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USE OF ROV'S IN OPERATION OF EAN UNDERWATER INSTALLATION IN THE NORTH SEA

F. Ricci

Elf Aquitaine Norge A/S
P.O. Box 168
N-4001 STAVANGER

1. INTRODUCTION

The purpose of the paper is to present the state of the Art in use of ROV for assistance in offshore operations. This is done through a review of operations and gained experience during East Frigg Field diverless installation in 1988 and 10 years or under water Inspection, Maintenance and Repair (IMR) on all Fields operated by Elf Aquitaine Norge A/S (EAN).

Basic requirements to the types of ROVs are given and the cost-efficiency of the operations are discussed.

The potential for further development of the ROVs to replace divers for a large part of annual IMR tasks below water is addressed.

2. SUMMARY

Over the last decade EAN has worked systematically to increase the efficiency in the use of ROVs in the annual inspection of structures and pipelines below water. In 1988 EAN performed 3231 hours of subsea work by divers and ROVs. 60 % of this was ROV work related to general visual inspection of structures below waters, cathodic potential measurements, cleaning of steel structures for MPI inspection, visual inspection and cathodic potential measurements of pipelines and drilling support.

The ROV's are either deployed from the offshore platforms or from ROV support vessels. The vessel support requires a higher dayrate than the platform support, but the flexibility of the operations is increased and for short duration operations this can be more cost efficient.

A further increase in utilization of ROVs in the inspection is foreseen when use of Eddy Current scanning technique and MPI has become feasible for crack detection on steel structures. A development project in this area is now being considered by EAN.

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INTRODUCTION

The purpose of this paper is to review the types of ROV operations presently undertaken as a part of the operations on the EAN installations on FRIGG and NORTH EAST FRIGG, and also to present the experience gained during the EAST FRIGG diverless installation.

Basic requirements to the types of ROV's will be given and the cost efficiency of the operations will be addressed.

The potential for further development of the ROV's to replace divers in the annual inspection, maintenance and repair (IMR) tasks below water will be discussed.

GENERAL

EAN was perhaps the operator on the Norwegian Continental Shelf that first started with a systematic use of ROV's in the day to day operation of offshore fields, and also in the development of ROV based systems to fit specific applications/projects.

Systematic use of ROV for general structural inspection below water was started in 1978 and included cathodic potential measurement (CPM). In 1981 the pipeline inspection was for the first time carried out by a large sophisticated ROV as a replacement for manned submarines.

In 1980 also the testing of cleaning systems for concrete structures below water was started and large areas of concrete (more than 300 m^2) were cleaned for marine growth.

It should also be mentioned that in 1982 the first ROV for subsea drilling support/assistance was introduced and since then, all drilling support has been performed by ROV.

In 1984 the first test of cleaning of nodes on steel structures was carried out, and this system has over the following years been further improved.

In 1988 a specialized ROV for diver support was tested for the first time during the annual IMR activities on the FRIGG Field with good results.

Also the same year the first MPI by ROV was performed as a part of a R&D project.

As a part of East Frigg project, a special ROV tool package was manufactured complemented with a large variety of ROV adaptor tools.

TYPICAL ROV'S INTERVENTION

This paper describes the typical ROV activities during 1988. The reason for selecting 1988 is that this is a typical year for work performed on a yearly basis.

The ROV activities were:

- Drilling support activities
- Inspection, Maintenance and Repair of permanent offshore structures
- Cleaning of steel structures
- Pipeline Inspection
- Diver assistance
- Assistance during EAST FRIGG installation

1 Assistance during drilling activities

For this work a large ROV was used with the following specifications:

Dimensions	2.2x1.5x1.8 m
Speed	0.25 m/s
Tether handling	100 m tether capacity
TV camera	colour, black and white
Still photo	yes
Manipulators	one seven function master/slave one five function rate control (grabber)
Handling unit	skid mounted, classified for zone two
Control room	classified for zone two, containerized.
Special tools	wire cutter 32 mm capacity, seal ring removal tools, water pump, special recovery hook.

In EAN terminology, this type of ROV is called a "DRIROV".

Scope of the work during Drilling Assistance

The first ROV operation is to perform bottom survey of the drilling location. The equipment used for this, is the scanning sonar and the TV camera.

During this survey debris, boulders etc. may be found. In such cases the ROV is used to remove these debris from the location.

The next ROV intervention is to assist during the lowering of the guide base and the installation of guides lines.

All this work is done by use of the ROV manipulators.

Once the guide base is installed, the next ROV intervention is to control the cement return. Cement may cover parts of the guide base or X-mas tree components and has to be removed.

This removal is done by water jetting, utilizing the ROV mounted water pump. The type of pump used will depend on the amount to be removed.

During normal drilling operation no ROV intervention is required. The ROV and the crew are kept in standby on the drilling platform.

A typically unplanned intervention is to change a broken guide wire or to remove a seal ring. Guide wire change out is performed by the ROV, removing the remaining piece of broken guide wire by use of a wire cutter and then installing a new guide wire.

For the seal ring a special purpose built tool is used.

At the completion of the drilling operation, the ROV performs a bottom survey.

2 ROV Assistance during Inspection, Maintenance and Repair (IMR)

At the Frigg and Heimdal fields all the fixed platforms are equipped with dedicated ROV locations. Each ROV location is provided with electrical power, communication and alarm connections. For underwater installations such as NORTH EAST FRIGG and EAST FRIGG, the inspection is performed with the ROV mobilized on the diving support vessel. Thereby combining the annual inspection with the ROV assistance to the diver. This combination has proved to be a very cost effective way to utilize ROV for inspection activities.

There are three types of underwater inspection:

- General Visual Inspection
- Close visual Inspection
- Non Destructive Testing (NDT)

2.1 General Visual Inspection

For this type of inspection a small ROV is used with the following technical specifications:

Dimension	1.2x0.8x0.8 m
Speed	1,25 m/s
Tether Handling	120 m tether
Camera system	high quality colour SIT camera black and white, still photo camera, cathodic potential measurement system, marine growth measurement devise, accurate depth sensor
Handling unit	Skid mounted, classified for zone two
Control room	classified for zone two, containerized

This type of ROV used for inspection is called "SIROV".

2.2 Scope of work for General Visual Inspection

The statutory in service inspection programme requires 100 % inspection of the underwater structure over a four years period in the Norwegian sector, and over five years period in the UK sector of the North Sea.

The purpose of this inspection is to evaluate the conditions in order to assess the platform integrity.

The main work for the ROV is to visually inspect the whole structure below water, take cathodic potential measurements and marine growth measurements. This is performed by the ROV using the high quality colour TV camera, potential measurement equipment and marine growth measurement device.

During operations the pilot of the ROV is flying the ROV under the instruction of dedicated inspection engineer. Any finding is reported and documented on video tape and still photos.

2.3 Close Visual Inspection and NDP

For this type of work a large ROV is used with the following technical specifications:

Dimension.	2.2x2x1.8 m
Speed	1,25 m/s
Tether management	150 m tether
Camera system	High quality colour/close-up capacity, SIT camera black and white miniature colour camera manipulator mounted, still photo camera stereo system
Manipulator	one seven or nine function master slave type, one seven function rate controlled, one three or five function grabber with suction pads
Special tools	air grit blasting system, hydraulic steel brush
Handling system	classified for zone two
Control room	classified for zone two

This type of ROV used for inspection is called "CLEROV".

2.4 Scope of work for Close visual inspection and non-destructive testing (NDT)

Close visual inspection requires that the inspected area is cleaned to an approved cleaning standard. This is performed by the ROV. By using the suction pads the ROV keep position in front of the work location and start cleaning. For close visual inspection all marine growth must be removed. This is achieved by using steel brush or air/grit blasting.

Operations over the last years have demonstrated that the most effective method of cleaning is to use the air/grit blasting system. With this system cleaning to the standard required for magnetic particle inspection (MPI) is achieved easily.

The next operation is to visually inspect the cleaned area with a colour camera. In areas with restricted access a manipulator mounted colour camera is used.

If necessary, still photo are taken using single or stereo still camera. Normally this camera is mounted on the manipulator.

Where NDT is required, the role of the ROV is to prepare the work site by cleaning to the required standard for MPI. This MPI is then performed by the diver from the diving support vessel.

2.5 Pipeline Inspection

The EAN production installations are connected by a network of pipelines. All pipelines must be annually inspected according to a similar In-service Inspection Programme as for the platforms.

For this work a large ROV is used with the following technical specification:

Dimension	2.5x2x2 m
Speed	2,25 m/s
Manipulator	one five function grabber
Camera system	low light TV for general purpose (SIT), colour TV for inspection purpose, two set of TV cameras mounted on telescopic boom showing both sides of the pipeline
Handling system	telescopic crane
Others sensors	trench profile, pipe tracker burial, measurement, cathodic potential measurement, bathyimetric system, still photo system, under water acoustic transducer

This type of ROV used for pipeline inspection is called "PIROV".

2.6 Scope of work

To perform the pipeline inspection the ROV is mobilized on a special vessel. The main characteristics of such a vessel are:

- Full dynamic positioning capability.
- Sophisticated surface positioning system.
- Underwater acoustic positioning system (HPR).

The purpose of this inspection is to assess the integrity of the pipeline. This is achieved by the ROV flying above the pipeline on a fixed altitude and inspect visually by TV camera. At the same time, continuous cathodic potential measurements are taken as well as the measurement of the burial depth, etc.

Where the pipeline is cover by gravel, the ROV follows the pipeline by using a pipe racker.

During the inspection the exact position of the ROV is recorded on-line and survey file produced.

ROV ASSISTANCE DURING THE EAST FRIGG DIVERLESS INSTALLATION

1 General

At an early stage of the project, the ROV was mainly considered as a potential back up for the main tools.

During the engineering phase several tasks and back up functions were assigned to ROV's. This led to specific ROV activities such as:

- ROV's operations on subsea modules and tools.
- ROV's operations on bundles and lines.

2 Selection of Rov's and interface to East Frigg equipment

The EAN philosophy for ROV operations was to use existing vehicles and manipulators and as far as possible use standard components for the interfaces with the EAST FRIGG (EF) equipment.

Above requirement was necessary to ensure flexibility in use of ROV over the entire production life of the project by allowing conventional ROV's to be compatible with the EAST FRIGG equipment.

3 Selected ROV's

A small and highly manoeuvrable type of vehicle was selected for all observation and inspection tasks. (OBSROV specification). (Such as: Sprint, UFO, Sea Owl).

For intervention on EAST FRIGG tools and modules a type of large ROV was selected (CLEROV specification) such as Triton, Super Scorpio, Challenger, Hydra Pioneer, Trojan.

4 ROV interface

In order to apply standard ROV's to the EF tools and modules, interface equipment were made, either for the ROV itself, like:

- Hydraulic work package.
- Docking frame.

Or for the ROV manipulators:

- Hydraulic connectors.
- Valve override tools.
- Adaptors.

The EF modules and tools were equipped with special ROV interface arrangements like:

- Lifting frames adapted with ROV local control panel.
- X-mas Trees fitted with valves panel.
- Modules and tools equipped with local control panel.
- Bundles dedicated with local control panel.
- Manifold valves fitted with Guidance System.

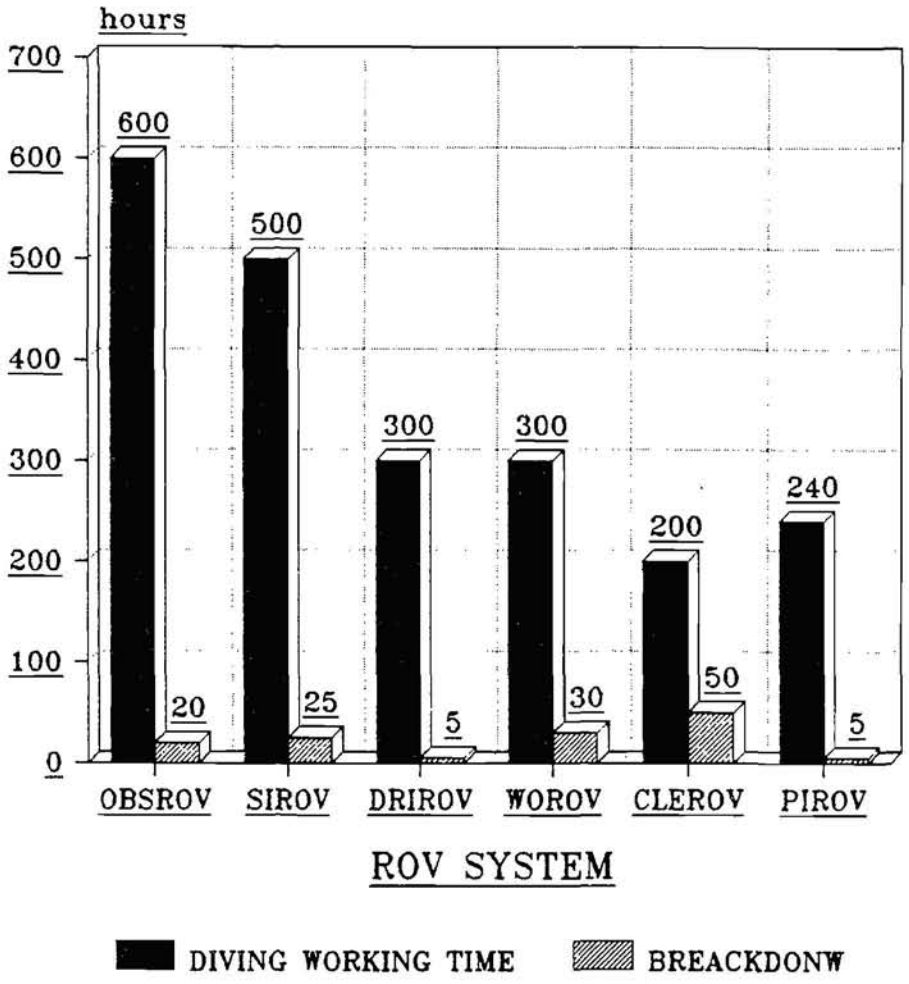
ROV PERFORMANCE

Over the last 10 years the general ROV performance has improved considerably. From the unreliable systems of the early eighties to the systems today the availability has improved from 20 to 80 % of total time.

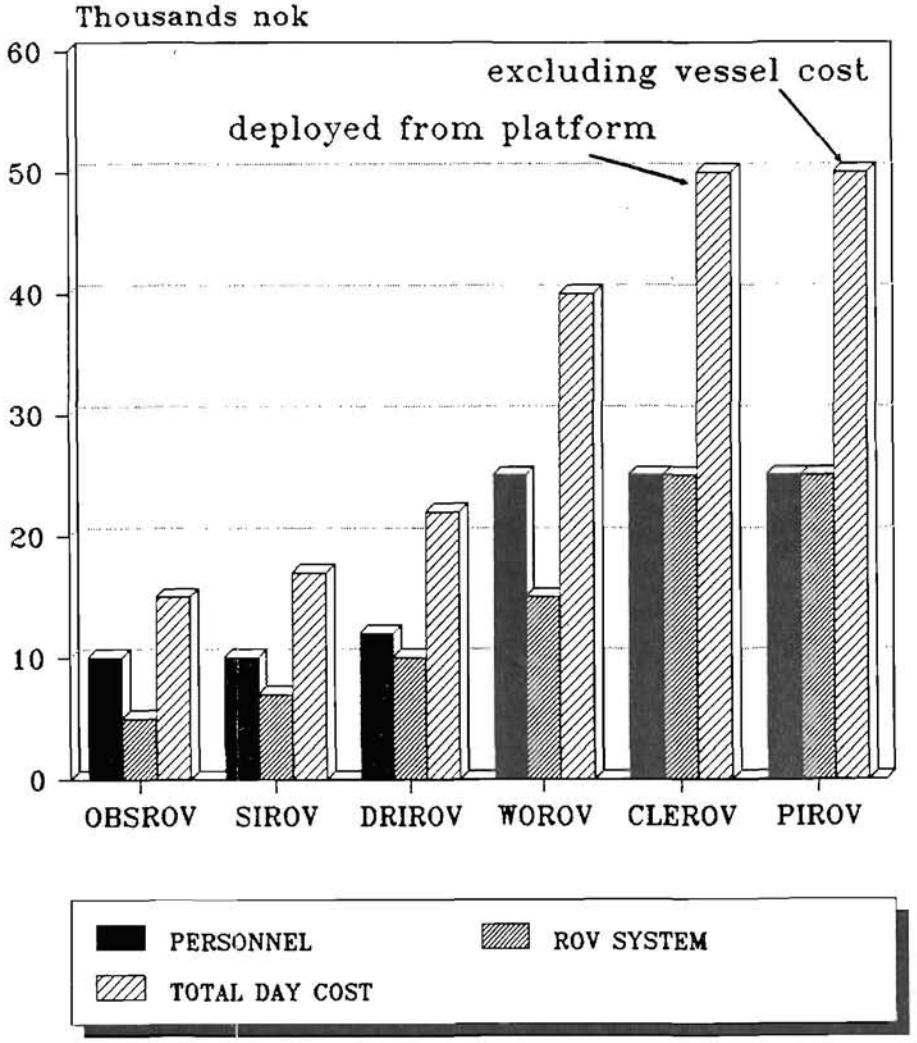
This is mainly due to the better quality control during fabrication and also the fact that ROV contractors, as a result of operational experience, can specify their requirements to the manufacturers.

A table showing ROV performance for particular applications is given in appendix 1.

ROV PERFORMANCE
OVER ONE YEARS OPERATION



ROV RELATED COST



note:personnel for 24 hours operation

ROV RELATED COSTS

Costs related to ROV intervention are dependant upon the scope of work for the ROV.

For observation work with small ROV manned for 12 hours operation per day the cost is about 9000 NOK/day.

For a large ROV for cleaning operation manned for 24 hours operation the cost comes up to 50-60 000 NOK/day.

Typical rates for ROV's operations are shown in appendix 2.

USE OF NEW TECHNOLOGY WITH ROV'S

In the field of ROV intervention it is generally agreed that the following sub systems need to be improved:

- Visual feed back to the operator/inspector.
- Better control of the manipulator.
- Better ROV tools for NDT inspection.
- Improvement of the documentation.

EAN has performed a study of the available technology related to the above sub systems. As a result of this the following improvements were implemented:

- Use of super VHS camera.
- Use of video printer.
- Use of laser beam scanner.
- Use of stereo TV camera.

EAN have initiated development projects within the following areas:

- Development of a single monitor stereo system.
- Development of a computer controlled manipulator.
- Development of new Eddy Current telemetry system, based on the use of the Eddy Current System developed by Harwell.

The developments are part of a main R&D project call REMO. This project was initiated in cooperation with Phillips Petroleum Company Norway on the basis of a 50/50 co-operation. The project was started in June 1990 and completion is planned for December 1991.

The objective of the REMO project is to develop a system which can perform inspection by NDT using ROV only.

The system shall be able to perform the following tasks:

- General Visual Inspection.
- Close Visual Inspection after cleaning.
- Cleaning.
- Crack detection by Eddy Current and MPI

CONCLUSION

We foresee in the future an increase in the use of large ROV capable to perform tasks which today are performed by divers, such as NDT inspection.

The use of new inspection method and the implementation to the ROV system of new technology, will improve the overall working capability and increase the performances.

It is believed that the key factors for cost effective use of ROV on underwater installations are:

- Evaluate design concepts with relation to use of ROV for installations and for IMR work and implement ROV work to the extent possible.
- Keep updated on new technology available.
- Implement this technology into specifications and procedures in order to reduce the overall cost of operation.
- For existing installations make the necessary modification to accommodate ROV operations from the installations if possible.

If the above considerations are taken into account these successful and cost effective ROV operations are resulting.