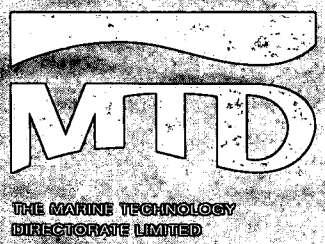
MARINE RESEARCH REVIEW 1



STRUCTURAL INTEGRITY MONITORING FOR THE OFFSHORE INDUSTRY

SOME DEVELOPMENTS WITH INDUSTRIAL POTENTIAL

MARINE RESEARCH REVIEWS

The aim of this new series of short reviews is to disseminate the results of MTD research programmes beyond the immediate circle of the researchers and their sponsors to a wider readership in the offshore and other marine industries. Results that are innovative and have practical potential will be presented in a form that will be accessible to the technically literate non-specialist. The aim is to encourage industry to participate in further development needed to convert research results into products or services that can reach the industrial marketplace.

The Offshore Supplies Office (OSO) of the Department of Trade and Industry has supported the establishment of the series. OSO has chosen the first five topics from MTD research programmes in underwater technology undertaken with the support of the OSO and the UK Science and Engineering Research Council. The series is published by MTD.

About OSO

As part of its work within DTI to assist the development of the offshore supplies industry, the research and development branch of OSO:

- gives financial assistance to support R&D projects and stimulate private sector support
- encourages oil companies to support R&D in their suppliers
- assists companies to obtain support from European Community programmes
- encourages links in offshore technology between universities, research establishments and industry.

About MTD

MTD is a UK-based association with an international membership. The Members have significant interests and capabilities in ocean-related technology, and come from industry, Government, research establishments, academic institutions, the UK Science and Engineering Research Council, and the Royal Academy of Engineering.

MTD operates programmes with a total value of £8 million a year in three broad areas:

- research and development
- education and training
- publications and information services.

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Acknowledgements

The Structural Integrity Monitoring (SIM) Programme had three phases between 1983 and 1989, followed by a final set of projects that developed further some of the topics. The later stages of the Programme were managed by Professor John Billingham of Cranfield Institute of Technology, and it was funded by the Science and Engineering Research Council, through MTD, and a number of industry and government sponsors (see box). The sponsors provided a Steering Group to direct the technical aspects of the Programme, and had a period of confidential access to the results, which has now ended.

Members of MTD may consult the full research reports in the MTD library. Anyone interested in taking up any of the techniques described should contact the researcher concerned or Dr M W B Lock at Cranfield Institute of Technology (see table, p4).

Sponsors

BP Petroleum Development	British Gas	Chevron Petroleum (UK)
Conoco (UK)	Department of Transport	Norsk Hydro
Offshore Supplies Office	Shell UK Expro	US Coastguard R&D

This Marine Research Review was written for MTD by Judith Mirzoeff, who is also the series editor.

Summary

Seven projects are reported that developed potential products for offshore inspection. The eddy current instrument can detect cracks through a surface coating or beneath an irregular surface. The twin eddy current/ACFM probe can detect and size cracks at a small lift-off. A gamma radiation device able to detect voids or flooded members has been designed to fit a purpose-built ROV. Several prototype Hall effect probes have a range of applications in crack characterisation and monitoring. A sonar TV system is able to produce a simple 3D picture at a longer range than optical systems. A compact and sensitive hydrogen sensor detects corrosion or cathodic over-protection under water. Leaky Rayleigh waves form the basis of a device that can find defects under a surface layer through a cleaned window nearby.

Some of these instruments already work under water, others could easily be adapted to do so now that the principle has been proved. The following descriptions indicate the stage of development of each project and the potential applications of the products.

The Structural Integrity Monitoring Programme has already seen some of its products reach the industrial market-place. All the programme participants are keen that the projects featured in this review should be further developed.

Introduction

The growing population of steel structures in the North Sea increases the level of demand from operators to inspect welds and to monitor the growth of potentially damaging cracks. Non-destructive testing techniques in use for underwater inspection at the beginning of the SERC/MTD Structural Integrity Monitoring Programme were generally based on ultrasound or magnetic particle inspection (MPI). They were technically adequate but expensive, usually requiring divers to operate them, after first cleaning off accumulated marine growth and sometimes any underlying surface coating.

There was, and remains, considerable potential for better ways to detect and measure cracks that permit greater automation in terms of ROV deployment, faster scanning, accurate positioning of the probe in relation to the geometry of the welded joint and computer control, with real-time measurement. Further desirable developments are instruments that do not need close contact with the bare metal

surface, those for example based on measuring disturbance in a magnetic field, and techniques for remote continuous monitoring that would avoid the need for any intervention until damage had reached a predefined level. Underwater inspection will be required not only for oil and gas installations, but for all kinds of marine steel structures, for example innovative structures for harnessing renewable energy at sea.

A number of significant advances were made in the Structural Integrity Monitoring Programme, with potential products being proven in the laboratory and sometimes under water. The most successful of these have already been taken up by industry, in particular an induced field ACFM probe with its associated software developed at University College London, which is now in widespread use. Other successful projects were not applicable to the offshore industry.

This review covers only those projects that are now ripe for further development for practical use by the offshore industry. The following table shows the projects described, where they were carried out and by whom.

An eddy current instrument for offshore application	University of Strathclyde	Dr A McNab
Novel integrated eddy-current/ACFM probe system for detection and sizing of cracks in metal	University of Essex	Dr D S Mirshekar
3D radiological imaging of thick underwater structural sections in the presence of marine growth	Brunel University	Mr B Bridge* Prof D C Imrie
Hall effect probes for crack detection and monitoring in steel structures	Cranfield Institute of Technology	Dr R L Allwood
Low cost acoustic imaging	Cranfield Institute of Technology	Dr R L Allwood Dr M W B Lock
NDT hydrogen sensor	University of Newcastle upon Tyne	Dr J V Dobson
Plate, leaky Rayleigh and creeping wave NDT for offshore structures	University College London	Dr L J Bond** Dr G Hughes

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** Now Professor of Mechanical Engineering at the University of Colorado at Boulder, USA