More than a remote possibility

Patrick Feeleus, Noordhoek Offshore BV, The Netherlands, discusses the company's Remote Operated Towed Vehicle (ROTV) and its application in pipeline inspection projects.

Figure 1. FOCUS-2 ROTV.

After having taken delivery of two MacArtney Focus-2 Remotely Operated Towed Vehicles (ROTV) at the end of April, the Survey Department of Noordhoek Offshore B.V. faces a busy schedule. May will see the yard testing of the system and in early June, the completion of the system sea trials is expected. The FOCUS-2 ROTV system will be the latest addition to the Noordhoek fleet of underwater vehicles and gives clients the opportunity to use an alternative survey contractor. From an availability point of view, in the increasingly tightly scheduled offshore market, this fleet extension can be very beneficial for clients, who now have the opportunity to use one provider for the provision of specialised and efficient survey services. Sea trials and qualification are expected to be successfully completed by early June 2007.

Pipeline inspections

The Noordhoek Survey Department has been operational for over four years. Throughout this period, Noordhoek has completed a wide variety of survey projects serving the oil and gas industry. Pipeline inspections comprise a major share of the survey/inspection activities performed by Noordhoek.

Pipeline inspections are a part of an integral asset management/integrity programme developed by the asset owning or operating company. Such Pipeline Integrity Management programmes are essentially non prescriptive and, rather than an outside agency or standards body detailing activities to be carried out, asset owners/operators are expected to develop and implement programmes that fit their own technical, organisational and political circumstances. As a result, these programmes are performance based, with success not measured by detailed compliance with a rule, but by the effectiveness of the incidents being prevented or controlled.

From an external pipeline assessment perspective, the Noordhoek Survey Department usually enters the pipeline inspection project at the 4^{th} phase of the five step ASME process. (Figure 2). The asset operator/owner previously defined their inspection requirements from Phase 1 to Phase 3. Dependant to the lifecycle phase of the pipeline and possible improvements made to the inspection programme defined in phase 1 to phase 3, the inspection requirements might involve detecting freespans, damage and defects, leaks, corrosion/erosion, pipeline movement, upheaval buckling, trenching depth or cathodic protection system measurements.

Table 1. Survey platform capabilities

	Sides scan	Multi beam	Pipetracker/ magnetometer	Subbottom profiler	Echo-sounder/ bathymetry	CP inspection	Video/ still photo inspection
Tow fish	Yes	Yes, Vessel mounted	Yes	Yes	Yes, vessel mounted	No	No
ROTV	Yes	Yes	Yes	Yes	Yes	No	No
ROV	No	No	No	No	Yes	Yes	Yes
WROV	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 2. Survey sensor terminology

Sidescan	Used for seafloor and seabed feature imaging (i.e., wrecks, sand waves, etc.). With the ROTV platform (stable and proper heading control) it is also possible to identify external deficiencies (i.e., damages) on a pipeline or pipeline coating.
Multibeam	Is used to establish a seabed (depth) profile and can also be used to detect pipeline freespans, exposures and upheaval pipeline buckling.
Pipetracker/magnetometer	Devices which are used to locate or fix the position of a (buried) pipeline where a pipetracker is used on an WROV and a magnetometer is used on a tow fish or ROTV.
Subbottom profiler	Can be used to locate/pinpoint a buried pipeline or pipeline section including the depth of burial and to visualise potential geohazards.
Echosounder/bathymetry	Used to detect and determine the depth immediately below the transducer.
CP Inspection	Cathodic protection measurement are performed to confirm the integrity of the pipeline cathodic protection system and to confirm whether the bare pipeline material is exposed by external damage on the protective layer (usually concrete).
Video/still photo inspection	Close visual inspection (usually on the top, left and right side of the pipeline) is performed to establish video/photo proof of the pipeline condition.

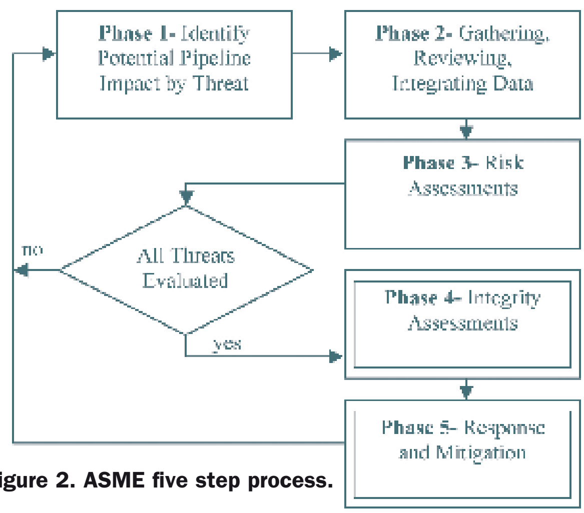

Figure 2. ASME five step process.

Survey techniques and platform suitability

Depending on the pipeline inspection requirements, the survey platform and the associated survey methodology are selected. Table 1 gives a brief overview on the survey methodology possibilities in relation to the potential survey platform, and demonstrates the ROTV possibilities in comparison to the other available survey techniques.

For the sake of clarity, a brief definition on the terminology used is given in Table 2.

ROTV inspection scenarios

A 'Rolls-Royce' pipeline inspection is performed by deploying a light work class ROV, including the associated DPII Survey Vessel. This relatively slow inspection methodology (approximately 750 m per hour effectively) will give the asset owner/operator a very detailed overview on the condition of the pipeline (including CP measurements), but due to the relatively low speed of survey, this methodology results in substantial cost per meter of survey. The high cost of this survey methodology relates

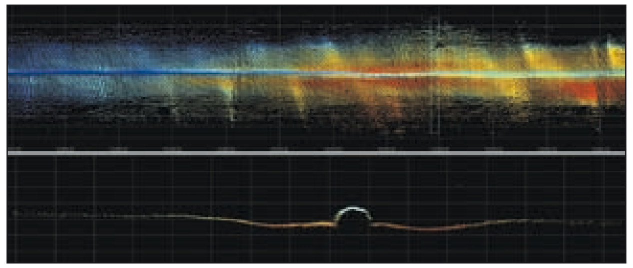

Figure 3. Multibeam profile image of a pipeline including the unburied section of the pipeline.

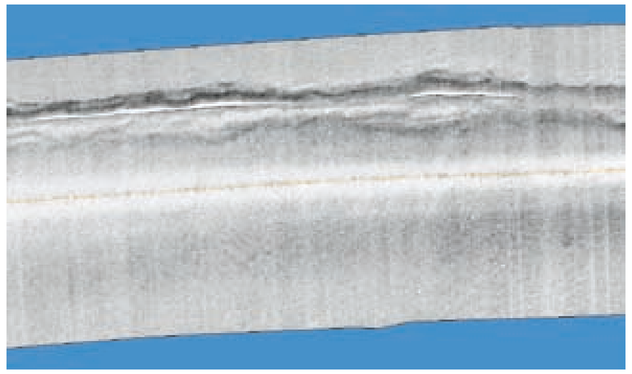

Figure 4. Side scan sonar image of a partially buried pipeline.

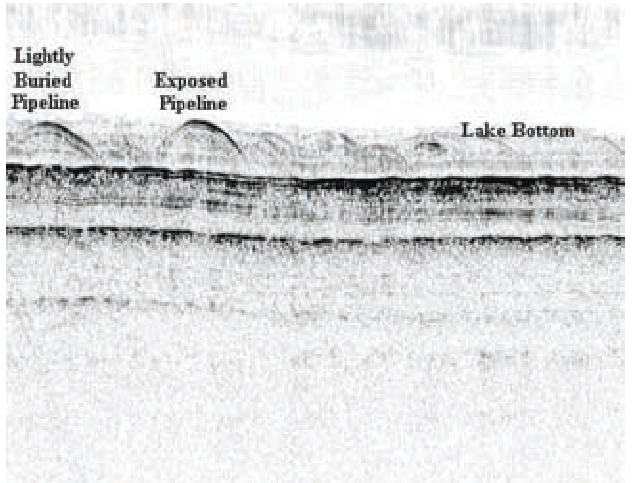

Figure 5. Subbottom profile image of a partially buried pipeline. *Courtesy of EdgeTech.*

Table 3. Scenario 1: Global pipeline inspection. Assumptions.		
	Tow fish	ROTV
Survey speed in km per day (deducted with reruns)	150	220
Survey vessel (Non DPII) dayrate	68%	68%
Survey crew dayrate	14%	18%
Survey platform dayrate	2%	14%
Total spread cost in percentage	84%	100%
Total price percentage per km of survey	123%	100%
Ratio	0.81	

to the DPII survey vessel requirement and high investment for maintenance cost of the WROV.

In case the requirement for a close visual inspection does not exist and a pure acoustic inspection suffices, a pipeline inspection can be very efficiently performed by the use of an ROTV.

Scenario 1: Global pipeline inspection

The purpose of a global pipeline inspection is to quickly obtain a general impression of the condition of the pipeline and the associated foundation and/or protecting medium (i.e., dumped rocks). The ROTV will be deployed through a non DPII survey vessel. Observations might include for instance seabed shape, pipeline movement and freespans. These observations might trigger a close visual inspection later in the season, or in the subsequent year

Scenario 2: Global pipeline inspection with various points of interest

The objective of the pipeline inspection in scenario 2 is similar to the objective described in scenario 1. The difference, however, is that a detailed investigation on points of interest will be performed straight after completion of the ROTV survey. The disadvantage obviously is the requirement of a DPII survey vessel plus a WROV, but the advantage is that no additional mobilisation or demobilisation is involved and the condition of the pipeline is more accurately known at the end of the survey campaign.

Scenario 3: Buried pipeline inspection

A third scenario in regards to pure pipeline inspection surveys is where an ROTV inspection can be efficiently performed, is that of a buried pipeline. This pipeline survey can again be performed by using a non DPII survey vessel, and the objective is to confirm a buried status of the pipeline, to identify the depth of burial and/or to locate a pipeline or pipeline sections.

Cost benefits

Cost benefits on a pipeline inspection, based on the information given in scenarios 1 and 2, are mainly due to the increased productivity (survey speed) of the ROTV operations. The other impacting variable which affects the total cost of a pipeline inspection project is initiated by the quality of the data. Higher quality data will require less reruns, and little closed detailed inspections.

The following approximate calculation example explains the cost differences on the two explained survey scenarios. The rates used through the example are for illustration only, and although arbitrary, the ratio between the various rates equals the currently used market rates.

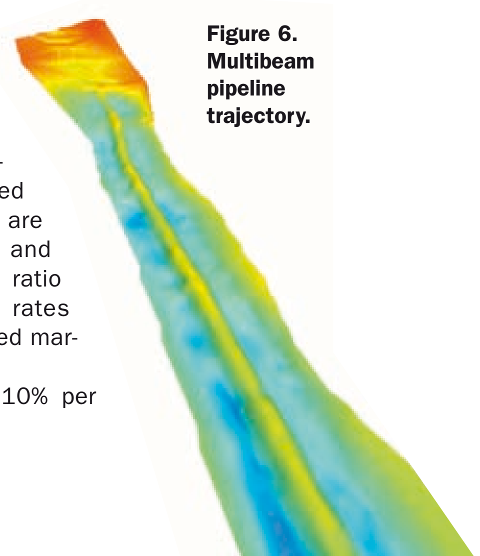

Figure 6. Multibeam pipeline trajectory.

In both scenarios, 10% per 150 km rerun requirements are assumed with a tow fish survey and consumables are excluded. In scenario 2, it is assumed that a tow fish inspection initiates 25 points of interest per 100 km survey length are to be surveyed in further detail by using a WROV, where as survey performed with a ROTV initiates ten points of interest due to the higher data quality effect. For both scenarios it is assumed that five points of interest per day can be surveyed by WROV in detail.

Scenario 1: comparison

A realistic differentiation in the total cost, including estimated rerun requirements, for a Tow-fish and ROTV survey spread is elaborated in Table 3. Assuming a price of €100 per km is representing 100% costs for an ROTV survey spread (thus the Tow-fish cost is €123 per km), the increasing costs differential per km survey is shown in Figure 7.

Scenario 2: comparison

A realistic differentiation in the total cost, including estimated rerun and detailed inspection requirements, for a WROV plus Tow-fish or ROTV survey spread is elaborated in Table 4. Assuming a price of €1000 per km represents 100% cost for the WROV + ROTV survey spread (thus the WROV + Tow-fish cost is €2350 per km), the increasing cost differential per km survey is shown in Figure 8.

Further ROTV advantages

Apart from the increased productivity and higher data quality, further advantages of ROTV surveys can be found in lower maintenance costs (compared with an WROV), fewer resources required onboard to perform the survey and associated preliminary data-processing, less restrictive operational limits and the ability to carry a versatile and multiple sensors packages

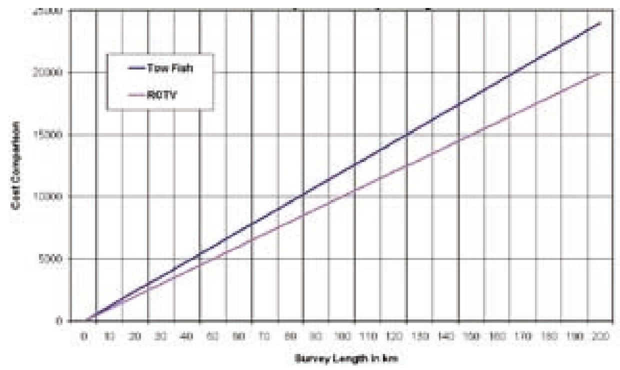

Figure 7. Estimated cost per survey length for a tow fish and ROTV.

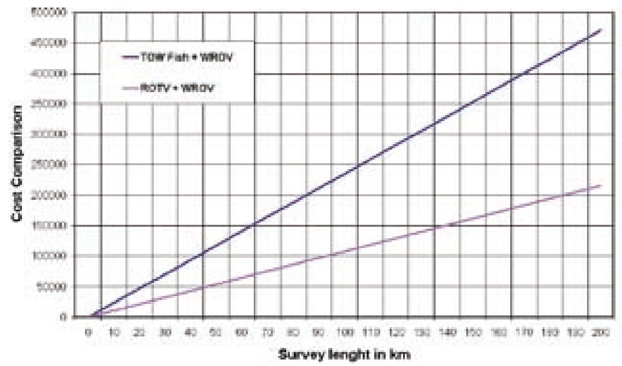

Figure 8. Estimated cost per survey length for a tow fish, ROTV and WROV.

Conclusion

With the latest addition of the Focus-2 ROTV, Noordhoek increases its position more firmly in the pipeline inspection market and route survey segment. Inspection survey services can in the short term be provided by ROV, ROTV, Tow-Fish and WROV and the required response and mitigation services can be provided by diver assistance supported by the Multipurpose Noordhoek Singapore DPII/DSV vessel.

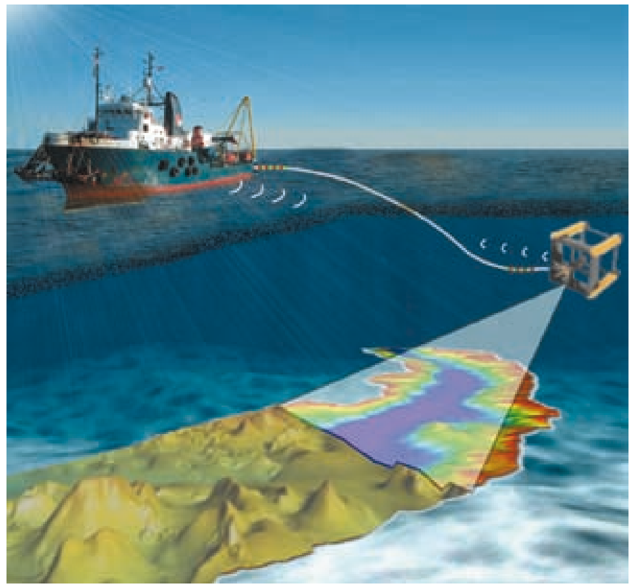

Figure 9. Noordhoek Singapore (DPII/DSV) vessel towing an ROTV.

Table 4. Scenario 2: global pipeline inspection with various points of interest. Assumptions.		
	Tow fish + WROV	ROTV + WROV
Survey speed in km per day (deducted with reruns)	150	220
Survey vessel (DPII) dayrate in euros	68%	68%
Survey crew dayrate in euros	7%	9%
Survey platform dayrate in euros	1%	7%
WROV platform (standby rates = operational rates)	11%	11%
WROV resources (additional to tow fish / ROTV Resources)	7%	5%
Extra days of WROV survey on POI investigation	0.05	0.02
Total spread cost in percentage	94%	100%
Total price percentage per km of survey	235%	100%