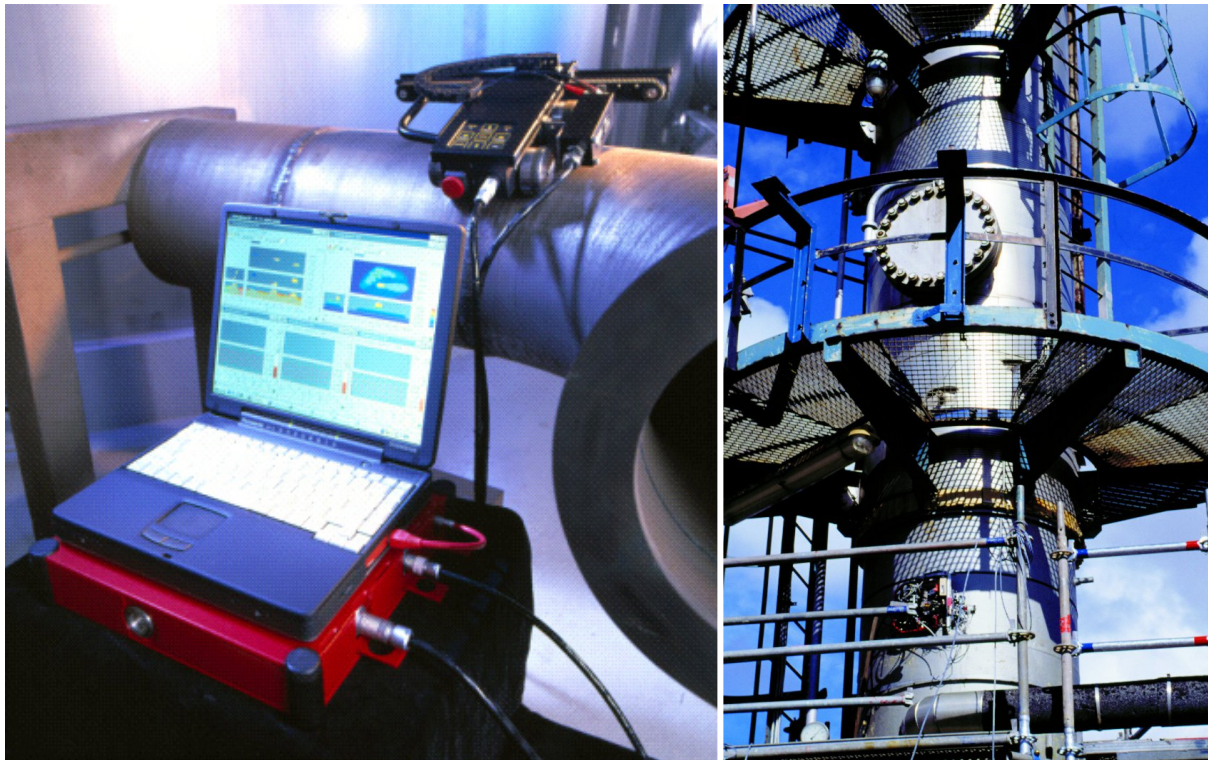
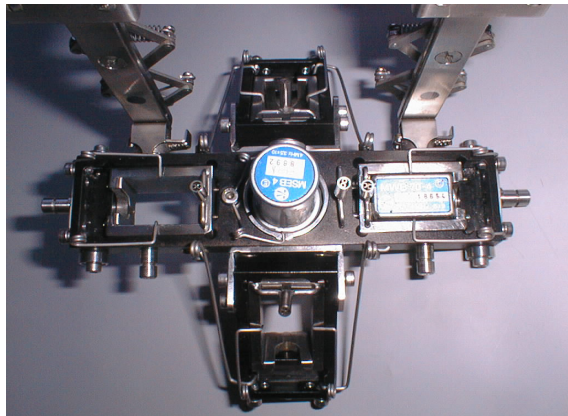
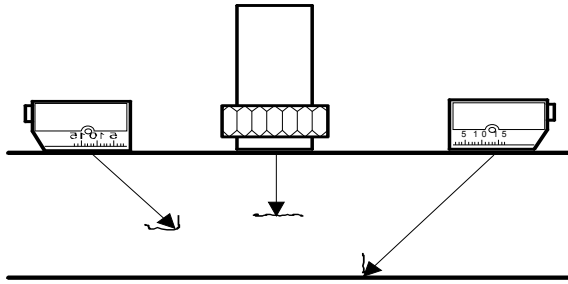


Inspection for hydrogen damages



Ultrasonic examination of pressure vessels and piping for hydrogen cracking is one of the most time consuming and costly manual examinations. Moreover, the examination requires accuracy for measurements and recording, which is hardly achievable for manual examination. This is particularly true if the scope of the examination is to establish growth rates and condition monitoring.

The application of automated ultrasonic examination for the detection of cracking and surveillance of defects during consecutive examinations is advantageous. The examination may be performed with the P-scan system with straight beam and angle probes in one single scanning and all echoes down to noise level are recorded.



Procedure for Automated Ultrasonic Examination of areas with hydrogen damages

FORCE Technology has a procedure for automated ultrasonic examination of areas with hydrogen damages, which has been validated through full scale pipeline testing. Furthermore, the procedure has been utilised in field operation (see example below). An extract of the procedure looks as follows:

• Scope

- This procedure describes the requirements for automated ultrasonic examination for Hydrogen Induced Cracking (HIC) in carbon steel components.
- This procedure covers detection and mapping of Hydrogen Induced Cracking in carbon steel components in a thickness range from 10 mm to 40 mm. The component geometry can be from plane to a diameter of 300 mm. The utilised techniques are amplitude based examination with 45° and 0° transducers and thickness measurement with 0° transducer.
- Possible failure in the components may be lamination type defects, step cracks and inner surface corrosion attack.

• Ownership and copyright

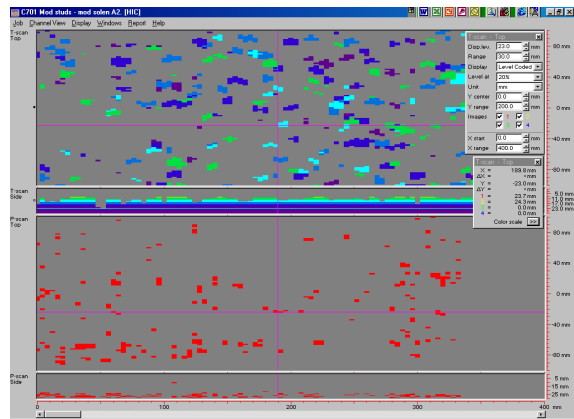
- Procedures made by FORCE Technology are not allowed to be published or copied. Extract with source reference must only be quoted upon prior permission in writing.

An example of automated ultrasonic examination of an area with damages at inner third of the shell (thickness 25 mm)

FORCE Technology has utilised the procedure for automated ultrasonic examination of areas with hydrogen damages on several occasions.

The picture below shows the result of an automated ultrasonic examination. In the upper large part of the picture, the laminar indications are imaged with a color scale (blue – green), which image depth positions as shown in the small image below. In this case, severe extent of laminar indications is observed. In the lower large part of the picture, the 'vertical' indications are imaged in one color (red) showing the area distribution. In the lower small image the position in depth is shown. In this case, severe extent of 'vertical' indications is observed.

Based on the acceptance criteria, which includes amplitude and position evaluation, FORCE Technology has recommended planning of the repair work, which must be performed during the first shut down.



Result of examination with straight beam probe (gate with reflections from defects) shown in the upper views (T-scan) and the results of examination with angle probes (P-scan) in the lower views



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