



PEMA
PT. PEMBANGUNAN ACEH

APPROVED WITH COMMENT

01/03/2024 ,14:15:29 By Rahmat Riski

REVIEWED
Rahmat Riski , 28/02/2024 ,15:22:20

????

PROSEDUR

MAGNETIC FLUX LEAKAGE INSPECTION PROCEDURE

(SOP-SCI-008)

NOMOR REVISI :

B

**PEMA**

PT PEMBANGUNAN ACEH

Rumah Budaya, Jl. Tgk. H. Mohd. Daud Beureuh, Kec. Kuta Alam, Kota Banda Aceh 23121 - Aceh
Telp : 0651 47414
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No. Dokumen	: SOP-SCI-008
Revisi	: B
Tanggal Berlaku	: 17 Januari 2024
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Jasa Konsultansi Inspeksi & Engineering Tangki Kondensat F-6104**LEMBAR PENGESAHAN****PT. PEMBANGUNAN ACEH & PT SUCOFINDO****STANDAR OPERASIONAL PROSEDUR****MFL Inspection Procedure****NO. DOKUMEN :
SOP-SCI-008**

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Tanggal Berlaku	:	17 Januari 2024	
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KETERANGAN	JABATAN	TANDA TANGAN
Dibuat Oleh : Andika Juliandahri	MFL Inspector	
Diperiksa Oleh : Ir. Heru Susanto	Project Manager PT SUCOFINDO	
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Disetujui Oleh : Rahmat Riski	Project Manager PT Pembangunan Aceh	

**PEMA****PT PEMBANGUNAN ACEH**

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DAFTAR DISTRIBUSI DOKUMEN

NOMOR	KODE DOKUMEN	PEMEGANG DOKUMEN
1.	SOP-SCI-008	
2.		
3.		
4.		
5.		

**PEMA****PT PEMBANGUNAN ACEH**

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CATATAN PERUBAHAN DOKUMEN

NO PERUBAHAN	TANGGAL PERUBAHAN	HAL & NO. PARAGRAF	DESKRIPSI PERUBAHAN
SOP-SCI-008 Rev.B	29-02-2024	2	Penambahan kolom tandatangan
		6	Perbaikan redaksi kalimat
		7	Perbaikan penomoran
		8	Perbaikan redaksi sesuai comment



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Jasa Konsultansi Inspeksi & Engineering Tangki Kondensat F-6104

1. TUJUAN UTAMA

Tujuan utama KONTRAKTOR dalam prosedur ini untuk melaksanakan PEKERJAAN dengan aman dan efisien sesuai jadwal dengan spesifikasi, kriteria dan prosedur proyek yang ditentukan oleh PERUSAHAAN. Dimulai dari tahapan persiapan personil dan peralatan, pengurusan izin kerja, review dokumen dan desain, dalam melakukan inspeksi *Magnetic Flux Leakage (MFL)* pada pelat dasar tangki (*bottom plate tank*) bertujuan untuk mendeteksi dan mengevaluasi potensi korosi atau kerusakan lainnya pada pelat atau dinding dasar tangki.

2. RUANG LINGKUP

Prosedur ini menjadi panduan dalam melakukan pekerjaan khususnya untuk melakukan Pemeriksaan *Magnetic Flux Leakage (MFL)* pada tangki penyimpanan bawah dan atap menggunakan unit peralatan BW Truflux untuk mengetahui tingkat korosi, selain itu prosedur ini juga untuk diperhatikan, dipahami dan dilaksanakan oleh semua pekerja yang terlibat terkait pekerjaan inspeksi *Magnetic Flux Leakage (MFL)* di wilayah PERUSAHAAN atau wilayah kerja lainnya yang telah ditentukan PERUSAHAAN.

3. TANGGUNG JAWAB

Pada inspeksi bottom plate tank dengan menggunakan teknologi *Magnetic Flux Leakage (MFL)*, peran dan tanggung jawab dari berbagai pihak yang terlibat dapat dibedakan. Berikut adalah tanggung jawab masing-masing peran:

3.1. Operator/ Inspector *Magnetic Flux Leakage (MFL)*

- Melakukan inspeksi MFL pada bottom plate tank sesuai dengan prosedur dan rekomendasi pabrikan, serta mengumpulkan data inspeksi.
- Menganalisis data hasil inspeksi MFL untuk mengidentifikasi potensi korosi, kerusakan, atau masalah struktural lainnya.
- Memberikan rekomendasi kepada aset owner terkait perbaikan atau tindakan pemeliharaan yang diperlukan berdasarkan hasil inspeksi.
- Menyusun laporan hasil inspeksi yang mencakup temuan, analisis data, dan rekomendasi.

3.2 Asisten Operator/ Inspector *Magnetic Flux Leakage (MFL)*

- Membantu operator MFL dalam menyiapkan, mengoperasikan, dan merawat peralatan MFL selama inspeksi.
- Memantau dan membantu dalam menjalankan proses inspeksi untuk memastikan kelancaran dan akurasi.
- Melakukan tugas pemeliharaan ringan pada peralatan MFL dan melaporkan jika ada masalah teknis.

4. REFERENSI

- 4.1 ASME Sec V Art16,2019: Magnetic flux leakage (MFL) examination.
- 4.2 API std. 650, 2013: Welded steel tanks for oil storage.
- 4.3 API std. 652, 2013: Design & Construction of large welded low pressure storage tanks.
- 4.4 API std. 653, 2013: Inspection and repair of storage tanks.
- 4.5 Manufacturer Operational Manual

5. DEFINISI

- 5.1 PERUSAHAAN : PT. Pembangunan Aceh (PEMA)
- 5.2 KONSULTAN : PT. Sucofindo
- 5.3 MFL : Magnetic Flux Leakage
- 5.4 API : American Petroleum Institute
- 5.5 ASNT : American Society of Non-Destructive Testing
- 5.6 ASME : American Society of Mechanical Engineers
- 5.7 APD : Alat Pelindung Diri



6. PERSONEL DAN PERALATAN

6.1. Daftar Tenaga Kerja

- 1 orang operator yang melakukan inspeksi *tank floor* dan *roof* (jika diperlukan) dengan syarat minimal memiliki kualifikasi sebagai ASNT NDT MT Level II berdasarkan pedoman dan praktik yang disarankan sesuai dengan ASNT-SNT-TC-1A dan memiliki sertifikat telah lulus mengikuti familirarisasi dan mengoperasikan alat MFL dari manufaktur.
- 1 orang asisten operator yang melakukan asistensi operator MFL saat pelaksanaan inspeksi *tank floor* dan *roof* (jika diperlukan) dengan syarat minimal memiliki kualifikasi sertifikat telah lulus mengikuti familirarisasi dan mengoperasikan alat MFL dari manufaktur, personal asisten operator yang juga memiliki kompetensi sebagai ASNT NDT MT Level II berdasarkan pedoman dan praktik yang disarankan sesuai dengan ASNT-SNT-TC-1A lebih di sarankan.
- 1 orang tenaga kerja pembantu untuk mengasistensi mobilisasi peralatan kerja dan peralatan pendukung guna memudahkan proses pelaksanaan pekerjaan inspeksi MFL yang dikerjakan oleh operator MFL dan asisten operator MFL.

6.2. Daftar Peralatan

- 1 Unit Magnetic Flux Leakage (Brand BW Truflux)



- Pelat Kalibrasi yang sesuai standard (menyesuaikan tebal pelat)



- 1 Unit *Ultrasonic Thickness Gauge*



- Peralatan ukur (penggaris, pita meteran, Pit Gauge dan lain – lain)



- Senter/ *torch light*



- Marker



6.3. Aspek Safety

Pekerjaan MFL dilakukan dalam ruang terbatas (confined space), hal safety yang harus diperhatikan adalah:

- Sirkulasi udara didalam ruang terbatas (blower dipasang pada inlet dan outlet mainhole, dengan mekanisme hisap dan tiup).
- Setiap personel dapat menggunakan masker baik catride atau masker debu untuk menghindari partikel terhirup.
- Pengecekan udara dalam ruang terbatas dilakukan dengan menggunakan gas detector dan dilakukan sebelum masuk kedalam tanki.
- Attendant mencatat setiap personel yang masuk dan keluar dari dalam tanki.
- Penerangan (Lampu/ sumber Cahaya sejenisnya) diperlukan untuk menerangi area didalam ruang terbatas.

Peralatan yang akan digunakan harus explosion proof
tambahkan SCBA atau ELSA radio komunikasi

7. LOKASI PEKERJAAN

Lokasi pelaksanaan pekerjaan inspeksi MFL dilakukan di area tangka F-6104 di area PT. PertaArun Gas, Lhokseumawe - Aceh

8. URAIAN PROSEDUR PELAKSANAAN

Uraian detail prosedur pelaksanaan inspeksi MFL terlampir pada dokumen lampiran.

- Ruang lingkup pekerjaan dari inspeksi dasar lantai menggunakan MFL (magnetic flux leakage) adalah untuk mengetahui tingkat korosi pada dasar lantai tanki yang terbatas hanya pada material yang terbuat dari ferromagnetic seperti karbon steel hingga ketebalan 20mm berdasarkan spesifikasi alat Truflux.
- Standart referensi prosedur pada MFL mengacu pada ASME sec V art. 16, API std. 650, 652 dan 653.
- Sebelum melakukan inspeksi tanki menggunakan MFL, diwajibkan untuk dasar lantai tanki dalam keadaan yang bersih dari kotoran dan kering.
- Kaliberasi alat MFL dilakukan dengan menggunakan plate kaliberasi yang disesuaikan dengan ketebalan plate yang akan di inspeksi.
- Scanning data dilakukan per plate dan disesuaikan urutannya berdasarkan baris dan susunan plate pada dasar lantai tanki.
- Jika terdapat anomaly defect, presentase besaran dari defect tersebut dapat dilihat berdasarkan color code pada alat MFL, dan pada hasil akhirnya data yang dapat di verifikasi dengan menggunakan UT atau alat ukur thickness.
- Pengurangan ketebalan dari material yang masih dapat diterima dapat ditentukan menggunakan standart referensi yang ada, dan umumnya pengurangan thickness lebih dari 40% dapat direkomendasikan untuk dapat di patch plate jika dibutuhkan atau sesuai rekomendasi dari tank inspector yang ada.



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9. LAMPIRAN

- Non-Destructive Testing Procedure for Magnetic Flux Leakage, doc. No. : 001/MFL/PKM.V/2023

 PARAMUDA KARYA MANDIRI PT. Paramuda Karya Mandiri	NON-DESTRUCTIVE TESTING PROCEDURE FOR MAGNETIC FLUX LEAKAGE	Rev : 00
		Doc no : 001/MFL/PKM/V/2023 Effective of May 01, 2023

PROCEDURE FOR MAGNETIC FLUX LEAKAGE (MFL)


	NON-DESTRUCTIVE TESTING PROCEDURE FOR MAGNETIC FLUX LEAKAGE	Rev : 00
		Doc no : 001/MFL/PKM/V/2023 Effective of May 01, 2023

REVISION HISTORY:

Rev No	Document release date	Prepared by	Reviewed by
00	01 May 2023	Andika Juliandahri	Saenal A Rapi


PT. PARAMUDA KARYA MANDIRI

Prepared by	Reviewed and Approved by	Authorized by
		
Andika Juliandahri NDT Level II Date: May 01,2023	Saenal Aladin Rapi NDT Level III Date: May 01,2023	M Agung Syahputra Director Date: May 01,2023

 PARAMUDA KARYA MANDIRI PT. Paramuda Karya Mandiri	NON-DESTRUCTIVE TESTING PROCEDURE FOR MAGNETIC FLUX LEAKAGE	Rev : 00
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1. SCOPE

This procedure describes the requirements for conducting Magnetic Flux Leakage (MFL) Inspection of storage bottom tank using BW Truflux to determine corrosion levels.

2. LIMITATIONS

2.1 The Floor map system is generally only suitable for floors:

- Made of ferromagnetic materials such as carbon steel.
- Horizontal and vertical floor plate designs, Up to 20 mm.
- Without any heating coils present.

2.2 The characteristics of MFL inspection as technology are such that it is volume related and it may on some types of corrosion underestimate where there is minimal defect below 3 mm diameter. MFL gives use estimated percentage wall loss (%EPL) which is not exact thickness loss. As with all inspection methods, the effectiveness of inspection is affected by obstructions such as pipes, the condition of the floor or annular plates, cleanliness, and preparation of the floor.

3. REFERENCE STANDARD


The following documents shall be referred to conjunction with these procedures:

- ASME Sec V Art16,2019: Magnetic flux leakage (MFL) examination.
- API std. 650, 2013: Welded steel tanks for oil storage.
- API std. 652, 2013: Design & Construction of large welded low pressure storage tanks.
- API std. 653, 2013: Inspection and repair of storage tanks.
- Manufacturer operational manual.

4. PERSONNEL QUALIFICATION REQUIREMENTS

4.1 Personnel performing tank floor inspection using MFL shall be qualified to a minimum of NDT Level II MT based on guideline. Recommended practice no: ASNT-SNT-TC 1A.

4.2 Personnel conducting NDT inspections do not have to be API certified storage bottom tank inspector. API 653 paragraph 4.10.3

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4.3 The final report shall be prepared and signed by the individual performing the inspection.

5. PREQUISITES

Before commencing a tank floor inspection using MFL, the operator should ensure the following information is available.


- I. Material of construction
- II. Floor plate and annular plate thickness.
- III. Floor coating thickness and coating material.
- IV. General condition of the top surface for cleanliness and pitting.
Presence of heater coils or other obstruction
- V. Minimum pit depth to be detected (as a percentage of floor thickness).
- VI. Floor plate numbering system to be used.
- VII. Name and contact details of client's site representative.
- VIII. Safety requirements (breathing apparatus, hot work permit system etc).
- IX. Appropriate work permits for the inspection process as well as the equipment's to be used. Number of copies of reports required
- X. Risk Assessment and Method Statement.

6. EQUIPMENTS

The following equipment are required for performing the tank floor testing using MFL.

- I. MFL system (TRUFLUX)
- II. Appropriate MFL reference plate.
- III. UT/UTG Set.
- IV. Personnel gas tester.
- V. Basic PPE.
- VI. Special PPB/equipment as may be required by the contract or client safety policies.
- VII. Pit Gauge.
- VIII. Ruler & Measuring Tape.
- IX. Torch Light.
- X. Marker.

7. PREPARATION

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The tank floor shall be clean and free from product residue, ferromagnetic scale, weld spatter or tack welds. The client shall arrange to sweep clean any loose debris away from a plate before scanning. The presence of pools of water shall be avoided otherwise damage to the sensors may take place. It is not always necessary to grit blast the floor in order to carry out a satisfactory MFL inspection.


- I. Adequate lighting shall be installed giving good visibility and positioned for the inspection.
- II. The floor plates and annular plates shall be numbered in accordance with the agreed numbering system.
- III. Conduct a visual examination of the floor to assess the cleanliness and degree of top surface corrosion present. If the surface condition for either of the above reasons is considered to reduce the sensitivity of the inspection, this shall be brought to the attention of the client's site representative.
- IV. The nominal thickness of each plate shall be determined by ultrasonic thickness inspections at 3 points diagonally either bottom right to top left or bottom left to top right across each plate within the whole tank. These details shall be recorded on UT report format.
- V. Validation of the calibration sensitivity of the system using the appropriate MFL reference plate and coating simulation shall be carried out on a non-magnetic substrate outside the tank.

8. CALIBRATION

Sensitivity calibration shall be carried out using a MFL reference plate of appropriate thickness in conjunction with a coating simulation sheet where necessary.

Following are the steps to follow to calibrate the equipment:

- i. Place the reference plate with the defects on the TOP surface.
Position the scanner to travel from lowest 20% to highest 80%. Drive the scanner across the four defects in the reference plate. Select Accept to confirm the first calibration scan.
- ii. Manoeuvre the scanner back to the 20% edge of the plate and correctly place the scanner onto the reference plate edge. Drive the

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scanner across the four defects in the reference plate. Select Accept to confirm the second calibration scan.

- iii. Turn over the reference plate so defects are on the BOTTOM.
- iv. Position the scanner to travel from lowest 20% to highest 80%. Drive the scanner across the four defects in the reference plate. Select Accept to confirm the third calibration scan.
- v. Manoeuvre the scanner back to the 20% edge of the plate and correctly place the scanner onto the reference plate edge. Drive the scanner across the four defects in the reference plate. Select Accept to confirm the fourth calibration scan.

9. INSPECTION

- i. The inspection shall be carried out in accordance with operating manual section "Data Acquisition Documentation", "Setting up and scanning plates".
- ii. The floor shall be scanned plate-by-plate.
- iii. Rectangular plates shall be scanned using a raster scanning pattern, where practical and sketch plates using the most convenient unit-directional pattern.
- iv. Each plate shall be scanned along the longitudinal axis starting at the intersection of a longitudinal and transverse weld.
- v. At the end of the scan, the motor wheels shall be raised and the scanner hand propelled so that the motor wheels can cross the weld to attain maximum coverage without giving a shock load to the sensor head system that could be seriously damaged if allowed to hit any obstructions and lead to false indications. The scan is completed as the front rollers of the magnet carriage reaches, but does not cross, the transverse weld.
- vi. With the drive wheels raised, the unit is manoeuvred through 180 to begin the next scan.
- vii. The overlap between two scans shall be 50 mm.
- viii. A transverse scan shall be performed at each end of the plate to ensure maximum plate coverage is achieved.

The Hand Scan system shall be used to cover the maximum practically possible dead zone areas as well as areas under pipes and heater coils that are inaccessible to the TRUFLUX.

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- i. If there is a plate that cannot be inspected by the TRUFLUX canner due to size, limited access, existing patch plates or corroded top surfaces of the plate then the dimensions of the plate shall be measured and entered the software and then saved. This will ensure that the software recognises the plate and correctly inserts the data for producing the tank bottom plan view.

9.1 Plate Setup

Once an inspection project has been created or loaded and the calibration process has been completed, touch the Scan button to enter the New Plate window.

9.2 Row & Plate Number

Choose the plate to be scanned by entering the Row and Plate numbers. Click the arrows each side of the row or plate number to change the plate number.

9.3 Dimensions

Enter the length and width of the plate in the relevant boxes. The plate width must always be greater than 300 mm.

9.4 Plate Orientation

Select the orientation of the plate, either vertical or horizontal in relation to the tank datum.


9.5 Scan Type

There are two methods to scan a plate:

- a) Parallel Scanning (one direction scanning) - where each consecutive scan is made in the same direction.
- b) Raster Scanning (two direction scanning) - where each consecutive scan is made in the opposite direction to the previous scan.
- c) Transverse Scanning Perpendicular to the normal scanning. Used to cover the unscanned area by above two scans.

9.6 Start Comer (Plate Reference)

Can select Top-Left, Top-Right, Bottom-Left or Bottom-Right which are all relative to the tank datum, shown on the bottom-left of the window.

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The start corner will become the plate reference. All positional information is measured from the plate reference.

9.7 Scanning

Once the Start Offset measurement has been entered, touch on the Enter key to begin a scan. Turning the drive handle at this point will simultaneously start the scanner motor and data collection functions. When the handle is turned, the scan progress is shown in the Scan Progress Window. The handle must be held in the ON position until the required scan length has been reached. Once the drive handle is released, TRUFLUX will stop and the data collection will be paused. The window shows details of the distance travelled. When the operator clicks Accept, TRUFLUX analyses the collected data and displays its visual representation on the screen.

10. INTERPRETATION OF RESULTS


- 10.1 Stored data interpreted with reference to the colour coding and corresponding thickness values are reported.
- 10.2 The analysis of the data shall be carried out in-situ using the acquisition software on the desktop.
- 10.3 The defects that exceed the minimum wall thickness specified by client shall be verified by ultrasonic thickness measurement for arriving at the exact wall thickness.

11. ACCEPTANCE CRITERIA

The minimum wall thickness result shall be specified by the client for the purpose of recommending the patch plates required.

12. REPORTING

- 12.1 The test reports to contain the following information and is generated by the TRUFLUX system.
 - i. Owner, Location, Type, Serial Number, and Identification of Tank.
 - ii. Diameter, Height, Material Type of the tanks.
 - iii. Bottom Plate Layout plate numbering and layout of nozzles, manhole etc.
 - iv. Extent of examination.

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- v. Personnel performing the examination qualification level.
- vi. Date of examination
- vii. Equipment Serial No, Model and Manufacturer.
- viii. All relevant instrument setting.
- ix. Procedure used-identification and revision.
- x. Test Standard.
- xi. Identify the plates or specific regions where scanning could not be done.
- xii. Results of the examination and related sketches or maps of the examined areas.

Survey



Nomor : 0918/MDN-I/ILSE/2024
Lhokseumawe, 26 Pebruari 2024

Kepada Yth.

DIREKTUR

PT PARAMUDA KARYA MANDIRI

Jl. Cendrawasih Blok A4 No. 09, RT/RW. 004/007

Kelurahan Jati Cempaka, Kecamatan Pondokgede

Kata Bekasi, Jawa Barat

Lampiran 1 (Satu) Set

Sifat Penting

Perihal **Penunjukan Pelaksana Pekerjaan NOT MFL for Tank Inspection F-6104**

Dengan Hormat,

Dengan mempertimbangkan Surat Penawaran Harga dari **PT Paramuda Karya Mandiri** Nomor **PKM-002-QT -11-2024** tanggal 16 Pebruari 2024 untuk pekerjaan **NOT MFL for Tank Inspection F-6104** di PT. Pembangunan Aceh (PEMA), maka PT SUCOFINDO Cabang Medan menyetujui dan menunjuk **PT PARAMUDA KARYA MANDIRI** sebagai pelaksana pekerjaan **NOT MFL for Tank Inspection F-6104** dengan ketentuan & syarat sebagai berikut :

1. Lokasi pekerjaan adalah di area kilang PT. Perta Arun Gas
- 2.
3. Pembayaran atas pekerjaan akan dilakukan secara **back to back** setelah adanya progress penyelesaian pekerjaan dan pembayaran dari PT Pembangunan Aceh (PEMA)
4. Jangka waktu penyelesaian pekerjaan, seluruh persyaratan dan ketentuan lainnya mengikut kontrak antara PT. PEMA dan PT. Sucofindo.
5. Berkomitmen mengalokasikan tenaga ahli sesuai bidangnya dengan jumlah dan kompetensi keahlian yang dibutuhkan sesuai SOW PT. PEMA dan Kontrak antara PT. PEMA dengan PT. Sucofindo.
6. Surat Penunjukan Pelaksanaan Pekerjaan ini bukan merupakan kewajiban finansial PT SUCOFINDO kepada PTParamuda Karya Mandiri.

PT SUCOFINDO
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Demikianlah kami sampaikan, atas perhatian dan kerjasamanya diucapkan terima kasih.

Hormat Kami,



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LILIK UCHARIADI

Kepala Cabang

Disetujui Oleh : **PT PARAMUDA KARYA MANDIRI**

Dengan ini Kami menyetujui isi Surat Penunjukan Pelaksanaan Pekerjaan **NOT MFL for Tank**

Inspection F-6104

PT PARAMUDA KARYA MANDIRI

MOHAMMAD AGUNG SYAHPUTRA

Direktur

BAUGH & WEEDON

NDE



TRUFLUX

High Resolution Digital Tank Floor Plate Scanner



bw-nde.com

The Truflux is a new concept in Magnetic Flux Leakage (MFL) tank floor plate inspection, incorporating a new level of user sophistication in its innovative design. The TruFlux has the benefits of advanced features and practicality.

As a fully self-propelled high-resolution digital scanner, the Truflux is capable of producing highly accurate topographical images of 6-20mm storage tank floor plates.

Particular attention has been paid to the mechanical design, notably in its physical size, weighing in at just 32kg inclusive of its slip-in-slip-out lithium ion battery pack.

Yet with its advanced design, no functionality has been compromised; in fact, significant advancements in floor plate inspection have been incorporated into the instrument and system design.

The TruFlux system is easy to use and highly practical. For ease of shipping the whole unit folds down easily for transportation, see below. With its reduced physical size and lower weight, handling and set-up require little effort, making life easier for the operator in the field.



Key Features

- Efficient & Effective Mechanical Design.
- Superior Resolution (5.2mm x 1mm)
- Lightweight, 32kg (inc. battery)
- Easy to transport, total shipping weight under 60kg (not including laptop).
- Easy reporting via Laptop, USB.
- Semi-rugged laptop upgradeable to a fully rugged option.
- Unique damping system provides easy lift-off.
- High resolution optical encoder. Positional accuracy of $\pm 1\text{mm}$ over a 20m scan track.
- Fast track-to-track scanning images.
- USB connectivity means the Truflux effectively works as a simple "plug and play" unit.
- Off-the-shelf battery technology.

Innovation

The Truflux incorporates a damping system designed to alleviate the usual high forces required to break magnetic contact. The active damping system controls the scanner lift-off and placement in one easily controlled motion, greatly reducing any high levels of mechanical loading.

The DAQ Software has been developed for both touch-screen and standard pc applications. With fast control function set-up allowing less operator inputs per scan, resulting in faster plate scan time. Auto-hierarchical directory construction eliminates possible overwrites or "non-save" issues.

It is well documented that for this type of magnetic flux leakage technique, speed variations whilst scanning cause adverse effects on data quality. TruFlux employs a proprietary Speed Compensation Algorithm to help remove spurious indications arising from this anomaly. In addition all scanning speeds are cross-correlated back to the calibration and kept within controlled margins.

Particular attention has been paid to data acquisition, data handling and communication protocols. The entire electronics package is housed within the fully ruggedized scan-head enclosure, powered only by the USB; effectively the Truflux has become a simple plug-and-play device. This greatly improves site reliability, as complex electronics and connectivity are susceptible within harsh environments.



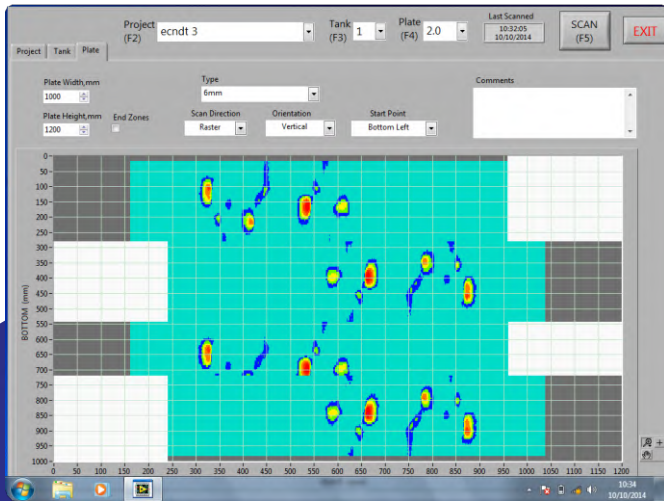


Fig 1: TruFlux Rasterscan

A new chapter in “Floor-Plate” inspection.

Baugh & Weedon’s Magnetic Flux Leakage (MFL) floor-plate scanner introduces a new dynamic to tank floor inspection. The Truflux high-resolution scanning system offers an unparalleled level of inspection.

Algorithms developed to filter flux leakage distortion, provide the operator and client a greater understanding of the visual data displays. Point-to-point data samples from 48 channels are stored in each track run and can be cross-correlated with subsequent inspections for predictive corrosion growth analysis.

High level of Positional Accuracy

The high-resolution optical encoder gives a positional accuracy of $\pm 1\text{mm}$ over a 20-meter scan track.

Digital Resolution

Readings from 48 hall effect sensors are captured and digitised every 1.0 mm of forward travel at a scanning speed of 500mm p/sec.

Auto-Drawing, Scaling and File Handling.

The software produces a full-scale drawing of the tank floor, with auto numbering of plates and tracks including annular rings. Scanned plots of tracks are auto-positioned onto plates; as are the plates into the tank image.

All file and directory handling is produced automatically, resulting in significantly faster track-to-track scanning speed.

Unrivalled data image display reveals any material loss as a high-resolution corrosion map with additional controls for zooming, panning and saving images.

Threshold sensitivity can be adjusted to client requirements along with colour choice, so if required, any indication over a set percentage loss can be set to a single indicative colour.

Once operator inputs have been selected an automatic plate scan strategy is generated. The operator has then only to follow the on-screen guidance, whilst also being able to choose and select end zone scanning.

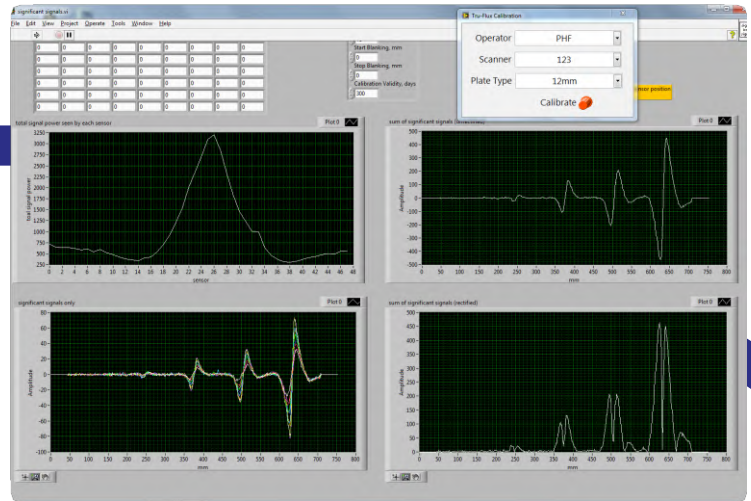


Fig 2: TruFlux 12mm Plate Calibration Signals

The DAQ software has a Preliminary PDF report output function, enabling the on-site operator to leave a first draft report upon inspection completion. This enables the client to be immediately reactive to possible issues.

Overlay Feature

Past inspection results can be overlaid in both tank, plate and track format providing the engineer with a view and indications of corrosion growth areas and trends, assisting with predictive analysis.

Battery Design Feature

The Truflux uses Lithium-ion battery technology with push-pull hot swappable capability. A fast recharge function and four batteries per unit provides 24hr utilisation.



Truflux Specification	
Principle Of Operation	Magnetic Flux Leakage
Detection	48 Hall Effect sensors
Scan Width	300mm
Method of Propulsion	DC motor
Speed	500mm/s
Thickness Range	6-20mm
Test Through Coatings	Yes
Maximum Coating Thickness	6mm
Maximum Sensitivity	20%
Auto-Stop	No
Power Requirements	24V
Transit Case	Meets IATA requirements for transporting magnetisable material.
Operating Weight	32kg
Stop on Defect	No
Real Time Analysis	Yes
Real Time Averaging	Yes
Real Time Digital Signal Processing	Yes
Freeze Screen Alarm	No
Linear Resolution	0.5mm
Speed Compensation Algorithm	Yes
Digital Data Storage	48 Channels x 0.5mm
Scan Length	Unlimited
Scan Plate End Zones	Yes
Adjustable Sensitivity Range	Yes
Laser Guide	Yes - optional
Fully dampened magnetic contact	Yes
Assisted Magnet Lift-Off	Yes. Minimal effort required to break magnet contact, resulting in considerably less operator fatigue.
Scan Length Alignment (whilst in magnetic contact)	Yes. The scan track can be fully aligned when the magnet is in contact with the plate, alleviating the need to break contact if track alignment was not achieved.

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BAUGH & WEEDON

NDE



MOCK-UP TEST MFL SCANNER TRUFLUX

PROJECT

Tank Cleaning & Internal Inspection

Condensate Tank (35-T-101)

GRISSIK GAS PLANT

ASSET INTEGRITY TEAM's



Background:

Latar belakang Mock-up Test MFL Scanner TRUFLUX ini adalah:

Alat MFL scanner TRUFLUX ini pertama kali diaplikasikan di Medco E&P

Purposed:

Tujuan dari mock-up test alat MFL Scanner TRUFLUX ini adalah untuk mengetahui lebih detail terhadap penggunaan/operasi dari alat; kelebihan dan kekurangannya; hasil/outputnya; serta kualitas penyampaian hasil inspeksi kedalam laporan.

Specifications

TRUFLUX

Truflux Specification	
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Maximum Coating Thickness	6mm
Maximum Sensitivity	211%
Auto-Stop	No
Power Requirements	24V
Transit case	Meets IATA requirements for transporting magnetisable material.
Operating Weight	32kg
Stop on Defect	No
Real Time Analysis	Yes
Real Time Averaging	Yes
Real Time Digital Signal Processing	Yes
Freeze Screen Alarm	No
Linear Resolution	0.5mm
	Yes
	48 Channels x 0.5mm
	Unlimited
	Yes
Adjustable Sensitivity Range	Yes
Laser Guide	Yes - optional
Fully damped magnetic contact	Yes
Assisted Magnet Off	Yes. Minimal effort required to break magnet contact, resulting in considerably less operator fatigue.
Scan Length Alignment (whilst in magnetic contact)	Yes. The scan track can be fully aligned when the magnet is in contact with the plate, alleviating the need to break contact if track alignment was not achieved.

Key Features

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- Unique damping system provides easy lift-off.
- High resolution optical encoder. Positional accuracy of ± 1 mm over a 20m scan track.
- Fast track-to-track scanning images.
- USB connectivity means the Truflux effectively works as a simple "plug and play" unit.
- Off-the-shelf battery technology.

Calibration / Verification Systems

Ketebalan artificial defect pada reference steel plate:

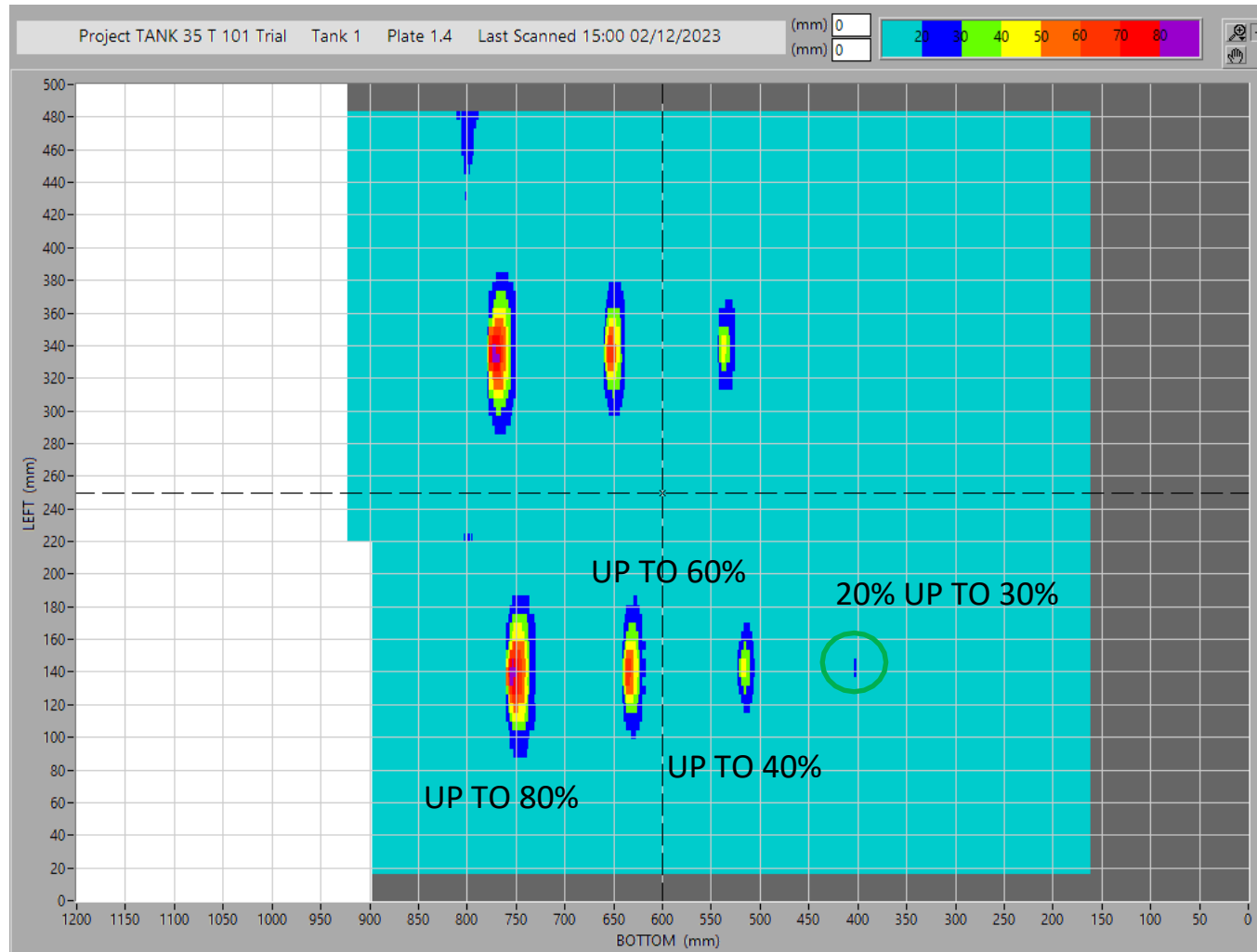
Defect	Aktual (UT Thickness) (mm)		
	Thickness Plate	Remaining Thickness	Depth
20%	10.05	7.98	2.07
40%	10.05	5.94	4.11
60%	10.05	4.00	6.05
80%	10.05	2.15	7.90

Nilai remaining thickness diatas adalah nilai ketebalan pelat dikurang kedalaman cacat. Nilai diatas hasil dari NDT UT Thickness measurement.



Reference steel plate w/ artificial defects

C-Scan View

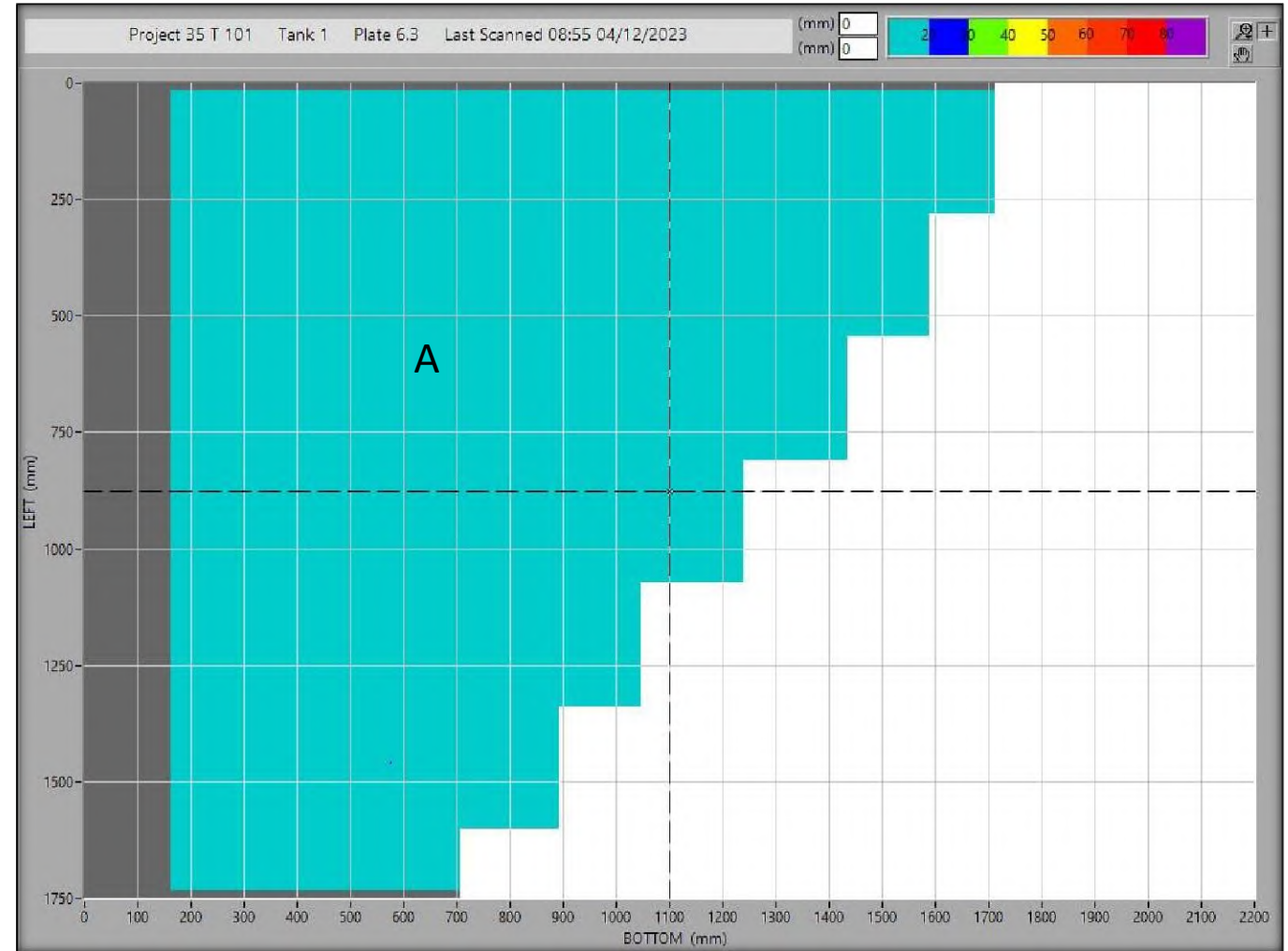


Tampilan C-Scan diatas adalah hasil dari scanning MFL TRUFLUX terhadap 4 artificial defect

Result of MFL scanning

A adalah hasil MFL **under 20%** discontinuity

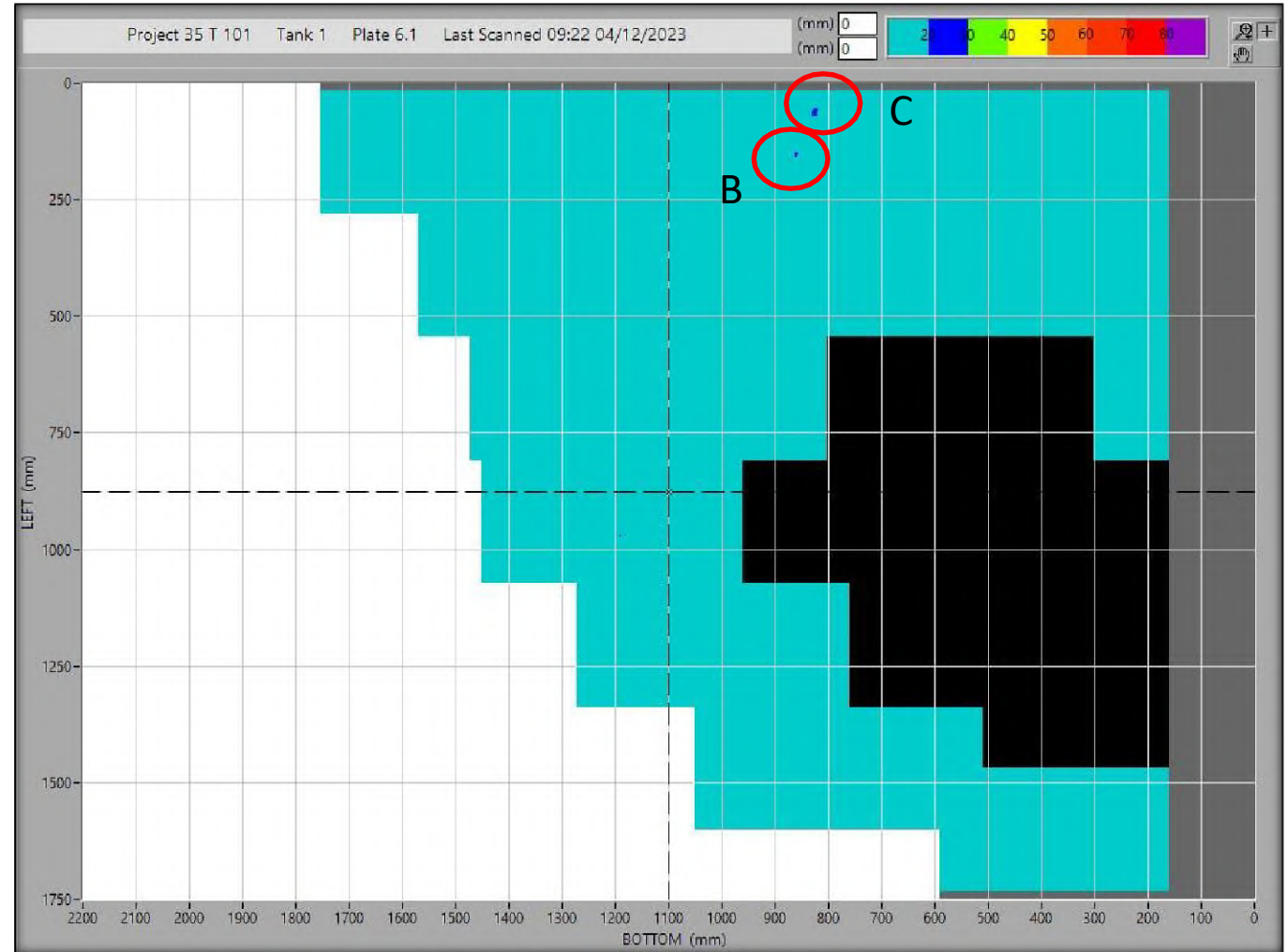
Hasil UT thickness measurement is **9.56 mm**.
Nominal thickness is **10.00 mm**



Result of MFL scanning

B adalah hasil MFL dalam range **20%- 30%** discontinuity, general corrosion in soil side.
Hasil UT verifikasi didapat **9.24 mm**. Nominal thickness 10.00 mm

C adalah hasil MFL dalam range **20%- 30%** discontinuity, pitting corrosion in product side.
Hasil pengukuran pitting gauge didapat depth **1.57 mm**



UT Thickness Verification of defect (B)

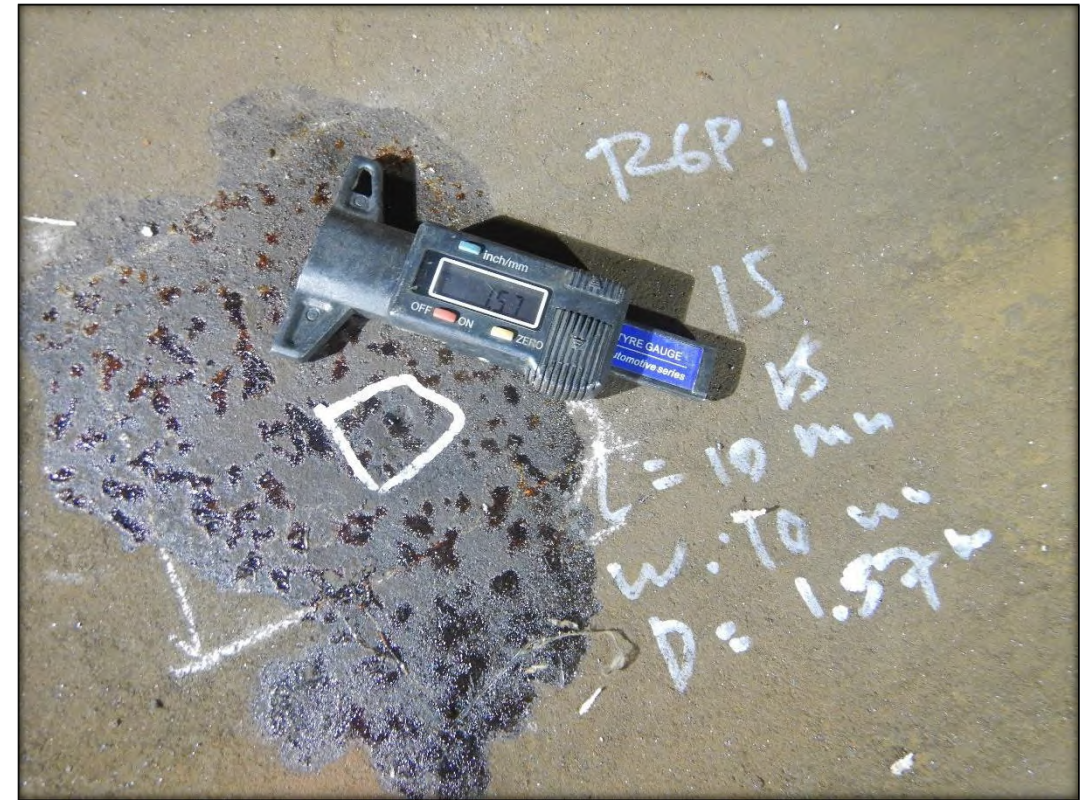
MFL result under 20% discontinuity (general corrosion)



Then, the remaining thickness of the defect is 9.24 mm
(Thickness nominal 10.00 mm)

The depth of pitting is 1.57 mm (C)

MFL result 20%-30% discontinuity (pitting corrosion)



Then, the remaining thickness of the defect is $10.00 - 1.57 \text{ (mm)} = 8.43 \text{ mm}$

Hasil keseluruhan

Discontinuity/ Defect	Nominal Thickness	MFL (Volumetric)	UT Thickness Verification	Depth of Pitting	Wall Loss thickness	Defect position
	(mm)		(mm)	(mm)	(mm)	
A	10.00	under 20%	9.56	-	4%	Both side
B	10.00	20%-30%	9.24	-	8%	Soil Side
C	10.00	20%-30%	-	1.57	16%	product side

Interpretasi

- Defect A
 - Dari hasil MFL menunjukkan under 20% discontinuity.
 - Wall loss berdasarkan hasil Pengukuran UT thickness adalah 4 %.
 - ***Comment: satisfy***
- Defect B
 - Dari hasil MFL menunjukkan dalam range 20% - 30% discontinuity.
 - Wall loss berdasarkan hasil verifikasi UT thickness didapat 9.24 mm (Thick Nominal 10.00 mm) atau 8% wall loss
 - By visual defect berada di sisi soil side
 - ***Comment: satisfy***
- Defect C
 - Dari hasil MFL menunjukkan range 20% - 30% discontinuity.
 - Wall loss berdasarkan hasil Pengukuran pitt depth gauge adalah 1.57 mm (Thick Nominal 10.00 mm) atau 16% wall loss
 - By visual defect berada di sisi product side
 - ***Comment: satisfy***

HASIL MOCK-UP TEST

Berdasarkan hasil mock-up test tersebut, dapat disimpulkan sebagai berikut:

- a. Hasil verifikasi terhadap 4 (empat) cacat buatan (*artificial defect*) yaitu defect/discontinuity 20%, 40%, 60%, dan 80% sudah sesuai. MFL TRUFLUX dapat menampilkan 4 defect tersebut pada C-scan viewnya dengan lift-off distance 1.5 mm.
- b. MFL TRUFLUX sesuai spesifikasinya adalah volumetric detection technique.
- c. Dengan hasil MFL wall loss persentase pada range under 20% pada general corrosion, artinya sama dengan more and less 4% wall loss dari hasil pengukuran UT thickness.
- d. Dengan hasil MFL wall loss persentase pada range 20%-30% pada general corrosion, artinya sama dengan more and less 8% wall loss dari hasil pengukuran UT thickness.
- e. Dengan hasil MFL wall loss persentase pada range 20%-30% pada pitting corrosion, artinya sama dengan more and less 16% wall loss dari hasil pengukuran pit-gauge.
- f. MFL TRUFLUX tidak dapat mengidentifikasi apakah defect/discontinuity di posisi soil side atau di product side atau dikedua sisi.

HASIL MOCK-UP TEST

- d. Output plotting dari MFL TRUFLUX ini tidak dapat menampilkan area yang tidak tercover oleh scanner.
- e. Berat dari unit TRUFLUX ini total adalah 32 Kg.
- f. Dimensi dari unit TRUFLUX ini adalah cm x cm. Dan dapat diperkecil/dilipat, sehingga mudah dalam manual handling dan dapat lewat melalui manhole 20 inch dan lebih.
- g. Dimensi MFL sensor adalah 25 cm x 25 cm.
- h. Lift-off distance sampai dengan 6 mm.
- i. Lama penggunaan baterai adalah 4 jam secara continue.
- j. Untuk dimensi pelat 600 cm x 600 cm, mulai persiapan, marking dan scanning memakan waktu kurang lebih 5-10 menit.

IMPROVEMENTS

Improvement terhadap alat MFL Scanner Introcor M150 sebagai berikut:

- a. Karena MFL TRUFLUX tidak dapat mengidentifikasi posisi defect. Maka operator utama harus memverifikasi dengan visual dan didukung dengan UT thickness, apakah posisi defect berada di bottom side, product side, atau kedua sisi.
- b. Karena output plotting MFL TRUFLUX tidak dapat menampilkan area yang tidak tercover oleh scanner. Maka operator utama harus membuatkan sketch dan ditandai area yang tercover dan yang tidak tercover oleh MFL scanner, dalam pelaporan agar lebih informatif, sehingga hasilnya mempresentasikan kondisi aktualnya.

Conclusions:

Secara umum, dapat disimpulkan bahwa alat MFL TRUFLUX “dapat diterima dengan catatan” atau “Accepted with Note”.

Note: Improvement harus dilakukan/dipenuhi

PHOTOGRAPH



THANK YOU

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