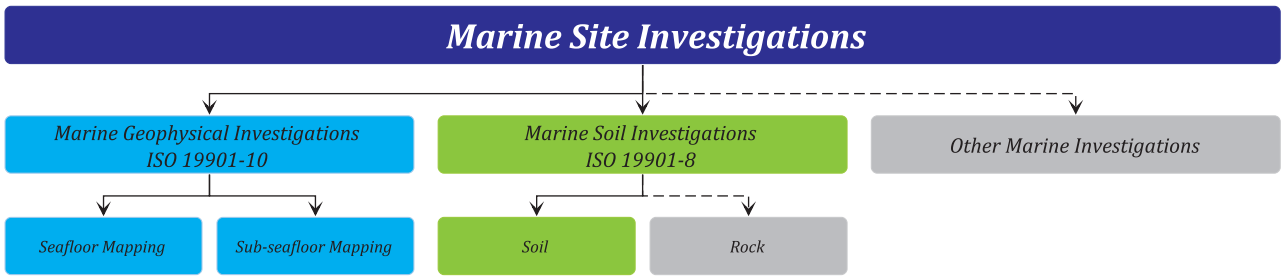

Figure 1 — Marine geophysical investigations as part of marine site investigations.

NOTE Subjects denoted in grey boxes in Figure 1 are neither covered in ISO 19901-8 nor in this document. However, marine geophysical investigations can provide information about soils and rocks, whereas rocks are only covered by ISO 19910-8 to the extent that ordinary marine soil investigation tools can be used, e.g. for chalk.

Marine site investigations for a specific project can comprise both geophysical and geotechnical investigations, depending on project scale and complexity. It is common practice to conduct first a marine geophysical investigation, sometimes in combination with a limited marine soil investigation consisting of shallow soil sampling and/or in situ testing. A more extensive marine soil investigation is often conducted at a later stage. In some cases, a marine site investigation can consist solely of a stand-alone geophysical survey that has a specific and limited purpose. A marine site investigation can also consist solely of a stand-alone marine soil investigation, for which details on soil investigation equipment and procedures are provided in ISO 19901-8.

Particular objectives of a marine geophysical investigation should be addressed in project specifications, which should specify desired investigation depths, desired resolutions (horizontal and vertical), and whether the objective is to illuminate the seafloor and/or the sub-seafloor. Caution is necessary in the selection of the type of equipment to be used, and operational parameters for that equipment, in order to meet those desired depths, resolutions, and illumination targets, particularly because local site conditions can affect the abilities of certain equipment to meet those objectives. This document includes discussion of the selection and operation of appropriate geophysical equipment.

Marine geophysical investigations and marine soil investigations can be (and often are) carried out as separate exercises, the results of which can be integrated into a ground model. This document applies to critical stages in the development of a ground model, from the initial conception stage through successive stages of increased detail.

In this document, the following verbal forms are used:

— “shall” indicates a requirement;

— “should” indicates a recommendation;

— “can” indicates a possibility or a capability;

— “may” indicates a permission.

Annex A provides additional information intended to assist the understanding or use of this document.

© ISO 2021 – All rights reserved
Documents
Document Sharing Hub
Full document details: BS ISO 19901-10:2021

Petroleum and natural gas industries — Specific requirements for offshore structures —

Part 10: Marine geophysical investigations

1 Scope

This document provides requirements and guidelines for marine geophysical investigations. It is applicable to operators/end users, contractors and public and regulatory authorities concerned with marine site investigations for offshore structures for petroleum and natural gas industries.

This document provides requirements, specifications, and guidance for:

a) objectives, planning, and quality management;

b) positioning;

c) seafloor mapping, including instrumentation and acquisition parameters, acquisition methods, and deliverables;

d) sub-seafloor mapping, including seismic instrumentation and acquisition parameters, and non-seismic-reflection methods;

e) reporting;

f) data integration, interpretation, and investigation of geohazards.

This document is applicable to investigation of the seafloor and the sub-seafloor, from shallow coastal waters to water depths of 3 000 m and more. It provides guidance for the integration of the results from marine soil investigations and marine geophysical investigations with other relevant datasets.

NOTE 1 The depth of interest for sub-seafloor mapping depends on the objectives of the investigation. For offshore construction, the depths of investigation are typically in the range 1 m below seafloor to 200 m below seafloor. Some methods for sub-seafloor mapping can also achieve much greater investigation depths, for example for assessing geohazards for hydrocarbon well drilling.

There is a fundamental difference between seafloor mapping and sub-seafloor mapping: seafloor signal resolution can be specified, while sub-seafloor signal resolution and penetration cannot. This document therefore contains requirements for the use of certain techniques for certain types of seafloor mapping and sub-seafloor mapping (similarly, requirements are given for certain aspects of data processing). If other techniques can be shown to obtain the same information, with the same or better resolution and accuracy, then those techniques may be used.

Mapping of pre-drilling well-site geohazards beneath the seafloor is part of the scope of this document.

NOTE 2 This implies depths of investigation that are typically 200 m below the first pressure-containment casing string or 1 000 m below the seafloor, whichever is greatest. Mapping of pre-drilling well-site geohazards is therefore the deepest type of investigation covered by this document.

In this document, positioning information relates only to the positioning of survey platforms, sources and receivers. The processes used to determine positions of seafloor and sub-seafloor data points are not covered in this document.

Guidance only is given in this document for the use of marine shear waves (A.8.3.3), marine surface waves (A.8.3.4), electrical resistivity imaging (A.8.3.5) and electromagnetic imaging (A.8.3.6).

© ISO 2021 – All rights reserved

AVA Documents Document Sharing Hub
Full document details: BS ISO 19901-10:2021

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

3 Terms and definitions

For the purposes of this document, the following terms and definitions 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
abyssal water
water depths greater than 3 000 m

3.2
acoustic impedance
seismic velocity multiplied by density

Note 1 to entry: Compressional-wave impedance uses compressional-wave velocity, and shear-wave impedance uses shear-wave velocity.

3.3
acoustic noise
unwanted acoustic signal

3.4
active tail buoy
buoy fitted with a global navigation satellite system transponder attached to the end of a streamer

3.5
airgun
seismic source that injects a bubble of highly compressed air into the water

Note 1 to entry: Whereas single airguns can be used, it is common practise to deploy and fire several airguns in arrays to produce an acoustic pulse that has certain temporal and spatial characteristics.

3.6
aliasing
effect that causes signals to be misrepresented in recorded data as a result of undersampling

Note 1 to entry: Undersampling can be in time or spatial domain.

3.7
anisotropy
dependence of velocity on direction or upon angle of wave propagation

3.8
array
system of linked hydrophones or seismic sources arranged in a geometric pattern to increase sensitivity and/or directionality and/or in the case of a seismic source, the pulse characteristics

© ISO 2021 – All rights reserved
Documents
Document Sharing Hub
Full document details: BS ISO 19901-10:2021

3.9
attenuation
reduction in amplitude or energy

Note 1 to entry: Attenuation in seismic data is related in part to soil conditions.

3.10
attribute
characteristic of a given object, structure or feature

Note 1 to entry: A seismic attribute is a quantity or property derived or extracted from seismic data that provides specific information contained within the data as an aid in interpretation.

3.11
backscatter
amplitude of echo sounder energy reflected by the seafloor that can be processed into information about seafloor features and texture

3.12
bandwidth
range of frequencies in an acoustic signal between the two half power points

Note 1 to entry: This corresponds with the frequencies at which the power drops to half the peak power (3 dB).

3.13
boomer
seismic source that operates by the rapid movement of a restricted metal plate

3.14
chirp
type of sub-bottom profiler that emits a frequency-modulated pulse of acoustic energy over a specified range of frequencies

3.15
common depth point
CDP
common reflection point at depth on a reflector, or the halfway point when a wave travels from a source to a reflector to a receiver

Note 1 to entry: In the case of flat layers, the common depth point is vertically below the common mid-point.

3.16
common mid-point
CMP
in multichannel seismic acquisition, the point on the surface halfway between the source and receiver that is shared by a number of source-receiver pairs

Note 1 to entry: CMP gather refers to the set of traces that have a common mid-point.

3.17
common reference point
datum point on a vessel to which all positioning systems are referenced in three dimensions

3.18
cone penetration test
CPT
CPTU
in situ soil strength testing device that makes direct measurements of cone resistance, sleeve friction and pore pressure response as it is pushed into the sub-seafloor

Note 1 to entry: See ISO 19901-8.

© ISO 2021 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS ISO 19901-10:2021

3.19
contractor
party or person responsible for an assigned scope of work described in project specifications

3.20
coordinate reference system
coordinate system that is related to an object by a datum

Note 1 to entry: Geodetic and vertical datums are referred to as reference frames.

Note 2 to entry: For geodetic and vertical reference frames, the object will be the Earth. In planetary applications, geodetic and vertical reference frames can be applied to other celestial bodies.

[SOURCE: ISO 19111:2019, 3.1.9]

3.21
deconvolution
filtering process that undoes the effect of another filter

Note 1 to entry: There are many applications in seismic data processing. One example is removing the filtering effect of the sub-seafloor.

3.22
deep water
water depths between 750 and 1 800 m

3.23
demultiple
seismic processing application that attenuates multiple energy

3.24
designature
filtering process to compensate for the non-minimum phase characteristics of a seismic source

3.25
digital terrain model
DTM
digital representation of a mapped surface usually defined by xyz values for defined cells

3.26
dip move-out
DMO
difference in the arrival times or travel times of a reflected wave, measured by receivers at two different offset locations, that is produced from dipping reflectors

Note 1 to entry: Dip move-out can be compensated for in processing.

3.27
direct arrival
recorded seismic energy that has travelled directly from source to receiver and has neither been reflected nor refracted

3.28
doppler velocity log
DVL
instrument to measure the speed of a survey platform by measuring the frequency shift of acoustic pulses reflected from the seafloor

3.29
dynamic range
ratio of the largest recoverable signal to the smallest recoverable signal

© ISO 2021 – All rights reserved
Documents
Document Sharing Hub
Full document details: BS ISO 19901-10:2021

3.30
exploration seismic data
seismic data containing frequencies between 0 Hz and 100 Hz, typically acquired for the purpose of exploring for oil and gas rather than site investigation

Note 1 to entry: In this document, "exploration seismic data" also includes data acquired for the purposes of hydrocarbon reservoir management (assessment, development, and monitoring).

3.31
far-field source signature
characteristic wave shape of a particular seismic source recorded at a remote distance, so that the wave front is close to a straight line

Note 1 to entry: In practice this is difficult to achieve, and a mid-field source signature is more common.

3.32
feather angle
angle between the line connecting the near and far receivers of a streamer and course made good of the nearest receiver

Note 1 to entry: Differences are caused by a cross current.

3.33
feature
item observed in seafloor mapping data or sub-seafloor mapping data that characterizes the site or renders it unique

Note 1 to entry: A featureless seafloor is completely smooth and flat, for example.

3.34
first break
first recorded signal attributable to seismic-wave travel from a known source

3.35
first pressure containment string
first casing installed in a well that will enable the pressure inside the well to be controlled

3.36
frequency spectrum
function of power versus frequency that illustrates the frequency content of a wavelet or signal

Note 1 to entry: A frequency spectrum is produced by a Fourier transform.

3.37
Fresnel zone
generally circular area on a reflecting interface from which all reflections contribute to the recorded signal

Note 1 to entry: The Fresnel zone is dependent on the period of the wave and determines lateral resolution.

3.38
geohazard
geological condition that has the potential to have adverse effects on persons, operations, infrastructure or the environment

3.39
geological model
explanation of geological conditions

© ISO 2021 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS ISO 19901-10:2021

3.40
ghost
spurious seismic reflection that occurs when energy is reflected between sources and/or receivers and the sea surface

3.41
global navigation satellite system
GNSS
satellite based navigation system that provides autonomous global positioning of a receiving device

Note 1 to entry: Global positioning system (GPS), and global navigation satellite system (Glonass), Galileo and BeiDo are typical examples of global navigation satellite systems.

3.42
ground model
2- or 3-dimensional representation of the seafloor (bathymetry) and, where applicable, the sub-seafloor conditions, at a given time, that is specific to the offshore structure(s) considered

3.43
ground-truthing
integration of seafloor or sub-seafloor geophysical data with data acquired by marine soil investigation and other dataNote 1 to entry: See, for example, ISO 19901-8 for marine soil investigation data.

3.44
high-resolution seismic
HR seismic
seismic reflection method that acquires seismic data containing frequencies between 75 Hz and 300 Hz

3.45
horizon
seismic reflector associated with the surface separating two strata

3.46
hydrophone
sensor that detects variations in pressure

3.47
inertial navigation system
navigation aid that uses accelerometers and gyroscopes to continuously calculate position, orientation and velocity by dead reckoning without external input

3.48
interval velocity
seismic velocity measured over a depth interval

3.49
isochore
line drawn on a map through points of equal vertical thickness of a soil unit, bed, formation or group of these

3.50
isochron
line drawn on a map through points at which a characteristic reflection time or interval has the same value

3.51
isopach
line drawn on a map through points of equal stratigraphic thickness of a sub-seafloor stratum or a group of these

© ISO 2021 – All rights reserved
Documents
Document Sharing Hub
Full document details: BS ISO 19901-10:2021

3.52
magnetic gradiometer
system which measures magnetic gradient using two or more closely spaced magnetometers

3.53
magnetometer
instrument used to measure the strength and/or direction of a magnetic field

3.54
marine geophysical investigation
type of marine site investigation of seafloor or sub-seafloor that uses non-destructive methods involving marine deployment of geophysical tools

3.55
marker horizon
seismic reflector that maintains its characteristics over an area or distance so that it can be used as an interpretation reference

3.56
metadata
metacontent
information describing the content and context of the data within the given file or format

3.57
migration
seismic data processing step in which seismic events are geometrically re-located to the true location at which the event occurs in the sub-seafloor rather than the location at which it was recorded at the surface

Note 1 to entry: A more accurate image of the sub-seafloor will be created by applying migration.

3.58
motion reference unit
MRU
instrument for measuring pitch, roll, yaw, surge, sway and heave

Note 1 to entry: The primary use is to provide observations needed to correctly determine the position of geophysical sensors and in the processing of the sensor data.

3.59
multiple energy
noise on seismic records caused by reverberations between strong reflecting interfaces, such as the seafloor and the sea surface

3.60
mute
removal of certain components of traces prior to common mid-point stacking

3.61
near-field signature
pulse shape measured within the near-field range of a seismic source, generally less than 1 wavelength

3.62
noise
unwanted signal

3.63
normal moveout
NMO
variation in reflection arrival time caused by variation in seismic source to receiver (offset) distance

© ISO 2021 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS ISO 19901-10:2021

3.64
offset
horizontal distance from the seismic source to the seismic receiver

3.65
offset well
existing well from which information is available to tie back to and assist with making predictions about conditions at another well location

3.66
penetration
greatest depth below seafloor from which geophysical signals (such as seismic reflections) can be recognized with reasonable certainty

3.67
pinger
transducer or array of transducers using piezo-electric effects used as seismic source in sub-bottom profiling profilers

3.68
pitch
up-and-down motion of the bow or stern of a survey platform about the horizontal axis that passes across it from port to starboard through its centre of gravity

3.69
positioning
process to derive a three-dimensional coordinate, which uniquely defines a location within the project coordinate reference system, that should include the time of the observations used to derive the coordinate

3.70
pre-stack depth migration
PSDM
migration applied to seismic data in depth domain, calculated from seismic data in time coordinates, and applied before the data is stacked

3.71
pre-stack time migration
PSTM
migration applied to seismic data in time domain before it is stacked

3.72
project specification
scope of work for marine site investigation assigned by the client to a contractor

3.73
P-wave
primary wave
elastic body wave in which the particle motion is in the direction of propagation

3.74
reflection
energy or wave from a seismic source which has been reflected or returned from an acoustic impedance contrast

3.75
refraction
change in the direction of travel of a wavefront, or the bending of a ray, as it passes from one medium to another, expressed mathematically by Snell's law

© ISO 2021 – All rights reserved
Documents
Document Sharing Hub
Full document details: BS ISO 19901-10:2021

3.76
resolution
distance between separate points or objects, such as sedimentary sequences in a seismic section, that can be distinguished

3.77
roll
up-and-down motion of the sides of a survey platform about the horizontal axis that passes along it through the bow and stern, and through its centre of gravity

3.78
sample interval
time interval between successive samples of a recorded signal

3.79
seafloor
interface at the bottom of the water column between the sea and soil or rock

Note 1 to entry: Equivalent terms "water bottom" or “mudline” are commonly used in seismic acquisition and processing.

3.80
SEG-D
SEG-Y
society of exploration geophysicists standard formats commonly used to record and/or exchange seismic data

3.81
seismic method
use of sound waves to image the earth’s subsurface

Note 1 to entry: This term should not be confused with the one used in ISO 19901-2, which defines seismic as being related to strong ground motions (earthquake-related). These ground motions are addressed during the design of structures, so that the structures are not vulnerable to the motions.

3.82
seismic data processing
applying geometrical corrections and signal processing techniques to improve the signal to noise ratio and facilitate the interpretation of seismic data

3.83
seismic source
source of controlled acoustic energy that is used in seismic reflection and seismic refraction marine geophysical investigation

3.84
shallow water
water depths less than 25 m

3.85
shallow water flow
flow of pore water into a hydrocarbon well from an overpressured formation causing difficulties in well control and effective cementing of casing

3.86
side scan sonar
SSS
instrument for imaging the seafloor to either side of a survey track line using acoustic pulses

© ISO 2021 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS ISO 19901-10:2021

3.87
site
defined investigation space, including seafloor and sub-seafloor, that can also include the water column

3.88
soil province
3D unit in which soil or ground conditions demonstrate a particular characteristic or fall within a defined range

3.89
source signature
output wavelet, or waveshape, of a particular seismic source from which frequency, output power and phase can be determined

3.90
sparker
seismic source that operates by producing an electric discharge in water

3.91
spherical divergence
decrease in acoustic signal strength with distance as a result of geometric spreading of acoustic energy

3.92
stack
process of making a composite record by combining traces from different records

Note 1 to entry: Most common application is common mid-point stacking.

3.93
statics
corrections applied to seismic data to eliminate the effects of variations in elevation and near-seafloor velocities

3.94
streamer
set of seismic receivers contained in a linear, normally neutrally buoyant, cable that is deployed aft of a seismic acquisition vessel

Note 1 to entry: Streamers can contain hydrophones, accelerometers, and geophones.

3.95
streamer bird
depth control or heading measurement device fitted to a streamer

3.96
sub-bottom profiler
SBP
seismic reflection instrument for investigating the upper few tens of metres of the sub-seafloor with a high vertical resolution

3.97
sub-seafloor
soil or rock existing beneath the seafloor/base of the water column

Note 1 to entry: Referred to as "seabed" in ISO 19901-8. "Sub-seafloor" should not be confused with "seafloor". Other commonly used terms are subsurface, sub-bottom and shallow section.

© ISO 2021 – All rights reserved
Documents
Document Sharing Hub
Full document details: BS ISO 19901-10:2021

3.98
survey platform
vehicle on which survey sensors and/or sources for marine geophysical investigations are mounted

EXAMPLE Towfish, autonomous underwater vehicle, remotely operated underwater vehicle, hydrophone streamer and surface vessel.

3.99
survey track line
line through coordinates of a sensor and/or sources used during seafloor mapping or sub-seafloor mapping

3.100
multi-beam echo sounder
swathe bathymetry system
instrument for measuring water depths within a defined swathe either side of a survey track line

Note 1 to entry: Two technologies exist. Beam forming multi beam echo sounders and interferometric or phase differencing bathymetric systems.

3.101
shear wave
S-wave
body wave in which the particle motion is perpendicular to the direction of propagation

3.102
tail buoy
buoy fitted to the end of a streamer

3.103
time slice
horizontal section through 3D seismic data that displays information at the same two-way reflection time

3.104
time-to-depth conversion
application of the appropriate seismic velocity to a measured reflection time in order to derive distance through the earth or the water column

3.105
trace
record of one seismic channel

3.106
trace header
identification information and parameters that precede data in a file of recorded traces

3.107
transponder
transducer that produces an acoustic response when it receives an acoustic signal from another transducer

Note 1 to entry: The other transducer can be mounted on a surface or subsea survey platform.

3.108
ultradeep water
Note 1 to entry: water depths from 1 800 m to 3 000 m

3.109
ultra-high-resolution seismic
UHR seismic
seismic reflection method that acquires seismic data containing frequencies between 250 Hz and 800 Hz

© ISO 2021 – All rights reserved

AVA Documents Document Sharing Hub
Full document details: BS ISO 19901-10:2021

3.110
ultra-short baseline system
USBL
sub-sea acoustic positioning system used to determine the position of towed or deployed sensors in the water column

Note 1 to entry: A transponder or responder is mounted on the sensor to be positioned and interrogated from a transducer of known position.

3.111
ultra-ultra-high resolution seismic
UUHR seismic
seismic reflection method that acquires seismic data containing frequencies between 750 Hz and 2 000 Hz

3.112
velocity analysis
process of calculating acoustic velocity from measurements of normal moveout

3.113
velocity model
model of discrete geological units or reflection time intervals with different acoustic velocities

3.114
vertical datum
vertical reference frame
reference frame describing the relation of gravity-related heights or depths to the Earth

Note 1 to entry: In most cases, the vertical reference frame will be related to mean sea level. Vertical datums include sounding datums (used for hydrographic purposes), in which case the heights may be negative heights or depths.

Note 2 to entry: Ellipsoidal heights are related to a three-dimensional ellipsoidal coordinate system referenced to a geodetic reference frame.

[SOURCE: ISO 19111:2019, 3.1.72]

3.115
wavelet
seismic pulse usually consisting of one-and-a-half to two cycles

3.116
yaw
sideways movement of the bow and stern of a survey platform about the vertical axis that passes through the centre of gravity

4 Symbols and abbreviated terms

4.1 Symbols

R_p	ping rate
S_r	slant range
σ	standard deviation

© ISO 2021 – All rights reserved
Documents
Document Sharing Hub
Full document details: BS ISO 19901-10:2021

4.2 Abbreviated terms

ASCII	American standard code for information interchange
AUV	autonomous underwater vehicle
AVO	amplitude versus offset
CIP	common image point
CRS	coordinate reference system
DBS	deconvolution before stack
DVL	doppler velocity log
EM	electromagnetic
FWI	full waveform immersion
GIS	geographical information system
GPS	global positioning system
HSE	health, safety and environment
INS	inertial navigation system
IOGP	International Association of Oil and Gas Producers
MBES	multi-beam echo sounder
MSL	mean sea level
psi	pounds per square inch
QC	quality control
QMS	quality management system
ROTV	remotely operated towed vehicle
ROV	remotely operated vehicle
SBES	single beam echo sounder
SEG	Society of Exploration Geophysics
SRME	surface-related multiple elimination
SSDM	seabed survey data model
SSS	side scan sonar
SV	sound velocity
TVF	time-variant filter
TWT	two-way travel time

© ISO 2021 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS ISO 19901-10:2021

UHR	ultra-high resolution
USBL	ultra-short baseline
UUHR	ultra-ultra-high resolution

5 Objectives, planning, and quality management

5.1 General

5.1.1 Objectives and project specifications

The general objective of a marine geophysical investigation is to provide information about the seafloor and sub-seafloor that is relevant to the design, placement, installation, operation, assessment/re-assessment, and decommissioning of offshore structures. This includes the assessment of geohazards over the lifetime of the development.

This document considers the upper portion of a hydrocarbon well as an offshore structure, and therefore covers the requirements for characterising ground conditions and identifying geohazards that can be encountered by the drilling operation and the installation, use and decommissioning of wells. The depth of interest for a marine geophysical investigation for a hydrocarbon well is typically (as appropriate)

— in the case of a targeted hydrocarbon reservoir shallower than 1 000 m below the seafloor, to a depth just above the reservoir, or

— for deeper reservoirs, at least 200 m below the preferred setting depth of the first pressure-containment casing string or 1 000 m below the seafloor, whatever is greater.

Marine geophysical investigations for pre-drilling well-sites focus on possible gas in the sub-seafloor overlying the reservoir that can pose a threat to the drilling operation. The investigations described here are not concerned with the reservoir that is targeted by the drilling operation.

Where relevant, project specifications should refer to methods described in this document. Any references to methods should be accompanied by method-specific information, as applicable. If method-specific information is contained neither in the project specification nor in this document, then contractor's practice applies. For some parts of a project specification, it can be necessary to provide preliminary specifications that require subsequent revision. An example is on-site revision of operational parameter values for data collection equipment, so that the actual site conditions can be taken into account and accommodated in order to achieve optimum performance.

With seafloor and sub-seafloor conditions having significant impacts on offshore structures, the following partial list of features can be of interest:

— human-made structure and debris, including existing infrastructure (e.g. platforms, cables, sub-sea infrastructure, etc.), archaeological features and unexploded ordnance;

— difficult soil conditions (e.g. very weak soils, boulders, permafrost);

— rugged or steep topography (e.g. escarpments, scarps, gullies);

— buried channels;

— seafloor or sub-seafloor instabilities or evidence thereof (e.g. mass transport deposits);

— faults;

— shallow gas, gas-charged pockets or fluid over-pressure zones;

— gas hydrates;

© ISO 2021 – All rights reserved
Documents
Document Sharing Hub
Full document details: BS ISO 19901-10:2021

— fluid expulsion features (e.g. pockmarks);

— tectonic features;

— carbonate reefs or bedrock;

— erosional features and processes (e.g. current scours and scouring; ice gouges and gouging).

A well-designed marine geophysical investigation allows the detection and characterization of such features, both at and below the seafloor. It also allows the assessment of the spatial variability of sub-seafloor materials. These features are captured in a ground model.

A marine geophysical investigation can, in some cases, also provide information about

a) environmentally or culturally sensitive areas,

c) military areas,

d) disposal areas, and

e) other government-protected areas.

5.1.2 Georeferencing and GIS

Marine geophysical investigation data shall be georeferenced using a coordinate reference system (CRS). Full specifications of the CRS shall be delivered with the metadata; without this CRS reference the description of position is ambiguous. Results from marine geophysical investigations can, with advantage, be presented in a GIS-compatible format.

Additional guidance is given in Clause 6 and in A.5.1.2, which contains details of the IOGP's SSDM as one option for data presentation.

5.1.3 Ground model

A ground model is constructed from a database of any valid input data. It can take different forms and, in the strictest sense, can be of any complexity. For example, when based on bathymetric data, it can take the form of a terrain and geomorphological model; or when based on geological data, it can take the form of a geological model. A geological model can include structural, stratigraphic or lithological components typically interpreted from seismic reflection data verified by ground-truthing. If soil-type and soil-strength data are included (see ISO 19901-8), it can be a soil model or a geotechnical model.

A ground model allows conditions to be inferred at any location within the model boundaries and can be updated and refined as more targeted investigations are performed. Evolution of the ground model is a fundamental objective in the design and execution of a marine site investigation, as illustrated in Figure 2. A ground model captures processes that influence the site in order to, where applicable,

— present an overview of seafloor and sub-seafloor processes, at regional and local scales,

— characterize the geological context of the site, in particular stratigraphic boundaries (horizons) that correlate with geotechnical data,

— present soil provinces and other information that estimate the spatial variability of soil types and terrain attributes,

— assess the potential for present and future natural and/or induced geological activity and human-made activity based on the evaluation of current conditions and inferred past geological events,

— allow selection of key targets for subsequent marine site investigations including soil investigations, and

— assess geohazards for risk management and mitigation purposes.

© ISO 2021 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS ISO 19901-10:2021

Integration of marine geophysical investigation data with geological and/or geotechnical data can be made with different levels of complexity:

— Geological and geotechnical information can be, in their simplest form, the background regional information or inferences made from earlier marine site investigations in nearby areas. In some cases, this can be sufficient to meet the project specifications and the requirements of ISO 19900 for adequate reliability.

— Pre-drilling well-site investigations for floating rigs are often based entirely on marine geophysical investigations, although these can be supplemented by other marine site investigation data to assist with the prediction of anchoring conditions.

— The integration of geophysical and geotechnical information enables development of a ground model which becomes the basis for

  a) understanding the main geological, geomorphological and geotechnical conditions, features and processes that can affect (1) short term offshore activities such as well drilling, rig anchoring of floating units and jack-up operations, and (2) the reliability of more permanent infrastructure such as fixed or floating platforms, pipelines, risers and sub-sea structures, or

  b) developing soil properties and parameter values for geotechnical design with advice from a geotechnical specialist (see ISO 19901-8 and ISO 19901-4).

The creation or update of a ground model can be a key outcome of a marine site investigation.

An initial ground model will be created at the desk study stage, and it can be incrementally improved with additional data and further interpretation. In some cases, such as a well-known site with existing structures where recent geophysical or geotechnical data are available, the initial ground model can prove to be adequate to satisfy the technical objectives without the need to collect additional information.

GIS can facilitate the integration of geoscience data with other datasets and help communication with end-users who might not be geospecialists.

5.2 Desk study

5.2.1 General

A desk study shall be performed and shall include the analysis of available data that are relevant for the project. A desk study is the starting point for every marine site investigation; its purpose is to investigate the site using existing data, and to address the need to acquire additional data.

A desk study can include output suitable for defining the scope and planning of seafloor mapping, sub-seafloor mapping and data integration, as applicable.

The following non-exhaustive list contains examples of data that can be included in the desk study:

— results (data and interpretation) of previous marine geophysical investigations in the area including exploration 2D and 3D seismic data;

— results (data and interpretation) of previous marine soil investigations;

— regional bathymetry, nautical and geological charts;

— research papers, publications and other public-domain data on geohazards, geology and spatial variability of the sub-seafloor;

— information about any known geohazards, for example, information from nearby hydrocarbon wells;

— drilling reports from hydrocarbon wells within the region;

— shipping lanes;

© ISO 2021 – All rights reserved
Documents
Document Sharing Hub
Full document details: BS ISO 19901-10:2021

— information regarding seafloor debris, such as shipwrecks;

— known offshore structures, including pipelines, well heads, manifolds, power cables, etc.;

— metocean (wind, wave, current, climate) conditions;

— protected/restricted areas;

— exploration and production licence requirements;

— information on other activities in the area, including ongoing or planned exploration or project development and production-related activities (drilling, exploration seismic data acquisition).

The following should be covered by the desk study:

a) assessment of existing data in terms of relevance, quality, age and spatial density to determine if they are usable and sufficient for an adequate understanding of site conditions;

b) if relevant to the project (e.g. for geohazards reasons), assessment of recent events, either metocean or in the geological record;

c) recommendation as to whether further marine geophysical and/or marine soil investigation data are required.

For investigations of very limited scope (in terms of geographic area or project specifications), repeat investigations in well understood areas, or for limited marine geophysical investigations performed for specific purposes, the desk study can be a relatively straightforward exercise that has an outcome of minimum complexity. For example, the desk study report can simply refer to nautical charts for planning of operations outside of designated shipping lanes or military testing zones.

5.2.2 Use of exploration 2D and 3D seismic data in a desk study

Exploration 2D and 3D seismic data are invaluable inputs to all but the most simple and straightforward site investigations including reconnaissance, engineering and detailed engineering. The data can allow early reviews of field-development plans and help identify areas where sub-seafloor mapping and marine soil investigation data can add value. Whenever they are available these data sets shall be included in the desk study.

Consideration should be given to the re-processing of exploration seismic data to enhance its quality in the depth range of interest.

5.2.3 Desk study for pre-drilling well-site investigations

The desk study for a pre-drilling well-site investigation shall consist of a review of relevant available site data and reports in the area of interest, including exploration 2D and 3D seismic data, covering all planned drilling locations (including potential relief-well locations). In frontier areas where there are no nearby existing wells, data and reports from wells linked to the area of interest by a seismic line should be included even if they are some distance away.

5.3 Scoping and planning

5.3.1 General

The process for marine site investigation typically comprises the following:

— determination of objectives

— desk study, including production of an initial ground model;

— scoping of marine site investigation;

© ISO 2021 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS ISO 19901-10:2021

— development of project specifications;

— operations planning;

— marine geophysical operations – seafloor mapping and sub-seafloor mapping;

— processing and analysis of marine geophysical investigation data and integration with desk study results for refinement of the ground model;

— marine soil (or other complementary) investigation(s) (see ISO 19901-8);

— analysis of marine soil investigation (or other complementary) data and integration with results of other investigations for refinement of the ground model;

— iteration, as required.

Project-specific data used to characterize the site and create the ground model(s) are usually acquired first from a marine geophysical investigation and then from a marine soil investigation. In some cases, seafloor mapping, sub-seafloor mapping, and marine soil investigation can be combined in a single campaign. The acquisition sequence is sometimes repeated or adjusted to fill knowledge gaps, investigate new challenges or to fit modifications in offshore structure layout.

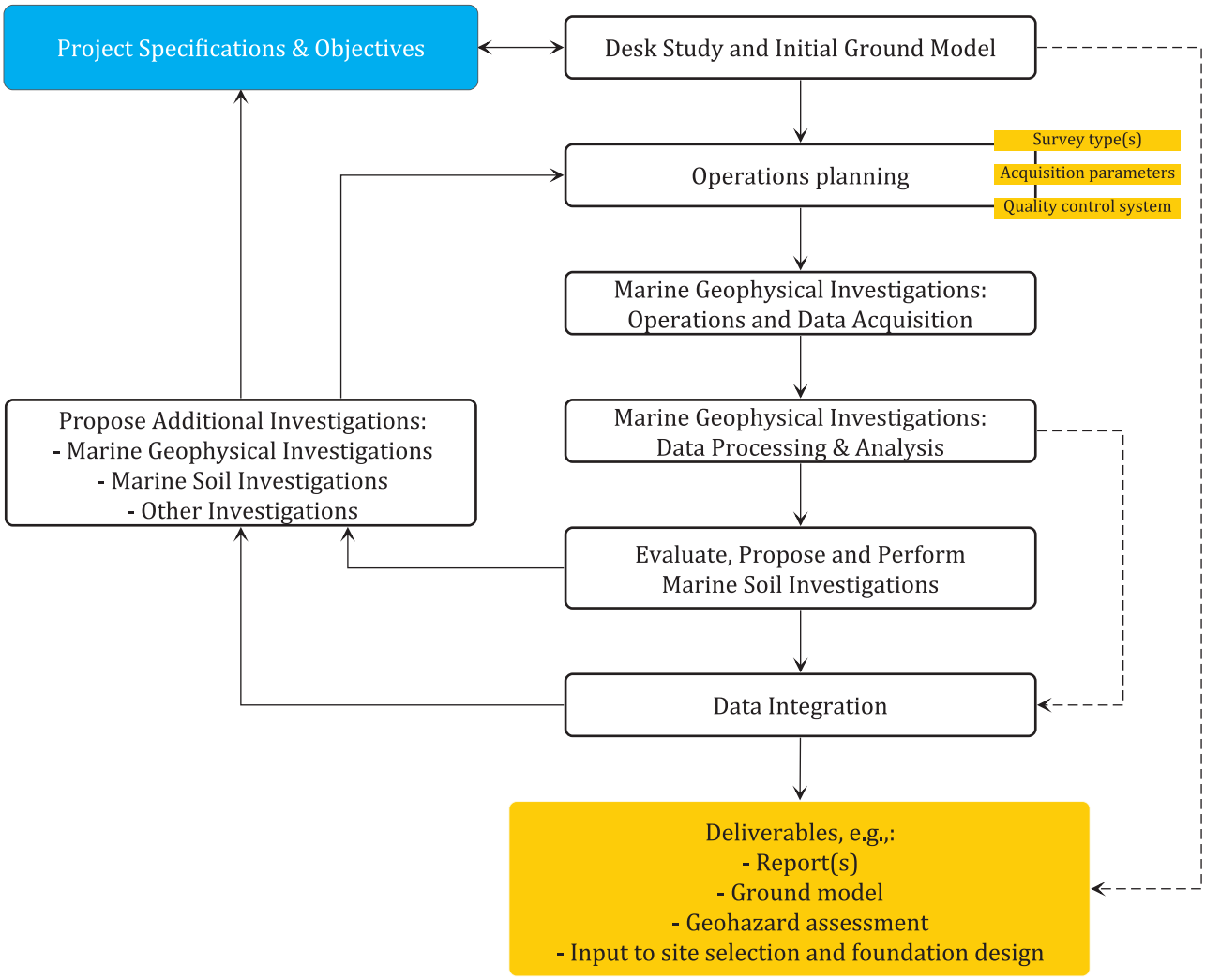

Figure 2 — Typical workflow for marine site investigation

© ISO 2021 – All rights reserved
Documents
Document Sharing Hub
Full document details: BS ISO 19901-10:2021

5.3.2 Scoping of seafloor mapping and sub-seafloor mapping

5.3.2.1 General

Scoping of seafloor mapping and sub-seafloor mapping provides project specifications, including

— types of mapping that shall be performed for adequate understanding of the site conditions, with the relevant level of detail required (see survey types defined in 5.3.2.2 to 5.3.2.8),

— specific specialist studies that shall be performed (for reasons such as slope stability, seepage, presence of carbonate soils),

— area that shall be covered, and

— specifications for sensors and sources.

Survey types are categorized as reconnaissance seafloor or sub-seafloor mapping, engineering seafloor or sub-seafloor mapping and detailed engineering seafloor or sub-seafloor mapping. Pre-drilling well-site investigation is included as a separate special category of seafloor and sub-seafloor mapping. This categorization considers required resolution of the data and is not necessarily related to life cycle phases of an offshore structure. For example, detailed engineering seafloor mapping can apply to the decommissioning phase of an offshore structure. Other survey types warranted to address specific or unusual concerns might not fit neatly into these categories, requiring an independent evaluation and definition of project specifications to meet the survey objectives.

For seafloor mapping, project specifications should specify required horizontal resolution in terms of DTM cell size. For sub-seafloor mapping, project specifications should specify required horizontal resolution in terms of spacing of survey track lines and shot point and receiver spacings.

For seismic methods, the vertical resolution achieved is partly determined by the temporal frequency bandwidth of the recorded pulse. This bandwidth will be strongly influenced by the bandwidth of the outgoing pulse and the characteristics of the sub-seafloor and can be much different from the bandwidth of the outgoing pulse. Therefore, vertical resolution of sub-seafloor mapping cannot be determined solely by the equipment used. Further guidance on this subject is given in A.5.4.2.

Seafloor and sub-seafloor mapping source and receiver systems should be calibrated where applicable. A verification of the calibrations should be performed prior to the beginning of seafloor mapping, and not before the start of the last port call. The validity of the most recent calibrations should be verified, and further calibrations carried out as appropriate.

All geophysical equipment used during a survey whose calibrations cannot be verified prior to the beginning of field operations should have valid performance certificates provided by the manufacturer or a recognized third-party equipment testing service provider.

The specifications for sensors and seismic sources covered by this document shall apply at the time of calibration, prior to their use in mapping. If no calibration applies, then the specifications for sensors and seismic sources covered by this document shall apply at the time of verification, prior to their use.

5.3.2.2 Reconnaissance seafloor mapping

Reconnaissance seafloor mapping can provide an initial overview of an area, typically covers a large spatial extent and has lower resolution requirements than engineering seafloor mapping.

Reconnaissance seafloor mapping is often carried out with an MBES mounted in the hull of a surface vessel. ROVs, AUVs, tow-fish or other types of sensors can also be used as a survey platform.

Reconnaissance seafloor mapping can be performed as part of an initial marine site investigation of an area. The nature of the offshore structures to be installed at the site will typically determine the shape of the area of interest; a new pipeline will typically require mapping along a corridor, a new field development will require mapping within a defined region, etc.

© ISO 2021 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS ISO 19901-10:2021