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AINDT

INDUSTRIAL EYE

THE OFFICIAL JOURNAL OF THE AUSTRALIAN INSTITUTE FOR NON-DESTRUCTIVE TESTING

RADIOGRAPHY ▪ ULTRASONICS ▪ EDDY CURRENT ▪ PENETRANT ▪ MAGNETIC PARTICLE
VIBRATION ANALYSIS ▪ LUBRICATION ANALYSIS ▪ THERMOGRAPHY ▪ ACOUSTIC EMISSION

THE GREEN ENERGY ISSUE

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a Baker Hughes business

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President's Message March/April 2023

Dr. Irene Pettigrew

There is the pressing need to expand and improve methods of obtaining green energy as the environmental health of our planet rapidly declines due to climate change and the depletion of fossil fuels. This means that the green energy sector is only going to grow and develop.

This journal topic focuses on green energy. It is worthwhile having a discussion on the differences between green, clean, and renewable energy. Green energy comes from natural sources, clean energy does not release pollutants into the air, and renewable energy is from sources that are continually being replenished, such as hydropower, wind power or solar energy. Wind turbines, photovoltaic installations, tidal turbines, wave energy devices, concentrated solar power plants, biofuel and biomass installations support the generation of energy using these methods.

A resource can be all three; environmentally friendly, self-replenishing and non-polluting such as wind power. Green, clean, and renewable energy terms are often used interchangeably but can be contradictory like with biomass energy where the energy source is renewable but not green or clean. A further example of where this situation could arise is where power generation burns organic material from sustainable forests that are renewable, but this is not considered green energy due to the carbon dioxide emission by the burning process. Another case for consideration is a hydroelectric dam which may divert waterways and impact the local environment. The big issue is the environmental damage caused by building the infrastructure to support the energy generation preventing any energy source from being truly green.

Efficiency in green energy is dependent on location. Currently, wind farms are considered as the most efficient source of green energy because they require less refining and processing than the production of other forms including that of solar panels.

The shift from fossil fuel power production to green energy sources means that the NDT industry continues to evolve to prepare for this shift in energy supplier. Similar infrastructure to deliver green energy including piping and pressure vessels is still required. However, the green energy sector integrates innovative and new materials and equipment mainly to deal with the harsh environment conditions and overall mass reduction of the structures. Lessons learned and fundamental NDT and CM knowledge from other industry sectors can be migrated for application on green energy assets. In terms of NDT and CM, there is no paradigm shift in the requirements currently used within to fossil fuels but a difference in where is inspected and that type of testing with complex materials that changes.

NDT and CM are a crucial part of the overall operation of any green energy project to ensure reliability, safety and efficiency thus allowing for any remediation and/or repair actions to be conducted effectively meaning cost effectiveness of the energy generation process. Green energy would be nearly impossible without NDT and CM to take of care these assets without invasive practices that risk causing damage.

Advances in composites technology and testing has helped improve the lifespan of wind turbines but this comes with added complexity in inspection. I have fond memories of developing a microwave testing inspection solution for a damaged section of a wind turbine blade to detect and quantify the distribution of any delaminations within the fiberglass layers surrounding the region where the blade had been damaged during a cyclone Western Australia. NDT 4.0 is now being exploited for green energy inspections with the use of walking robot-based systems to taxi NDT solutions for inspection of wind turbines in lieu of rope-access deployment.

The requirement to maintain continuous service, has led to the development and deployment of CM predictive maintenance methods that avoid any down time associated with outages. Acoustic emission has been used for structural health monitoring for many applications including wind turbine blades and towers and well as pressure vessels associated with renewable energy. Data sets are large, and analysis can be perplexing and difficult to automate often still requiring human intervention and sanity checking of the data. However, automatic analysis algorithms can improve data acquisition parameters and be used to discriminate unwanted noise source signals such as friction from responses from primary damage events.

The next question surrounds where information can be sought on how to perform NDT and CM particularly to tackle inspection of complex materials. There is a lot of good research happening that is not widely published. Most literature available is in the form of conference papers and journal articles and not easy to find in one place. This journal explores some of these golden nuggets on what is happening in the green energy inspection space.

Haste Ye Back!
Dr Irene Pettigrew

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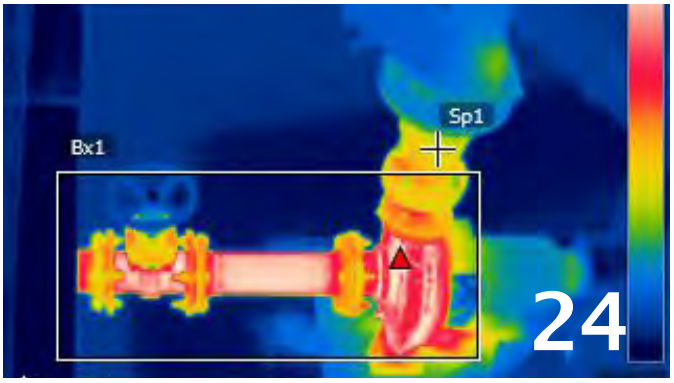

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Both wind and solar energy are at the forefront of green energy.

Editorial Committee
Peter Milligan
Fiona Obaidini
Production Fiona Obaidini
Design Alarna O'Connell

AINDT
PO Box 52, Parkville Vic 3052
P: (03) 9328 8831
www.aindt.com.au
E: federaloffice@aindt.com.au

ADVERTISING
AINDT Federal Office
P: (03) 9328 8831
E: journal@aindt.com.au

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Manuscripts should be submitted in electronic form:
1. in word
2. typed with single spacing
3. with figures as tif or jpeg files at better than 300dpi

Manuscripts should include:
1. symbols and abbreviations conforming to recognised standards; metric units (SI)
2. references listed, after the text, in the order in which they occur in the paper
3. references indicated in the text by arabic numerals in square brackets
4. tables and figures numbered separately but consecutively with Arabic numerals and brief, descriptive titles
5. a reference in the text to all tables and figures
6. graphs and diagrams made with lines of sufficient thickness to reproduce well
7. titles and address of authors

Procedure for submission of manuscripts:
1. articles should be sent to: journal@aindt.com.au
2. manuscripts will be submitted to referees who will remain anonymous
3. reprints of each paper will be supplied free to the author

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Member List

April 2023

The AINDT is a national peak body which promotes the professional practices of non-destructive testing and condition monitoring personnel. Our mission is to provide members, industry and the community with an independent and professional level of service in relation to the science and practice of non-destructive testing.

Through the State Branches and Federal Office, the AINDT aims to be an efficient and effective technical society by operating as a recognised notification body and providing membership to individuals, companies and government bodies who wish to keep informed or have an interest in non-destructive testing, engineering, or materials and quality testing in general.

AINDT provides businesses with the opportunity to be recognised as a contributor of this professional Institute by becoming a Company, Corporate or Sustaining member. By holding such membership, companies can benefit from advertising opportunities, heightened support, staff certification control and much more.

We would like to thank the following companies for their valued support:

SUSTAINING MEMBERS

ALS Industrial Pty
ATTAR
Stork Technical Services
Intertek-Adelaide Inspections Services
D R May Inspections

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Azure NDT Quality Services Pty Ltd
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Evident Australia Pty Ltd
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MDR Certification Engineers Pty Ltd
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NDT Equipment Sales Pty Ltd
Nobel Engineering Services
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Russell Fraser Sales Pty Ltd
SmartChem Industries Pty Ltd
Sonix NDT Pty Ltd
Simplifi Nii P/L
Thermal Imaging Services (AUS)

QLD

AXS Pty Ltd (Mackay)
Industrial Mining Inspection Solutions
International Tube Testing Pty Ltd
Lucas Drilling
Metal Testing Pty Ltd
M-Test Mackay
Queensland Alumina Limited
Testing Inspection and Calibration Services

VIC

ABEN Technical Services
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Gippsland NDT Services Pty Ltd
iTest NDT
LMATS Pty Ltd (Williamstown)
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NDT Instruments Pte Ltd
OMS Software Pty Ltd
QENOS
Shantou Institute of Ultrasonic Instruments Co Ltd
Stocks and Partners Ltd

SA

ASC Pty Ltd
NDE Solutions
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WA

Alliance Solutions Group
Applecross Electrical & Testing Service
Asset Reliability Inspections Pty Ltd
Australian Institute of Maintenance Engineering
GoldField NDT
Hofmann Engineering
Integrity Engineering Solutions
Metlabs Australia
MJ Engineering Inspection Services (Welshpool)
Vertech
Weld Integrity
Wood - Asset Performance Optimisation

Non-destructive Testing Certification Board (NDTCB) – Chairperson's Message

Barry Cooper

With the introduction of the new requirements of ISO9712:2021, the AINDT NDT Certification Board has implemented new requirements to enable a smooth transition for certification applicants. It should be remembered that these new requirements are being implemented pro-rate meaning any applications received pre-January 2023 will be dealt with under the rules of the 2022 guide to certification and qualification.

Any application received post January 2023 will be processed as per the new published guide which became active as of January 2023. For renewal and recertification applications, the ongoing experience requirements will be processed pro-rate as some experience will have been gained under the old rules and the remainder under the new rules of the published guide.

Certificate holders should be aware that if they struggle to meet the new requirements, they do have an option of completing a special consideration form detailing circumstances with which they need assistance. Whilst the special consideration process doesn't guarantee a favorable outcome for such circumstances, it does mean that applicants have a process to request special consideration from the NDTCB.

Recently, the AINDT Federal Office have been fielding requests for extensions of certification expiry dates. Whilst we did have a process for extending certification due to the COVID pandemic, certificate holders should note that the AINDT NDTCB policy is not to extend expiry dates of certification as the AINDT AQB network is now fully operational and delivering regular examinations.

During the APCNDT 2023 Certification Panel Session, a great deal of feedback had been received from industry regarding possible additions and improvements which could be implemented into the AINDT Certification processes. These have been collated and will be discussed at the next NDT Certification Board meeting to be held mid-April. However, if any members and/or Certificate holders wish to reach out to the Certification Board with further ideas we encourage you to email the AINDT Federal Office so these suggestions can be captured and fed into the meeting.

Barry Cooper
Chairperson – AINDT NDT Certification Board

Condition Monitoring Certification Board (CMCB) – Chairperson's Message

Shawn Moore

As reported in the last board update, that Condition Monitoring process for certification and membership applications is to be an online process. This being true, the process has not been fully implemented as yet and the Certification Board will still accept paper applications until the full online system is established. Updates will be published as the online system is fully implemented.

The 16th Asia Pacific Conference for Non-Destructive Testing was a wonderful event with the AINDT Board Members able to meet and discuss future plans. Networking was carried out over the week with many international and local delegates.

The event was a great opportunity for ideas to be discussed, with insight into some of the future challenges facing the condition monitoring industry into the future. One of the highlights at the conference was the progress in technology and the applications for drones.

AUSPTA sessions on the 3rd March at the conference contained presentations on new technologies for electrical monitoring, real case examples of cost savings in mining equipment monitoring and increased in service life of bull dozers, demonstrating real cost saving to mining industry.

Shawn Moore
Chairman – AINDT CM Certification Board

From the Institute

JH Cole award recipients 2023.

The JH Cole award was established in honour of James Henery Cole, who was the AINDT Federal Council Secretary/Treasurer from its inception in 1967 through to 1985. He was a founding father of AINDT and worked tirelessly for the development of NDT in Australia. This award is named after him, so that his name and legacy are not forgotten.

The JH Cole Award which takes the form of a framed scroll, is presented to a recipient who has made a significant contribution to NDT in Australia. It is AINDT's privilege to announce the J H Cole Award recipients for 2023.

Mr Paul Grosser

Who revolutionised the way NDT Technicians are trained and examined in Australia. He has revised all training courses, created new courses and delivered them all himself. In the process he has become the most Certified NDT Technician with ISO 9721 Level 3 Certificates in PT, MT,ET,RT,UT, PAUT and TOFD.

His innovations have included production of Excel based animations to enable a better understanding of the principles of NDT techniques, all of which are free for students to download. There are 25 of these on the ATTAR website and include:

- Eddy current calculator
- Digital radiography noise simulation tool
- Radiation safety – shielding & distance
- Ultrasonics analog vs digital calibration
- Simulator Phased array ultrasonics visualisation tool and
- Ultrasonics TOFD calculator

He has overhauled the AINDT exam database and assisted in the creation of an on-line examination package. Driven by the COVID pandemic lock downs, he further developed remote learning packages for students so that they have to spend less time away from home and the job, while studying.

He has also been involved in AINDT Federal Council, having been President over 2016-2018 as well as a member of the Certification Board. He has also been Chair of the IAEA NDT Technical Committee and is also a member of Standards Australia Committee MT004 NDT.

Finally, Paul spent a large amount of time organising the APCNDT2023 conference.

Paul has certainly made a significant contribution to NDT and is a worthy recipient of the JH Cole Award.

Mr Richard Nowak

Richard started his journey in NDT technology with Olympus, where he represented advanced NDT solutions across Australia and New Zealand in a National Technical Management role. This role him support key Mining, Maintenance, Aerospace, Defence and Oil & Gas projects.

He became an AINDT member in 2011 and contributed to the industry on the Victorian Branch Committee for over 10 years. He became President of the branch in 2014 & Federal Council Representative in 2016.

Richard has been instrumental in setting up an advanced NDT technical forum, allowing NDT experts to share ideas and technical knowledge. This positioned him as an industry leader supporting and educating the NDT industry.

and actively attends other industry relevant association's tradeshows, technical nights and events where he has spent an inordinate amount of his career out "at the coalface" giving technical support, training and technical seminars. He consistently goes above and beyond to support the future of NDT and the people involved.

Richard Nowak consistently volunteers himself at any opportunity to promote NDT and advanced testing solutions, whether it be at AINDT social or technical events, or organised industry seminars where he gives technical presentations and demonstrations advising fellow associates on methods of inspections to assist in further developing their knowledge or inspection efficiency.

Mr Neil Young

Neil's nomination was put forward by two members of the WA Branch council and supported unanimously at the Branch Council Meeting in July 2022.

Neil has supported the AINDT as a representative on the Federal Council for 10 years, 8 years as a director, and as as AINDT Federal President for 2 years. He has made outstanding contributions at both branch council and federal level including his promotion of AINDT as the certifying body of choice within Australasia.

In recent years he has been involved in the development and review of international standards relating to NDT methods and been major part of the alignment and integration with AICIP.

Neil is consistently providing energy, passion and time commitments in supporting and engaging with young people, providing necessary training, and integrating them into the industry.

AINDT Federal Councillors, Certification Board Members and Convenors of Committees of Federal Council 2022 – 2023

The AINDT constitution requires that each branch nominates councillors to Federal Council, depending on the size of branch membership (i.e. for 20–100 members, 2 representatives; 101–200 members, 3 representatives; and over 200 members, 4 representatives).

The AINDT constitution also gives Federal Council the power to appoint committees to which it can delegate responsibility, to propose policy and perform specific functions.

The two main committees of Federal Council are the Executive Committee; comprising of the Federal President, Federal Secretary, Federal Treasurer, Immediate Past Federal President, Federal Vice-President and Secretariat Liaison, who make decisions on routine matters and any specific matters delegated by the Federal Council and Certification Board, which is responsible for certification scheme.

Convenors of committees are required to report annually to Federal Council on policy and coordination of branch/committee activities in their particular field of activity.

FEDERAL COUNCILLORS

Board of Directors
President: Irene Pettigrew
Immediate Past President: Nick Eleftheriou
Vice President: Richard Stocker
Treasurer: Justin Cavanagh
Secretariat Liaison: Richard Nowak

New South Wales Branch
Darren Quinn
Neil Burleigh
Stuart Smart

Victorian Branch
Pranay Wadyalkar
Paul Trigg
Mark Welland

South Australia Branch
Craig Taylor Membership Registrar
Andrew Morris
Karl Saul
Tyson Jenke

Queensland Branch
Ian Hogarth
Damian Clarke
Roger Hardy

Western Australian Branch
Colm Kinsella
Catherine Fleay
Derek Bruns

NDT CERTIFICATION BOARD

Chairman: Barry Cooper
Honorary Secretary: Victor Mierzwa
Vice Chairman: TBA
Nata Rep: Diane Hobday
L2 Technician Rep: Yan Xu
Member: Angelo Zaccari
Training Provider: Mark Welland
Welding Rep: Bruce Ham
NANDTB Rep: Rodd Smith
Non-Voting member: Irene Pettigrew

CM CERTIFICATION BOARD

Chairman: Shawn Moore
Honorary Secretary: Dana Lake
Vice Chairman: Paul Rand
IRT Application/Exam Panel Chairman: Erik Thorup
LA Chair: Nick Thomas
Member: Joshua Morris
CMCB-Practitioner: Daniel Campbell
End User: Guy Salathiel
Commercial Provider: Keith DCruz
CMCB Practitioner: Sarel Klopper

Membership Registrar's Message

The Asia Pacific Conference for Non-Destructive Testing (APCNDT) was held at the Melbourne Convention Centre on the 28th Feb 2023 and is considered the major regional event for the Asia Pacific Federation for NDT.

The conference allowed NDT practitioners and presenters an opportunity to network about the latest and greatest NDT developments. This included providers, suppliers and associations involved in the NDT community across the country and abroad. This was no more evident with the technical and social interactions between like-minded people in all fields of NDT.

Personally, the APCNDT Conference venue facility was exceptional, spacious meeting rooms and exhibitor areas, quiet areas for attendees and professional support from the facility staff.

The AINDT organising committee should be congratulated as the conference ran seamlessly with the preparation in the workshops, meetings and support of the exhibitors and delegates during the four days.

I cannot thank this group of volunteers enough in the successful running of the APCNDT Conference.

Kind Regards
Craig Taylor

VIC and Tasmanian Branch News

President	**Paul Trigg**
Vice President	**Miro Katouzi**
Secretary	**Richard Nowak**
Treasurer	**Samad Ashgary**

The Victorian Branch would like to congratulate the organisers of APCNDT 2023 the 16th Asia Pacific Conference for Non-Destructive Testing. All delegates who attended will agree it was a fantastic industry conference. Over the four days delegates attended presentations and technical sessions delivered by industry experts and mingled at social gatherings which brought our community together.

It was clear a great deal of effort went into planning the event. It flowed so smoothly and flawlessly. The dedication from the AINDT office and Paul Grosser's commitment to this event must be applauded. Congratulations to all the industry award winners which included our very own Victorian Branch member Richard Nowak who was presented the JH Cole Award. Well done Richard. Your years of dedicated and continued service to AINDT and the NDT industry is recognised by receiving such a significant award.

Coming up, the Victorian Branch have a number of technical events in the pipeline;

- May 2nd Technical Night on Welds in NDT by Sadegh Abbaspour, 6pm at Golden Gate Hotel in South Melbourne
- Intro to NDT by Paul Grosser for engineers, students and associated technologists – planned for first week May

These technical events are valuable opportunities not to be missed. Getting involved, sharing knowledge and skills, and learning from experienced operators is such an important part of fostering your own passion and self-development in NDT.

Richard Nowack receiving the JH Cole Award.

I would like to thank the Victorian Branch for their commitment to AINDT, the industry and its members. Thank you, Miro Katouzi, Richard Nowak, Glen Haberl, Samad Ashgary, Pranay Wadyalkar, Peter Milligan, Mark Welland, James Burton and Sadegh Abbaspour. I'd also like to congratulate Shaina Johnson on being accepted onto the branch council. Shaina has previously held councillor positions in Queensland. She will surely be an asset to our Victorian Branch.

Please reach out to the branch council if you'd like to get involved or have any questions. I'm sure one of the councillors would be happy to support you in any way they can.

Regards
Paul Trigg – AINDT Vic & Tas Branch President

SA Branch News

Greetings from the SA branch!

It has been a slow start to the year for the South Australian branch, with no branch meetings held in the first months of 2023 due to several branch councillors attending the APCNDT. Branch activities will now start to pick up as the year progresses, with a number of events in planning that we are hoping to deliver for members. These include our AGM / social events, as well as some technical evenings we have in the pipeline. We are also in the planning stages of an introduction to NDT course as a benefit for SA Branch members, and an evening discussion on the new certification scheme.

As the SA branch was fortunate enough to have a number of councillors attend APCNDT 2023 in Melbourne recently, I have asked Simon Wilding, the branch vice president, if he could write about his experience at the conference. He writes:

"Proud to have been part of the South Australian contingent that was at the APCNDT (Asia Pacific Conference for NDT), there were well into the double figures of attendees based in our state, representing different organisations including Evident, ASC, Red Earth NDT, NDE Solutions, Kuzer Technical, Intertek and the new kids on our block ARI. In the words of Nick Eleftheriou "South Australia continues to punch above its weight".

APCNDT was a fantastic event held over 4 days, with good exhibits, great presentations and fantastic networking opportunities, both at the conference and social events after hours. It was helpful to put a face to the voice we hear on the telephone or to catch-up with old friends and new.

A shout out to the event organising committee, things appeared to run smooth and the content of the papers was a very high standard, there is a saying that "what happens in Vegas, stays in Vegas", but I think that what happened in Melbourne will resonate throughout the Asia Pacific and around the world."
– Simon Wilding, AINDT SA Branch Vice President

With Simon's words, I will wrap up the branch update for this issue and look forward to what the SA branch has in development for the next quarter.

Cheers
Karl Saul, AINDT SA/NT Branch President

PNI

Professional Networking Institute

WOMEN IN ENERGY
AUSTRALIAN INSTITUTE OF ENERGY

YOUNG MINING PROFESSIONALS

ENERGY CLUBWA

ENERGY RESOURCES LAW

AINDT
Australian Institute for Non-destructive Testing
Western Australia Branch

YES!
SUT: Young Engineers and Scientists!

YOUNG ENERGY PROFESSIONALS
AUSTRALIAN INSTITUTE OF ENERGY

Energy and Mining
(Mining, Oil & Gas and Renewable Energies)
Collaboration Networking

Sundowner & facilitated speed-networking

Thursday, 11th May 2023

NSW Branch News

A technical evening is being planned for the second quarter of this year with En De Tek supporting a night all about the maintenance requirements for tank testing equipment. This will get down and dirty in the MFL space as often this equipment is neglected, banged in and out of manholes, and the bare minimum completed to keep it in production. We will focus on maintenance to ensure good ongoing working condition and extending the life of these very important assets. More information on this technical evening will be made closer to the event.

We are also actively seeking options for further collaborations and combining some future meetings with other industry bodies, where we can bring value to our members.

There are quite a few parallels across different sectors and market segments that can see a combined approach make sense and will bring together likeminded people to ensure Australia is at the forefront of technology and expertise. If you work with any other industry bodies, and recognise some crossover, please reach out and we will get together on increasing our reach and help promote knowledge sharing.

The AINDT NSW Branch Council is proud to have a combined 225+ years of active council experience on the current committee, once you add in industry work experience, the years start getting a bit scary! A few of our councillors are now in their 3rd and 4th decades of continuous service to the AINDT membership. With this vast knowledge we urge everyone to come along to the events throughout the year. Please keep a look out for upcoming event information from the federal office, we hope to see you there!

Regards,
Sam Hallifax – NSW Branch Secretary

AQB Availability

AINDT examinations are available through a network of AINDT Authorised Qualifying Bodies (AQB's) as well as the two scheduled AINDT exam rounds.

AQB's are free to offer AINDT approved training and initial/recertification examinations in any Australian state at any time throughout the year. The scheduled AINDT examination rounds are conducted twice yearly (normally June and November) with dates being advertised in both the *The Industrial Eye* and the AINDT e-newsletter.

Whilst AINDT makes every effort to notify certificate holders of expiry of certification, it is the certificate holders responsibility to initiate the renewal & recertification process prior to expiry of certification (late fees apply to late certification applications).

Listed below are the AQB's for which AINDT has authorised to conduct AINDT examinations and the AINDT examination.

South Australia

Kuzer Technical

Contact: David Suede
Phone: 1300 199 086
Email: info@kuzer.com
Schedule: kuzer.com/schedule/

NDT Methods Levels Industry Sectors offered:

Ultrasonic Testing 1, General Engineering
Ultrasonic Testing 2, Welds
Radiographic Testing 1,2 Welds
Magnetic Particle Testing 1,2 Multisector
Penetrant Testing 1,2 Multisector
Visual/Optical Testing 2 Multisector
Phased Array Ultrasonic Testing 2 Multisector
Eddycurrent Testing 2 Multisector

Victoria

ATTAR – AQB – Advanced Technology Testing and Research

Contact: Mark Welland
Phone: 03 9574 6144
Fax: 03 9574 6133
Email: training@attar.com.au

NDT Methods Levels Industry Sectors offered:

Computed & Digital Radiography 2, 3
Ultrasonic Testing 1,2,3 Welds, Casting, Wrought, Aerospace, Thickness
Radiographic Testing 2,3 Welds, Casting, Aerospace
Magnetic Particle Testing 1,2,3 Multisector, Aerospace
Penetrant Testing 1,2,3 Multisector, Aerospace
Eddy Current Testing 2,3 Multisector, Aerospace
Magnetic Flux Leakage 2
Tank Bottom Testing
Phased Array levels 2 & 3 Ultrasonics 2 Multisector
Visual/Optical Testing 2 Multisector
Time of Flight Diffraction (TOFD) levels 2 & 3 Welds
Heat Treatment
ISO 9712 UT Level 2 Corrosion/Erosion – Detection and Mapping (CDM)
Limited Certification

Western Australia

ALS Training Academy

Phone: 08 9232 0300
Email: trainingacademy@alsglobal.com

NDT Methods Levels Industry Sectors offered:

Ultrasonic Testing 1,2 Welds
Magnectic Particle Testing 1,2 Multisector
Penetrant Testing 1,2 Multisector
Phased Array Ultrasonic Testing 2 Multisector

ATTAR – Advanced Technology Testing and Research – Authorised Examination Centre

Contact: Mark Welland
Phone: 1300 139 155
Email: training@attar.com.au

NDT Methods Levels Industry Sectors offered:

Computed & Digital Radiography 2, 3
Ultrasonic Testing 1, 2,3 Welds, Casting, Wrought, Aerospace, Thickness
Radiographic Testing 2,3 Welds, Casting, Aerospace
Magnetic Particle Testing 1,2,3 Multisector, Aerospace
Penetrant Testing 1,2,3 Multisector, Aerospace
Eddy Current Testing 2,3 Multisector, Aerospace
Magnetic Flux Leakage 2
Tank Bottom Testing
Phased Array levels 2 & 3 Ultrasonics 2 Multisector
Visual/Optical Testing 2 Multisector
Time of Flight Diffraction (TOFD) levels 2 & 3 Welds
Heat Treatment
ISO 9712 UT Level 2 Corrosion/Erosion – Detection and Mapping (CDM)
Limited Certification

Queensland

ALS Training Academy – Authorised Examination Centre

Phone: 07 3816 5500

NDT Methods Levels Industry Sectors offered:

Ultrasonic Testing 1,2 Welds
Magnectic Particle Testing 1,2 Multisector
Penetrant Testing 1, 2 Multisector
Phased Array Ultrasonic Testing 2 Multisector

Condition Monitoring Training Centres

The following training providers offer training in one or more Condition Monitoring methods, categories and industry sectors.

This training has been approved by the AINDT as meeting the national syllabi as endorsed by the AINDT Certification Board.

Learners are advised to obtain a copy of the training module (syllabus) from the training body, or by downloading from the AINDT web site, when undertaking training in an CM method or industry sector module.

Applicants for Certification must complete the training program and training hours as set down in ISO18436 for the relevant CM Method, Category and Industry Sector.

All exams are conducted by the AINDT please contact the office for dates and other relevant information.

CM Training Centre Locations:

Victoria

University of Melbourne

Parkville
Victoria 3010
Phone: +61 3 9810 3348
Contact Email: claudine.evans@unimelb.edu.au

Industrial Precision Instruments

Unit 12, 634-644 Mitcham Rd Vermont
Victoria 3133
Phone: +1300781701
Email: training@ipi-inst.com.au

SKF Reliability System

SKF Australia Pty Ltd
17-21 Stamford Rd
Oakleigh, Victoria 3166
Phone: +61 3 9269 0763
Contact Email: laszlo.Csernatony@skf.com

Wood - Asset Performance Optimisation

Level 3, 171 Collins Street
Melbourne, Victoria 3000
Phone: (08) 6314 2000 / (08) 6314 2280
Email: svt.bu.training@woodplc.com

Western Australia

ALS Training Academy

109 Bannister Road, Canning Vale
Western Australia 6155
Phone: 08 9232 0300
Email: trainingacademy@alsglobal.com

Wood - Asset Performance Optimisation

Level 1, 240 St Georges Terrace
Perth, Western Australia 6000
Phone: (08) 6314 2000 / (08) 6314 2280
Email: svt.bu.training@woodplc.com

Queensland

Advanced Infrared Resources Australia AIRA

PO Box 372 Hervey Bay
Queensland 4655

Phone: 0467 565 836
Email: jeff@irtau.com.au

ALS Training Academy

7 Brisbane Road Riverview
Queensland 4303
Phone: 07 3816 5500
Email: trainingacademy@alsglobal.com

Wood - Asset Performance Optimisation

Level 20, 127 Creek St
Brisbane, Queensland 4000
Phone: (08) 6314 2000 / (08) 6314 2280
Email: svt.bu.training@woodplc.com

AOG Energy 2023

AOG Energy 2023 was held at the Perth Convention & Exhibition Centre from the 15th to the 17th of March. AOG Energy is held annually in the energy hub of Australia, Perth. For over 40 years it has brought the entire oil, gas and energy supply chain together as a platform for discovering innovation, capabilities and opportunities, supported by major operators, government and industry.

To reflect the innovative and changing environment of the oil and gas industry, the event has been rebranded as AOG Energy from the Australian Oil & Gas conference. The theme for this year's event was 'Powering the Energy Future, highlighting the renewed focus on energy security and opportunities that may not have previously been available to local businesses within the oil and gas industry.

It was fantastic to see the exhibition presence come back to the size and scale we have enjoyed in the past, after a smaller scale event in 2021. There was strong attendance in Western Australia, nationally and internationally, with lots of interest at all exhibition stands. The AINDT and AICIP stand was well attended with many positive discussions shared, and the USB sticks, pens, rulers, and journals being taken by the end of the event! The stand was hosted by the AINDT WA Branch contingent including Irene Pettigrew, Derek Burns, Richard Stocker, Paul Lavender and Colm Kinsell a with some interstate assistance from Nick Eleftheriou who was attending on behalf of Evident, another great supporter of the AINDT.

As well as the exhibition, there were opportunities to attend several talks and discussions including sessions such as the Opening Party, a Diversity and Inclusion Breakfast, and the Subsea Energy Australia Welcome Drinks.

Richard Stocker presenting at The Knowledge Forum.

Paul Lavender, Richard Stocker, and Irene Pettigrew at the AINDT stand.

Of note was the excellent Knowledge Forum for 2023 for which the AINDT facilitated. The AOG Energy Knowledge Forum aims to educate, inspire and inform through technical and educational conference sessions.

Bringing together specialised industry sectors to discuss the latest techniques and technology, the Knowledge Forum provided a platform to share insights that enable the industry to overcome both current and future challenges. Supported by key industry bodies, the Knowledge Forum reflects the current trends and challenges impacting the wider oil and gas industry.

This year, our knowledge forum was focused on recent NDT technology developments for ageing assets and

Matt Santich, Irene Pettigrew, Richard Stocker, Rhiannon Bealey.

Irene Pettigrew addressing delegates at The Knowledge Forum.

was hosted by Richard Stocker. The three presentations delivered were very well attended and received and consisted of:

- Non-Intrusive Inspection for Corrosion Under Insulation: Irene Pettigrew (Enermech)
- PA-CAT' - corrosion under pipe supports: Colm Kinsella (ARI)
- External Inspection of Subsea Pipelines and Risers using Acoustic Resonance Technology (ART): Stuart Kenny

Overall, it was a successful event, with positive contributions and interactions for the AINDT and its member companies in attendance. We are hopeful that AOG Energy 2024 will once again increase in size and that the AINDT Knowledge Forum will return!

AOG 2023 exhibition area in full swing.

Day two of AOG Energy with the Diversity & Inclusion Breakfast. Our keynote presenter Rebecca Tomkinson, Chief Executive from the **The Chamber of Minerals and Energy of Western Australia.**

See you there next year!
aogexpo.com.au/subscribe/

APCNDT2023

Well, that's a wrap! After almost 9 years of planning and a global pandemic, the 16 Asia Pacific Conference on NDT, APCNDT2023 (Originally APCNDT2021) has concluded.

AINDT won the bid and the privilege of hosting the 16 Asia Pacific Conference on NDT at the Mumbai Conference in 2013. Originally planned for March 2021, it was the first time in history that the Asia Pacific Conference on NDT would be postponed for a 2-year period, however the planning and organisation by a small group of AINDT volunteers and staff never stopped, they have worked tirelessly to promote the event at every opportunity.

Thank you to:

Paul Grosser
Peter Milligan
Catherine Fleay
Colm Kinsella
Irene Pettigrew
Ian Hogarth
Justin Cavanagh
Keith Arcus
Neil Young
Nick Eleftheriou
Pranay Wadyalkar
Richard Stocker

Without the efforts of this group, the support from AINDT members, sister societies and affiliations, the conference would not have been the success it proudly was.

Traditional smoking ceremony.

APCNDT VIP's enjoying the opening ceremony.

Welcome to country at the opening ceremony of APCNDT23.

ICNDT Chairmen, Dr Sajeesh Kumer Babu addressing the audience at the opening ceremony.

APFNDT Dr. Norikazu Ooka presenting AINDT's President Dr Irene Pettigrew with a gift from the association.

Prof. Younho Cho. President of WCNDT updating the attendees on plans for the WCNDT event .

AINDT President Dr Irene Pettigrew congratulating Dr Christine Scala on her presentation of the Alex Wilson Memorial Lecture.

Keynote speaker and NATA CEO, Jennifer Evans.

As a proud host we were thrilled with the response from our community, bringing together people from across a range of related disciplines to network in Melbourne for an innovative, informative and engaging experience.

The APCNDT2023 was an important event for our region, bringing international experts, manufacturers, cutting edge equipment and suppliers to the Asia pacific region across a four day, jam packed event, covering various industry sectors including oil and gas, power, mining, aerospace and transportation.

A Special mention to Dr Christine Scala who delivered the Alex Wilson Memorial Lecture and Jennifer Evans, Iain Baillie, Paul Holloway & Paul Grosser who each delivered a key note address.

The APCNDT2023 wouldn't be possible without the support of our sponsors and exhibitors. The support that the AINDT receives form these companies is immense.

Platinum Sponsor

EVIDENT | OLYMPUS

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Waygate Technologies
a Baker Hughes business

Coffee Sponsor

ATTAR
www.attar.com.au

Satchel sponsor

NATA DELIVERING CONFIDENCE
for more than 75 years

Name badge and Lanyard Sponsor

IRIS NDT

And we can't forget our exhibitors who were integral to the conference, showcasing the latest products, services and technology in the market.

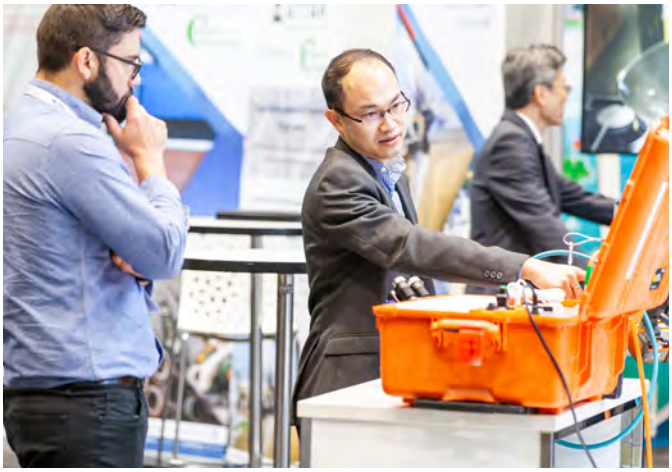
We are very much looking forward to the 17th Asia Pacific Conference on NDT, to be hosted by ASNT in Hawaii 11-14 May 2026!

The NATA team enjoying the exhibition.

The amazing team at Evident preparing for a full on day!

APCNDT offered attendees the latest in equipment available to the industry.

Mr Neil Burleigh from En De Tek Australia working the floor at the expo.



Attendees gaining valuable equipment information during the event.

Attendees enjoying a well earned coffee break.

Mr Chemie staff enjoying the event.

Mr Paul Grosser and friends enjoying the opening cocktail function at the exhibition.

Our international guests working off the jetlag following a long flight from the UK.

Dr Sajeesh Babu presenting Dr Irene Pettigrew with a gift from the NDT society of Singapore.

Evident staff socialising at the opening cocktail function.

The gangs back together! Gary Barber, Gary Martin and John Macarone.

The team at ATTAR enjoying the gala celebration.

Students being guided around the expo by Colm Kinsella.

NDT World Event Calendar 2023/2024

If you were able to attend either the APCNDT 23 or AOG ENERGY international conferences this year, your appetite for knowledge and networking would have been piqued. Yes, borders are open and travel is beckoning!
The following list offers information on upcoming international NDT conferences for your consideration:

May 15 – 17, 2023
Dach Annual Conference
Annual meeting (dgzfp.de)
Graf – Zeppelin-Haus, Friedrichshafen Germany

NDT in research, development and application

Lake Constance with its picturesque town of Friedrichshafen is once again the venue for the DACH Annual Conference 2023. After an overwhelmingly positive response to the DACH Annual Conference 2019, the city at the border triangle was chosen again.

Even though many people may be aware of the advantages of the city on the Swabian Sea, especially those who were already among the participants in 2019, we would like to warmly recommend Friedrichshafen to the "new" DACH visitors.

Interesting cities are usually characterised by three things: exciting jobs, high recreational value and friendly people. With the score that Friedrichshafen would achieve with these three criteria, it would have earned a top spot among German cities.

A lot of culture, a breathtaking view of the Alpine mountain range, which stretches from west to east in the south, many companies and universities that have further developed the heritage of well-known greats and of course Lake Constance offer everything to live and work. Therefore, it is definitely worth coming back to deepen the topic "NDT in research, development and application" in lectures and poster presentations.

The Graf-Zeppelin-Haus welcomed us warmly in 2019 and offers everything necessary for a contemporary conference. It is therefore obvious to hold the DACH conference again in this conference center.

In accordance with the open-minded spirit of Friedrichshafen, all areas of science, research and the practical application of NDT methods should be reflected at this DACH annual conference. Experience reports and exchange, results of practical tests and manual testing in production or maintenance are just as much in demand as those from automated, industrial testing.

From almost 130 applications for contributions, the programme committee put together an interesting programme in December 2022.

Numerous registrations have already been received for the accompanying equipment exhibition. The booking of an exhibition stand is possible until 31 March 2023, subject to availability.

We look forward to seeing you in Friedrichshafen and looking forward to an interesting conference!

June 6 – 8, 2023
The 10th edition of the Cofrend Days
Presentation Cofrend2020 – Non Destructive Testing (Cofrend2023.com)
Marseille – Palais Chanot

Organised by the French Confederation for Non-Destructive Testing, this conference offers A unique program of highlights, to effectively link exhibitors, researchers, scientists and visitors around Non Destructive Testing. An Open Day on June 7th, dedicated to the students from the Region of Marseille, to discover the NDT profession.

A STRONG, DIVERSIFIED, ADVANCED, WORLD-RANKING INDUSTRIAL PRESENCE

AEROSPACE – NAVAL CONSTRUCTION AND REPAIR – RENEWABLE ENERGY – NUCLEAR – OIL AND CHEMISTRY – IRON AND STEEL INDUSTRY – RAILWAY TRANSPORT

Openness and access to information and technology are a priority in terms of innovation and technological advances. They must make it possible to apply the latest techniques to offer better services in inspections and non-destructive testing.

The scientific program, made up of approximately 160 scientific and technical conferences, led by quality speakers in terms of expertise, will allow participants to discuss around:

- New industrial applications of NDT methods;
- Feedback from industry
- Research and development

Poster sessions will allow young PhD students to present their thesis subject to scientists and industrialists. Note, the awarding of the COFREND Prize, to 3 winners, on the criteria of the Jury, and the celebration of the Prize during the Gala evening.

Also, every afternoon at the opening of the technical program, there will be scientific plenary conferences.

- highlighting technological evolution and presenting new possibilities and applications of the various NDE methods in industrial domains through technical conferences and an exhibition
- fostering thoughts on the new industrial challenges of NDE in face of imperatives in terms of competence, employment, and promotion of the inspector's

profession through specific debates and « Open Days » centred on training and on the professional career path.

July 3 – 7, 2023
13th European Conference on Non-Destructive Testing (ECNDT 2023).
ECNDT2023
Centro de Congressos de Lisboa (CCL), Lisbon, Portugal.

The next European Conference, the 13th in the series, organised by RELACRE, the Portuguese Association of Laboratory Accreditation, is to be held in Lisbon, Portugal.

The European Conference on Non-Destructive Testing (ECNDT) is considered the major international event for EFNDT and its member societies. The event shows the importance of this economic sector and the diversity of its activity and competence to ensure Safety, joining all the community of NDT (Academia, Inspection Companies, Accredited Laboratories, Industry, and Suppliers of Equipment). It is the perfect opportunity for networking and to get in touch with the state-of -art of research and innovation and to meet the developments of equipment provided by the European and World NDT Community.

The conference includes a technical and scientific programme which presents the latest developments in the field of research and development as well as the application of NDT in all major industrial areas. The exhibition organised in conjunction with the conference emphasises the close link between research and development, and the equipment and instruments used by industry.

The conference and the exhibition are combined the best promotion of NDT and at the same time offer unique opportunities to establish contacts and exchange experience and ideas between participants and visitors

September 12 – 14, 2023
19th International Conference on Condition Monitoring and Asset Management CM 2023
About the conference

The British Institute of Non-Destructive Testing (BINDT) is pleased to invite you to this premier event, the Nineteenth International Conference on Condition Monitoring and Asset Management (CM 2023), which will be co-located with NDT 2023 to celebrate the 60th Annual British Conference on NDT. To find out more about NDT 2023, click here.

The conference is being organised by BINDT in close partnership with the International Society for Condition Monitoring (ISCM) and the US Society for Machinery Failure Prevention Technology (MFPT). This combination of the efforts of these leading organisations creates one of the largest events of its kind at a truly international level and builds on the highly successful 18 international condition monitoring (CM) conferences organised by BINDT, the First World Congress on CM in 2017 organised by BINDT and ISCM and 71 annual conferences organised by the MFPT Society.

BINDT has always recognised the importance of encouraging students to participate in this major international event. As a gesture to celebrate the nineteenth international conference, the Institute will be providing sponsorship of student registrations in 2023, resulting in a reduction of fees for student attendance.

23 – 26 October, 2023
ASNT 2023 Annual Conference
ASNT 2023
Marriott Marquis & George R. Brown Convention Centre Houston, Texas, USA

"EVOLUTION"

The NDT world is evolving at a rapid pace. From advances in technology, to artificial intelligence and machine learning, to an everchanging workforce, NDT continues to evolve. ASNT 2023: The Annual Conference is a reflection of this evolution. Save the date and make plans to join us in Houston, Texas. Call for presentations is now open. Click here to present.

ASNT 2023 is the place to mingle with more than 2,000 NDT industry professionals and hear industry experts present high-quality, innovative content. The conference will feature exciting general sessions and time to connect with your peers, plus a vibrant exhibit hall with over 225 exhibitors. ASNT 2023 is the best opportunity to share your research/work, hear updates on the latest NDT advances, network with your colleagues and meet new ones.

27 – 31 May, 2024
The 20th World Conference on Non-Destructive Testing (20th WCNDT)
20th WCNDT
Songdo Convensia, Incheon, Korea

It is our great honour to invite you to attend the 20th World Conference on Non-Destructive Testing (20th WCNDT) hosted by the Korean Society for Non-destructive Testing (KSNT) to be held in Incheon, South Korea in May 2024 under the auspice of ICNDT.

We have been waiting for such a long time this wonderful world conference to take place in Korea, and are now ready to provide a revitalised conference and exhibition.

The Organising Committee will offer a dynamic technical program that will be highly informative for every participant. The conference will be the place to interchange and integrate of professional colleagues from all around the world with an interest in this field.

We are so confident that the 20th WCNDT will turn out to be the most successful platform for networking and inspiring new technical ideas with the support from all of you.

The venue, Songdo Convensia, Incheon, is a centre of trade and transportation built upon the advanced infrastructure of Incheon International Airport (IATA: ICN). Within an hour's distance from Seoul by public transportation, visitors will be given the opportunity to experience a mix of diverse cultures and world-class urban life. We look forward to meeting you all at Songdo Convensia, Incheon in May 2024.

Thermography in Action

Welcome to *Industrial Eye*'s regular feature on infrared thermal images from the Australian Professional Thermography Association. (AUSPTA). Every infrared image tells a story. These images and information are presented as brief snapshots to show examples of thermography in action in the real world.

It's all about the . . . temperature variation!

AUTHOR: SCOTT FLETCHER

As professional thermographers we are often asked the question: "So what temperature is a fault"? There is never a simple answer as Thermography must always consider many factors. In the following scenario we can investigate an explanation.

This example highlights the situation that as thermographers we are looking for many factors when performing our day-to-day function. In this example the factor is "an anomaly" that leads us to into the diagnosis.

Whilst carrying out an electrical survey I was walking past this pump setup and from the thermal difference I could tell that from what I was seeing, something was not as it should be.

The pump supply is from the left horizontal pipe entering axially into the pump and the discharge is delivered radially from the pump into the vertical pipe.

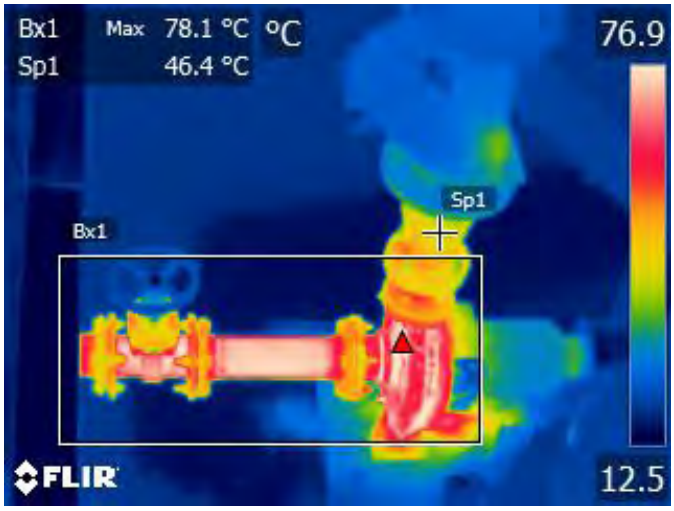
From the first thermal image of pump #2 furthest away, the supply and discharge temperatures were very different to each other.

Some might say: "Its pumping hot water!"

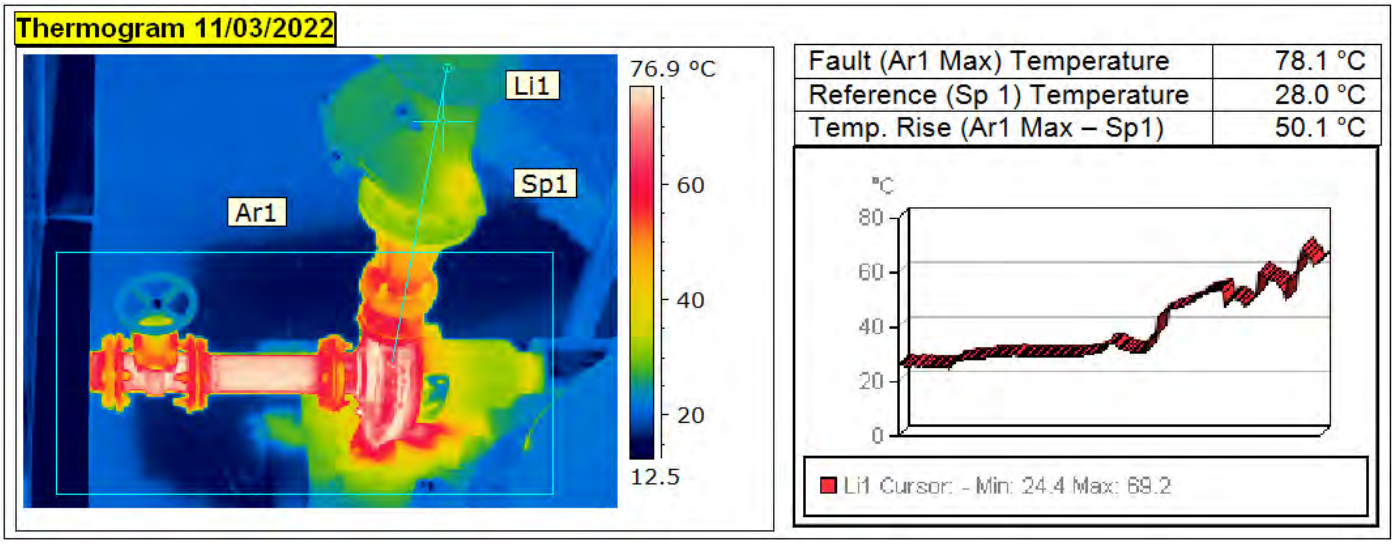
Well, how is it then that the delivery is much cooler?

Maybe it's hot water and the pump is not running? Well, the thermal gradient in the supply pipe is telling me it's the hottest within the pump and the motor is also warm, both inform me the pump is, or at least has been running.

But how about if the pump is running but the non-return valve directly above the pump is closed? While that would make sense thermally, why would that be the case?



IR image shows thermal anomaly.



Above, temperature plotted graph is shown.

The scenario

From the picture we can see two pumps in this pit with both pumps having separate supply lines.

What you can't see from the picture is that both discharges merge (out of frame) into the same pipe.

The pumping system was configured to only run one pump at any one time, when the question was asked: Why are we then running two pumps online at the same time? It was presumed that running two pumps together would give a greater flow overall.

The Maintenance department noted at the time that the hot pump was going through mechanical seals more often than the other pump.

They could also tell that Pump #1 (closest to the camera) would always be started first in the sequence, followed by Pump #2.

It can be seen in the photos that a ball type non-return valve is fitted to both pumps just above the pipe transition piece within the discharge pipe work above the pump. This non return valve is designed to be held down closed on the stopped pump #2 when pump #1 is running and vice versa.

However, when Pump #2 was started with Pump #1 already running, it would not create enough pressure to lift the ball from its seat to allow flow, causing the water to just "recirculate inside the pump" and heat up.

Possible danger, failure

This is a potentially dangerous situation. If there is enough power from the motor, the churning of the water within the wet end can cause the water to boil, and possibly pressurise. There is a risk that faulty operation could lead to a failure.

The site owner was informed of the situation immediately and Pump #2 was shut down. An incident report was filed with the issue to be fully investigated.

Conclusion

Once again, this identified fault was diagnosed due to the in-depth knowledge of thermography and understanding thermal variations and heat transfer principles combined with having a full understanding of both the mechanical and electrical systems at work.

There is no substitute for engaging properly trained, certified, and experienced Thermographers to carry out your plant inspections.

It is far better to manage the condition and not the failure: In this case running a piece of equipment to no additional gain, and only to its own detriment.

Scott Fletcher is an accredited Cat 2 Thermographer. Scott is also a Foundation, and Committee member of AUSPTA.

AUSPTA

Standards Report by Angelo Zaccari Chairperson MT007

With great support from our new Standards Australia Project Manager (Engagement Officer), her efforts to ensure we maintain traction with all developments and voting, the systems have improved greatly which will allow MT007 to bring further developments to you at a quicker rate.

As we can see in industry, a lot of changes are continually taking place within material manufacturing processes, fabrication and welding, accreditation schemes, training and certification schemes with many organisation specifications calling on ISO or USA Standards. At present, it can be seen that these International Standards will continue to be ramped up across many industry sectors which most likely will greatly impact NDT.

The MT007 Committee was bolstered by David Padfield, an expert in the field of Acoustic Emission. There have been an extensive amount of AE Standards being developed by the ISO Committees and David will certainly be kept busy reviewing these Standards and providing the necessary feedback to all members.

We also welcome to the Committee, Ali Hadigheh from the University of Sydney who has diverse experience in Non Destructive Testing and

MT007 held a meeting on the 9th February 2023 with the main items covered and responses to the proposals are as follows

- To adoption of ISO 3452.1
- To adoption of ISO 3452.2
- To adoption of ISO 9712 Current Version.
- Review adoption of EN 4179
- The addition of University of Sydney to Stakeholders.

At the APCNDT Conference held in Melbourne a number of Open Panel Q&A sessions were held where Standards was represented very well with Paul Grosser, Keith Arcus and myself present, however unfortunately I could only attend the first Q&A session but with second session also well represented all questions could be answered with other members from MT007.

Further ballots were held regarding ISO Standards being developed and as they progress through the ISO Committees. They were as follows.

1. NDT – MT007

ISO/FDIS 18251.2 – Infrared thermography – Test method for integrated performance of system & equipment

ISO/DIS 24367 – Non-destructive testing – Acoustic emission testing – Metallic pressure equipment.

2. Con Mon – ME087

As I indicated in the previous Standards News, the information and details regarding the ME087 Committee is no longer available to me

We do bring to everyone's attention, to make public commenting easier and simpler for both commenters and committees, Standards Australia has launched a new public commenting platform through the contributor portal, **Connect.** You can register on the portal and make comment following the below link.

www.standards.org.au/news/standards-australia's-new-public-comment-platform-launched

Please contact me using the details below if you have any questions or require further information and I will reply at the first opportunity.

Angelo Zaccari
MT007 Standards Chairperson
azaccari@aben-tech.com.au

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New examination format and criteria

The recent APC NDT Conference was held at the Melbourne Conference and Exhibition Centre from February 28th to March 3rd. This event marked the first in-person conference for many attendees in several years, as travel and gathering restrictions due to the COVID-19 pandemic had previously limited such opportunities.

Hosted by the AINDT, the conference featured a specialized stream on pressure equipment, with a session chaired by Neil Young, David Lake, and Jamie Hislop. This session offered updates on the ongoing revision of AS3788 and the adoption of new examination formats for future assessments. Throughout the conference, several engaging presentations with a focus on pressure equipment were delivered, shedding light on the challenges and innovations faced by service providers and asset owners alike.

AS3788, currently under development by the standards committee, is anticipated to be released for public comment by the end of June. Despite some unforeseen setbacks, the revised standard is expected to provide an updated reference for modern inspection practices, promoting the acceptance of Risk-Based Inspection (RBI) methodologies and advanced inspection techniques for data collection.

Following the release of AS3788, AICIP will introduce an exam question bank tailored to the updated standard. The exam format will remain online, with AINDT and AICIP agreeing to administer the exams more frequently through approved qualification bodies. This approach will resemble the existing delivery of training and examination for ISO9712 courses. The transition to the new examination format and questions will occur gradually, allowing future ISI and SISI exam candidates sufficient time to prepare according to the new criteria.

The most recent AICIP ISI and SISI exam round took place across Australia in March, with a robust attendance across all states and territories. The results of this exam round are expected to be available in the coming weeks, and participants will receive their results via email from the secretariat once they are finalized.

AICIP are seeking expressions of interest for persons wishing to take part in future exam invigilation and marking, as well as a steering a committee for the development and approval of future exam questions and criteria. If you would like to register your interest, please forward your current CV and covering letter to uma.sudhakar@aindt.com.au

The role of accreditation in NDT 4.0

The skillsets of NDT 4.0 are being defined now. As 'Industry 4.0' and the increased use of automation and AI change the world of NDT, confidence in the competence of testing providers is as important as it ever was.

AUTHOR: JENNIFER EVANS CEO OF NATA AND CHAIR OF ASIA-PACIFIC ACCREDITATION COOPERATION.
WWW.NATA.COM.AU

Traditionally an NDT test was a discrete activity at a single point in time, a report was issued following a test, and it was clear what competencies were needed to provide sound information to decision makers.

The continuous advancement of automated tools are now evolving that process, demanding different skills with the advent of robotics, big data analytics, machine learning and digital twins. Although these tools may be new, and represent extended capabilities, they're still underpinned by existing principal NDT techniques; however, they're now being used in more sophisticated technical settings.

The knowledge, skills, and attributes required to support new approaches to testing are undergoing a fundamental shift. However there are some fundamentals that won't change.

NATA has co-evolved with the industry for the past 75 years and that has provided a robust foundation for ensuring competency of NDT organisations for the coming decades.

A not too distant future

We're not far away from a future where, I believe, asset owners will come to expect real-time information on the integrity of their assets. They will expect to know when the earliest signs of potential failure appear. And they will expect to know before it impacts operational activities. They will want to monitor issues as they arise and choose to correct or modify or repair failures in a controlled proactive manner. They will want to decrease costs due to failure and improve safety.

There are likely to be sensors embedded in the infrastructure, and robots that are continuously monitoring and relaying information to interested parties. Routine scheduled checks may no longer be required. These checks may be superseded by the vast data lake of information that continuous monitoring is likely to provide.

It's a place where the future 'laboratory' uses tools such as artificial intelligence, machine learning and big data analytics to identify the meaningful signals that show potential concerns in the dataset for the asset. In this future laboratory, I believe there will still be a need for level 1, level 2 and level 3 NDT professionals. And it's my firm belief that key personnel will become more important, not less, with greater adoption of technological developments.

In this new world, NDT professionals, and the technical control under which they work, will need new skill sets that will be more closely aligned to interpreting generated data. They will, of course, still be required to manage the testing and reporting of the non-destructive tests undertaken, however, much of the manual testing as we see it today will become the exception to the rule!

Technology operating on the spectrum between sophisticated algorithms and actual artificial intelligence is already available. And automation of testing is not new. Since I started at NATA 35 years ago, we've been accrediting increasingly automated testing across many industries. For example, when I worked in a pathology laboratory, the daily work of a scientist at the bench involved some semi-automated testing and still a large number of tests performed manually – using test-tubes, timers, pipettors, 37°C water baths, microscopes, even home-made reagents and solutions. Most, if not all these tests have been made obsolete by automation and/or new technologies such as DNA analysis. The skill set of scientists in pathology transitioned to the management and quality assurance of these automated processes, and a focus on actioning significant or critical results.

In the NDT future I am referring to, level 1 technicians might operate such 'black boxes' doing highly automated testing as in my pathology laboratory example, and our Level 2s and Level 3s will be interpreting, trouble-shooting, and managing a more technically complex set of processes that technicians rarely interrupt.

From my perspective, we can look to the past for how to best prepare for this future.

Traditional NDT and the past

NATA has been working with NDT testing organisations since 1947. Back then, the first Registration Committee for Industrial Radiography convened to decide what the criteria would be to allow a facility to be registered with NATA for non-destructive testing. NDT was one of the foundation 'fields' of testing.

The requirements listed in the minutes from the first meeting of that registration committee in 1947, which may look familiar:

- A well-defined range of work (a scope).
- Suitable equipment
- Competent personnel
- Laboratory procedures
- Records
- Radiation safety

Non-destructive testing, or industrial radiography, was at the cutting edge of technological development, with

radiation safety a key consideration, and controlling technology that had been in industrial use since the 1930s.

NATA itself, was born out of war-time necessity. Ensuring that munitions manufactured in Australia could fit weapons made in the US, was of vital importance to the war effort. In 1950 when W. Edwards Deming was telling Japan's post-war chief executives that improving quality would reduce expenses and increase productivity, Australian NDT facilities were at the forefront of establishing and operating 'Quality Management Systems' as registered NATA testing facilities.

Our activities at this time piqued international interest and our peer-review system of accreditation has formed the basis for the establishment of over 100 accreditation bodies world-wide and, through the International Organisation for Standardisation (ISO), the development of international standards for laboratories and for accreditation bodies themselves.

The requirements from 1947 are effectively unchanged. From NATA's requirements for registration, to ISO Guide 25, and now to ISO/IEC 17025, these are still the fundamental components of a competent testing facility. The quality framework we now expect supports the testing and provides a buffer against staff and equipment changes and other changes that may impact the laboratory's operations. This is how it was over seven decades ago, and despite changes to technology and customer expectations, accreditation is based on the same principles today, and will do so into the future.

Peer-review a model for futureproofing

NATA's model for peer-review assessment uses industry specialists as volunteer technical assessors. Our criteria for their appointment is selective and rigorous. The credentials of nominated Technical Assessors are reviewed and verified by NATA, and if supported by the accreditation advisory committee, a candidate is invited to join our panel of Technical Assessors. Technical Assessors aren't just knowledgeable, they're at the top of their field and to be a Technical Assessor for NATA is a badge of honour.

The work of technical assessors is also recognised by many personnel certification bodies, such as the AINDT ISO 9712 certification program, as a form of the continuing professional development supporting applications for certification renewal.

Importantly, our Technical Assessors don't just see their role as assessing compliance with standards, they also see their work as a way to 'give back' to their industry, a contribution to a bigger picture.

Their work allows for an on-going cycle of continuous improvement, as they bring the highest levels of contemporary knowledge to each assessment.

ISO/IEC 17025 protects accredited organisations from being limited by the technology of the past as technical assessors who visit facilities with NATA lead assessors are up-to-date experts in the fields they are assessing. They know and recognise the changes to technology happening in real time and are in a position to advise NATA about how we can meaningfully assess competency in the new environment. Some of these experts are also on NATA's Accreditation Advisory Committee. We rely heavily on our AAC's and they advise us on industry activities, trends and current research ensuring NATA accreditation always remains contemporary.

Hidden infrastructure

NATA is not alone in supporting Australia's technical infrastructure, called the Standards and Conformance Infrastructure. All pillars of the SCI work together to support Australian industry and the public interest: and it comprises documentary standards (Standards Australia), metrology and traceability of measurements (National Measurement Institute or NMI), and accreditation (JAS-ANZ and NATA). All of these pillars work together.

Documentary Standards (Standards Australia)

Standardisation is critical to the process, without a standards framework there is no benchmark to identify and define the minimum or optimum process necessary to have meaningful comparability of results.

Metrology and traceability of measurements (National Measurement Institute)

Comparability also rests on the traceability of measurements, the assurance that any particular measurement is linked by an unbroken chain of comparisons back to a standard reference. This means that the use of units in a measurement by one facility can be meaningfully compared to the use of that unit by another facility.

Accreditation (NATA and JAS-ANZ)

Both support the SCI by accrediting conformity assessment bodies: NATA accredits laboratories and inspection bodies. JAS-ANZ accredits certifications bodies such as the Institute for its NDT (ISO 9712) personnel certification program.

From the NDT perspective, NATA accredits NDT facilities to affirm their competence to perform NDT activities. These facilities employ AINDT certified personnel, to perform metrologically traceable measurements following standard methods.

Together with our partners in the accreditation of certification bodies, in measurement and in standards development, NATA accreditation is part of a hidden infrastructure supporting trade and business.

Impact of AI and why accreditation has never been more important

In NDT, we are witnessing the implementation of robotic and automated ultrasonics, as well as a shift from film to computed and digital radiography. And while these moves are happening, we can anticipate the rise of machine learning. In the context of NDT (or indeed any other modern testing environment), NDT 4.0 is the next toolkit.

But the requirement for human oversight is not going away. In fact, it will become more important managing automated systems comprising NDT 4.0.

Trust in the competence of facilities using NDT4.0 technologies will be critical. Together, accreditation of facilities and certification of personnel are intrinsic to the maintenance of that trust. A reliable framework will still be required to control and maintain the reliability of the test results.

Accreditation will still be the evidence of the effectiveness of that framework.

The technology we have now provides more information than the same process was capable of providing 10 years ago. And we're doing more testing now, not less. That trend will continue. But increasing volumes of data have created the situation whereby having more data does not, in and of itself, lead to better outcomes. NDT 4.0 is about finding ways to transform and translate the data into meaningful, real-time insights.

AI and complex algorithms are likely to be generating some automated reports because these systems will be capable of filtering out clearly acceptable and clearly unacceptable test results.

In most testing environments, this will reduce routine decision making. This naturally increases the time available to spend on challenging evaluations. Humans can spend their time on cases where their skills, knowledge and attributes are most needed.

Skilled NDT professionals will make judgements and write more nuanced reports for asset owners to make their decisions. For NDT 4.0 technology to become mainstream, emerging technologies must demonstrate their functionality, reliability and cost-effectiveness.

Increasing industry demands are already driving the adoption of these technologies in other economies. Automated image recognition for dye penetrant already exists in routine production. There are many academic papers now available talking about the use of neural networks and deep learning for the interpretation of NDT images.

To many of us, robots crawling across wind turbine blades is no longer remarkable, and is likely to soon be commonplace. As the cost of the equipment falls and becomes more accessible and reliable, such technology will be introduced into the workplace here, and it will become mainstream.

All the skills that are needed now will continue to be used but there is a range of new skillsets emerging. The range of opportunities in this industry is expanding to include things like data analytics, hardware and software development, and management of AI systems.

Certification of personnel to standards like ISO 9712 provides a baseline assurance of the knowledge, skills and attributes for those performing and managing testing. Testing and certification of software systems provides confidence in the suitability of the system to be implemented by a facility.

Accreditation of the facility, the ecosystem comprising NDT professionals at various levels, the equipment they use, and the NDT 4.0 tools at their disposal, tells customers, asset owners and regulators that they can continue to trust your results.

Even now, if a facility purchases a commercial off-the-shelf information management system specifically designed for this industry, it needs to be verified on installation, and any customisation or contextualisation must be validated. Use of an NDT 4.0 tool will similarly require verification and validation. Confidence in the facility's use of this toolkit can be assured through accreditation. Technical assessors and NATA lead assessors will assess that validation, as they already assess the implementation of other automated systems in accredited laboratories.

The future is here

Standards Australia says that over 4000 new standards will be necessary in the next decade to support the rapid pace of digitalisation and scientific advancement.

A core aspect of NATA's purpose has always been, and will continue to be, risk mitigation for asset owners and decision makers in Australia. We are here to support decision makers and deliver confidence in test results. No matter the changes of inputs, be they hardware, software or human, there will always be a need to provide assurance of test outcomes by an assessment of the processes and techniques used to generate those results.

We've seen in other markets with more mature adoption rates of AI, that humans remain vital to the generation of trusted testing results.

NDT is at an inflection point; automated systems are starting to recommend further testing where it may be required, but ultimately the decision making is still a completely human process. In the near future we are likely to need more specialists to help evolving automated systems to resolve data into meaningful information.

It will be the responsibility of the NDT professional to understand enough to evaluate the results that an automated system produces, and not unequivocally accept what is offered. Yes it's true that techniques and technological advancements are evolving, yet Australia's Standards & Conformance Infrastructure supporting this innovation will be crucial to its ultimate success. The fundamentals of what makes a quality organisation will not change. Ensuring levels of competency for both those systems and personnel will become even more important as job roles and skills shift.

Our peer assessment model, using experts in their field, ensures NATA will always remain contemporary for NDT and reflect its best practice, no matter what the future brings.

The way that we understand and apply the clauses of ISO/IEC 17025 will change as it is applied to technology that was unimagined at first drafting. But the principles — the fundamental criteria needed to issue quality, trusted reports — will not change. The requirement for outcomes to be technically valid and trusted will never waiver.

The future may be unknown, but whatever NDT 4.0 brings, accreditation will continue to provide assurance in testing results and confidence for asset owners for the next 75 years and more.

Unmanned Systems in Energy

Scaling drones and robotics as utilities transition toward zero emissions.

AUTHOR: JOANNE COSTIN

Drones have proven their value among energy firms despite regulations. UAS reduce the need for costly and dangerous inspections, improve the quality of data collected and save time. Reducing the downtime required during inspection adds further savings. The next step for many utilities is to scale use throughout their organizations.

Kay Wackwitz, CEO & founder of Drone Industry Insights, said energy currently represents the largest sector of the commercial drone market. By 2026, commercial drones in energy will be valued at $6 billion, or 14.5% of a $41.36 billion market.

Furthermore, a 2021 Drone Analyst Market Report found that, among utilities, nearly half of firms spent more than $50,000 on drones, and many spent well above that amount.

“There is certainly a high interest to leverage cost and times savings by utilizing a higher degree of automation and increasing the operational radius,” Wackwitz said.

“Virtually all utility providers currently use manually operated drones and/or basic GPS-based automated flights to collect data via drone service providers or in-house programs, but manual data capture is not the ideal solution for scalability,” added Kabe Termes, director of solutions engineering for Skydio, of Redwood City, California. “Training requirements for operators are high, flight efficiency can be low [especially with pilots who do not regularly fly] and data review is tedious.”

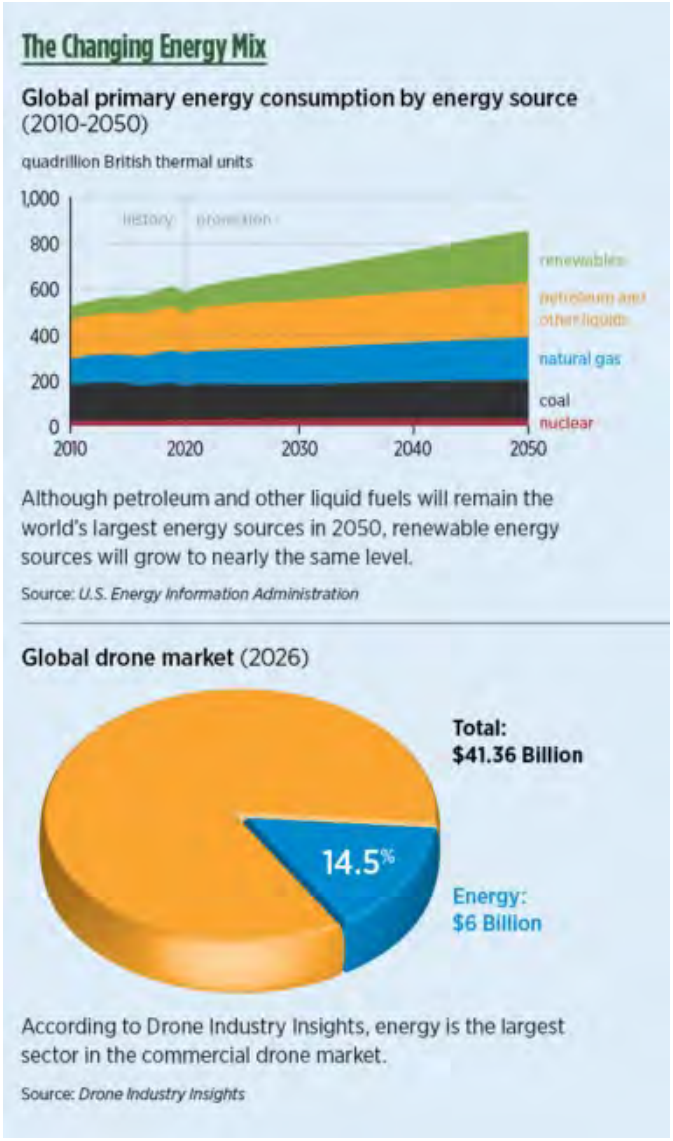
Termes believes more widespread adoption of drones will be driven by improved flight autonomy, AI analytics and regulatory pathways that allow for remote operations. “Any time you can relieve the operator of spending any mental collateral on functions such as preventing collisions, they can spend more time focusing on the mission at hand,” Termes said.

Automated drones and AI analytics make the collection of detailed data more efficient, consistent and rapid. And while the operator/pilot is still present, data can be collected to build a safety case for automated drone inspections without the direct oversight of a human operator/pilot.

The impact of Net-Zero

According to the International Energy Outlook 2021 from the U.S. Energy Information Association, global energy consumption will rise nearly 50% over the next 30 years. The energy industry is undergoing a massive transition as efforts to reduce emissions take place around the globe. Even with the huge investments required to pull it off, more than 136 countries have

Caption TBC.



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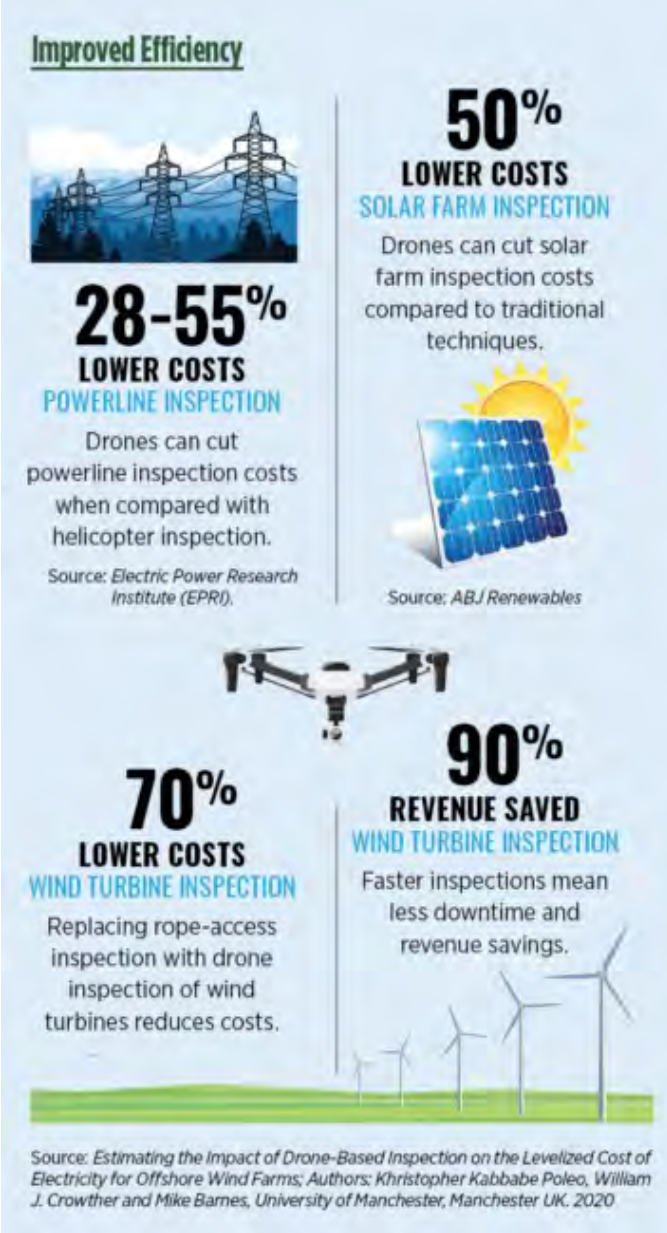

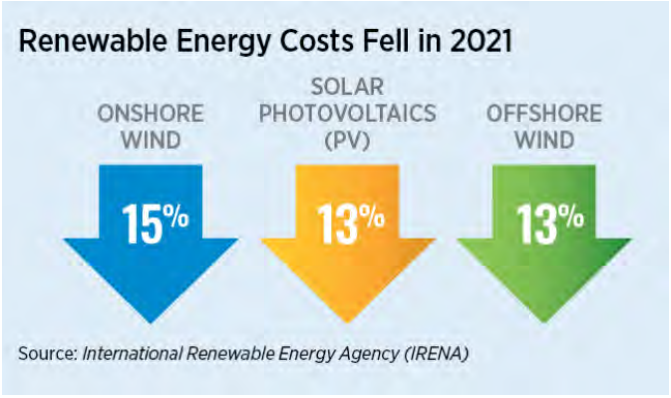

Green Hydrogen Projects Take Off

Project	Renewable Energy Produced	Green Hydrogen Produced Annually	Location	Completion Date
AMAN/CWP	30 GW	1.7M tons	Mauritania, Africa	Not Available
Aquaventus	10 GW	1M metric tons	Germany	2035
Asian Renewable Energy Hub	26 GW	1.8M tons	Australia	2025
Baofeng	200 MW	23,700M tons	China, Ningxia	2021
Egypt (Unnamed)	100 MW	90,000 tons Green ammonia	Egypt	2024
Enegix Energy	3.4 GW	600M kg	Brazil	2025
Green Hydrogen International	60 GW	3B kg	USA, Texas	2026
HyDeal Ambition	95 GW	3.6M tons	Spain	2025
HyDeal España	9.5 GW	150,000-330,000	Spain	2025
NextEra Energy/FPL	30 GW	500M kg	USA, Florida	2023
North2	10 GW	1M metric tons	Netherlands	2030-2050
REC Renewable Energy Qazaqstan/Svevind Energy	30 GW	3M tons	Kazakhstan	2028
SGN H100 Fife	Not available	100 tons	UK	2027
Siemens Energy	10 MW	Not available	French Guiana	2023
Sinopec	300 MW	20,000 tons	China, Xinjiang	2023
The Puertollano (Ciudad Real)	100 MW	3,000 tons	Spain	2022
Western Green Energy Hub	Up to 50 GW	3.5M tons	Australia	2028

The U.S. Department of Energy is putting up to $100 million into the research and development of hydrogen and fuel cells. The European Union will invest $430 billion in green hydrogen by 2030 to help achieve the goals of its Green Deal.

Source: *Inside Unmanned Systems, July 2022*

pledged to reach net-zero emissions, including China, the U.S., Germany and the EU. Together, these four countries account for nearly 40% of all emissions.

Rising fossil fuel prices and lower costs for renewable technology are spurring investment in renewables. Europe's energy security crisis is raising additional concerns. In a survey conducted by the World Energy Council in April, more than 50% of global respondents expect faster energy transitions as a result of the energy crisis. And, as analysed in this issue's feature on methane (p. 48), the energy sector is responsible for about 40% of total methane emissions attributable to human activity, second only to agriculture.

The declining cost of renewable energy is one reason for the growing interest in green hydrogen—a hydrogen fuel created using renewable energy instead of fossil fuels.

Green hydrogen is produced through the electrolysis of water, leaving nothing but oxygen as a by-product. Most experts believe green hydrogen will play a key role in meeting net-zero. It's significant because it has the potential to decarbonize energy-intensive processes such as making steel and cement, as well as in shipping and transportation where it can be used as fuel. Green hydrogen also can be used with fuel cells to power anything that uses electricity, such as electric vehicles and devices. Unlike batteries, hydrogen fuel cells don't need to be recharged, as they have hydrogen fuel (For more on green hydrogen use, see SoCal Gas Use Case.].

U.S.-based NextEra Energy, one of the largest utilities in the world, recently announced Real Zero, a commitment to eliminate carbon emissions from its operations by no later than 2045, leveraging low-cost renewables to drive energy affordability for customers. A significant portion

of this plan will take place at Florida Power & Light Company (FPL), NextEra's principal subsidiary, which is the nation's largest electric utility, serving more than 12 million people.

According to FPL, the company has already improved its carbon-emissions rate by 40% over the past 20 years. To reach "Real Zero," the company will rely on a diverse mix of solar, battery storage, existing nuclear, green hydrogen and other renewable sources. Solar capacity will be increased to more than 90,000 megawatts. Additional battery storage (50,000 megawatts) will be added to the grid, up from 500 megawatts today. Existing natural gas units (16,000 megawatts) will be converted to run on green hydrogen. FPL also plans to generate up to 6,000 megawatts of carbon-neutral power with renewable natural gas (RNG).

What a changing energy mix means for drones and robotics

"Autonomous drones are going to play a big part in reliability and the way to maintain the grid safer and more economically," said Eric Schwartz, manager of technology & innovation at Juno Beach-headquartered FPL.

"A smart grid and smart devices will only get us so far [in identifying problem areas], "Schwartz said. "It will get us to a quarter mile or less than a quarter mile from where the issue is. The drone will be the next step in the process to narrow it down and find the active spot."

Schwartz views regulation as one of the potential limiting factors facing the drone industry, but there continues to be progress.

In July, Dominion Energy and Skydio announced a pivotal waiver that allows Dominion to inspect 40-plus energy generation facilities across seven states. The waiver allows individual operators to fly drones BVLOS. "Skydio's vision-based autonomy makes it one of the only solutions available for automated flight within energized environments," Termes said. "Because we do not utilize magnetometers for vision-based navigation when flown manually or autonomously, pilots can safely fly their missions in close proximity to structures."

On its solar installations, FPL uses drones equipped with thermal imaging to identify dead spots and defects, at installation and during annual inspections. Vip Jain, CEO of ABJ Renewables, a drone inspection company specializing in renewables, said about 2 to 3% of the panels develop bad cells each year. That can reduce efficiency.

FPL completed approximately 6,000 wind turbine inspections last year (out of 11,000 total wind turbines). "We are doing it to check for cracks and damage to the blades," Schwartz said. If a small crack is found before it becomes a larger issue, it greatly reduces maintenance costs.

By focusing on proactive maintenance, Jain said ABJ Renewables has been able to increase the electricity coming out of wind farm assets by 30%. The global company's WindVue technology can detect such substructural internal wind turbine generator blade defects as bonding, delamination, cracks, wrinkles and lighting damage, as small as 3 to 4 millimetres with minimal downtime. It uses both thermal and optical imaging. "Most of the damages start inside the blade," he noted.

Offshore wind is growing with the development of floating wind turbines that can be installed in deeper waters, where winds are higher. Instead of being rooted to the seabed, the floating structures are secured to the seabed with mooring lines and anchors. Though these drone inspections are complicated by floating turbines, high winds and inclement weather, they can reduce maintenance costs and foster safety.

Unlike Schwartz, Jain doesn't believe automation technology is ready to take the place of drone pilots. "The reality is, are you willing to risk a mistake and crash into a multimillion-dollar asset?" A recent study found that increasing the autonomy of drone operations increases the speed at which inspections can be performed but introduces additional costs in terms of complexity and compliance with regulations. As such, the study authors found only a 2% reduction in inspection costs with fully autonomous operations and a drone fleet commanded by single remote supervision. *

"The biggest struggle is that renewable power is new and power companies don't understand what is required to run them efficiently," Jain said. "Without proper maintenance they will not get enough productivity out of the assets."

Drones aren't the only tool for utilities. Robots are getting attention as well. A 2021 study from Drone Analyst found 63% of energy and utilities companies planned to purchase or already purchased robotics systems.

FPL currently operates eight autonomous rovers: two at fixed locations and six mobile units, along with two Spot robots. They use the rover for automated daily inspections around the substation, looking for thermal intrusion, digging at the fence line (signs of animal intrusion), and hotspots. "Use of rovers is not as widespread as drones, because they are limited in their use due to limited battery life," Schwartz said. Spot robots are still in the pilot stage, but FPL is using them at its nuclear and gas power generation facilities.

Tremendous change is coming in the energy sector and drones and robotics will play a significant role in ensuring efficiency, reliability, safety and security. Moving from pilot programs to everyday work tools will only discover more use cases that will increase their value to the sector.

*Source: Estimating the Impact of Drone-Based Inspection on the Levelized Cost of Electricity for Offshore Wind Farms.Authors: Khristopher Kabbabe Poleo, William J. Crowther and Mike Barnes, University of Manchester, U.K., 2020.

Practical NDE and QC Applications of Time Domain Terahertz Technology

This is an introductory talk, which will briefly introduce the principles of the generation and measurement of terahertz energy, look at its interaction with different materials and show how these principles can be employed to perform inspections of a wide variety of non-conductive materials, including single or multi-layer plastic structures and coatings on both conductive and nonconductive substrates.

JOSEPH MCLEAN BUCKLEY[1], IRL DULING[2]
[1]BAUGH & WEEDON, HEREFORD, ENGLAND
[2]LUNA INNOVATIONS, ANN ARBOR, MICHIGAN, USA

Terahertz technology is another tool in the box enabling accurate measurement of thickness, location of metallic inserts, and detection of discontinuities in materials that are unsuited for 'conventional' inspection approaches.

This talk will discuss the applicability of this technology to several practical applications in the aerospace, manufacturing, energy, construction and oil and gas industries. We will also mention its application in several heritage investigations.

This includes applications where the technology has been implemented into production, and others where it has been investigated, shown to be feasible, but not yet implemented due to external factors.

Keywords: Terahertz, Coatings, Films. Composites, Heritage, Aerospace

Introduction

Terahertz radiation is in the part of the electromagnetic spectrum which lies between microwaves and the far infrared,

1.1 Terahertz for NDT applications

For NDT applications we typically use frequencies around 100 GHz up to about three TeraHertz, this represents frequencies that give a wavelength in free space from around 3mm down to 100 microns, i.e., comparable to the wavelengths that we are used to dealing with for ultrasound.

THz radiation penetrates through most non-conductive materials, it can measure thickness and can reveal imperfections such as voids, cracks, and variations in density. A key advantage is that terahertz radiation is non-ionising and involves no safety issues.

When terahertz waves pass through an interface between materials having different dielectric constants some of the energy is reflected. The strength of this reflection will depend primarily on how different the dielectric constants are. With a conductive material none of the energy is transmitted. We can measure the strength and timing of these reflections and we can then calculate the thickness of the material layers and assess whether they are intimately bonded.

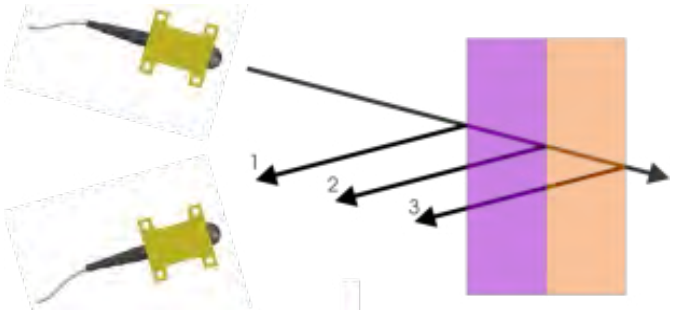

Figure 1: Reflections from layers

This presentation illustrates principles and applications using Terametrix equipment from Luna Innovations Inc, however the general principles of terahertz inspection are not, in general, equipment specific.

1.2 Generation and measurement of terahertz energy

We generate the terahertz radiation by putting an electrical bias across a specialised photoconductive antenna, when we hit this with a very short (around 100 femtosecond) laser light pulse it will conduct, giving a short (200-300 fs) burst of electromagnetic radiation. This transmitter can be packaged like a standard telecom component to make the equipment reliable and robust which of course is important in practical NDT applications.

To detect the reflected or transmitted terahertz energy we use a similar device which becomes conductive when hit with a laser pulse – the resultant current is the product of the laser on off parameter and the energy of the incoming terahertz wave at that instant.

By setting the delay between the transmit and receive laser pulses we can measure a specific point on the waveform, by changing this delay while firing the laser at a high repetition rate (around 80MHz) we can produce a digitised waveform

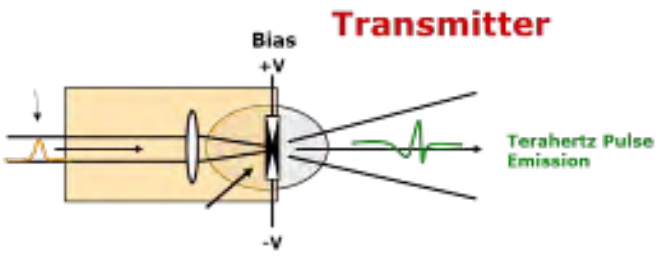

Figure 2: Terahertz transmitter

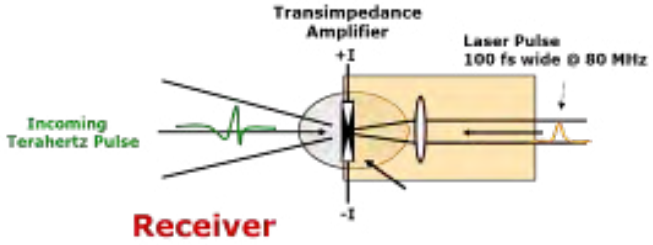

Figure 3: Terahertz receiver

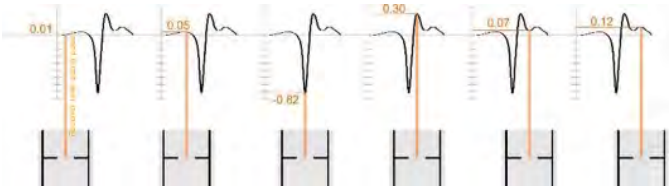

Figure 4: Reconstructing a terahertz signal by moving the measurement point.

In the Terametrix equipment this is done by a rotating multi-faceted mirror array which can scan through a time range of several hundred picoseconds at a rate of up to 1000 times a second. This repeating scan is combined with a longer adjustable delay (multiple reflections) allowing the scanning range to be accurately positioned so that the delay between transmit and receive pulses corresponds to the distance of the path between the transmit and receive sensors and the desired measurement range.

The terahertz laser system is connected to the transducer elements using an umbilical cable containing high quality polarisation preserving fibre optics. To maintain the laser pulse fidelity a compensation system, providing a wavelength dependent delay, is required to balance the dispersion within the fibre optic cable. Without this the pulse would spread to several times its original width, especially when a long umbilical cable (the system can accommodate cables over 30m) is used.

1.3 Terahertz Signal processing

To improve resolution and signal clarity of the received signal it can be digitally processed in several ways.

The transmitter device produces energy over a wide spectrum, this can only be altered by changing its physical design (several transmitter head options are

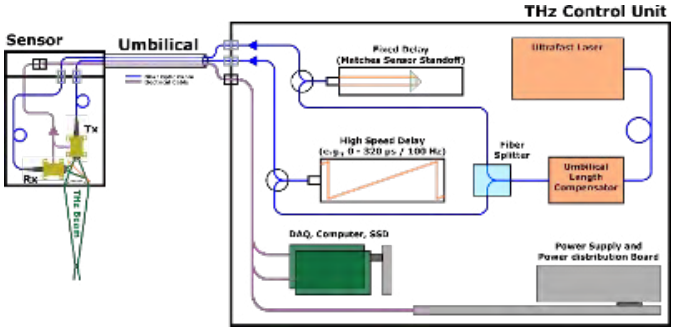

Figure 5: Block diagram of Terahertz system.

Figure 6: Terahertz control unit, Online sensor head and umbilical cable

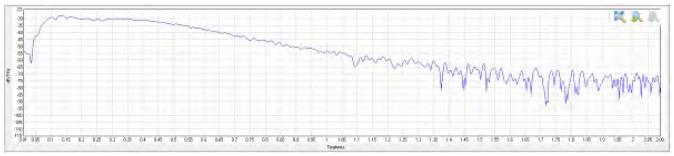

Figure 7: Typical TeraHertz energy spectrum.

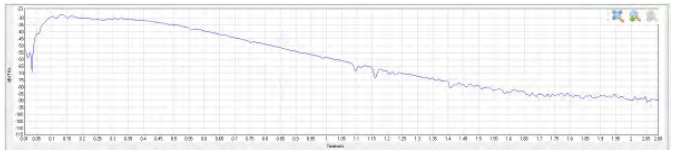

Figure 8: Effect of 20 x signal averaging

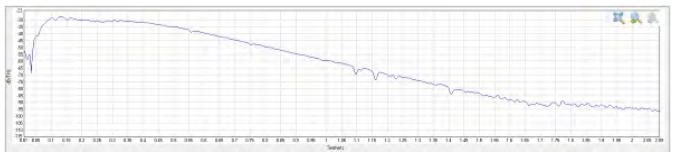

Figure 9: Effect of 100 x signal averaging

possible to optimise penetration or resolution), but the digitised signal can be filtered. Generally, the 'low bandwidth' filtering gives cleaner results, but increasing the bandwidth and possibly suppressing lower frequencies may be required for adequate resolution on very thin layers.

Averaging multiple waveforms can significantly improve the signal to noise ratio and thus increase the usable bandwidth, although obviously this will proportionately

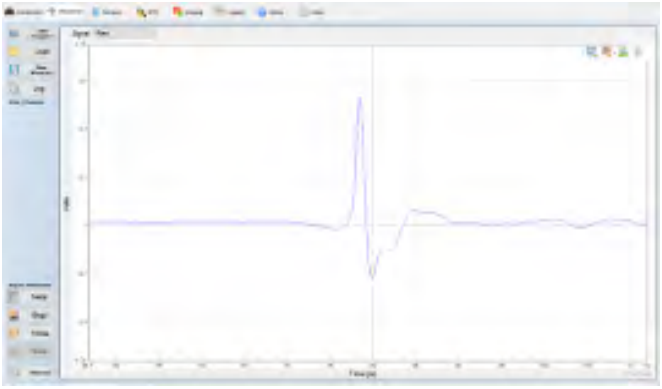

Figure 6: Terahertz control unit, Online sensor head and umbilical cable

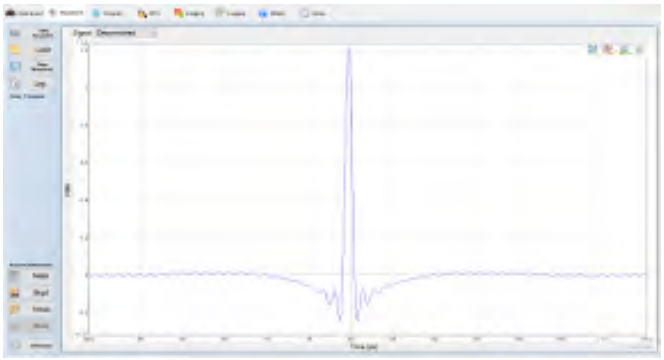

Figure 11: Deconvolved signal from metal surface

reduce the maximum speed when scanning.

To improve resolution a deconvolution algorithm processes the signal based on a known reference waveform from a smooth metal surface. Using this deconvolution process maximises resolution and generally gives signals which are easier to interpret and gate.

2. Equipmentfor Terahertz Inspection

The Terametrix Terahertz Control Unit (TCU) is available with four different scan length / waveform sample rate configurations, primarily defined by the rotating delay system.

- 100 Hz max rate, 320 ps scan length, suitable for typical materials (plastic etc.) up to around 30mm thick
- 100 Hz max rate, 700 ps scan length, suitable for typical materials up to around 70 mm thick
- 1 kHz max rate, 80 ps scan length, suitable for typical aterials up to around 5 mm thick
- 1 kHz max rate, 160 ps scan length, suitable for typical materials up to around 12 mm thick

A variety of different sensor heads can be connected for different applications. These include:

- Separate transmitter and receiver heads, which can be used in ‘through transmission mode’ (e.g., for spectroscopy) or with a separate collinear adapter (beam splitter)

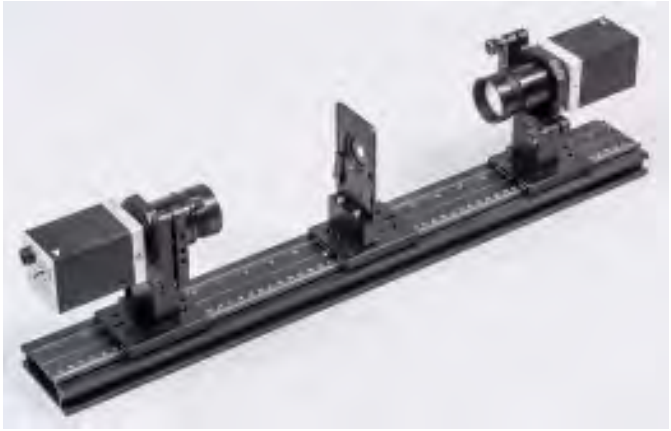

Figure 12: Separate transmit receivers mounted on rail for spectroscopy

Figure 13: Explosion proof sensor

Figure 14: Handheld Single Point Gauge

- Integrated online sensors with an integral beam splitter for general industrial use or mounting on a scanning system.
- A version of the sensor head approved for use in explosive atmospheres, primarily used for real-time measurement of sprayed coatings
- Handheld sensors with an integrated display for single point measurements or line scanning.

For some of these sensors custom software is installed on the Terahertz control unit.

Figure 15: Handheld Line Scan Gauge (Requires 1 kHz sample rate)

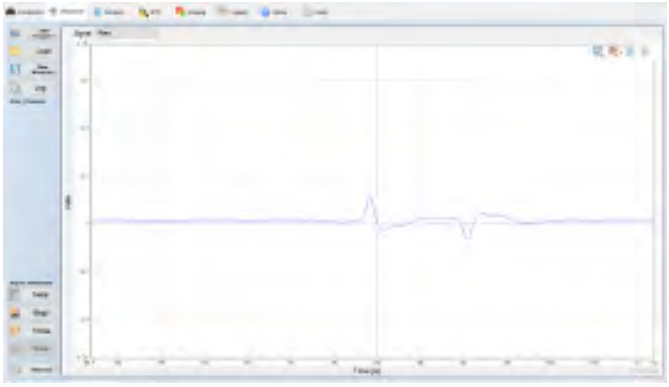

Figure 16: Raw signal from a thin (approx. 1mm) plastic shim

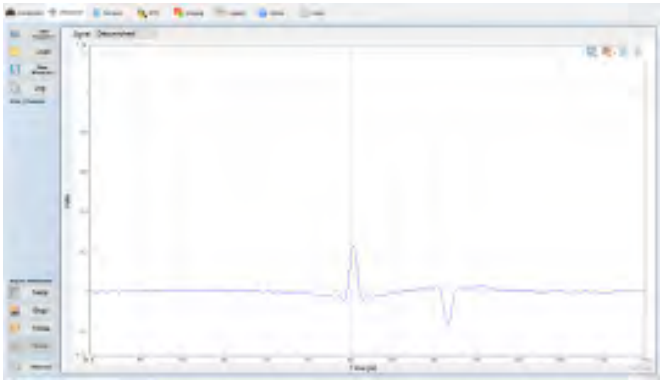

Figure 17: Deconvolved signal from a thin (approx. 1mm) plastic shim

3. Application o Terahertz on measurement of Non-Conductive Films, Sheets and Coatings

3.1 Measurement of Films and Sheets

Figure 16 and Figure 17 show reflections from a thin plastic shim, normally we will get a positive reflection when passing from air to a material with higher dielectric constant, a negative one when passing back to air.

Suitable measurement gates can be applied to this signal, allowing accurate timing, and thus thickness, assessments.

We can measure structures having multiple layers. The waveform in Figure 18 shows a three-layer plastic sheet.

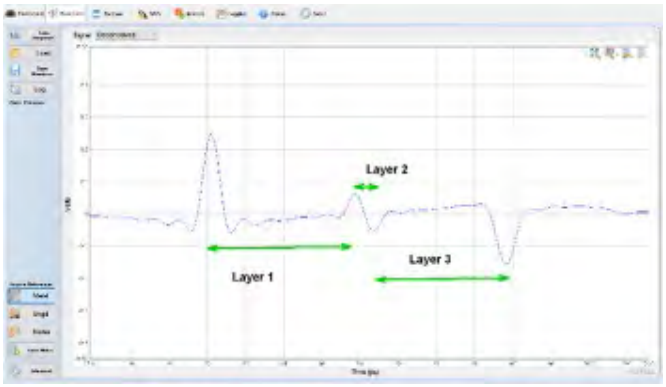

Figure 18: Reflections from three-layer sheet

Figure 19: Display on single point gauge

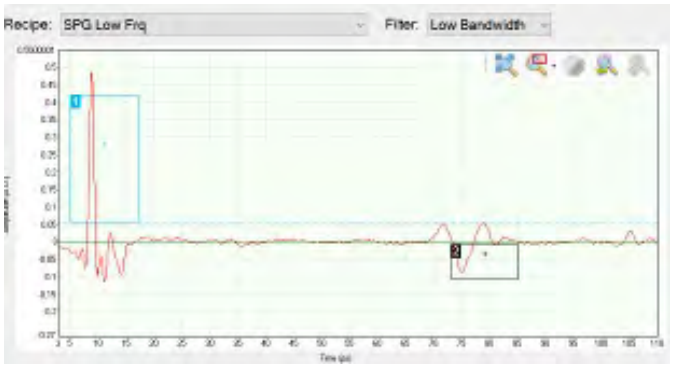

Figure 20: Thicker composite material, showing front and rear reflections.

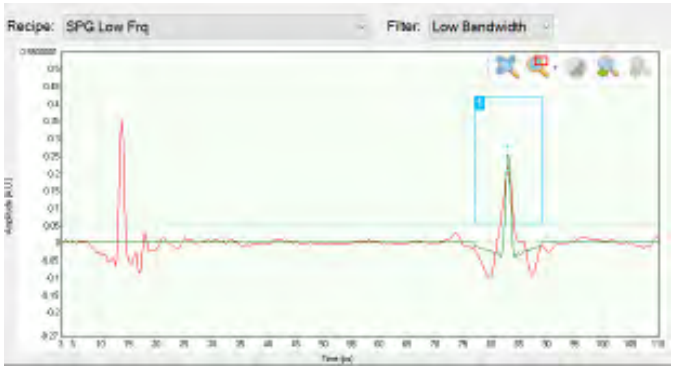

Figure 21: As Figure 20, showing reflection from a far side metal target (coin)

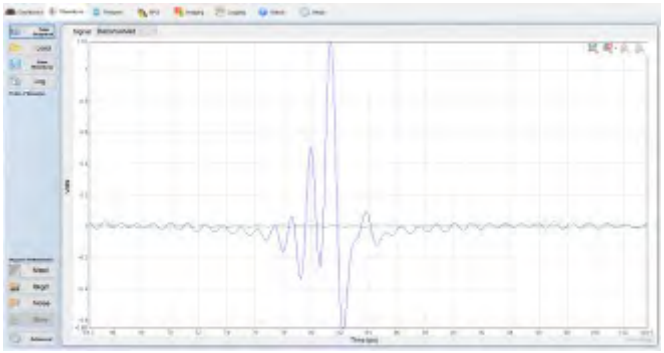

Figure 22: Terahertz signals from paint on metal

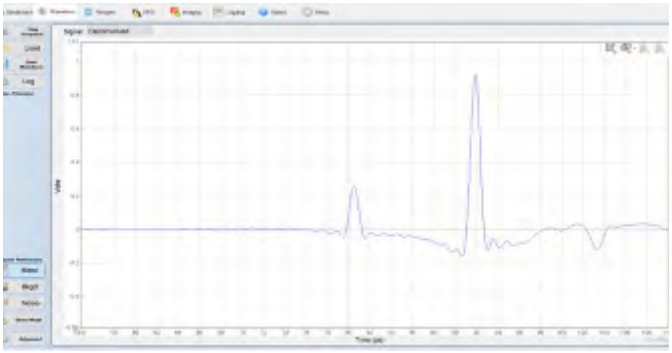

Figure 23: Terahertz signals from thick plastic coating on metal

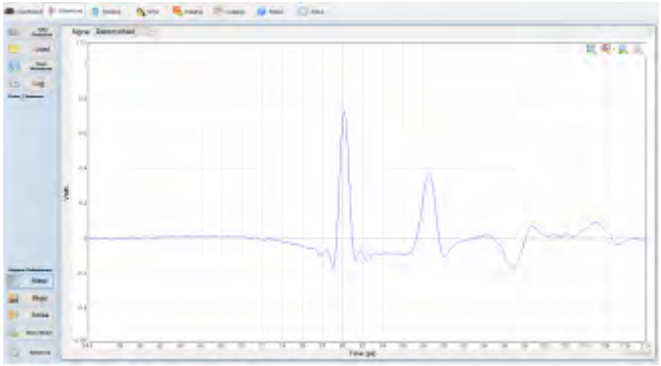

Figure 24: Terahertz signals from ceramic coating on metal

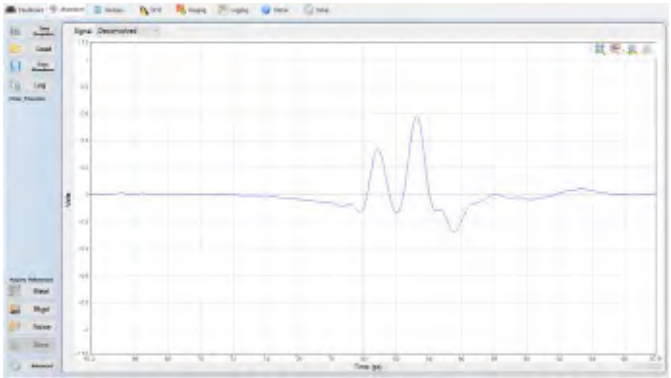

Figure 25: Terahertz signals from paint on carbon composite

Thicker and less homogeneous materials, such as Glass Fibre composites, can show significant attenuation and internal noise (as with ultrasound), and in extreme cases it may be useful to test with a metal target behind a sample to confirm that there is adequate penetration and that the reflection we are measuring is in fact from the back wall.

3.2 Measurement of coatings

The reflections from coatings on conductive surfaces are similar, the relative strength and polarity of the reflections will depend on the thickness and dielectric constants on the materials involved, examples are shown below.

- Paint on metal, (Figure 22) in this example a high bandwidth filter is used for maximum resolution, the paint layer is around 100 um, combined with the low dielectric constant this gives a short transit time, making the reflections relatively hard to distinguish.
- Plastic coating on metal (Figure 23) again a low dielectric constant, but thicker, so easier to measure. Note the second reflection showing energy reflected twice through the coating.
- Ceramic coating (Figure 24) The coating has a high dielectric constant, so much more of the energy is reflected at the surface of the coating, and the fraction of energy penetrating to the metal substrate is much less. The initial signal is larger than the reflection from the ceramic-metal interface. Again, multiple reflections are visible.
- Paint on Carbon fibre composite (Figure 25) in this situation some of the energy is interface is transmitted into the composite and absorbed, in consequence

4. Key Practical Applications of Terahertz NDE

Terahertz NDE has several key features as an inspection method.

- Non-Contact: can work at a distance from part of 25-100mm or greater.
- Can be used in through transmission or single sided configuration.
- Scanning rate up to approx. 1000 points per second.
- Can resolve indications 1-2mm in diameter or better.
- Distance resolution to a few microns
- Can penetrate low density materials which do not transmit ultrasound well.
- WILL NOT penetrate conductive materials, including Carbon.

Some of the applications where it is particularly useful are detailed below.

4.1 Terahertz measurement of Films and sheets

As we have seen Terahertz measurement is very effective for non-contact examination of thickness. It is therefore very suitable for sample and in-line measurement of plastic materials. This includes.

- Blow moulded Plastic or glass containers – Terahertz measurements can be used for automated multipoint measurement, for example with a robot, or can be installed on a production line to make single measurements of parts as they come through.

Figure 26: Terahertz inspection of plastic containers with a robotic system

Figure 28: Static Coating measurement

Figure 27: Control of plastic sheet thickness

Figure 29: Real-time coating measurement in spray booth

- Film and sheets being produced continuously. The Terahertz measurement can be used purely for QC or can be fed back to roll pressure control to ensure correct and consistent thickness across the width of material as it is produced.

4.2 Terahertz measurement of coatings

Terahertz is one of very few viable non-contact methods for measuring the thickness of paint and similar non-conductive coatings. This means it can be used for both wet and dry measurement. Typically, the Terahertz system can measure coatings greater than around 50 microns, with a typical accuracy of around +/- 5 microns (*).

The explosion proof test head option is designed to be mounted with a spray gun, and allows continuous measurement of thickness as a coating is built up.

Terahertz measurement has also been used for assessment of heat resistant coatings on turbine engine parts.

4.3 NDT of Non-conductive composites structures

Among the many successful applications for Terahertz inspection are:

- Radomes. These are inherently non-conductive to achieve their function, so terahertz inspection is a suitable method for detecting disbonding and confirming repair integrity. Terahertz inspection at specific frequency lines is also good for detecting water intrusion.
- Car Trim parts inspection. This is mostly used during development to ensure correct thickness and absence of internal defects such as bubbles.
- Slush moulded parts – These are made when control of external finish is critical (Car dashboards are a common example) by filling a heated metal mould with polymer powder. After a suitable time, the excess powder is tipped out and the mould cooled. Because of irregular or textured surfaces, they are often difficult to inspect by other methods. Terahertz inspection allows measurement of thickness and allows moulding time to be optimised.
- Sprayed on foam insulation (SOFI) and insulating tiles on space vehicles. Terahertz has been used to inspect the underlying structure and confirm bonding.

Examples are shown below.

Figure 30: Photo and Terahertz Images of Radome repair

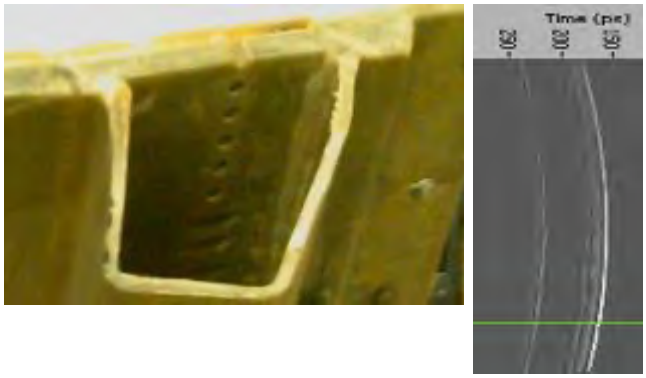

Figure 31: Terahertz scan of C-130 Radome showing layers

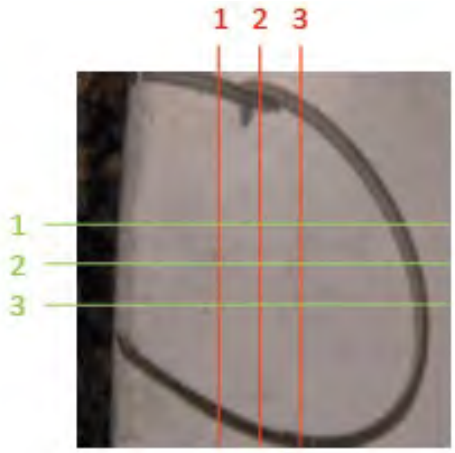

Figure 32: Plastic Car panel showing scan lines

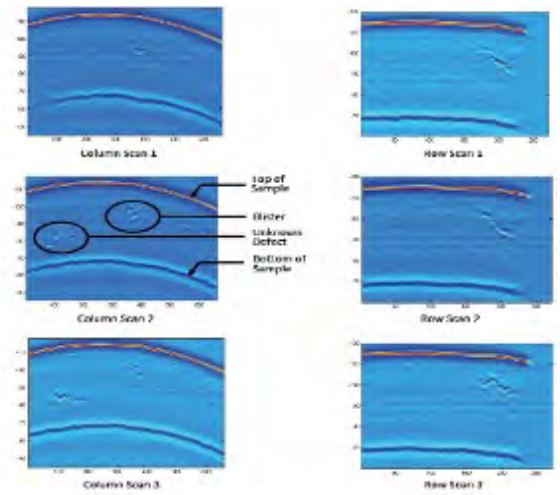

Figure 33: B-scans of panel showing minor defects (which can show on surface)

4.4 Assessment of bonded seams

Terahertz inspection works well for single sided assessment of overlap bonding between polymer sheets. Typical examples include.

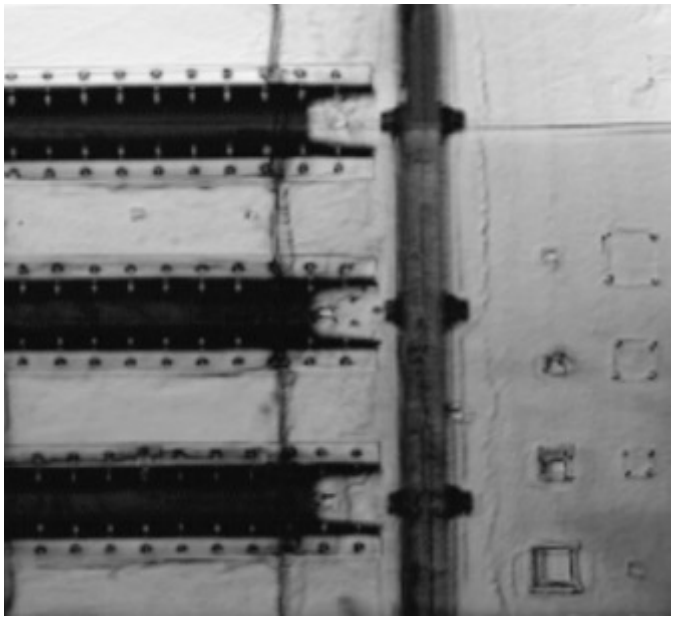

Figure 34: Scan of structure under SOFI (Shuttle Fuel Tank)

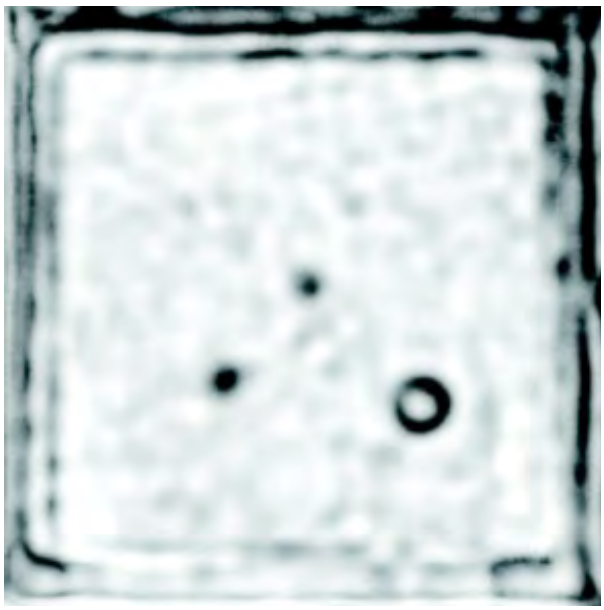

Figure 35: Scan of heat resistant tile bonding (ARTEMIS)

- Waterproofing membranes for flat roofs. This is typically installed under an asphalt layer. Once the roof is completed and in service it can be difficult or impossible to find the location of any leaks, so inspection immediately after installation to eliminate these can save significant risk and reduced insurance costs.
- Fuel bladders for aviation and motorsport, these are normally pressure tested, terahertz inspection provides a method of assessing bonding during manufacture.
- Balloons – Large passenger balloons are often made using heat bonded strips of a fibre reinforced polymer – again bond integrity is critical.

4.5 Checking for correct assembly

Figure 36:Flat roof – finding a leak could be difficult!

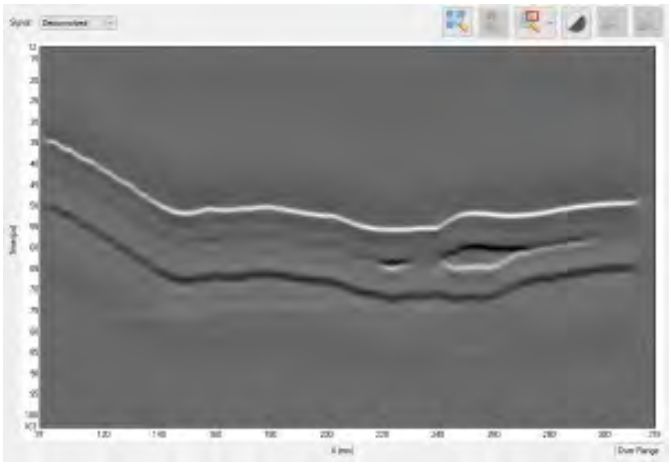

Figure 37:B-scan of Bond

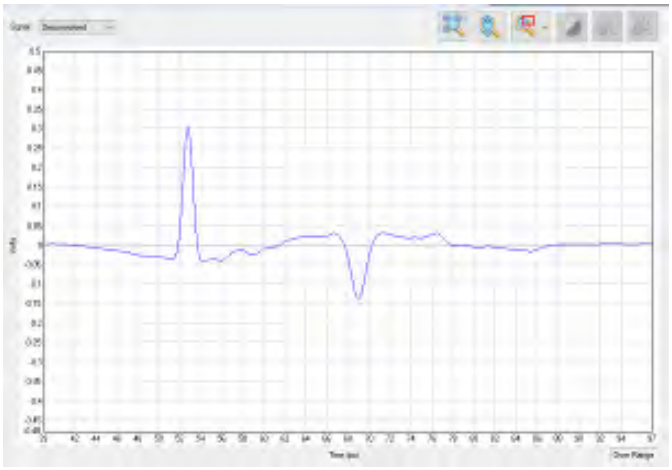

Figure 38: Waveform of well bonded area

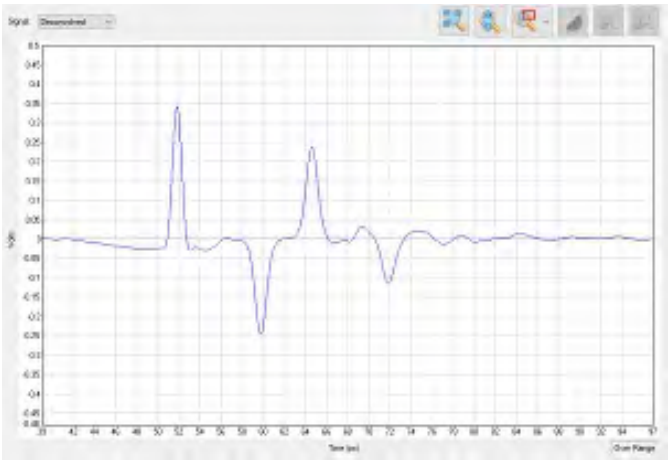

Figure 39:Waveform at defect.

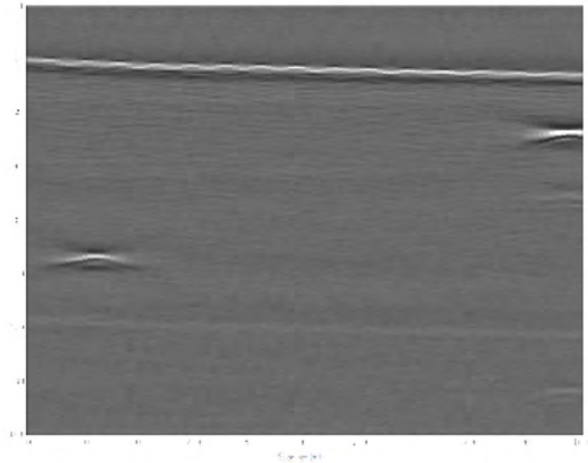

Figure 40:Location of wires within non-conductive foam structure

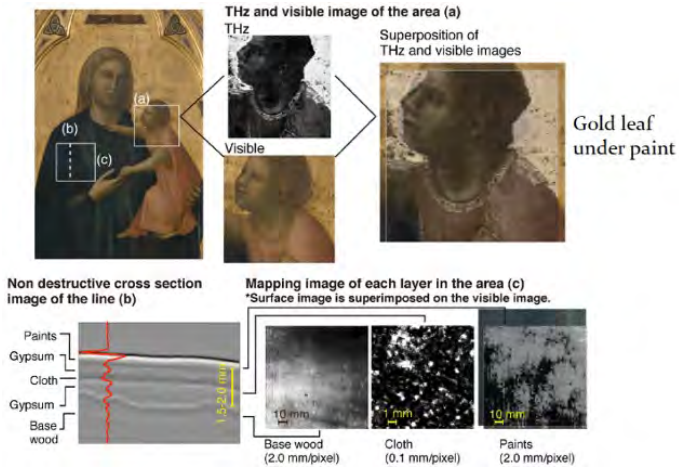

Figure 41:Investigation of internal structure of the Badia polyptych (Giotto c1300)

Terahertz scanning can be used to verify the location and depth of metallic inserts within non-conductive assemblies. One example is verifying correct position of framework, heating elements and other wiring within car or aircraft seat assemblies.

4.6 Cultural Heritage Applications

Murals and panel paintings often have a multi-layer structure, typically consisting of plaster and fabric over the substrate to create a surface suitable for paint. In conservation work it can be critical to assess the thickness and integrity of these layers. Terahertz inspection, being non-contact is a very suitable method for this.

- Terahertz can detect the presence and location of metallic layers (such as gold leaf) used within paintings.
- Terahertz provides another tool for distinguishing pigments which look identical in visible or infra-red light.

Figure 42: Arrangement to carry out Terahertz Scan of da Vinci's 'Last Supper'

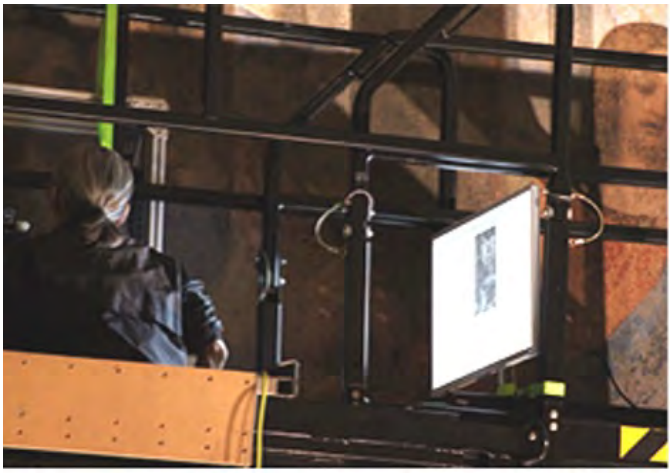

Figure 43: Terahertz Scan of da Vinci's 'Last Supper'–Detail

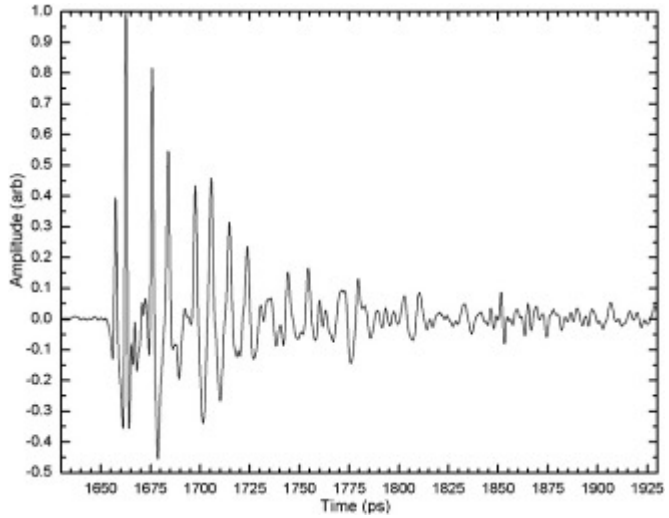

Figure 44:Terahertz waveform from pine sample showing wood grain layers

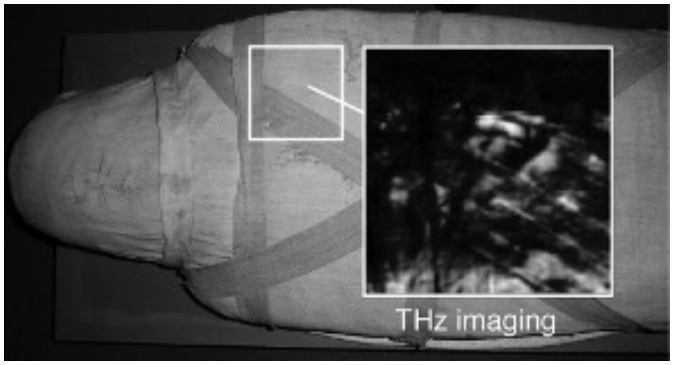

Figure 45:Terahertz imaging of a wrapped Egyptian mummy

- Terahertz can identify previous conservation work.
- Terahertz in useful in dendrochronology – assessing the grain structure in wood to confirm dating. With terahertz the analysis of this can be done without removing paint.

5. Conclusions

Terahertz measurement and imaging is a powerful method which should be considered part of our NDT toolbox. While the cost is relatively high compared to some other methods it can find answers where no other method can.

6. Acknowledgments

This presentation draws heavily on work done by colleagues at Luna Innovations and elsewhere. In the cultural heritage area, the work of Kaori Fukunaga, from the National Institute of Information and Communications Technology in Tokyo is particularly significant.

7. Author Details

Joe Buckley is the owner of Level X NDT, a UK based consulting company, providing application support and Level III services to several companies based in the UK and overseas. He holds Level III certification in ultrasonics and eddy current, as well as a degree in physics from the University of St. Andrews and an MBA from the Open University.

He works with Luna Innovations and Baugh & Weedon to support terahertz products for the NDT market.

Dr Irl Duling is director of business development at the Terametrix division of Luna Innovations, where he has worked since 2006, He held a number of technical roles before that, including 13 years as a research physicist at the US naval research laboratory.

He studied Engineering at West Point, Physics at MIT and, and has a PhD in Optics from the University of Rochester.

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