

Remotely operated vehicle (ROV) services

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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 Subject to development and publication of international standards, the relevant NORSOK standard will be withdrawn.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

This NORSOK standard is a consequence of an industry wide effort to make a NORSOK standard for remote operated vehicles (ROV) services.

This NORSOK standard has been produced to establish a single common standard for ROV operations. Users of this standard will typically be Companies involved in oil and gas production, and the renewable energy industry. Relevant information and requirements included in this standard may also be used for other services which have similarities to the ROVs and the way they are operated. These other services can include autonomous underwater vehicles (AUVs), remotely operated tool (ROT), remotely operated towed vehicle (ROTV) and dredging machines operating with similar technology to ROVs. This edition has therefore excluded specific sections related to trenchers and AUVs.

This NORSOK standard has focus on typical requirements, deliveries and documentation expected between Companies and Contractors.

1 Scope

This NORSOK standard defines basic requirements for personnel, equipment and systems for ROV operations related to the petroleum industry.

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

IMCA R 015,	Code of practice for the safe use of electricity underwater
IMCA R 005,	High Voltage Equipment - Safety procedures for working on ROVs
ISO 9001:2008	Quality management systems - Requirements
+ Cor 1:2009,	
ISO 13628-1,	Petroleum and natural gas industries - Design and operation of subsea production systems - Part 1: General requirements and recommendations
NORSOK U-100,	Manned underwater operations

2.2 Informative references

ISO 13628-8,	Petroleum and natural gas industries -- Design and operation of subsea production systems -- Part 8: Remotely Operated Vehicle (ROV) interfaces on subsea production systems
NORSOK R-003,	Safe use of lifting equipment.

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

can

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

3.1.2

client

purchaser of ROV services

3.1.3

contractor

the same as contractor group

3.1.4

contractor group

contractor, his affiliated companies participating in the work, his subcontractors and their contractors and subcontractors, participating companies in a joint venture established for the performance of the work, and the employees of the aforementioned companies

3.1.5

high voltage

voltage values above 999 V

3.1.6

lifting appliances

any part of load bearing equipment used in conjunction with ROV systems equipment for lifting/handling

3.1.7**may**

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

3.1.8**remotely operated vehicle****ROV**

common term for ROV, AUV, UUV/UUUV and similar equipment, where ROV is equipment used in water with an ability to observe the surroundings and positioning itself remote controlled from the surface through a cable

NOTE AUV is equipment used in water with an ability to positioning itself without interference from surface control. UUV/UUUV is equipment used in water with an ability to positioning itself without cable to the surface.

3.1.9**ROV system**

system which comprises the ROV, the handling system, the surface control system and all associated equipment

3.1.10**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

3.1.11**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

3.2 Abbreviations

AUV	autonomous underwater vehicle
CP	cathodic protection
DVD	digital versatile disc
GA	general arrangement
HD	high definition
HES	health, environment and safety
HSE	health safety environment
IMCA	The International Marine Contractors Association
LARS	launch and recovery system
LP	low pressure
PA	public announcement
ROV	remotely operated vehicle
RS	recommended standard
SWL	safe working load
TMS	tether management system
UUV	unmanned underwater vehicle
UUUV	unmanned untethered underwater vehicle
VAC	volt alternating current

4 Remotely operated vehicle (ROV) classification**4.1 Class I – Pure observation**

Pure observation vehicles are physically limited to video observation. Generally they are small vehicles fitted with video camera, lights and thrusters. They cannot undertake any other task without considerable modification.

4.2 Class II – Observation with payload option

Class II A – Observation class vehicles with payload option

Vehicles capable of carrying additional sensors such as still colour cameras, cathodic protection measurement systems, additional video cameras and sonar systems. Class II A vehicles should be capable of operating without loss of original function while carrying at least two additional sensors.

Class II B – Observation class vehicles with light intervention, survey and construction capabilities

Vehicles capable of carrying additional sensors such as still colour cameras, cathodic protection measurement systems, additional video cameras and sonar systems. Class II B vehicles should be capable of operating without loss of original function while carrying at least two additional sensors. Class II B is also capable of carrying light working manipulators and tooling kits. The vehicle is able to perform light construction, intervention, and survey tasks.

4.3 Class III – Work class vehicles

Vehicles large enough to carry additional sensors and tooling, through frame lift capability and full size manipulators. Class III vehicles commonly have a multiplexing capability that allows additional sensors and tools to operate without being “hardwired” through the umbilical system.

Class III A – Work class vehicles typical < 100 kW.

A compact ROV with typical capability up to 2000 kg through frame lift, pay load up to 200 kg.

Class III B – Work class vehicles typical >100 kW

A larger ROV with typical capability more than 2000 kg through frame lift, pay load more than 200 kg,

5 Administrative requirements

5.1 General

Contractor shall establish and maintain a quality management system in accordance with ISO 9001:2008.

Contractor shall utilise the system to continuously search for improvements to its processes both with respect to equipment and personnel. No activities shall start unless covered by appropriate procedures, plans or checklists. Furthermore, contractors shall establish and maintain matrixes for simple review by client e.g.:

- compliance to relevant regulations and standards;
- compliance to project specifications;
- compliance to personnel qualifications.

Contractor shall evaluate items of non-compliance. Qualified alternative solutions may be suggested. Contractor shall forward non-compliances to client for acceptance.

5.2 Documentation

Contractor shall establish necessary routines to document that the quality system meets the requirements outlined in ISO 9001:2008. The documentation requirements shall aim at collecting data to ensure that quality standards and client requirements are met.

As a minimum, the contractor shall define, document and make available prior to mobilisation, the following:

- mobilisation plan;
- list of services required from work-site;
- structured plan for system acceptance test;
- procedure for normal and emergency operation of the equipment;
- procedure for maintenance of all equipment under the services;
- minimum list for spare parts;

- personnel competency matrix for allocated personnel.

5.3 Document availability

As a minimum, contractor shall ensure availability of updated editions of the following documents on the work site:

- contractors project quality assurance (QA) manual/plan;
- contractors HES plan for the work-site;
- contractors operational manuals, pertaining to relevant contract;
- contractors contingency plan for the relevant contract, interfaced with clients plan for the relevant area;
- procedures for all activities pertaining to the relevant contract;
- relevant risk analysis;
- log to document operational activities;
- maintenance programmes and records for last 12 months.

5.4 Responsibilities and authorities

An organogram shall be produced to outline reporting lines at the work-site and in the onshore organisation. Interfaces towards other work-site teams, i.e. marine crew on a vessel, shall be described.

Job descriptions shall be made for relevant onshore project personnel and for ROV personnel, detailing responsibilities and authorities.

5.5 Maintenance system

5.5.1 General

A system for preventive maintenance shall be established, covering critical components comprising the ROV system. Historical data shall be logged to collect operational experience on critical components in order to ensure continuous improvements.

The maintenance program shall be based on manufacturer's recommendations and/or own experience. Test conditions and intervals for components and the facility in general, shall be specified. At regular intervals, Contractor shall review the maintenance system in order to meet the requirements in ISO 9001:2008.

All maintenance shall be performed according to the maintenance plan and recorded. Last year's maintenance records for the components comprising the system shall be available onboard.

As a part of the maintenance system, contractor shall establish and maintain an inventory and equipment database. This database shall clearly define the minimum spare parts required for the system. The spare part list shall be defined based on failure mode and effect analysis and/or operational experience. The stock level shall be sufficient to support the system for minimum 30 days of normal operation.

The maintenance program shall include a system for updating of certificates, covering all ROV related equipment, systems and machinery.

5.5.2 Time for maintenance

5.5.2.1 General

Contracts shall specify time allowed for scheduled maintenance and the maintenance intervals as required by the maintenance program relevant for the specific system and the type of activity at hand.

Contracts shall further define the functionality requirement relevant for the system as given in 5.5.2.2 to 5.5.2.4.

5.5.2.2 ROV system available on request

Maintenance and change outs to be agreed between client and ROV supplier at times convenient with respect to the activity.

5.5.2.3 ROV system in water at all times minus maintenance intervals

Maintenance and change outs to be performed in accordance with agreed intervals and time allowances.

5.5.2.4 ROV system in water 24 h per day

Requires back-up system at site. The status of the back-up system is irrelevant as long as it is ready when needed for change out with main system.

Downtime in excess of what is allowed and agreed (see above) shall be considered as breakdown.

5.6 Reporting

5.6.1 General

Contractors reporting of ROV operations shall be structured to provide the client with data to meet both regulatory and administration requirements in addition to internal requirements. The level of reporting requirements above standard shall be described in scope of work.

5.6.2 Contractors reporting responsibilities

5.6.2.1 Daily report

A report with a brief summary of the last 24 h events to be handed over to the client representative the following day, or according to the contract, and should be signed by both parts.

Daily report should as a minimum include the following:

- date/reference to contract no/job no;
- name of installation/vessel;
- name of personnel performing the work;
- arrival/departure of personnel;
- time tagged activities and description of same;
- time table giving summary of hours in water, hours on standby, hours of maintenance and breakdown;
- list of additional equipment;
- total working hours and reimbursable overtime;
- a plan for the next 24 h.

5.6.2.2 Video log

During execution of the work, the crew shall make a video log for all recorded work. The log shall track all significant issues and have real time reference. The original log shall follow the video recording and be handed over to client as described in the scope of work.

As a minimum, the video log shall contend the following:

- date of recording reference to contract no/job no;
- name of support vessel;
- reference to daily log and dive log;
- real time reference to the recording;
- description of recorded event;
- reference to first hand report on special events.

5.6.2.3 First hand report

The ROV crew shall prepare first hand reports on special events as requested by client. These reports shall have a detailed description of the event, including sketches with possible measurements and supported by video recordings or pictures.

5.6.2.4 Maintenance report

Maintenance work performed shall be reported according to the established maintenance program. A copy of this report shall be made available to the client on request.

5.6.2.5 Equipment failure

Contractor shall have an established system for registration of equipment failures. This system shall meet the requirements in ISO 9001:2008.

5.6.2.6 Reporting of undesired events

Contractor shall have a system for reporting of undesired events such as accidents, non-conformances and near-accidents with potential for damage to personnel and/or equipment. The system shall meet requirements in relevant legislation and industry standards.

5.6.2.7 Experience reporting

By the turn of the year or 30 days after the operation, the contractor should produce an experience report that evaluates the operation, procedures and equipment used.

6 Personnel qualification requirements**6.1 General**

This clause addresses the personnel and crew requirements. The personnel operating ROV systems require training in a wide range of specialised fields.

The requirements below are set out to ensure that the operations are executed in a safe and efficient manner.

The personnel qualification requirements will be specified

- as crew qualification requirements,
- as qualification requirements for the individual positions.

6.2 Crew requirements**6.2.1 Manning level**

The system manning level shall be based on the planned tasks and duties that are required to perform the work.

The manning levels for basic ROV operations are as follows:

	12 h	24 h
Class I system	2	4
Class II system	2	4
Class III systems	3	6

Furthermore, job specific requirements may demand additional crew members due to

- requirements for maintenance and repair of additional tooling packages,
- specialised personnel for operating temporary sensors and equipment,
- overall offshore management of ROV operations,
- maintenance of eventual stand-by systems.

Sufficient, qualified personnel shall be allocated for scheduled maintenance work that shall take place outside the operational team's normal working hours.

6.2.2 Crew qualification requirements

The ROV crew in general shall as a minimum be able to maintain and operate the system. When planning for a specific project, the overall crew competence should be obtained by proper planning and training.

6.3 Remotely operated vehicle (ROV) personnel requirements

6.3.1 General requirements

Due to the nature and complexity of ROV systems, the personnel operating and maintaining these systems require a broad based training to understand the various parts of the systems.

The skill FU Operatør - Operatør fjernstyrte undervannsoperasjoner (remote underwater operations) is a formal education leading to the ROV pilot technician level in the ROV industry.

Alternative recruitment can be made from the following disciplines:

- electronics;
- automations;
- remote systems;
- hydraulics;
- electric.

6.3.2 Personnel requirements - High voltage ROV system

The majority of ROV systems have a power distribution system that operates with voltage above 999 V.

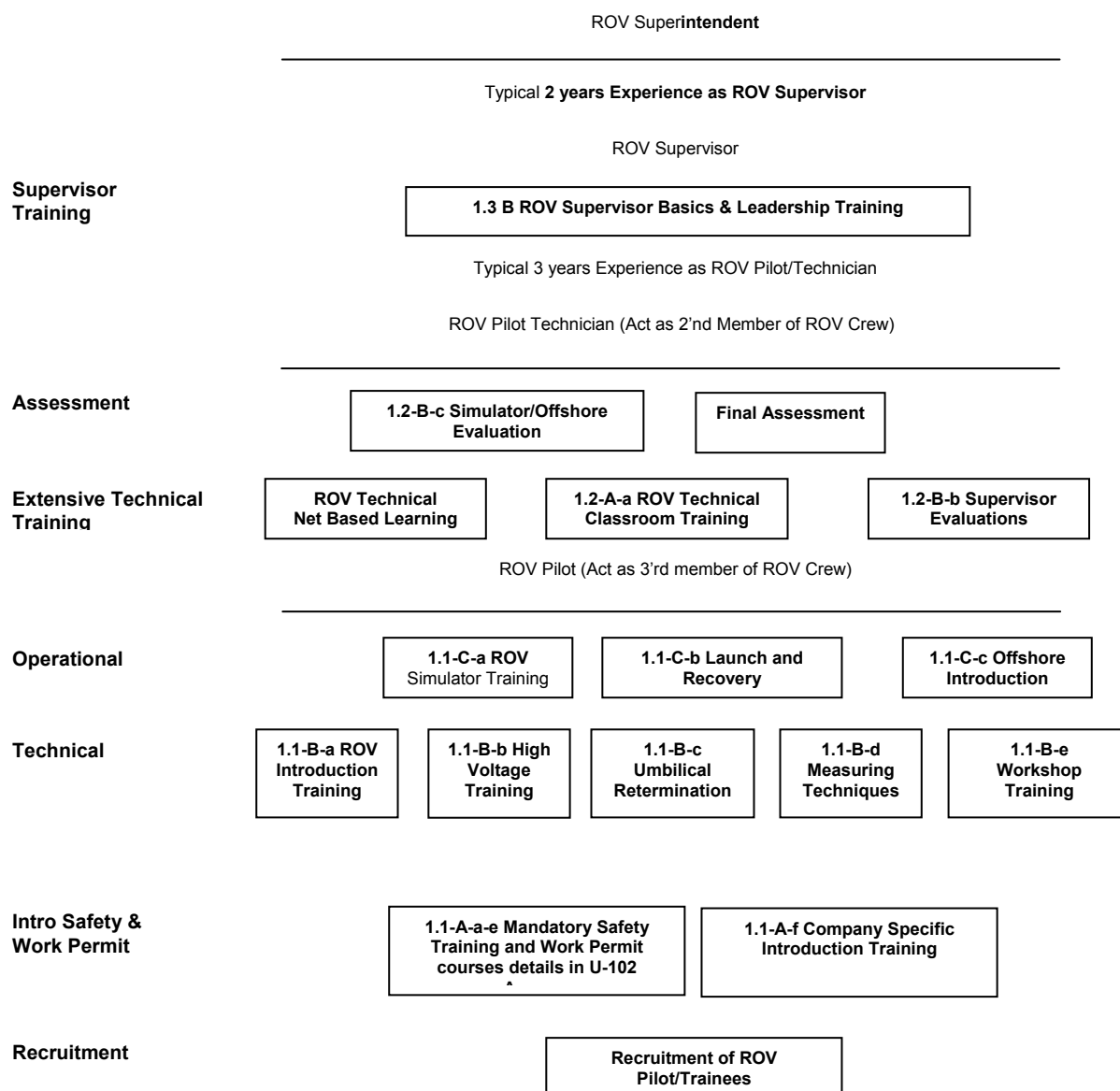
In order to maintain these systems all involved personnel shall have undertaken training in high voltage safety procedures and be familiarised with the protection gear for the system in question.

On board system responsible personnel shall, as a minimum, be qualified as follows:

- qualified as electrician or equivalent;
- additional training in maintaining high voltage systems;
- additional course for the high voltage equipment in question;
- be familiar with IMCA R 015 and IMCA R 005.

6.3.3 Personnel category requirements

The matrix below describes a typical career path for all levels in the ROV operational environment including the training elements within each level. The elements are described in Annex A.



See Annex A for further recommendations of training modules content and duration.

7 Interface requirements

7.1 Work site requirements

The work site (i.e. vessel, barge, installation or other) shall constitute a stable work platform from where the operations can be performed safely and efficiently.

7.2 Remotely operated vehicle (ROV) system interface requirements

The interface between ROV system and support vessel/installation is defined as critical for efficient mobilisation and use of ROV systems. These interfaces should be defined prior to issue scope of work to the contractor. All interfaces shall be addressed and agreed between client and contractor prior to mobilising equipment to site.

Typical interfaces are as follows:

- a) prior to mobilisation, deck loadings and footprint shall be evaluated and agreed between responsible parties on installation. The documents shall be available at the installation site. The weight of all major components shall be verified and registered prior to mobilization. A GA drawing shall be available;
- b) sufficient clean electric power (maximum voltage variation +/- 10 %) available and terminated in utility enclosure at dedicated location in GA drawing;
- c) enclosure for signal connection at dedicated location in GA drawing. (specified in illustration)(t);
- d) noise level in work area must be considered (hydraulic pumps, motors or similar);
- e) considerations towards vessel/installation outlets must be taken (exhaust, fans, accommodation vent etc.);
- f) access to attachment point for fall arrestors when installation is in hangar;
- g) easy and safe access between control station and launch site (escape routes, working areas);
- h) launch position free of obstructions;
- i) motion characteristic for launch area (vessel respons amplitude operator data);
- j) consideration of working environmental data;
- k) safe distance between launch position and vessel thruster propellers;
- l) outlet of fresh water, work air, and cooling water at dedicated location in GA;
- m) drain/waste area for contaminated sludge/oil at dedicated location in GA;
- n) protected area for maintenance work;
- o) system deck area shall be clear and free for hazards;
- p) hoses and cables routing;
- q) zone II interface requirements (if required);
- r) interface requirements for company provided item.

Table of typical utility signal enclosure:

Specification
Clearcom/intercom
Quad/signal
Local area network (LAN)
Video
ROV/survey sensor
Hipap/Navigation
Telephone
PA
Fire bell
Fire alarm
ROV Power
LARS Power
Cooling water
Work/Instrument air

NOTE All cables to be screened.

8 Technical requirements

8.1 General

This clause specifies the minimum technical requirements for ROV systems in the various classes, measurement requirements and units to be used.

A table for definition of client's ROV system requirements is included in Annex B. This table is based on the minimum requirements outlined in the standard for the relevant ROV classes, and shall be used as a description of the clients minimum and additional requirements and the contractors compliance to this. Also see ISO 13628-8.

8.2 ROV Class I – Pure observation vehicles

8.2.1 Operational depth

Maximum operational depth shall be specified. The ROV system shall satisfy all operational depth requirements. Length of umbilical shall be appropriate to the operational depth, included extra length for re-termination.

8.2.2 Buoyancy

Buoyancy shall ensure stability of the vehicle with neutral trim.

8.2.3 Ability to move in the horizontal and vertical plane.

The ability to move in the horizontal and vertical plane is the most important performance criteria.

Speed shall be given in m/s for forward, backward, lateral and vertical directions.

Speed testing shall be performed with standard equipment installed.

Speed measurement shall be carried out at a relevant depth.

Verification of speed in horizontal plane can be performed by using vessel positioning system, or measured distance.

If required, speed can be verified as follows:

Procedure using vessel positioning system:

- the average speed shall be measured moving towards the current and with the current;
- the ROV shall be given 5 m to accelerate up to speed;
- the measurement shall be over minimum 30 m in order to reduce influence of distance measurement accuracy;
- average of minimum two measurements to be used as the achieved speed of the ROV.

Procedure using measured distance:

- the distance shall meet a known length, i.e. quay side, subsea structure, pipeline;
- the ROV shall be given 5 m to accelerate up to speed;
- the measurement shall be over minimum 10 m;
- the current shall be taken into account; preferably the measurement shall be performed moving towards and against current.

Verification of speed in vertical plane shall be measured using the ROV depth gauge over a minimum of 20 m. The ROV shall be given 5 m to accelerate up to speed. Average of minimum two measurements to be used as the achieved speed of the ROV.

8.2.4 Cameras and lights

8.2.4.1 General

The cameras and lights constitute the viewing system. Acceptance criteria for the viewing system shall be as follows:

- interference-free pictures;
- the video system shall be able to record a minimum of 400 lines.

The quality of the viewing system can be verified in accordance with the following:

- the picture quality shall be tested in water using a test sheet with artificial light;
- the test sheet shall be made to meet the requirements in ISO-13628-1, 5.5.11 (typical test sheets exist on the internet using key words as video resolution chart or test pattern).

The cameras and lights are specified as listed below.

Standard outfit of cameras shall include

- 1 ea. low light navigation camera,
- 1 ea. colour camera or (1 ea. optional HD camera).

8.2.4.2 Low light navigation camera

The camera is used primary for navigation. The camera is placed in front of the vehicle and shall provide high quality images enabling safe navigation with a wide angle view over long distances.

Low light cameras shall satisfy the following technical requirements:

- minimum light sensitivity: 3×10^{-2} lux at face plate and 3×10^{-1} lux at scene;
- horizontal resolution > 400 lines;
- field of view minimum 60 degrees diagonal;
- depth of focus 150 mm to infinity.

8.2.4.3 Colour camera

Colour camera is primarily used for inspection. The camera shall provide high inspection quality images at typical inspection ranges 0,2 m to 2 m generally with good quality lighting, with zoom and focus capability for optimum performance, and satisfy the following requirements:

- sensitivity; 1 lux
- extended shuttered sensitivity; 0,1 lux
- horizontal resolution. > 400 lines

8.2.4.4 HD camera

The HD camera shall include all equipment necessary to transmit and store the picture in the same resolution. The camera shall provide high inspection quality images at typical inspection ranges 0,2 m to 2 m generally with good quality lighting, with zoom and focus capability for optimum performance, and satisfy the following requirements:

- sensitivity (faceplate); 0,1 lux
- resolution (horizontal); 1080i or 720p
- sufficient lightning to reproduce HD quality.

8.2.4.5 Lights

The light system

- shall be designed to give optimum and even illumination of areas viewed through the camera lenses,
- should preferably have possibility for both spot and flood lighting,
- shall have variable intensity. The lights shall be distributed on minimum two independent circuits.

8.2.5 Instrumentation

Following instruments shall be included:

- depth gauge (with accuracy specified both for full range and relative to the depth variations);
- compass.

8.2.6 Auto functions

The following auto functions shall be available:

- auto depth;
- auto heading.

8.2.7 Transponder/responder

The ROV shall be equipped with a transponder/responder preferably continuously charged from ROV, and, if relevant, compatible with system onboard the platform/vessel for navigational purposes and emergency recovery.

8.3 ROV Class II A – Observation vehicles with payload option**8.3.1 General**

Requirements as for ROV Class I, with additions specified in 8.3.2 to 8.3.6.

8.3.2 Buoyancy

The buoyancy elements shall be sized to give sufficient buoyancy for the vehicle with standard and additional equipment.

8.3.3 Cameras and lights**8.3.3.1 General**

The cameras and lights constitute the viewing system. Acceptance criteria for the viewing system shall be as follows:

- interference-free pictures;
- the video system shall be able to record a minimum of 400 lines; The quality of the viewing system can be verified in accordance with the following:
- the picture quality shall be tested in water using a test sheet with artificial light;
- the test sheet shall be made to meet the requirements in ISO-13628-1, 5.5.11 (typical test sheets exist on the internet using key words as video resolution chart or test pattern).

The cameras and lights are specified as listed below.

Standard outfit of cameras shall include

- 1 ea. low light navigation camera,
- 1 ea. colour camera or (1 ea. optional HD camera).

8.3.3.2 Low light navigation camera

The camera is used primary for navigation. The camera is placed in front of the vehicle and shall provide high quality images enabling safe navigation with a wide angle view over long distances.

Low light cameras shall satisfy the following technical requirements:

- minimum light sensitivity: 3×10^{-2} lux at face plate and 3×10^{-1} lux at scene;
- horizontal resolution > 400 lines;
- field of view minimum 60 degrees diagonal;
- depth of focus 150 mm to infinity.

8.3.3.3 Colour camera

Colour camera is primarily used for inspection.. The camera shall provide high inspection quality images at typical inspection ranges 0,2 m to 2 m generally with good quality lighting, with zoom and focus capability for optimum performance, and satisfy the following requirements:

- sensitivity; 1 lux
- extended shuttered sensitivity; 0,1 lux
- horizontal resolution. > 400 lines

8.3.3.4 HD camera

The HD camera shall include all equipment necessary to transmit and store the picture in the same resolution. The camera shall provide high inspection quality images at typical inspection ranges 0,2 m to 2 m generally with good quality lighting, with zoom and focus capability for optimum performance, and satisfy the following requirements:

- sensitivity (faceplate); 0,1 lux
- resolution (horizontal); 1080i or 720p
- sufficient lightning to reproduce HD quality.

8.3.3.5 Lights

The light system

- shall be designed to give optimum and even illumination of areas viewed through the camera lenses,
- should have possibility for both spot and flood lighting,
- shall have variable intensity. The lights shall be distributed on minimum two independent circuits.

8.3.4 Sonar

8.3.4.1 General

Sonars shall be specified for the work to be performed.

Testing of the different sonar types shall be performed by installing a target of specified size, to be identified at the maximum range as specified in the scope of work.

Sonars can be divided into two groups, see 8.3.4.2 to 8.3.4.3.

8.3.4.2 Type 1 - Obstacle avoidance/navigation sonar

Sonar normally used for construction and drill support.

Typically running at low frequency 325 kHz giving longer range and high scanning rate. Typical verification can be to find a 19 mm wire deployed at 20 m from the ROV.

8.3.4.3 Type 2 - Sonar used for measuring purposes

Sonar normally used for construction and survey.

Sonars can be used for measuring distances. Such sonars will have a different scanning frequency (i.e. typically 625 kHz or higher) and lower scanning rate.

8.3.5 Minimum of plug-in connection points for additional equipment**8.3.5.1 Electrical**

- 12 and/or 24 VDC; 5 A
- 110 and/or 220 VAC; 1 A

8.3.5.2 Signal

1 quad or 2 data channels through optical fiber (typically RS 232/485)

8.3.5.3 Video

1 x video connections for additional cameras

It shall as a minimum be possible to view two cameras simultaneously.

8.3.6 Transponders

See 8.2.7

8.4 ROV Class II B – Observation vehicles with payload option**8.4.1 General**

Requirements as for ROV Class I and II A, with additions specified in 8.4.2 to 8.4.6.

8.4.2 Buoyancy

The buoyancy elements shall be sized to give sufficient buoyancy for the vehicle with standard and additional equipment.

8.4.3 Cameras and lights**8.4.3.1 General**

The cameras and lights constitute the viewing system. Acceptance criteria for the viewing system shall be as follows:

- interference-free pictures;
- the video system shall be able to record a minimum of 400 lines;

The quality of the viewing system can be verified in accordance with the following:

- the picture quality shall be tested in water using a test sheet with artificial light;
- the test sheet shall be made to meet the requirements in ISO-13628-1, 5.5.11 (typical test sheets exist on the internet using key words as video resolution chart or test pattern).

The cameras and lights are specified as listed below.

Standard outfit of cameras shall include

- 1 ea. low light navigation camera,
- 1 ea. colour camera or (1 ea. optional HD camera).

8.4.3.2 Low light navigation camera

The camera is used primary for navigation. The camera is placed in front of the vehicle and shall provide high quality images enabling safe navigation with a wide angle view over long distances.

Low light cameras shall satisfy the following technical requirements:

- minimum light sensitivity: 3×10^{-2} lux at face plate and 3×10^{-1} lux at scene;
- horizontal resolution > 400 lines;
- field of view minimum 60 degrees diagonal;
- depth of focus 150 mm to infinity.

8.4.3.3 Colour camera

Colour camera is primarily used for inspection. The camera shall provide high inspection quality images at typical inspection ranges 0,2 m to 2 m generally with good quality lighting, with zoom and focus capability for optimum performance, and satisfy the following requirements:

- sensitivity; 1 lux
- extended shuttered sensitivity; 0,1 lux
- horizontal resolution. > 400 lines

8.4.3.4 HD camera

The HD camera shall include all equipment necessary to transmit and store the picture in the same resolution. The camera shall provide high inspection quality images at typical inspection ranges 0,2 m to 2 m generally with good quality lighting, with zoom and focus capability for optimum performance, and satisfy the following requirements:

- sensitivity (faceplate); 0,1 lux
- resolution (horizontal); 1080i or 720p
- sufficient lightning to reproduce HD quality.

8.4.3.5 Lights

The light system

- shall be designed to give optimum and even illumination of areas viewed through the camera lenses,
- shall preferably have possibility for both spot and flood lighting,
- shall have variable intensity. The lights shall be distributed on minimum two independent circuits.

8.4.4 Sonar

8.4.4.1 General

Sonars shall be specified for the work to be performed.

Testing of the different sonar types shall be performed by installing a target of specified size, to be identified at the maximum range as specified in the scope of work.

Sonars can be divided into two groups, see 8.3.4.2 to 8.3.4.3.

8.4.4.2 Type 1 - Obstacle avoidance/navigation sonar

Sonar normally used for construction and drill support.

Typically running at low frequency 325 kHz giving longer range and high scanning rate. Typical verification can be to find a 19 mm wire deployed at 20 m from the ROV.

8.4.4.3 Type 2 - Sonar used for measuring purposes

Sonar normally used for construction and survey.

Sonars can be used for measuring distances. Such sonars will have a different scanning frequency (i.e. typically 625 kHz or higher) and lower scanning rate.

8.4.5 Minimum of plug-in connection points for additional equipment**8.4.5.1 Electrical**

- 12 and/or 24 VDC; 5 A;
- 110 and/or 220 VAC; 1 A.

8.4.5.2 Manipulator

The vehicle may be equipped with optional manipulator(s), a grabber manipulator or working manipulator.

8.4.5.3 Grabber manipulator

The grabber manipulator may have following requirements as defined in the contract:

- grip capacity;
- minimum functions;
- minimum out reach; mm
- lift capacity (full out reach). kg

8.4.5.4 Working manipulator

The working manipulator may have the following requirements as defined in the contract:

- minimum functions;
- minimum out reach; mm
- lift capacity (full out reach); kg
- minimum wrist torque Nm

8.4.5.5 Hydraulics

The vehicle may be equipped with optional hydraulic power pack.

8.4.5.6 Signal

1 quad or 2 data channels through optical fiber (typically RS 232/485).

8.4.5.7 Video

1 x video connections for additional cameras.

It shall as a minimum be possible to view two cameras simultaneously.

8.4.6 Transponders

See 8.2.7.

8.5 ROV Class III – Work class vehicles**8.5.1 Operational depth**

Maximum operational depth shall be specified. The ROV system shall satisfy all operational depth requirements. Length of umbilical shall be appropriate to the operational depth, included extra length for re-termination.

8.5.2 Buoyancy/ballast

The buoyancy elements shall be sized and configured to give sufficient buoyancy and stability for the vehicle with standard and additional equipment.

8.5.3 Ability to move in the horizontal and vertical plane

The ability to move in the horizontal and vertical plane is the most important performance criteria.

Speed shall be given in m/s for the following directions: forward, backward, lateral and vertical.

Speed testing shall be performed with standard equipment installed.

Speed measurement shall be carried out at a relevant depth.

Verification of speed in horizontal plane can be performed by using vessel positioning system, or measured distance.

If required, speed can be verified as follows:

Procedure using vessel positioning system:

- the average speed shall be measured moving towards current and with current;
- the ROV shall be given 5 m to accelerate up to speed;
- the measurement shall be over minimum 30 m in order to reduce influence of distance measurement accuracy;
- average of minimum two measurement to be used as the achieved speed of the ROV.

Procedure using measured distance:

- the distance shall meet a known length, i.e. quay side, subsea structure, pipeline;
- the ROV shall be given 5 m to accelerate up to speed;
- the measurement shall be over minimum 10 m;
- the current shall be taken into account; preferably the measurement shall be performed moving towards and against current.

Verification of speed in vertical plane shall be measured using the ROV depth gauge over a minimum of 20 m. The ROV shall be given 5 m to accelerate up to speed.

Average of minimum two measurements to be used as the achieved speed of the ROV.

If force measurements are required, the following guidance shall be used:

Force shall be given in N (Newton) for forward, backward, lateral and vertical directions. The test shall be performed with standard equipment installed.

Force measurement shall be carried out with calibrated equipment and at a specified depth. The measurements will be relevant for test depth and deeper.

Verification shall be measured using a calibrated force measuring device. Typically mechanical load cell connected to a subsea structure, i.e. clump weight.

The measurements shall include the x, y, z planes.

8.5.4 Electrical or hydraulic power

The overall power available on the vehicle shall be given in watt (W), as input or output effect (kW).

Maximum available power for propulsion and tooling shall be separately given in W.

All hydraulic circuits shall be measured in pressure (bar) and flow (l/min).

8.5.5 Cameras and lights

8.5.5.1 General

The cameras and lights constitute the viewing system. Acceptance criteria for the viewing system shall be as follows:

- interference-free pictures;
- the video system shall be able to record a minimum of 400 lines; The quality of the viewing system can be verified in accordance with the following:
- the picture quality shall be tested in water using a test sheet with artificial light;
- the test sheet shall be made to meet the requirements in ISO-13628-1, 5.5.11 (typical test sheets exist on the internet using key words as video resolution chart or test pattern).

The cameras and lights are specified as listed below.
Standard outfit of cameras shall include

- 1 ea. low light navigation camera,
- 1 ea. colour camera or (1 ea. optional HD camera).

8.5.5.2 Low light navigation camera

The camera is used primary for navigation. The camera is placed in front of the vehicle and shall provide high quality images enabling safe navigation with a wide angle view over long distances.

Low light cameras shall satisfy the following technical requirements:

- minimum light sensitivity: 3×10^{-2} lux at face plate and 3×10^{-1} lux at scene;
- horizontal resolution > 400 lines;
- field of view minimum 60 degrees diagonal;
- depth of focus 150 mm to infinity.

8.5.5.3 Colour camera

Colour camera is primarily used for inspection. The camera shall provide high inspection quality images at typical inspection ranges 0,2 m to 2 m generally with good quality lighting, with zoom and focus capability for optimum performance, and satisfy the following requirements:

- | | | |
|-----------------------------------|-------|-------|
| • sensitivity; | 1 lux | |
| • extended shuttered sensitivity; | 0,1 | lux |
| • horizontal resolution. | > 400 | lines |

8.5.5.4 HD camera

The HD camera shall include all equipment necessary to transmit and store the picture in the same resolution. The camera shall provide high inspection quality images at typical inspection ranges 0,2 m to 2 m generally with good quality lighting, with zoom and focus capability for optimum performance, and satisfy the following requirements:

- | | | |
|---|---------------|-----|
| • sensitivity (faceplate); | 0,1 | lux |
| • resolution (horizontal); | 1080i or 720p | |
| • sufficient lightning to reproduce HD quality. | | |

8.5.5.5 Lights

The light system

- shall be designed to give optimum and even illumination of areas viewed through the camera lenses,
- shall preferably have possibility for both spot and flood lighting,
- shall have variable intensity. The lights shall be distributed on minimum two independent circuits.

8.5.6 Manipulators

8.5.6.1 General

The vehicle shall be equipped with at least two manipulators. A grabber manipulator installed at the port side and a working manipulator at the starboard side.

8.5.6.2 Grabber manipulator

The grabber shall have a grip capacity of 0 mm to 200 mm and satisfy the following requirements:

- minimum five functions;
- minimum out reach; 1 300 mm
- lift capacity (full out reach). 100 kg

8.5.6.3 Working manipulator

The working manipulator shall have master/slave control with

- minimum seven functions,
- minimum out reach, 1 600 mm
- lift capacity (full out reach), 60 kg
- minimum wrist torque. 70 Nm

Type of claw(s) to be specified in Annex B.

8.5.7 Sonar

8.5.7.1 General

Sonars shall be specified for the work to be performed.

If required, testing of the different sonar types shall be performed by installing a target of specified size, to be identified at the maximum range as specified in the scope of work.

Sonars can be divided into two groups, see 8.4.7.2 to 8.4.7.3.

8.5.7.2 Type 1 - Obstacle avoidance/navigation sonar

Sonar normally used for construction and drill support.

Typically running at low frequency 325 kHz giving longer range and high scanning rate. Typical verification can be to find a 19 mm wire deployed at 20 m from the ROV.

8.5.7.3 Type 2 - Sonar used for measuring purposes

Sonar normally used for construction and survey.

Sonars can be used for measuring distances. Such sonars will have a different frequency (i.e. typically 625 kHz or higher) and lower scanning rate.

8.5.8 Instrumentation

The following instruments shall be included:

- depth gauge (the accuracy shall be specified both for full range and relative to the depth variations);
- compass:
 - for general navigation - magnetic compass for navigation and orientation;
 - for survey and accurate navigation - north seeking gyro or equivalent. Update rate and accuracy is to be specified.

8.5.9 Auto functions

The following auto functions shall be available:

- auto depth;
- auto heading.

8.5.10 Minimum of plug-in connection points for additional equipment**8.5.10.1 Electrical**

- 12 and/or 24 VDC; 5 A
- 110 and/or 220 VAC; 1 A

8.5.10.2 Signal

1 quad or 2 data channels through optical fiber (typically RS 232/485).

8.5.10.3 Video

1 x video connections for additional cameras.

It shall as a minimum be possible to view three cameras simultaneously.

8.5.10.4 Hydraulics

3 x 2 way low flow valves.

Additional high flow hydraulic output (typical flow is 30 l/min).

8.5.11 Transponders

The work ROV shall be equipped with a transponder/responder preferably continuously charged from the ROV, and, if relevant, compatible with system onboard the platform/vessel for navigational purposes and emergency recovery.

9 Operational requirements**9.1 Planning and execution****9.1.1 General requirements**

Detailed operational procedures covering planning, preparations and execution of the operation shall be available to personnel involved.

Documentation required for safe execution of the operation, including relevant rules and regulations, shall be updated and easily accessible at the work-site.

9.1.2 Risk assessment

Risk assessments shall be actively used in preparations for the operation and shall be performed in accordance with recognized methods. Prior to shift changes, tool box meeting shall be held in order to ensure that the ongoing shift is made aware of the situation at the work site, status of the work, any incidents on the previous shift and any other information with relevance to the safe and efficient performance of the work.

9.1.3 Operational log

An operational log, detailing all relevant data and events, shall be kept in accordance with 5.6.2.1.

9.1.4 Operational management

A superintendent/supervisor shall be appointed the operational responsibility/supervision. He or she shall ensure that the execution of the operation is in accordance with all applicable rules, regulations and operational procedures.

The platform/vessel chief engineer has the overall responsibility for the technical interfaces between the platform/vessel and the ROV system(s).

The platform/vessel electrician shall be the overall electrical equipment coordinator. As such it is his or hers responsibility to ensure that all electrical equipment brought onboard is well maintained and certified, and that all personnel working on electrical equipment are qualified for the work.

Any additional tools or equipment (third party or client) shall be accepted for use by the ROV supervisor/superintendent who has a particular responsibility to ensure compatibility with the ROV and associated systems. Maintenance arrangements and operational procedures for such additional tools and/or equipment shall be agreed prior to use.

9.2 Mobilisation/demobilisation

Mobilisation shall be conducted in accordance with a defined mobilisation plan. When the mobilisation has been completed, notice shall be given to the client for acceptance.

The mobilisation plan shall ensure that all equipment is mobilised, installed and tested in a manner ensuring conformance with rules, regulations, equipment specifications and functional requirements.

The personnel mobilisation procedures shall ensure that all personnel are qualified for the work at hand.

Demobilisation shall be conducted in accordance with a defined demobilisation plan.

9.3 Function testing prior to use

All equipment shall be function tested prior to use. Function testing shall be performed in accordance with a defined test program. Such testing will normally be documented in a separate mobilisation acceptance test form.

Additional performance testing/demonstration may be required by the client, and shall be agreed prior to start of mobilisation.

9.4 Familiarisation

All personnel shall be familiarised with the work they are going to perform and with the HES requirements relevant for the operation. Familiarisation shall be performed in accordance with a defined program. The familiarisation program shall be adapted to the individuals' competence level and tasks to be performed by the individual. Completion of the familiarisation shall be documented for each individual.

9.5 Procedures

Procedures shall be based on recognised best practices and previous experience.

9.6 Transfer of experience

There shall be a system in place to ensure that new experience is gathered and used to continuously improve the operational procedures, the equipment, the maintenance procedures and/or the onboard spares lists.

9.7 ROV observation of divers

ROVs used for observation of divers shall be in accordance with NORSOK U-100. A safe distance between divers and ROV shall be maintained. The purpose of the ROV in such cases is to provide the best possible overview of the divers and the work-site for the diving supervisor. The ROV personnel shall in such cases report to the diving supervisor and follow his instructions. Any anomalies observed shall immediately be reported to the diving supervisor.

Video presentation shall include overlay text displaying critical data such as pipeline identification, kilometre point (Kp), date and time, sword depth, vehicle speed and heading, vehicle pitch and roll. 24 h black box video records shall be maintained throughout.

9.8 Tether management system (TMS)

9.8.1 General

The system shall have docking facility for the vehicle to safely dock with the TMS in weather conditions agreed in contract.

9.8.2 Safe working load (SWL)

The TMS shall have a SWL that correspond with the weight of the vehicle including its standard equipment and additional equipment as specified in the contract.

9.8.3 Length of tether management system (TMS) tether

The TMS shall have a tether length in accordance with agreed scope of work.

9.9 Umbilical/tether cables

9.9.1 Umbilical

The umbilical shall be designed and certified in accordance with applicable regulations for lifting appliances.

The minimum length shall be based on the water depth as stated in the agreed scope of work. The umbilical shall withstand dynamic loads and environmental impacts, i.e. deep water operations. The umbilical shall in addition to the vehicle requirements be capable of additional signal and power transfer as required in the scope of work.

9.9.2 Tether

The tether shall be designed to limit mechanical damage during normal operations. Bending characteristics/ tether water weight shall not hamper the ROV during its operation. The tether shall in addition to the vehicle requirements be capable of additional signal and power transfer as required in the scope of work.

9.10 Handling system

9.10.1 General

The handling system shall be designed, constructed and certified to meet regulatory requirements and standards applicable for the work sites specified in the contract.

The design report shall document

- operational limitations,
- maximum static load,
- maximum dynamic load,
- check for slack umbilical/snap load.

9.10.2 Handling system safe working load (SWL)

The SWL of the handling system shall cover the weight of the ROV with TMS and additional equipment as specified in the agreed scope of work.

9.10.3 Launching criteria

The handling system shall meet launching and recovery criteria agreed in contract, see interface criteria in 7.2 i).

9.10.4 Umbilical winch

The umbilical winch is part of the handling system and shall meet both structural and electrical certification requirements that apply to the work site stated in the contract. The umbilical winch shall have a line speed of minimum 30 m/min.

9.11 Control facilities

9.11.1 Control room

The equipment in the control room shall be designed and installed to withstand shaking and shock which will be imposed during transportation, handling, installation and operation.

The ROV control room is the operation room for ROV systems and shall be considered a workplace where personnel are present over longer periods.

Even though that the environment is regulated through regulations it is important to emphasise the following:

- the noise level in the control room shall, as a minimum, conform with current legislation and further minimised as much as possible;
- the ROV control room shall be equipped to enable a stable climate control both to keep the temperature down during operations and to maintain a dry atmosphere during non operational periods. The outlet from an air-conditioning unit shall not be directed directly towards the ROV operator;
- the lights shall be dimmable. The positions of the lights shall be considered to minimise reflections in the ROV operator's computer and video monitors.

9.11.2 Remotely operated vehicle (ROV) operator station

The ROV operator station shall be designed to minimise the physical stress. There shall be adjustment possibilities to enable good end ergonomic correct working position for each individual ROV operator.

Considerations such as radiation from video- and computer monitors and quality of monitors shall be taken into account in the selection of the displays.

9.11.3 Communication

The following communication systems shall be available:

- open line communication system between ROV control and launch and recovery system, bridge and other entities directly involved in the operation;
- PA speaker;
- telephone system.

9.11.4 Video

The following video systems shall be available:

- two video recorders (DVD format if not otherwise agreed);
- video overlay and annotation unit to overlay and annotate the video recording with information such as time, date, ROV heading, ROV depth, client logo, contractors logo and information about the work;
- view, four camera pictures simultaneously. If the system is equipped with more than four cameras there shall be a video switcher option;
- one video signal amplifier to enable video distribution to other locations onboard the ROV platform/ vessel.

9.11.5 Condition monitoring

The ROV operator station shall have provision of status monitoring during operation, including, but not limited to

- earth fault detection and shut down system on high voltage,
- earth fault detection system on ROV low voltage system,
- electric/hydraulic motor voltage and current,
- hydraulic pressure,
- hours run indicator,
- ROV turns counter,
- depth readout,
- water ingress alarms,
- volume in the electric compensation system,
- volume and temperature in the hydraulic compensation system,
- failure alarm system,
- diagnostic system.

Annex A **(informative)** **Personnel qualification requirement details**

A.1 Introduction

The matrix in 6.3.3 describes a typical career path for all levels in the ROV operational environment.

This annex serves to outline in greater detail a recommended program of training modules and estimated duration for such training. The duration may vary based upon the individual ROV company's basic training philosophy.

A.2 ROV personnel requirements

A.2.1 Requirements for ROV pilot

The candidate is employed as a trainee and held at this level during the initial training period and until the offshore introduction period is fulfilled.

A) Health, safety and work permit requirements

- a. Health certificate approved of the Norwegian Maritime Directorate
- b. Health certificate for persons engaged in the petroleum activity (I-1148)
- c. Basic safety training and helicopter underwater escape training.
- d. Course - work permit and safe job analysis
- e. Course – HSE Offshore
- f. Other required HSE courses

B) Technical requirements

- a. ROV introduction training – typically 3 days
 - The need for ROVs in the current oil industry
 - Hydraulic symbols and components
 - Data signals and signal adaption
 - Sensors and use of sensors
 - Cables and couplings
 - Signal transmission in cables and slip rings
 - Video transmission
 - Methods of measurements
 - Fiber multiplexers and fiber termination
 - Equipment costs/Economic consciousness raising
- b. High voltage training- typically 1 day
 - Norwegian legislation for high voltage networks
 - Company specific procedure for safe work on ROV high voltage system
 - Signs and labelling
 - Use of grounding devices
 - Ground fault detection systems
 - First aid
- c. Umbilical re-termination typically 1,5 days
 - Mechanical re-termination including load test

- d. Measuring instruments – typically 1 day
 - Multimeter
 - Optical time domain reflectometer
 - Time domain reflectometer
 - Oscilloscope
 - Megger high voltage insulation testing
- e. On job training in workshop – typically 14 days
 - A two week period familiarising with local procedures and ROV related maintenance tasks
- C) Operational requirements
 - a. Basic simulator training - typically 2 days = 15 piloting hours
 - Basic ROV operation
 - Navigation
 - Master/slave manipulator operation
 - Tether management
 - Dive log keeping
 - b. Introduction to applicable launch and recovery procedure – typically ½ day
 - c. Typically a 2 weeks introduction trip on an ROV system offshore

NOTE After completing this plan the candidate is qualified for acting as a 3rd member on any crew. The composition of a crew should make way for the inclusion of a pilot.

A.2.2 Requirements for ROV pilot technician

The ROV pilot technician shall as a minimum have the same qualifications and experience as ROV pilot in addition to the following:

- A) Technical requirements
 - a. Technical training in relevant ROV system including troubleshooting – typically 5 days
 - Electrical power flow to the ROV
 - Telemetry link layout and hydraulic system overview
 - Principles for ground fault systems
 - ROV control system
 - Fiber optics including safety aspects when working with fibers
 - Troubleshooting
 - Practical exercises
- B) Operational requirements
 - a. Site specific launch and recovery training on the applicable LARS according to NORSOK R-003
 - b. Evaluations from offshore supervisors in order to follow the candidate's development
 - c. Final operational assessment covering:
 - Knowledge of and use of ROV control system in both operational settings and troubleshooting
 - Knowledge of- and use of sonar
 - Navigation by use of sonar, gyro and depth gage sensors
 - Operation with use of master/slave manipulator
 - General control of the ROV
 - Control of tethers and cage/TMS operation
 - General understanding of the operations
 - Operation of ROV considering dynamic factors like heave, current, and poor visibility etc.
 - Communication and interaction with co-pilot and other co-operating functions
 - Risk identification regarding operation of the ROV
 - d. Typically 200 h experience with relevant ROV operations
 - e. Have training in task reporting

A.2.3 Requirements for ROV supervisor

The ROV supervisor shall as a minimum have the same qualifications as ROV pilot technician in addition to the following:

- A) Operational requirements
 - a. Be fully conversant with all applicable legislation at the work site
 - b. Has a typically of 3 years experience with relevant ROV operations
- B) Basic supervisor training
 - Conflict management
 - Conditions for teams
 - Procedures
 - Communications
 - Supervisor work scope
 - Contracts/terms and conditions
 - Client's expectations
 - Technical
 - ROV auditor

A.2.4 Requirements for ROV superintendent

The ROV superintendent shall as a minimum have the same qualifications as ROV supervisor in addition to the following:

- A) Operational requirements
 - Experience in overall planning and management of offshore operations
 - Typically 2 years experience as ROV supervisor

Annex B
(informative)
Remotely operated vehicle (ROV) system requirements

Refer- ence	Description ROV Class I, II, III	Unit	Client's requirement	Contractors data
8.2	ROV Class I - Pure observation vehicle			
	ROV			
	Manufacturer/Type			
	Length	m		
	Width	m		
	Height	m		
	TMS			
	Manufacturer/Type			
	Length	m		
	Width	m		
	Height	m		
9.8.3	Tether length	m		
	Umbilical winch			
	Manufacturer/Type			
	Length	m		
	Width	m		
	Height	m		
9.9.1	Umbilical length	m		
	Line speed	m/s		
	Control container			
	Manufacturer/Type			
	Length	m		
	Width	m		

Refer- ence	Description ROV Class I, II, III	Unit	Client's requirement		Contractors data	
	Height	m				
	Workshop container					
	Manufacturer/Type					
	Length	m				
	Width	m				
	Height	m				
	Handling system					
	Manufacturer/Type					
	Length	m				
	Width	m				
	Height	m				
	Total required deck space	m ²				
	Maximum weight					
	Vehicle	kg				
	TMS	kg				
	Umbilical winch	kg				
	Control container	kg				
	Workshop container	kg				
	Handling system	kg				
	Auxiliary power pack/Clean power unit	kg				
	Total maximum overall weight	kg				
	Area classification (zone 1 or 2)					
	Power supply requirements					
	Vehicle	kVA				
	TMS	kVA				
	Umbilical winch	kVA				
	Control container	kVA				
	Workshop container	kVA				
	Handling system	kVA				

Refer- ence	Description ROV Class I, II, III	Unit	Client's requirement	Contractors data
	Maximum total power consumption	kVA		
8.2.1	Operational depth/depth rating			
	Operational depth	m		
8.2.2	Buoyancy			
	Payload	kg		
	Vehicle frame carrying load	kg		
8.2.3	Ability to move in the horizontal and vertical plane			
	Forward	m/s		
	Backward	m/s		
	Vertical	m/s		
	Lateral	m/s		
	Number of thrusters and position	Number		
8.2.4	Cameras and lights			
8.2.4.2	Low light navigation camera			
	Manufacturer			
	Model			
8.2.4.3	Colour camera			
	Manufacturer			
	Model			
8.2.4.4	Lights			
	Number of lights on vehicle			
	Total lighting capacity	Lumen		
	Lighting circuits			
	Model/Type			
8.2.5	Instrumentation			
	Depth gauge			

Refer- ence	Description ROV Class I, II, III	Unit	Client's requirement	Contractors data
	Manufacturer			
	Model/Type			
	Compass			
	Manufacturer			
	Model/Type			
8.2.6	Auto functions			
	Auto heading			
	Auto depth			
8.2.7	Transponders			
	Manufacturer			
	Model/Type			
8.3	ROV Class II - Observation vehicle with payload option (requirements as for ROV class I)			
	ROV			
	Manufacturer/Type			
	Length	m		
	Width	m		
	Height	m		
	TMS			
	Manufacturer/Type			
	Length	m		
	Width	m		
	Height	m		
9.8.3	Tether length	m		
	Umbilical winch			
	Manufacturer/Type			
	Length	m		
	Width	m		

Refer- ence	Description ROV Class I, II, III	Unit	Client's requirement	Contractors data
	Height	m		
9.9.1	Umbilical length	m		
	Line speed	m/s		
	Control container			
	Manufacturer/Type			
	Length	m		
	Width	m		
	Height	m		
	Workshop container			
	Manufacturer/Type			
	Length	m		
	Width	m		
	Height	m		
	Handling system			
	Manufacturer/Type			
	Length	m		
	Width	m		
	Height	m		
	Total required deck space	m ²		
	Maximum weight			
	Vehicle	kg		
	TMS	kg		
	Umbilical winch	kg		
	Control container	kg		
	Workshop container	kg		
	Handling system	kg		
	Auxiliary power pack/Clean power unit	kg		
	Total maximum overall weight	kg		
	Area classification (zone 1 or 2)			

Refer- ence	Description ROV Class I, II, III	Unit	Client's requirement	Contractors data
	Power supply requirements			
	Vehicle	kVA		
	TMS	kVA		
	Umbilical winch	kVA		
	Control container	kVA		
	Workshop container	kVA		
	Handling system	kVA		
	Maximum total power consumption	kVA		
8.2.1	Operational depth			
	Operational depth	m		
8.3.2	Buoyancy			
	Payload	kg		
	Vehicle frame carrying load	kg		
8.2.3	Ability to move in the horizontal and vertical plane			
	Forward	m/s		
	Backward	m/s		
	Vertical	m/s		
	Lateral	m/s		
	Number of thrusters and position	Number		
8.2.4	Cameras and lights			
8.2.4.2	Low light navigation camera			
	Manufacturer			
	Model			
8.2.4.3	Colour camera			
	Manufacturer			
	Model			
8.2.4.4	Lights			
	Number of lights on vehicle			

Refer- ence	Description ROV Class I, II, III	Unit	Client's requirement	Contractors data
	Total lighting capacity	Lumen		
	Lighting circuits			
	Model/Type			
8.2.5	Instrumentation			
	Depth gauge			
	Manufacturer			
	Model/Type			
	Compass			
	Manufacturer			
	Model/Type			
8.2.6	Auto functions			
	Auto heading			
	Auto depth			
8.3.4	Sonar			
	Type (8.3.4.2 - 8.3.4.3) -			
	Manufacturer			
	Model			
	Frequency			
	Range			
	Resolution			
	Scanning sector			
	Scanning speed			
8.3.5	Minimum of plug-in connection points for additional equipment			
8.3.5.1	Outlet (12 VDC, 24 VDC and/or 250 VDC - 5 A)			
	Outlet (110 VAC and/or 220 VAC - 1 A)			
8.3.5.2	Spare quad or two data channels through fiber			
8.3.5.3	Spare video lines			
8.3.6	Transponder			

Refer- ence	Description ROV Class I, II, III	Unit	Client's requirement	Contractors data
	Manufacturer			
	Model/Type			
	Additional sensors and equipment			
	Altimeter			
	Pitch and roll sensors			
	Emergency flasher			
	Emergency beacon			
	Wire cutter			
	Torque tool			
	LP water jet			
	CP probe			
	Frame grabbing equipment			
	Digital recording system (DVD)			
	DVD burner			
8.3	ROV Class II - Observation vehicle with payload option (requirements as for ROV class I)			
	ROV			
	Manufacturer/Type			
	Length	m		
	Width	m		
	Height	m		
	TMS			
	Manufacturer/Type			
	Length	m		
	Width	m		
	Height	m		
9.8.3	Tether length	m		
	Umbilical winch			

Refer- ence	Description ROV Class I, II, III	Unit	Client's requirement		Contractors data	
	Manufacturer/Type					
	Length	m				
	Width	m				
	Height	m				
9.9.1	Umbilical length	m				
	Line speed	m/s				
	Control container					
	Manufacturer/Type					
	Length	m				
	Width	m				
	Height	m				
	Workshop container					
	Manufacturer/Type					
	Length	m				
	Width	m				
	Height	m				
	Handling system					
	Manufacturer/Type					
	Length	m				
	Width	m				
	Height	m				
	Total required deck space	m ²				
	Maximum weight					
	Vehicle	kg				
	TMS	kg				
	Umbilical winch	kg				
	Control container	kg				
	Workshop container	kg				
	Handling system	kg				

Refer- ence	Description ROV Class I, II, III	Unit	Client's requirement		Contractors data	
	Auxiliary power pack/Clean power unit	kg				
	Total maximum overall weight	kg				
	Area classification (zone 1 or 2)					
	Power supply requirements					
	Vehicle	kVA				
	TMS	kVA				
	Umbilical winch	kVA				
	Control container	kVA				
	Workshop container	kVA				
	Handling system	kVA				
	Maximum total power consumption	kVA				
8.2.1	Operational depth					
	Operational depth	m				
8.3.2	Buoyancy					
	Payload	kg				
	Vehicle frame carrying load	kg				
8.2.3	Ability to move in the horizontal and vertical plane					
	Forward	m/s				
	Backward	m/s				
	Vertical	m/s				
	Lateral	m/s				
	Number of thrusters and position	Number				
8.2.4	Cameras and lights					
8.2.4.2	Low light navigation camera					
	Manufacturer					
	Model					
8.2.4.3	Colour camera					
	Manufacturer					

Refer- ence	Description ROV Class I, II, III	Unit	Client's requirement	Contractors data
	Model			
8.2.4.4	Lights			
	Number of lights on vehicle			
	Total lighting capacity	Lumen		
	Lighting circuits			
	Model/Type			
8.4.5	Manipulators			
8.4.5	Grabber manipulator			
	Manufacturer			
	Type			
	Control method			
	Number of functions			
	Type of jaws			
	Size of recess for T-bars/handles	φ mm		
	Outreach	mm		
	Lift capacity	kg		
8.4.5	Working manipulator			
	Manufacturer			
	Type			
	Control method			
	Force feedback			
	Number of functions			
	Type of jaws			
	Size of recess for T-bars/handles			
	Outreach	mm		
	Lift capacity	kg		
	Wrist torque	Nm		
8.4.5.3	Hydraulics			

Refer- ence	Description ROV Class I, II, III	Unit	Client's requirement	Contractors data
8.4.5.3	Number of low flow outputs			
8.4.5.3	Pressure	bar		
	Flow	l/min		
8.4.5.3	Number of high flow hydraulic output			
8.4.5.3	Pressure	bar		
8.4.6	Flow	l/min		
	Manufacturer			
	Model/Type			
	Additional sensors and equipment			
	Altimeter			
	Pitch and roll sensors			
	Emergency flasher			
	Emergency beacon			
	Wire cutter			
	Torque tool			
	LP water jet			
	CP probe			
	Frame grabbing equipment			
	Digital recording system (DVD)			
	DVD burner			
8.4	ROV Class III - Work class vehicles			
	ROV			
	Manufacturer/Type			
	Length	m		
	Width	m		
	Height	m		
	TMS			
	Manufacturer/Type			

Refer- ence	Description ROV Class I, II, III	Unit	Client's requirement		Contractors data	
	Length	m				
	Width	m				
	Height	m				
9.8.3	Tether length	m				
	Umbilical winch					
	Manufacturer/Type					
	Length	m				
	Width	m				
	Height	m				
9.9.1	Umbilical length	m				
	Line speed	m/s				
	Control container					
	Manufacturer/Type					
	Length	m				
	Width	m				
	Height	m				
	Workshop Container					
	Manufacturer/Type					
	Length	m				
	Width	m				
	Height	m				
	Handling system					
	Manufacturer/Type					
	Length	m				
	Width	m				
	Height	m				
	Total required deck space	m ²				
	Maximum weight					
	Vehicle	kg				

Refer- ence	Description ROV Class I, II, III	Unit	Client's requirement	Contractors data
	TMS	kg		
	Umbilical winch	kg		
	Control container	kg		
	Workshop container	kg		
	Handling system	kg		
	Auxiliary power pack/Clean power unit	kg		
	Total maximum overall weight	kg		
	Area classification (zone 1 or 2)			
	Power supply requirements			
	Vehicle	kVA		
	TMS	kVA		
	Umbilical winch	kVA		
	Control container	kVA		
	Workshop container	kVA		
	Handling system	kVA		
	Maximum total power consumption	kVA		
	Deck cables minimum length	m		
8.4.1	Operational depth/depth rating			
	Operational depth			
8.4.2	Buoyancy			
	Payload	kg		
	Vehicle frame carrying load	kg		
8.4.3	Ability to move in the horizontal and vertical plane			
	Speed			
	Forward	m/s		
	Backward	m/s		
	Vertical	m/s		
	Lateral	m/s		

Refer- ence	Description ROV Class I, II, III	Unit	Client's requirement	Contractors data	
	Force				
	Forward	N			
	Backward	N			
	Vertical	N			
	Lateral	N			
	Number of thrusters and position	Number			
8.4.4	Electrical or hydraulic power				
	Overall available power	W			
	Propulsion	W			
	Tooling	W			
	Number of hydraulic circuits				
	Pressure	bar			
	Flow	l/min			
8.4.5	Cameras and lights				
8.4.5.2	Low light navigation camera				
	Manufacturer				
	Model				
8.4.5.3	Colour camera				
	Manufacturer				
	Model				
	Utility camera 1				
	Manufacturer				
	Model				
	Utility camera 2				
	Manufacturer				
	Model				
8.4.5.4	Lights				
	Number of lights on vehicle				
	Total lighting capacity	Lumen			

Refer- ence	Description ROV Class I, II, III	Unit	Client's requirement	Contractors data
	Lighting circuits			
	Modell/Type			
8.4.6	Manipulators			
8.4.6.2	Grabber manipulator			
	Manufacturer			
	Type			
	Control method			
	Number of functions			
	Type of jaws			
	Size of recess for T-bars/handles	φ mm		
	Outreach	mm		
	Lift capacity	kg		
8.4.6.3	Working manipulator			
	Manufacturer			
	Type			
	Control method			
	Force feedback			
	Number of functions			
	Type of jaws			
	Size of recess for T-bars/handles			
	Outreach	mm		
	Lift capacity	kg		
	Wrist torque	Nm		
8.4.7	Sonar			
	Type (8.4.7.2 - 8.4.7.3)-			
	Manufacturer			
	Model			
	Frequency	Hz		
	Range	m		

Refer- ence	Description ROV Class I, II, III	Unit	Client's requirement		Contractors data	
	Resolution					
	Scanning sector	degree				
	Scanning speed	degreeS/s				
8.4.8	Instrumentation					
	Depth gauge					
	Manufacturer					
	Model/Type					
	Compass					
	General navigation					
	Manufacturer					
	Model/Type					
	Survey Gyro					
	Manufacturer					
	Model/Type					
8.4.9	Auto functions					
	Auto heading					
	Auto depth					
	Auto altitude					
	Auto roll					
	Auto pitch					
8.4.10	Minimum of plug-in connection points for additional equipment					
8.4.10.1	Outlet (12, 24 and/or 250 VDC - 5 A)					
	Outlet (110 and/or 220 VAC - 1 A)					
8.4.10.2	Spare quad or two data channels through fiber					
8.4.10.3	Spare video lines					
8.4.10.4	Hydraulics					
	Number of low flow outputs					
	Pressure	bar				

Refer- ence	Description ROV Class I, II, III	Unit	Client's requirement	Contractors data
	Flow	l/min		
	Number of high flow hydraulic output			
	Pressure	bar		
	Flow	l/min		
8.4.11	Transponders			
	Manufacturer			
	Model/Type			
	Additional sensors and equipment			
	Altimeter			
	Pitch and roll sensors			
	Emergency flasher			
	Emergency beacon			
	Wire cutter			
	AX/VX ring tool			
	Torque tool			
	LP water jet			
	Dredge pump			
	Grinder			
	CP probe			
	Frame grabbing equipment			
	Digital recording system (DVD)			
	DVD burner			

