

NORSOK STANDARD
COMMON REQUIREMENTS
SUBSEA INTERVENTION

U-CR-007
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Please note that whilst every effort has been made to ensure the accuracy of the NORSOK standards neither OLF nor TBL or any of their members will assume liability for any use thereof.

1 FOREWORD

This standard has been developed by the NORSOK Standardisation Work Group for the widest possible national and international application.

Annex A is normative.

2 SCOPE

The purpose of this standard is to define primary requirements to functionality of unmanned intervention systems and interfacing equipment.

Specify an acceptable level of quality in conformance with relevant regulations and standards covering:

- Intervention Control System
 - Surface control
 - Subsea control
- Remotely Operated Tools
 - Pull-in and connection equipment
 - Pull-in and connection tool
 - Component/module replacement tool
 - Skid arrangements
- ROV tools

3 NORMATIVE REFERENCES

NORSOK Standards:

U-DP-001	Principals for design and operation of subsea production systems
U-CR-001	Subsea structures and Piping Systems
U-CR-003	Subsea X- mas Tree System
U-CR-005	Subsea Production Control System
U-CR-006	Production Control Umbilical
U-CR-008	Subsea Colour and Marking
M-DP-001	Material Selection
M-CR-501	Surface Preparation and Protective Coating
M-CR-503	Catodic Protection Design

4 DEFINITIONS AND ABBREVIATIONS

4.1 Definitions

Subsea intervention	Installation / retrieval of modules and components, inspection, maintenance and repair work carried out subsea. Vertical wellbore intervention and internal flowline inspection is excluded.
ROT system	ROT (Remotely Operated Tool) system comprises negatively buyoant, wire suspended tools with control system and support handling system for performing dedicated intervention tasks. This includes typically pull-in and connection of flowlines and umbilicals and replacement of modules and components.
Back-up intervention	Scheduled intervention method when primary intervention method fails.
Contingency intervention	Performance by an unscheduled intervention method.
Sealines	All pipelines, flowlines, umbilicals and cables installed subsea on the seabed.
Termination head	Part of the pull-in and connection system interfacing with the sealine.
Pull-in head	Part of the pull-in system acting as attachment point for the pull-in wire.

4.2 Abbreviations

COB	Centre of Buoyancy
COG	Centre of Gravity
CT	Connection Tool
DP	Dynamic Positioning
FAT	Factory Acceptance Test
HPU	Hydraulic Power Unit
ICS	Intervention Control System
PGB	Permanent Guide Base

PICS	Pull-in and connection system
PICT	Pull-in and Connection Tool
PIT	Pull-in Tool
ROT	Remotely Operated Tool
ROV	Remotely Operated Vehicle
SWL	Safe Working Load
MQC	Multi Quick Connector
WOCS	Workover Control System.

5 FUNCTIONAL REQUIREMENTS

The primary objective for the intervention system shall be to facilitate safe and cost efficient intervention on subsea installations.

The ROT and ROV systems shall in combination perform all intervention tasks during the installation, testing and operational phase of the subsea field. The systems shall be designed with a clearly defined "area of responsibility" between the two systems.

The ROT system shall be used for installation and replacement of heavy components subsea. ROT tasks requiring special purpose designed tools and interfaces shall be carefully defined/planned in advance.

The ROV system shall primarily be used for installation and replacement of small, lightweight components, back-up operation of ROT's and general operational support (observation, cleaning of seal areas, operation of valves etc.). The tasks should be performed by use of the ROV manipulators or dedicated tools without requirements for additional ROV modifications.

Manned intervention shall be used only as a contingency intervention method. Special attention shall be paid to safety aspects if manned intervention is used.

6 ROT SYSTEM - GENERAL

6.1 Main Elements

The ROT system includes the following elements:

- Intervention control system
- Pull-in and connection system
- Module/component replacement tools

6.2 ROT System Requirements

- All functions on the ROT's shall be optimised with regard to durations.
- All ROT operations shall be possible to interrupt in a safe manner and restart in the event of failure or adverse weather conditions. Operations shall be fully reversible at any stage.
- The ROT system shall provide a safe locking of the module/component during handling, deployment/retrieval and operation. If power failure occurs or is switched off during running, the component or module shall remain locked to the tool.

- The umbilical and lift wire attachments shall include a feature for safe splitting of the umbilical and lift wire from the ROT in case of vessel drift off.
- All ROT functions which upon failure may prevent retrieval of the tool to surface shall have back-up override features. This shall include the release from both the permanently installed subsea systems (where locking mechanism is used) as well as from the modules or components.
- No possible or realistic failure shall result in reduced safety for the personnel or cause damage to the surface vessel or to the subsea station.
- All elements within the ROT system shall enable safe and efficient operation, including deck handling and deployment.
- The ROT's shall be controlled by use of a subsea HPU (ROT or ROV mounted).
- All hydraulic components in the ROT system shall be compatible with the hydraulic fluid used in the ICS.
- The ROT shall be fitted with shock absorbers or soft landing systems.
- The ROT system shall be designed for a maximum landing velocity of 1,8 m/s.
- ROT's shall have provision for flushing of the hydraulic system.
- Active hydraulic or electric components should not be left subsea
- The minimum design temperature for the ROT is minus 18 °C.
- The ROT system shall be made as simple, reliable and robust as possible. Elements such as manipulators, thrusters and haul down equipment should be avoided.
- All ROT functions shall have visual subsea status/position indicators visible from ROV, clearly indicating the respective function status. Operations passing through several steps, shall clearly identify the various stages of the operations (e.g. clamp connection).
- The installation of tv-cameras and lights on the ROT should be avoided or kept at a minimum.
- Cutting-loops shall be included for hydraulic functions with override possibilities in order to enable cutting of the loops with an ROV and hence prevent pressure lock in the respective hydraulic function.
- The ROT requirement for special/purpose built ROV tools shall be minimized.
- The ROT and corresponding module/component shall enable adequate access, manoeuvring space and viewing position for work-ROV and obs-ROV to perform all inspection and manipulative work required during ROT operation.
- The ROT systems shall allow operations from drilling rigs simultaneous with drilling and completion activities. This shall include safe entering of the ROT onto the subsea guideposts and landing receptacles. (Target is 10° entry offset).
- The primary guidance system shall be guidelines.
- The guidefunnels should be spaced to suit standard API guidepost spacing (distance between guideposts 2586 mm).
- The guidefunnels shall enable a simple and efficient way of entering the guidewires and eliminate trapping of guidewires during offset running. A full opening guidefunnel is preferred. However, if slotted guidefunnels are used, the slots on the tool and on the transportation skid guideposts shall be located on the same side and oriented such that the tensioned guidewires can be inserted by moving the ROT tools and transport skid to the launching position.
- The ROT shall be well balanced with the resulting centre of gravity point straight below the handling cable attachment point.
- The horizontal running clearance between the ROT the nearest obstructing element in any running mode shall be minimum 1,0 m while on guidewires and 0,2 m while on guideposts.

- Skids for the various tools, components, modules and tool carrier shall be designed for safe and efficient use during transportation and deck operations. The skids shall also be designed for long term storage of the tools, components and modules.
- The skids shall be designed to enable easy and efficient change out of the tools and respective components without the use of deck handling cranes.
- The replacement of components/modules in the various ROT's on surface shall be performed by skidding.
- Each tool including skid shall be supplied with lifting slings certified for the maximum expected handling weight. This shall, where applicable, include the weight of the component/module to be handled by the tool.
- The skid may act as a combined test, storage and transport frame, and shall include all facilities (piping, valves and gauges etc.) required for function testing of the various ROT's.
- The skids shall be well balanced for lifting and handling with the dedicated ROT installed.
- The skids shall be fitted with replaceable mini-guide posts for guidance and locking of the tools onto the respective skids where required.
- Tools, components, modules, skids and trolleys shall have provisions for seafastening.
- The seafastening attachment points shall be clearly marked "For seafastening only".
- All equipment where personnel has to climb onto the module and module stack-ups for handling, inspection or maintenance purposes, shall be furnished with taylor made ladders and temporary grating.
- All control panels, umbilical termination and tool MQC plates shall be protected to prevent damage and contamination.
- Hydraulic lines on the ROT shall be hard pipe unless otherwise agreed.
- Sensitive components/items which may be damaged during running , operation, ROV intervention or interactions with wires shall be protected.
- The ROT system shall avoid snagging points for guidewire, lift wire and umbilical.
- The lifting equipment shall be designed and documented in accordance with DnV's "Certification note 2.7-1".
- Design loads for lifting equipment shall include hydrodynamic loads where applicable.
- Pad eyes for emergency lifting shall be included on all ROTs.
- All elements in the ROT system shall be certified for a safe working load (SWL) to suit the maximum expected load conditions during testing, transport, and offshore operations.

7 INTERVENTION CONTROL SYSTEM (ICS)

7.1 Main Components

The ICS includes the following main equipment:

- Surface control system
- Umbilical and umbilical/liftwire winch system
- Subsea control system.

7.2 General Requirements

- The hydraulic return line system shall allways have a pressure higher than ambient in order to prevent seawater ingress.
- The hydraulic system shall be designed to maintain project specific cleanliness and water content requirements.
- All equipment shall be designed to withstand vibrations during transportation and operation.

- Separate purifier drain and fill connections shall be fitted to all hydraulic reservoirs.
- The sizing of electrical and hydraulic systems shall cater for 20% increase in number of functions.

7.3 Surface Control System

- All the electrical systems shall be designed and approved for use in explosion - hazardous areas, zone 2, temperature class T3, according to "Regulations for Electric installations in Explosive Areas" issued by NVE.
- Electrical equipment shall be water ingress protected with correct IP rating.
- The equipment shall be supplied complete with all necessary interface piping, instrumentation, cabling and hose jumpers so that no on-site installation is required except from connecting the units together.
- The surface control system shall include facilities for computerized storage and printout of relevant feedback data from the various operations.
- Monitoring of applicable surface activities shall be provided.
- All lines, cables, fittings and connectors shall be clearly marked to enable easy identification and connection.
- All control cables, piping, hoses and associated equipment shall be supported and protected adequately to minimize damage during testing, equipment handling and operation.
- The following surface control equipment shall be located in the ICS container :
 - Control console
 - Power distribution
 - Colour monitors
 - Communication to crane/winch and ROV control cabins.
- Facilities for video recording of ROV and ROT operations.
- The ICS container shall have min. 2 off colour monitors and provision for installation of 2 spare monitors. The total number of monitors shall reflect the maximum numbers of functions to be monitored simultaneously.
- The layout of the ICS container shall allow easy access to all components for maintenance and repair. Removable hinged side panels shall be included for protection and maintainability during onshore/offshore operations and transportation.
- The ICS container shall enable deck positioning flexibility, e.g. location of doors, panels, cable inlets/outlets etc.
- The Control console shall have an operator friendly design. Control panels shall be easy readable with logical and understandable marking and multiplexer.
- The control room shall have proper lighting, ventilation and heating.
- The control room shall be noiseprotected according to regulations.

7.4 Umbilical and Umbilical/Wire Winch System

- The umbilical shall be designed for easy handling and operation by incorporating high strength, combined with good flexibility and low weight.
- The umbilical shall contain necessary power cables, twisted pair signal cables and coaxial cables for video signal transmission. Minimum one spare electrical/signal cable each shall be included (fiber optic data transmission will be acceptable).
- The umbilical design shall be suitable for the application required, particularly in respect to torque balance, tensile strength, elongation, fatigue bending and rough handling.
- The jumper umbilicals/cables shall be minimum 75 m.
- The jumper umbilicals/cables shall be provided with hand operated storage reels.

- The umbilical subsea termination shall include an umbilical bend protector.
- The umbilical MQC plates shall be easy to operate. Guidance, alignment and orientation features shall be provided to ensure correct coupler alignment and prevent coupler damage during connection and disconnection.
- The umbilical terminations should be lightweight design to enable handling and connection/disconnection by two operators.
- Umbilicals shall have a system for easy attachment to the lift wire.
- A combined umbilical/lifting wire may alternatively be used. It shall be subject to an agreed test program to verify breaking strength and fatigue resistance.
- Arrangement for umbilical/wire handling and routing shall enable easy and efficient installation and operation.
- All sheaves shall suit umbilical/wire diameter and minimum bending radius.
- Wires shall be of a low grease and non twisting design. Fiber rope shall be evaluated as alternative pull-in wires.
- Winches shall provide efficient running, operation and storage of the complete umbilical/wire. It shall have ample lift and brake capacity to handle the complete umbilical/wire weight (submerged).
- Winches shall include an adjustable constant tension mode with capacity to operate with the umbilical/wire in tension during maximum operation requirement.
- The constant tension winches shall allow direct switch over from normal operation (in and out) to constant tension.
- A lebus arrangement to evenly spool the umbilical/wire on the drum during wind-in shall be included on all winches.
- Winches shall be equipped with a mobile remote operation control in addition to local control at the reels.
- The constant tension winches shall be fitted with mechanical brakes.

7.5 Subsea Control System

- The subsea control system includes the following components and subsystems:
 - HPU with oil reservoir
 - control valves
 - umbilical termination unit
 - sensors
 - distribution system incl. ROV hotlining (if required)
 - TV-cameras and lights (if required)
- All hydraulic piping and fittings should be made of stainless steel. The same hydraulic system pressure class shall be used throughout the system (tentatively 207 bar).
- Subsea electrical units shall be installed in oilfilled, pressure compensated compartments. The oil shall not be part of the hydraulic system.
- The HPU installed shall be mounted on a subframe isolated from the lifting frame by elastomer mounts.
- The hydraulic oil used should preferably be compatible with the oil used by the work ROV.
- Alarm shall be provided upon critical low pressure and reservoir levels in the hydraulic system.

- The following requirements are applicable to a tool carrier:
 - The tool carrier shall act as a common lifting frame and power/control unit for all the various tools in the ROT system.
 - The connection between the tool carrier and the tool shall enable a simple way of positioning and securing the tools to the tool carrier which can be easily operated by a work ROV.
 - The lifting wire attachment point to the tool carrier shall be adjustable to suit the various tools' COG.
 - Umbilical connection to the ROT shall be positioned close to the lifting point in order not to disturb the balance when constant tension is applied to the umbilical.
 - The tool carrier shall be equipped with easy removable grating for protection during deck operations.
 - The tool carrier shall be fitted with two guidefunnels on adjustable guide arms.

8 PULL-IN AND CONNECTION

8.1 Introduction

The pull-in and connection system is used for pull-in and connection of sealines and connection of other equipment/modules to be connected to the subsea production system. The system includes the necessary tools as well as the equipment and components to be installed by the tools. Separate pull-in and connection tools or a combined pull-in and connection tool (PICT) may be used.

8.2 Main Components

The pull-in and connection system includes the following main equipment:

- Pull-in tool
- Connection tool
- Connectors and seal assemblies
- Hubs and terminations
- Pull-in heads and caps
- Tie-in porches/alignment structures
- Subsea electrical connection system

8.2.1 Pull-in Tool

- The PIT shall perform the complete pull-in operation in a single run and secure the sealine in a safe and defined position .
- The PIT shall be mechanically locked to subsea structure or the inboard hub during pull-in operations.
- The PIT shall be capable of performing 1st and 2nd end pull-in.
- A subsea winch shall be used for final pull-in. Surface pull-in winch/take-up reel may be used.
- The minimum pull-in speed during final pull-in shall be 1.0 m/min.
- All PIT elements shall be dimensioned for the maximum sealine pull-in force.
- The PIT shall be capable of performing pull-in without back-tension in the sealine.
- Skew load on the pull-in tool shall be included based on the maximum entry angle of the wire.
- ROV shall establish the connection between the the pull-in wire and the pull-head.

- The pull-in wire anchor shall contain a latch mechanism for easy ROV stabbing on to the pull-in head.
- A wire delivery mechanism shall be included if direct ROV pick up of the pull-in wire is not possible.
- The PIT shall have a pull-in wire feed out mechanism allowing the ROV to maintain tension in the pull-in wire while the PIT is paying out wire.
- The length of wire for second end pull-in shall be 40m from pull-in funnel.
- The pull-in wire shall be ROV releasable from the flowline/umbilical pull head.
- The PIT shall be able to release the pull-in wire from the pull-in head and the complete pull-in head from the outboard hub after the pull-in is completed.

8.2.2 Connection Tool (CT)

- The CT shall be able to perform the complete connection or disconnection operation in a single run.
- The CT shall be designed to meet the maximum connection force required for mating the fixed and the stroking hub.
- The CT shall be mechanically locked to subsea structure or the fixed hub during connection operations.
- The stroking force generated by the CT shall account for all forces within the connection system.
- The CT shall have the capability to enter, catch and align the hubs at a defined worst misaligned condition.
- The CT shall facilitate replacement of seal assembly
- The CT shall have a counting device monitoring number of clamp jackscrew revolutions.
- The CT shall include means of testing the seal integrity after a connection is made up.
- The CT shall be capable to install a single subsea piglauncher to the inboard hub of a single bore sealine.

8.2.3 Connector and Seal Assembly

- The preload shall be maintained mechanically without use of hydraulic pressure or springs.
- The connection shall withstand cyclic loads caused by pressure, temperature and external loads.
- The seal assemblies shall incorporate metal to metal seals for all pressure-containing bores.
- Subsea electrical connections shall be electrical coupler/pigtails connected by ROV to receptacles in the termination head.
- The connectors for the sealines shall permit repeatable connections and disconnection, preferably without the need for replacement of the metal to metal seals.
- Connectors should be of a standard size/rating to facilitate standardisation and easy interfacing with the CT design.
- Clamp connectors and seal assemblies shall be remotely replaceable without retrieval of either hub to the surface.
- Metal to metal seals in piggable lines shall have a inside diameter flush with the line ID.
- An external resilient seal shall be included outside the metal to metal seals. The port shall allow for external pressure test of the connection. No seawater ingress is allowed into the test port after the pressure test. The annular area shall be vented in order to avoid pressure build up in case a leak develops in the metal to metal seal.
- Connectors should include a leak detection system by monitoring the pressure in the cavity between the metal seal and external resilient seal.

- Connectors shall include an orientation and alignment arrangement for the reentry of the CT.
- Multibore connections shall have a system for orienting the seal assembly relative to the hubs.
- Connectors shall be designed for uniform force distribution around the hub circumference.
- Connectors shall incorporate features that prevent unintentional release due to impact from tools, ROV, falling objects, tool failures or due to any other operation imposed loads.
- The connector/seal assembly shall be carried by a proper failsafe suspension arrangement in the Connection Tool.
- The bending moment capacity of the connections are to be equal to that of the pipe as a minimum.
- The resulting face-to-face angular gap after stroking the hubs shall allow the clamp to enter the hubs with proper margin and provide final alignment and make-up of the connection.

8.2.4 Hubs and Termination Heads

- The fixed hub shall meet PICS flexibility requirements.
- The distance between fixed and stroking hubs shall enable installation/retrieval of pull-in head, cap and connector. The distance between fixed and stroking hubs after completed pull-in shall allow inspection and cleaning of hub sealing faces without lifting or lifting off the tool.
- Hydraulic lines shall include check valves to prevent loss of hydraulic fluid or ingress of water and dirt when disconnected.
- All surplus bores in standard multibore hubs shall be permanently plugged.
- For multibore sealplates it shall be possible to utilize the spare lines in umbilicals by installing a special X-over sealplate .
- Hubs shall not represent a flow restriction.
- The hub seal preps shall in case of damage accomodate contingency sealing by installation of modified seal rings.
- Hubs in piggable lines shall have flush inside diameter with the line.
- The termination head shall be optimised with regards to weight and size.
- The termination head shall withstand all loads from the sealines and dispose them into the subsea structure via the pull-in funnel or lockdown device. The disposal of structural loads through the fluid connection should be avoided.
- The termination head shall have wire attachment points for laydown purposes or in case a pull-out of the sealine is required.
- The umbilical termination head shall have a marking system for rotation identification.
- The termination head for umbilicals shall have provision for installation of electrical coupler receptacles and a splice chamber for electrical lines between the umbilical termination and the electrical couplers. The splice chamber shall be oilfilled (dielectric) and pressure compensated.
- The termination head shall have provisions for installation of ROV removable covers, protecting the electrical coupler receptacles.

8.2.5 Pull-in Heads and Caps

- The long term protection cap shall include means of protecting the seal area. The long term protection cap shall be installed on surface and retrieved by ROV.
- The long term protection caps shall prevent intrusion of salt water to the hub sealing areas and shall not be pressure containing. If required, a pressure equalization device shall be included.

- The pressure caps/blind hubs shall be installed/retrieved by use of the CT. The pressure caps shall be connected by means of a connector and shall have same rating as the hub/bores it blinds off.
- The short term protection cap shall protect against dirt and seawater circulation and be installed/retrieved by ROV.
- The pull-in head and corresponding clamp shall be designed to prevent accidental release during all phases of the installation and pull-in operations.
- There shall be provision for installation of dirt protection plugs on any vital parts.
- The pull-in head shall be designed to enable connection of an ROV installed hotstab for flushing and pressure testing purposes. The possibility of using the hotstab for pigging purposes shall be evaluated.
- The pull-in head shall be designed for bleed-off through the hot stab.
- The pull-in head shall if practicable be retrievable to surface.

8.2.6 Tie-in Porches/Alignment Structures

The tie-in porches/alignment structures shall preferably be designed as "skid mounted " complete units for easy integration into the subsea installation /structure.

The pull-in and connection equipment including the tie-in porches shall be designed to withstand snag loads in accordance with project specific requirements.

- The pull-in funnel or alignment structure shall have a minimum elevation above seabed.
- The single bore sealines shall not be oriented during pull-in.
- The maximum entry angle (horizontal plane) of the termination head as it enters the alignment funnel is 10 °. for rigid lines and 15 °. for flexible lines and umbilicals.
- Multibore sealines shall be oriented +/- 90 °.
- Lockdown mechanism for sealines in connected and unconnected positions shall be included. The lockdown mechanisms may be ROV operated if practicable.
- The structural interfaces shall resist the imposed forces and moments from the sealines. The loads shall be transferred via the structural interface to the subsea structure and not through the fluid conduit or electrical connections. Further, the structural interface shall be arranged to avoid any local bending of the lines due to expansion forces imposed by the sealines.

8.2.7 Subsea Electrical Connection System

The below requirements apply to the ROV operated electrical connection system:

- If a dual chamber electrical connector is not used for dielectric fluid protection of the couplers, a dedicated actuation tool with flushing capability of the electrical couplers shall be provided.
- The electrical connectors shall be parked in a safe position during the pull-in and connection and shall be protected from damage by ROVs.
- The electrical connectors shall be arranged to enable individual replacement by ROV.
- The electrical connector receptacles in the termination head shall have ROV removable protection caps.
- Sufficient space shall be left for inspection and possible cleaning of the electrical connectors in the termination head.
- The protective caps and dummy receptacles for the electrical connectors shall include means of flushing with di-electric fluid if dual chamber electrical couplers are not used.

9 COMPONENT/MODULE REPLACEMENT TOOLS

9.1 Introduction

It is a primary objective to standardize the replacement tool interfaces so that all components/modules can be replaced using the same replacement tool.

9.2 Main Elements

The main component/module replacement tools are :

- insert valve replacement tool
- choke replacement tool
- control pod replacement tool

9.3 General Requirements

- The component/module shall be landed in a two step sequence:
 - land tool on subsea landing structure
 - final landing and alignment of module/component onto the subsea interface.
- The component/module replacement tools shall be designed with sufficient flexibility to self align and enter freely the component/module mating point.
- The component/module itself shall self align and enter freely the landing receptacle.
- Component/modules interfacing pressurized equipment (e.g. valve insert, clamp connection) shall have provisions for verifying that internal pressure is bled off . It shall also be possible to verify the seal integrity on connection point through ROT system.
- The replacement of the component/modules shall be based on vertical retrieval and reentry to the landing receptacle.

9.4 ROT System Test Requirements

- The ROT's shall have provisions for extended surface testing.
- All ROT functions (including back up) shall be verified
- New designs shall be evaluated with respect to requirement for qualification and wet testing.
- The ROT system tools and components shall be match tested on all working location(s).
- The ROT system tools and components shall be drop tested to demonstrate the systems ability to withstand dynamic shocks as specified. All functions shall be tested and verified before and after the drop test.
- All structural, mechanical and control (electrical and hydraulic) internal interfaces within the ROT system shall be verified.
- All structural, mechanical and control (electrical and hydraulic) external interfaces between the ROT system and interfacing systems and components shall be verified.
- The ROT stability (COG/COB in air and water) shall be verified.
- Entry and landing of ROT at max. entry angle shall be verified.
- All dimensions and weights shall be verified, including weight in water for tools and modules to be handled subsea.
- All capacities such as torque output, stroking forces, override forces/torques shall be verified.

- Proper calibration of all relevant equipment such as sensors, switches, gauges etc. shall be verified.
- ROV access for monitoring, inspection; and operation of relevant ROT functions (including back up) shall be verified.
- All required ROV tools shall be interface tested with the ROV.

9.5 ROV tools

9.5.1 ROV Tools requirements

- Special skids underneath or at the sides of the ROV shall be avoided.
- Proven components and interfaces shall be used where possible.
- The tools shall include all elements required for performing the planned operations.
- The ROV tools shall preferably be operated without any additional surface support.
- The ROV tools shall be designed to enable flushing of the hydraulic circuits.
- High contrast colours shall be used to highlight moving parts such as tool and valve handles.
- The ROV tools shall allow for efficient operation by a typical work ROV.
- The submerged weight of the ROV tools shall be within the weight carrying capacity of a typical ROV.
- The ROV tool handles shall be easy replaceable and be adopted for various types of manipulators.
- The ROV tool handles shall include an reaction plate or similar arrangement preventing rotation of the tool when being held by the ROV.
- Transport boxes for ROV tools shall be robust and suitable for offshore transportation. A content list, drawings, parts list and general operation instructions shall be mounted in a laminated plastic cover fitted to the inside of the box.
- New ROV tool design shall be evaluated with regard to requirements for wet testing as part of FAT.
- The medium torque tool version for ROV operated valve shall be based on a torque range up to 1700 Nm
- The high torque tool version for ROV operated valve shall be based on torque values up to 9500 Nm.
- The valve torque tool shall be fitted with a valve interface of shape, dimensions and tolerances according to relevant standards.
- The valve torque tool shall be designed for valves with non-rising spindles
- Hub cleaning and inspection tools shall be based on high pressure water jet cleaning and mechanical brushing which shall include a connection port for injection of chemicals and internal cameras with lights for monitoring/inspection purposes.

9.6 ROV interface requirements

- ROV interfacing equipment shall be optimized for direct use of ROV manipulators.
- Grabber bars or docking platforms allow the work ROV to dock or land in a stable position with good view and reach to the work task location.
- ROV platforms should be flush and without any obstructions for the ROV .
- The vertical distance from the lowest point on the ROV frame down to an area to be inspected and/or cleaned by the ROV, shall be max. 300 mm.
- The horizontal distance from the front part of the ROV to a work location shall be minimum 500mm and maximum 1500mm.

- The general operational envelope for observation-ROV is 1,9m x 1,5 m x 1,5 m (LxWxH) The operational envelopes with special equipment / tools fitted to be agreed on a case to case basis.
 - The general operational envelope for work-ROV is 3,5m x 2,9 m x 2,9 m(LxWxH) The operational envelopes with special equipment / tools fitted to be agreed on a case to case basis.
 - The distance from the outskirts of structure to the task site shall be evaluated with respect to minimizing the need for flying the ROV backwards out of the structure.
 - The surrounding/interfacing structures and equipment such as valve spindles and mini-guidepost shall be designed to avoid potential snagging points for the ROV and its tether or umbilical.
 - The ROV system and the surrounding/interfacing structures shall be designed to minimise adverse impact on ROV operation from environmental conditions such as strong currents and poor visibility.
 - Sensitive equipment/components located in areas which may require intervention shall be protected against ROV impact (1000 kg at 0.5 m/s).
 - Low torque ROV operated valves shall be fitted with a handle suitable for operation directly by the ROV manipulator.
 - The low torque valve handle shall be fitted with mechanical stops at either end-position preventing the valve to be overturned and overloaded. The stopping mechanism shall not protrude the front side of the valve panel.
 - Valve handles and attachments for ROV manipulator operation shall for low torque valves as a minimum be designed and tested to a torque of 400 Nm, a bending moment of 1000 Nm and an axial force of 5000 N.
 - The valve handle shall be used as the valve status indicator. Robust and clearly visible position marks for both handle positions shall be included. The distance between the indicator and the reference point should be 5mm.
 - Position indicators shall not exceed one revolution between end stops.
 - Several valve- or actuator spindles close to each other shall be grouped on the same ROV panel.
 - The valve spindle location shall allow sufficient access for the work ROV. An area equal to a circle of 300 mm around the valve spindle shall be free for any obstruction.
 - The valve spindle and reaction system for medium and high torque ROV operated valves shall be designed to transfer only rotational torque to the valve. Other loads such as axial force, sideways force and bending moments shall not be transferred to the valve/actuator.
 - The torque tools shall provide a torque minimum 30 % higher than the maximum required operation/break out torque value measured at the torque tool interface. For valves up to 3" bore the valve design torque shall be minimum 100% greater than the maximum required operation torque measured at the torque tool interface.
 - The medium and high torque ROV operated valves shall be designed and tested to take a bending moment of minimum 3000 Nm and an axial force of 3000 N at the ROV interface and still be operable within the specified torque values.
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ANNEX A INTERFACES (Normative)

The various detailed internal and external interfaces shall be identified and sorted out on a project to project basis.

Interfaces identified below are included as a guideline for establishing an interface register:

- **Vessels** , consider features such as handling, skidding and deployment/cursor system; electric, pneumatic and hydraulic power; deck facilities, moonpool size, size and weight limitations of ROT and modules, control container/room facility including communication and monitoring system, stationkeeping, motion characteristics, etc.

The total stack-up height of the ROT including component/module and umbilical sheave arrangement should be less than 7 m from deck level to suspension point for liftwire/umbilical sheave, due to rig and existing handling system limitations.

The maximum weight of any ROT including module/component should for handling purposes not exceed 30 tonnes.

The launching system shall be designed to minimize mobilisation time on vessel.

The deck handling system shall allow efficient deck handling of tools and components minimizing the need for use of cranes, hence a trolley or skid system shall be used for transporting the tools and components between working deck and launching position.

The guidance system will contain the following equipment:

- Constant tension guide wire winches with guide wires
- ROV retrievable guide wire anchors of Company standard dimensions
- Suitable guide wire sheaves.

The guide wire system on surface may allow asymmetrical adjustment of the guidewire distance.

- **Subsea structures** (templates, manifolds and riserbases), consider features such as layout and size landing area , guideposts, locking mechanisms and the pull-in funnel/alignment structure; process piping /manifold system, sealine snag loads, etc.
- **Subsea tree system** (incl WOCS), consider features such as layout and dimensions of PGB landing area; guideposts, locking mechanisms and the pull-in funnel/alignment structure; process piping , wellhead load capacities, tolerances, sealines snag loads, etc.
- **Production control system** , consider features such as number of lines, sizes, pressures, fluids, electrical connections, etc.
- **Flowlines** , consider features such as size, rating, stiffness, termination, material, snagloads, backstroke limitations, etc.
- **Umbilical**, consider features such as size, rating, stiffness, umbilical termination, material, snagloads, backstroke limitations, electrical connections, etc.
- **Risers** , consider features such as size, rating, stiffness, termination, material, forces, etc.
- **Testing** , consider features such as test facility location, test equipment, etc.

- **Transportation** , consider features such as site location, method of transport, weight and size limitations, seafastening, etc,
- **Installation of structures**, consider features such as levelling requirements, positioning tolerances, installations, weight limitations, etc.
- **Installation of sealines**, considering features such as pipelaying and umbilical installation, sequences, trenching, mattresses and rockdumping, etc.
- **Work ROV and observation ROV** , consider access for observation and inspection, operation of ROV tools, handling of pull-in wire, operation of lockdown mechanisms and mechanical overrides, cleaning of hubs, etc.