GUIDANCE

IN-SERVICE INSPECTION PROCEDURES

Number: **PEC 18 a**

Prepared by: **Pressure Equipment Committee (TC1)**

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Reference: **Blind trial: Remote Visual Inspection (RVI) of a Horizontal Multitubular Steam Boiler**

Boiler Details:

Robey Lincoln, Serial No. B65059
Manufactured 1974
SOL 100psi
Location – Cairo House, Oldham

Introduction

The boiler used for the trial had been out of use for several years and has been used for training of boiler inspectors. It was in good condition with few defects so some defects were simulated by drilling holes at various locations and cutting a slot through the shell to determine whether the remote inspection equipment was capable of finding them.

Two suppliers of remote visual inspection equipment were used in the trial but they provide different services so the results are not directly comparable.

Both suppliers visited the site before the trial to assess the dimensions, access available and what camera positioning equipment would be necessary.

Scope of trial

The trial was set up to demonstrate whether or not the remote visual equipment was capable of finding defects in the boiler, the ease of use, time taken for an examination and interpretation of images.

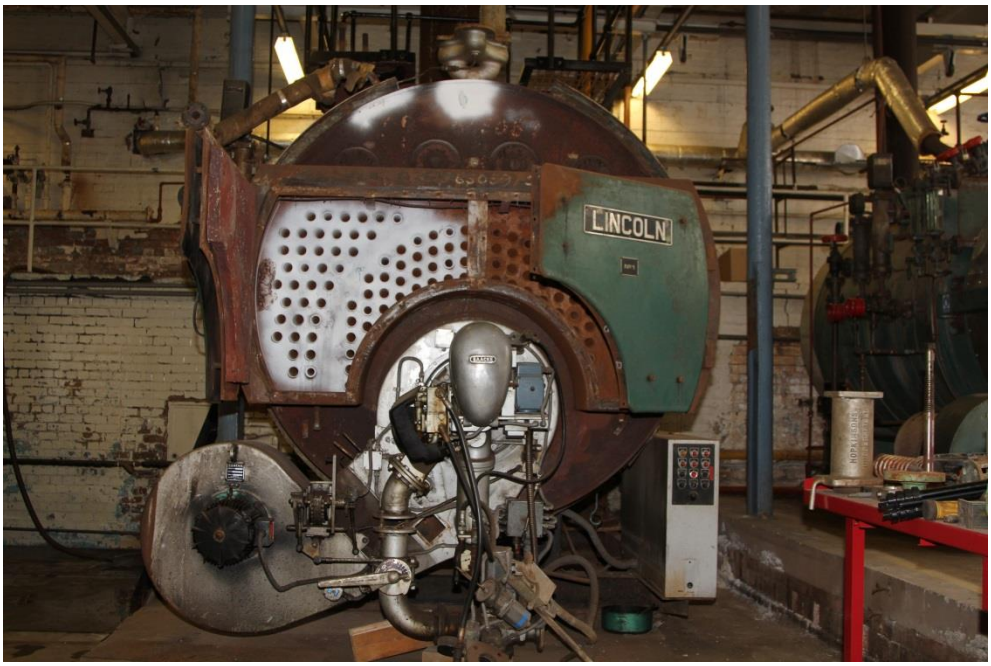

Fig 1. Robey Lincoln Boiler

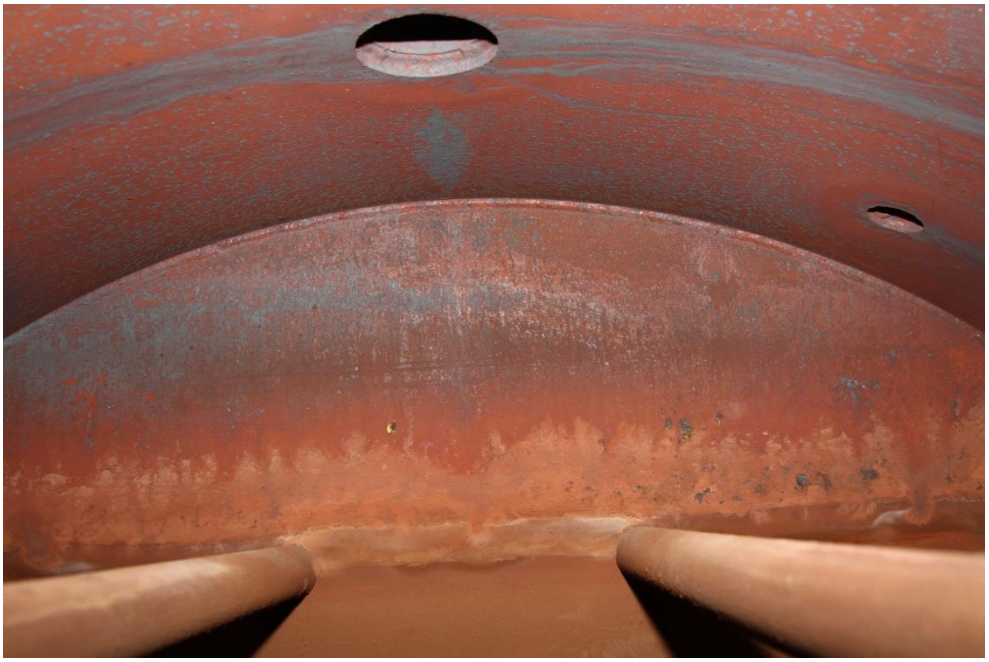

Fig 2. Boiler waterside looking towards the front tubeplate.

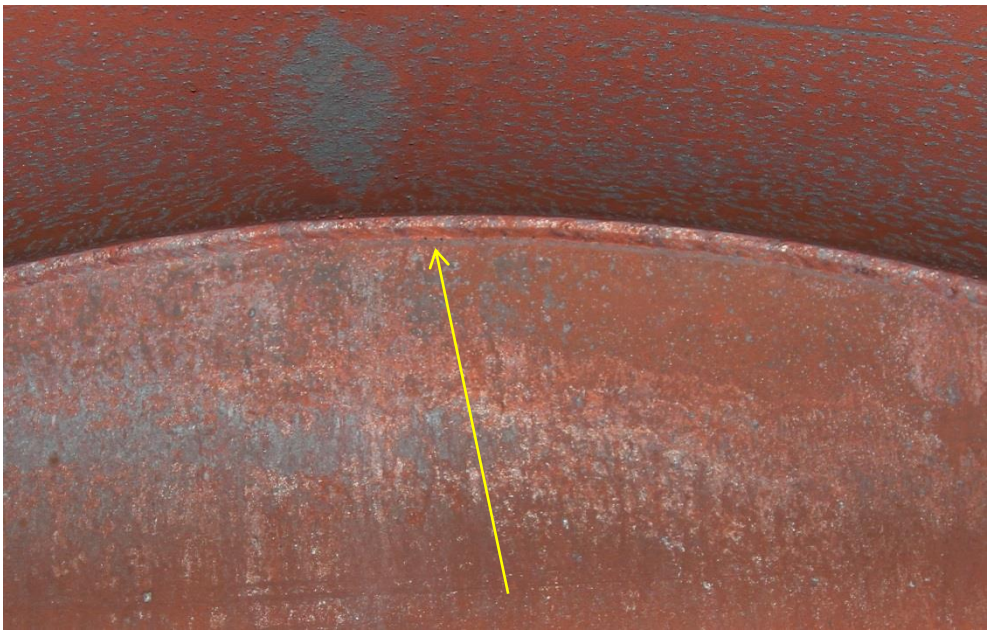

Fig 3. Closer view of front tubeplate to shell showing two off 2 mm diameter holes at the tubeplate toe of the internal fillet weld.

Results

Both sets of equipment were capable of resolving the simulated defects placed in the boiler. Whether the operator would or could have positioned the camera to find the defects without being directed to them was not determined. The memory card used to record the results of the second examination was defective and the test was not repeated as it would have been for a genuine plant examination so there are no photographic and video records of this.

Both operators had some difficulty positioning the cameras in the required locations, identifying the locations accurately and repeating the positioning for consistent results. At one point an inspector had to enter the boiler waterside to hold the camera in position.

Findings

- The overall examinations were significantly longer than a man entry examination with initial discussions, then to the positioning of the cameras in the required locations and then to confirm where they actually were. Some efficiencies can undoubtedly be gained with experience but it would still be a much longer process.
- When using flexible guide tubes the operator was unable to hold the scope steady due to the length of reach from the manway to the boiler tubeplate.
- An inspector would have to be present to direct the operator and interpret the results. The costs for an inspector's time would be around 3 or 4 times that taken for a man entry examination in addition to the costs of the operator and equipment
- Dust from scale in the boiler caused problems on one lens which had to be withdrawn repeatedly for cleaning
- Lighting is difficult as the camera lights shine directly on the surfaces. Normally an inspector will shine a torch beam along the surface to identify discontinuities, deflections and surface condition

- Sizing of defects found is more difficult with RVI. A twin lens system for measuring the depth of defects did not give accurate results
- Cleaning of surfaces for examination is not possible with RVI. Waterside scale deposits and fireside soot deposits would normally be chipped or rubbed away by an inspector to examine the surfaces underneath
- The sense of touch is an important faculty for an inspector but is not available with RVI
- RVI is capable of accessing parts of the boiler which would not be accessible to the inspector, although this did not form part of the trial.

Conclusions

The nature of shell boilers make it a challenging environment for RVI. It could have some uses to supplement visual inspection of shell boilers when the design or size prevents internal access but the additional benefits in relation to the costs would need to be clarified.

For shell boilers that can be entered, using RVI as an alternative to man entry does have a number of disadvantages both in terms of its capability and cost. If the appropriate RVI equipment is selected, a suitable procedure is drawn up and a competent operator is used, then with guidance from a boiler inspector, it does have the capability to detect defects of a small (sub-critical) size. However there is a greater risk of defects being missed by RVI than by man entry. This is due to limitations with RVI; namely being unable to clean deposits from surfaces, manipulate the camera to completely cover all the surface areas under examination and to direct illumination to the optimum position. An evaluation of the criticality of defects likely to be missed should be considered before employing RVI.

Defects detected by RVI will need to be sized to determine criticality. As a result of limitations on accurate sizing with RVI, subcritical defects may end up being sentenced as critical as a result of the uncertainty.

In order for RVI to be successful then consideration would need to be made to adding RVI specific inspection openings to the boiler and/or building specific rigs which allows the camera head to be properly deployed in the relevant areas within the boiler. A change to RVI as the means of examination would necessitate a change to the written scheme of examination.