Technical Guideline No. 06– Deployment of current meter moorings

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2014

To be used in conjunction with:

GUIDELINES FOR THE ENVIRONMENTAL MONITORING AND IMPACT ASSESSMENT ASSOCIATED WITH SUBSEA OIL RELEASES AND DISPERSANT USE IN UK WATERS

1 Purpose and Scope

In any emergency event understanding the dynamics of the current regime at a site close to the release site is essential if the fate of the oil release is to be determined. These current files can be used to predict the near field flow distribution (three dimensional current) and also to calibrate oceanographic numerical models.

This document covers the deployment, operation and recovery of a mooring to measure horizontal and vertical currents on the shelf seas (0-200 m) and in deeper waters (200 m to 3000 m). Data from these moorings can be recorded in self contained systems and/or sent by acoustic/satellite systems to shore based data centres.

This document supports and should be used in conjunction with environmental monitoring guidelines for subsea oil releases (Law et al., 2014).

2 Health and Safety Considerations

To work towards a uniform approach, planning of activities through the development of generic Risk Assessments and Method Statements (RAMS) is essential. Application of these RAMS extends from the shore-based warehouse preparation, through sea-borne operations, and returning to the warehouse for data recovery, analysis and interpretation.

Deployment and recovery of moorings, either in shelf seas or deep water, involves ropes/wires, anchor systems, and buoyancy (both surface and sub-surface). The weight, size and composition of a number of these items are determined by the environmental conditions and restrictions of the deployment site but surface buoys can weigh several tonnes.

It should be noted that individual survey contractors and vessel operators will each run separate safety management systems. Interface between different operators and teams (ship, land based transport) should be approached early in this process so as to determine suitable Bridging Documents which act to combine (and provide orders of precedence) for individual contractors safety management systems.

Due to the possible heavy loads associated with this work, coherent manual handling procedures should be instigated and maintained, with a strong health and safety culture for sharing information regarding hazards to partner organisations. For example, some acoustic current meters can weigh 50 kg.

When undertaking operations during both warehouse and field-based operations, appropriate PPE should be worn. The level of PPE shall be determined by the task being undertaken, the nature of the hazards, and the environment in which it is undertaken. There should be a minimum PPE requirement for each task (e.g. steel toe-capped footwear, hard hat, gloves, lifejacket, etc), with options for implementation as conditions dictate (e.g. warm weather gear for cold conditions, high visibility clothing in low light conditions, etc).

Before the survey starts, the SIC (Scientist-in-Charge) and Ships Safety Officer should ensure that all scientists and crew have been adequately briefed in relation to the safe operating procedures relating to deployment of gear. Daily (or task specific where environmental / deck conditions vary) "tool box" talks should be undertaken to ensure all procedures are undertaken and that feedback from scientists and crew is captured.

Suitable COSHH statements and supporting documentation should be available for any chemicals used in the deployment/operation/recovery of a mooring. This includes greases, cleaners or solders. Particular attention should be paid to batteries especially Lithium based.

There are a number of standards that relate to the collection of metocean data for projects within the oil and gas industry, however OGP (2011) specifically produced a guidelines document covering health and safety for metocean surveys in particular, in addition to surveys within the Arctic.

3 Mooring Design

3.1 Environmental Consideration

A provisional understanding of the following should be obtained in order to suitably approach mooring design:

- Oceanographic deliverables e.g. horizontal current velocities every 50 m with accuracy of 1 cm/s throughout whole water column
- Water depth
- Expected mean and maximum velocities – With any deep sea mooring the rigidity of the mooring is a crucial parameter to estimate in order to reduce "knock down". This rigidity depends on the drag of the equipment and wire/rope and the vertical current profile (often a worst case profile is used). Floatation spheres (see Figure 1) can be added, either distributed or in blocks, to increase the rigidity. Mooring design software is available to determine knock down along with internal wires loads.
- Surface conditions (impacts on surface and near-surface buoyancy)
- Seabed conditions (composition of the seabed to determine if anchor weights will settle with time)
- Magnetic infrastructure in the region which may influence in-built compasses.
- Biofouling – in shelf seas or on near surface instrumentation on deep sea deployments, where nutrient and light levels are significantly higher and biofouling can develop over even short deployments. An assessment of the impacts on biofouling and mitigation strategies should be undertaken.

Figure 1 - Glass Sphere Buoyancy for moorings.

3.2 Equipment Consideration

Due to the expected nature of these surveys (i.e. in the event of an emergency), the selection of equipment may entirely be based on availability at the time, however there are some considerations that are required which may assist the equipment selection process:

3.2.1 What data are required?

The specifics of the data requirements will impact which equipment can be effectively used.

3.2.1.1 Acoustic profiling current meters

Acoustic profiling current meters have several advantages including three dimensional profiling capability and provision of backscatter profiles [1]. These are robust, have a good track record and are widely used by the majority of survey contractors.

Several different acoustic profiling current instruments are available in a variety of acoustic frequencies and depth ratings from a range of instrument manufacturers, including (but not limited to) Nortek, Rowe Technologies, and Teledyne RDI. As the acoustic profiling current meters provide data over a profile, the current speed and direction (and backscatter) can be provided at regular intervals throughout the entire water column with either one or several devices.

[1] The Backscatter information may be of use to visualise the passage of either gas bubble or oil droplet plumes. Calibration of backscatter is notoriously difficult and often only quoted as qualitative.

For acquisition of current profiles using acoustic profiling current meters, the bin size [2] and measurement accuracy will dictate the acoustic frequency of the units required.

This acoustic frequency will then determine the range of the instrument, thus impacting how many individual instruments are required to survey the water column profile. Typically, higher frequency units have a shorter range, however have a better vertical resolution and measurement accuracy.

3.2.1.2 Point Current Meter

Alternatively, point current meters may be used along all or part of the mooring string to provide independent current velocity measurements. The benefit of this method is that it provides some redundancy within the deployed instrumentation, where should one unit malfunction, the rest within the mooring string will continue to acquire data. In this case, and subject to the importance of the data at that water depth, the mooring may remain in place to continue data acquisition. Point current measurements are also useful if current velocities near to a boundary (e.g. the seabed or sea surface) are required as these areas are restricted in their measurement by acoustic profiling current meters (due to side lobe interference).

3.2.2 Acoustic Releases

Consideration should be made to use type and rating of Acoustic release as well as their configuration (e.g. if duplicated either in "series or in parallel"). Acoustic releases as well as allowing the mooring to detach from the seabed can also act in a location mode.

3.2.3 When are the data required?

3.2.3.1 Real Time

Data required in real time will need the ability to communicate to a shore-station.

This can be done in a number of ways, however the following are most common:

1. Inductive Modem – The deployed instrument (usually bed mounted) is connected to the shore / offshore structure via a communication link which delivers power to the unit and delivers recorded data from the unit. This method is only usually implemented in conditions where the length of cable is kept to a minimum.
2. Acoustic telemetry – The deployed units are linked to an acoustic telemetry beacon, which acts to transmit data from the unit to a receiver station. This receiver station is located at the sea surface (deployed from a buoy or vessel), and subject to depth, may be required to be relayed to avoid data loss via attenuation of the acoustic signal. Where buoys are used as the receiver station, further telemetry is then required via high frequency radio or satellite communications.

Data transmission rates can be relatively low (equivalent of 4800 baud), therefore only summary information or short data packets are normally sent. Redundancy and error checking procedures can result in acceptable transmission confidence.

[2] The depth of water over which current velocities will be averaged.

The selection of the equipment (based on the data required) will most likely determine the most suitable method of telemetering data in real time as each manufacturer operates slightly different methodologies.

3.2.3.2 Post Recovery

Where data are not required until the unit has been recovered, the complexities of data telemetry need not be considered.

3.2.4 How long are the data needed for?

The duration of the intended deployment will then need to be considered in order to ensure that the memory and power capacity of the instrument is suitable for the task, however it is likely that a compromise of data measurement and deployment duration will be implemented to maximise the return of data. If tidal analysis is a scientific deliverable consideration, the length of the deployment should be sufficient to identify the longest tidal constituent required.

3.2.5 Other Measurement Requirements

The instrument mooring used for current velocity measurements may also be used to acquire additional environmental data (using CTD sensors (e.g. Seabird MicroCat), particle size analysers (e.g. Sequoia LISST) and water sampling equipment) which may assist the emergency programme. This information can be used to cross reference with traditional CTD casts, establish the variability in density levels from internal waves or identify the passage of an eddy through the area. Other sensors (e.g. Fluorometers) can also be interfaced to these devices.

Alternatively, a profiling CTD on a mooring or tethered system could be mounted to repeatedly undertake profiles remote from any vessel (e.g. McLane Moored Profiler – MMP). This device can carry a variety of sensors including oxygen, flourometers and current meters and telemeter the information by inductive modem.

Self contained water samplers can also be mounted on the mooring. It should be noted that additional instrumentation may have an impacted on mooring rigidity and should be assessed.

3.3 Other Considerations

3.3.1 Vessel

Mooring design should also give consideration to the capabilities of the likely deployment and recovery vessels.

3.3.2 Biofouling

Biofouling will deteriorate data quality throughout the deployment, therefore suitable protection may need to be considered.

3.3.3 Corrosion

A corrosion management plan should be undertaken in order to reduce losses from the in appropriate use of mixed metals or the use of in-effective anodes. All stainless steel components should be of the same (A4) Standard to inhibit corrosion.

3.3.4 Back-Up Recovery Methods

Consideration should be made for multiple recovery methods if the primary system is lost due to fishing activity, storm damage or mechanical failure. This may include the use of acoustic released surface marker buoys, long ground wires for grapneling and recovery using ROVs.

3.3.5 Acoustic Releases

Whilst it is highly unlikely that the acoustic command codes will be duplicated on other moorings or instrumentation, the make, model and acoustic command codes should be sent to the central control authority. Considerations should be made to mounting acoustic position pinger or surface satellite tracking systems to high value instruments should the mooring be damaged/lost.

3.3.6 Stakeholder Engagement

As a safety zone is likely to be applied in the immediate vicinity of the incident, the mooring does not need to be "trawl proof" but this may not be the case at other locations. In any case, all marine users should be informed through the issuing of warning notices through "Notices to Mariners", Kingfisher warnings and posters at local Fisheries Offices, etc . Subject to the nature of the fishing in the area, it may also be worthwhile to commission a local Fisheries Liaison Officer to manage the required communication on your behalf.

3.4 Typical Design

A potential mooring design for a 2,000m full depth mooring is shown schematically in Figure 2. This involves an upward and downward looking acoustic profiling current meters mounted at approximately 700m along with a downward looking surface mounted acoustic profiling current meter. These are connected using an acoustic modem and onwards using a satellite link.

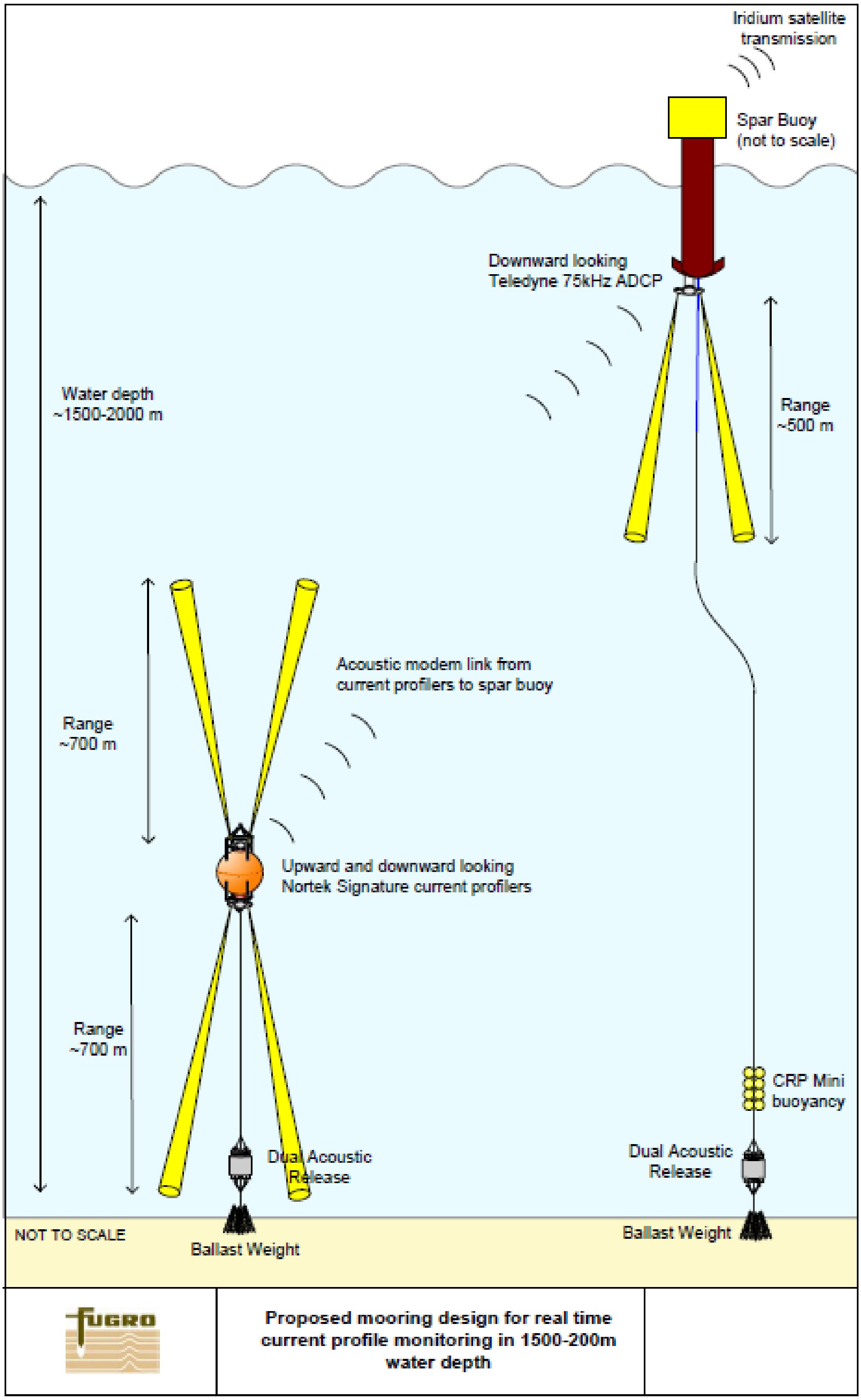

Figure 2 - Schematic mooring design for depths 1500-2000m (Courtesy of Alastair Stagg (Fugro GEOS)).

4 Survey Operations

4.1 Pre-Deployment

4.1.1 Equipment Preparation

It is essential to ensure that instruments are prepared and set-up in accordance with the manufacturer's guidelines. All instruments should also be serviced with appropriate audit material. Moorings should also be prepared using the same (or similar) metals to avoid targeted corrosion. In addition, protection should be put in place in the form of anodes to attract corrosion away from the mooring.

4.1.2 Equipment Testing and Calibration

Instruments should be wet-tested (where possible) to full depth prior to deployment to ensure that water-tight seals are not compromised. If appropriate, scientific instruments should be calibrated before deployment in their mounting brackets e.g. compass calibration. Auxiliary instrumentation such a self recording CTD should be calibrated using the high precision CTD/Rosette taking into account the longer response times of the self contained CTD thermister.

4.1.3 Equipment Set-Up

Prior to instrument set-up, the computer which is used to set-up the instruments should have its time corrected to GMT/UTC. This will then feed into each of the instruments (which typically correct themselves to the computer's clock) and ensures that measurements are concurrent between units.

It is suggested that the survey data recording settings are saved (usually as a standard output – e.g. *.log for Nortek AWACs), both for inclusion within the data package as a form of metadata, and to also provide the survey crew with the ability to check that the input settings are correct.

Following set-up of the instrument with the survey data recording settings, it is recommended that acoustic instrumentation start data collection prior to deployment. By doing so, it is possible to check that the instruments are working prior to deployment through electrical and acoustic interference of an analogue radio [3].

Where instruments are set-up using a communication link which provides mains power to the unit, checking that the instrument is working provides the survey crew with the confidence that the unit's battery power supply has not been compromised.

4.1.4 Lifting Equipment and Certification

All lifting points and lifting equipment (including shackles, wire ropes and slings) should all be visually inspected on a regular basis, in addition to the enforced statutory requirements. Additionally, corroborating certification should be shipped with the mooring as this may be inspected by the vessel's Master prior to use. Absence of this documentation may prevent operations taking place as there will be no evidence to suggest that the equipment is within certification.

[3] Radio should be using long wave or medium wave frequency band with radio tuned to acoustic frequency close to that (or the multiple) of the acoustic instrument. It is essential that the frequency is 'white noise' only when being used for this purpose.

4.2 Vessel Operations

4.2.1 Deployment

Depending on the ships layout and configuration it is normal to build the mooring on the deck and wind onto a “net drum” with insertion points for instruments. This is essential for long or full depth moorings where several kilometres of rope or wire will be used. Shorter and shelf seas moorings can be “flaked out” on the deck and instruments/floatation directly attached.

Once on site, the depth should be confirmed by echosounder with that used in planning using the corrected local speed of sound. It is also good practice to test the acoustic releases at full water depth.

Traditionally, moorings are deployed with the surface (or sub-surface buoyancy) first. For long moorings, scientific instruments are attached to the rope or wire as it is paid away. Finally, the acoustic release and anchor (often scrap chain) is attached to the mooring line. The ship then can gently manoeuvre onto the designated site before releasing the anchor using a slip hook. Other deployment strategies can be used using an acoustic release to lower a seabed frame to the seabed and then releasing (see Figure 3).

It is suggested that one member of the survey team checks over all of the instruments and mooring to ensure that shackles are connected in the correct place, all blanking plugs are in the correct ports on instrumentation, that instruments are switched on and working. To assist this process, it may be worthwhile having a checklist which can be checked off with serial numbers, dates/times and mooring diagram.

Once deployed, the surface marker or spar buoy should be checked to ensure that it is riding correctly with the planned freeboard.

Figure 3 - Preparation to deploy a seabed mounted upward looking Acoustic Current meter.

4.2.2 Post-Deployment Checks

Once deployed only those moorings with real-time communication systems using either acoustic or Inductive modems and satellite transmission will need any actions. Before leaving the site, these systems should be checked.

4.2.3 Recovery

The recovery of a mooring either in shelf seas or deep seas depends largely on the mooring design and if a surface marker has been used.

If a surface marker was used and if present on recovery, normally moorings are recovered (by heaving up on the line attached to the surface marker) using this route. In deep water, the acoustic release will be "fired" (to release the sacrificial anchor) and the mooring hauled aboard.

If no surface marker has been used, the acoustic release is fired and the whole mooring will rise to the surface s (due to the sub-surface buoyancy). During the ascent which may take several hours, the ship should track the position of the acoustic release. On reaching the surface the mooring should be recovered as quickly as possible as wave action can entangle the rope.

Once on deck, scientific instruments should be photographed (see Figure 4), logged and removed from their mounting brackets or frames. After cleaning in fresh water [4], instrument cases can be dried and data downloaded. Once downloaded, data should be copied immediately onto a new data medium as a backup. Care should be taken when opening battery canisters as gases may have been generated during the deployment.

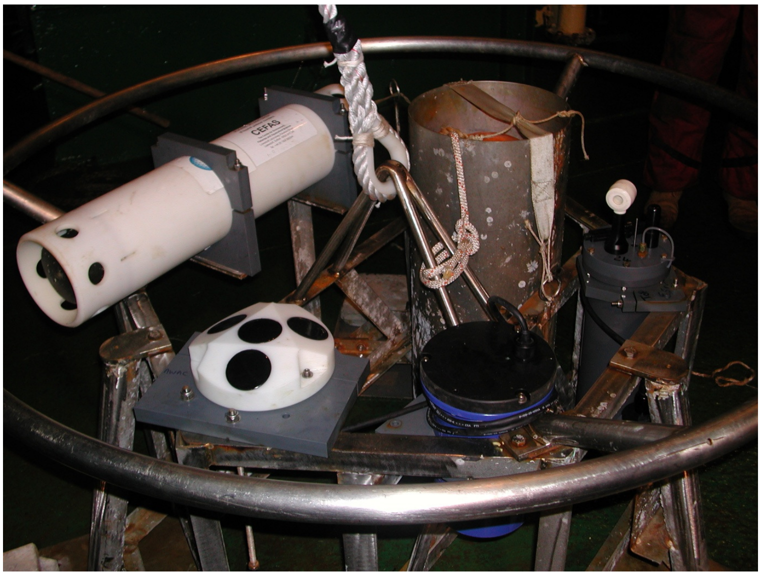

Figure 4 - Seabed frame with Acoustic Current Meter and water quality instruments.

Regardless of the certification in place at the commencement of the deployment, due to the impacts of salt water on the mooring, it should be assumed that any component of the mooring may fail and precautions put in place accordingly.

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[4] Care should be taken to avoid using pressure washers on acoustic transducers as the instruments are not designed to take focussed pressure in this way. Note in some circumstances, a post deployment is required and therefore cleaning should not too thorough around sensor heads.

4.3 Data

4.3.1 Data Analysis and Reporting

Depending on the scientific deliverables, raw data should undergo a quality assessment to identify potential incorrect data points. Further analysis and interpretation of the data may be required to produce products required by the control authority. This may involve harmonic analysis of tidal elevation and current velocity data against a known set of constituent harmonics (with the number of harmonics dependent upon the length of the time series) to reduce data to a known astronomical component and a residual component. Additionally it may involve the identification and characterisation of key physical oceanographic processes (e.g. eddies, internal tides, vertical structure) and interpretation of backscatter profiles for gas bubble or oil droplet plumes.

4.3.2 Data Management

A data management strategy should be implemented during the design stage. This will involve use of standard operation procedures, use of log sheets (either paper or electronic) and data management flow routes. Data standards as well as Meta data standards should be used.

Real-time data should be sent to the appropriate control locations in the format required and the frequency determined by the control authority. All deliverables (including data, log sheets, metadata, etc) should be sent to the appropriate Data Archive Centre (DAC).

5 References

OGP, 2011, HSE guidelines for metocean and Arctic surveys, Report No. 477, International Association of Oil and Gas Producers

Law, R.J., Brant, J.L., Kirby, M.F., Lee, J. Morris, D. and Rees, J. 2014. Guidelines for the environmental monitoring and impact assessment associated with subsea oil releases and dispersant use in UK waters. Science Series Technical Report. Cefas, Lowestoft, 58 pp.

6 Other Publications

In addition to the previously mentioned OGP (2011) publication (also referenced below), the following may provide some additional information regarding metocean surveys and the use of metocean data within the Oil, Petroleum and Natural Gas industries:

- DNV, 2010, Recommended Practice DNV-RP-C205: Environmental Conditions and Environmental Loads, Det Norske Veritas
- ISO 19901-1:2005 Petroleum and natural gas industries – Specific requirements for offshore structures – Part 1: Metocean design and operating considerations.
- NORSOK, 2010, NORSOK Standard N-002: Collection of metocean data, Edition 2 (October 2010), Standards Norway (Norway)
- OGP, 2003, HS&E guidelines for metocean surveys, Report No. 348, International Association of Oil and Gas Producers.

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