NDT SCOOP

INSPECTION MAGAZINE

by NDT CORNER

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Q4.2023

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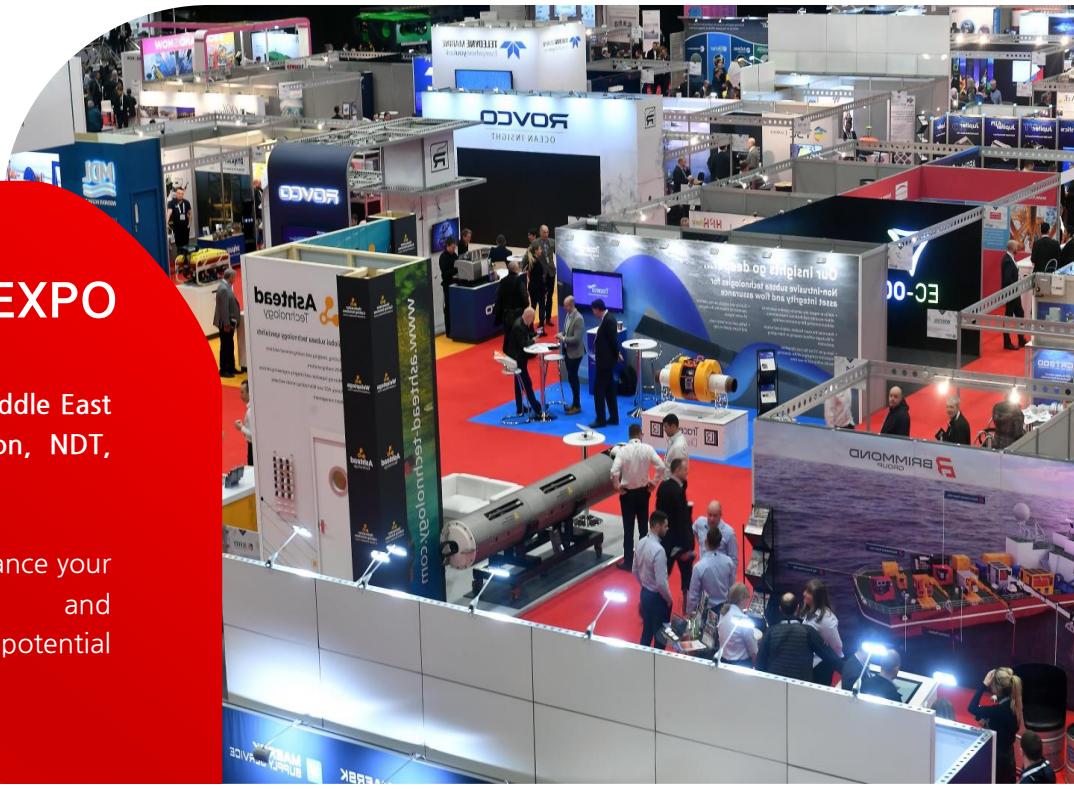
07 – 09 MAY 2024 | EGYPT INTERNATIONAL EXHIBITION CENTER



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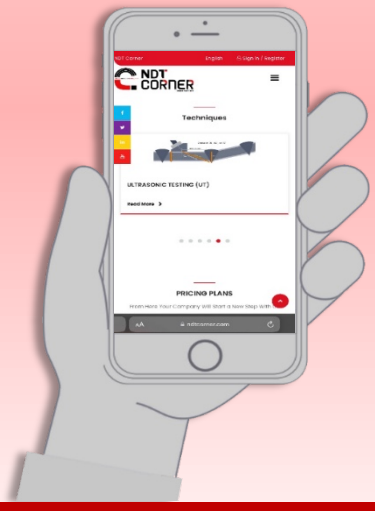

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SCAN ME

NDT SCOOP
INSPECTION MAGAZINE

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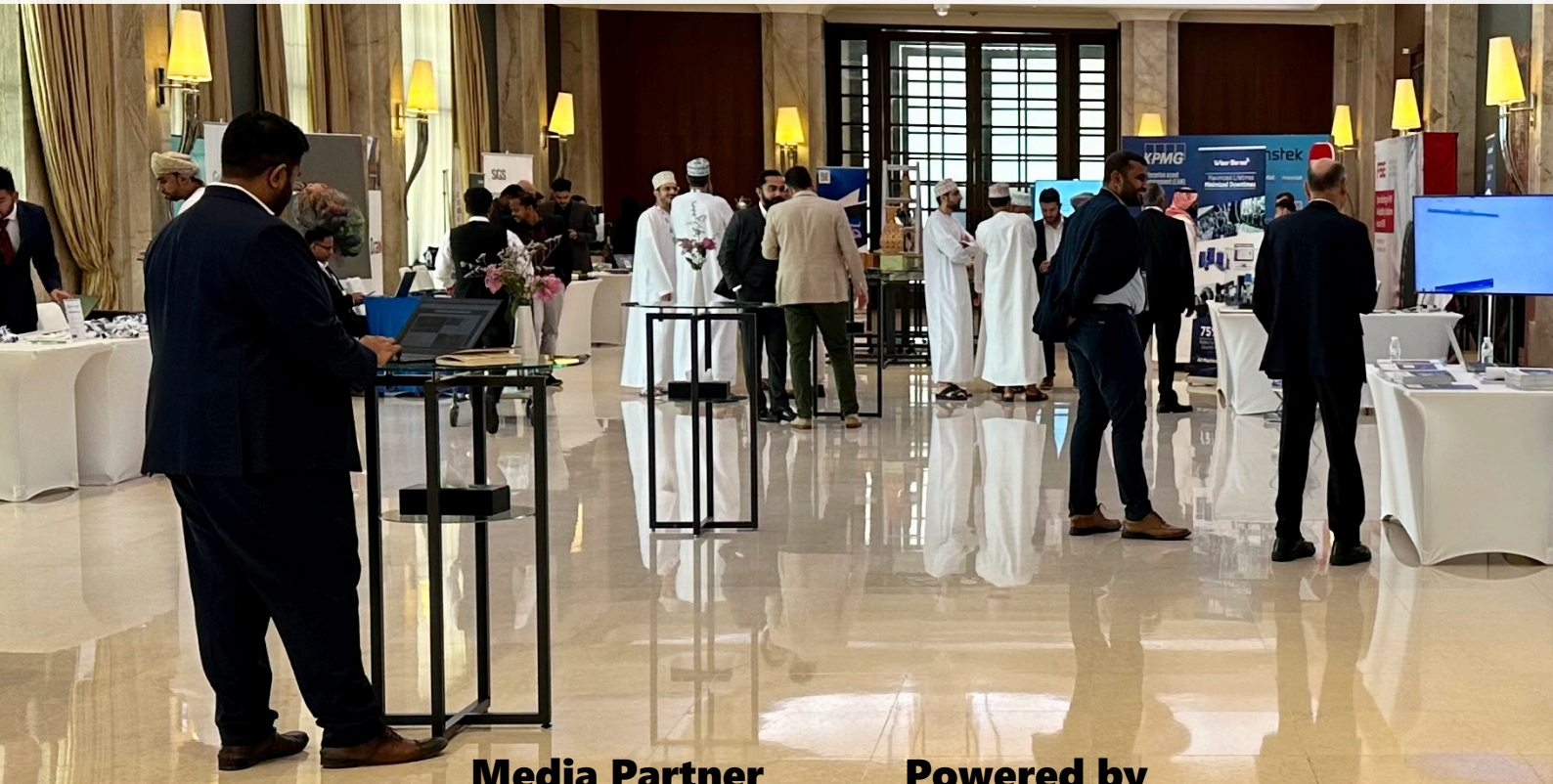

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Mr. Javed Khan Dalwai
Head of Digitalization
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Conference moderator

"Great to be part of the Asset Integrity Management (3rd edition 2023) Oman.

Enjoyed moderating an interactive panel discussion "Leveraging Digitalization for Revolutionizing Asset Performance, Management, Operations, Reliability and Maintenance"."

Building upon the success of previous editions where Asset Integrity Managers, Digital Transformation Heads, Corrosion Management Specialists, Maintenance Experts, Contractors, and Heads of Special Projects from the Oil and Gas Sector will gather to discuss the latest trends, innovations, and key technologies.

The Conference focused on Oman's journey towards achieving operational excellence, addressing challenges related to asset visualization, well and pipeline integrity, corrosion monitoring and control, HSE concerns, leak detection, system integration, and data collection. Additionally, advanced de-carbonization strategies and energy reduction methods will be explored to ensure sustainability and business continuity. Certified workshops conducted to enhance professionals' skills in asset management and goal achievement, considering risks, costs, and performance.

This conference aims to facilitate networking, learning, and collaboration, driving innovation, generating leads, fostering business growth, and advancing the industry.

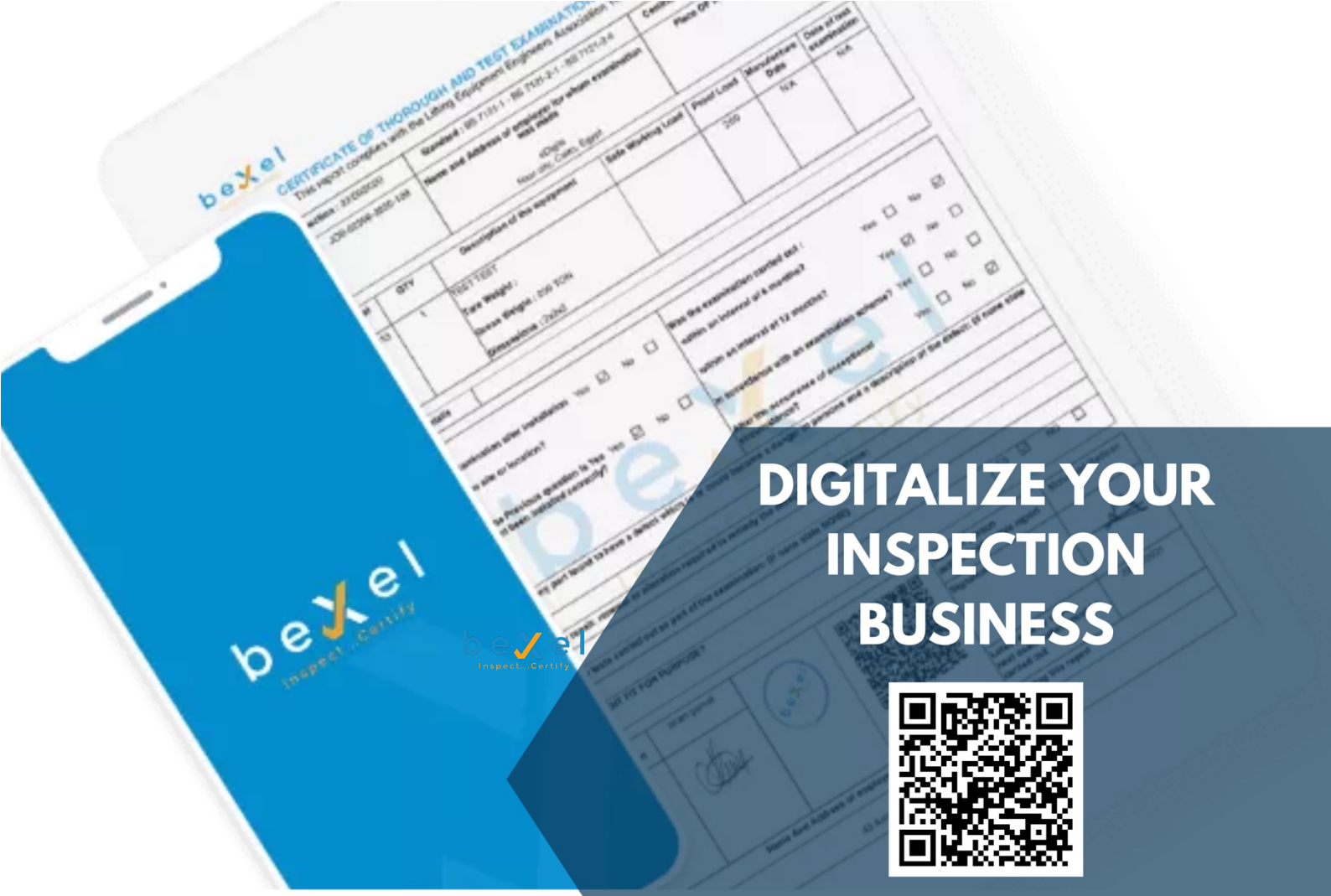
The conference featured keynote speeches from top-tier industry experts sharing their experiences on Robust Asset Integrity, Maintenance and Business Continuity Strategies, Leveraging Digitalization for Revolutionizing Asset Performance and Empowering Maintenance 4.0 and mitigating challenges risks and best practices towards achieving Oman's vison and operational excellence. Engaging panel discussions will convene policymakers, engineers, operation and maintenance, asset integrity and reliability heads to debate the latest trends and strategic solutions for maintaining asset integrity.

Maintenance 4.0 is about putting smarter technology to work to enhance everyday asset operations. Some of the cornerstones of Maintenance 4.0 include:

- Preventive maintenance.
- Predictive maintenance.
- Condition monitoring and trigger-based maintenance.
- Life cycle engineering.

Maintenance 4.0 is a machine-assisted digital version of all the things we have been doing for the past forty years as humans to ensure our assets deliver value for our organization. In a nutshell, Maintenance 4.0 applies technologies better to reduce costly and inefficient errors.

Chief drivers for Industry 4.0 are the Industrial Internet of Things (IIoT), Wireless Sensors, Cloud Computing, Big Data, Analytics, ML and AI and technologies like augmented reality (AR) and virtual reality (VR), Maintenance 4.0 is the realization of these technologies.



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Industrial Thermal Imaging

Thermal Imaging

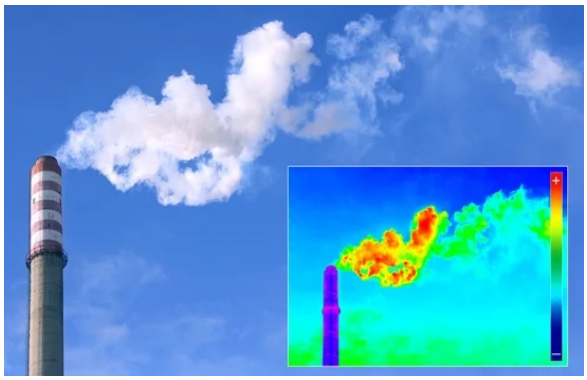
A screening method by IR Thermography.

Thermal imaging is the **technique of using the heat** given off by an object to produce an image of it or to locate it. In essence, a thermal imaging camera measures variations in heat, or infrared radiation, and represents the heat as different **colors in an image**.

Thermal imagers are useful to monitor any mechanical and electrical equipment. This includes pressure vessels, weld monitoring, glassware manufacturing, plastic injector molding, and more. Accurately track process temperatures with infrared cameras.

This style of imaging is used by many industries from medical, law enforcement, to plumbing and electrical. For instance, electricians use thermal imaging to detect hot spots in electrical systems which can indicate dangerous faults.

This method is based on triage techniques employed in the medical field and uses the test results obtained by an infrared thermographic camera and ultrasonic thickness gauge as determination criteria. Aiming at evaluating the wall thinning caused by aqueous corrosion due to sludge in pipes, an infrared thermographic camera was used to conduct studies to find a method for detecting sludge inside a pipe and a method for measuring the distribution of wall thinning. Testing conditions, signal processing, etc., were developed and adapted for actual pipes, and their validity was confirmed.



APPLICATIONS:

- Industrial Manufacturing Field,
- Security Field, Home & Outdoor,
- Electric field,
- Energy and Petrochemical field,
- Environmental Monitoring and Forest Fire Prevention,
- Automotive Night Vision Field,
- Medical,
- Research & Development,
- Spectral imaging for agriculture,
- Plastic inspection.

What are the two types of thermal imaging?

Thermographic cameras can be broadly divided into two types based on sensor used:

- **Cooled** infrared detectors
- **Uncooled** infrared detectors.

Cooled infrared cameras typically operate slightly under room temperature. If the sensor does not cool off, the sensor risks being flooded by its own thermal radiation, causing the sensors to be blinded. Because of this need to cool off, cooled thermal cameras are integrated with a device called a cryocooler. Thermal cameras that use cooled image sensors are more expensive to manufacture, require more maintenance, and consume more energy for ventilation. Furthermore, when starting up the camera, a wait time of up to several minutes may be needed for it to cool down before it can be used. Even though cooled equipment may be bulky and expensive, they can produce crisper, higher resolution images than uncooled cameras.

Uncooled infrared cameras do not require expensive and bulky cryocoolers. The sensor in an uncooled thermal camera is stabilized at or close to room temperature, using less complicated temperature control elements. These sensors can stabilize the changes of resistors, voltage, and power when infrared radiation causes the temperature to rise. Despite their lower resolution and image quality in comparison to cooled cameras, uncooled thermal cameras are smaller and more economical.

What's the difference between infrared and thermal imaging?

Active IR systems use short wavelength infrared light to illuminate an area of interest. Some of the infrared energy is reflected to a camera and interpreted to generate an image.

Thermal imaging systems use mid- or long wavelength IR energy. Thermal imagers are passive, and only sense differences in heat.

What is thermography in NDT?

Thermography is a non-destructive testing method used to detect and measure small temperature differences to help find deterioration in assets and plant sites.

Thermography can support the maintenance of industrial plants and equipment with its fast and cost-effective application.

Choosing the right INFRARED camera for your application:

► **Emissivity & Reflection**
Thermal imagers which allow the operator to set the emissivity and reflection is the one to pick if you are planning on using the thermal imager for any application. In essence, emissivity is the efficiency with which an object emits infrared radiation. To ensure correct temperature readings, thermal imaging cameras today have in-built emissivity settings for a wide range of materials.

The same is true for reflection as well. A camera that allows you to adjust the angle while pointing to an object will ensure that the thermal images are free from any misinterpretations caused by reflections.

► **Manual Span & Level Correction**
Automatic thermal imagers set the span and level of the displayed thermal images based on the highest and lowest temperature found on the subject. However, this is ineffective if you want to see only a small spectrum of the temperature range. Manual settings allow you to set your own higher and lower temperature limits so that you can limit the scope of your examination.

► **Integrated Digital Camera**
An integrated digital camera allows the operator to take normal pictures of the subject alongside the thermal pictures. This is extremely helpful when evaluating a complex scene. A visible light picture will help you compare and locate the areas that need attention easily.

► **Picture in Picture**
Picture in Picture mode or P-i-P enables the camera to combine digital and thermal image in one frame. This is helpful when the operator needs better visibility of the subject without compromising thermal imagery.

► **Thermal Fusion**
Thermal fusion combines thermal and digital image to show only the points of interest in a different hue. This method is great at isolating problems.

These are the core features that will help you find a capable thermal imager. With advances in technology, modern thermal imagers come with a variety of comfort features that include Bluetooth capability, normal camera mode, WIFI connectivity, and other ergonomic features.

However, make sure not to compromise on core features for the sake of comfort and aesthetics.

► **Fixed or Portable camera?**
Handheld or portable infrared cameras are one of the most popular types of infrared pyrometer. They are very popular in many industries and applications including HVAC, automotive, building inspection, energy audits, plant maintenance, electrical contractors, insulation experts and many more.

Fixed mount infrared thermometers are commonly used in industrial processes where the thermometer can be mounted in a stationary position.

How to choose a Thermal Camera?

The three major factors that you should keep in mind when buying a thermal camera as a part of cost and quality are:

- ► Detector Resolution,
- ► Thermal Sensitivity.
- ► Wavelengths ranging

The Detector resolution is the number of pixels that the thermal imager can fill in a frame. More the pixels, more detailed the image is going to be!

The standard resolutions are 160 x 120, 320 x 240, and 640 x 480 pixels. A 160 x 120 resolution will have 19,200 pixels while a 640 x 480 resolution will have 307,200 pixels. Going for higher pixel density will give you clearer and more detailed pictures.

The Thermal sensitivity is the smallest degree of temperature change that the thermal imaging camera can measure. If the thermal sensitivity of a thermal imager is 0.05°, it can separate two surfaces having 0.05° of a temperature difference by denoting the colder and hotter surface with different hues of color.

Also, make sure that the range of the thermal imager is sufficiently large so that you don't run into limits, -4°F to 2,192°F is a typical example of a good thermal range.

The Wavelength Range there are three basic types of infrared imaging cameras: short wavelength, mid-wavelength, and long wavelength.

Infrared cameras detect light or heat at wavelengths ranging from 0.7 to 2.5 micrometers (short-wave infrared light), 3 to 5 micrometers (middle-wave infrared light), or long-wave infrared light (8 to 14 micrometers).

SWIR, MWIR, or LWIR camera depends largely on why you need to use it. They all do some things better than others. If you're inspecting agriculture products, paper money, or works of art, SWIR might be the best choice. MWIR cameras are essential safety equipment for manufacturers and industries that use hazardous gasses or for gas utilities to detect hidden gas leaks. Wildlife researchers may use LWIRs to track or record wildlife populations and movements, while military and government organizations may use them for security and defense purposes.

Selection of infrared or thermal?

► **Infrared** thermometers are more precise and can be used to measure the temperature of specific points on an object.

► **Thermal** imaging is useful for detecting temperature variations across large areas or for identifying hot spots in machinery or electrical systems.

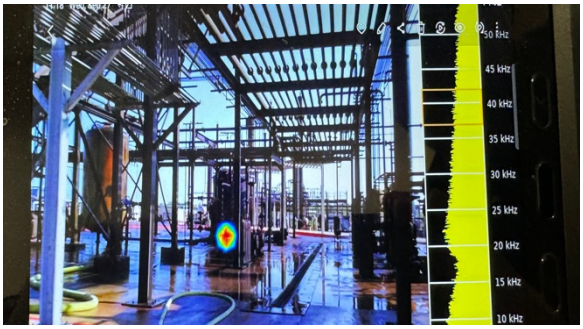
Note: all thermal cameras are infrared cameras since they operate in the infrared spectrum. However, not all infrared cameras are thermal cameras, as some infrared cameras may be used for purposes other than thermal imaging, such as surveillance, night vision, or remote sensing applications.

Industrial Camera Application Example

OGI Ultimate Hydrocarbon Gas Leak Detection

The MFE Optical Gas Imaging Camera

In the realm of gas leak detection, the MFE OGI Camera stands distinctively as an innovative and efficient tool. This device, paired with Boston Dynamics' Spot, heralds a new era in hydrocarbon gas detection, offering enhanced precision and mobility.



The MFE OGI Camera meets the stringent Quad-O standards, emphasizing its commitment to safety and environmental preservation. Powered by Sierra Olympic's Ventus OGI camera core, known for its excellence in the mid-wave infrared spectrum, the camera effectively detects and vividly illustrates hydrocarbon gases, including methane and propane. This real-time visualization provides operators a comprehensive view into the nature, movement, and direction of gas leaks. Such insights facilitate quicker safety procedures and effective mitigation of the leak itself.

One of the defining features of the MFE OGI Camera is its adaptability with Boston Dynamics' Spot. When integrated with Spot, the camera leverages the robot's unparalleled mobility, allowing operators to automate regular inspection tasks and reach challenging areas. This combination of the camera's precision with Spot's agility brings transformative potential to industries that prioritize gas leak detection.

MFE OGI

Optical Gas

Imaging Camera

Moreover, the MFE OGI Camera isn't limited to its mounted capabilities. For detailed inspections, operators can transition to its handheld mode, ensuring flexibility and precision in close-up examinations.

The camera also integrates advanced image processing capabilities. Features such as automatic gain and dynamic contrast control augment the visual experience for operators. The inclusion of Shutter and Scene-based Non-Uniformity Correction (NUC) further refines its accuracy, especially in scenarios with complex temperature profiles.

The MFE OGI Camera represents more than just advanced technology; it is a significant advancement in gas leak detection. By facilitating rapid leak detection and remediation, the device plays a pivotal role in safeguarding lives and minimizing environmental impact. For industries, it promises operational efficiency, reduces product loss, and presents considerable time and monetary savings. The MFE OGI Camera is an essential tool for a safer, environmentally conscious future.

APPLICATIONS

Systems integrators, Pipe racks, Gathering and Transmission lines, Above and below ground gas pipelines, Fuel Gas Line, Valves, Flanges, Connections, Seals, Vent stacks, Compressors, and Storage Tanks.

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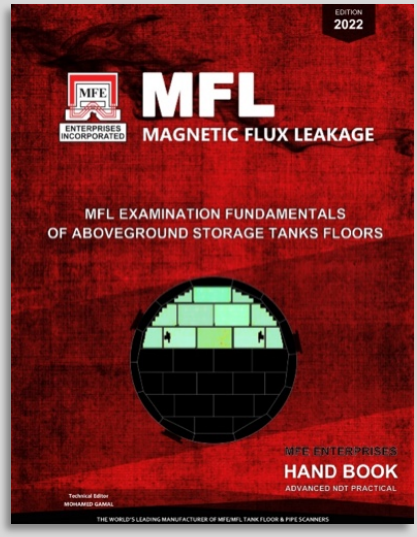

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MFE Middle East
MENA Director
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Review v. 2019

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ABSTRACT

This Book is strongly providing a comprehensive guide to the MFL Tank Floor Examination.

Magnetic Flux Leakage (MFL) inspection is a method of non-destructive testing (NDT) used to detect and assess corrosion, pitting and wall loss in lined and unlined metallic storage tanks and pipelines. A powerful magnet is used to magnetize the steel. In areas where there is corrosion or missing metal, the magnetic field “leaks” from the steel. MFL tools use sensors placed between the poles of the magnet to pinpoint the leakage field.

MFL is a rapid and robust approach that continues to be widely used to detect corrosion defects in Tank Floors as it considered a large area within short time scales. Once a defect has been detected, the main failing of the MFL approach is its inability to size and classify. To improve sizing accuracy, defect needs to be quantified and followed up by prove up using UT thickness with A scan features.
MFL is a widely used to detect corrosion in above ground storage tank floors (ASTs) within the oil industry where tank floors are inspected periodically, the AST to be taken out-of-service and emptied. This makes maintenance times that much more expensive and calls for techniques that are both reliable and fast. MFL is widely used in the context because of its inherent speed.

MFL is accepted technology for locating defects on a tank floor. It is recommended by ASME Code and API 653. While MFL signals are often related to the volume of a defect, its depth is perhaps the most difficult to estimate and the most critical dimension since it indicates the closeness of a potential leak and if misinterpreted can lead to erroneous repair strategies with costly outcomes. Therefore, accurately determining the geometry of defects is pivotal if an optimum repair strategy is to be formulated.

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- RAT / UT with A-SCAN

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- Digital RT
- Acoustic Emission

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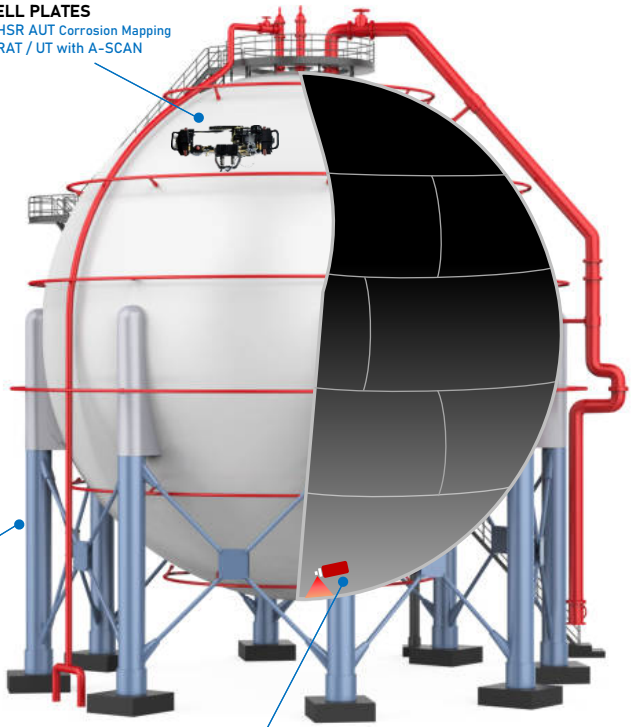
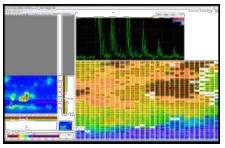
- Penetrant Test (PT)
- Magnetic Test (MT)

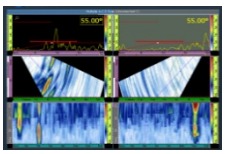
SUPPORTS INSPECTION
- Pulsed Eddy Current
- Guided Wave



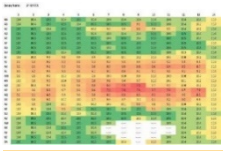
Welds & Surface Defects
- PT & MT Tests



AUT Scan



PAUT Scan



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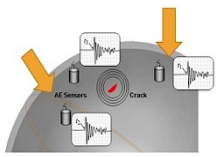
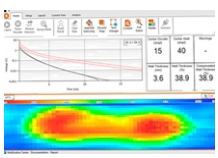


Acoustic Emission

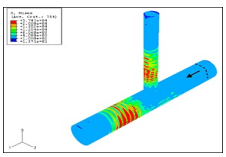
Thermal Imaging



ECT Scan

MT Test

PT Scan



LRUT Test

Spherical LPG Tanks Inspection

Spheres are typically used to store ambient temperature liquids and pressurized gases such as ammonia, propylene, LPG, butadiene, etc.

WRITER

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Master's Degree Mechanical Engineer

Ankara,Turkey

Born in Ankara,Turkey in 1987, been living in Turkey/Hatay for many years. Graduated from Akdeniz University in 2010 as a Mechanical Engineer, and in 2012 completed master's degree in heat transfer & fluid mechanics at Mustafa Kemal University. Been working as a mechanical engineer in the sector for 13 years. Worked in the field of production and manufacturing for the first 3 years of his profession, and then for 2 years worked in project-based maintenance-repair and capacity increase works in Oil & LPG terminals. Been working at Milangaz for the last 8 years. Been working as LPG Operations Engineer for 5 years and as LPG Terminal Manager for 3 years.

The LPG spherical tank is a fixed-pressure vessel at normal temperature, with a single-layer tank structure, dedicated to storing liquefied petroleum gas, using steel plates for the vessel, with excellent performance, safety, and reliability. The spherical tank is quite important to the storage and production process. It can be eroded by the internal medium, and may defects such as corrosion, cracks, holes in the walls and welds.

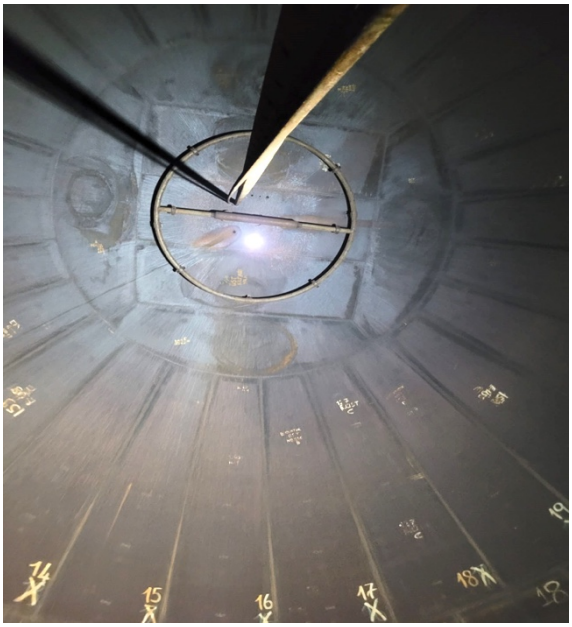
For these reasons, inspection of LPG tanks is very important. Also, Inspection is a necessary means to ensure the safe operation of the spherical tank.

Inspection is mainly conducted to identify wear and tear, and corrosion around components such as vessel connections, welded nozzles and seams, and areas near to welds, external controls, or fittings, and so on.

Spherical Tanks Internal Inspection

Unless justified by a RBI assessment, the period between internal or on-stream inspections shall not exceed one half the remaining life of the LPG vessel or 10 years, whichever is less.

LPG Tanks are designed to store LPG gas. Leaks or failure in tanks may lead to major accident on site. Inspection is done to identify this failures and leaks in LPG tank. Inspection involves measurements and testing. The inspection is done on non-destructive basis. To improve quality control inspection is most important. Inspection also ensures the safety or reliability of structures. During inspection it is necessary to do inspection using proper steps.



PREPARATION

Internal Inspection REQUIREMENTS

Internal inspections require the tank to be empty so that the internals of the tank can be checked to ensure that there is no corrosion, wastage, or damage due to the contents of the tanks. The thickness of the internal walls is also measured to test structural integrity.

To inspect the tank internally, the tank should be decommissioned, and an atmosphere should be created in which an inspection expert can work with safely.

These processes are generally called Gas free, but itself is not enough for safety.

In addition, there must be sufficient oxygen and no toxic vapors or substances inside.

Furthermore, there should be sufficient lighting inside the tank so that the inspection expert can visually inspect the welds with naked eye.

Conventional NDT used for internal Inspection!

Most common methods are Visual Testing, Magnetic Particle Testing, Penetrant Testing, Ultrasonic Testing, Radiographic Testing and Eddy Current. In these tests, defects such as corrosion, cracks, decrease in wall thickness or gaps in internal structures are identified in ferritic and austenitic steels, aluminum alloys, nickel, copper and titanium alloys during production or usage. Non-destructive testing methods can change depending on the procedure, size, thickness, and structure of the material.

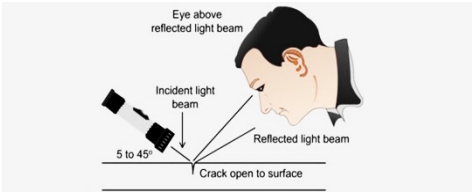
Visual Inspection.

VT is the fastest and cheapest method of Non-destructive testing. It's the first step of every inspection before any other Non-destructive test starts. When performing visual test with naked eye, equipment such as magnifying glass, light source, borescope, and mirror can also be used.

The condition of the surface is important to detect discontinuities such as cracks, porosities, and undercuts. Required cleanings must be finished before visual testing starts. surface cleaning is very important.

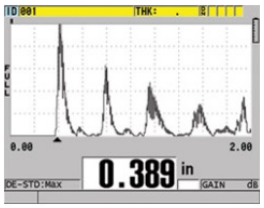
Visual Testing is perhaps the oldest and most widely used inspection technique. Often the eyes of the inspector are the only "equipment" used for the inspection. Visual İnspection is applicable to virtually any material, at any stage of manufacture, at any point in its service life. **To perform a successful direct visual examination, adequate lighting and good inspector eyesight is required.**

VT seems like an easy method, but it has its own inspection terms, and the experience of the staff is important. Test should be performed under enough light, minimum 500 lux, with an angle not lower than 30° and the distance between eye and the surface shouldn't be less than 300 mm.



Ultrasonic Testing

Wall Thickness & Metal Loses measurements using UT Thickness Gauges includes A-scan feature to able to detect corrosion failure and display reading in Digital & A-scan view.

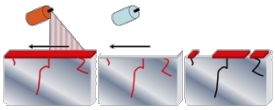


Magnetic Testing

MT is essentially a surface-type examination, although some imperfections just below the surface are detectable. This type of examination is limited to materials which can be magnetized (hence it is not appropriate for austenitic stainless steels). An area to be examined by magnetic particle examination can be completely examined or examined on a random sampling basis, as specified.

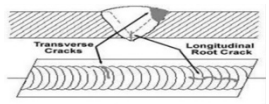
Penetrant Testing

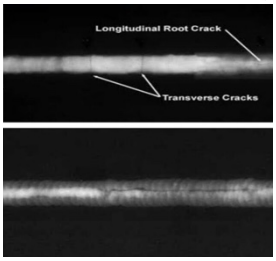
PT is a method to detect surface-connected defects. It is important to have a clean and smooth surface. After mechanical, chemical precleaning the surface must be dry and any dirt such as rust, oil, or paint should be cleaned from the surface as it will affect the process. The biggest advantage of this method is it has no restrictions about the material.



Radiography Testing

Random RT X-ray or gamma ray radiography may be used. The selection of the method should be dependent upon its adaptability to work being radiographed. When random radiography of welds is specified by the engineering design, it should be done on the number of welds designated. The engineering design shall specify the extent to which each examined weld should be radiographed. Random radiography may also be used for examination of piping components such as a valve or fitting to any extent specified by the engineering design.





Advanced NDT used for internal & external Inspection!

Most common methods are Phased Array UT, Automatic UT Corrosion Mapping, Acoustic Emission, Pulsed Eddy Current, Short Range guided wave. In these tests, you will have a permanent record and digital report for corrosion assessment. Defects such as corrosion, cracks, decrease in wall thickness or gaps in internal structures are identified in ferritic and austenitic steels, aluminum alloys, nickel, copper and titanium alloys during production or usage. Non-destructive testing methods can change depending on the procedure, size, thickness, and structure of the object need to inspect.

Ultrasonic Thickness Grids Measurement

UT Grid scan with spot digital reading & A-scan.

An ultrasonic thickness gauge works by precisely measuring how long it takes for a sound pulse that has been generated by a small probe called an ultrasonic transducer to travel through a test piece and reflect from the inside surface or far wall. From this measurement, the thickness of the test piece is calculated and displayed on a digital screen. The portability of the testing equipment allows for on-site inspection and results are instant. If a problem has been detected by the technique, additional non-destructive testing methods can be used to further investigate the findings.

Manual point thickness measurements using conventional ultrasound (UT) is a widely used technique for monitoring corrosion in many infrastructure applications. Depending upon the nature of the corrosion (e.g., localized, versus generalized and pitting), an inspector typically records the minimum thickness reading within a small area (usually 1 in.2). This however can lead to inconclusive inspection data due to minimal coverage of large areas, operator variability, lack of pitting or localized corrosion detection, and inadequate data reporting and analysis.

Automatic UT Mapping

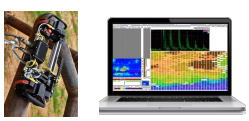
Ultrasonic technique using powered scanners.

AUT is using mechanical scanners with magnetic wheels to only adhering purposes to locate inherent defects within a given material. AUT is the term used to describe corrosion mapping inspections, pulse-echo weld inspection, Phased Array and Time of Flight Diffraction.

Typical Automated Corrosion mapping systems can inspect 20-30 sq. meters per standard workday. The benefit of using the automated imaging systems allows a picture (C-Scan Image) quickly identifies any significant reduction in wall thickness. These automated corrosion mapping scans can then be superimposed into development drawings of equipment and accurately indicate location of problem regions. The images on this page show some significant problems detected from field inspections.

Automated Corrosion Mapping Ultrasonic scans of materials, uses a range of colors to represent the thickness range of part being inspected, typically blue colors are used to represent nominal wall thickness with orange and red colors used to indicate significant wall reduction.

Mapping of pipelines for follow up of Smart Pig surveys and Long-Range UT (LRUT) programs allows accurate assessment of localized areas of concern. Due to the speed of modern systems considerable coverage can be completed daily. If you have a critical system and you require 100% coverage for process reliability, then this is the solution you require.



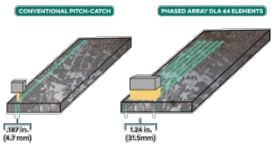
Phased Array UT

Inspect large surface areas quickly with high resolution.

Inspect large surface areas quickly with high resolution. Typically, a thickness reading is performed every 1 mm2, which represents 500 more sample points than conventional ultrasound. This high resolution makes it possible to detect small, localized indications, such as corrosion pits, and it enables the operator to profile the shape of the corroded area.

Intuitive and affordable phased array instruments are now commercially available. These devices are easy to setup so users can record and archive data for further analysis. Easy-to-read images make interpreting acquisition data straightforward. The data can then be used to perform corrosion assessments according to ASME B31G and other applicable standards.

Multiplexing, sometimes called an electronic or linear scan, is used to perform corrosion monitoring. The sensor consists of a long-phased array probe, 25 –100 mm (1 – 4 in.) with between 32 and 128 elements. A small group of elements, defined as the active aperture, is activated to generate an ultrasonic beam propagating normal to the interface. This group of elements is then indexed using electronic multiplexing, creating a true physical movement of the ultrasonic beam under the array with an index as small as 1 mm (0.040”). The electronic indexing is performed so fast that a 4-inch (100 mm) line length is covered by the ultrasonic beams in milliseconds. The travel time of these beams is used to determine the component’s thickness at each acquisition point.



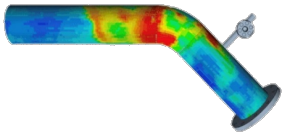
Pulsed Eddy Current

Inspection over Insulation to determine the condition of pipes and monitor corrosion.

PEC technology does not require direct contact with a test object nor specific surface cleaning, making inspection fast and easy even at high temperatures and on offshore wells. Inspections can be conducted, and corrosion can be monitored during operation to allow for planned maintenance and repairs to be scheduled and carried out at times optimal for your business.

Pulsed Eddy Current readings conducted many times at the same location can be reliably reproduced regardless of casing, coatings, or insulation. PEC technology provides results with a plus/minus 10% accuracy for corrosion detection and a plus/minus 0.2% accuracy rate for corrosion monitoring. Moreover, Pulsed Eddy Current inspections can be successfully and easily carried out at temperatures ranging from -100° C to 500° C (-150°F to 932°F).

Pulsed Eddy Current technology is based on electromagnetics and provides average wall thickness values over the probe footprint area. It measures and compares the percentage variation in average wall thickness throughout an object. Pulsed Eddy Current can be effectively applied for corrosion detection and monitoring on pipes and vessels made of carbon steel or low-alloy steel without contacting the steel surface itself. PEC technology allows measurements to be made through insulation, concrete, or corrosion barriers.

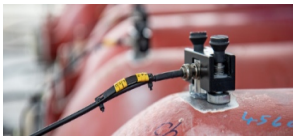


Acoustic Emission

When a material with defects is subjected to mechanical stress or load, it releases energy. This energy travels in the shape of high-frequency stress waves. These waves or fluctuations are obtained with the utilization of sensors which in turn transforms the energy into voltage. This voltage is electronically overstated with the utilization of timing circuits and later refined as acoustic emission signal data.

AE refers to the generation of transient elastic waves produced by a sudden redistribution of stress in a material. When a structure is subject to an external stimulus (change in pressure, load, or temperature), localized sources trigger the release of energy, in the form of stress waves, which propagate to the surface and are recorded by sensors. With the right equipment and setup, motions on the order of picometers (10 – 12 m) can be identified. Sources of AE vary from natural events like earthquakes and rock bursts melting, twining, and phase transformations in metals. In composites, matrix cracking and fiber breakage and debonding contribute to acoustic emissions. AE’s have also been measured and recorded in polymers, wood, and concrete, among other materials.

Need more, read Edition# 3



Spherical Tanks Supports Inspection

Many foundation structures in refineries such as skirts of process columns and the supports of spherical storage tanks are covered with a layer of fireproofing for safety reasons. Small cracks or holes in fireproofing may cause ingress of water, resulting in corrosion underneath the covering. The deterioration process cannot be detected by Visual Inspection alone. Failing to adequate condition monitoring tools, the deterioration process may eventually cause the foundation to collapse with disastrous results.

Corrosion Under Fireproofing (CUF) is nothing different than Corrosion Under Insulation (CUI).

Pulsed Eddy Current (PEC)

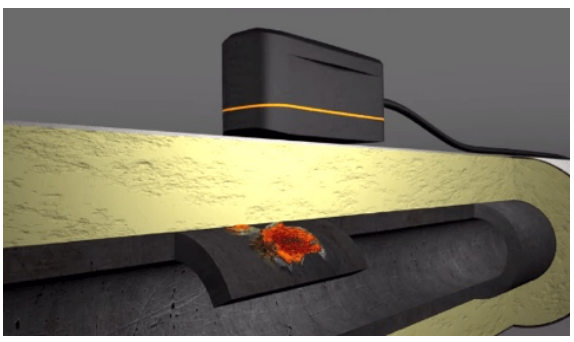
Pulsed Eddy Current (PEC) is an advanced electromagnetic inspection technology used in detecting flaws and corrosion in ferrous materials typically hidden under layers of coating, fireproofing, or insulation.

Why Pulsed Eddy Current for Corrosion Under Insulation & Fireproofing?

- No need to remove insulation, cladding, asbestos, fireproofing, concrete, coating over test materials, thus eliminating the operating asset's downtime.
- PECT can be applied at high temperatures up to 550°C of metal under insulation.
- Measurement accuracy of ±10% of measured wall thickness
- PEC testing can be performed on insulated layers up to 250mm thick.
- Test over corrosion scabs or blisters. No need of surface preparation thus cost saving for the plant owner
- PEC is an Inservice inspection which is not affected by flow of fluids within the subject equipment, thus no shutdown required.
- Battery powered instrument, thus perfect for remote locations.
- PEC is a fast-screening tool.

Standards guiding PEC Inspection

ISO 20669



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AHMED El SHERIF
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Rotating Equipment Department Head
CMRP, CRL, CAMA, BMI
AMOC Co.

Asset Management

Machine learning & Digital Twin!

According to ISO 55000 (International Standard), an **asset** is defined as an item thing or entity that has potential or actual value to an organization, and **asset management** is defined as a coordinated activity of an organization to realize value from assets.

The asset management & maintenance activities receive significant importance due to the high potential consequences involved in terms of cost, risk and safety of personnel, environment, and reputation.

Significant time and effort are invested in improving asset operations by optimizing the reliability and availability, reducing the operation and maintenance costs and by adopting digitalization to improve decision-making.

The Institute of Asset Management (IAM)'s conceptual model on asset management states there are six subject groups, namely strategy and planning, asset management decision-making, life cycle delivery, asset information, organization and people and risk and review. The assets are classified into physical, financial, human, information and intangible assets, Examples of physical assets include equipment, systems, components and plants in the process, mining, chemical and oil and gas industries.

Asset management, it cannot be done without Reliability Engineering.

Reliability Engineering. Reliability is defined as the probability that an asset, equipment or a component will not fail over a specified time interval. The equipment failures over time may be best represented by different probability distribution functions and various statistical inference techniques such as maximum likelihood estimation. Statistical methods are used to identify the best-fit probability distribution function from the historical failure data.

Reliability, Availability and Maintainability (RAM) studies, Operational availability may be defined as the fraction of total time that the equipment is functioning, and the maintainability is defined as the probability that a component or a piece of equipment is being maintained over a specified time interval (Ease of Maintenance). The key performance metrics of RAM studies are mean time to failure and mean time to repair which are derived from the probability distribution functions of failure history and repair time of the equipment.

A Reliability Block Diagram (RBD) may be first modelled & simulated over the life cycle to quantity determine the system availability.

Reliability-Centered Maintenance (RCM) technique helps to determine the maintenance strategies of the equipment by considering their functions, functional failures within their operating context, followed by the selection of tasks (according to an algorithm) to prevent or mitigate the consequences. A criticality analysis of each failure mode may also be performed, as a part of the RCM studies.

Improving Asset reliability is the core subject of interest for reliability engineers and maintenance professionals.

Seven factors if existed, an asset reliability can be improved at the design, Operation, and maintenance phases.

1. Improve data and quality.
2. Rank assets according to criticality.
3. Improve the effectiveness of maintenance work.
4. Develop metrics that track reliability.
5. Increase equipment redundancy.
6. Improve skills & on job training of Asset operator.
7. Improve Reliability culture.

Machine Learning is widely used in asset maintenance and management owing to the Fourth Industrial Revolution Maintenance 4.0 and availability of big data that are interconnected. It is a very efficient tool in processing huge amounts of data and identifying patterns and classifying them to understand the asset better and to facilitate proper management of assets.

The dataset is used as an input to the computer as a prior experience and the computer is trained to learn the patterns of the dataset to give a 'trained model'. This will aid in predicting the likely pattern of a new dataset when presented to the trained model.

This can uncover the hidden patterns of the new dataset, which would improve the decision-making and optimize the asset operations and availability.

Digital Twin is an application of the machine learning in asset management include the development and predictive analytics for fault diagnostics and anomaly detection to monitor the health of the equipment.

There are several Methods model fault detection and reliability prediction systems considering all type of data for industrial equipment such as pumps, bearing, gearbox, air compressors, steam turbines, gas turbines etc.

The concept of digital twin first proposed was by NASA in the aerospace industry in 1969, with the term 'digital twin' coined by Michael Grieves in 2002. The technology has gained popularity over the recent years in the energy sector for asset management and is being mentioned as a promising technique in Industry 4.0, complete with different operating contexts, and may be simulated over numerous scenarios to arrive at a decision on asset management.

The data from the physical asset are linked to the digital twin platform to continuously update the digital twin models to complement the physical entities. The digital twin models may be a combination of statistically derived models and artificial intelligence techniques.

The main advantages of using a digital twin includes improving the decision processes for operation and maintenance of the assets, predicting the asset behavior and equipment failures over the life cycle of assets, and simulating over any phase of the life cycle of the asset to determine the total cost of ownership and to optimize the reliability, availability, and maintainability of the assets.

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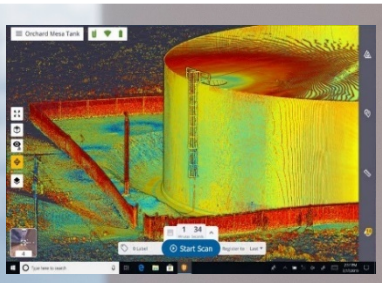

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Magnetic Flux Leakage Tank Floor Corrosion Mapping Inspection

According to the Standards set forth by API 653 Annex G, and SNT TC 1A.

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- Includes Original MFL HANDBOOK, Classroom, and Hands-on.
- Breakfast & Lunch Provided All Five Days
- One Final Exam and a Practical Test.

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- Factors of MFL testing
- Function testing
- Reporting analysis
- Scanning operations
- MFL limitations
- Manual & Mapping scanning
- Defects sizing
- Defects & Corrosion profile
- System setup & assembling
- Inspection process
- Exercises & Case study

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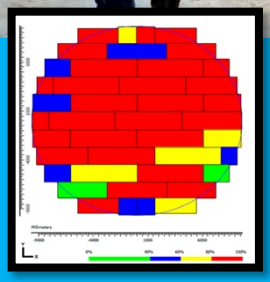

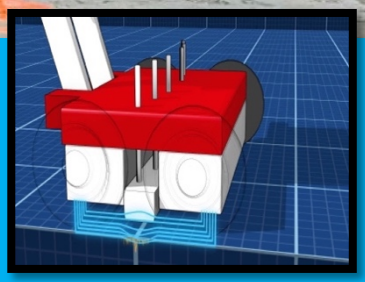

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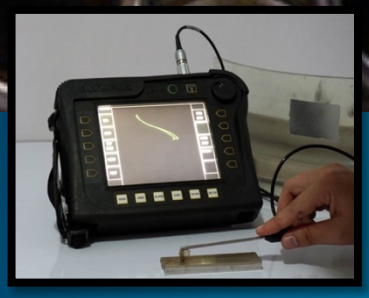

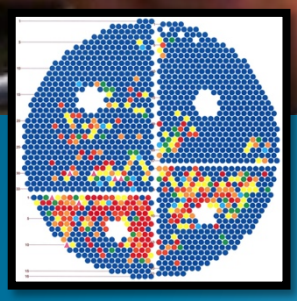

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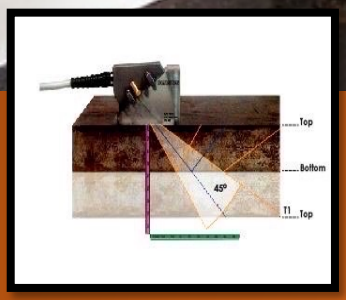

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PAUT Certification LEVEL II

COURSE CONTENT

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- Reporting analysis
- Scanning operations
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GNDT Heavy Equipment Trading LLC, established in 2018, is an ISO 9001:2015 accredited company specialising in the marketing, sales and support to the Non-Destructive Testing Industry.

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bp Achieved a Huge Success in Optimizing On-Stream Inspections During Live Operations with the Help of DIMATE!

In a pilot phase prior to the go-live, BP had tested the DIMATE PACS capability to exchange digital data with NDT service contractors. The DIMATE PACS passed the test with flying colors - or as Peter van Bruggen put it, Delivery Orchestration Lead I&E - Digital Production & Business Services at BP: "This innovative NDT picture archiving and communication system enables our Plant Inspection Department and the contractors, who are integrated in NDT, to work in an entirely new way. With DIMATE we are seeing the future of improved inspections."

From business case to best practice

In October 2020, BP had started their digitalization journey with a contextual inquiry of their NDT practices, performed by BP Solutions and I&E Intelligent Operations. In early 2021, this evolved into a business case with the aim to digitalize NDT processes and to optimize management of NDT data at the different sites.

In cooperation with DIMATE, BP Refinery Rotterdam initiated a proof of concept which was realized by a multidisciplinary team. In a first step, user stories were defined focusing on the end-to-end workflow of the ND process and integrating maintenance, plant inspection and ND service contractors.

A first iteration of Scrum sprints provided proof that implementation of the DIMATE PACS can enable all user stories. The new digital E2E NDT workflow offers the following capabilities:

- Management of pipe wall thickness-readings from images feeding into Meridium at CML / TML level.
- Transmitting NDT order and isometry data from Meridium to all parts of the plant.
- Online access of all NDT data sets, including historic image data, enabling the inspector to assess corrosion development over a period, by comparing images.
- More efficient management of residual pipe wall thickness readings due to automated processes replacing manual Excel load.
- Higher level of maturity regarding cooperation with and integration of NDT service contractors: shared data responsibility and governance, increased data integrity in Meridium thickness monitoring.
- Development of a platform for future inspection methodologies, e.g., drone-based images, GPS-based data analysis by Al.

Introducing the DICONDE IT-standard

Migrating existing NDT data sets optimizes data analysis since recent as well as historic data can be accessed at any time and from anywhere.

Processes could be further streamlined since the DIMATE PACS is based on the recognized DICONDE standard - a precondition for end-to-end data management between all BP sites and NDT service contractors at different sites and working with different NDT test systems.

Maintaining data integrity across systems by different vendors is no longer a major hurdle since the new data management with defined data ownership roles and responsibilities and DICONDE-compliance ensure data quality and data integrity.

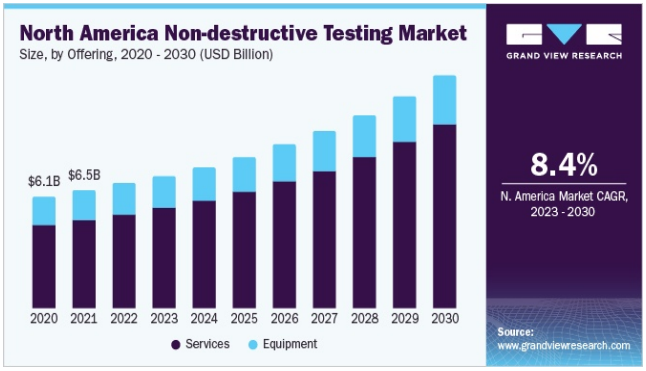
The transition from pilot to standard operation in late January meant that service contractors as well as the BP Refinery Rotterdam Plant Inspection Department had to adopt new ways of working. The transition was facilitated by quick reference cards that explain the key steps.

In mid-February the system will also transfer to a standard support model. So far, feedback by users and contractors alike has been excellent.

Non-Destructive Testing (NDT) market Size, Growth & Forecast from 2023 to 2030 (Global Industry Research)

The global NDT market exposed to grow at a CAGR of percentage during the forecast period. This growth can attributed to the increasing demand for quality control and inspection, along with stringent safety regulations in industries. Additionally, the rising need for preventive maintenance and the growth of the infrastructure and construction sectors are driving the market growth.

One of the latest trends in the NDT market is the adoption of advanced technologies such as phased array ultrasonic testing (PAUT) and computed radiography (CR). These technologies offer faster and more accurate testing results, thus reducing inspection time and improving efficiency. Furthermore, the integration of artificial intelligence and machine learning algorithms in NDT equipment enables automated defect detection and analysis, enhancing productivity and reducing human error.



The market is also witnessing the development of portable and handheld NDT devices, allowing for easy and efficient testing in remote or hard-to-reach areas. These portable devices offer real-time data analysis and instant reporting, facilitating quick decision-making.

With the increasing focus on sustainability and environmental regulations, there is a growing demand for eco-friendly NDT methods that minimize the use of hazardous materials or chemicals. The industry is investing in research and development to develop non-toxic and low-impact testing solutions.

Overall, the NDT market expected to witness significant growth in the coming years, driven by technological advancements, increased safety requirements, and the need for efficient quality control in various industries.

Non-Destructive Testers (NDT) Major Market Players

The non-destructive testers (NDT) market is highly competitive, consisting of several key players such as Roper Technologies, Olympus, Eddyfi, GE, Sonatest, MFE, Bosello High Technology, Comet Holding, Fischer Technology, MISTRAS Group, Magnaflux, Nikon, SGS, Zetec, Bureau Veritas, and Fujifilm. Each company in this market offers a wide range of non-destructive testing solutions across various industries like oil and gas, aerospace, automotive, and manufacturing.

One prominent player in the market is Roper Technologies, an American diversified technology company. Roper Technologies has a long history, with its roots dating back to 1981. It has experienced significant market growth over the years due to its focus on innovation and strategic acquisitions. With a strong emphasis on research and development, Roper Technologies has been able to expand its product portfolio and cater to a diverse customer base. In 2020, the company reported a revenue of $ 3 billion.

Olympus is another leading player in the NDT market. It is a Japanese multinational corporation with a rich history dating back to 1919. Olympus has established itself as a frontrunner in the NDT market by offering advanced inspection systems and solutions. The company's market growth has driven by its commitment to developing cutting-edge technologies and providing high-quality products and services. In 2020, Olympus reported a revenue of approximately $ 1.6 billion.

GE, also known as General Electric, is a global conglomerate that has a significant presence in the NDT market. With a history that spans over a century, GE has leveraged its expertise in various industries, including aviation, healthcare, and power, to develop innovative NDT solutions. The company's commitment to research and development, as well as its strong customer base, has contributed to its market growth. In 2020, GE reported a revenue of $ 5.78 billion.

It is important to note that the sales revenue of companies can vary year to year due to various factors such as market conditions, product demand, and global economic situations. Therefore, the aforementioned revenue figures are approximate and based on the latest available financial reports.

Overall, the non-destructive testing (NDT) market is highly competitive, with key players like Roper Technologies, Olympus, and GE driving market growth through their innovative solutions and strong customer base. These companies have a proven record of accomplishment of success and continue to invest in research and development to stay ahead in the market.

The **average** of exported quantities stood at 3,438,000 **bpd** in September 2023

(Reuters)

The crude oil barrels exported from oil fields in central and southern **Iraq** to neighboring Jordan during the month.

Iraqi oil exports from Kirkuk and the Kurdistan region through the Kirkuk–Ceyhan Oil Pipeline remained suspended since the end of March upon a decision by the Turkish authority after an international court decided that SOMO is the only entity authorized to manage export operations through the Turkish port of Ceyhan.

Iraqi Prime Minister Mohammed Shia al-Sudani stressed Sunday the necessity of completing expansion and maintenance projects for Iraqi oil ports.

During a meeting to follow up on projects and plans for developing the oil sector, Sudani stressed the importance of completing gas projects and expanding investment in Iraqi fields producing natural gas, for the purpose of supplying power stations and national fertilizer-producing factories with their gas needs.

The Iraqi PM further underscored the necessity of completing the refinery projects as quickly as possible, to reach self-sufficiency in oil derivatives and fuel.

Iraq's Oil Ministry announced that the increase in production capacity at the Karbala refinery to 140,000 bpd.

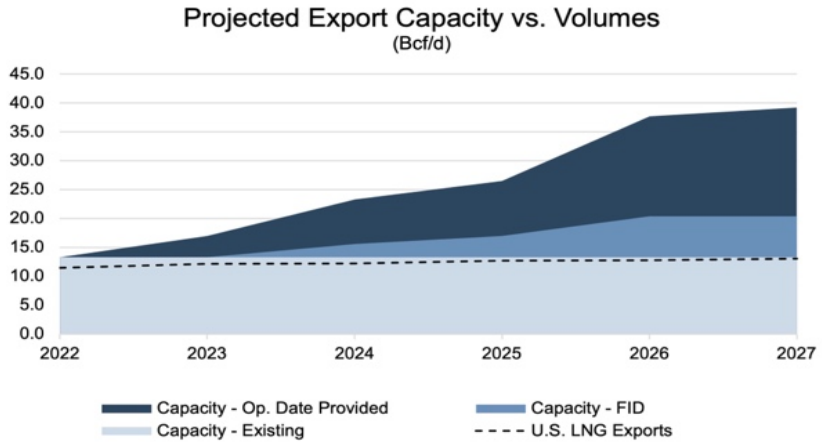
LNG exports expected to total $63 billion in 2024 -

Australian Energy Producers Chief Executive Samantha McCulloch said: "These strong forecasts are a reminder of the need for regulatory approval certainty so companies can invest in new gas supply and secure future economic benefits for Australia.

"LNG exports worth $71 billion support thousands of jobs, flow through to Australian businesses via tens of billions in industry expenditure and deliver billions more to governments to help build hospitals and roads.

"But these benefits come after a long, high-risk and capital-intensive process needing regulatory certainty.

"Investment barriers - such as the growing uncertainty over vague regulations and the logjam of approvals with the national regulator – threaten this economic windfall for Australians.



Source: EIA International energy Outlook (2021), Mercer Capital Analysis

"To continue to produce these results, Australia must ensure an approval "Reforms are desperately needed so Australia can avoid recent cases in which approvals for two major projects - Woodside Energy's $16.5 billion Scarborough development off Western Australia and Santos' $5.8 billion Barossa project off the Northern Territory – were overturned."

"Our LNG exports can also help importing nation's lower emissions by switching to gas," she said. The REQ report found oil exports would hit $15 billion this financial year, up from $13 billion in 2022 - 2023.

Peak crude demand is fueling anger and argument in the world of oil! (CNBC)

The International Energy Agency predicted that peak oil demand would reached by 2030 and hailed the decline of crude as a "welcome sight."

OPEC leaders reacted harshly, accusing the agency of fear mongering, and risking the destabilization of the world economy.

Oil producers have accused of dialing back their climate pledges in recent months following record annual profits.

It has been a war of words and numbers between two major players in the energy industry the International Energy Agency and OPEC – as they spar over the future of something crucial to crude producers' survival: peak oil demand.

Peak oil demand refers to the point in time when the highest level of global crude demand reached, which will immediately followed by a permanent decline. This would theoretically decrease the need for investments in crude oil projects and make them less economical as other energy sources take over.

That is why when the chief of the IEA, an intergovernmental organization that advocates for oil-consuming countries, predicted that peak oil demand would reach by 2030 and hailed the decline of crude as a "welcome sight," OPEC was furious.

"Such narratives only set the global energy system up to fail spectacularly," OPEC Secretary-General Haitham al-Ghais said in a Sept. 14 statement. "It would lead to energy chaos on a potentially unprecedented scale, with dire consequences for economies and billions of people across the world." He accused the agency of fearmongering and risking the destabilization of the global economy.

More broadly, the spat reflects the ongoing clash between climate change concerns and the need for energy security. That juxtaposition was on full display at ADIPEC – the annual gathering whose name stood for Abu Dhabi International Petroleum Exhibition Conference until this year, when it quietly changed to Abu Dhabi International Progressive Energy Conference.

The United Arab Emirates will be hosting the COP28 climate summit in November and has been marketing its sustainability campaigns, all the while ramping up its crude production capacity in preparation for what it expects to be growth in future demand. The UAE is OPEC's third-largest oil producer.

CEOs of oil majors and state oil producers stressed the need for a dual approach, insisting that their companies were part of the solution, not the problem, and that an energy transition is not possible without the security and economic support of the hydrocarbons sector.

"I don't know if we're going to have peak oil in 2030. But it's very dangerous to say that we must reduce investment because that is against the transition," Claudio Descalzi, CEO of Italian multinational energy company Eni, said Monday during a panel hosted by CNBC's Steve Sedgwick.

He warned that if oil investment and therefore supply drops and fails to meet demand, prices would surge, crippling the economy.

Descalzi acknowledged that burning fossil fuels "is producing lots of CO2," but added, "We cannot shut down everything and rely just on renewables and that is the future, no. It is not like that. We have infrastructure, we have investment that we have to recover, and we have the demand that is still there."

The IEA wrote in its August 2023 report that "world oil demand is scaling record highs" and is set to expand this year but added that faster adoption of electric vehicles and renewable power, as well as the West's decoupling from Russian gas, will hasten peak demand before 2030.

"Based on current government policies and market trends, global oil demand will rise by 6% between 2022 and 2028 to reach 105.7 million barrels per day (mb/d) … Despite this cumulative increase, annual demand growth is expected to shrivel from 2.4 mb/d this year to just 0.4 mb/d in 2028, putting a peak in demand in sight," the agency wrote in a June 2023 report.

The IEA also outlined its road map for net zero by 2050, calculating that worldwide oil demand would need to fall to 77 million barrels per day by 2030 and 24 million barrels per day by 2050.

However, those figures are staggering when confronted in real-world terms: during the most intense global lockdown period of the Covid-19 pandemic, in March and April of 2020, worldwide daily oil demand slashed by 20% – something only possible because the economy came to a near-complete standstill. The IEA's road map calls for daily oil demand to slash by 25% in seven years' time.

STORY of Saudi Aramco

The story of Saudi Aramco since its initial public offering (IPO) in December 2019.

Even with a Brent oil price averaging around US$80 per barrel (pb) in Q2 – an historically elevated price for 'non-crisis' oil markets in recent years – 65 percent of its net income went on a debt to shareholders, in the form of dividends.

If the net income stayed the same in Q3, this debt payment would rise to 98 percent. The story is, then, that due to the ill-conceived IPO thought up in late 2015/early 2016 by Crown Prince Mohammed bin Salman (MbS), Saudi Arabia's corporate crown jewel must continue to operate under a crushing debt burden.

Because of that, it is limited in the new exploration and development work it can do, which cripples its ability to increase its reserves and its production numbers. Because of that, it will keep having to act as the instrument through which Saudi Arabia continues to push oil (and gas) prices higher. And because of that, the U.S. at some point will fully enact the 'No Oil Producing and Exporting Cartels' (NOPEC) bill and destroy Saudi Aramco as we know it today.

It should be remembered that back in late 2015/early 2016, MbS conceived the plan to IPO Aramco as a key part of his strategy to take over the position of heir-designate to King Salman from Prince Muhammad bin Nayef (MbN). In theory, the idea had several positive factors going for it that would benefit MbS. First, it could raise a lot of money, part of which might be used to offset the economically disastrous effect on Saudi Arabia of the 2014-2016 Oil Price War, as analysed in my new book on the new global oil market order.

Second, it could boost Saudi Arabia's reputation in the global financial markets, which would help with further IPOs and would boost foreign investment into the country's domestic capital markets more broadly. And third, both new funding flows could be used as part of the 'National Transformation Program' 2020 – in turn part of Saudi's 'Vision 2030' development plan – that sought to diversify the Kingdom's economy away from its reliance on oil and gas exports. After a few months of further discussion, MbS assured senior Saudis that he could absolutely ensure the flotation of 5 percent of Aramco, which he said would absolutely raise at least US$100 billion in much-needed funds for Saudi Arabia.

This, in turn, would place a valuation on the entire company of at least US$2 trillion. In addition, MbS said, Saudi Aramco would absolutely be listed on one of the world's major stock exchanges, with the New York Stock Exchange and the London Stock Exchange being the two preferred options.

This theory ran into practical difficulties from the moment that major Western investors began to look at Aramco in more depth. For a start, the crude oil production figures that Saudi Arabia had long bandied around as being fact were evidently no such thing, as forensically analyzed in my new book.

Far from being able to produce 10, 11 or 12 or more million barrels per day (bpd), Saudi Arabia struggled to produce anything over 9 million bpd. To be accurate: from 1 January 1973 to Monday 14 August 2023, Saudi Arabia's average crude oil production is 8.257 million bpd. This means that its equally much-vaunted spare capacity of around 2 million bpd is also not true, founded as it is on a false baseline crude oil production capability.

Additionally concerning then, as now, were Saudi Arabia's equally fantastical claims about its oil reserves. Specifically, at the beginning of 1989, the country claimed proven oil reserves of 170 billion barrels. Just one year later, and without the discovery of any major new oil fields, it claimed proven oil reserves of 257 billion barrels, an increase of 51.2 percent. Shortly afterwards, Saudi Arabia's proven oil reserves miraculously increased again, this time to just over 266 billion barrels, again without the discovery of any major new oil fields. Proven oil reserves increased once more in 2017, to 268.5 billion barrels, again with no new major oil finds being discovered.

At the same time as these increases being announced, the country was extracting an average of 8.162 million bpd. Therefore, from 1990 (the year in which Saudi Arabia's claimed proven oil reserves jumped from 170 billion barrels to 257 billion barrels), to 2017 (the year when Saudi Arabia was claiming proven oil reserves of 268.5 billion barrels), Saudi Arabia had physically removed from the ground forever an average of just over 2.979 billion barrels of crude oil every year.

The total amount of crude oil permanently removed from the beginning of 1990 to the beginning of 2017, was, then, 80.43 billion barrels. In short, from 1990 to 2017, Saudi Arabia's official crude oil reserves number had gone up 98.5 billion barrels, despite there being no new oil finds and it physically removing 80.43 barrels forever.
These facts – together with Aramco being used as a key source of funding for various socio-economic projects that had nothing to do with its business and would destroy shareholder value – meant that no major global financial players wanted to invest in Aramco and not a single major Western or Eastern stock market wanted Aramco to list on it.

Given this, the stage was set for a series of events that help to define the new global oil market order, as also analyzed in depth in my new book on that subject. One of these was a face-saving offer for MbS from China that he has never forgotten and that has underpinned Saudi Arabia's drift towards China since then. Another was the expediting of Saudi Arabia's move away from the U.S. and towards Russia that had been gathering pace since the end of the Second Oil Price War in 2016.

Even more specifically for Saudi Aramco, it meant that MbS had to offer massive incentives to investors to buy any of the IPO. One of these was a guarantee by the Saudi government that, whatever happened, it would pay a US$75 billion dividend payment in 2020, split equally into payments of US$18.75 billion every quarter. These payments, of course, have now risen and will be made even more destructive to Aramco's basic functioning by the addition of extra performance-linked dividends.
These are designed to target 50-70 percent of annual free cash flow, net of the base dividend, and other amounts including external investments, according to Aramco's chief executive officer, Amin Nasser.

The highly precarious financial tightrope on which Aramco finds itself also means that Saudi Arabia has no alternative but to keep pushing oil (and gas) prices ever higher. And, as day follows night, this means a collision course with the U.S. and its allies, who regard rising energy prices as direct threats to their economic and political well-being. This comes on top of an increasingly antagonistic relationship between the U.S. and Saudi Arabia, following the de facto break-up of their foundation stone 1945 agreement.
The mechanism to destroy Aramco in its current form is already in place, in the form of the NOPEC bill, as also analyzed in my new book. This legislation would open the way for sovereign governments to be sued for predatory pricing and any failure to comply with the U.S.'s antitrust laws. OPEC is a de facto cartel, Saudi Arabia is its de facto leader, and Saudi Aramco is Saudi Arabia's key oil company.

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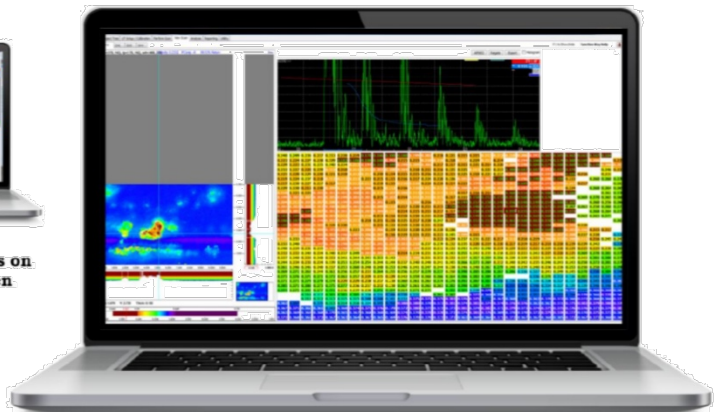

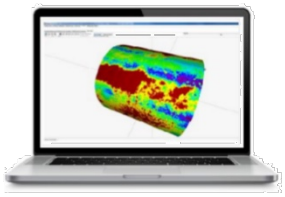

3-D Corrosion Mapping

(Must be used with optional laser attachment)

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MFE Middle East

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E-mail: Sales@mfemiddleeast.com
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E-mail: k.ramadan@deltaips.net
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Established: 01-01-2019
Category: Inspection Software & Consultancy Service

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Country: Egypt, Al Iskandariyah
Established: 01-03-2009
Category: Service Provider

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Country: Libyan Arab Jamahiriya
Established: 01-01-2013
Category: Inspection Service Provider

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GNDT Heavy Equipment trading LLC.

Website: gndt.me
E-mail: gm@gndtme.com
Country: United Arab Emirates, Dubai
Established: 12-20-2017
Category: NDT Equipment Supplier

GNDT Heavy Equipment Trading LLC, established in 2018, is an ISO 9001:2015 accredited company specializing in the marketing, sales, and support to the Non-Destructive Testing Industry. GNDT offers both mechanical and electronic workshops with qualified service engineers to maintain, repair and calibrate a wide range of equipment.

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Website: apexfi.net
E-mail: info@apexfi.net
Country: Egypt, Al Iskandariyah
Established: 01-03-2017
Category: Inspection & Consultancy Service

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Website: joud-ndt.com
E-mail: dcc.joud@gmail.com
Country: Iraq, Al Basrah
Established: 22-05-2014
Category: Third Party Inspection

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MFE Enterprises

Website: mfeenterprises.com
E-mail: sales@mfe-is.com
Country: USA
Established: 01-01-1998
Category: MFL, NDT Equipment Manufacturer

MFE Enterprises manufactures Non-Destructive Testing (NDT) and Magnetic Flux Leakage (MFL) inspection equipment for both storage tank and pipeline applications. Our mission has never changed: We provide educational information to the NDT community about MFL technology and the advantages of deploying our MFL Scanners for FAST and ACCURATE inspection of your plant assets.

Global Engineering Solutions (GES)

Website: fmg-eg.com
E-mail: info@fmg-eg.com
Country: Egypt, Dumyat
Established: 02-02-2013
Category: Inspection & Consultancy Service.

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UPCOMING EVENTS

EGYPS Exhibition 2024

13 – 15 February 2024

The EGYPS Technical Conference brings together global oil, gas and energy professionals to showcase the latest technical opportunities and challenges, breakthrough research findings, innovative technologies and industry solutions, creating an excellent learning and networking hub for the industry's technical experts. In 2023, the Technical Conference will showcase the technologies being used today and those transforming the industry of the future. Our international technical expert speakers will share their wealth of experience and knowledge. With 19 technical categories to select from, we look forward to receiving your abstract submissions.

Nigeria Oil & Gas International

09 – 13 July 2023

The **NOG International Exhibition** in Abuja, is Nigeria's most important **oil, gas, LNG and energy exhibition**, where energy professionals convene to exchange in dialogue, showcase technological advancements, identify innovative solutions and forge business partnerships. The NOG International Exhibition will take place from **9 – 13 July 2023 in Abuja** at the **International Conference Centre** with an expanded exhibition space of **5,000 sqm** attracting **5,000+ attendees** from Africa, Middle East, Europe, Asia and the USA to create and unparalleled business opportunity for exhibiting companies to tap into this vital market.

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SPRINT Robotics

2023

Submit your abstract to speak at the SPRINT Robotics Asia-Pacific Summit 2023, a key event for Inspection, Maintenance & Cleaning robotics professionals. We are welcoming abstracts about use cases or new technologies for robotics for Inspection & Maintenance in capital-intensive industries. The SPRINT Robotics Asia-Pacific Summit will take place at the end of March 2023 in Singapore. The event features a dynamic program of technical presentations, an exposition, and demonstration day and dedicated networking events. The planning for the I&M Robotics week will be announced at the beginning of November.

PETROCHEMICAL & REFINING CONGRESS: EUROPE

2023

Petrochemical and Refining Congress is an annual downstream oil and gas B2B networking platform which is gathering more than 350 industry leaders from major companies including BP, Shell, Eni, McDermott, Fluor, Wood, BASF, Borealis, SABIC, and many others. The PRC Europe 2023 edition raises such hot questions as industry de-carbonization, petrochemicals and alternative fuels production, recycling technologies and plant improvements.

World Petrochemical Conference (WPC)

2023

The World Petrochemical Conference (WPC) is the premier gathering for the petrochemical industry, bringing together more than 1,000 senior chemical industry decision-makers from more than 40 countries for networking, unparalleled insight, and critical analysis from IHS Markit, your trusted partner in decision-making.

Hydrogen Technology Conference & Expo

28 June 2023

Hydrogen Technology Conference & Expo is North America's must-attend exhibition and conference that is exclusively dedicated to discussing advanced technologies for the hydrogen and fuel cell industry. The event brings together the entire hydrogen value chain to focus on developing solutions and innovations for low-carbon hydrogen production, efficient storage, and distribution as well as applications in a variety of stationary and mobile applications.

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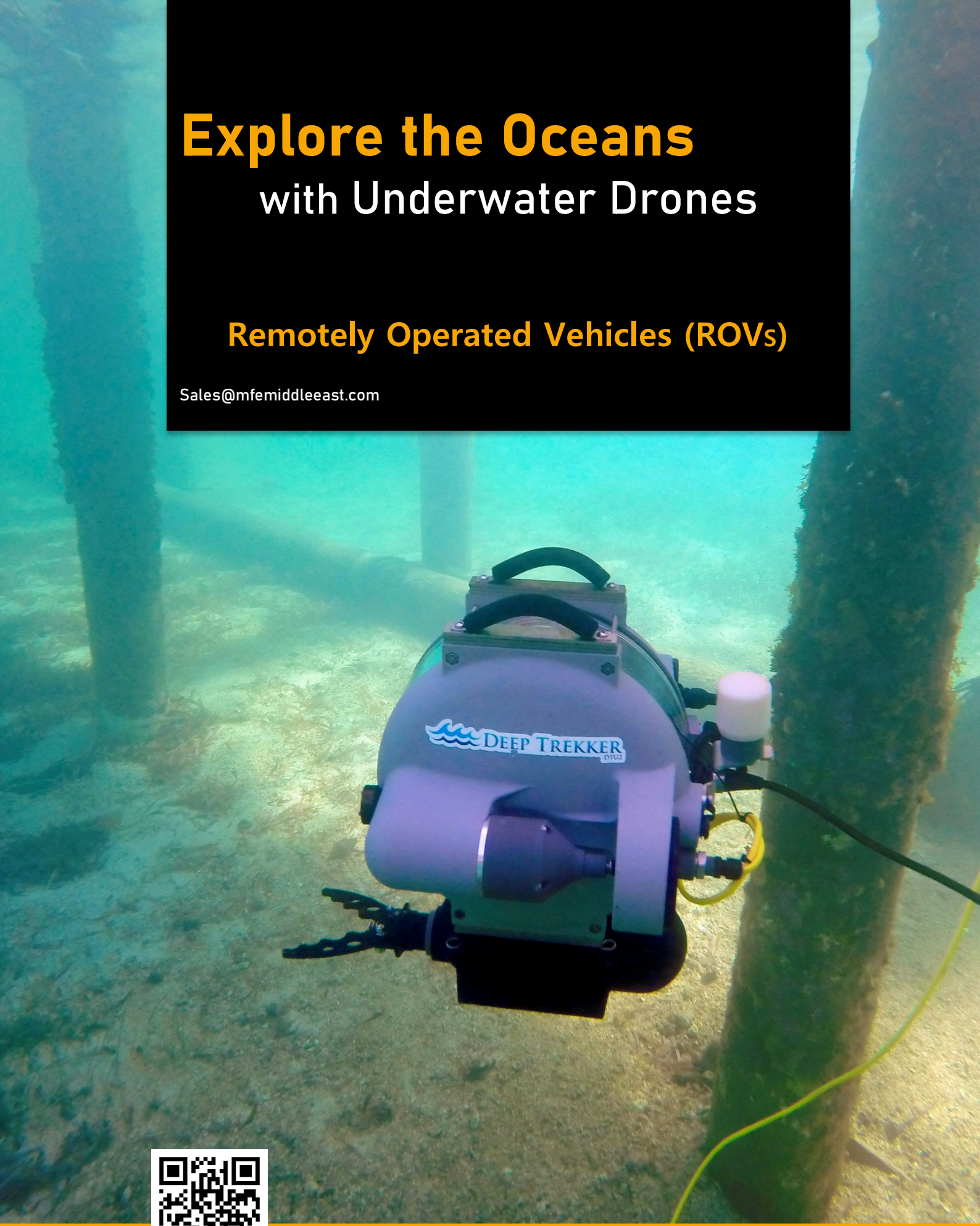

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ABSTRACT SUBMISSION

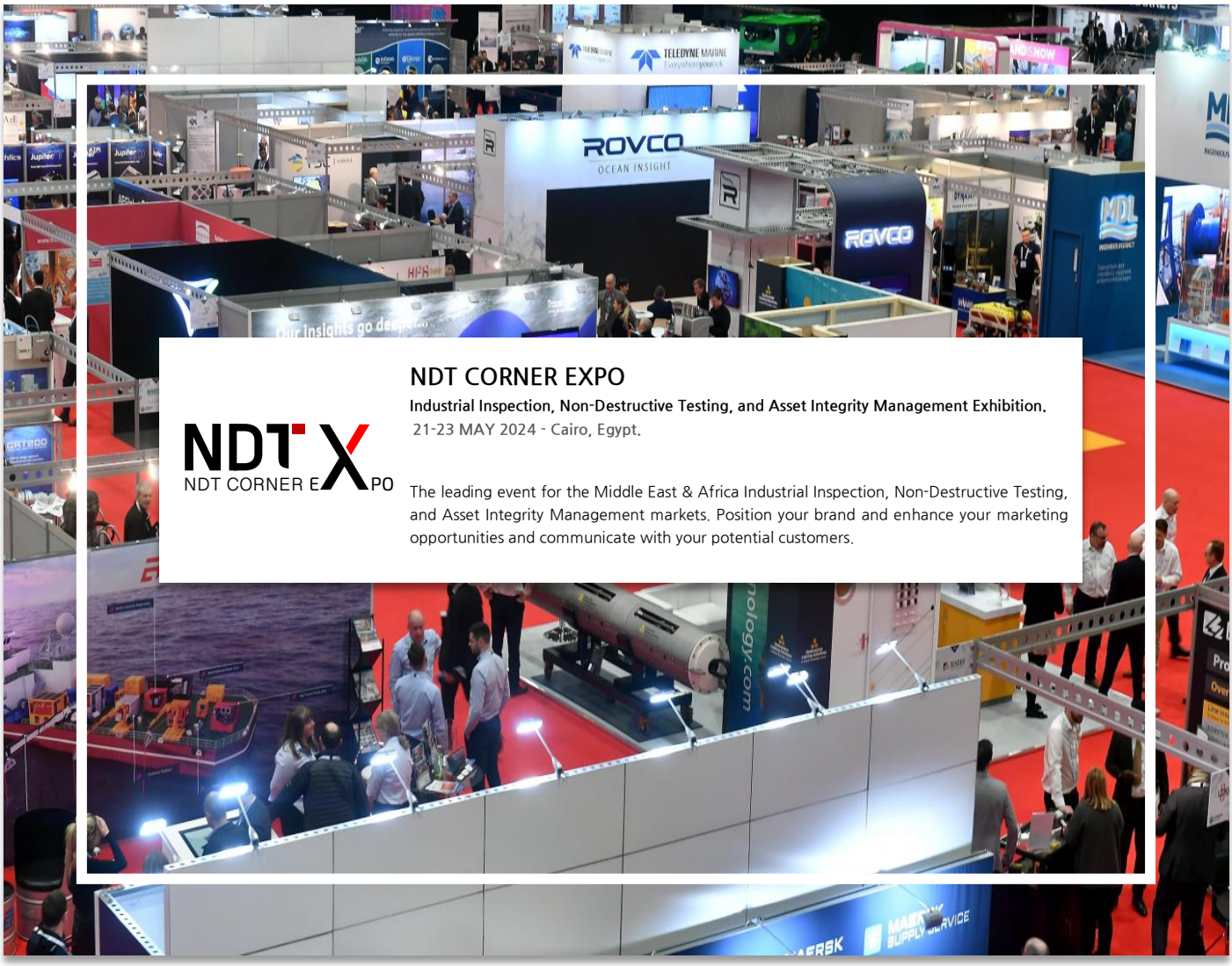
Page in MS Word Document (Times New Roman, Font Size 12pt, single space) should be submitted via email **Support@ndtcorner.com**

Deadline of Full Paper
25 April 2024

CONFERENCE PRESENTATION

- TITILE in CAPITAL LETTERS
- AUTHOR(S) name of the presenting author and position.
- Power Point Presentation
- 45 minutes maximum.

The full conference program will be revealed over the coming months.



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