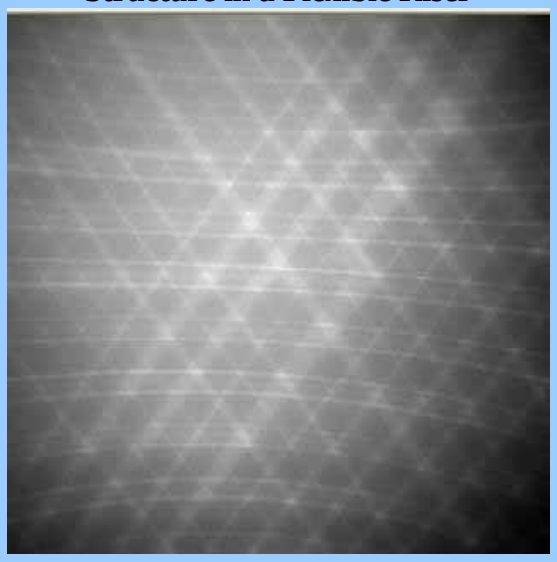
Digital Radiographic Inspection

Radiograph showing Complex Multilayered Structure in a Flexible Riser



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Flexible Riser Integrity Safety Assessment Non Destructive Radiography Inspection Technology

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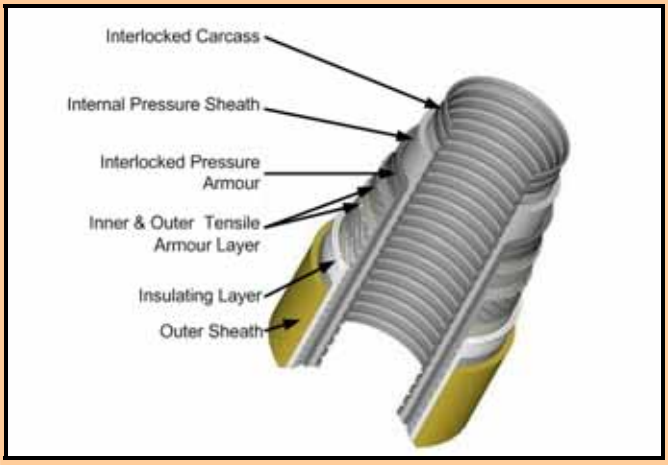
Executive Summary

Flexible risers are being used worldwide in the process for deep water crude oil extraction. The operational uptime requirements are high since flexible risers can undergo degradation due to the impact of hostile environmental factors. This in turn can reduce the product life cycle, thereby increasing the possibility of hydrocarbon leaks and spillage from offshore production facilities.

Two years ago with EC FP6 CRAFT part funding, a consortium called FlexiRiserTest was established. This team comprising end users Petrobras, Wellstream, together with research institutes TWI, Zenon, Research Centre Juelich, and SMEs CIT, TSC Inspection Systems and EuroNDT started developing an underwater digital radiography inspection technology, which has evolved with proof of concept, and prototype construction of the solution. The results are encouraging with the confirmation that the developed flexible riser inspection technology can be applied to real world applications for safety assessment and monitoring for prompt predictive maintenance. Using such an inspection system offers the possibility to collect radiography information which can be used to map the product life cycle and facilitate risk assessment of the system.



NDT Inspection Service Team Partners

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Background

This white paper summarises the inspection of flexible risers through the world's first underwater NDT Digital Radiography Inspection System. The system allows the possibility for volumetric inspection of flexible risers and to detect defects through the use of a digital recognition software package. The key advantage of opting for the Flexible riser inspection project is its ability to work undersea in an in-situ environment, thereby saving time and increasing production efficiency. The proven industrial digital radiography adapted for a marine environment helps detect defects at an early stage, thereby enhancing integrity and reliability of flexible risers. The advances in digital radiography entail that there is less radiation required to capture a useful image and that digital algorithms built to meet acceptance criteria can provide accurate results. Thus, the Flexible riser inspection project offers an attractive proposition to improve productivity, partner SME competitiveness and provide reliable tamper-proof data to enable validated acceptance criteria.

Flexible risers consist of a number of layers of steel and polymer that have a complex structure and some of the layers are shielded by others, making the Non Destructive Testing (NDT) particularly difficult. Radiography has long been proven as a versatile method for carrying out NDT industrial radiography. With advances in digital technology, digital radiography has also established itself as reliable and efficient way of conducting industrial radiography. Digital advancements have now made underwater radiographic inspection a reality with together with equipment adapted for marine and subsea environments.

Objectives

- To improve integrity and reliability of flexible risers through volumetric inspection and defect recognition
- Prevent failure of flexible risers, thereby ensuring continued oil production
- Elimination of offshore leakage and oil spills resulting in service failure
- To enable safety assessment monitoring and plan predictive maintenance

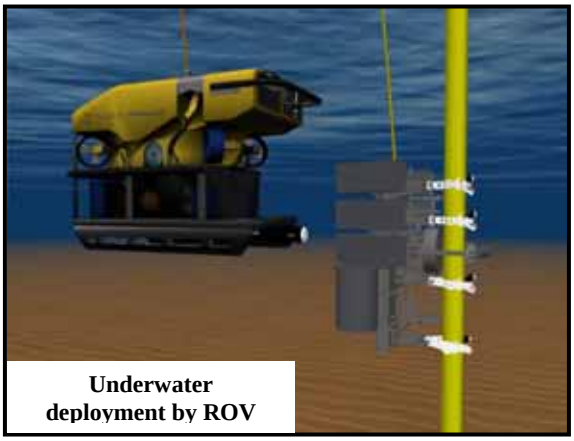
The flexible risers are expected to work for a period of around 20 to 30 years, which is the expected lifetime of an oil or gas field. In such a scenario, a flexible riser failure could be catastrophic leading to high economic and environmental consequences. Flexible risers comprise multiple layers, and the main layer of concern is the tensile armour layers which exist to withstand tension loads. The tensile armour layers are of major concern because they are surrounded by other metallic layers and so is difficult to inspect. Radiography also enables other metallic layers to be inspected including the pressure armor and inner carcass layers.

The Flexible riser Inspection System described in this white paper is able to detect the following defects:

- Unlocking of pressure armour (loss of interlock)
- Wire Cracking
- Wire Breaking
- Reduction in Wall Thickness
- Wire buckling

Features

- Offshore In-situ Underwater Inspection
- Custom-designed "marinised" Equipment
- Automatic Defect Recognition
- Security Measures
    - Isotope safety monitoring
    - Radiography warning audio-visual alarm system
    - Radioisotope device safe position
    - CCTV feedback system
- High Quality Digital Imaging
- Information Management and Archiving



Underwater deployment by ROV

System Specification

The Flexible Riser Inspection Technology consists of the following major subsystems:

- Sea borne operator control command centre
- Flexible riser automatic inspection application
- Digital radiography acquisition system
- Underwater robotic crawler unit that can be deployed with Remotely Operated Vehicles (ROV) or lowered from the FPSO
- Information management software application for NDE data and archiving

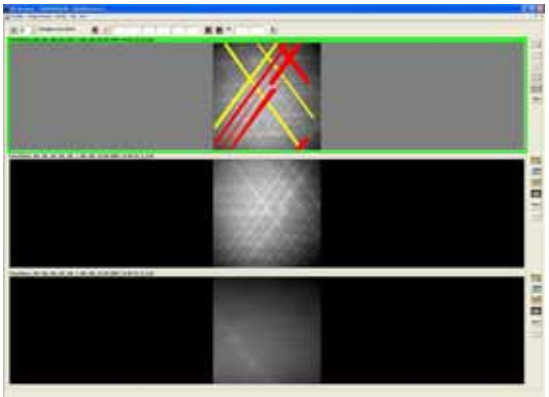
Through trials the inspection technology described in this white paper is able to inspect flexible risers from 12 mm to 100 mm thickness comprising multi-grid structures. The majority of the inspection process is automated, which includes automated defect detection and archival technology.

Operator's Control Console Unit

Sentinel 865 underwater Gamma Isotope holder

Flexible riser Inspection System – Robot crawler

Flexible riser Inspection System – Robot crawler



Digital radiography results

Flexible riser inspection system control application

This inspection technology has been tested to 20 meters water depth and in real life deployment is capable of being used at much greater water depths. The FlexiRiserTest consortium team via the exploitation team has set up an NDT Inspection team comprising CIT, TSC and EuroNDT that will be specialised in conducting underwater inspection tasks for underwater man made structures including umbilical, pipes, flexible risers.

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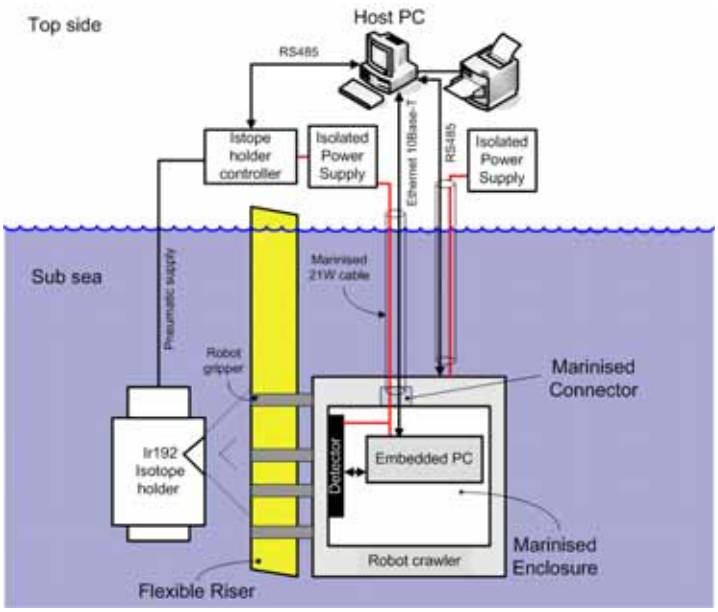
System Overview

The robotic crawler unit forms the backbone of the Flexible riser inspection system. Its payload comprises a digital radiography detector and the radiation control device enclosed in marinised containers. The crawler grips to and crawls on the flexible riser using a gripper pair sliding mechanism, and positions the detector and the radiation device accurately to acquire images. The detector that is attached to an embedded pc generates the images, which are sent to the host pc via marinised umbilicals. The host PC installed with CIT's proprietary DRBrowser software customised for use with the Flexible riser inspection system is used to inspect the image for defects using advanced Automatic defect detection algorithms.

Utmost care has been taken to account for security as the system deals with harmful gamma radiations. This is implemented in the form of an Operator's Control Console Unit, which consists of Isotope safety monitoring and radiography warning (audio-visual alarm systems), and CCTV feedback system.

In addition, the Operator's Control Console Unit also enables you to interpret, measure and archive images for future reference.



Technical Specifications

Radiation Isotope Source	
Source	Ir192 (max. 25 curie)
Focal Spot	2mm X 2mm
Controlled	Air-pneumatic operator unit/fall
Safety	Visual and audible with non-detector (waterproof)
Exposure Time	auto timer from 1 sec to ...
Weight	27 kg (approximate)
Dimension	TBC
Digital Computed Radiograph (option 1)	
Inspection Area	254mm X 312mm
Weight	TBC
Dimension	TBC
Interface	Data communications
P.S.U Facility	240V, 50Hz
Operational depth	TBC
Detector (option 2)	
Resolution	0.4mm
Active Area	200 mm x 200 mm
Weight	30kg
Dimension	550mm diameter
Interface	Ethernet
P.S.U Facility	240V, 50Hz
Operational depth	20m

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