1.7.7. FATIGUE AND CORROSION MONITORING BY MEANS OF ACOUSTIC EMISSION (AE) ON TRANSPORT PRODUCTS

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Basic. Fatigue cracks and corrosion damages are beside human errors the main causes for structural failures of all surface transport products like ships, road tankers and railway tank cars. Examples are catastrophic ship accidents with a tremendous pollution of the maritime environment or fatal explosions during the use of transport vehicles. Although evolving defects have to be identified in time to enable appropriate repair, preventive maintenance activities are usually carried out on time driven basis. As example transport products for cargo like crude oil and pressurised gases have to be taken out of service for visual inspection and sub-sequent non-destructive tests (NDT). Findings have to be repaired later on. This procedure is time consuming and expensive, especially the lost service time decreases the competitiveness of the European transport industry. Despite this high effort the risk of not detecting the onset of a defect is still implied in this maintenance process and thus failure within the next service period may occur.

Within an EC-funded project (SCP7-GA-2008-218637) an overall strategy for the maintenance and inspection, especially the necessary AE-equipment for the different transport products was developed. The partners of this funded project represents many leading companies on their specific field (Conventional NDT, Acoustic Emission (AE), Inspection, Ship Classification, Universities dealing with calculation of different transport products, Maintenance including a Ship Yard). The partners are: TÜV AUSTRIA SERVICES (Austria), Vallen Systeme (Germany), ABS Europe (United Kingdoms), BAM Berlin (D), University of Thessaloniki (Greece), University of Gdansk (Poland) ISQ (Portugal), University of Krakow (Poland), Nuclear NDT (Romania), Reneko (Estonia) and Naval Ship Yard Gdansk (Poland).

The result of the project shall be an overall strategy for the maintenance and inspection, including the necessary AE-equipment and application rules for the different transport products.

The main aim was to investigate, if is possible to replace the normal “time driven” inspection intervals by maintenance intervals, which are driven by results coming from the monitoring of the structures.

Results. During laboratory measurements the monitoring rules for the on-line detection of corrosion processes and fatigue cracks the different structures were investigated. During these tests, which were performed at the different partners, the same test parameters were used. The data, coming from corrosion and different fatigue cracks were load up into a frequency based evaluation system and combined to a data base, where the AE-signal could be sorted out according their different sources of origin. The laboratory tests were performed with these loading sequences, which are expected during the normal service (e.g. stress, loading frequency, environment conditions). The tests were performed on test specimen, which were comparable to the hot spots on the different ships, tracks and railroad car. As basis for these experiments the hot spots for the different structures and also damage mechanism has to be defined on the experience of all partners, which are involved into the transport business for a long time.

Furthermore it was important to compare the AE signals with the expected background noise, which occurs during the service of the transport product. Of course the

background noise for the different transport products (ships, trucks and railroad cars) are completely different and has to be validated for every type of transport product itself.

The comparison between the different AE signals was done on time and frequency domain pattern recognition systems and showed distinguishable differences between the background and the different damage mechanisms. This distinction was important because the background noise of the different transport products during shipping are too high to work only with a frequency filtering and detection of any AE-signal.

The works will be continued on real structure, where we are able to measure the influence of all disturb noise directly.

All these measurements are accompanied by validation of conventional NDT for the follow up of the flaws, which were detected and evaluated by AE. These tests became necessary to offer the industry a complete methodology and not only the monitoring part.

Discussions. The first results coming from laboratory tests showed from the technical side, that it would be possible to monitor the structural integrity in term of developing fatigue cracks and wall thickness diminution due to corrosion. This will enable preventive maintenance on a condition driven basis. This proposal addresses ships, railroad cars and road tankers. The experienced structural failures for these products are similar and thus the same process applies. Cost effectiveness is clearly given by reasonable installation and service costs of the monitoring system in relation to increased availability and safety, which even will be developed within the upper mentioned EC-funded project. Preventing failure of transport products is a major contribution to environmental protection. Minimising personnel entry into tanks improves working conditions.

Summary. The paper shall point out the today's problems with the time driven maintenance and inspection of all ground transportation products. It shows, that the conventional methodology is time-consuming, expensive and sometimes improper. By the application of a monitoring technique, which can detect the different damage mechanism during their origin, we would be able to replace the maintenance intervals by information, which is coming in-service and on-line from the monitoring technique. As monitoring Acoustic Emission based was chosen, because it provides an integral statement about the structure.

During the pre-tests the application of AE was proven even the support of other techniques (e.g. preceding calculations and definition of hotspots, further in-service measurements) become necessary for a complete health monitoring of the transport products.