Project n°: 505936
ROTIS II
Remotely Operated Tanker Inspection System II

Instrument: STREP
Thematic priority: Sustainable Surface Transport (6.2)

PUBLISHABLE FINAL ACTIVITY REPORT

Eni GROUP Tecnomare

GROUPE cybernétix INNOVATION & ROBOTIQUE AVANCÉE

EUROPEAN COMMISSION DIRECTORATE-GENERAL Joint Research Centre

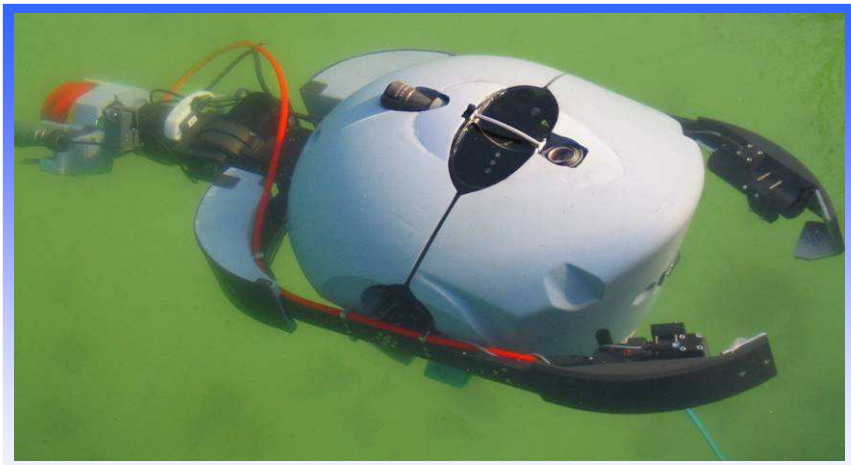
AVIN OIL TRADER MARITIME COMPANY

CS & Associates Ltd. Naval Architects & Marine Consultants

Lloyd's Register

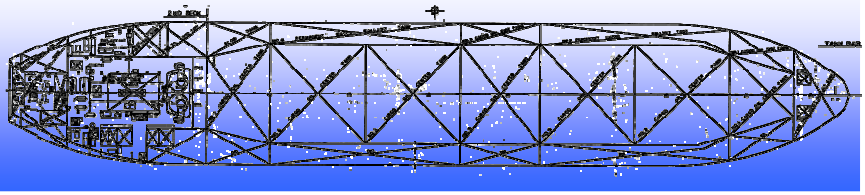
Start date of project: 01/03/04 **Duration:** 36 months

Project coordinator name: Walter Prendin
Project coordinator organisation name: TECNOMARE S.p.A. Revision: 0



Project ROTIS II

Remotely Operated Tanker Inspection System



Sponsor

Rotis II is a project sponsored by European Commission within Research Framework 6. Funding Programmes: SUSTDEV-2002-3.2.2.2.5 Strategies and processes for clean maintenance, dismantling and recycling of vehicles and vessels

Background and motivation

The disasters of ERIKA on December 1999 and PRESTIGE in November 2002 have put once more in evidence the importance of periodic ship inspection and credibility of such assessment. To date, maritime vessel inspection is based on

(a) close-up visual inspection
(b) steel plate thickness measurements.

Prior to inspection a ship must be made fully available at the harbour area, all access spaces must be made safe (de-gassed etc) and prepared accordingly, often in dry dock, thus resulting in a considerable ship idle time and, consequently, a significant cost. In the case of big, double hull tankers it can easily amount to multiples of $100,000.The introduction of double hull vessels is widely seen as the response to the need of preventing maritime catastrophes such as the one of the PRESTIGE oil tanker. However, to be effective, it must be coupled with measures towards more efficient and cost effective inspection procedures. Adequate tools must be provided to the surveyors, ship owners, as well as to state and port authorities providing them with the capacity to perform, through diagnostic or tale-operated equipment, rapid but safe and reliable inspections.

Objectives

ROTIS II is a robotic system designed to perform inspections of ship's ballast tanks. It can operate on oil tankers, dry- and mixed cargo carriers or FPSO. The purpose of the project was to prepare and test a prototype in real-life conditions. It was achieved in July 2008.

Rotis II Consortium

Rotis II consortium was an association of European companies and institutions joined by the purpose of producing, improving and testing the Rotis system prototype. Their roles in the project could be classified as follows:

- **Developers**: Tecnomare, Cybernetix, JRC, tasked with conducting initial research, testing and producing final elements of the system
- **End-users**: CS & Associates, Alexandra Shipping Company, responsible for providing feedback to the developers regarding the future operation of Rotis and assisting the testing of the system
- **Regulatory body**: Hellenic Lloyd's, an organization with established presence in ship classification and the designer of many shipping safety criteria

Tecnomare (project manager) http://www.tecnomare.it/

Engineering Company for Oil Upstream

Tecnomare provides design and engineering services to oil companies around the word since 1971. The Company activities cover every phase of the life-cycle of upstream plants, from feasibility studies to construction and from start-up to decommissioning. Operations in sectors such as deep water and subsea, project planning & management, HSE, maintenance engineering and asset integrity, demonstrate excellent skills. Tecnomare also provides HSEQ analysis and certification services, develops innovative oil and gas technologies and supplies turnkey equipment and systems

Cybernetix http://www.cybernetix.fr/

Cybernetix is a world leader in innovating solutions in robotics and automation for interventions in hostile environments. Its competences:

- Product engineering: design, engineering, full systems in small series production
- Designing specific high value-added services and innovating solutions to meet customer's needs

Joint Research Centre http://ec.europa.eu/dgs/jrc/index.cfm

The Joint Research Centre is a research based policy support organisation and an integral part of the European Commission. The JRC is providing the scientific advice and technical know-how to support a wide range of EU policies. Our status as a Commission service, which guarantees our independence from private or national interests, is crucial for pursuing our mission.

CS & Associates http://www.csassociates.gr/

ALEXANDRA SHIPPING COMPANY

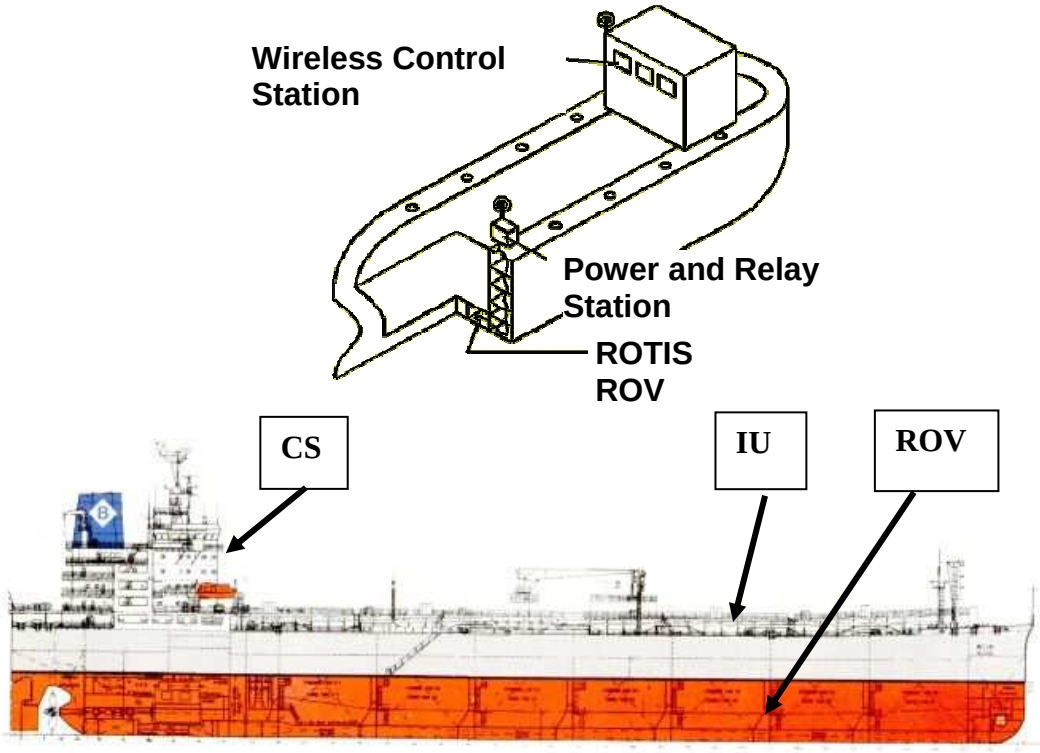
Alexandra Shipping Company

Hellenic Lloyd's

Lloyd's Register is an independent risk management organisation. Hellenic Lloyd's is part of the Lloyd's Register Group. The Lloyd's Register Group works worldwide to help improve its clients' safety, quality, environmental and business performance throughout the world, because life matters. Its expertise and activities cover shipping, railways, other land-based industries and oil and gas.

Rotis II System

General



Principal capabilities

The ROTIS small vehicle (ROV) is introduced within flooded ballast tanks, between the inner and the outer hull, and has therefore access to virtually all cells and structural parts of a double hull vessel through standard man-holes and openings

Dexterous 3 joint arm to reach all surfaces, also webs and flanges of the stiffeners
The system can operate on a transiting vessel as well as in harbour
ATEX compliant system, can be deployed on loaded tankers
Weather-independent operation controlled remotely thanks to wireless system architecture
Reaches everywhere in the tank without risk of entanglement due to on-board tether drum
Components of the ROTIS system are 2-man transportable. The components described above can be carried and commissioned by two persons on board a vessel.

System scheme

The ROTIS II system consists of three main parts:

ROV – Remotely Operated Vehicle

= a purpose-designed small ROV fitted with 6 cameras and a NDT ultrasound probe. The ROV is powered and controlled through a long, thin, and neutrally buoyant umbilical which provides a medium for power and data transmission. The umbilical is paid in and out from a tether management system embedded on board the ROV.

IU – Intermediate Unit

= power and relay Station providing energy to the ROV and a passing communication between the ROV and the Control Station. The IU is placed close to the entrance hatch of the ballast tank and complies with rules for use in Explosive Atmosphere (ATEX).

CS – Control Station

= wirelessly connected computer console to serve as a the Human Machine Interface (HMI) to operate the ROV and to log inspection data. The CS can be placed in a safe area, i.e. in the ship's control room, and communicates with the IU through a wireless data link.

Specifications (subject to change)

	ROV	**IU**	**CS**
Size:	Φ < 550mm	650x700x400mm	600x800x600mm
Weight:	60kg (in air)	80kg	50kg
Power:	< 1 kW	1.5 kW	< 700 W
Power input:	Powered by IU	Pressurised air at 7bar or 220/110 Vac	220/110 Vac
Total reach:	~70m umbilical	Wireless link up to 200m Ethernet cable up to 100m	

Example Rotis deployment scenario

Rotis II is designed with portability and ease of deployment in mind. The system is enclosed in three separate boxes, each portable by 2 men. It is easily shipped by air.
It can be quickly deployed once on board of the vessel in the following steps (guideline only)

Preparation:

- Delivering the boxes on board of the vessel
- Flooding of the chosen ballast tank

Installation:

- CS is installed in the place of convenience, normally within the superstructure
- Simplified model of the ship's double hull's cells is prepared using the editor provided
- At the same time, the IU can be installed next to the entry hatch of the ballast tank and connected to the appropriate outlet (compressed air or AC power)
- Rotis II ROV is wheeled to the location, slid out of the box and submerged in the tank
- Start-up checklist is followed and the system is powered on

Survey:

- The UTM probe is calibrated on a provided test piece of metal (if UTM measures are to be conducted)
- ROV is navigated to the place of inspection, passing to the desired cells while its position is tracked on the 3D model for the purpose of pilot's orientation
- Measurements are taken; still pictures of the inspected areas are recorded, etc.
- The ROV is brought back to the hatch, back-tracking the original entry route

Demobilization:

- The system is switched off after following end-of-mission checklist
- ROV is removed from the tank and packaged
- IU and CS are disconnected and packaged, the system is shipped to the next destination

Figure 1 Loading the packed elements on board of the ship

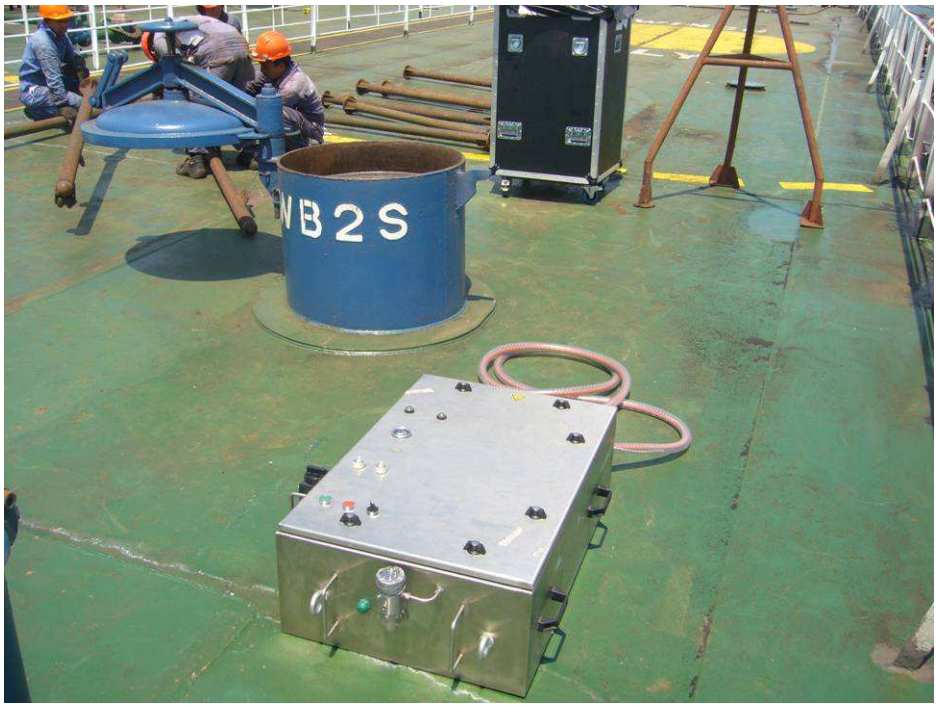


Figure 2 Placing the Rotis II ROV and the IU next to the desired tank opening

Figure 3 Installation of the CS in a place of convenience

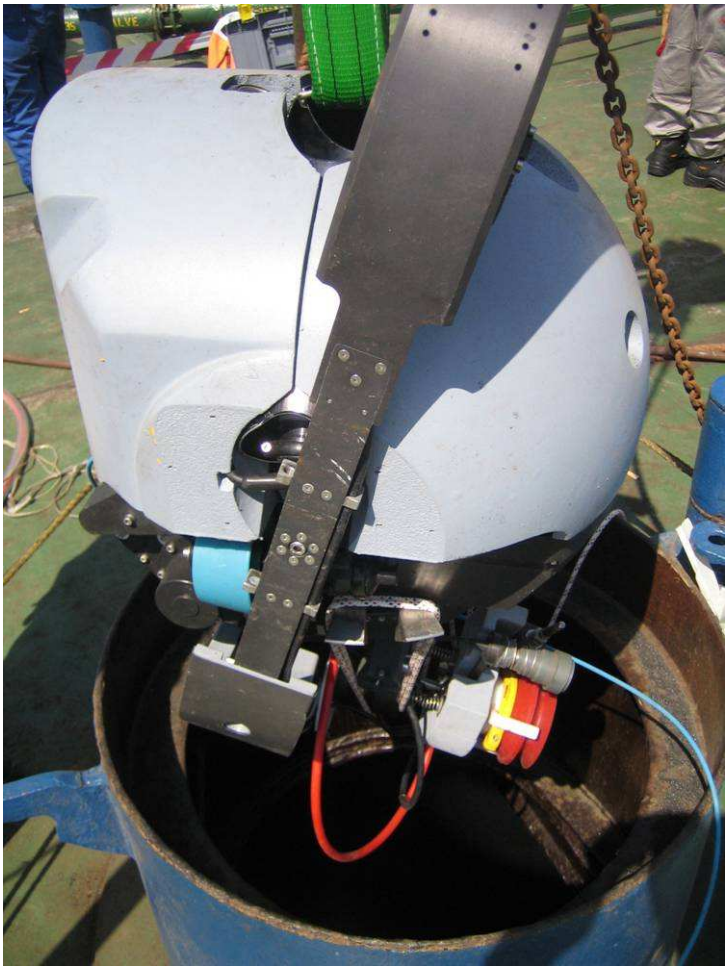


Figure 4 Inserting the ROV into the flooded ballast tank

Figure 5 Start-up of the system and navigation to consecutive measurement/inspection points

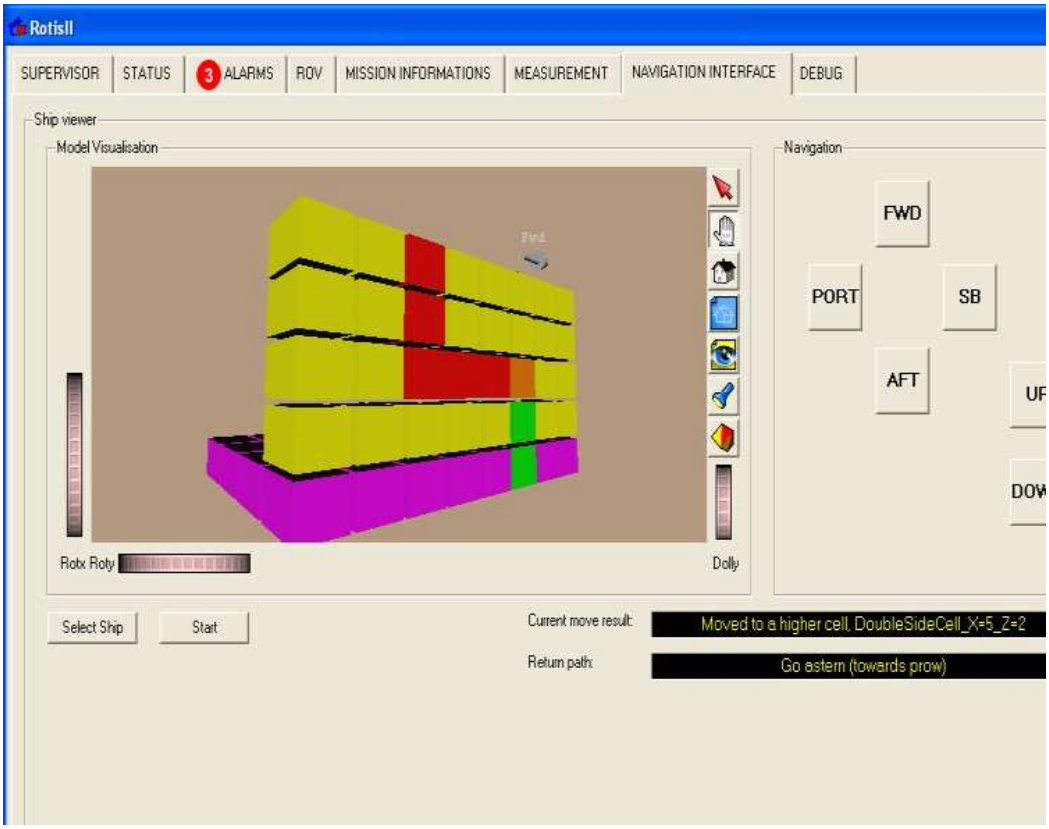


Figure 6 The user can follow the movement of the ROV between the double hull cells using previously prepared simple model

Figure 7 Navigation / visual inspection (optional)

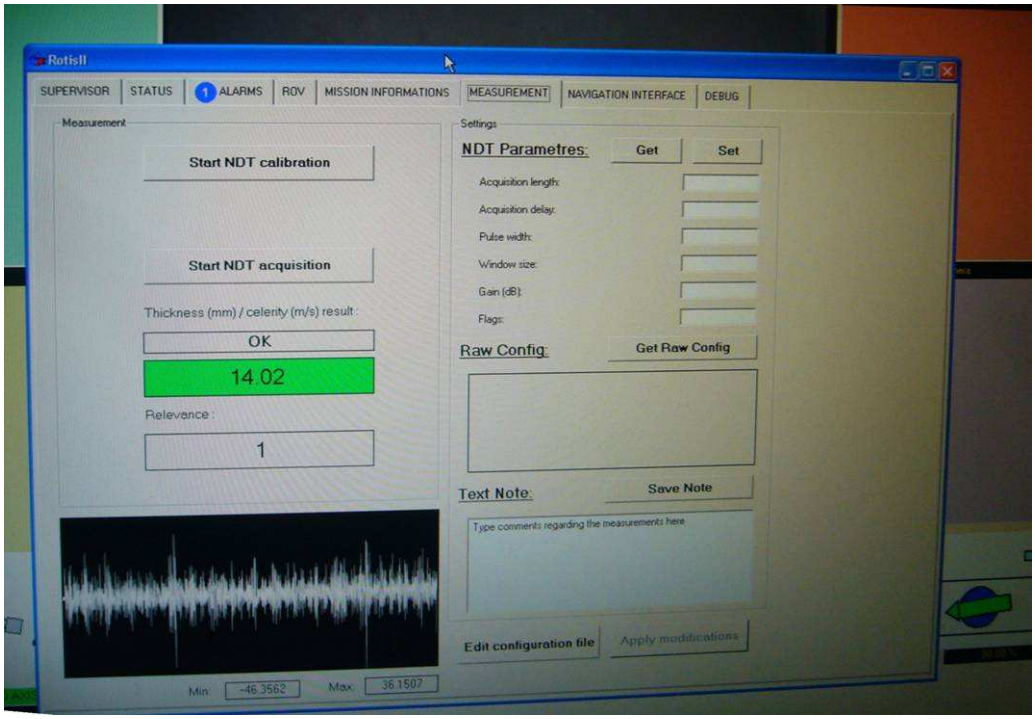


Figure 8 Ultrasonic Thickness Measurement recording

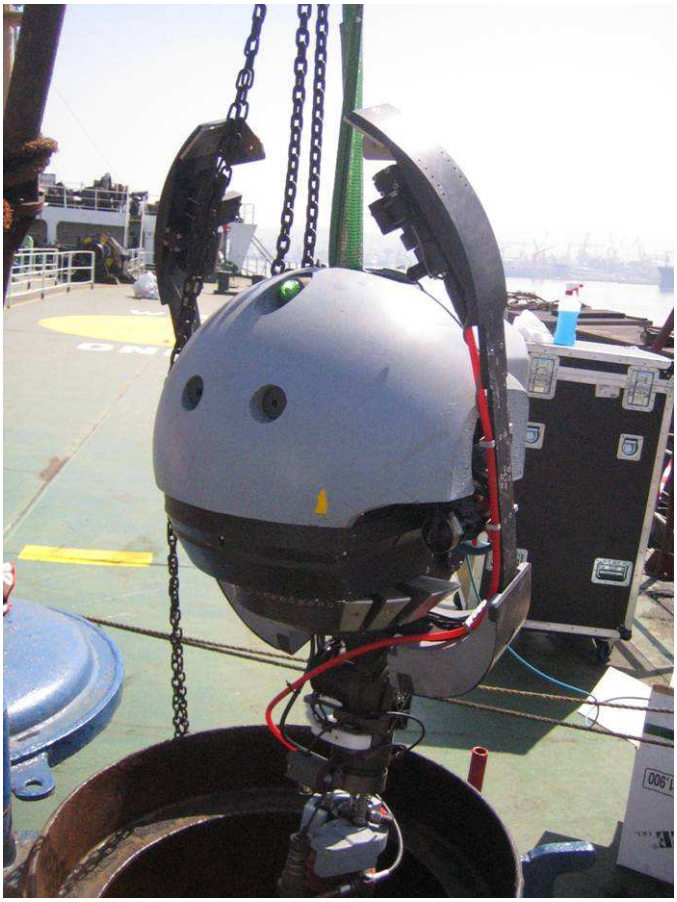


Figure 9 Return, power-down and demobilization of the equipment