

Atmospheric Diving as an Alternative Technology for Platform Inspections

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ABSTRACT

Platform inspections are a complex and costly proposition using either traditional diving or ROV technologies. Multiple vertical excursions make diving expensive and ROV inspection can be very time consuming. Atmospheric diving systems (ADS) offer an alternative with many advantages. This paper discusses the application of state of the art ADS equipment to platform inspection. A summary of ADS inspection tools and techniques is provided along with a cost analysis. Results from over thirty successful platform inspections using ADS are presented.

INTRODUCTION

The requirements for inspection of fixed platforms in the outer continental shelf (OCS) areas are determined by the Minerals Management Service (MMS). The Code of Federal Regulations governed by MMS states "All platforms installed in the OCS shall be inspected periodically...". At last count the MMS website reported 3,412 active platforms in the Gulf of Mexico installed in depths of 650 feet (200 meters) of water or less. Increased environmental concerns coupled with the ever increasing age of these shallow water platforms and mounting concerns over storm damage have lead to significant growth in the market for inspection services. As the demand increases, oil companies are looking for inspection techniques that offer thorough and accurate inspections in a cost effective manner.

The traditional approach to platform inspection has been to use either ROVs or divers. An ROV equipped with video and still cameras, water jetting and/or wire brush cleaning tools can be used for platform inspection. An ROV has the advantage of high speed in the water column, practically unlimited depth capability and the ability to make long horizontal excursions. The disadvantages of the ROV include poor access to structures, limited visual acuity, and limited spatial



awareness. The ROV also requires highly adapted NDT tools and equipment for remote operation.

Divers offer the advantage of much improved access to structures, much improved visual acuity and a wide range of off the shelf hand held NDT inspection tools available. Marine growth cleaning for divers is achieved quickly and efficiently using water or grit blasting equipment. The disadvantages of diving include depth or decompression limitations, limited vertical and horizontal excursion capability, and in the case of saturation diving, very high equipment and operating costs coupled with extended decompression time.

The modern atmospheric diving systems (ADS) available today, known as the HARDSUIT™, combines the advantages of ROVs and divers with few, if any, of the disadvantages. The HARDSUIT™ is capable of using hand-held diver NDT tools with little or no modifications. Marine growth cleaning is done in the same way as with divers using high pressure, surface supplied, water jets. Decompression considerations are eliminated and horizontal excursion capability is comparable to that of an ROV and vertical excursion is unlimited. Access to structures and visual acuity is comparable to divers, however equipment and operating costs are significantly lower than saturation diving.

PLATFORM INSPECTION REQUIREMENTS

MMS requirements for platform inspection are based on the American Petroleum Institute (API) recommended practices. The API recommendations involve periodic basic (Level II) and detailed (Level III) underwater inspections. The results of the periodic underwater inspections can then invoke a requirement for further NDT inspection (Level IV). A basic or

Level II underwater platform inspection consists of an underwater visual inspection and the measurement of cathodic potentials in critical areas. The visual inspection is intended to detect the following:

- Excessive corrosion
- Accidental or environmental overloading
- Scour, seafloor instability, etc
- Fatigue damage
- Design or construction deficiencies
- Presence of debris
- Excessive marine growth

The cathodic potential measurement is intended to measure the condition and effectiveness of the passive corrosion protection. Still and video photography are normally required as part of the Level II survey.

The detailed or Level III survey includes the requirement for detailed inspection of pre-selected high risk areas, or areas where damage is suspected. This requires cleaning of marine growth to permit thorough inspection. Still and video photography are also normally required. Some NDT inspection is often conducted.

Damage found or suspected during a basic or detailed inspection requires further NDT inspection (Level IV). The extent and nature of the NDT inspection will depend on the nature of the damage suspected however ultrasonic thickness measurements or flooded member detection are the most common. Additionally crack detection may be required using alternating current field measurement (ACFM), magnetic particle inspection (MPI), or ultrasonic crack detection techniques. In many cases additional cleaning and/or area grinding is required in order to perform NDT accurately.

The end result of platform inspection is intended to provide reasonable assurance that a platform can continue to operate safely. In many cases remediation of inspection findings can extend platform lifetimes. Removal and replacement of anodes, removal of excessive marine growth, debris removal, and installation of bracing are all examples of steps that can be taken to extend the useful life of a platform provided accurate and thorough inspection data is provided to the owner.

HARDSUIT™ ATMOSPHERIC DIVING FOR PLATFORM INSPECTION

The HARDSUIT™ HS1200 atmospheric diving suit provides an ideal solution for platform inspection. The HS1200 is a one atmosphere diving suit equipped with the following features:

- Dual (redundant) self contained life support systems.
- Digital hardwire and acoustic through-water communications.
- Vertical and lateral thruster systems.
- Neutrally buoyant main umbilical provide power, communications, video, and spare conductors to the surface.

The HS1200 interior remains at one atmosphere which



HARDSUIT™ HS1200

eliminates the requirement for decompression. This allows the pilot unlimited mobility in the water column. The typical requirement for HARDSUIT™ equipment for platform inspection work is for two HS1200 suits with umbilical, a surface control/workshop van, and a simple crane launch system for launching and recovering the suits. The HS1200 is operated in a free swimming mode and the umbilical is hand tended or handled with an umbilical spooling winch.

Standard cleaning and inspection tools are easily adapted for use with the HARDSUIT™. Specific requirements are met as follows:

- Marine growth cleaning is accomplished with a 10,000 or 20,000 psi water blaster. The surface supplied water blaster is essentially identical to a standard diver water blaster with two minor modifications. Flotation is added to the tool to reduce its weight in water and the

low velocity reaction jet on one end is replaced with a second jetting nozzle. This allows the HARDSUIT™ to use the water jet in a two-ended mode.

- Surface video is received from a helmet mounted pan and tilt video camera. The camera is controlled by the supervisor and recorded on an SVHS recorder.
- Still photography has been accomplished both with a PhotoSea 35mm camera and flash and with a digital still camera. The PhotoSea camera was mounted on a special tool hand pod which allows the HARDSUIT™ pilot to trigger the camera from inside the suit.
- Cathodic Potential measurements are made with a standard electrolytic cell (Silver-Silver Chloride). The CP cell is mounted on the suit shoulder to allow hands free operation. Spare conductors in the HARDSUIT™ umbilical are connected to the cell which allows continuous monitoring of the cathodic potential.
- Ultrasonic Thickness measurements and flooded member detection are done using standard diver tools. Tools such as the Cygnus ultrasonic thickness probe are connected to the HARDSUIT™ power supply and a spare twisted shielded pair in the HARDSUIT™

- Other NDT tools have been used by the HARDSUIT™ including MPI and ACFM. Tools are modified based on the specific application.

The HARDSUIT™ offers a number of specific advantages to platform inspection:

- The HARDSUIT™ pilot is certified for NDT inspections. The inspection client is able to communicate directly with a qualified inspector who is able to look directly at a suspected defect.
- Atmospheric diving is safer than ambient pressure or saturation diving. There is zero risk of decompression related injuries.
- The HARDSUIT™ pilot has excellent spatial awareness and is able to enter structures or confined spaces safely without fear of entrapment or umbilical entanglement.
- The HARDSUIT™ pilot has near perfect visual acuity. The vision dome can be positioned only inches away from a suspected problem area.
- The HARDSUIT™ digital communications provides crystal clear communications between the pilot and the surface.
- The HARDSUIT™ is capable of immediately

	ROV	Air Diving	Saturation Diving	HARDSUIT™	Air Diving and HARDSUIT™
Range					
Depth Capability	>3300 ft	<200 ft	1000 ft	1200 ft	1200 ft
Horizontal Excursion	Excellent	Moderate	Poor	Excellent	Excellent
Vertical Excursion	Fast	Moderate	Slow	Fast	Fast
Structure Access	Poor	Excellent	Excellent	Excellent	Excellent
Economics					
Capital Equipment Cost	Moderate	Low	High	Moderate	Moderate
Vessel High	Moderate	Low	High	Moderate	Moderate
Crew Cost	Small	Moderate	High	Moderate	Moderate
Capability					
Still Photography	Yes	Yes	Yes	Yes	Yes
Video Photography	Yes	Yes	Yes	Yes	Yes
Visual Acuity	Moderate	Excellent	Excellent	Excellent	Excellent
Marine Growth Removal	Slow	Fast	Fast	Fast	Fast
CP Measurements	Yes	Yes	Yes	Yes	Yes
UT Measurements					
Thickness Measurements	Yes	Yes	Yes	Yes	Yes
Flooded Member Detection	Yes	Yes	Yes	Yes	Yes
Remediation	No	Yes	Yes	Yes	Yes

Table 1 – Capabilities comparison between ROV, Diving and ADS for Platform Inspection

umbilical is used to transmit RS-485 data to the surface.

undertaking many remediation tasks at the request of the client. This can save significant

remobilization costs if a problem can be resolved when it is encountered.

Another strength of atmospheric diving as an option for platform inspection is the potential for efficiencies generated while working in conjunction with air diving. On a typical air diving inspection job, air divers quickly use up their available bottom time. If an air diving crew is also trained for HARDSUIT™ operations, the same divers can then safely operate the one atmosphere suit, making better use of personnel. In addition to the improved personnel efficiency, because the HARDSUIT™ is able to use most diver held NDT tools with little or no modification, further savings are realized by sharing tools between the air diving and HARDSUIT™ operations.

HARDSUIT™ ATMOSPHERIC DIVING COMPARISON OF EFFECTIVENESS

Table 1 above contains a comparison of HARDSUIT™ effectiveness for platform inspection as compared with ROV, air diving, and saturation diving. The combination of air diving and HARDSUIT™ diving is also compared.

PROVEN HARDSUIT™ PLATFORM INSPECTION PERFORMANCE

Past experience in the Gulf of Mexico has shown that the HARDSUIT™ atmospheric diving system working in conjunction with air divers has been an extremely effective and cost competitive means of performing platform inspections. This combination of HARDSUIT™ and air diving was used for the inspection of more than thirty platforms during a single mobilization period. The following equipment and operational methodology was used:

Diving Equipment:

2 x HS1200 HARDSUIT™ ADS

Mobile crane launch system.

Surface supplied air diving spread.

Air diving equipment was used primarily in the 0-100' range where decompression could be kept to a minimum.

Vessel:

140' four point moor, dive vessel.

The vessel was either tied up alongside under the platform superstructure or a forward anchor and stern tie was used.

Visual Inspection:

The HARDSUIT™ was used to do fly-by inspections of each structural member. Areas of interest were video taped using SVHS recording equipment. Selected anodes were measured using hand tools and structural member roundness (ovality) was verified with go-no-go gauges or calipers.

Cleaning:

The air-divers used grit blasting in the 0-100' range. 10,000 psi water blasting was used by the HARDSUIT™ for cleaning anodes and members.

Cathodic Protection (CP) Reading:

A proximity CP probe was mounted on the shoulder of the HARDSUIT™ and a continuous reading was achieved using spare conductors in the suit umbilical. Typically readings were taken every 10' down each platform leg and at every anode.

Weld Inspection:

Following member node cleaning, the HARDSUIT™ pilot performs visual inspection of the welds. The pilots were all certified inspection divers. Weld inspection details were recorded over the suit communications and recoded using the suit video.

Photography:

A PhotoSea 35mm camera and strobe were mounted on the HARDSUIT™ hand pod for still photography. The pilot placed photo boards to identify locations/nodes.

Flooded Member Detection:

A Krautkramer flooded member detector was interfaced to the suit electronics.

Debris Removal:

In certain cases the HARDSUIT™ was used for immediate debris removal when encountered. The ability of the HARDSUIT™ to perform on the spot rigging tasks eliminated the requirement for a separate mobilization and resulted in significant cost savings to the client.

Results:

Platforms Inspected:	31
Level II Inspections:	6
Level III Inspections:	25
Nodes Cleaned	37
Platform Legs Inspected	166
J-Tubes Inspected	36
Risers Inspected	31
Sumps Inspected	26
Average Depth:	308'
Maximum Depth:	730'

# of Air Dives	163
Air Dive Avg. Time	38 minutes
# of HARDSUIT™ Dives	107
HARDSUIT™ Dive Avg. Time:	182 minutes

CONCLUSIONS

Atmospheric diving is an alternative technology to ROV or diving that has been proven to perform and is cost effective for meeting today's platform inspection requirements. In water depths between 100' and 1200' the ADS can perform the necessary tasks for platform inspection safely, accurately, and at a lower overall cost than with either ROVs or saturation divers. At depths less than 100' air diving has been found to be the most effective method and when combined with HARDSUIT™ operations further efficiencies are realized. The HARDSUIT™ has been used successfully for all tasks required for platform inspection. The HARDSUIT™ is able to use most diver ready cleaning or NDT inspection tools with little or no modification.

REFERENCES

Code of Federal Regulations, Title 30, Part 250, Subpart I, Section 912, "*Periodic Inspections and Maintenance*",

American Petroleum Institute, API RP2A "*Recommended Practice for Planning, Designing, and Constructing Fixed Offshore Platforms*", Section 14, Surveys

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