MFE 2412 Mark II
Operation and Maintenance Manual

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***** Safety Notice *****

This equipment makes use of very powerful rare earth magnets. When disassembling the unit or moving the magnetic carriage great care should be exercised to prevent damage to either the operator or equipment. Maintenance work should always be carried out on a wooden as opposed to metal bench. All tools should be kept well away from the magnetic bridge until required.

***** Safety Notice *****

SECTION 1

Introduction

This manual has been written to ensure that operators of the MFE 2412 Mark II have all the information necessary to carry out the best possible examination of any given tank floor. It is strongly recommended that any technician intending to use this equipment reads this document in its entirety prior to carrying out any inspections.

Any operator using this equipment should be capable of demonstrating a full understanding of the inspection principles involved. Ultrasonic Prove Up should only be carried out by personnel who are adequately trained, certified, and experienced in the evaluation of corrosion type indications. More than one significant defect has been missed due to the improper ultrasonic evaluation of indications detected by magnetic flux leakage.

SECTION 2

Magnetic Flux Leakage

This equipment uses Magnetic Flux Leakage as a detection tool. The powerful magnetic bridge introduces a magnetic flux into the material near to saturation level. Any localized reduction in the thickness of the material will result in a flux leakage at the surface. A series of sensors are placed between the poles of the magnetic bridge to detect these leakage fields. The strength of the leakage field is a function of volume loss and is not a reliable indication of remaining wall thickness. Although the amplitude of the signal generated by the sensors gives some relative severity information it is not recommended that amplitude alone be used for accept/reject criteria purposes. Flux Leakage should only be used as a detection tool. Truly quantitative information can only be obtained using Ultrasonic assessment of the areas identified by the Magnetic Flux Leakage Scanner.

SECTION 3

MFE 2412 Mark II
General Description

The MFE 2412 Mark II is comprised of the following modules:-

1. **Magnet Bridge**
2. **Sensor**
3. **Battery Module**
4. **Handle Assembly**
5. **Electronics Module**
6. **Signal and power cables**

Magnetic Bridge

The Magnetic Bridge provides the necessary flux levels to achieve saturation of the plate thickness to be inspected. It is supported on four low rolling resistance, durable wheels at each corner allowing easy maneuverability of the scanning head. Different plate thicknesses and coatings can be accommodated by changing out the wheels as described in Section 8.

Sensor Bar

The Sensor Bar contains an array of sensors across the full width of the scanning head. These sensors detect the leakage fields generated by the inspection process. The Sensor Bar extends almost to the outer edge of the wheels allowing maximum possible coverage. It is suspended and spring mounted within the Magnetic Bridge by four studs and adjustable wing nuts allowing the adjustment of the height of the sensors from the inspection surface.

Battery Module

The Battery Module contains an 18 amp hour sealed gel Lead Acid Battery that is both leak proof and can be placed in any orientation. This type of battery is not regarded as hazardous by the airlines for shipping purposes. The battery can provide power for the system for at least 12 hours of continuous use. A 3 amp fuse is located under the top cover to prevent any damage to the module should a short occur within the power supply wiring. The module incorporates an array of super bright white LED's which can illuminate the area in front of the scanner in dark locations. This can be turned on and off at will using the switch on top of the module. The Battery Module can be quickly and easily removed from the scanner for use as a remote light source if necessary.

Handle Assembly

The Handle Assembly is connected to the Magnetic Bridge using two 3/8 inch bolts, washers and nylock nuts and rests between two pivot bars. The pivot bars can be rotated to provide a different angle and therefore a different handle height. N.B.. Both pivot bars must be rotated to the same positions to ensure the central location of the 3/8 inch attachment bolts. The handle provides mounting points in the form of shoulder bolts and clamping bolts for the Battery Module and the Electronics Module and can be folded in half for transportation. When in use it is locked in place using two quick release pins. Two neoprene wheels are mounted either side of the pivot bar and along with the leverage afforded by the handle allow the easy removal of the Magnetic Bridge from the inspection surface.

Electronic Module

The Electronic Module processes the signals from the sensors and displays the data on a twelve channel L.E.D. display panel. The front panel incorporates the controls for power, gain, alarm and display brightness. A voltage display is incorporated to give a real time battery voltage indication. If this drops below a nominal 12.0v reading then the battery must be recharged using the battery charger provided. A fuse holder is mounted on the back panel and contains a 3 amp fuse to protect the electronics in case of a power problem.

SECTION 4

MFE 2412 Mark II
Operation

Setup

The scanner is shipped in a custom transportation case that contains the complete scanning system, function test plate, battery charger, tool kit and spares. In order to unpack the container it should be placed on it's back and the lid removed by releasing the catches and using the handles provided. N.B.. The Function Test Plate is mounted in the lid and can be removed by unscrewing the two retaining wing nuts and carefully lifting it out. THE TWO HANDLES ATTACHED TO THE LID ARE TO ASSIST IN THE REMOVAL OF THE LID ONLY AND ARE NOT TO BE USED TO LIFT OR CARRY THE COMPLETE TRANSPORTATION CASE.

Remove the battery charger, tools and spares and lift the container up on end with the magnetic bridge now on the bottom. At this time the handle can be rotated out of the container, extended to it's full length and pinned in place using the two quick release pins supplied. It will now be possible to lever the scanner from the keeper plate and remove it from the container.

Connect the cables to the Electronics Module (these should be disconnected for shipping). They are keyed connectors and can only be connected in the correct configuration. The small connector is for power and the large connector for signal. WHEN CONNECTING OR DISCONNECTING THESE CABLES TAKE CARE TO TURN THE LOCKING COLLAR ONLY. ANY TURNING OF THE STRAIN RELIEF WILL RESULT IN TWISTING AND POSSIBLE BREAKAGE OF WIRES.

Once everything is connected, place the unit on the system function test plate and check that the sensor bar is correctly located. This can be accomplished by removing the Magnetic Bridge top cover and lowering the sensor bar, using the four wing nuts provided, until the bar rests on the surface. Tension each wing nut and then add an additional one turn on each to lift the sensor bar just above the surface of the plate.

Turn the unit on by activating the ON/OFF switch. Activate the alarm by pressing the ALARM ON/OFF switch. The LED below the Alarm will be illuminated. RESET the ALARM by pressing the ALARM RESET switch. Check that the battery voltage reads at least 12.0v. If not, charge the battery.

The unit is now ready for scanning the system function test plate. Raise the gain control by using the low and high gain switches on the front panel to 30 and push the scanner across the test plate at a moderate walking pace. Three distinct responses should be noticed. All the channels should respond to the notch in the plate and illuminate the full display to maximum screen height. Both the 40% through wall simulated pit and the 3/16" through hole should illuminate at least one channel to full screen height.

Check that both indications trigger the alarm at this gain setting. Both red LED's above the display should illuminate and flash if any signal goes into the red section of the display. The alarm can be canceled by pressing the ALARM RESET switch. The alarm can be disabled by pressing the ALARM ON/OFF switch and the amber LED will be extinguished.

If the above function test is successful then the system is ready for scanning. Refer to Section 8 if the scanner does not meet the above performance criteria or the plate to be inspected is thicker than the function test plate

If this system check is carried out in the actual tank, the test plate must be elevated at least 4" from the floor plate using sufficient wooden supports to prevent the plate from bending.

Scanning

The scanner has been optimized for a medium walking pace. Faster scanning speeds will result in higher signal amplitudes due to the sensor characteristics and is not recommended and may be detrimental to the inspection process.

Slower speeds, however will result in lower signal amplitudes, and it is recommended that when it is found necessary to scan at lower speeds, e.g.. in confined spaces, the system gain must be increased to compensate.

Maximum coverage of the floor area is achieved using overlapping scans on a plate by plate basis. The scanner is extremely maneuverable and can be rotated around its axis and easily lifted from the plate onto the neoprene wheels for quick and easy relocation purposes. Do not attempt to pull or push the unit over the lap welds without first tipping the unit back onto the neoprene wheels. Damage to the Sensor Bar and Magnetic Bridge can result from this practice.

Any given floor will generate a level of noise dependent on the top surface condition of the plate. This will be displayed as a general low level signal across the display. The level of this noise will dictate the achievable sensitivity of the inspection.

As soon as discreet signals are noted they must be proved up using Ultrasonics. This will give the operator the information required as far as the system sensitivity is concerned and allow the determination of an adequate scanning sensitivity for the remainder of the floor. The channels are numbered from left to right 1 - 12 and correspond to a twelve inch scan width. The system can be rocked backwards and forwards over the indication for accurate location purposes. Lines drawn at the center of the array and the channel number of the indication will intersect within an inch of the cause of the indication.

All indications determined to be significant by the operator must be marked up for subsequent prove up. When it is apparent from the display that a large area of lake type corrosion is present, the boundaries of such an area can be quickly determined using the scanner and the most significant indications within that area marked up for prove up. Amplitude alone must not be used solely as the criteria for prove up purposes. The operator must use all the information available from the display to determine the relative significance of any given indication.

It is therefore recommended that the provided alarm facility is NOT used as the basis of accept/reject decisions but rather as an alarm for the operator in the event that his attention is distracted from the display whilst scanning.

SECTION 5

MFE 2412 Mark II
Maintenance

****** CAUTION ******

This equipment incorporates proprietary information and trade secrets and is the subject of a "Restricted use, Nondisclosure and Non circumvention agreement signed by each purchaser of this equipment. In order not to breach this agreement please take note of the following restrictions.

The scanner has been designed to be as maintenance free as possible and is extremely ruggedly constructed. The inspection environment is often extremely dirty and dusty and therefore the bulk of the maintenance required involves cleaning and removal of magnetic debris and product residue. DO NOT SPRAY WATER OR DETERGENT ON ANY PART OF THE SCANNER. DO NOT USE ANY SOLVENT CLEANERS ON THE DISPLAY TOUCH PANEL. The scanner can easily be dismantled with the use of the hand tools provided and the individual parts cleaned using degreaser and absorbent cloths. DO NOT REMOVE THE STAINLESS STEEL COVER PLATES ON THE BRIDGE POLE PIECES. This will invalidate the warranty. DO NOT ATTEMPT TO OPEN THE ELECTRONICS MODULE. This will invalidate the warranty. DO NOT ATTEMPT TO DISMANTLE THE SENSOR BAR other than for the removal and replacement of the sensor protector. This will invalidate the warranty.

Should any of these items require attention they must be returned to the manufacturer for service.

IT IS RECOMMENDED THAT ALL MAINTENANCE AND CLEANING OPERATIONS CARRIED OUT ON THE BRIDGE BE CONDUCTED ON A WOODEN OR NON MAGNETIC SURFACE FOR SAFETY REASONS

A. As required during scanning

1. **Remove build up of ferritic debris from the underside of the scanner.**
2. **Check condition of Bridge and Sensor protection plates.**

B. Daily

1. **Run system function test.**
2. **Check tightness of all fasteners.**
3. **Check condition of wheels. (Any unevenness will result in vibration and increased noise levels)**

C. Weekly

1. Separate the handle from the Magnetic Bridge and remove the wheels to aid in a thorough cleaning of the component parts of the scanner. The Battery and Electronic Modules can be quickly released from the handle for separate cleaning purposes.

2. Remove Sensor Protector cover, check for damage and replace in necessary. Clean and dry the sensor bar.

The wheel bolt threads and sensor protector retaining screws should be lubricated with an anti-sieze compound periodically to ease removal.

SECTION 6

Ultrasonic Prove Up

Magnetic Flux Leakage is an excellent detector of under floor corrosion but can give no truly accurate assessment of remaining wall thicknesses due to the limitations imposed by the inspection environment. Accurate quantitative assessment is obtained using Ultrasonic prove up. It is important that the operator who carries out this assessment is adequately trained and experienced in this type of indication analysis. This is not just " thickness measurement ". In order to arrive at accurate remaining wall thickness it is necessary for the operator to use equipment which is capable of giving him the information that he needs as well as the application of the correct technique. The following type of prove up equipment and technique is strongly recommended:-

A. It is essential that a good quality A-scan display is used for the assessment of any corrosion detected . The equipment must be capable of determining location, size and the accurate quantification of remaining wall thickness.

B. A good quality 5 Megahertz twin crystal focused contact transducer of either 0.375" or 0.500" diameter.

C. Surprisingly enough ordinary water and plenty of it provides the best coupling media in most cases.

D. The amplitude of the signal from the corroded back wall must be raised to at least the same screen height as the calibration reflector.

E. Elevated gates tied to a digital read out are not recommended as this technique invariably underestimates the severity of the indication.

F. The nearest facet of the reflection must be identified and the true remaining wall thickness read from the timebase.

SECTION 7

Battery Management

The batteries provided with the units are sealed gel lead acid and provide sufficient power for at least 12 hours of continuous use even at very low temperatures when fully charged. They should only be charged using the supplied battery chargers which are fully automatic and will maintain the battery at full charge if left connected and turned on for extended periods without damage to either battery or charger. If the charger is turned off for any reason the battery must be disconnected from the charger.

The fully automatic maintenance charger provided with the scanner is the only charger that should be used on this equipment. Charging of the battery can be achieved by plugging the connector plug from the charger into the mating receptacle on top of the Battery Module.

Under no circumstances may the charger be rigged so that the unit is powered up during the charging process. This will cause severe damage to the electronics module.

It is recommended that the battery be charged overnight, every night when the unit is in continuous use and continuously when not in use. This will ensure an adequate maintenance of battery power so that the unit will be ready for use at a moments notice.

If it is necessary to remove or replace the battery at any time be sure to replace all of the rubber shielding and foam provided to ensure the original degree of protection against physical damage and possible dead shorts of the electrical system is maintained.

SECTION 8

Scanner Adjustments

Standard setup

The majority of tank floors are constructed of uncoated plates in the order of 0.250 inches in thickness. The MFE 2412 Mark II as supplied from the manufacturer is set up to function on this configuration of tank floor. No additional set up is required other than the adjustment of the sensor bar as outlined in Section 4. The intention is to run the sensor bar as close to the inspection surface as possible without actually contacting the plate. A sensor bar rubbing along the surface will generate a level of unnecessary noise. CAUTION! Raising the sensor bar too high from the inspection surface will result in a significant reduction in sensitivity.

<u>The wheels fitted for the standard setup are BLUE in color.</u>

Non -Standard Setup

It will be noticed that the wheels supplied with the scanner are color coded and different diameters. This allows the user to configure the scanner for various plate and coating thicknesses.

THE TABLE ON THE FOLLOWING PAGE MUST BE USED AS A GUIDE ONLY. ALL SETUPS MUST BE PROVED ON THE BASIS OF ACTUAL SIMULATION OF CONFIGURATION THICKNESSES

Wheel Color	Diameter	Plate Configuration
BLUE	4.10"	0.250" uncoated 0.250"and thin film coatings
GREEN	3.90"	0.250" coatings 10 - 80 mils thick 0.325" and thin film coatings
YELLOW	3.70"	0.325" coatings 10 - 80 mils thick 0.375" and thin film coatings
RED	3.50"	0.250" coatings over 200 mils thick 0.375" coatings 10 - 80 mils thick 0.500" and thin film coatings

When setting up the equipment for a non standard configuration it is necessary to establish the minimum size of defect to be detected. Only use the smallest wheel size necessary to achieve the required detection capability. This will ensure that neither the equipment or the operator will be unnecessarily stressed. The closer the bridge is to the surface, the greater the rolling resistance of the scanner and the more effort required to maneuver it around the tank floor.