

MFE 1212 Mark II Operation and Maintenance Manual

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SECTION 1

Introduction

This manual has been written to ensure that operators of the MFE 1212 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.

The MFE 1212 Mk II is intended for use as a supplemental scanner to the MFE 2412 Mk II. It uses the same handle and Electronics module as the MFE 2412 Mk II and these items can be interchanged to provide some redundancy. It is not recommended that the 1212 be used in areas where it is possible to scan with the 2412 as the smaller bridge is not capable of achieving the same levels of saturation and therefore sensitivity may be lower to smaller volume indications.

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 1212 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. An additional set of guide wheels are attached to one side of the bridge to maintain proximity to the shell when inspecting the annular plates.

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 two 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 8 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 8 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 Battery Module can be quickly and easily removed from the scanner for charging purposes.

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 sets of shoulder 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. The leverage provided by the handle allows the scanner to be easily tipped onto the rear wheels for removal or moving around the floor.

Electronic Module

The Electronic Module processes the signals from the sensors and displays the data on a twelve channel L.E.D. display panel. Only the first six channels are utilised in the MFE 1212 Mk II. The module is exactly the same as that for the MFE 2412 Mk II and can be interchanged at will. 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 1212 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. The complete handle assembly including the battery and electronic processor can now be removed from the container.

Extended the handle to its full length and pin in place using the two quick release pins supplied. Lift the container up on end with the magnetic bridge now on the bottom. At this time the bridge assembly can be lifted from the keep plate by using the leverage provided by the front handle grip.

Remove the the two attachment assemblies from the pivot plate at the bottom of the handle. The 3/8" bolt, locknut washer and spacer are used on the front connection point. The spacer is placed between the bearing on the bridge and the top pivot plate. Tighten the bolt and locknut only enough to take out any play in the connection.

The 3/8" clevis pin, washers and clip can be inserted in the rear connection point to lock the scanner in the straight ahead position.

Remove the function test plate from inside the lid.

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.

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 lowering the sensor bar, using the two wing nuts provided, until the bar rests on the surface. Tension each wing nut and then add an additional two turns 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 60 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.

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.

The scanner can be used with the pivot locked for straight scanning or unlocked

when scanning around the radius of the shell. The guide wheels can be switched over to the other side of the bridge if clockwise scanning is preferred.

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 rear 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 rear 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. Only the first six channels of the display are active. 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 1212 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. The scanner can easily be dismantled with the use of the hand tools provided and the individual parts cleaned using degreased 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 8 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.

******* 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 *******

RESTRICTED USE, NON-DISCLOSURE AND NON CIRCUMVENTION AGREEMENT

This agreement is made and entered into this the day of in the year , by and between MFE Enterprises, Incorporated ("MFE") a corporation duly organized and existing under the laws of the State of Texas and (the purchaser) for the purposes set forth herein:

RECITALS

- A. MFE desires to sell, and purchaser wishes to purchase certain tank floor scanning equipment, which MFE has developed and manufactured, and which specifically includes the following items:
MFE 2412 Mark II Tank Floor Scanner**
- (hereinafter referred to as the "Scanners").**
- B. Purchaser recognizes and acknowledges that MFE has invested substantial and valuable resources in developing the Scanners and in the technology incorporated in the development, manufacturing and operation of the Scanners (the "MFE Proprietary Information"), and that the MFE Proprietary Information is secret, confidential, and proprietary to MFE.**
- C. Purchaser recognizes and acknowledges that MFE's sale of the Scanners does not include the right to reproduction of the Scanners or their component parts.**
- D. MFE desires to maintain the confidentiality of the MFE Proprietary Information. Purchaser recognizes and acknowledges that the unauthorized use of the Scanners or disclosure of the MFE Proprietary Information to any person or entity except MFE and its duly authorized representatives would be detrimental and damaging to MFE.**
- E. Both MFE and Purchaser (collectively "the parties") represent that they are not aware of any express or implied obligation to any third parties that conflicts with any of the obligations of this Agreement.**

NOW THEREFORE, in consideration of the mutual promises, covenants and conditions contained herein, the Parties agree as follows:

- 1. All Scanners, the components thereof, the technology incorporated therein, and the MFE Proprietary Information shall be treated as confidential and proprietary to MFE by the Purchaser, and are subject to the terms of this agreement. Purchaser must not copy, replicate, reproduce or modify for the purpose of copying, the Scanners or the component parts thereof.
Purchaser will not manufacture or produce equipment similar to the Scanners based on the MFE Proprietary Information.**
- 2. Purchaser must not (a) modify or translate the MFE Proprietary Information; (b) reverse engineer, decompile, or disassemble the Scanners (for other than routine maintenance and cleaning); (c) create derivative works based on the MFE Proprietary Information; (d) merge the MFE Proprietary Information with another product; (e) export or use the data compilations, structures, or algorithms constituting the MFE Proprietary Information with another product; (f) remove or obscure any proprietary rights, notices, or labels on the Scanners, or (g) charge a fee or royalty, or request donations, for any of the distribution or transmission of the MFE**

Proprietary Information.

- end,
other
sell,
component
written consent
3. **Purchaser is the sole party authorized to use and operate the Scanners. Purchaser will not use the Scanners in a manner inconsistent with the purpose intended for the Scanners in the inspection of tanks. To this neither Purchaser nor any of its employees, agents, contractors, or persons or organizations over which purchaser has control, will rent, assign, transfer, or relinquish possession of the Scanners or any thereof, to any person or organization, without the express of MFE.**
 4. **Neither Purchaser nor any of its employees, agents, contractors or other persons or organizations over which the Purchaser has control, will at any time publish, release or disclose any MFE Proprietary Information to any person or organization, without the express written consent of MFE.**
 5. **Purchaser will undertake all necessary, reasonable and appropriate steps to protect and maintain the confidentiality of all MFE Proprietary Information related to the Scanners and the components thereof. These steps include but are not limited to the following:**
 - a.) **Preventing the resale or transfer of the Scanners to a third party without the express written consent of MFE.**
 - b.) **Advising all Purchaser's employees and representatives with access to the Scanners, of this Agreement and the obligation to protect the MFE Proprietary information from disclosure;**
 - c.) **Requiring persons who have access to the Scanners to take all necessary, reasonable, and appropriate steps to protect the confidentiality of all MFE Proprietary Information.**
 - d.) **Limiting the use of the Scanners to those purposes for which the Scanners are intended;**
 - e.) **Prohibiting, preventing and refraining from the disassembly, decompilation, break down, or attempts to perform reverse engineering on the Scanners or of any components thereof; and**
 - f.) **Copying, replicating or modifying the Scanners for purpose of copying the Scanners.**
 - 6.) **The parties recognize and acknowledge that Purchaser's use of the Scanners or disclosure of the MFE Proprietary Information in a manner inconsistent with the terms of this Agreement may cause MFE irreparable harm for which legal remedies may be inadequate. Purchaser agrees that MFE shall have the right to other equitable relief from a court of competent jurisdiction as may be necessary and appropriate to prevent unauthorized use or reproduction of the Scanners, or use, publication, or disclosure of MFE's Proprietary Information, by the Purchaser, its employees or agents. As such, Purchaser shall not oppose such injunction on the grounds that an adequate remedy is available at law.**

Such remedy shall be in addition to other remedies available to MFE.

- 7.) Nothing contained in this Agreement, or the Terms and Conditions set forth on the corresponding invoice shall be construed as granting or conferring to Purchaser any rights in MFE's Proprietary Information or in the technology MFE incorporated in the development, manufacturing and operation of the Scanners.
- 8.) This agreement constitutes the entire agreement between the Parties, their affiliates and subsidiaries and supersedes any prior or contemporaneous oral or written representations with regard to the subject matter thereof. This Agreement may not be modified except in writing signed by both Parties.
- 9.) Defined terms have the meaning ascribed to them through out this Agreement, whether capitalized or lower case. Where the context requires, singular and plural terms include the other.
- 10.) This Agreement shall be construed and governed in all respects in accordance with the laws of Texas. This Agreement is performable in Harris County, Texas, and unless the parties agree otherwise in writing, venue for the resolution of any dispute regarding this Agreement or enforcement of rights relating to this Agreement shall be proper only in Harris County, Texas. Any legal proceedings to enforce or interpret the provisions of this Agreement must be brought exclusively in the District Court of Harris County, Texas or in the United States District Court for the Southern District of Texas.
- 11.) In the event that any provision of this Agreement is determined by a court of competent jurisdiction to be void or unenforceable, then all remaining paragraphs and provisions shall remain in full force and effect, as if the invalid provision was originally deleted from the Agreement.
- 12.) In the event of a breach of this Agreement, or in the event that such breach appears to be imminent, the non faulting party shall be entitled to all legal and equitable remedies afforded by law as a result thereof. MFE shall, in addition to any and all other forms of legal and equitable relief, recover from the other party all reasonable costs and attorney's fees incurred in seeking any such remedy.
- 13.) This Non-Disclosure Agreement may be executed in facsimile copies, which shall serve as original.

IN WITNESS WHEREOF the parties have executed this Non-Disclosure Non-Circumvention Agreement on the date indicated below: Signatures represent agreement to 4 pages including signature page.

MFE Enterprises, Inc.

By: William B. Duke
19419 Pinehurst Trail Drive
Humble, Texas 77346

By: Purchaser -

Date: