100 – Norwegian Oil and Gas Recommended guidelines for assessing remote measurement solutions

PREFACE

These guidelines are recommended by the Norwegian Oil and Gas technical network for environmental risk and oil spill preparedness, and by the Norwegian Oil and Gas committee for the environment. It has also been approved by the director general. The work group has comprised representatives from the following companies:

- Eni Norge AS
- Statoil Petroleum AS
- ExxonMobil Exploration
- Production Norway AS
- E&P Norge AS
- Det Norske Oljeselskap ASA
- Total E&P Norge AS
- ConocoPhillips Skandinavia AS
- A/S Norske Shell
- Wintershall Norge AS
- Talisman Energy Norge AS
- Norwegian Clean Seas Association for Operating Companies (Nofo)
- Hjelmstad AS
- DNV

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These Norwegian Oil and Gas guidelines have been developed with broad participation by interested parties in Norway's petroleum sector, and are owned by that industry represented by Norwegian Oil and Gas. Its administration has been assigned to Norwegian Oil and Gas.

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1 INTRODUCTION

1.1 Purpose

The purpose of this document is to provide guidelines on how to comply with the requirement in section 57 of the activities regulations: "The operator shall establish a remote measuring system that provides sufficient information to ensure that acute pollution from the facility is quickly discovered and mapped so that the amount and spread can be determined." Information from the remote measurement system must be sufficient to ensure that the correct measures are taken. The requirement is also specified in section 48 of the framework regulations. The duty to take action is based on section 4.1 of the Petroleum Activities Act.

Generally speaking, the HSE regulations express an expectation that the operators will draw up a plan for continuous (daily) remote measurement of their facilities based on a risk analysis focusing on environmental aspects. The remote measurement plan can be included in the operator's emergency preparedness plan for dealing with acute pollution, or be a stand-alone document.

These guidelines are intended to provide advice on how the performance standards in the remote measurement system can be defined and how operators on the Norwegian continental shelf (NCS) can establish remote measurement systems which function satisfactorily in relation to the environmental risk posed by their activities.

1.2 Terminology

1.2.1 Remote measurement

The term "remote measurement" refers most frequently in other contexts to the acquisition of information from surfaces or objects without physical contact between the measuring instrument and the object. In Norway's HSE regulations, it refers to systems which can <u>detect</u> and <u>map</u> the position, extent, quantity and properties of acute pollution regardless of visibility, light and weather conditions. The term in this context also includes such aspects as visual observations by dedicated personnel and instruments installed on subsea installations which must be in contact with the oil before a discharge is discovered. For further details, see the guidelines to section 57 of the activities regulations.

This system must provide the earliest possible detection of a discharge as well as the ability to map its position, extent, quantity and pollution properties. The purpose of remote measurement is to ensure that information about the pollution is sufficient for the appropriate measures to be initiated in time to halt, limit, map and if necessary combat the pollution.

1.2.2 Dimensioning discharge incidents for remote measurement

The guidelines to section 57 of the activities regulations note that the remote measurement plan should be based on a risk analysis focusing on environmental aspects. Identifying possible discharge incidents from the facility is one of the preparatory stages for an environmental risk analysis (guidelines to section 17 of the management regulations). This can be done, for example, with the aid of hazard identification (Hazid) or environmental impact identification (Envid). Environment-focused risk and emergency preparedness analyses often concentrate on major incidents. While these large acute discharges can easily be detected visually or by process monitoring equipment on the facilities, however, the remote measurement system must also pick up minor acute discharges and leaks. The latter are the incidents which require continuous remote measurement to be detected. They will accordingly be dimensioning for the detection of acute discharges. Determining dimensioning incidents as the basis for assessing performance requirements for the remote measurement system accordingly forms one of the steps in the assessment (see chapter 3.1.5).

1.2.3 Vulnerable environmental resources and habitat types

The drift time from the start of an acute discharge until it affects a vulnerable natural resource will determine how much time is available before relevant measures must be implemented. Vulnerability is defined in the comprehensive management plan as the ability of a species or a habitat type to maintain its natural condition in relation to external, often human-created, influences. Vulnerability is assessed on the basis of the effects which different influences may have on the development and survival of the species and population.

The relevant influence here is the acute discharge of crude oil and condensate to the sea surface or from subsea facilities. Vulnerable natural resources in this context related primarily to the sea surface, and include seabirds and marine mammals as well as a number of shorelines. Aquatic resources such as plankton, roe and fish larvae have often demonstrated lower vulnerability to oil pollution. Whether they are nevertheless affected depends on the duration and scope of the discharge.

No updated prioritisation of environmental resources in relation to acute oil discharges exists today. However, resources vulnerable to oil discharges have a high density close to shore, as shown in Norway's model for environmental priorities (MOB). Drift time to land has accordingly been selected as the criterion for the proposed performance standards related to remote measurement (table 1).

1.2.4 Significant pollution

Acute discharges must be notified or reported to the Petroleum Safety Authority Norway (section 29 of the management regulations). The guidelines to this section specify that the PSA must be notified immediately of discharges which could be significant for the environment, while discharges of a less serious or acute character have to be reported in writing by the operator on the first working day after the

incident occurred or was discovered. Significant pollution is described in section 34 of the management regulations as “pollution which entails or can entail damage or nuisance for the
environment beyond the purely minor. Whether or not the pollution is of significance, shall be assessed in each individual case.” The purpose of the Pollution Control Act is in part (section 1) to prevent damage to the productivity of the natural environment and its capacity for self-renewal. The proposals for performance standards outlined in table 1 (chapter 3.2.1) reflect to a great extent a precautionary principle approach to the probability of this type of damage to the natural environment.

The guidelines to section 20 of the management regulations specify some recommended levels for notifying or reporting accidental discharges. Where liquid hydrocarbons are concerned, all discharges larger than one cubic metre must be notified, while those between 10 litres and one cubic metre are to be reported. To meet the government’s requirements, it is important to have clear and secure systems which make it possible to demonstrate that relevant discharges are actually notified or reported.

However, significant differences in environmental consequences will exist between a one-cubic-metre discharge of liquid hydrocarbons which occurs abruptly to the sea surface and a corresponding volume which leaks out over a long period from a subsea facility. When proposing performance standards for the detection system (table 1, chapter 3.2.1), the discharge rate is accordingly used as an important basis for differentiating the requirements.

1.3 Definitions and abbreviations

Definitions

Acute pollution	“Acute pollution means significant pollution that occurs suddenly and that is not permitted in accordance with provisions set out in or issued pursuant to this Act.” (section 38, Pollution Control Act.
Gap analysis	This type of analysis studies the gap between the present position and the desirable condition.
HSE regulations	These include the framework, management, facilities, activities, and technical and operational regulations.
Facilities	Installations, plants and other equipment for the petroleum industry, but excluding supply and support ships or vessels carrying petroleum in bulk. Facilities also include pipelines and cables unless otherwise specified.
Monitoring	Monitoring means tools and methods which can provide detailed information during an incident about its combatability, origin, degradation, oil budget, transport and spreading, as well as the impact of the pollution on environmentally vulnerable resources.

Operator	The company which conducts the day-to-day management of petroleum operations on behalf of the licensees.

Abbreviations

Alarp	The principle that risk should be "as low as reasonably practicable".
BAT	Best available technique for a specific purpose.
Envid	Environmental impact identification. This process can be implemented in the same way as Hazid, but its purpose is to identify environmental challenges.
Hazid	Hazard identification study. Process which involves identifying hazards or risks.
MOB	Model for prioritising environmental resources in the event of acute oil pollution along the Norwegian coast. Norwegian Environment Agency: TA 1765/2000. In Norwegian only.
Nofo	Norwegian Clean Seas Association for Operating Companies.
PSA	Petroleum Safety Authority Norway.

1.4 References

a. Petroleum Activities Act. Act of 29 November 1996 No 72 Relating to Petroleum Activities.
b. Pollution Control Act. Act of 13 March 1981 No 6 Concerning Protection Against Pollution and Concerning Waste.
c. Activities regulations. Regulations relating to conducting petroleum activities.
d. Guidelines to the activities regulations.
e. Framework regulations. Regulations relating to health, safety and the environment in the petroleum activities and at certain onshore facilities.
f. Guidelines to the framework regulations.
g. Norwegian Oil and Gas Recommended guidelines for establishing area emergency preparedness (guidelines no 64 - in Norwegian only).
h. Norwegian Environment Agency, 2011. Guidelines for applications concerning offshore petroleum activities.
i. DNV 2010. Recommended practice. Selection and use of subsea leak detection systems. DNV-RP-F302.

2 SPECIFICATION OF CHANGES

From 15 June 2013, changes have been made to every chapter, and all the appendices have been replaced with new ones.

3 METHOD FOR CHOOSING AND EVALUATING REMOTE MEASUREMENT SYSTEMS

3.1 Background

The purpose of evaluating and choosing remote measurement systems is to ensure that significant acute oil pollution from the enterprise's own operations is detected, mapped, assessed and notified so that the necessary measures can be initiated.

The process for evaluating and choosing a remote measurement system is illustrated below. Its steps are described in greater detail in the sections of this chapter.

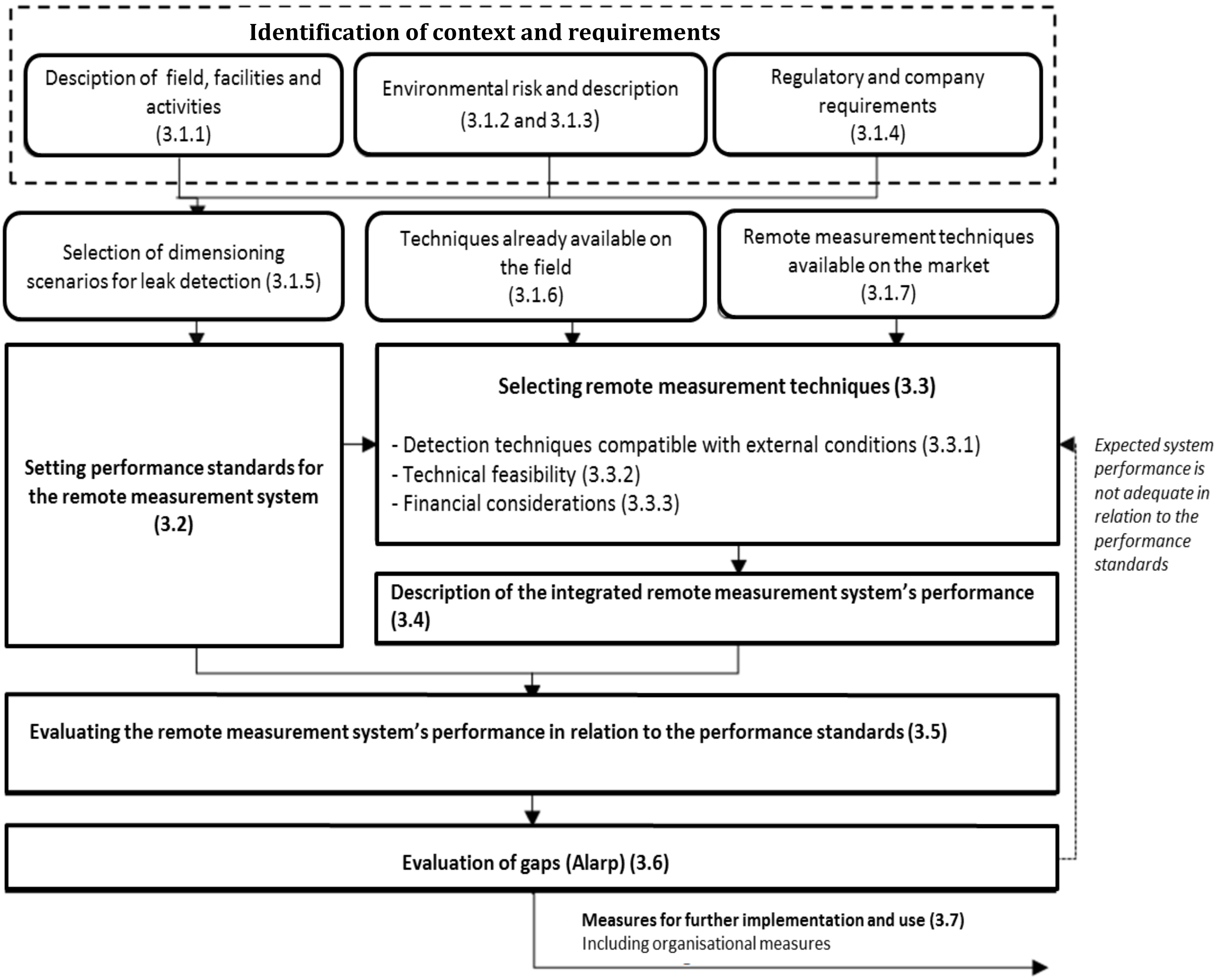

Figure 1: Process for assessing remote measurement techniques. Figures in brackets refer to the sections in this chapter of the guidelines.

3.1.1 Description of field, facilities and activities

The first stage in the process is a description of the field, its facilities and activities there. A field with only subsea installations, for example, will often have other requirements for technology than one with staffed facilities. This will be reflected both in the performance standards and in the relevant remote measurement techniques. In addition, the properties of the hydrocarbons (spreading, evaporation, mixing in the water column, viscosity, etc) may set limits for the technologies which can be applied effectively.

3.1.2 Environmental risk

Remote measurement must take account of the enterprise's environmental risk (section bib of the activities regulations). The environmental risk analysis can indicate the factors which need to be taken into account both for assessing relevant remote measurement techniques and for determining performance standards. It should therefore describe which environmental resources exist near the field, their vulnerability, and expected drift time from the field to the resources.

3.1.3 Environmental description

Descriptions of the natural conditions which might influence the ability to conduct remote measurement should be included in the assessment of the various techniques. This includes:

- Wave heights
- Visibility
- Wind
- Light conditions
- Ocean currents
- Precipitation
- Relevant and if possible verifiable statistics and distribution functions for various parameters should be included in this description, since they are critical for assessing the total probability of detection and the rate of false alarms for the various remote measurement solutions.

Subsea facilities incorporating remote measurement solutions, including process instrumentation and in-situ sensors, should have a corresponding environmental description incorporating the parameters which influence sensor performance and operating life.

3.1.4 Regulatory and company requirements

The most relevant regulatory requirements are enshrined in the Petroleum Activities and Pollution Control Acts, in addition to the HSE regulations enforced by the PSA. In connection with discharge permits, the Norwegian Environment Agency also imposes individual detection requirements which exceed regulatory provisions. See 1.4.

Most operator companies have internal procedures, guidelines and strategies which must be observed. These will represent important inputs when defining remote measurement criteria.

3.1.5 Selection of dimensioning incidents for detecting acute discharges

Continuous remote measurement should be able to detect any significant discharge. The potential for acute oil pollution is identified through environmental risk and emergency preparedness analyses, but these concentrate by and large on major incidents. While such large acute discharges can easily be detected visually or by process monitoring equipment on the facilities, picking up minor acute discharges and leaks will often depend on continuous remote measurement. As a result, the latter will often be dimensioning incidents for the detection of acute discharges. This is particularly critical in those cases where small discharges can be expected to develop into major incidents.
Several methods can be used to assess discharge incidents and their criticality for remote measurement. A process for choosing dimensioning incidents can be built up step by step:

a. Scenarios taken from environmental risk and emergency preparedness analyses, and from defined hazard and accident conditions (DFUs)
b. Quantitative information on potential discharges based on statistics and incident databases
c. Further mapping of potential discharges – with the aid of Hazid or Envid processes, for example.

A certain number of potential incidents can be chosen on the basis of these three points. They should be based on the probability of acute discharges as well as on the type of discharge which should be detectable with the aid of the leak detection system. These will be dimensioning discharge incidents for the detection of acute discharges. Location, rate, duration and medium should be specified for each of these incidents.

An evaluation should result in a description of the most relevant discharge incidents. The dimensioning incidents for remote measurement must be described. A description should also be included of the oil's properties (terminal oil thickness, colour, etc) and their associated significance for remote measurement. Weathering studies and/or oil drift modelling should indicate how a discharge will develop. Ability to detect and thereby the choice of remote monitoring technology will be affected if oil drift modelling shows that the oil will occur in separate slicks and/or form very thin films.

3.1.6 Techniques already available on the field

Several techniques are available for detecting large acute discharges from facilities on the NCS. Existing manual and automated solutions should be assessed as part of a total system, since these might form the basis for cost-effective detection of large discharges. They could include, for example, inspection routines, satellite monitoring organised through Nofo or as purchased services, aerial monitoring, level, pressure, flow and density measurements, and possibly hydrocarbon sensors.

3.1.7 Remote measurement techniques available on the market

Relevant remote measurement techniques which could be appropriate for the relevant facility must be described. The most usual solutions are described in the appendices to these guidelines (appendices 1 and 2). In addition, supplier specifications and DNV's recommended practice (DNV-RP-F302) could be relevant sources.

3.2 Setting performance requirements for the remote measurement system

The purpose of remote measurement solutions is to ensure that established system exist for detecting significant acute discharges within an acceptable time frame, and that satisfactory expertise and methods are available for determining the position, extent, quantity and combatability of discharges.

Performance requirements for detection can be determined from an assessment of the distance to vulnerable resources, oil properties and discharge volume (rate and duration).

3.2.1 Performance standards – rates and detection time

Performance standards for rates and detection time should be stricter for facilities close to vulnerable resources and for activities which represent an enhanced probability of incidents which could cause acute discharges. This normally means that standards for remote measurement should be stricter for production facilities, wells, risers, loading systems and so forth than for pipelines.

The figures in the tables are intended to serve as proposed performance standards for elements associated with an enhanced risk of acute discharges offered by a field development solution. Other performance standards can be proposed for components with a substantially lower risk, such as transport pipelines and in-field flowlines.

Efforts have been made to classify rates in the tables below at levels which provide a high probability that substantial environmental risk can be avoided (precautionary principle approach). It is up to the operators to set their own standards and adapt these to the external factors underlying the requirements.

Table 1: Proposed performance standards for detecting acute discharges from surface installations. Some indicative detection times and quantities for various remote measurement techniques are described in appendix 1.

Oil	**Shortest drift time to land (95 percentile)***	
	< 72 hours	**> 72 hours**
< 10 litres/hour	ROV/inspections	
0.01–1 cu.m/hour	4 weeks	4 weeks
1-10 cu.m/hour	24 hours	72 hours
10 cu.m – 10%/hour	3 hours	24 hours
> 10% of flow**	< 1 hour	< 1 hour

* Drift time found by modelling oil drift in connection with environmental risk and emergency preparedness analyses.
** Volume through the system/time.

Corresponding performance standards should also be prepared for subsea facilities. These should build on principles equivalent to those for surface facilities. This means that detection times should be shorter for facilities close to land, for relatively large leaks and for facilities with a higher risk of leaks. Since external conditions have an insignificant effect on seabed sensors, other assumptions may be applicable when setting the standards. In addition, substantial challenges will be presented in retrofitting sensors to existing subsea installations. It could therefore be appropriate that the operator's performance standards are more exact for new subsea facilities than for existing installations.

3.2.2 Performance standards for characterising acute discharges

When discharges are detected, they must be characterised in terms of position, extent, volume and combatability. This calls for an organisation, expertise and a system for continuous handling of remote measurement information. The various estimated volumes must be related to routines for notification and the scope of measures.

3.3 Selection of remote measurement techniques

A number of factors influence the selection process. Some of the most relevant are presented below. This part of the evaluation can be based on a framework corresponding to a BAT analysis.

3.3.1 Detection techniques compatible with external conditions

A selection process must be conducted to take account of external factors which influence the choice of techniques. This will be related to environmental risk in the area and environmental conditions (weather, light, visibility and so forth) which can affect the performance of the various techniques. The properties of the various remote measurement technologies are presented in the appendices to these guidelines.

3.3.2 Technical feasibility

A number of considerations must be taken into account when selecting different sensors and techniques. Evaluating technical feasibility will identify the basic requirements for applying the technique. While some techniques require relatively substantial adaptations for such aspects as technical integration, operational commitment and maintenance, others can be implemented without excessive modifications or adaptations. The maturity and availability of the techniques are other factors which should be assessed.

3.3.3 Financial considerations

Cost will be a factor which influences the choice of remote measurement techniques, and both installation and operating costs should be taken into account. In addition to the capital costs associated with the techniques, this will include an on-going evaluation of remote measurement data and the follow-up of signatures/indications which could be caused by acute pollution. Different techniques will also call for a different degree of commitment in terms of personnel time and training. Cost will also be a relevant consideration when evaluating system performance.

3.4 Description of the integrated remote measurement system's performance

Once a combination of techniques has been chosen, it is important that the individual components as well as the total system are described. The purpose of this description is both to provide a basis for further assessment of the system's performance (3.5) and an evaluation of possible gaps (3.6). In addition, the description can provide a basis for the engineering process and dialogue with suppliers. It should first present an overall system solution and assembly, and the need for a detailed presentation should then be considered. A typical detailed description will provide a functional outline of the whole system and sub-systems, and then a technical specification with the required and desired level of detail. This technical description should incorporate performance parameters, the chosen implementation and other relevant considerations. Because this represents an integrated remote measurement system, efforts should be made to describe how the components fit together, what types of data are exchanged and how that information is integrated. Since the remote measurement system will include human use and response, it is important that this aspect is included in the description.

3.5 Evaluating the remote measurement system's performance in relation to the performance requirements

The purpose of evaluating the system's performance is to identify whether acute discharges exist which are not being picked up under certain conditions. This includes evaluating conditions which could mean that system performance is undermined by operational and/or external factors. A number of methods can be used for such an evaluation, including gap analyses where the system's performance is assessed in relation to the standards set.

Evaluating estimated detection times and methods for the defined discharge incidents makes it possible to identify incidents which are unlikely to be detected and mapped quickly enough. Table 2 presents an example of an evaluation form. The expected detection times for the relevant type of discharge incident under the conditions described (weather, light, visibility) can be entered in the columns headed "techniques". The shortest detection time and the techniques which achieve this time are entered in the columns on the right. This detection time must then be compared with the performance standards described earlier, and could lead to the discovery of a gap.

This evaluation must be conducted for each of the dimensioning incidents for detection of acute discharges.

Table 2: *Proposed table for evaluating the detection system with individual incidents. One table is required per incident.*

Discharge incident (location, rate, duration, oil type)			**Techniques**				
			Technique A	Technique B	Technique C	Shortest detection time	Technique used
	Weather (wind)	0-3 m/s					
		4-8 m/s					
		8-12 m/s					
		> 12 m/s					
	Light	Light					
		Dusk					
		Dark					
	Visibility	Clear					
		Fog					
		Precipitation					

3.6 Evaluating gaps

Possible gaps identified must be evaluated. Key issues include:

- Probability of the incident: how often is this type of acute discharge expected to occur?
- Performance of the detection system: under which conditions will the system fail to detect the defined discharge incidents and how frequently (specified as a percentage or as the number of hours per year) are these conditions present?
- Environmental consequences: what consequences will the defined discharge incidents have, and are the consequences of reduced performance for a limited period acceptable?
- Costs: what will it cost to close the gap?

An Alarp analysis is used to assess estimated costs against the anticipated gain. In some cases, the gap could be closed by special measures for a limited period – systematic patrolling by vessel(s), for example. Should substantial gaps exist, and measures available for a limited period are insufficient to meet the performance requirement, the selected techniques must be re-evaluated and supplemented with additional techniques.

3.7 Organisational measures

Routines for detecting, evaluating, notifying and reporting form an integrated part of the remote measurement system. Along with associated expertise, these routines ensure that the remote monitoring system's performance is continuously present and verified. Sensor systems with opportunities for fully automated detection and reporting will always have limitations. So manual routines play an important role in the remote measurement system.

Adequate education in using the system and detection procedures must be provided for relevant personnel. This includes learning how the system functions, its limitations and its possibilities. In addition, inspection procedures and fixed routines can increase the ability to detect when the performance of other techniques is reduced. That could include, for example, more inspection rounds when weather conditions do not permit radar detection. Special routines could be appropriate under low-visibility conditions or with operations which involve an increased risk of acute discharges.

The ability to detect must be balanced against a relatively low incidence of false alarms. These factors are often mutually incompatible, and a specific assessment of where the balance is to lie should be carried out. The starting point should be that the system is set up with a low threshold for detection/alarm and with adequate resources for manual follow-up. When sufficient experience with the system has been achieved, the threshold for detection can be adjusted to reduce the number of false detections/alarms.

All sensor systems are dependent on supervision and maintenance. The consequences of faults and shutdowns for repair must be taken into account when planning remote management procedures.

Fixed procedures must be established for dealing with detections/signatures which could be caused by acute oil pollution. This will be a critical factor with genuine discharges. Good reporting of false alarms will help in adjusting the system's sensitivity and the need for manual follow-up. In addition, good information and documentation will contribute to continued development of remote measurement techniques and systems.

4 REMOTE MEASUREMENT PLAN

A remote measurement system is the sum of organisational and technical measures initiated to detect and map an acute discharge. The purpose of the remote measurement plan is to describe the system and the routines for detecting and mapping the scope of acute pollution so that the incident can be notified and emergency response mobilised.

The remote measurement plan is intended to document the methods used for this purpose in the relevant area, how remote measurement data are acquired, distributed, evaluated and followed up. Remote measurement systems on fields and facilities close to each other should also be included if this is relevant for the area.

Clear information should also be provided about possible gaps which might still exist, and what measures can be implemented for a limited period in the event of external conditions which could undermine the system's performance. If these measures are due to be taken in the future, a timetable should also be attached.

4.1 Interface with remote measurement during oil spill clean-ups

Remote measurement during an oil-spill clean-up involving collection or the use of dispersants should be dealt with in the operational part of the emergency response plan. Nofo has developed routines for remote measurement during clean-ups, and the person responsible for petroleum activities can refer to these in their plans. In that way, the discussion of remote measurement during oil-spill clean-ups can be limited to the organisation and handling of remote measurement information.

4.1.1 Proposed structure of a remote measurement plan

An example of a remote measurement plan, or the remote measurement chapter in an emergency response plan, is provided below.

OPERATIONAL PART

- Description of the remote measurement system
- Requirements for and maintenance of expertise
- Organisation of remote measurement
- Routines for detecting acute pollution
- Mapping the scope of the pollution
- Notification and mobilisation of emergency response resources
- Remote measurement during clean-up operations (own and Nofo's routines)

INFORMATION WHICH SUPPORTS REMOTE MEASUREMENT

- Oil properties
- Duration
- Dispersability
- Terminal oil thickness
- Discharge conditions, drift and spreading
- discharge conditions
- oil drift
- spreading
- Assessment of film thickness, volume and oil properties
- visual assessment of oil volume – appearance code
- interpretation of information from remote measurement sensors
- oil's visual impression – colour
- Sampling