NORSOK STANDARD

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Collection of metocean data

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Foreword

The NORSOK standards are developed by the Norwegian petroleum industry to ensure adequate safety, value adding and cost effectiveness for petroleum industry developments and operations. Furthermore, NORSOK standards are, as far as possible, intended to replace oil company specifications and serve as references in the authorities' regulations.

The NORSOK standards are normally based on recognised international standards, adding the provisions deemed necessary to fill the broad needs of the Norwegian petroleum industry. Where relevant, NORSOK standards will be used to provide the Norwegian industry input to the international standardisation process. Subject to development and publication of international standards, the relevant NORSOK standard will be withdrawn.

The NORSOK standards are developed according to the consensus principle generally applicable for most standards work and according to established procedures defined in NORSOK A-001.

The NORSOK standards are prepared and published with support by The Norwegian Oil Industry Association (OLF), The Federation of Norwegian Industry, Norwegian Shipowners' Association and The Petroleum Safety Authority Norway.

NORSOK standards are administered and published by Standards Norway.

Annex A and Annex B are informative.

Introduction

Offshore metocean monitoring systems can vary from simple weather stations for aviation purposes to complete data acquisition systems incorporating a wide range of sensors and sophisticated data processing, display, storage and transmission features. By providing real-time information for operational use and long-term records for engineering design purposes, offshore metocean monitoring systems play an important role in ensuring safe offshore operations.

This NORSOK standard is intended as an initial reference for offshore operators when planning metocean monitoring equipment on offshore installations. It covers both statutory requirements and operator's own requirements, spanning applications such as weather forecasting, climate statistics, helicopter traffic, tanker loading, marine operations etc.

The collection of metocean data is normally the result of requirements imposed by PSA or other authority, and the operator's own needs. When specifying a metocean data collection system, this standard shall be supplemented by a list stating which requirements to fulfil. This NORSOK standard contains the necessary information for the requirements normally imposed by PSA, and a check-list to identify operator's own needs.

1 Scope

This NORSOK standard presents functional requirements and common principles for the collection of metocean data, i.e. meteorological and oceanographic data.

2 Normative and informative references

The following standards include provisions and guidelines which, through reference in this text, constitute provisions and guidelines of this NORSOK standard. Latest issue of the references shall be used unless otherwise agreed. Other recognized standards may be used provided it can be shown that they meet the requirements of the referenced standards.

2.1 Normative references

NMI, 1997:	Norwegian Meteorological Institute: Report 18/97 KLIMA. Recommended format (NORSOK) for the delivery of metocean data
BSL G 7-1,	Civil Aviation Authority – Norway: Forskrift om flyværtjeneste (2008-07-01)
BSL D 5-1,	Civil Aviation Authority – Norway: Forskrift om kontinentalsokkelflyging - Ervervsmessig luftfart til og fra helikopterdekk på fartøy og innretninger til havs (2008-01-01)
ICAO Doc 9328-AN/908,	Manual of Runway Visual Range Observing and Reporting Practices, ICAO, 2005
PSS 78,	The Practical Salinity Scale 1978
WMO-No. 8,	Guide to Meteorological Instruments and Methods of Observation, WMO 2008 Geneva
WMO-No. 49,	Technical Regulations, Vol II, Meteorological Service for International Air Navigation, WMO 2004, Geneva
WMO-No. 306,	Manual on Codes, Volume I.1, WMO 1995, Geneva

NOTE The WMO is the major international reference on many of the topics discussed herein. The technical documentation of WMO is extensive; therefore this standard makes specific references to relevant parts of WMO documentation. Furthermore, NMI has accepted the responsibility to provide easy access to updated versions of the WMO publications referenced herein.

2.2 Informative references

WMO-No. 842,	Guide to the Provision of Meteorological Service for International Helicopter Operations, WMO/ICAO 1996, Geneva

NOTE The following handbooks (in Norwegian only) (distributed by NMI) are standard equipment at all observing stations:

- NMI: Meteorologisk Kode, SHIP, Maritime stasjoner
- NMI: Meteorologiske koder for flyværtjenesten
- NMI: Veiledning for meteorologiske målinger offshore

3 Terms, definitions and abbreviations

For the purposes of this NORSOK standard, the following terms, definitions and abbreviations apply.

3.1 Terms and definitions

3.1.1
shall
verbal form used to indicate requirements strictly to be followed in order to conform to this NORSOK standard and from which no deviation is permitted, unless accepted by all involved parties

3.1.2
should
verbal form used to indicate that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others, or that a certain course of action is preferred but not necessarily required

3.1.3
may
verbal form used to indicate a course of action permissible within the limits of this NORSOK standard

3.1.4
can
verbal form used for statements of possibility and capability, whether material, physical or casual

3.2 Abbreviations

BSL	bestemmelser for sivil luftfart
CTD	conductivity-temperature-depth sensor
FM 13-XII Ext. SHIP	Format description of the report SHIP
FM 15-XIII Ext. METAR	Format description of the report METAR
FM 16-XIII Ext. SPECI	Format description of he report SPECI
ICAO	International Civil Aviation Organization
METAR	aviation routine weather report
metocean	meteorological and oceanographic
MOB	man over board
MOR	meteorological optical range
NMI	Norwegian Meteorological Institute
PSA	Petroleum Safety Authority – Norway
PSU	practical salinity unit
RVR	runway visual range
SAR	search and rescue
SHIP	report of surface observation from a sea station
SPECI	aviation selected special weather report
UTC	universal time coordinated
WMO	World Meteorological Organization

4 Common requirements

4.1 General

Procedures, which ensure the proper functioning of the measuring and recording system, described in this NORSOK standard as well as instrument accuracy and calibration, shall be established and maintained.

Qualified personnel shall carry out observations, select, install, check and maintain the equipment and repair any faults or malfunctions. Service and calibration interval on equipment shall be maximum one year. When new types of instruments are introduced, a notification shall be given to all regular receivers of data.

Time references given in UTC shall be recorded together with the measured data or derived parameters. The time reference should not be dependent on manual setting following a possible stop in operation of the system. Local user interfaces should show both UTC and local time, clearly marked.

4.2 Instrumentation

The accuracy, range, type and location of the instruments should be determined with due regard to the purpose of the recordings.

The required measurement uncertainty of metocean recordings should be chosen in accordance with Annex A.

NOTE Annex A is based upon the table in Annex 1.B of WMO-No. 8.

5 Meteorology

5.1 General

Details on instrument accuracy and calibration are found in WMO-No. 8.
Part I - Measurement of Meteorological Variables
Part III - Chapter 4 Testing, Calibration and Intercomparison

Data that cannot be measured by means of instruments shall be obtained by observation by qualified observers. Observers shall have completed relevant training at NMI, or an equivalent course. During the first year of active observation duty, a refresher/repetition course shall be completed.

5.2 Weather observation and reporting for helicopter operations

The specifications given herein do only address environmental conditions, and do not constitute a complete system for offshore helicopter operations. BSL G 7-1 and BSL D 5-1 give relevant regulations for helicopter operations.

A complete aviation routine weather report is specified in WMO-No. 306, under code FM 15-XIII Ext. METAR. The message consists of information derived from instrumental measurements and manual observations taken by a qualified observer, see 5.1. The parameters included are

- wind direction,
- wind speed,
- visibility (according to METAR specifications, and RVR, if available),
- weather,
- cloud,
- dew-point temperature,
- air temperature,
- air pressure (atmospheric pressure at nautical height),
- significant wave height,
- sea surface temperature.

The wind measurements from the top of derrick are normally not representative for the wind field at the helicopter deck. A separate wind sensor shall be installed near the helideck to measure values representative for the wind field at the helicopter deck. This requirement may be waived if it can be clearly demonstrated that this is not necessary.

Experience has shown that this is best achieved if the location of the wind sensor is selected to minimize the influence from the construction itself, e.g. living quarters, cranes etc. This means that top of derrick or mast is the best choice in most cases.

The measurement of these parameters does not replace the need for an easily perceptible wind cone.

The observations shall be recorded in accordance with WMO-No. 306, Section A, pp 25-36.

In addition to METAR, a code for special reports is specified in WMO-No. 306, under code FM 16-XIII Ext. SPECI.

The criteria for, and frequency of, issue of METARs and SPECIs is the responsibility of the relevant aviation regulations. International recommendations may be found in WMO-No. 842 (Chapter 4).

5.3 Weather observation and reporting for weather forecasting services

A complete weather observation report is specified in WMO-No. 306, under code FM 13-XII Ext. SHIP. The message consists of information derived from instrumental measurements and manual observations taken by a qualified observer, see 5.1. The parameters included are

- wind direction,
- wind speed,
- air pressure,
- air temperature,
- sea surface temperature,
- humidity,
- wave height,
- wave period,
- clouds,
- visibility (MOR),
- weather,
- icing.

Observations shall be made at standard synoptic hours, expressed in terms of UTC, at which, by international agreement, meteorological observations are made simultaneously throughout the globe. Standard synoptic hours are 00, 03, ... 21 UTC. The observations shall be recorded in accordance with WMO-No. 306, under code FM 13-XII Ext. SHIP (Section A, pp. 7-24).

5.4 Weather observation and reporting for climatologically purposes

5.4.1 General

In addition to the data collected for the weather report (SHIP-format), the wave parameters: maximum wave height, peak period and wave direction, shall be included, if available. The normal recording interval shall be 1 h, and the resolution of the data shall be in accordance with the instrument accuracy.

There is presently no WMO or other internationally recognised format for this sort of data. A flexible format in extensive use in Norwegian waters is documented in NMI, 1997. The development and documentation of this format (according to user requirements) is the responsibility of NMI, and this format should be used for delivery of climatologic data to NMI.

5.4.2 Annual reports

Annual reports shall be issued. They shall include a description of the recording methods and contain an assessment of data quality, frequency tables, calculations of mean values and extreme values as well as descriptions of special incidents.

The data should be presented in such a way as to allow other users to carry out extreme value analyses without having to resort to the original unprocessed data, for instance by presenting frequency tables including cumulative distributions for the year being reported upon as well as for the total data set if it consists of multiple years.

In the case of extreme environmental conditions of significance to safety conditions or to working environmental conditions, separate descriptions of these conditions should be included.

5.5 Weather observation and reporting for operational needs

The operator may have operational needs for metocean information. If such needs are identified, a plan for collection, storing and distribution of such data should be established. The plan should include a list of all required metocean parameters. A check-list including potential applications is given in Annex B.

The metocean parameters should preferably be selected from the parameter lists in 5.2 and 5.3. If these parameters do not meet the operator's need, a specific reference to relevant WMO, or other available publication, should be established. Requirements for sensor location should be given.

6 Oceanography

6.1 General

In the context of this NORSOK standard, the term oceanography shall mean

- ocean currents at specified depths,
- water level,
- sea temperature at specified depths,
- salt content (salinity) at specified depths,
- oxygen content at specified depths,
- icebergs, size and drift,
- sea ice.

NOTE Ocean waves and sea surface temperature are defined as part of meteorology, and covered in Clause 5.

Apart from ocean currents and water level, the measurements and observation of oceanographic parameters are not commonly included in platform metocean systems. The operator shall, however, consider his own need for collecting such data contingent upon the natural conditions at the location, the inadequacy of the data basis, the type of structure or installation, and the operational situation of the facility. A check-list is given in Annex B.

6.2 Measurements and observations

Ocean currents should be measured at fixed depths (or bins), and at least include three depths in shallow waters: near surface, mid depth and near bottom.

For measurements in deeper waters, the following depths should be considered in addition to near surface and near bottom: 50 m, 100 m, 150 m, 200 m, 300 m and every 200 m to 3 m above the seabed.

The mean speed and direction of ocean currents shall be recorded at least once per hour. Measurements of sea temperature and salinity should be performed as an integrated activity. If Nansen bottles or similar equipment are used, data should be recorded at standard depths: 0 m, 5 m, 10 m, 20 m, 30 m, 50 m, 75 m, 100 m, 125 m, 150 m, 200 m, 250 m, 300 m, 400 m, 500 m, 600 m, 800 m etc.

If a CTD is used for measuring temperature and salinity, data should be stored for at least every 0,5 bar.

Oxygen content, if required, should be measured at a subset of the temperature/salinity depths given above. However, the number of depths may be considerably reduced.

The observation of sea ice and icebergs (size and drift), can be performed by combining e.g. manual observations, instrument recordings and remote sensing.

7 Data quality control

Procedures shall be established to ensure that collected data are processed and standard analyses carried out in such a way that the quality of the data may be verified. The analyses should be sufficiently extensive to allow all significant errors to be discovered. The data should be compared to other recorded data to the extent this is practicable.

Recorded data together with a report concerning data quality should be submitted to NMI within a month after the completion of the recording period. The recording period should typically be one month. The data shall be submitted by way of a computer readable medium in an agreed format. Necessary documentation shall accompany the data.

Annex A
(informative)

Recommended instrument accuracy and typical operational performance

Table A.1 is based on the very similar table presented in Annex 1.B, pp 19-24, chapter 1 of WMO-No. 8. A system built according to these recommendations will fulfil the requirements set by NMI and PSA.

Table A.1 — Recommended instrument accuracy and typical operational performance

(1) Variable	(2) Range	(3) Reported resolution	(4) Mode of measurement/ observation	(5) Required measurement uncertainty	(6) Sensor time constant	(7) Output averaging time	(8) Typical operational performance	(9) Remarks
1. Temperature 1.1 Air temperature	-40 to +40 °C	0,1 °K	I	0,1 °K	20 s	1 min	0,2 °K	Operational performance and effective time constant may be affected by the design of thermometer solar radiation screen.
1.2 Extremes of air temperature	-40 to +40 °C	0,1 °K	I	0,1 °K	20 s	1 min	0,2 °K	
1.3 Sea-surface temperature	-2 to +40 °C	0,1 °K	I	0,1 °K	20 s	1 min	0,2 °K	
2. Humidity 2.1 Dewpoint temperature	< -60 to +35 °C	0,1 °K	I	0,1 °K	20 s	1 min	0,5 °K	If measured directly. Tending to ±0,1 °C when relative humidity nearing saturation.
2.2 Relative humidity	5 to 100 %	1 %	I	±3 %	40 s	1 min	±3 to 5 %	Solid state sensors may show significant tempera-ture and Humidity nearing saturation.

								humidity depen-dence.
3. Atmospheric pressure 3.1 Pressure	920 to 1080 hPa	0,1 hPa	I	0,1 hPa	20 s	1 min	0,3 hPa	Range to sea level. Accuracy seriously affected by dynamic pressure due to wind and temperature coefficient of transducer.
3.2 Tendency	Not specified	0,1 hPa	I	0,2 hPa			0,2 hPa	Difference between instantaneous values.
4. Clouds 4.1 Cloud amount	0/8 to 8/8	1/8	I	1/8	n/a		2/8	Period (30 s) clustering algorithms may be used to estimate low cloud amount automatically.
4.2 Height of cloud base	0 m to 30 km	10 m	I	10 m for ≤100 m 10 % for >100 m	n/a		≈10 m repeatability	Accuracy difficult to determine since no definition exists for instrumentally measured cloud base height.
5. Wind 5.1 Speed	0 to 60 m/s	0,5 m/s	A	0,5 m/s for ≤5 m/s 10 % for >5 m/s	Distance constant 2 to 5 m	2 and/or 10 min	0,5 m/s for ≤ 5 m/s 10 % for > 5 m/s	Average over 2 and /or 10 minutes. Non-linear devices. Care needed in design of averaging process.
5.2 Direction	0 to 360º	1º	A	5º	1 s	2 and/or 10 min	5º	
5.3 Gusts	0 to 75 m/s	0,1 m/s	A	10 %		3 s	0,5 m/s for ≤ 5 m/s 10 % for > 5 m/s	Highest 3 s average should be recorded.
6. Visibility 6.1 MOR	< 50 m to 70 km	10 m	I	50 m for ≤500 m 10 % for >500 m ≤ 1500 m 20 % > 1500 m	< 30 s	1 and 10 min	The larger of 20 m or 20 %	Achievable instrumental accuracy may depend on the cause of obscuration. Quantity to be averaged: extinction coefficient

								(see WMO-No. 8, Part III, Chapter 3, section 3.6). Preference for averaging logarithmic values.
6.2 RVR	10 m to 1500 m	10 m	A	10 m for ≤400 m 25 m for >400 m to ≤ 800 m 10 % for > 800 m	< 30 s	1 and 10 min	The larger of 20 m or 20 %	In accordance with WMO-No.49, Volume II, Attachment A (2004 ed.) and ICAO Doc 9328-AN/908 (Second ed., 2000)

7. Waves 7.1 Time series of sea surface elevation	-15 to +20 m	0,1 m	I		0,5 s	n/a	±0,2 m for ≤5 m ±4% for >5 m	Length of time series 17 min (typical). Sampling frequency 2 Hz.
7.2 Variables from time series (zero crossing analysis)							Depends on averaging time and sea regularity as well as intrinsic instrument accuracy	
7.2.1 Significant wave height ($H_{1/3}$)	0 to 20 m	0,1 m	A	0,5 m for ≤ 5 m 10% for >5 m	0,5 s	20 min (typical)		
7.2.2 Average zero crossing period (T_Z)	3 to 30 s	1 s	A	0,5 s	0,5 s	20 min (typical)		
7.2.3 Maximum Wave height (H_{max})	0 to 35 m		I		0,5 s	20 min (typical)		Observed value at location of sensor. New value every 30 min (typical).

7.3 Wave spectrum						Minimum 17 min	Depends on averaging time and sea regularity as well as intrinsic instrument accuracy.	Instruments may include wave buoys, altimeter, microwave doppler radar, high frequency radar, navigation radar etc. (1 Hz sampling frequency is sufficient).

7.3.1 1-D spectral density		0,1 m^2Hz^{-1}	I				Shall be sufficient to achieve 7.4 requirements.	
Frequency	0,035 to 0,3 Hz	< 0,01 Hz						
7.3.2 2-D spectral density		0,1 m^2Hz^{-1} rad^{-1}					Shall be sufficient to achieve 7.4 requirements.	
Frequency	0,035 to 0,3 Hz	< 0,01 Hz						
Direction	0 to 360 °	10 º (see remark)						2-D spectrum may be based on parameterized directional distribution and reported as direction and spread parameters.

7.4 Variables from wave spectrum							Depends on averaging time and sea regularity as well as intrinsic instrument accuracy.	
7.4.1 Significant wave height (H_{mo})	0 to 20 m	0,1 m	A		0,5 s	20 min	0,5 m for ≤5 m 10% for > 5 m	
7.4.2 Average period (Tm02)	3 to 30 s	0,1 s	A		0,5 s	20 min	0,5 s	
7.4.3 Peak period (Tp)	3 to 30 s	0,1 s	A		0,5 s	20 min	0,5 s	Period of peak of frequency spectrum.
7.4.4 Mean direction	0 to 360 °	10 º	A		0,5 s	20 min		May be spectrally averaged or based on
7.4.5 Direction							20 º	

spread	0 to 360 °	10 º	A					angular harmonics.
8 Ocean currents 8.1 Current speed	0 to 250 cm s^{-1}	1 cm s^{-1}	A	1 to 10 cm s^{-1}	1 s	5 to 20 min	2 to 10 cm s^{-1}	Achievable accuracy affected by type of measurement; direct or acoustic doppler profilers
8.2 Current direction	0 to 360 °	1 º	A	±5 º	1 s	5 to 20 min	±5 º	
9 Water level	±3	1 cm	I	±1 cm		10 min	±5 cm	
10 Temperature profile	-2 to +25 ºC	0,1 ºK	I	0,01 ºK	0,5 s	1 s	0,05 ºK	Achievable accuracy according to commonly used CTD sensors.
11 Salinity profile	0 to 40 PSU	0,1	I	±0,01 PSU	0,5 s	1 s	±0,05 PSU	As per temperature profile unit: PSU according to PSS 78.
12 Oxygen	0 to 15 ml/l	0,1 ml/l	I	±5 %	0,5 s	1 s	±5 %	

NOTES

1. Column 1 gives the basic variable.
2. Column 2 gives the common range for most variables; limits depend on local climatological conditions.
3. Column 3 give the most stringent resolution as determined in WMO-No. 8.
4. In column 4:
   I: Instantaneous. In order to exclude the natural small-scale variability and the noise, an average value over a period of 1 min is considered as a minimum and most suitable; averages over periods of up to 10 min are acceptable.
   A: Averaging. Average values over a fixed time period, as specified by the coding requirements.
   T: Totals. Totals over a fixed time period (s), as specified by coding requirements.
5. PSU: parts per thousand or grams of salt per kilogram of solution.

Annex B
(informative)

Potential application for metocean information

Check-list (in alphabetical order):

Application	Comments
Bridge and flotel disengagement	
Crane operations	Wind and waves (or heave on a ship) do have an impact on safety margins for crane operations.
Installation	Wind and wave data are usually needed for setting deck and modules, and currents can be important for running risers and stabbing tension leg platform tendons.
Diving operations	May depend on a number of metocean parameters.
Evacuation	Meteorological and oceanographic data is vital for decisions regarding time of evacuation and selection of evacuation means.
Maintenance	Maintenance operations, especially outdoor work above open sea, are often subject to restrictions on weather and sea state.
Marine operations	Various marine operations need reliable metocean information
Production shut-down	May depend on a number of metocean parameters, mainly waves and wind
Remotely operated vehicle operations	May depend on a number of metocean parameters, mainly waves and ocean currents
SAR/MOB	Accurate metocean information may be crucial to effective and safe SAR and MOB operations.
Tanker loading	Tanker loading operations are sensitive to sea state and wind conditions, in particular during docking operations.
Verification studies	A number of long term metocean parameters may be required for verification of offshore structures. Verification studies may depend on special metocean parameters or installation of standard instruments in special locations.