NDT SCOOP

NON-DESTRUCTIVE TESTING MAGAZINE

by ndtcorner.com

ISSUE. 8 QUARTER. 4 (OCT. – NOV. – DEC.) 2024

+ Featured

+ Flange Face inspection Live TFM.

AI + Rethink Artificial Intelligence in NDT.

+ NDT Career Path! Start Your Work in 2025.

+ Pressure Vessels Inspection Challenges

+ Beyond Technical Challenges (People in NDT).

+ Aligning Asset Management STRATEGIES.

+ and more.

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NDT SCOOP Publication

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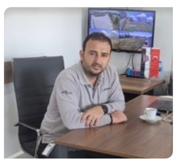
NDT Manager
Dura-Bond Industry
USA



Onur ÖZUTKU
Milangaz Ter. Mgr.
Turkey

AHMED El SHERIF
CMRP, CRL, CAMA, BMI
AMOC Rotating Equipment
Dep.Head. Egypt.

Christian Els
sentin GmbH
Germany

Maximilian Topp
sentin GmbH
Germany

ON THE COVER

RVI Infinity Innovation is a company based in Germany, they are dedicated on design, develop and manufacture remote visual inspection products and solutions for industrial confined space inspection and quality control of NDT.

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The **2**nd EDITION

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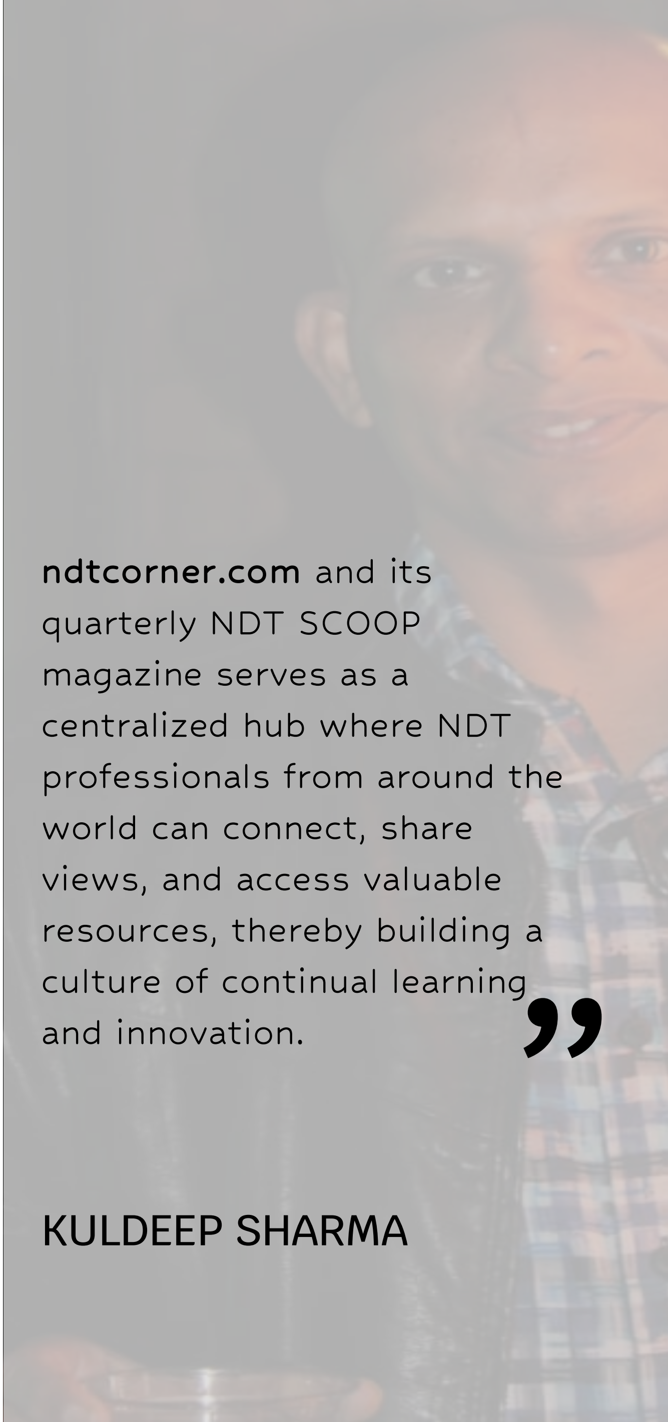


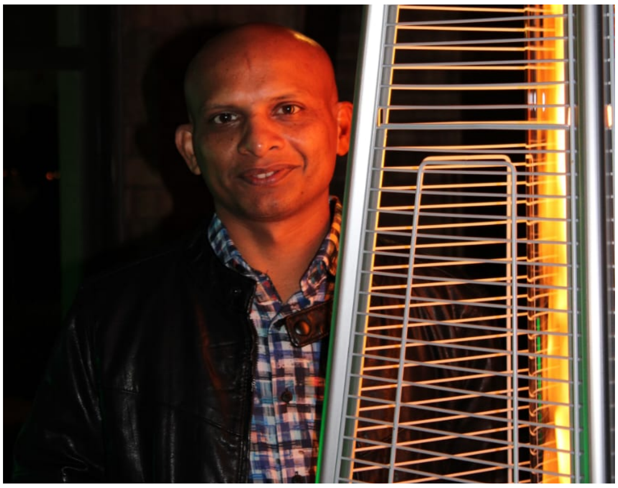
"**In my opinion,** platform like ndtcorner.com and its quarterly NDT SCOOP magazine plays a key role in transforming the landscape of Non-Destructive Testing (NDT) by providing various ways to help encourage growth, information exchange, and a high level of professionalism in new candidates.

ndtcorner.com and its quarterly NDT SCOOP magazine serves as a centralized hub where NDT professionals from around the world can connect, share views, and access valuable resources, thereby building a culture of continual learning and innovation."

KULDEEP SHARMA

Pioneering Excellence in Non-Destructive Testing (NDT).

Interview with Kuldeep Sharma:



With nearly two decades of expertise in the realm of Non-Destructive Testing (NDT), Kuldeep Sharma leads quality and innovation as NDT Manager at Dura-Bond Industry in the USA. Armed with ASNT NDT Level III certifications and a Bachelor of Science degree. In his career journey Mr. Sharma has been marked by a focus on ensuring the highest standards of quality in NDT practices. In his current position, he is at the forefront of overseeing NDT procedures, Defect Analysis and Prevention, Training and Certification, Technique Selection, Root Cause Analysis and playing a key role in the implementation of cutting-edge NDT machines, and meticulously calibrating instruments. A dynamic aspect of his role involves managing internal and external audits, fostering collaboration with third-party inspectors and clients, and championing rigorous quality management standards.

He is actively contributing to the growth of the NDT industry, he is deeply involved in many professional committees of ASNT (Technicians Resource Development Committee, Advocacy Committee, Council for Women in NDT and the Engineering Council), Board of studies (BOS) member 2023 (CENTRAL UNIVERSITY OF JAMMU) and many more. He is ASNT NDT face 2024.Having worked in both the USA and India, his international background not only positions him as a seasoned professional but also as a forward-thinking leader contributing significantly to the progress of NDT. His multifaceted engagement in industry committees and dedication to advancing knowledge in NDT underscore his commitment to shaping the future of this crucial field.

Can you share insights into your journey in the field of Non-Destructive Testing?

My journey into Non-Destructive Testing (NDT) began unexpectedly during a walk-in interview with Jindal SAW Limited. At that time, I was pursuing my master's in physics and had little knowledge about NDT. However, based on my science background, they saw potential in me and offered me a position in NDT department.

Initially, I was unaware of the significance of NDT in various industries. It was only after interacting with colleagues from different departments that I realized the enormity of the opportunity I had stumbled upon. Learning about the critical role NDT plays in ensuring the quality and safety of structures, pipelines, and components intrigues me.
From that point onwards, I embarked on my journey of learning and growth in the field of NDT.

What are the primary responsibilities you undertake in your current role as a Level III at M/S DURA-BOND INDUSTRIES, USA?

As a Company NDT Level III at M/S DURA-BOND INDUSTRIES, my responsibilities include a multifaceted spectrum, including technical oversight, quality management, and managerial leadership. From developing and approving NDT procedures to coordinating installations of cutting-edge NDT machinery, I ensure adherence to the highest standards of quality and efficiency in all NDE activities. Moreover, my role extends to personnel management, encompassing performance appraisals, recruitment, and training initiatives aimed at developing a skilled workforce.

CONTINUE *Interview with KULDEEP SHARMA*

How do your engagements contribution of volunteering activities and professional committees within the NDT community to your professional growth and the advancement of the industry?

My involvement in various professional committees, councils, and volunteering activities is driven by a shared vision of advancing the NDT industry through collaboration, knowledge exchange, and advocacy. Serving as a member of bodies like the ASNT T&E Technicians Resource Development Committee and the Engineering Council allows me to contribute to the development of standards, training programs, and best practices. Moreover, these engagements provide invaluable networking opportunities and allow me to build a nature of continuous learning and innovation. Every day I strive to be able to provide growth to the field of NDT and at the same time build on my own personal endeavors.

With over 19 years of experience in NDT, could you share some key milestones or defining moments that have shaped your career trajectory?

Throughout my 19-year journey in Non-Destructive Testing (NDT), several key milestones have played pivotal roles in shaping my career trajectory. One significant milestone was being selected as the ASNT NDT face for 2024, which not only recognized my contributions to the field but also provided an opportunity for networking and knowledge exchange on a global platform.

One significant milestone was my transition from NDT Level II personnel to achieving ASNT NDT Level III certifications in various methods such as UT, RT, MPI, and LPT. This marked an important turning point in my career, as it encouraged me to take on greater responsibilities and leadership roles within the industry.

Another defining moment was my tenure with Welspun Group, where I served in various managerial positions across different locations in India and the USA. These experiences not only honed my technical expertise but also provided insights into global NDT practices, standards, and regulatory frameworks.

Furthermore, my involvement in professional committees and volunteering activities, such as serving as a member of ASNT committees and editorial advisory boards, has been instrumental in expanding my network, partaking knowledge, and contributing to the advancement of the NDT community.

What do you envision for the future of Non-Destructive Testing, and how do you see yourself contributing to its evolution?

The future of NDT holds immense potential, driven by advancements in technology, automation, and data analytics. As a stalwart in the field, I am committed to playing a critical role in molding this future by using my experience and intuition. Whether it's spearheading research initiatives, mentoring the next generation of NDT professionals, or advocating for industry-wide standards and regulations, I am dedicated to driving positive change and ensuring that NDT continues to be a cornerstone of safety, reliability, and innovation across various sectors.

CONTINUE *Interview with KULDEEP SHARMA*

How has your work impacted the NDT field?

My work has made a significant impact on the field of Non-Destructive Testing (NDT) by driving novelty, setting higher standards, and arising collaboration within the industry.

Through my leadership roles, technical expertise, and involvement in professional committees, I have contributed to the development of cutting-edge NDT techniques, procedures, and best practices.

By guiding research initiatives, presenting at conferences, and publishing in various journals, I have shared information and ideas that have advanced the field's understanding and capabilities.

Furthermore, my commitment to mentoring the next generation of NDT professionals ensures a legacy of excellence and unbroken improvement.

Overall, my work has left an indelible mark on the NDT landscape, paving the way for safer, more reliable infrastructure and components worldwide.

What is the message for new personnel coming to NDT?

For new personnel entering the field of Non-Destructive Testing (NDT), I would convey a message of encouragement and guidance.

Importance of continuous learning, dedication, and attention to detail, I would encourage them to embrace every opportunity for growth and skill development.

NDT is a dynamic field that requires a combination of technical expertise and practical experience, so I would advise them to immerse themselves fully in hands-on training and educational resources because these opportunities will be very useful in the future.

Additionally, I would stress the significance of upholding the highest standards of integrity, professionalism, and safety in all NDT practices.

By encouraging these practices in newer recruits, we can help them grow individually and a whole.

By fostering a culture of collaboration, curiosity, and innovation, new personnel can contribute to the advancement of NDT and play an integral role in ensuring the integrity and reliability of critical infrastructure and components.

How do you perceive the influence of pioneering initiatives like the NDT SCOOP Magazine in reshaping the landscape of Non-Destructive Testing (NDT)?

In my opinion, platform like **ndtcorner.com and its quarterly NDT SCOOP magazine** plays a key role in transforming the landscape of Non-Destructive Testing (NDT) by providing various ways to help encourage growth, information exchange, and a high level of professionalism in new candidates.

ndtcorner.com and its quarterly NDT SCOOP magazine serves as a centralized hub where NDT professionals from around the world can connect, share views, and access valuable resources, thereby building a culture of continual learning and innovation.

By providing a platform for discussions, webinars, and training programs, NDT SCOOP enables practitioners to stay abreast of the latest advancements in technology, techniques, and industry trends.

Not only that but, it serves as a catalyst for standardization and harmonization of NDT practices by promoting the adoption of best practices and quality assurance protocols.

In the long run, platforms like NDT SCOOP plays a crucial role in increasing the standards of excellence within the NDT field and driving constructive change towards a safer, more reliable future.

CONCLUSION

All in all, Kuldeep Sharma's journey exemplifies the spirit of excellence, innovation, and leadership in the realm of Non-Destructive Testing.

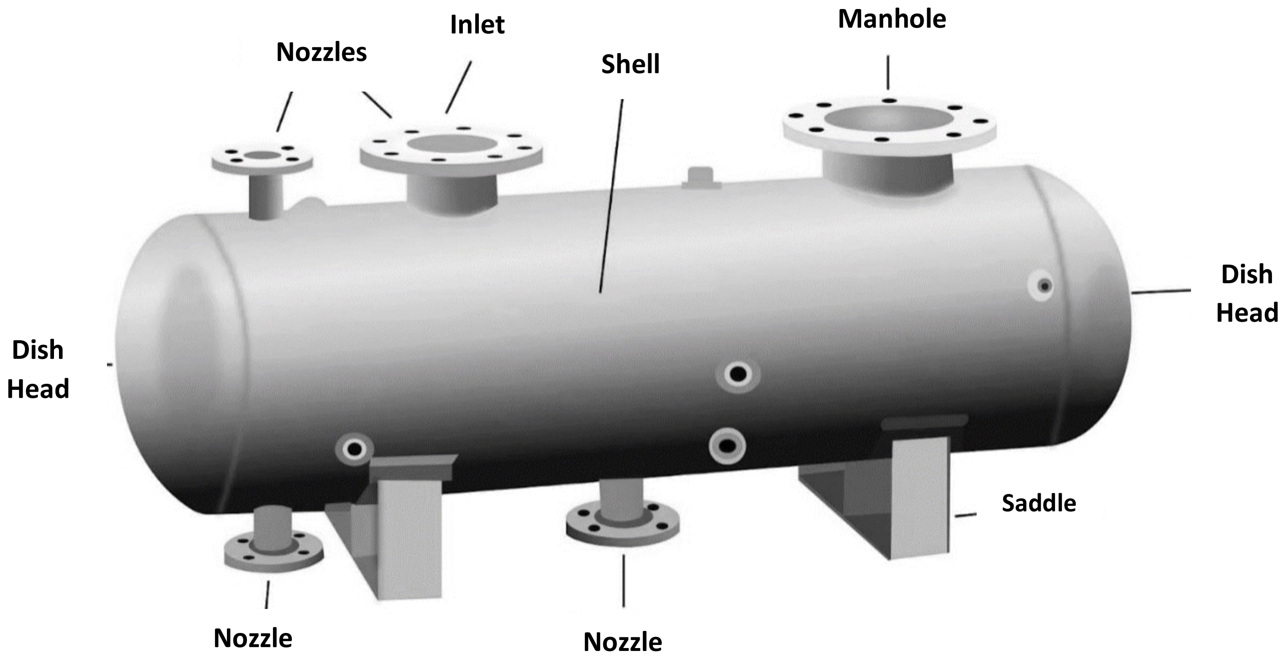
His unwavering commitment to pushing the boundaries of technological advancement and his tireless efforts in mentoring, advocacy, and knowledge dissemination underscore his pivotal role in shaping the future of the industry.

As he continues to chart new horizons and inspire countless professionals in the field, Kuldeep remains a beacon of excellence and a driving force for positive change in NDT.

Pressure Vessels
Inspection Challenges

Onur ÖZUTKU
Master's Degree Mechanical Engineer
Ankara,Turkey
Milangaz - LPG Terminal Manager.

What is Pressure Vessel? When is it Required inspection? What are the inspection challenges?



Pressure vessels are critical components used in various industries, including oil and gas, chemical manufacturing and power generation. Their primary function is to contain gases or liquids at high pressure, so their integrity is essential for safety and operational efficiency.

However, the inspection of these vessels presents several CHALLENGES that must be addressed to ensure compliance with safety regulations and prevent catastrophic failures.

Complex Designs and Configurations.

Pressure vessels come in a variety of shapes and sizes, often with complex geometries. These designs can include nozzles, flanges and internal components that make access and inspection difficult.

INSPECTORS must be familiar with the specific design features to identify potential failure points, which can vary significantly from vessel to vessel.

Inspection, testing, involves non-destructive tests that ensure the integrity of a new pressure vessel or on previously installed pressure equipment that has been altered or repaired.

In the early days of pressure vessels, many pressure vessels were over-pressurized, and they would explode. This problem was part of why the American Society of Mechanical Engineers (ASME) formed. This body came up with specifications to govern the way pressure vessels are manufactured and maintained. Today, the ASME is still responsible for establishing standards for pressure vessels in the U.S. Other countries have their own standards for pressure vessels.

There are two standards that every manufacturer and user of pressure vessels should be aware of:

- ASME Section VIII: ASME Section VIII covers the requirements for both fired and unfired pressure vessels, including how they're designed, the way they're fabricated, how they should be inspected and tested and what's required for their certification.

- API 510: Another relevant standard to be aware of is API 510, which is an inspection code from the American Petroleum Institute. This standard specifies how inspections, repairs, alterations and other activities should be carried out on pressure vessels and pressure-relieving devices.

Deterioration and Wear Over Time

Pressure vessels are subject to wear and tear due to the harsh conditions in which they are often operated, including extreme temperatures and corrosive environments. Over time, materials can deteriorate, leading to problems such as corrosion, cracking and fatigue. INSPECTORS must use advanced techniques such as ultrasonic testing, radiography or acoustic emission to detect these subtle signs of deterioration, which may not be visible to the naked eye.

Access Restrictions

Many pressure vessels are in areas that are difficult to access, whether due to their size, location within a plant or the need for scaffolding. This can complicate the inspection process, requiring additional time and resources to ensure a thorough assessment. INSPECTORS often must rely on remote inspection technologies, such as drones or robotic devices, which can further complicate the inspection process.

Regulatory Compliance

Pressure vessel inspections must comply with strict industry standards and regulations, such as those set by the American Society of Mechanical Engineers (ASME) and the National Board of Boiler and Pressure Vessel Inspectors. Keeping up with these regulations can be a challenge, especially for facilities that operate in multiple jurisdictions with different compliance requirements.

Interpreting Inspection Results

Interpreting inspection results can be complex. Data from various non-destructive testing (NDT) methods must be accurately analyzed to determine the condition of the vessel. MISINTERPRETATION can lead to incorrect conclusions about the integrity of the ship, potentially compromising safety.

Scheduling and Downtime

Pressure vessel inspections often require equipment to be taken offline, resulting in production downtime. SCHEDULING INSPECTIONS without disrupting operations can be challenging, especially in plants that operate continuously. Balancing safety with operational efficiency is a critical management consideration.

Technological Advancements

As inspection technologies evolve, staying current with the latest methods and equipment is essential for inspectors. While advanced tools can improve accuracy and efficiency, they also require ongoing training and investment. FACILITIES must weigh the benefits of new technologies against the COSTS and potential DISRUPTIONS to operations.

Human Factors

Human's factors play an important role in the inspection process. The EXPERIENCE and TRAINING of inspectors can influence the outcome of an inspection. Ensuring that personnel are trained and competent in the use of inspection tools and the interpretation of results is critical to maintaining safety standards.

Conclusion

Inspecting pressure vessels is a complex task with many challenges, ranging from designs and access to regulatory compliance and technological advances. To ensure the efficiency of these critical asset, it's essential that organizations invest in proper training, adopt inspection technologies to safety and regulatory compliance. By addressing these challenges head on, industries can mitigate risk and improve the reliability of their pressure vessel operations.

Advanced NDT used for PRESSURE VESSEL 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. NDT 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.

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. 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.

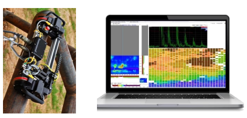
Automatic UT Mapping

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.

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.

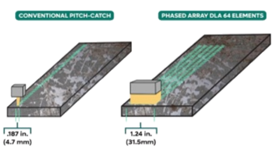


Phased Array UT

Inspect large surface areas quickly with high resolution. 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.

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.

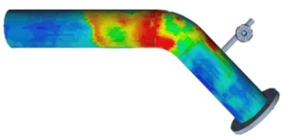


Pulsed Eddy Current

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.

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.

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.

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.

Eng. AHMED El SHERIF
Asset Management & Reliability Consultant
Rotating Equipment Department Head.
CMRP, CRL, CAMA, BMI
AMOC Co.

Aligning Asset Management STRATEGIES with Turnaround Planning

Asset management and turnaround planning are two critical components of any successful business operation. *However*, many companies struggle to effectively align these two strategies, leading to inefficiencies, increased costs, and missed opportunities for improvement.

In this article, we will explore the importance of aligning asset management strategies with turnaround planning and provide practical tips for achieving this alignment.

By integrating these two essential processes, organizations can optimize their resources, improve operational performance, and ultimately drive greater value for their stakeholders.

We will delve into the key considerations for integrating asset management and turnaround planning, including the role of data-driven decision-making, cross-functional collaboration, and the implementation of technology solutions.

Additionally, by understanding the synergies between asset management and turnaround planning, businesses can proactively manage their assets, minimize downtime, and enhance their overall competitiveness in the market.

Join us as we explore the critical link between asset management and turnaround planning and uncover the potential for driving sustainable business success.

Asset Criticality Assessment: Conduct a thorough assessment of asset criticality to identify key equipment and components that have a significant impact on production, safety, and environmental performance. Understanding the criticality of assets helps prioritize maintenance activities during turnarounds.

Data-Driven Decision Making: Utilize asset performance data, reliability analytics, and historical maintenance records to inform turnaround planning. Data-driven decision-making ensures that maintenance activities are targeted towards addressing the most critical reliability issues and optimizing the life cycle of assets.

Risk-Based Prioritization: Apply risk-based methodologies to prioritize maintenance tasks and inspections during turnarounds. By focusing on high-risk assets and failure modes, organizations can allocate resources effectively and mitigate potential reliability concerns.

Integrated Asset Management Systems: Implement integrated asset management systems that capture asset performance data, maintenance history, and reliability information. A comprehensive asset management system facilitates informed decision-making and ensures that maintenance activities are aligned with asset management strategies.

Cross-Functional Collaboration: Foster collaboration between asset management, maintenance, reliability, and turnaround planning teams. Effective communication and collaboration between these functions ensure that maintenance activities are aligned with asset management goals and turnaround objectives.

Proactive Maintenance Strategies: Develop proactive maintenance strategies that focus on preventive and predictive maintenance techniques to address potential reliability issues before they escalate. Proactive maintenance can extend the life cycle of critical assets and minimize the need for reactive interventions during turnarounds.

Asset Performance Monitoring: Implement real-time condition monitoring and performance tracking systems to continuously assess the health and performance of critical assets. Monitoring asset performance allows for early detection of potential issues and facilitates targeted maintenance interventions during turnarounds.

Continuous Improvement Culture: Foster a culture of continuous improvement by capturing lessons learned from past turnarounds and maintenance activities. Applying these insights to refine asset management strategies and maintenance practices contributes to extending the life cycle of critical assets.

Reliability-Centered Turnaround Planning: Integrate reliability engineering principles into the turnaround planning process, ensuring that maintenance activities are aligned with asset management strategies. Reliability- centered planning optimizes maintenance efforts and supports the long-term reliability of critical assets.

In conclusion, the alignment of asset management strategies with turnaround planning is a critical factor in driving operational efficiency and financial performance, particularly in industries such as oil and gas. *Companies* have demonstrated the tangible benefits of integrating these two essential processes, leveraging advanced technologies and proactive maintenance practices to optimize asset performance and minimize downtime during planned turnarounds.

By understanding the synergies between *asset management and turnaround planning*, businesses can proactively manage their assets, minimize downtime, and enhance their overall competitiveness in the market. *As organizations continue* to prioritize operational excellence and cost-effective asset management, the successful alignment of these strategies will remain a key differentiator in driving sustainable business success.

Ultimately, the integration of asset management and turnaround planning represents a strategic imperative for organizations seeking to maximize the value of their assets, improve operational efficiency, and achieve long-term success in their respective industries.

By embracing this alignment and learning from the successes of industry leaders, businesses can position themselves for sustained growth and resilience in an increasingly competitive global marketplace.

As the landscape of asset management and turnaround planning continues to evolve, the imperative for integration will only become more pronounced, making it essential for organizations to prioritize this alignment as a cornerstone of their operational strategy.

Introduction

Flanges are found everywhere in industry, they are the main form of connecting pipeline lengths to other pipes, valves, vessels etc. They are often exposed to corrosive fluids and challenging environments that can cause damage over time, potentially leading to failure. Accordingly, it is vital that any degradation is identified during inspections to maintain the asset and avoid leakage or catastrophic failure.

Visual inspection is a common method for inspecting flanges but this means having to shut down the plant and open the flanges which costs time and money. Phased array allows the inspection of flanges, in service, without having to take them apart, resulting in quicker and lower cost inspections.

Figure 1 – Flange face defects

Inspection information:

The inspection was performed from the flange face as shown in the image below, this is usually a fully accessible surface for in situ inspections.

Figure 2 -Flange inspection scan plan

Industries

- Chemical & Petrochemical Sector
- Oil & Gas Sector
- Nuclear Energy Sector
- Wind Power Renewables Sector
- Pharmaceutical Sector
- Mining Sector
- Construction and Infrastructure
- NDT Service Providers

Application

- Corrosion / Thickness measurement
- Casting / Forging Inspection
- Storage Vessel Inspection
- Asset Integrity

Typical Parts

- Storage vessel ancillary attachment points
- Refinery Pipelines
- Oil and gas plant pipelines
- Chemical plant pipelines
- Fume tower flanges

Inspection Techniques

- PAUT L-Scan
- TFM

Features and Benefits

- Faster inspection speeds, lowers the cost of inspection
- Less downtime as the flanges do not need to be taken apart to check the faces visually
- Better resolution images can be achieved by using FMC/TFM, if required
- The Veo3 has a 128 Gb memory allowing many scans to be recorded without having to store externally

- A 5MHz, 64-element PAUT transducer was used for this inspection. Smaller probes may also be used to get a greater amount of coverage.
- For best results, the inspection should be encoded. Specific scanners can also be used, when applicable Between 50% and 70% coverage of the flange face is achievable when inspecting from the bolt face.
- using a PA scan. Combined with a TFM LL mode scan, the profile assessment is greatly improved. LL stands for direct mode and is based on the compression wave velocity TFM scan type.

The inspected flange has a groove for the gasket (it can be seen in the image above). It can be suspectable to corrosion and pitting. The following figures show the results of an inspection on this area.

When detecting defects on the flange face, the extractor box's position is moved so that it covers the area between the grove and inside corner of the flange. The image below shows the full top view. You can easily spot the good and bad areas.

The sample has two defects in the flange face: one central and one on the edge, as shown in the images at the beginning of this application note. Please see the images below, which show how the defects appear after an inspection.

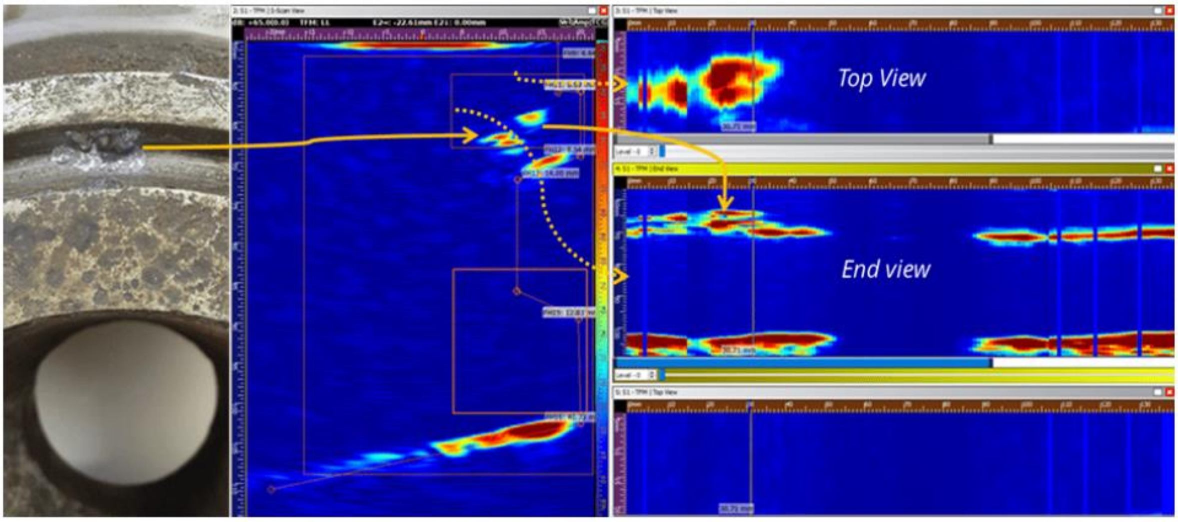


Figure 3 – Defect detection of wall losses in the flange face groove

The flange lip geometry generates a corner echo. A new or an undamaged flange will define a back-wall echo following the internal pipe. It is shown in Figure 4. The Live TFM view and extracted view include visual hints; any echo changes will be spotted immediately.

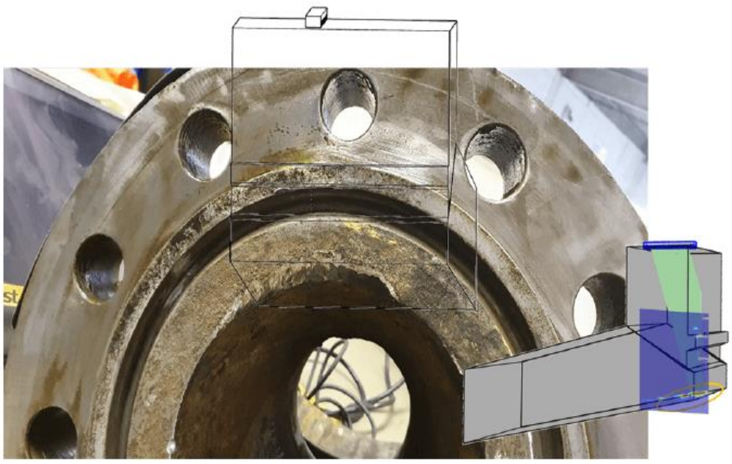


Figure 4 – Flange edge and its TFM scan location

Specifically, on the further flat echo, it matches the inner pipe surface location. It also reaches the flange corner when it is not damaged. The corroded feature #2 (encircled in orange in Figure 2) has an angled face that deflects the sound when the flange grooves are rounded. Therefore, this inner echo should fade away as it gets further damaged.

Conclusion:

- TFM, using the LL propagation mode, provides a clean “shot” of the flange’s inner face and grooves.
- The interpretation of the scan is improved by using UTstudio+
- Using multiple extracted views on a specific area enhances the analysis of complex areas.
- With improved CAD tools, BeamTool 9 remains the best software to create this scan plan.
- It would not be possible to get 100% coverage of the flange face using this method as some areas are blocked by bolt holes.

For further information or support, please contact the Sonatest Applications Team: applications@sonatest.com

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Recommended Tool Package

Category	Part #	Description
Acquisition Unit	VEO3 phased array data acquisition unit	
Probe	D1A 5M32E probe and D1AW N60S wedge	
Encoder	AXYS Encoder	

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Sonatest (Head Office)
Dickens Road, Old
Wolverton Milton Keynes,
MK12 5QQ
t: +44 (0)1908 316345
e: sales@sonatest.com
Sonatest

(North America)
12775 Cogburn, San Antonio Texas,
78249
t: +1 (210) 697-0335
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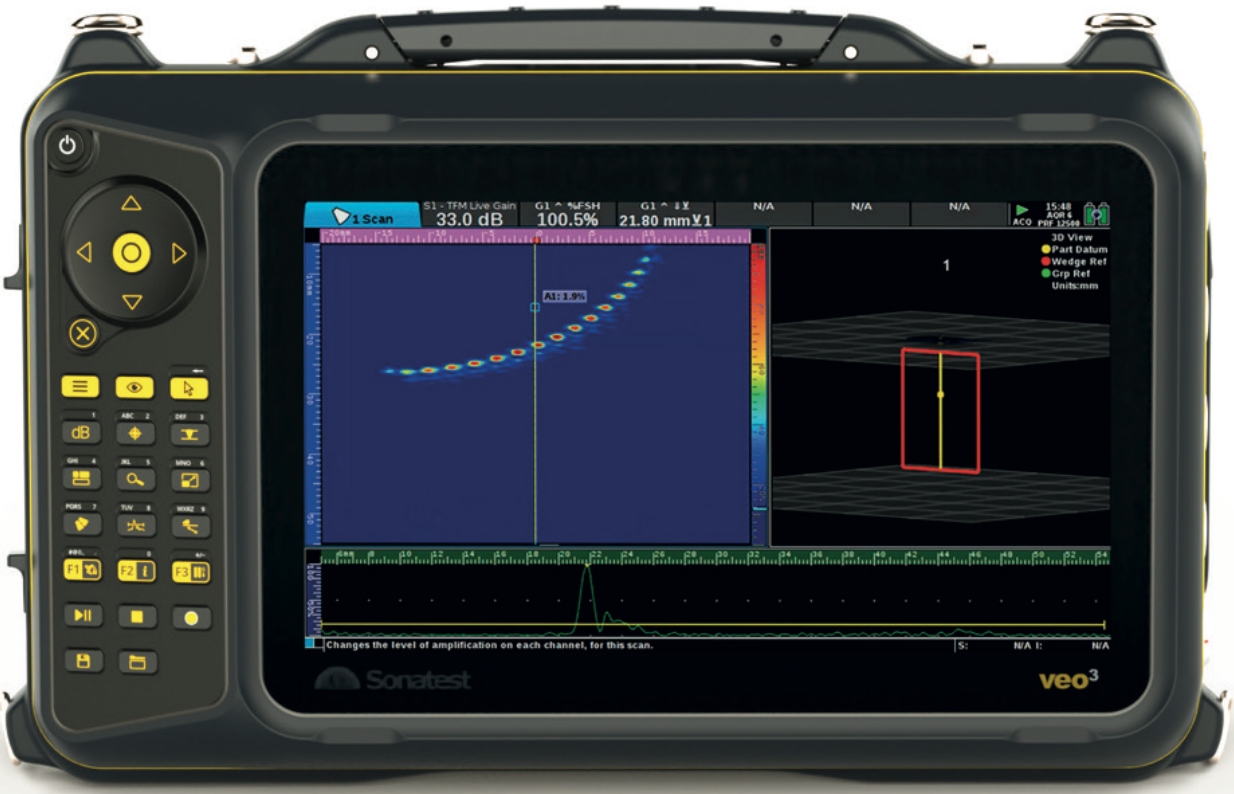

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Rethink Artificial Intelligence in Non-Destructive Testing

Christian Els
sentin GmbH
Germany

Maximilian Topp
sentin GmbH
Germany

AI

Introducing Critical Image Detection (CiD) and Single Image Detail Analysis (SiDA).

The **non-destructive testing (NDT)** industry has undergone significant changes over the years, driven by advancements in technology. One of the most impactful developments has been the integration of artificial intelligence (AI) into inspection processes. While AI has shown first impacts in automating defect detection and recognition (ADR), its potential extends far beyond this application.

NDT often relies on human evaluators to interpret complex data sets, facing today's challenges like demographic change and skilled labor shortage. To tackle these challenges the German software company, sentin, is the first company to develop a new system for AI in NDT using Critical Image Detection (CiD) and Single Image Detail Analysis (SiDA) focusing on the whole inspection workflow (like fraud/duplicate detection, IQI evaluation, documentation and report generation) and not just defect detection. This development marks a new era of efficiency with the potential to revolutionize the way inspections are performed in the future.

By streamlining the inspection process to a digital workflow and leveraging AI, these systems can generate substantial business value through time and cost savings. In this article, we will look deeper into what CiD and SiDA are, their benefits, and how they can be applied to various inspections.

What are these systems?

A two-step process for finding critical images fast (CiD) and precise (SiDA).

Critical Image Detection (CiD) and Single Image Detail Analysis (SiDA) are two innovative approaches that can be applied to image-based inspection like radiographic testing, thermographic, visual or drone inspection.

While most current discussions around AI in NDT revolve around automated defect recognition (ADR), CiD and SiDA look at the complete inspection process with all workflow steps in mind. This means the system will also do tasks like accessing image quality, evaluating IQIs, finding IDs and references for documentation.

It is a two-step process - while CiD tells which images are affected e.g. with bad image quality, SiDA tells where in the image the indications are (e.g. detector artifacts on a weld).

CONTINUE *with AI in NDT!*

Reduce down-time and prioritize the 1% of findings.

Applications of Critical image Detection (CiD) can be Fraud Detection, Image Quality Check, Defect Detection and more.

Critical Image Detection (CiD) is designed to find critical images fast by processing whole batches of images. CiD will look at all images in a dataset e.g. all images taken from a shift and run the (AI) algorithms to check them. The system then will pre-sort and prioritize images based on various indicators such as potential defects, duplicates, missing labels or references, and many more.

Often a huge fraction of parts / images inspected does not show any indications and e.g. only 1% of them is critical. The CiD system enables inspectors to look at the 1% of "critical images" showing indications first and not the 99% of "good images". Therefore, triggering repairs or rescanning faster and reducing downtimes.

Figure 1 shows an example of CiD applied to a dataset of 10 images. A few images with critical indications have been found and therefore prioritized and put to the top of the list. Two pairs of duplicates have been found, which indicates a manipulated inspection. Three images had missing IQIs and one had blemishes (bad image quality). The other four images had no findings, so that they can be put to bottom.

Some applications of CiD are:

1- **Fraud detection**: Identify and flag suspicious images that may be indicative of tampering, manipulation or duplicates of other images.
2- **Image quality check**: Ensure the image meets the required standards for analysis, so that a compliant evaluation is possible.
3- **Defect detection**: Detect potential defects or anomalies in the image, enabling evaluators to e.g. find undercut, porosities or cracks faster.

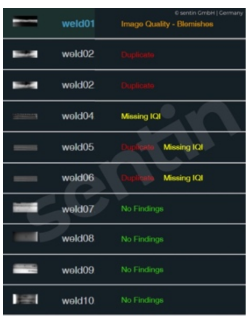


Figure 1 - Critical Image Detection example

Automate the inspection workflow and report generation.

Applications of Single Image Detail Analysis (SiDA) can be IQI Detection / Evaluation, Defect Recognition, ID and Text Recognition.

Single Image Detail Analysis (SiDA) is a system that provides detailed information about the findings, like potential defects, and their location in an image. When looking at an image in NDT there are many more things to do than finding defects. Often a lot of documentation and compliance tasks must be done before that. SiDA will automatically trigger your workflow steps to reduce the manual tasks in an inspection.

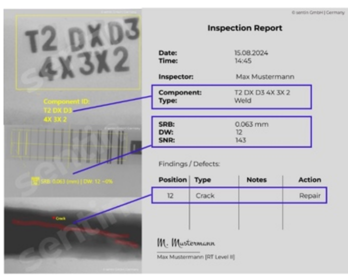
Some application of SiDA are:

1- **IQI Detection / Evaluation**: Identify Image Quality Indicators (IQIs) to ensure a compliant image quality e.g. SNR / CNR.
2- **Defect Recognition**: Recognize and classify defects based on their characteristics and severity.
3- **ID and text recognition**: Extract relevant information from the image, including IDs, labels, and other textual data.

It can output boxes, polygons, texts and more advanced data formats integrating in your digital infrastructure. This means the inspector may have the relevant double wire, SNR values, component ID (from lead letters) and defect highlighted or pre-filled in a report without a single click.

Figure 2 shows how the image is evaluated automatically (showing on the left side of the image) and the results can also automatically be processed to pre-fill a report. In this case the Identification of a weld, the double wire IQI (including SRB and an SNR measurement) as well as a defect (crack) have been detected and filled in. This workflow can save inspectors precious time and reduce mistakes when transferring inspection results.

Figure 2 - Single Image Detail Analysis example



This even works for non-image data like UT or sensors

CiD and SiDA boost inspection speed and precision.

The principles of CiD and SiDA are also applicable to non-image inspections like data from ultrasonic or other sensors. The batch processing of inspection data can also find the 1% of critical items (Critical Item Detection - CID) in other methods by tweaking the algorithms for that data format. The same is possible for looking at single items in detail to tell where indications are (Single Item Detail Analysis - SIDA) e.g. in a UT Scan. This modular design allows to adapt the system to inspection specific needs.

Whether image-based or other inspections, the advantages of CID and SIDA include:

1- **Increased efficiency**: Automate routine tasks and reduce manual effort required for inspections.

2- **Improved accuracy**: Enhance the quality of inspection results by identifying critical images and defects more accurately.

3- **Reduced costs**: Minimize downtime, labor costs associated with manual inspections and maximize resource utilization.

Use the AI system today

A practical approach to AI in NDT

The introduction of CID and SIDA marks a new chapter in the history of AI in NDT. The user-centric approach boosts efficiency / accuracy and saves costs. The use of AI is not a dream of the future but is already available today. It will change the way we work in NDT and inspections.

sentin is a leading provider of digital automation and artificial intelligence for the non-destructive testing (NDT) and inspection industry. As one of the first companies specializing on Artificial Intelligence in NDT and years of experience the software company from Germany is actively pushing innovation in this industry. As the first company providing a CID and SIDA systems their international customers are entering a new era of inspections today.

E-Mail: contact@sentin.ai Tel.: +49 234 54506170

References

Topp, M., Nestler, D., & Els, C., 2024, "Critical Image Detection (CiD) and Single Image Detail Analysis (SiDA) – A practical approach to AI in NDT," e-Journal of Nondestructive Testing., 29(8), https://doi.org/10.58286/30042

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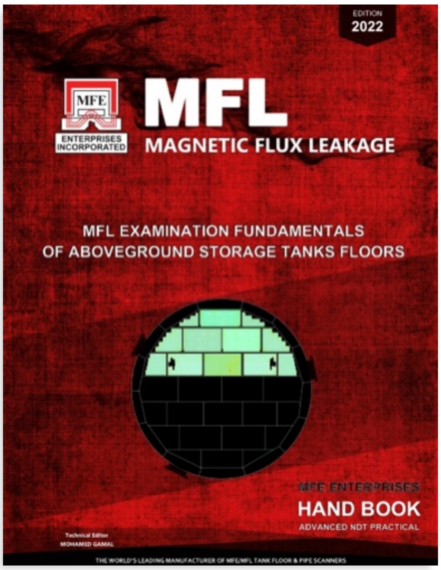

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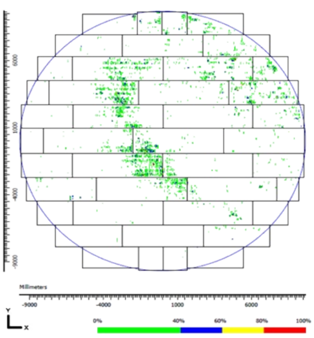

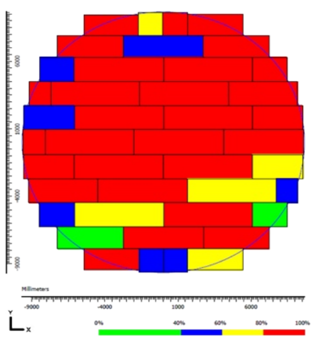

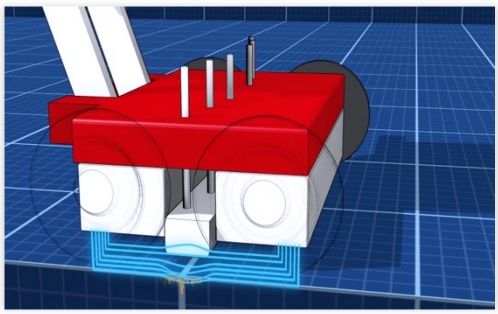

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The best time to start a career in NDT!

Why now is the best time to start a career in NDT?

NDT careers are exciting and both personally and financially rewarding. This makes NDT jobs extremely desirable. Whether you're looking for a reliable career path or want to upgrade your career, NDT (non-destructive testing) offers many great opportunities.

NDT careers in 2024 are in high demand and readily available. **In fact, 2025** is the perfect time to get started in non-destructive testing!

Here's what you can expect from a career in NDT and why now is the best time to get involved.

- **What does an NDT technician do?**
- **Is NDT a good career choice?**
- **Why now is the time to start?**
- **How do I start a career in NDT?**

What does an NDT technician/operators do?

An NDT technician inspects various materials and structures for defects, flaws and damage. The main goal of an NDT technician is to ensure that equipment, structures and materials are safe and reliable.

There are many different non-destructive testing jobs available. Therefore, what an NDT technician does day-to-day, and the industry they work in, will vary depending on their expertise and level of training.For instance, each type of NDT technician can be CERTIFIED AT THREE LEVELS – Level 1, Level 2, and Level 3.

An NDT technician can also be certified in more than one type of NDT. This means that a single technician can employ various methods of non-destructive testing.

Technicians who are certified in multiple testing methods at higher levels (Level 3 being the highest) can provide more complex NDT services.

career path

NDT careers are available in a wide variety of industries. Here's where your career in NDT could take you.

Industries NDT Technicians Work In:
Organizations in many different sectors require NDT technicians. Some of the **most common industries** in ME & Africa that utilize non-destructive testing include:

- Oil and gas,
- Mining,
- Fertlizer,
- Industrial construction,
- Aerospace,
- Automotive,
- Rail transportation,
- Defence,
- Heavy equipment manufacturing,
- Power generation,
- Pipeline and more.

Is NDT a good career choice?

It offers high pay, flexibility, the option to work in various industries and many opportunities for career growth. That being said, certain people are more suited to NDT careers than others.
Here are some important **strengths and skills** you'll need to succeed.

- Mind for mathematics and science,
- Ability to understand technology,
- Strong problem-solving skills,
- Attention to detail,
- Strong reasoning skills,
- Ability to think quickly,
- Strong written & verbal communication,
- Good vision (especially colour vision)

Why NDT Careers Are In-Demand in 2025!

The demand and price for oil and gas have skyrocketed in 2023 and 2024. As a result of increased productivity in the oil and gas industry, the need for NDT technicians has grown. Therefore, more jobs and more opportunities are available in the field. This makes 2025 the perfect time to get started with a career in NDT.

Want to become an NDT technician? Here's how you can get started.

How do I start a career in NDT?

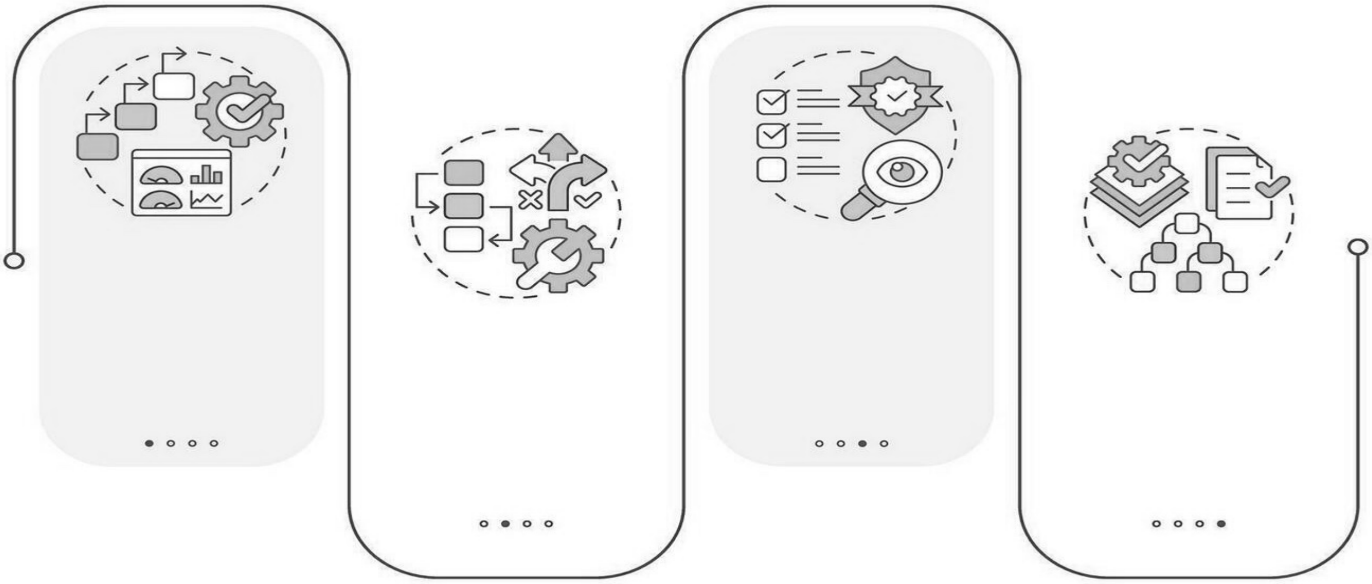
There are SEVERAL STEPS you'll need to take to start an NDT career. Here's what you'll need:

1. High school or GED equivalent.
2. College education in Material Science or Welding (this is not required, but will help reduce the time it takes to earn your NDT certification)
3. NDT certification from a Recognized Training Organization (RTO) – this step includes extensive training and work experience.

Therefore, you will need to complete training and testing in all the NDT methods you wish to use in the field.

KEEP IN MIND, once you are certified, you are also responsible for keeping your certification up-to-date. This means staying up to date with changes in technology and code and renewing your certification.

Guide to Global NDT CODES & STANDARDS



CODE

Code is a standard that has been adopted by one or more governmental bodies and has the force of law, or when it has been incorporated into a business contract.

- Codes are generally the governing documents, providing a set of rules that specify the minimum acceptable level of safety for manufactured, fabricated, or constructed objects.
- Most codes will provide acceptance and rejection criteria for the required inspections.
- ASME (American Society of Mechanical Engineers) Codes are legally enforceable in many US states. Whereas, in the other part of the world they are not legally enforceable, but such countries have their own similar codes.

STANDARD

Standards are documents that establish engineering or technical requirements for products, practices, methods, or operations.

- Standards are the documents, prepared by professional societies or committee, which are believed to be efficient engineering practices and which contain mandatory requirements.
- An inspection standard may include information on how to apply multiple testing techniques.
- Standardization of certain items to prevent multiple versions to be used.
- Standards are usually created by individual companies, organizations, or countries. They are not legalized.

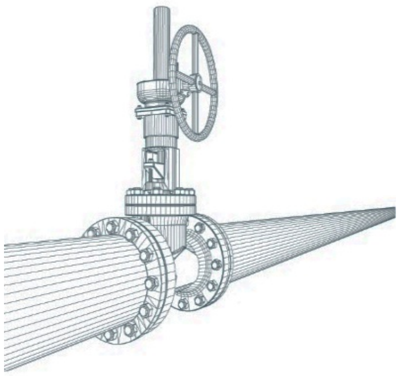
Most countries have one or more organizations ("standards bodies") that develop and publish technical industrial standards. Some do not, and those usually reference existing codes and standards for their manufacturing, fabrication, and construction projects. *In the United States,* these organizations are usually independent organizations from private industry, but in many countries, they are government.

Authorized Organizations

To create CODES & STANDARD

For Non-Destructive Testing

ASNT (American Society of Non-Destructive Testing)
ASTM (American Society for Testing & Materials)
ASME (American Society for Mechanical Engineers)
API (American Petroleum Institute)
AWS (American Welding Institute)
AIA (Aerospace Industries Association)
NBBI (National Board of Boiler and PV Inspectors)
ISO (International Organization for Standardization)
CEN (European Committee for Standardization)
PED (European Pressure Equipment Directive)



AUTHORIZED Organizations

For

TRAINING

CERTIFICATION

Non-Destructive Testing

American Society of Non-Destructive Testing (ASNT), a globally established organization, which offers NDT persons, a broad level of certification and training including all methods of NDT. ASNT offers, ASNT Level II, ASNT Level III.

British Institute of Non-destructive Testing (BINDT), an accredited certification organization that offers a Personnel Certification in Nondestructive Testing (PCN).

International Standards Organization (ISO), ISO 9712 (Non-destructive testing – Qualification and certification of NDT personnel) is a published standard that details the requirements for qualification and certification of personnel that perform NDT.

American Petroleum Institute (API), API offers numerous Individual Certification Programs (ICPs) specific to NDT personnel in the petroleum and petrochemical industries.

Natural Resources Canada (NRCan), NRCan manages the Non-Destructive Testing Certification Body (NDTCB), which offers a Canadian General Standards Board (CGSB) certification.

Another organization that can do it; French Committee for Non-destructive Testing Studies (COFREND), Canadian Standards Association (CSA Group), Canadian General Standards Board (CGSB)

The exact regulations designed to handle NDT vary by country and industry.

ASNT

THE AMERICAN SOCIETY FOR NONDESTRUCTIVE TESTING.

is a member-based, non-profit professional society.

Provides NDT related reference materials, technical conferences, and certification documents. ASNT does not publish standards that describe how to perform NDT tasks.

Those are published by ASTM International and are discussed in that section,

ASTM

ASTM International

(Formerly the American Society for Testing and Materials) is one of the largest voluntary standards development organizations in the world, providing technical standards for materials, products, systems, and services. Over 180 ASTM NDT standards are published in the ASTM Annual Book of Standards, Volume 03.03, and Non-destructive Testing. ASTM defines three of their document categories as follows:

A "**GUIDE**"

is a compendium of information or series of options that does not recommend a specific course of action. A guide increases the awareness of information and approaches in each subject area.

A "**PRACTICE**"

is a definitive set of instructions for performing one or more specific operations or functions that does not produce a test result. Examples of practices include, but are not limited to application, assessment, cleaning, collection, decontamination, inspection, installation, preparation, sampling, screening and training.

A "**TEST METHOD**"

is a definitive procedure that produces a test result. Examples of test methods include, but are not limited to identification, measurement and evaluation of one or more qualities, characteristics or properties.

Here are the most used ASTM NDT standards. Additional standards could be sourced in the ASTM Annual Book of Standards, Volume 03.03.

ASTM E709:	Standard Guide for Magnetic Particle Testing
ASTM E1444:	Standard Practice for Magnetic Particle Testing for Aerospace
ASTM E165:	Standard Practice for Liquid PT for General Industry
ASTM E1417:	Standard Practice for Liquid Penetrant Testing
ASTM E1208:	Standard Practice for PT using the Lipophilic Post-Emulsifiable
ASTM E1209:	Standard Practice for PT using the Water-Washable Process
ASTM E1210:	Standard Practice for PT using the Hydrophilic Post- Emulsifiable
ASTM E1219:	Standard Practice for PT using the Solvent-Removable Process
ASTM E114:	Practice for UT Pulse-Echo Straight-Beam by the Contact Method
ASTM E164:	Standard Practice for Contact Ultrasonic Testing of Weldments
ASTM E213:	Standard Practice for Ultrasonic Testing of Metal Pipe and Tubing
ASTM E2375:	Standard Practice for Ultrasonic Testing of Wrought Products
ASTM E94:	Guide for Radiographic Examination
ASTM E1742:	Practice for Radiographic Examination
ASTM E1000:	Guide for Radioscopy
ASTM E1255:	Practice for Radioscopy
ASTM E1030:	Test Method for Radiographic Examination of Metallic Castings
ASTM E1032:	Test Method for Radiographic Examination of Weldments
ASTM E999:	Guide for Controlling the Quality of Industrial RT Film Processing
ASTM E142:	Method for Controlling Quality of Radiographic Testing
ASTM E2007:	Standard Guide for Computed Radiography
ASTM E2738:	Standard Practice for Digital Imaging for Computed RT (CR) Test
ASTM E268:	Electromagnetic testing
ASTM E1962:	Standard Practice for UT Surface Testing using (EMAT) Techniques
ASTM E426:	Practice for Electromagnetic (Eddy-Current) of Seamless and Welded Tubular Products, Austenitic Stainless Steel and Similar.

www.astm.org

ASME

AMERICAN SOCIETY OF MECHANICAL ENGINEERS

is a not-for-profit professional organization that enables collaboration, knowledge sharing and skill development across all engineering disciplines, while promoting the vital role of the engineer in society. ASME codes and standards, publications, conferences, continuing education, and professional development programs provide a foundation for advancing technical knowledge and a safer world. ASME publishes multiple codes and standards including (but not limited to) the following documents:

The "ASME Boiler & Pressure Vessel Code" (BPVC). The 2010 edition of the BPVC with 2011 addenda was made available in July 2011. This code is made up of 12 sections, or "books," covering the following subjects:

The BPVC is now published biennially in odd-numbered years without addenda in the intervening year.

ASME# Sec. 1: Power Boilers

ASME# Sec. 2: Materials

ASME# Sec. 3: Rules for Construction of Nuclear Facility Components

ASME# Sec. 4: Heating Boilers

ASME# Sec. 5: Nondestructive Examination

ASME# Sec. 6: Recommended Rules for the Care & Operation of Heating Boilers

ASME# Sec. 7: Recommended Guidelines for the Care of Power Boilers

ASME# Sec. 8: Pressure Vessels

ASME# Sec. 9: Welding and Brazing Qualifications

ASME# Sec. 10: Fiber-Reinforced Plastic Pressure Vessels

ASME# Sec. 11: Rules for In-service Inspection of Nuclear Power Plant

ASME# Sec. 12: Rules for Construction and Continued Service of Transport Tanks

ASME B31.1: Power Piping. This code contains requirements for piping systems typically found in electric power-generating stations, industrial institutional plants, geothermal heating systems, and heating and cooling systems.

ASME B31.3: Process Piping. This Code contains requirements for piping typically found in petroleum refineries; chemical, pharmaceutical, textile, paper, semiconductor, and cryogenic plants; and related processing-plant terminals.

www.asme.org

API

AMERICAN PETROLEUM INSTITUTE

is a national trade association that represents all aspects of America's oil and natural gas industry, including producers, refiners, suppliers, pipeline operators, marine transporters and service and supply companies. Among the standards that API publishes are the following:

API 510: Pressure Vessel Inspection: In-Service Inspection, Rating, Repair and Alteration

API 570: Piping Inspection: In-service Inspection, Rating, Repair, and Alteration of Piping Systems

API 650: Welded Tanks for Oil Storage

API 653: Tank Inspection, Repair, Alteration, and Reconstruction

API 1104: Welding of Pipelines and Related Facilities

www.api.org

AWS

AMERICAN WELDING SOCIETY

is a nonprofit organization with the goal of advancing the science, technology, and application of welding and related joining disciplines. AWS provides certification programs for welding inspectors, supervisors, educators, etc., and publishes multiple standards, many of which contain procedures for the application of nondestructive testing methods and techniques above and beyond visual inspection. A few of their standards are listed here:

AWS D1.1: Structural Welding Code - Steel

AWS D1.2: Structural Welding Code - Aluminum

AWS D1.3: Structural Welding Code - Sheet Steel

AWS D1.5: Bridge Welding Code

AWS D1.6: Structural Welding Code - Stainless Steel

www.aws.org

ISO

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION

the world's largest developer and publisher of International Standards, is a non-governmental organization located in Geneva, Switzerland. ISO is a network of the national standards institutes of 161 countries, one member per country. Many of the ISO member institutes are part of the governmental structure of their countries or are mandated by their government. Other members have their roots uniquely in the private sector, having been set up by national partnerships of industry associations. Three of the many ISO standards are listed below:

ISO 9712, Non-destructive testing – Qualification and certification of personnel.
This International standard, which was revised in 2012, provides the requirements for the NDT certification of NDT personnel by an accredited third-party certification body that conforms to the requirements of ISO/IEC 17024, Conformity assessment – General requirements for bodies operating certification of persons.

ISO/IEC 17024, Conformity assessment – General requirements for bodies operating certification of persons.
This international standard was developed with the objective of achieving and promoting a globally accepted benchmark for organizations operating certification of persons.

ISO/IEC 17011, Conformity assessment – General requirements for accreditation bodies accrediting conformity assessment bodies.
This international standard specifies the general requirements for accreditation bodies. ANSI, the U.S. accreditation body that has accredited ASNT is accredited under ISO 17011 and is a member of the International Accreditation Forum (IAF), the world association of Conformity Assessment Accreditation Bodies in the fields of management systems, products, services, personnel, and other similar programs of conformity assessment.

www.iso.org

AIA

AEROSPACE INDUSTRIES ASSOCIATION

is a trade association with more than 100 major aerospace and defense member companies. These companies embody every high-technology manufacturing segment of the U.S. aerospace and defense industry from commercial aviation and avionics to manned and unmanned defense systems, to space technologies and satellite communications.

NAS 410, NAS Certification & Qualification of Nondestructive Test Personnel. This employer-based certification standard establishes the minimum requirements for the qualification and certification of personnel performing nondestructive testing (NDT), nondestructive inspection (NDI), or nondestructive evaluation (NDE) in the aerospace manufacturing, service, maintenance, and overhaul industries. In 2002, NAS 410 was harmonized with European Norm 4179 (listed in the CEN section), so that the requirements in both documents are identical.

NAS 999, Nondestructive Inspection of Advanced Composite Structures. This specification establishes the requirements for non-destructive inspection (NDI), NDI standards, NDI methods, and NDI acceptance criteria.

www.aia-aerospace.org

CEN

EUROPEAN COMMITTEE FOR STANDARDIZATION

is a business facilitator in Europe, removing trade barriers for European industry and consumers. Its mission is to foster the European economy in global trading, the welfare of European citizens and the environment. CEN is a major provider of European Standards and technical specifications. It is the only recognized European organization according to Directive 98/34/EC for the planning, drafting and adoption of European Standards in all areas of economic activity except for electro-technology and telecommunication. CEN's 31 National Members work together to develop voluntary European Standards (ENs).

Standards (Norms) developed by CEN are considered "harmonized standards" that are required to be accepted by all member nations in the European Union. The following two ENs are NDT certification standards:

EN 4179, Aerospace series – Qualification and approval of personnel for non-destructive testing. This employer-based certification standard is the European version of NAS 410, which was described under the Aerospace Industries Association section on this web page.

EN 473, Non-destructive testing – Qualification and certification of NDT personnel – General principles. This European Standard established principles for the third-party ("central") qualification and certification of personnel who perform industrial non-destructive testing (NDT) by an accredited third-party certification body. Under EN 473, certification bodies had to administer procedures for certification according to the requirements of EN 473 and must fulfill the requirements of EN ISO/IEC 17024.

EN ISO 9712, which was approved in June 2012, replaced EN 473 as the European harmonized standard (Norm) for NDT central certification effective 1 January 2012. EN ISO 9712 permits the use of current EN 473 certifications until the certificate holders' next renewal period, at which time they must recertify in accordance with the EN ISO 9712 requirements. EN ISO 9712 and ISO 9712 are identical except that EN ISO 9712 has been approved as a harmonized standard for use under the European Pressure Equipment Directive 97/23/EC.

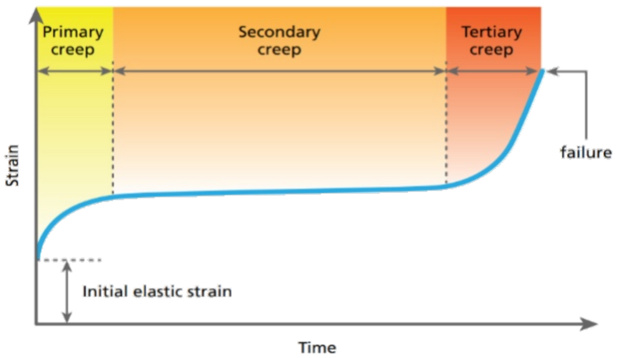
www.cen.eu

FAILURE MODES FOR TANK SHELLS & ASSOCIATED PIPEWORK

The metals used for tanks & pipelines can be subject to a range of failure modes, e.g., creep, stress, thermal shock, and brittle fracture:

CREEP

Creep describes the gradual extension of material under a steady tensile stress over a long period of time, particularly in high-temperature conditions. Tensile refers to the pulling apart of the metal in a single plane. Another aspect is elasticity, which refers to the degree to which the material will return to its former length after stretching. Tensile strength and elasticity decrease with increasing temperature, which means that creep is more likely to occur at higher temperatures. Exposed to creep, the metal of a tank or pipe may deform and eventually fracture.



STRESS

Stress refers to the tensile or compressive loading placed on a material. Strain refers to the deformation that it will undergo when stress is applied to it. This gives rise to two broad categories of material; ductile, which will move under strain, and brittle, which simply breaks under strain. Steel is ductile and will yield before it breaks; cast iron is brittle and does not yield.

Stress failures occur because of the impact on a material of the conditions to which it is exposed. So, in tanks and pipework, the metal will be subject to stress because of the loading exerted by the contents, changes in temperature and variations in loading. For example, a tank being emptied and then refilled will be subject to movement as the structure responds to the variation in the load placed on it. In pipework at flanges, openings and connections, there will be greater loading and therefore more stress.

Stress corrosion is an example of failure that occurs when a metal corrodes because of exposure to a specific environment and is unable to take the load placed on it, e.g., mild steel exposed to nitrates. Similarly, in some situations, hydrogen atoms will invade steel and cause hydrogen embrittlement. At high temperature, hydrogen enters the steel and then reforms as hydrogen molecules, taking up space and putting pressure on the steel, which then cracks.

THERMAL SHOCK

Thermal shock results from exposing materials to rapid and extreme temperature changes. This causes the different parts of the material to expand by differing amounts, which in turn gives rise to uneven expansion. As a result, cracking occurs when the stress applied by the expansion exceeds the strength of the material. The crack will continue until the object or material fails.

BRITTLE FRACTURE

Brittle fractures occur suddenly when the material is put under excessive stress and has no, or limited, elasticity. This may happen because the material is intrinsically brittle or the loading on it has happened so fast that it has not had time to be elastic. This is usually referred to as impact or 'snatch' loading. In brittle fracture, small cracks rapidly spread through the material, which then suddenly fails under stress. As there is no elastic component, if the two ends of a brittle fracture are put back together, they join up perfectly, unlike ductile fractures that have become deformed. Low temperatures can increase the occurrence of brittle fracture, e.g., materials used for storing and conveying LPG.

FATIGUE FAILURE

Fatigue is the formation of crack(s) because of repeated application of loads that individually do not create sufficient stress to cause failure. It may appear as thermal fatigue, contact fatigue, surface or pitting fatigue, subsurface cracking or subcase fatigue, and corrosion fatigue.
The fatigue fracture is caused by the simultaneous action of:

- Cyclic stress, i.e., repeated actions creating stress, filling/ emptying, loading/unloading.
- Tensile stress, i.e., putting a load on the material.
- Plastic strain, i.e., the material does not yield (exhibit elasticity).

For storage tanks, fatigue may also be induced by:

- Wind load/vibration.
- Pump-induced vibration.
- Pedestrians walking on/over components.

Although we have discussed a few different types of failure above, there are many other types. For example, corrosion is a significant issue, especially when vessels and pipelines are in or near the sea, when corrosion rates can be significantly higher.

Ref. NEBOSH-PSM

UPCOMING
EVENTS

EGYPES — EGYPT ENERGY SHOW

EGYPS Exhibition 2025
17 – 19 February 2025

The EGYPS 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 2025, 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.

NDT X 2025
EGYPT EXPO 2025

- Non-Destructive Testing,
- Asset Integrity,
- Welding,
- Corrosion and QC,
- Testing Equipment.

International Annual Exhibition & Conference.

When: **26th - 28th August 2025.**
Where: Egypt International Exhibition Center
New Cairo - Egypt.

Leading event for the Middle East & Africa Industrial Inspection, Non-Destructive Testing, and Asset Integrity Management markets. NDTX 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. This expo attracts NDT leaders, technicians, and NDT experts who are eager to hear from industry experts, discover innovative content, and network with peers.

ASNT 2025
ASNT — The American Society for Nondestructive Testing

ASNT 2025 Heads to Florida!

6 - 9 Oct. 2025

Engage with your customers and prospects face-to-face at the largest NDT event of the year! ASNT 2025 is the place to engage with a global audience of NDT industry professionals. This event attracts NDT leaders, technicians, and NDT stakeholders eager to hear from industry experts, discover innovative content, and network with peers. Take advantage of bustling exhibit hall, featuring more than 225 exhibitors, to connect directly with your customers and prospects and showcase your solutions to a highly engaged audience.

APCNDT 2025
APCNDT — HOSTED BY ASNT

17th Asia Pacific Conference for Non-Destructive Testing

Hawaii USA 11-15 May 2026

The 17th Asia Pacific Conference on Non-Destructive Testing (APCNDT) is set to be an unmissable event for NDT professionals across the globe. Held under the theme "Breaking Barriers: NDT Solutions for a Changing World – Innovate, Adapt, Transform," this premier conference will showcase the latest innovations and emerging technologies that are redefining nondestructive testing. Attendees will have the opportunity to connect with global experts, share knowledge, and explore new solutions to address the evolving challenges faced by industries worldwide. Join us to discover how NDT is driving transformation, enhancing safety, and paving the way for a dynamic and sustainable future.

Explore more!
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DUBAI
UAE.
P.O.BOX: 28027

CAIRO
New Cairo,
Egypt.

support@ndtcorner.com
Expo.ndtcorner.com
ndtcorner.com

CONVERSATION FACTORS

LENGTH

1	Centimeter	=	0.3937	Inches	1	Inch	=	2.54	Cms
1	Meter	=	3.2808	Feet	1	Foot	=	0.3048	Meters
1	Kilometer	=	0.62137	Miles	1	Mile	=	1.60934	Kilometers
1	Kilometer	=	0.53996	Naut. Miles	1	Naut. Mile	=	1.852	Kilometers

AREA

1	Sq. meter	=	10.7639	Sq. Feet	1	Sq. Feet	=	0.092903	Sq. meters
1	Hectare	=	2.47105	Acres	1	Acre	=	0.404686	Hectares
1	Sq. Km	=	0.3861	Sq. Miles	1	Sq. Miles	=	2.58999	Sq. Kms
1	Sq. Km	=	247.105	Acres	1	Acre	=	0.004047	Sq. Kms

WEIGHT

1	Kilogram	=	2.20462	Pounds (lbs)	1	Pounds (lbs)	=	0.45359	Kilogram
1	Metric Ton	=	0.98421	Long Tons	1	Long Ton	=	1.01605	Metric Tons
1	Metric Ton	=	1.10231	Short Tons	1	Short Ton	=	0.907185	Metric Tons

VOLUME

1	Liter	=	0.2642	U.S. Gallons	1	U.S. Gallon	=	3.785	Liters
1	Liter	=	0.21997	U.K. Gallons	1	U.K. Gallon	=	4.546.9	Liters
1	Cu. Meter	=	6.2898	Barrels	1	Barrel	=	0.159	Cu. Meters
1	Barrel	=	42	U.S. Gallons	1	Barrel	=	158.97	Liters

STANDARD ENERGY EQUIVALENTS

1000 metric tons of oil equiv. (TOE)

10	Tera calories (net)
41.9	Tera joules (net)
1.43	thousand metric tons of coal equiv.
1.2	million cubic meters of natural gas
11.63	gigawatt hours of electricity
7	thousand barrels of oil equiv
39.68	billion (10^9) BTUs (net)

1000 barrels of oil Equivalent (BOE)

1.43	Tera calories (net)
6	Tera joules (net)
0.204	thousand metric tons of coal equiv.
0.172	million cubic meters of natural gas
1.661	gigawatt hours of electricity
0.143	thousand barrels of oil equiv.
5.674	billion (10^9) BTUs (net)

1000 metric tons of coal equiv. (TCE)

7	Tera calories (net)
29.3	Tera joules (net)
0.84	million cubic meters of natural gas
8.14	gigawatt hours of electricity
0.7	thousand barrels of oil equiv.
27.78	billion (10^9) BTUs (net)

SPECIFIC GRAVITY: VOLUME PER TON

Degrees API	Specific Gravity @ 60°F	Barrels per* Met. Ton	Barrels per* Long ton.
25	0.904	6.98	7.09
26	0.898	7.02	7.13
27	0.893	7.06	7.18
28	0.887	7.1	7.22
29	0.882	7.15	7.27
30	0.876	7.19	7.31
31	0.871	7.24	7.36
32	0.865	7.28	7.4
33	0.86	7.33	7.45
34	0.855	7.37	7.49
35	0.85	7.42	7.54
36	0.845	7.46	7.58
37	0.84	7.51	7.63
38	0.835	7.55	7.67
39	0.83	7.6	7.72
40	0.825	7.64	7.76
41	0.82	7.69	7.81
42	0.816	7.73	7.85

SPECIFIC GRAVITY RANGES

	Specific Gravity	Barrels per metric ton
Crude Oils	0.80 - 0.97	8.0 - 6.6
Aviation Gasolines	0.70 - 0.78	9.1 - 8.2
Motor Gasolines	0.71 - 0.79	9.0 - 8.1
Kerosine's	0.78 - 0.84	8.2 - 7.6
Gas Oils	0.82 - 0.90	7.8 - 7.1
Diesel Oils	0.82 - 0.92	7.8 - 6.9
Lubricating Oils	0.85 - 0.95	7.5 - 6.7
Fuel Oils	0.92 - 0.99	6.9 - 6.5
Asphaltic Bitumen's	1.00 - 1.10	6.4 - 5.8

CALORIFIC VALUE OF FUELS

Rough Gross Values in Btu Per lb	
Crude Oils	18 300 - 19 500
Gasolines	20 500
Kerosine's	19 800
Benzole	18 100
Ethyl Alcohol	11 600
Gas Oils	19 200
Fuel Oil (Bunker)	18 300
Coal (Bituminous)	10 200 - 14 600
LNG	22 300

Multiples

micro	=	one millionth	hecto	=	one hundred
milli	=	one thousandth	kilo	=	one thousand
centi	=	one hundredth	mega	=	one million
dec	=	one tenth	giga	=	one billion (10^9)
deca	=	ten	tera	=	one trillion (10^{12})

Ref. Petroleum Magazine