

**THIS DOCUMENT IS NOT A SPECIFIC PROCEDURE
IT IS INTENDED AS A GUIDE TO THE PREPARATION
OF USER SPECIFIC PROCEDURES**

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1.0 Purpose

The purpose of this procedure is to establish a method for the Magnetic Flux Leakage Inspection of Tank Floors to ensure the maximum achievable coverage and best possible sensitivity to under floor corrosion.

2.0 Scope

This procedure shall be used when utilizing any of the MFE 2412/1212 series of scanning systems for the inspection of Tank Floors looking for under floor corrosion.

3.0 References

- 3.1 MFE2412/1212 Operations and Maintenance Manual
- 3.2 The truth about Magnetic Flux Leakage as applied to Tank Floor Inspections. Paper presented by D.M. Amos, MFE Enterprises Incorporated, at the International Chemical and Petroleum Industry Technology IV A.S.N.T. Topical Conference, Houston, Texas, June 22nd 1995

4.0 Personnel Qualification

- 4.1 Personnel operating this equipment shall have demonstrated to the employer a full understanding of this application of Magnetic Flux Leakage and an ability to use and maintain the equipment in line with this procedure and the relevant Operation and Maintenance manuals.

- 4.2 Personnel conducting the Ultrasonic Prove Up of indications detected by the Flux Leakage equipment shall be trained, qualified and certified in accordance with a nationally recognized training and certification scheme. They shall be capable of demonstrating a full understanding of corrosion analysis using ultrasonics as an accurate quantification tool for remaining wall thickness.

5.0 Equipment

- 5.1 The equipment utilized for the Flux Leakage Inspection of Tank Floors using this procedure shall be any of the MFE 2412/1212 Scanning systems currently available.
- 5.2 This equipment uses very powerful rare earth magnets in order to near saturate the plate in the area of the scanning head. Coil sensors placed between the poles of the magnetic bridge detect the flux leakage fields and provide a low voltage output signal to the electronic module for processing and real time display.
- 5.3 The electronic processing and display module is common to both scanning systems.
- 5.4 The effective scan width of the MFE 2412 scanner is 12 inches and the MFE 1212 scanner, 6 inches. The real time LED display has twelve channels, one for each inch of scan width in the case of the MFE 2412 and for each half inch in the case of the MFE 1212.
- 5.5 Precise location of indications is readily achievable using this equipment.
- 5.6 Proper use of this equipment does not require the setting of calibration thresholds as the amplitude of the signal is an unreliable indicator of remaining wall thickness.

6.0 Floor Condition Considerations

The achievable sensitivity of any Flux Leakage Inspection on any given floor is directly dependent on the overall top surface condition. In ideal conditions it is possible to find very small corrosion areas on the underside of the plate. As the top surface deteriorates in regard to cleanliness, topside corrosion, and /or floor plate curvature the achievable inspection will become relatively less sensitive and the results more and more unreliable. Every effort must be made to ensure that the top surface is as clean as possible and free from any product residue, rust or loose scale. The effect of any undulations or buckling of the floor plates must be taken into account in the assessment of indications and in the scanning method.

7.0 Flux Leakage Limitations

- 7.1 Flux Leakage is a Qualitative not Quantitative inspection tool. It is very good at detecting magnetic anomalies and covering the very large floor areas of tanks very quickly. It is not, however capable of the accurate quantification of the signals as regards the remaining wall thickness. The amplitude of the signals is a function of the volume loss of material rather than a measure of the thickness loss. This is the main reason that MFE Enterprises Incorporated does not support either the single level threshold or quantified mapping approach to this particular application. Accept/ reject criteria based on the above two methods can lead to significant defects going undetected when only the amplitude of the signal is taken into consideration.
- 7.2 There are reasons for the generation of Flux Leakage Signals other than from plate corrosion. Localized changes in material properties, weld scars and arc strikes can also cause significant indications. This must be born in mind during the inspection process and the cause of signals properly evaluated.

8.0 Function Test

As previously stated the achievable sensitivity is very much dependent on the material under test and the top surface condition. Prior to starting an inspection it is necessary to check that the equipment is functioning as intended and is set up to obtain the best possible sensitivity. The physical set up of the equipment as regards magnet and sensor heights dictates the level of sensitivity. For any given thickness of plate and for any thickness of coating it is recommended that a system function test plate as described in the Operation and Maintenance Manual be constructed to prove the capability of the system.

9.0 Electronic Gain Setting

As previously stated the mechanical arrangement of magnet and sensors dictates the achievable sensitivity. If there are no leakage signals due to a poor mechanical set up then it will not matter how much electronic gain is incorporated there will be nothing to see. Fine tuning of the electronic gain and mechanical set up are necessary in order to achieve the best possible signal to noise ratio and defect detection. These parameters should always be arrived at using the function test plate prior to inspections.

10.0 Inspection method

- 10.1 Each plate within the tank must be scanned in a logical manner to ensure the maximum coverage possible. The use of the smaller scanning head may be required adjacent to welds, obstructions and the floor to shell areas which are difficult to get to using the large scanning head.
- 10.2 Scanning across the weld areas is not possible owing to scanner clearance limitations. The entire floor is scanned on a plate by plate basis, the scanning head being moved clear of the weld area whilst transitioning from plate to plate.

- 10.3 Full coverage of the floor area using these systems is virtually impossible due to the many and varied access limitations. If full coverage is required it is possible to manually scan the omitted areas using ultrasonics.
- 10.4 The systems are optimized for a medium walking pace. Once properly set up variations in speed will effect the amplitude of the signal but not the detection capability of the machine. Faster speeds will result in much higher amplitude signals. This is also true of the background noise levels. An optimum speed giving the best signal to noise ratio is preferred. In a very high noise environment it is sometimes necessary and acceptable to reduce scanning speeds and increase the electronic gain to optimize the signal to noise ratio. This optimum set up may vary from floor to floor and even from plate to plate.
- 10.5 The object of the exercise is to:-
- 10.5.1 Identify any indication that clearly exceeds the background noise levels.
 - 10.5.2 Determine the type of indication i.e. isolated pitting or lake type.
 - 10.5.3 Confirm the indication by scanning from different directions.
 - 10.5.4 Locate and mark the exact position of pitting corrosion and outline any area of lake type corrosion for further investigation to determine the worst case occurrences within the area marked.
- 10.6 Accurate location of individual leakage signals is achieved by rocking the system backwards and forwards over the defect until the operator is satisfied that he is stopped over the top of the indication. By noting the highest affected channel number and marking both the center of the array and the corresponding rule mark on the front of the scanning head good location can be achieved.
- 10.7 In the evaluation of indications it is necessary to determine the reason for the response. In the absence of of an obvious topside source or geometric anomaly it must be assumed that the indication is from an underside source.
- 10.8 Magnetic Flux Leakage cannot differentiate between top side and under side corrosion. With these systems the response to topside indications is often less than those obtained from an equivalent bottomside indication. This must be born in mind when topside corrosion is present. When high amplitude signals are obtained from the same area it will be necessary to investigate further and to determine whether bottomside indications also exist at that location.
- 10.9 All indications determined to be significant shall be indelibly marked for subsequent ultrasonic prove up.

11.0 Ultrasonic Prove Up

The MFE 2412 and 1212 scanning systems are ideally set up for the detection of isolated pitting corrosion. Isolated pitting with a small base area and large through wall dimension are often difficult to find and measure Ultrasonically. The reason for this is that sufficient sound energy must be returned from the area of the greatest through wall penetration point to give a readable response. If the right equipment and technique is not applied in the ultrasonic prove up of flux leakage signals significant errors can occur.

- 11.1 Digital read out thickness meters are not recommended.
- 11.2 Digital displays with very slow screen rewrite frequency are difficult to use as they preclude any real time scanning capability.
- 11.3 In order to carry out a good assessment of corrosion it is necessary to use a real time A scan display. Analog displays are far superior for this application than digital. Analog sets, however, are becoming extremely hard to get hold of as manufacturers turn to the cheaper and more reliable digital technology. Data processing and display speeds are the important consideration when using digital ultrasonic equipment.
- 11.4 A good quality twin crystal compression wave contact transducer in the order of 0.375" in diameter, with a frequency of approximately 5 Mhz. will generally suffice for the ultrasonic prove up. Some focusing of the sound beam is an advantage for this application.
- 11.5 It may be necessary to change to a different transducer when examining through some coatings or on particularly rough surfaces.
- 11.6 Ultrasonic coupling can be maintained using any of the proprietary brands of couplant. Water works surprisingly well for this application.
- 11.7 The instrument must be properly calibrated and the ultrasonic prove up carried out in accordance with a specific procedure.
- 11.8 The location and minimum remaining wall thickness must be indelibly marked on the floor plate.

12. Reporting

The final report shall include sufficient information, organized in such a manner so that the client can quickly relocate and identify indications found during the inspection for repair or replacement consideration. Marking the floor, alone, is not sufficient. It will be necessary to produce a log of all recordable indications along with a sketch showing the floor plate layout.

- 12.1 The following information must be included as a minimum for every recordable indication:-
1. Plate number
 2. Indication number
 3. Indication type
 4. Datum Point
 5. X and Y direction and distance from datum.
 6. Minimum Ultrasonic reading of indication.
 7. Adjacent nominal thickness
 8. Percentage wall loss
- 12.2 Approximate location of indications can be indicated on a floor plate layout sketch depending on the number of indications identified. If necessary individual plate sketches can be added for reporting clarity purposes.
- 12.3 Should the client require an assessment of the topside condition a similar log will be necessary except with the severity determined with the aid of a pit gauge .

13. Safety Considerations

- 13.1 The MFE range of equipment employs extremely powerful rare earth magnets. When handling or lifting the equipment it is vital that precautions are taken to prevent either injury to persons or damage to the equipment.
- 13.2 When transporting the systems over long distances it is recommended that the custom transportation box provided is used. This includes a keep plate to reduce the effect of the powerful magnetic field produced by the magnetic bridge.
- 13.3 Close proximity of the magnetic bridge to magnetic storage media, heart pace makers, credit cards can have a detrimental affect and must be avoided at all times.
- 13.4 It is recommended that all maintenance, cleaning and adjustments are carried out on a wooden bench or platform to minimise the risk of personel or equipment damage. All tools should be kept well away from the magnetic bridge until needed.

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