Document Number: EVI-2005-0002  
Document Date: 7/7/2005

Document Title:
Scanning Report of Flexible Riser Pipe Section

Customer:
AEA Technologies

Type:
Inspection Report

Prepared by: Robert J. Stakenborghs  
Date: July 7, 2005

Reviewed by: Jack R. Little  
Date: July 7, 2005

Approved by: ____________________________  
Date: ____________________________

Evisive, Inc.  
8867 Highland Road  
#378  
Baton Rouge, Louisiana, USA 70808 
phone: (225)769-2780  
fax: (225)769-2751  
www.evisive.com
Purpose/Background

This report details the results of the Evisive microwave scanning of a portion of an Oilfield Flexible Riser pipe. The riser pipe was provided to AEA Technologies and was made available to scan. The purpose for the scan was to evaluate the capability of the patented Evisive microwave method to provide information on the first row of steel bands (i.e. – the first tensile strength layer) located below the outer external fluid barrier.

This sketch shows the construction of a typical flexible riser pipe.

![Figure 1: Construction of Flexible Riser Pipe](image)

The method will be assessed for its capability to interrogate the sub-surface structure of the first tensile strength layer and detect flaws, including potential breaks in the tensile strength bands.

The pictures below (Figures 2 through 4) are of the flexible riser pipe section that was scanned.
The photograph in Figure 5 shows the manual demonstration scan equipment as it is installed on the flexible riser pipe segment.

The scans were performed manually with no equipment adjustments attempted to optimize the image. Two scans were performed, one larger scan at a radial
spacing (i.e. – X direction) of ¼ inch and one smaller scan at a radial spacing of 1/8 inch. As stated previously, these are manual scans and the equipment is capable of much better resolution using automated methods. Also, better image quality could be achieved following method optimization, although the images obtained are clearly high quality, as demonstrated in the accompanying figures.

Results

Figures 6-9 illustrate the results obtained from the microwave scans.

Figure 6 is a complete 360 degree scan of a 13 inch (axially) portion of the riser. Note the alternating light and dark bands and lines visible in the scan. These light and dark bands and lines have been confirmed to be the wires and gaps between the wires, respectively. Information from the scanned image was used to size the wires and their helical wind angle. The calculated results indicated a wire size of 12mm and a helical angle of 60 degrees. The actual wire size was confirmed to be 12mm and the helical wind angle was confirmed to be 65 degrees, well within the expected accuracy of the scanned image. All of this information confirms that the microwave method is providing an image of the outer tensile strength layer.

Also, the sequence of wires and gaps was identified by visual inspection of the exposed wires at the top of the piece of the riser, and the sequence is as follows:

Big/5w/big/w/big/9w/med/3w/med/2w/s/2w/s/w/s/2w/s/10w/m/3w/s/22w

Total Count - 60 wires and 11 gaps

A w represents a wire or a group of wires (i.e. – 5w represents 5 wires) and the underlined sizes (i.e. – big, med, or s) represent the size of the gaps. Three big gaps of approximately ¼ inch were identified and several smaller gaps of 1/8 (medium) to 1/16 inch (small) were also identified.

This sequence of gaps and wires was laid out to scale and rotated in an attempt to match the scan results. As can be seen in Figure 7, the patterns match very closely, which is another indication that the scan is definitely down to the tensile strength wire layer and can detect the difference between wires and gaps. Therefore, it is reasonable to expect that any gap created by a flaw in a wire, such as a break, would be easily detectable using this inspection method.

Figure 8 shows the detailed scan that was performed. Again, as can be seen by the X axis scale, the locations of the wires can be matched from the expected wire layout locations, based on the 12mm size.

Figure 9 is a portion of the large scan that enhances the view of the right side. Included in this scan is a clear view of the large gaps, plus several indications of
unknown origin that might be potential flaws in the riser pipe section. These could be indications of items that might prove noteworthy if seen on scans of risers either post manufacture or in service.

Conclusions

The patented Evisive microwave method is capable of producing clear images of the first tensile strength wire layer below the external fluid boundary. The detail in the images indicate that the method sensitivity could provide useful information in the detection of breaks in individual or groups of tensile strength wires, as well as other defects or structures of interest in this layer. Also note that the inherent sensitivity of microwaves to the presence (or absence) of liquid water or hydrocarbons could prove useful if leak detection in this layer is required. The method is currently field capable and could easily be adapted to undersea or in-factory equipment to scan the flexible riser pipes.
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Figure 6
The X axis scale is based on the width of a 12mm wire laid at a 65 degree angle.

Figure 8

Note the pattern of wires in the X direction repeats at a 1 to 2 wire interval. This allows an accurate wiring sizing from this scan.
Sub-surface Indication of Unknown Origin

Sub-surface Indication of Gap Between Wires, Typical of Multiple Indications

Figure 9

Sub-surface Indication of Unknown Origin