GEO OCEANS

Technical Note

Mini-ROV Class Survey System

MINI-ROV CSS BY GEO OCEANS

www.geooceans.com

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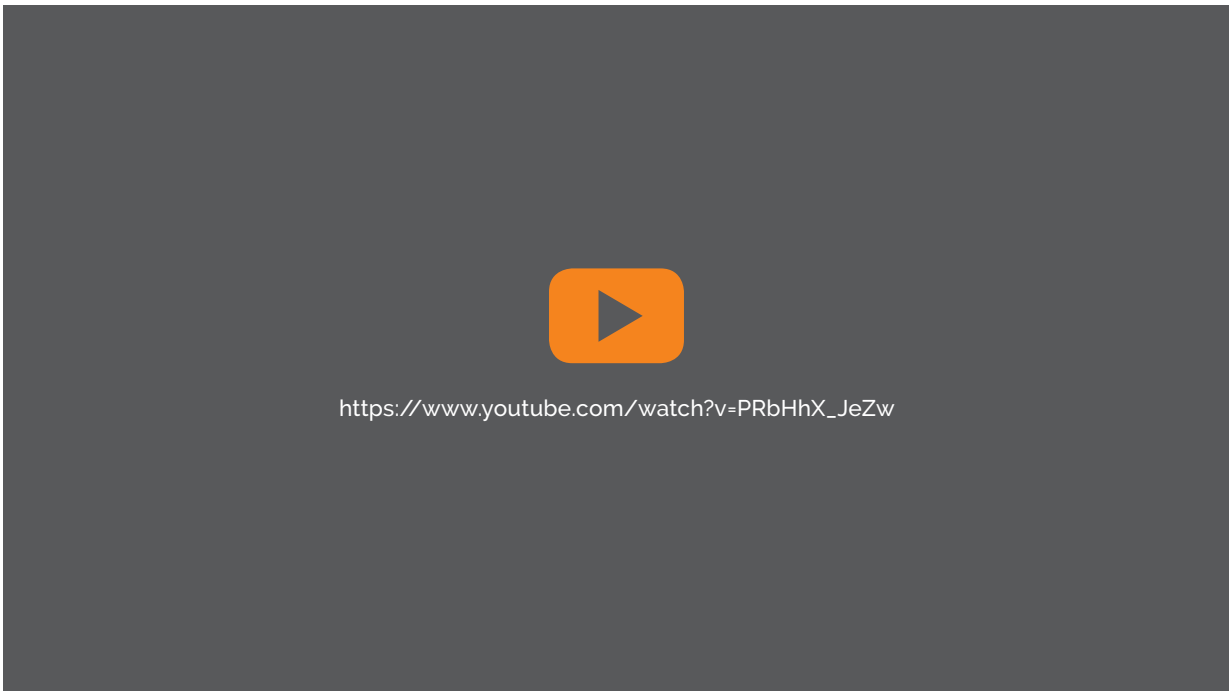


1 / Who We Are

Geo Oceans develops world-leading innovative mini-ROV technology to provide clients with specialist inspection, maintenance and repair (IMR) ROV services. The Mini-ROV Class Survey System (CSS) consists of advanced sensor, tooling and manipulator ROV technology that has been developed by Geo Oceans to provide clients with industry industry-leading subsea services, with large cost savings compared to traditional diver and work class ROV methods. Geo Oceans uses this cutting-edge technology to complete subsea work that was previously not possible using mini-ROV systems, such as subsea tooling, cleaning, positioning and entire vessel class inspections.

Geo Oceans works with Vertech to provide clients with industry-leading and turnkey IMR services. Geo Oceans and Vertech are part of the Global Energy Group, which provides multinational resources to deliver high-quality projects on a global scale.

> "From my contribution as Inspection Maintenance Coordinator, the communications, willingness to deliver, reporting, task execution, mobilisation and close out has been thoroughly professional and a pleasure to execute, whilst providing confidence of a successful outcome, which they delivered." – *Client Testimonial*

2 / Technological Improvements

Mini-ROV inspection technology has many benefits over traditional manned and remote inspections methods.

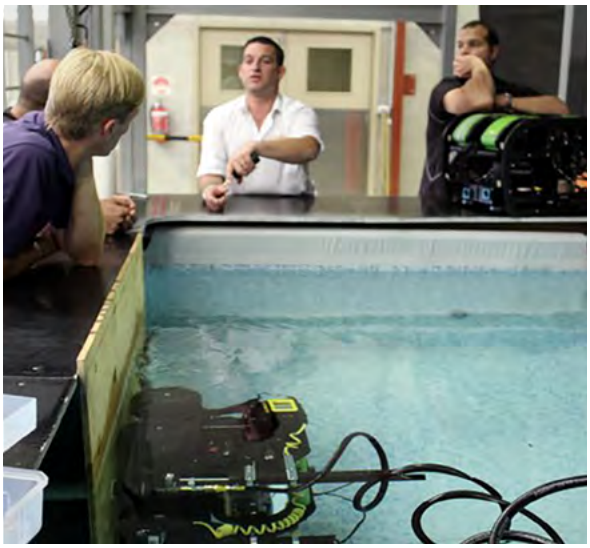
Reduced cost

- 80–95% cheaper than using divers
- Small team size (2–4-person ROV team)
- Efficient deployment and diving operations
- Hull and internal tanks can be inspected in a single mobilisation
- No costs for additional survey vessels

Reduced health and safety risk

- Reduced HSE risk due to diverless approach
- Safe operations in the hazardous 'splash zone'
- Intrinsically safe (Ex-Rated) ROV system

> "The newly developed camera arm to inspect the sea chests without physical intervention by divers thoroughly impressed the Lloyds inspector along with huge cost savings to the SOW."
>
> *– Client Testimonial*



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Reduced impact on facility operations

- No isolations required
- Flexible survey operations and schedules
- Reduced personnel on board (POB)
- Small footprint on vessel
- Simple installation of Launch and Retrieval Systems (LARS)
- Efficient deployment operations
- Hull and internal tanks can be inspected in a single mobilisation
- No costs for ROV support vessels

Improved data quality

- Access to all areas of vessel hull
- HD video record event logging and surveyor commentary
- 3D modelling of components
- Stereo cameras for accurate measurements
- Innovative tools for surface preparation

Reduced downtime

- Full redundancy and spares
- Specially designed for rough conditions (splash zone)
- ROV stabilisation/attachment system
- Highly trained team of survey professionals

REDUCED COSTS

83% cheaper FPSO UWILD class survey and 95% cheaper subsea construction support

3 / The Mini-ROV CSS Technology

The Mini-ROV CSS is used to remotely perform subsea operations in the challenging offshore environment. The small ROV technology is designed to outperform divers, manned and larger ROV systems for a fraction of the cost. The equipment is designed for simple and efficient integration, replacement and repair to maximise the time the ROV is in the water. Duplicates of key equipment and repair kits are mobilised to minimise equipment downtime. The calibration and maintenance logs and certificates for the Non-destructive Testing (NDT), ROV and cleaning equipment are available onsite for review by the surveyor and operators.

MINI-ROV CSS BY GEO OCEANS

Typical Mini-ROV CSS Specifications

Component	Attribute	Specification
ROV	Mini-ROV	Seabotix vLBV. Depth 900 m. 18.1 kg
	Micro-ROV	Seabotix LBV, VideoRay and AC-ROV
	Deployment	Ex-rated LARS. Manual or mechanical lifting aids
	Attachment	Crawler skid with tracks, vortex suction 23 kgf Magnetic coupling
Cameras	Video	1080p HD 1 channel + SD 2-3 channels
	Still camera	Still cameras full topside control
	3D ROV camera	Photogrammetry 3D modelling camera
Sensors	Sonar	Scanning and multi-beam sonar
	Lasers	Laser scales
	Lighting	4-6 ultra bright LED flood lights
	UT probes	Class approved A-scan unit with twin crystal probes
	Inclinometer	Chain/pipe angle measurements
	Caliper/gauges	Chain and other measurements
	Cathodic protection	Proximity or contact CP probes
	ACFM	Remote magnetic probe guides
Tools	Manipulators	Linear and rotating actuator, grabber
	Torque tool	> 30 Nm of torque. Max drilling dia. 10 mm
	Mechanical brush	No load speed Max 1300/min. Sponge, wire, nylon, milling bits.
	Mechanical scraper	Marine fouling, coral and barnacle remover
	High-pressure blaster	Ex-rated HP blasters and cavitational cleaners
Topside	Mobile control unit	2 x computers, 3 x monitors

3 / The Mini-ROV CSS Technology (cont)

3.1 Remotely Operated Vehicles

The Mini-ROV CSS technology can be mounted to mini- and micro-ROV platforms. The preferred ROV for subsea work in exposed waters is the Seabotix vLBV, particularly when operating in the splash zone or when deployed off platforms. This ROV is an ideal size and power to work in rough seas and to attach to the infrastructure. The vLBV is also ideal for internal tank inspections so we can perform internal and external inspections on one mobilisation.

For small openings, pipes and tanks we use our micro-ROVs, the Seabotix LBV, Video Ray, and AC ROVs. Where deep water or heavier tooling tasks are required, we can access larger ROVs and design work programs to suit project requirements.

Magnetic and vacuum attachment systems allow the pilot to attach and stabilise the ROV against the structures while operating the tools and sensors.

3.2 ROV Tools

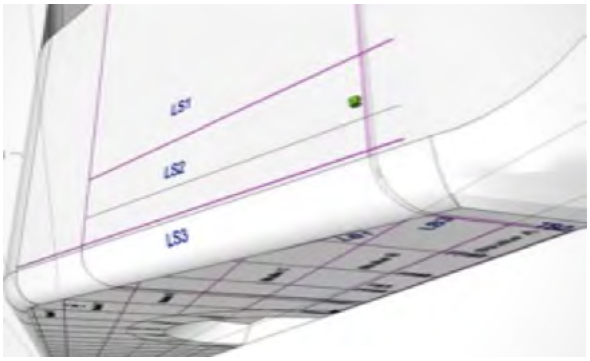
The Mini-ROV CSS includes a suite of sensor and tooling technology that is mounted on rotating and linear actuator manipulators and probe handlers. The manipulators provide a level of dexterity and control previously not available on mini-ROVs.

3.3 Non-destructive Testing (NDT)

NDT sensors including Ultrasonic Thickness Measurement (UTM), Cathodic Protection (CP) and Alternating Current Field Measurement (ACFM) are mounted on specialised actuators and tracks on the ROVs. Readings are taken, recorded and evaluated according to the Class Measurements Rules on each facility.

3.4 Navigation

ROV dive plans and navigation procedures are prepared prior to mobilisation and deployment. The ROVs have sensors that allow the pilot to navigate along the ship's hull, mooring chains or seafloor and to locate target structural components or areas. The sensors include compass, depth sensor, video cameras and scanning sonars. Sonar can be used to measure and triangulate the location of the ROV from objects to estimate the position of the ROV. Several sonar reflectors and clump weights can be deployed from the vessel at known locations to provide reference points for the ROV to locate and navigate.



3.5 Spatial Positioning

Survey grade ROV positioning can be provided with the Mini-ROV CSS system. The positioning systems comprise Ultra Short Baseline (USBL) or Long Baseline (LBL) technology options, depending on the accuracy required.

3 / The Mini-ROV CSS Technology (cont)

3.6 Launch and Retrieval Systems

The small size and weight of our Mini-ROV CSS provide flexibility in the deployment and retrieval methods. The ROV can be handled and deployed manually by two personnel using simple davit and winch systems.

The Mini-ROV CSS can be deployed from several different locations on the facility to allow safe and efficient access to all areas of the vessel hull. Deployment locations can be established in liaison with the facility management to maintain safe operations and to minimise disruption to the facility. Deployment locations can be clearly marked with barriers and tags to segregate the work zone. Only intrinsically safe and facility-approved tools and equipment are used when operating in hazardous areas.

3.7 Tether Management

Geo Oceans use innovative tether management systems and procedures to increase the efficiency of the survey, improve the operational limits of the ROV and reduce the risk of damage, snagging or loss of the ROV. The systems are designed to deploy the ROV over-the-side from several locations on the asset while operating from one control room location.

During ROV operations, a combination of clump weights, davits and rope trains pulley systems can be used to tender the ROV in marginal weather conditions and around topside and subsea infrastructure.

3.8 Surface Cleaning and Preparation

Any areas of the vessel that are covered in marine growth or are badly corroded can be cleaned for coating assessments and NDT. Marine fouling can be removed without damaging the coatings or infrastructure, using tools including mechanical scrapers, brushes and high-pressure water blasters. The tools are operated using topside-controlled actuator arms.

3 / The Mini-ROV CSS Technology (cont)

3.9 Metrology and 3D Modelling

The Mini-ROV CSS system includes imaging technologies for accurate size and area measurements. The 3D ROV camera system acquires high-definition video and still images that can be processed for scaled measurements and 3D modelling.

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4 / Project Planning

The project planning phase involves consultation with all relevant stakeholders and the exchange of all information required for the development and execution of the work scopes. A project kick-off meeting can be arranged between the ROV team, client, attending surveyor and site operators to gather scope and site-specific information for use in the development of inspection work packs. Work packs document the project HSE management and methods that the field team will employ during the inspection campaign, and detail the data management from acquisition through to reporting. Data acquisition and report templates are generated during the project planning phase to facilitate efficient and real-time processing in the field.

4.1 Safety Management

Geo Oceans is committed to a rigorous risk-based approach to safety to ensure the personal safety of all our employees, subcontractors and anyone else affected by our activities. We operate a comprehensive and effective health, safety and environment system whereby all operations are risk assessed, JHAs are completed for all activities and toolbox talks are held as part of standard operations. Geo Oceans ensures that all personnel satisfy the industry health and competency requirements to operate offshore.

4.2 Offshore Inspection Team

Our offshore inspection teams have highly skilled, experienced and competent personnel that work together to successfully complete the project objectives. Team size and composition will vary from 2 to 4 personnel depending on the complexity of the tasks, duration and inspection requirements.

> "Multiple amendments and clarifications from Lloyds and WEL engineering were met and proven by the Geo Oceans team. This not only included simplification of tasks but the development of specialist equipment."
>
> – *Client Testimonial*

5 / In-Water Vessel Inspections

Classification societies (Class) have statutory requirement for hulls and submerged areas on vessels to be inspected periodically. Using the Mini-ROV CSS technology we are able to conduct accredited UWILD inspections to satisfy Class inspection requirements. Inspection surveys are tailored to the individual assets, considering the age of the facility and condition of the vessel being inspected. The survey can be broken down into overall visual status check requirements also known as General Visual Inspection and Close Visual Inspection. The visual status check is supplemented with CP, UTMs and other NDT. Anode assessments, coating assessments, marine growth assessments and other measurements can be completed on:

- Hull plating
- Penetrations
- Sea chests
- Bilge keel
- Load line markings
- Cathodic protection system
- Lower turret area
- Chain table
- Chain stopper assemblies
- Mooring chains
- Rudder and propeller

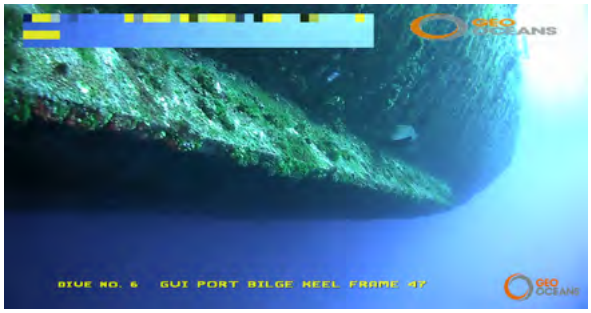
Specific sections of the hull are cleaned – without damaging the hull coating – to allow thorough inspection. Comprehensive inspection reports are produced with detailed anomaly reports for any anomalies identified.

> "Geo Oceans' ROV system for OIWS has proven from this campaign the HSEQ impact and draw from core crew and operational assistance was minimal. The previous method involved dive teams, containers of equipment and a huge imposition to operations resources."
>
> – *Client Testimonial*

5.1 Visual Inspections

A General Visual Inspection (GVI) assesses the overall condition of the entire hull structure and determines areas to be targeted during Close Visual Inspection (CVI), cleaning and Non-Destructive Testing (NDT).

A GVI will discover substantial corrosion, significant deformation, fractures, damage or other structural deterioration that may be present.



A CVI may include inspection of areas with coating breakdown, arrested wastage or active wastage areas, primary and secondary structure, penetrations, previous anomalies and any areas deemed as critical or suspect by the client or the attending class surveyor.

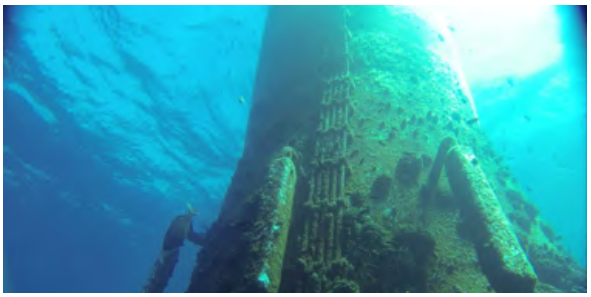
5.2 Sea chests

Visual inspections inside and outside sea chests can be performed using high-definition and probe video cameras. The sea chest grating can be inspected for any debris or blockage and fasteners can be checked if secure and in place. Any marine growth can be recorded using a Marine Fouling Chart before the sea chest gratings are cleaned. The anodes and valves can also be visually inspected. Close visual inspection can be performed on the fillet welds of the shell plating.

5 / In-Water Vessel Inspections (cont)

5.3 Hull Penetrations

All hull penetrations and their marking can undergo a visual status check. Cleaning of marine growth may be necessary. Where safe access permits, the valves can be inspected with a small probe camera and lights and valves can be actuated to check if in good working order. Caisson strainer rings and baskets can be inspected for damage and blockage.

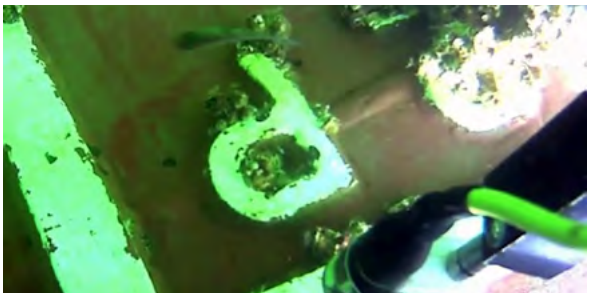


5.4 Riser Turret Mooring Inspection

The riser, turret and mooring (RTM) can be inspected by deploying the ROV from the facility, eliminating the need for a support vessel operating inside the exclusion zone. All associated attachments, connections and appurtenances can be inspected at their interface with the RTM.

5.5 Chain Measurements

Mooring systems can be cleaned for inspection using a high-pressure water blaster chain cleaning system. The ROV can position caliper tools on the mooring components to record accurate measurements of bar thickness. Chain angle measurements of all chain stoppers and chains can be taken using an inclinometer.



5.6 Thickness Measurements

UTMs can be recorded and evaluated according to the Permissible Diminution as per Class Measurements Rules. The attending Class Surveyor can select the locations of the UTM readings with reference to points inspected on previous surveys. All UTMs can be completed with a live display in the ROV control room, using class-approved UT sets that allow accurate measurements through coatings using echo–echo mode. With a UT probe attached to an actuating arm, the ROV can obtain measurements on all required structural areas.

6 / Ballast Tanks

Classification societies (Class) have statutory requirements for ballast tanks on vessels to be inspected periodically. Utilising advanced ROV inspection technologies and methods we conduct tank inspections with attending Class surveyors to meet the specific Class requirements of each asset.

ROV flight plans can be drawn up to illustrate a clear understanding of the ROV's inspection path.

> "Geo Oceans' ROV equipment was transported in equivalent to 1 x MINI sea container with little deck space required to execute scope." – *Client Testimonial*

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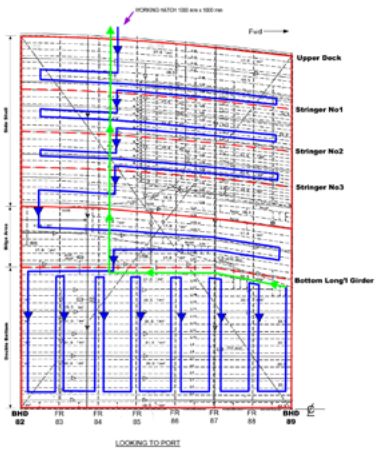

6.1 General Visual Inspection

The GVI would include inspection of the marine piping, anode assessment, access ladders, platforms, hand rails and coating condition in accordance with the criteria found in the Lloyds rules for survey after construction.

A Close-up Survey is a survey where the details of structural components are within the close visual inspection range of the Surveyor, i.e. normally within hand's reach. Close-up Survey Requirements for a Special Periodic Survey No.3 are as follows;

- All complete web frame rings, including adjacent structural members in all ballast tanks.
- All transverse bulkheads, including girder and stiffener systems and adjacent structural members in all ballast tanks.

Visual inspection data will be captured using high definition video and stills, the inspection can be witnessed live in standard definition (SD) and high definition (HD) if required.

6 / Ballast Tanks (cont)

6.2 Thickness Measurements

Thickness Measurement location sketches can be provided detailing the areas of test for each structure requiring UTM. All UTM readings are recorded on the Relevant Thickness Measurement Sheets (TM1 – TM8) in accordance with the requirements of the Classification society. All UTM readings wastage allowances are automatically calculated in the TM Sheet Template.

https://www.youtube.com/watch?v=Xn3nrmLLlcM

7 / Subsea Survey and Construction Support

Geo Oceans provide ROV support for subsea construction and decommissioning operations through observation tasks, positioning surveys and light intervention tasks. We can remotely provide live data feeds to topside crane and vessel operators allowing accurate subsea positioning of objects such as pipelines, stabilisation mattresses, blocks and anchors. We can perform pre and post construction surveys for engineering and scientific requirements including surveys for environmental assessments and approvals.

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https://www.youtube.com/watch?v=mpzOZecV_mQ

8 / Recent Project Case Studies

8.1 Vessel Hull In-Water Survey (UWILD)

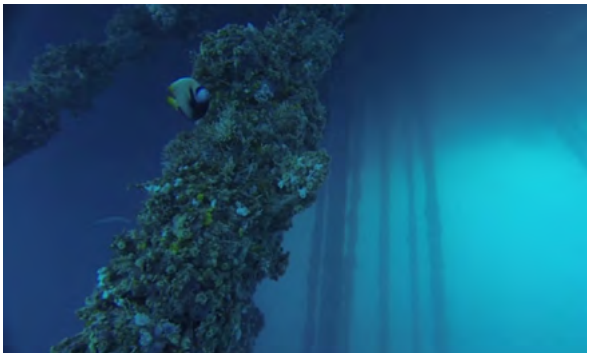
Geo Oceans completed a world-first full in-water vessel (Lloyds Register) class diverless survey of an active FPSO facility, using only mini-ROVs. The entire survey was completed by a three-man ROV team working from one control room on the FPSO. The survey was completed at a fraction of the cost and risk of traditional diver surveys and caused no delays, no isolations and had minimal impact on the facility operations.

The ROV surveyed nine mooring legs (to 100 m water depth), 100% of the vessel hull, 38 penetrations, two active caissons and a 500 m² section of hull that had not been inspected during two previous UWILD diving campaigns (over 10 years) because the area was too dangerous for divers to access.

> "The Northern Endeavour operations group cannot speak more highly of the team's integration, commitment, diligence to task and adherence to WEL procedures and policies. Once again no HSE issues to complete this task to personnel, equipment, environment and no impact to production or operations."
>
> *– Client Testimonial*

8.2 Riser Inspection – Hotshot Mobilisation

Geo Oceans were mobilised to a remote FPSO in the Timor Sea to inspect the turret and risers pipes after a suspected loss of containment. The Mini-ROV CSS and team were 'hotshotted' to site on a helicopter and the mini-ROV was in the water and completing riser inspections to 200 m water depth within 48 hours.



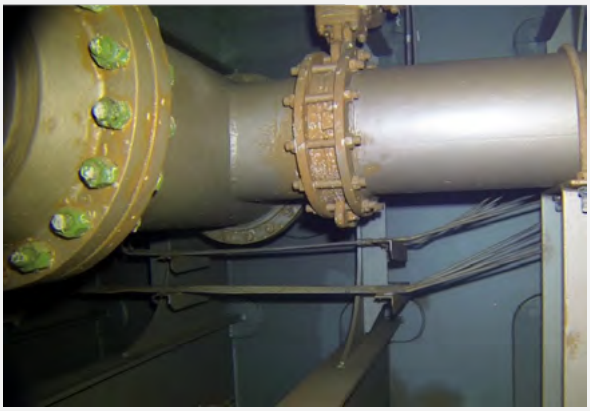
8.3 Penetration Isolation for Valve Replacement

The mini-ROV system was used to insert a pneumatic plug into a 50 mm diameter penetration to isolate a boiler blowdown valve for an internal replacement of the valve. The task was completed in 6 hours.

8 / Recent Project Case Studies (cont)

8.4 FPSO Ballast Tank Class and RTM Inspection

The scope included inspection of two internal ballast tanks for ABS class requirements and inspection of the FPSOs riser turret mooring. Geo Oceans' mini-ROV team worked closely with Vertech's inspector and the attending ABS Class Surveyor to achieve the requirements of the scope successfully. The team operated the ROV from inside a specially designed ROV habitat within a hazardous area on the FPSO.



8.5 Subsea Survey and Construction Support

Geo Oceans provided 24/7 mini-ROV support for over 40 days of subsea pipeline installation operations for Vale in New Caledonia saving the client 93% of costs compared to a dive support vessel that was also onsite during the operation.

The scope involved operating the ROV from a construction barge to provide visual guidance for the crane operators, as-built inspections and tooling tasks.

https://www.youtube.com/watch?v=wp-Mu97S_0pY

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