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Editor

In view of future demands for ultrasonic inspection of subsurface structures of offshore platforms FORCE Technology several years ago upgraded its diver assisted subsea inspection system to a ROV assisted version.

The performance of the ROV assisted automated system is expanded concurrently with demands set by customers. The ultrasonic processor has been upgraded to incorporate Eddy Current meaning that the system is able to do both techniques in the same scanning. Further more the system is now pressure tested for operational working depth of 3.000 metres.

For the future FORCE Technology is now working on scanner designs for inspection of more complex geometries like node welds. The basis for such development is scanner systems developed for inspection in the nuclear industry. This may push the development towards a flexible subsea inspection system suitable for almost any requirement.

*Leif Jeppesen
Head of Sensor and NDE Innovation*

Subsurface brace welds inspected dry from the inside

Remote operated ultrasonic inspection system examined subsurface brace welds on lattice tower legs by using a scanner moving in circumferential tracks 48 meters down inside the leg.



The lattice tower at South Arne Platform

The offshore installation South Arne is located in the Danish sector of the North Sea where the water depth is about 60 meters. The platform, operated by Amerada Hess, sits on a concrete oil storage tank. The topside is supported on the concrete storage tank by one concrete column leg and a steel lattice frame for well head conductors.

Brace welds on two of the lattice tower legs should be inspected for defects in the heat affected zones at the leg side of the brace welds. As the target welds were located about 25 meters below surface the feasibility and costs of different inspection methods involving divers and a DSV were evaluated by the platform operator and based on this the possibility of internal inspection with ultrasound was chosen.

The selected solution, provided by The Department of Advanced NDE Services at FORCE Technology, was to introduce a scanner system into the hollow and dry lattice leg through a small opening cut in the upper leg section for that purpose. The maximum allowable size of the opening was set to be 400 mm wide and 600 mm high. Light, video camera end a magnetic wheel scanner (modified version of AWS-5D) equipped

with 7 UT probes was manually lowered 48 meters inside the slightly tilted leg to the target depth. Arrived there the scanner's guide wheels were released allowing magnetic wheel to get contact with the leg wall. From that moment scanner movements were controlled by operator's topside via the P-scan system 4 instrumentation. The scanner with its 4 magnetic wheels and two motors could be moved in circumferential tracks and up or down as well. The approximate depth of the scanner was verified by visual identification of girth welds with known position. The exact position was then found and verified by the use of the ultrasonic signals from the welds. Due to the complex configuration of probes and their view angles it was possible to examine for defects, independent of defect direction based on rather few track runs. The scan data could be viewed and evaluated topside simultaneously with progress of the scan operation. The inspection revealed satisfactory integrity of the examined brace welds.



The AWS-5D scanner equipped with 4 magnetic wheels, 2 motors and 7 UT probes mounted on the Y-drive arm. The scanner is fitted with 4 pneumatic operated guide wheels for release of the magnetic wheels.

The probability of detecting defects

FORCE Technology has accomplished a Probability of Detection (PoD) test with P-scan system 4 on a full scale mock-up with artificial defects and came out with an excellent result.

FORCE technology was requested to produce a probability of detection (PoD) curve for the automated ultrasonic technique used for examination of brace welds on two platform legs of the **Amerada Hess** platform South Arne in the North Sea. The examination technique used in these tests includes the equipment, procedure and personnel.

In order to establish the PoD curve a full scale mock-up was produced. Artificial defects simulating fatigue cracks of different depth and length were made as Electrical Discharge Machining (EDM) notches. A total of 26 notches were made in the mock-up. The width of these notches were in the range of 0,1 mm to 0,3 mm and the sizes (depth x length) varied from 1 x 5 mm to 6 x 30 mm. The majority (18 notches) were of size 3 x 6 mm or smaller because the emphasis should be put on detection of small defects, as the technique's capability to detect these was the main concern. The detection capability regarding larger defects was not questioned. The depth of defects was verified by a moulding technique and microscope measurement.

The mock-up was scanned according to the established inspection procedure by five different operators (one made two separate scans). Each operator should perform three circumferential scans in order to cover all areas of interest. The coordinate lines for the scans were made on the inside of the mock-up whereas the outer surface with artificial defects was hidden. The data were evaluated in accordance with the procedure by eight different persons and three of these evaluated their own scan data. Only one among the involved persons had prior knowledge about the number, size and location of defects. However, this knowledge could not influence the results since conditions for scanning and evaluation were set in the procedure. To fulfill the requirement of independency only six of the eight evaluation results were used in the subsequent statistical analysis.



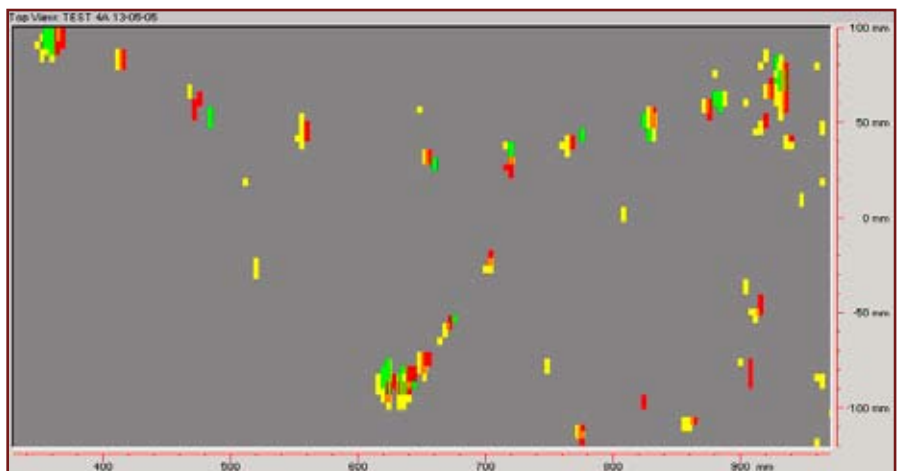
1830 mm high mock-up of platform leg with brace welds. The wall thickness of the leg is 45 mm and its internal diameter is 940 mm.

The six ultrasonic scans recorded significant indications at all locations with simulated defects. Seven of the eight examiners identified and reported all 26 defects. One examiner reported 21 of the defects correctly and had the remaining 5 (small defects grouped closely together) reported as a single defect. However, this deviation was due to the examiners misinterpretation of the reporting requirements and not a misinterpretation of the scan data.

The size range and number of defects covered by this test are not well suited for determination of a PoD curve as a function of defect size where PoD decreases with decreasing size of defect. All defects were detected and this is of course a success. However, a PoD test done with even smaller defects in the muck-up or a test under real field conditions would probably have shown the size below which the PoD decreases.

When a crack is found in a structure its depth is normally afterwards sized by the TOFD technique and such sizing is in general considered being correct. The depth sizing of the simulated defects by the moulding technique offered a possibility for comparison with TOFD. Therefore a singel scan of all defects was performed in order to size the depth of each defect by the TOFD technique. In this comparison the mould measurement was considered being the true value. A statistical analysis of deviations did not indicate that these were related to depth. The estimated uncertainty of the TOFD values (based on analysis of the actual data) was found to $S = 0,12$ mm and this confirms a reasonable reliability of the TOFD depth sizing. The actual deviation between the moulding result and the TOFD measurement was in all cases within $\pm 0,2$ mm.

The results were verified and approved by an independent third party.

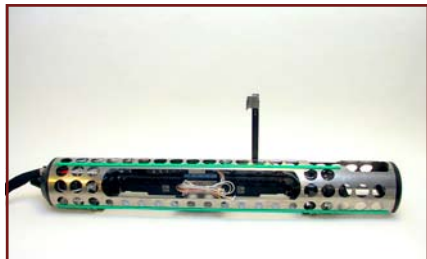


Example of scanning of lower part of the upper weld and the area between the welds. In this scanning the sound beam direction is circumferential in both directions in relation to the pipe.



Low profile scanner for enclosed tank systems

The remotely operated automatic scanner can be launched through narrow access openings.



Front view of 4 wheel scanner AMS-28 with raised camera arm

Some tank systems are constructed with a steel tank placed inside another tank which may be of concrete. The space between the tank walls may be rather narrow and access for inspection difficult.

Access to the inside tank is in some cases through pipes with internal diameter ranging from 5" to 8".

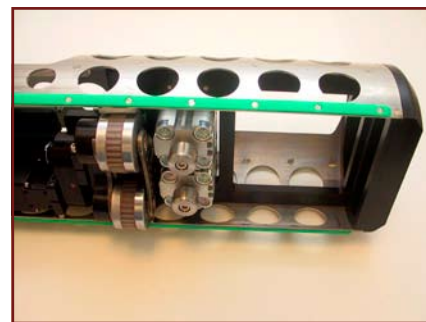
Scanners for such inspections require special design efforts since the scanner in addition to the normal scanner modules also must carry video camera and light. The latest version of the low profile tank scanner, AMS-28, is based on FORCE Technology standard modular components and that eases maintenance end service.

The scanner modules are mounted on a base frame and all housed in a cylindrical shield. The scanner has two set of magnetic wheels mounted to enable a four-wheel contact when the scanner moves on a slightly curved surface. The Scanner is equipped with 3 motors.

In order to release the scanner from the surface it is equipped with 4 pneumatic operated release feet.

AMS-28 has a camera arm for video camera and light. The camera arm is raised from its docking position below the shield to upright position and turned back by a pneumatic cylinder.

The scanner is able to carry up to 4 ultrasound transducers.



AMS-28 has magnetic wheels and pneumatic operated Jack pads for release of scanner from the steel surface

Meet us at:



FORCE Technology will be exhibiting selected P-scan products in Hall Estrel, booth E 07

New scanner saves down time

An automated non-destructing inspection system for suction roll shells will save down time for the Pulp & Paper Industry.



AMS-33 with probe holding system, rotation drive and longitudinal rail drive

Suction rolls are some of the remaining components of paper machines that are removed, inspected by NDE methods and overhauled at fixed intervals. It is because suction roll shell failures can result in considerable damage to surrounding parts and typically take days to repair. Losses are many times counted in the millions of dollars.

Failure of a suction roll will most often arise from cracking developed in its internal surface.

FORCE Technology has constructed a new scanner, called AMS-33, dedicated to inside inspection of suction roll shells. It is designed for automated ultrasonic and eddy current inspection for cracks and other defects between suction holes. The scanner will be used by FORCE Technology Sweden for on-site examination of suction rolls that are temporarily removed from the machine for inspection and overhaul. The AMS-33 is simple to pack for transportation and to prepare for inspection as well. The scanner is equipped for inspection of suction rolls with internal diameters ranging from 573 mm to 1722 mm.

The AMS-33 is constructed with a probe holding system mounted on a 3.6 metre long rail, which is installed inside in the roll axis. The probe holding system includes a rotating drive with a frame extending like a propeller towards the inside wall of the roll. Spring-loaded probe holders mounted on the frame ends keep probes in close contact with the inside surface.

When the scanner is operating probes are moved on the inside surface in circular tracks with centre in the roll length axis. The probe holding system with its rotating drive can be moved by a rail drive motor along the length axis of the suction roll. Each end of the probe holding frame has 4 probes meaning that a half rotation covers 4 parallel complete circular track separated 6 mm. After a rotate sequence the probe holding system is indexed one step along the length axis rail and a new sequence can start.

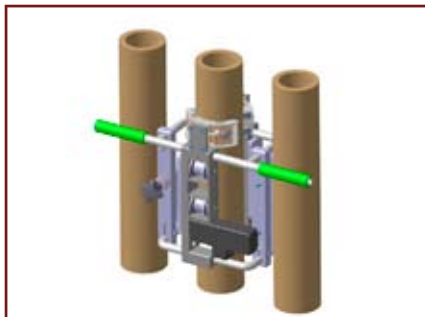
The P-scan 4 software controls via the P-scan 4 Flex the automated operation of the scanner. All data are displayed online and saved in a PC memory.



AMS-33 installed for scanning

Reformer Pipe Scanner

An automated modular scanner for ultrasonic inspection of reformer pipes has been designed for an Asian customer.



Reformer Pipe scanner clamped on pipe. It has two probes and two wheels on each side of the pipe.

About P-scan News

P-scan News is a newsletter created to serve customers and contacts with up-to-date information on P-scan and closely related inspection methods provided by FORCE Technology.

Enquiries and Comments

If you need more information or have comments to specific products, known applications or even potential applications do not hesitate to contact the editor directly.

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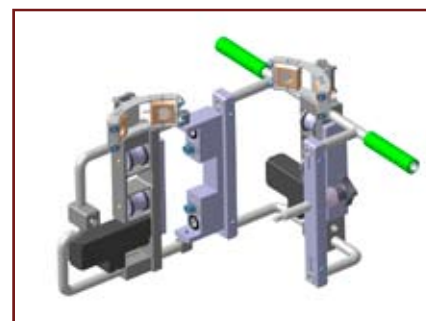
Reformer pipes are difficult to access and time-consuming to inspect onsite by manual methods because reformer pipes may be 12 to 20 meters long and are placed in rows rather close together.

Components like reformer pipes, operating at high temperatures, experience various kinds of damage mechanisms including creep, fatigue and creep interaction, fracture and environment attack. Some inspection methods for reformer pipes include attenuation of ultrasonic signals in the fitness-for-service-assessment.

FORCE Technology has in 2005 designed an automated scanner for quick ultrasonic inspection of reformer pipes. The scanner includes 4 ultrasonic probes, which measure attenuation in two cross sectional sectors of the pipe while the scanner moves up or down along the pipe. The scanner has spring loaded probe holders and spring loaded fixtures for its four driving wheels. This configuration enables the scanner to pass welds on the pipe and adapt to

changes in pipe diameter. The scanner has an encoder to position scan data along the pipe.

The scanner is a light weight (5 to 7 kg) clamp-on type for easy installation. It is based on modular components and has two motors to run two driving wheels on each side of the pipe. The operation speed is in the range of 4 to 6 metres of pipe per minute. Scanner operation and data collection are remotely controlled by P-scan system 4 units.



Reformer Pipe Scanner in open condition and ready to be clamped on a pipe.

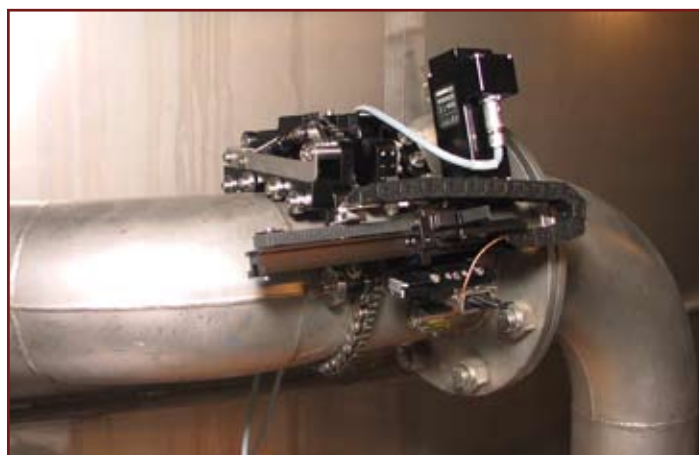
APS-6, Pipe scanner

The new automatic pipe scanner works on non-magnetic pipe materials.

The APS-6 (Automatic Pipe Scanner-6) is a wheel XY scanner primarily developed to ease inspection of non-magnetic pipes. It is designed with special attention to performance, easy mounting and low profile dimensions. The scanner is assembled using standard modular components.

The scanner uses a guide chain mounted on the pipe for the X-direction movement and a transmission chain to achieve a stable movement along the guide chain. The transmission chain and the scanner's chain tension system ensure that the scanner always is in close contact with the pipe surface.

The scanner is ideal for areas where a robust and stable scanner is required for inspection with high speed, large strokes, several probes etc. The major application areas are weld inspection and corrosion mapping of pipes down to OD 100 mm.



The automatic scanner APS-6 working on an 8 inch pipe