

INDUSTRIAL

EYE

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

RADIOGRAPHY ■ ULTRASONICS ■ EDDY CURRENT ■ PENETRANT ■ MAGNETIC PARTICLE
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President's Message



Joshua Morris

57th Federal Council Meeting

From November 12 to 13, the Australian Institute for Non-Destructive Testing held its 57th Federal Council Meeting in Melbourne. This event provided an opportunity to review our progress and work on key strategic directions.

We reached consensus on several critical initiatives, including a standardised fee structure for NDT exams across AQB's, updates on legal matters, improved policies and guidance for our volunteers and notable updates to our website, database, and Newcastle 2025 conference. Additionally, significant progress was made in improving the efficiency of AINDT's operations and governance.

Reflecting on 2024

As we approach the end of 2024, it is an opportune time to reflect on the past year. It has been a period marked by significant challenges as well as exceptional progress for the institute. I am proud of all that we have been able to achieve together.

Strengthening our Leadership

This year began with a significant change in leadership following an out-of-cycle nomination process. The Federal Council and Board of Directors worked diligently to elect a new team. I was honored to be re-elected as President, with Angelo Zaccari as Vice President, Ian Hogarth as Immediate Past President, Sam Hallifax as Secretary, and Glen Haberl as Treasurer.

We are a team that blends experience with fresh perspectives, and I am confident in our ability to continue moving AINDT forward. I am pleased to report that our entire Board of Directors was recently unanimously re-elected. I extend our thanks to the previous Board members for their professionalism and dedication during this transition.

Finding the right leader for AINDT was a priority this year, and after a thorough search, we appointed Stuart Norman as our new CEO. His appointment has brought much needed stability to AINDT, both within Australia and internationally. Stuart joined us at a time of considerable change, and his leadership has been invaluable as we navigate these transitions. I am grateful for his commitment and patience during this period.

Peter Dawson was appointed to the position of Certification Services Manager in May. Although Peter has decided to pursue other opportunities, he made significant contributions. We are grateful for his work and pleased that he will continue to assist with AQB audits on a contractual basis before Christmas. Our search for a new Certification Services Manager continues, and we look forward to filling this critical role.

Independent Governance Review

A key focus for us this year was ensuring that AINDT is well-positioned for the future. We initiated an independent governance review, which is currently being conducted by Governance By Design. The insights and recommendations from this review will guide us to approve our governance framework.

Whilst considering Governance model options during the recent Federal Council meetings, it was emphasised by the Federal Councilors, with near-unanimous agreement, that the participation of each State Branch through the Federal Council model is a fundamental strength of the institute and should be maintained. This emphasises the ongoing importance of both the state branches and every institute member.

Successful Events

This year has featured numerous successful technical evenings, webinars, and social events nationwide. In the latter half of 2024, our state councilors hosted branch AGMs across the country. Feedback from these AGMs has been positive, with significant member turnouts reported. The state branch AGMs provide exceptional networking opportunities in both NDT and CM, often including heavily discounted food and beverages for current financial members.

These events owe their success to the dedicated efforts of the branch council members. I encourage all members to attend AINDT branch meetings and technical evenings and actively participate as contributing members.

Certification Board

The NDT Certification Board's work to ensure alignment with JAZ-ANZ and ICNDT requirements continue as we hope to finalise our transition to the newest revision of ISO9712 early next year.

I would like to thank NDT Certification Board Chairman Barry Cooper, Victorian Chairman Mark Welland, and all members of the Certification Boards for their continued dedication to the integrity and success of our certification processes.

The recent NDT Certification Board meeting, held prior to the Federal Council meeting, emphasised the ongoing progress of the newly restructured Certification Board. This progress includes the addition of new board members and numerous new additions to the Panel of Examiners.

Thank You and Warm Wishes

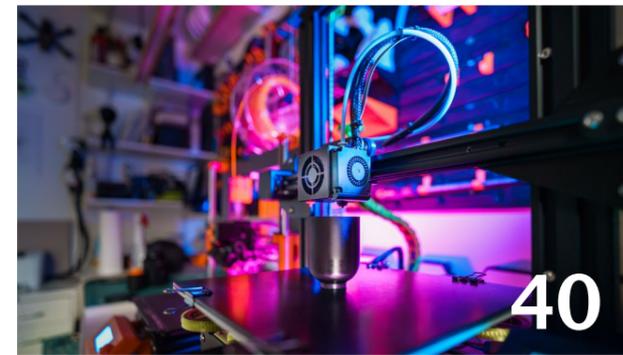
As we conclude the year, I want to express my sincere gratitude to everyone who has contributed to the ongoing success of the AINDT in 2024.

It has been a challenging year, and I recognise that at times, some voices may have felt underrepresented. Please know that every effort has been made with the best intentions. Many of us balance our roles with full-time work and family commitments, and I deeply appreciate the dedication of our volunteers and board members.

A special thanks to our AINDT office staff for their dedication and commitment throughout the numerous changes this year and to all the volunteers whose generosity of time and expertise ensures the smooth operation of AINDT, thank you. Your efforts are the backbone of our success.

Wishing everyone a Merry Christmas and a joyful, prosperous New Year. I look forward to the continued growth and success of AINDT in 2025 and beyond.

Warm regards,
Joshua Morris,
President Australian Institute for
Non-destructive Testing



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Vice President: Mr Angelo Zaccari
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Secretariat Liaison: Mr Samuel Hallifax
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INSTRUCTIONS TO AUTHORS OF TECHNICAL ARTICLES

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 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)
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 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
- Published by:
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A Message from the CEO

A New Website and Database



Stuart Norman

In November, the Federal Office implemented some substantial changes to our operations. The first was the launch of our new website (aindt.com.au), which is visible and accessible by the public; and the second was the launch of our new certification and membership database which is regularly used by members and individuals applying for certification, renewing or recertifying.

The AINDT website has undergone a long-overdue transformation, and now offers a modern, user-friendly design on a state-of-the-art platform. This upgrade enhances the Institute's ability to effectively engage with both members and the wider public, ensuring seamless communication and accessibility.

The new website offers enhanced opportunities to showcase AINDT and provide additional resources for members and the industry. As we continue to refine and develop the site, it will become an invaluable tool for members, granting greater access to essential information and exclusive benefits.

Recognising that no website is ever truly finished, we are committed to ongoing improvements. To ensure it meets the needs of our members, we will be gathering

feedback through the State Branches in early 2025.

Earlier this year, the Federal Office initiated the transition of the Institute's certification and member database to a more modern, supported, stable, and secure platform. While the previous database, developed in 2011, was highly effective at the time, evolving technology and changing needs have made this upgrade essential.

The transition has been expertly managed with the support of the original developers, who possess a deep understanding of our operations. Their expertise has ensured a smooth move to a robust, secure system already trusted by several major membership organisations across the country.

As a member or an individual applying for certification, recertification, or renewal, you'll experience minimal changes during the process. However, the new database significantly enhances the Federal Office's efficiency, streamlining systems and processes. Most importantly, it ensures that all data is securely stored and fully compliant with Australian Privacy Legislation.

Governance Review

At the Extraordinary General Meeting (EGM) held in January a motion was passed that the Institute conduct an independent review into the governance of the organisation and its supporting documentation. We engaged a professional governance advisor to conduct the review which is now complete. The findings of the review were discussed at the Federal Council meeting in November.

Should any member be interested in the review or discussing its findings with me please feel free to reach out; I can meet with you to discuss the process, findings and next steps.

Following the Federal Council meeting, it is safe to say that the Institute will need to make some changes to ensure that we continually improve our governance framework and operations.

At the latest NDT Certification Board and Federal Council meetings it was agreed that the Institute make a small increase in certification fees to come into effect as of 1 January 2025. Certification fees have not increased

in over a decade, during which time the costs to the Institute have risen dramatically.

We've been mindful of the increase in the cost of living and as such will be implementing a 2 per cent increase across all certification fees.

In June, the Board of Directors decided to maintain membership fees at the present level, with the view of increasing membership numbers and continuing to deliver great value for members.

Thank You and Season's Greetings

As I write this last CEO piece for 2024, I want to take the opportunity to wish everyone a wonderful Christmas and a Happy New Year. I understand that many of you will be working over this time but I trust that you will have the chance to celebrate with friends and family.

Once again, I'd like to thank everyone who has volunteered their time and efforts to the AINDT

throughout 2024. It's been a big year as we work to consolidate the Institute as the certification body of choice for those who work in our industry. Everyone from the Board of Directors, the Certifications Boards and Federal Council through to all of our Branch Councillors, have made a significant contribution to the Institute throughout the year. Thank you.

On a personal note, I'd like to thank all of the members and non-members I've met in my first year as AINDT's CEO. So many people have made me feel welcome and been willing to share their knowledge and insights.

It has been challenging, but also highly rewarding. I look forward to 2025 and our ongoing focus on the continual improvement of all aspects of the Institute.

Merry Christmas.
Stuart Norman

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 NEWCASTLE CITY HALL

MORE INFORMATION TO FOLLOW

Member List

December 2024

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

Through the work of our state branches and federal office, AINDT is committed to fostering a community of professionals and organisations dedicated to the fields of non-destructive testing, engineering, and materials and quality testing.

We offer a tiered membership structure, inviting businesses to enhance their professional standing and industry influence by becoming a Company, Corporate, or Sustaining member. Our memberships unlock a suite of benefits, including marketing opportunities, heightened support, streamlined staff certification management, and much more.

AINDT would like to thank the companies below for their valued support.

SUSTAINING MEMBERS

ATTAR
 D R May Inspections
 EnerMech
 SRG Industrial Pty Ltd
 Intertek

SUPPORTING MEMBERS

Chevron

CORPORATE MEMBERS

Azure NDT Quality Services Pty Ltd
 Bureau Veritas Australia
 Chemetall (Australasia) Pty Ltd
 Evident Australia Pty Ltd
 Hofco Oilfield Services
 IRISNDT
 OMS Engineering Pty Ltd
 SafeRad SE Asia Pty Ltd
 TR Pty Ltd

COMPANY MEMBERS

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ARL Laboratory Services Pty Ltd (Yennora)
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 Bluescope Steel (Port Kembla)
 ENDETEK
 Hot Engineering
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 Magnetic Analysis Aust Pty Ltd
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 NDT Equipment Sales Pty Ltd
 Nobel Engineering Services
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 RPG Australia
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 Kuzer Technical
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WA

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 GoldFields NDT
 Hofmann Engineering
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 Integrity Engineering Solutions
 MJ Engineering Inspection Services (Welshpool)
 NDT Instruments Pty Ltd
 Vertech
 Optiflow Pty Ltd
 Portable Scientific Pty Ltd
 Weld Integrity
 Wood - Asset Performance Optimisation

Membership Registrar Update

AINDT's Federal Council meeting was held on 12 to 13 November 2024.

The following outcome were:

- AINDT NDT exam fee endorsement
- AINDT certification and commercial matters
- AINDT Governance: AICIP, JASANZ, ICNDT and ISO 9712: 2021
- Federal office operations and compliance
- AINDT Reports: NDT and Condition Monitoring Certification Board, Membership and branch reports
- AINDT Awards: Examination, J.H. Cole, Honorary membership and Tony Sonneveld Meritorious Service Awards

- Recruitment of an NDT Certification Manager

Just a reminder that each Branch President regularly meets with the Membership Registrar and Federal President to discuss AINDT activities. These include Federal Office updates (website, social media and certification), AINDT Standards Board outcomes, future events (national and international) and state branch reports.

Kind regards
Craig Taylor
AINDT Membership registrar

Congratulations to the Champions: AINDT's 2024 Footy Tipping Winners Announced

TB AINDT is thrilled to congratulate the winners of our 2024 AFL and NRL footy tipping competitions.

It's been a season of intense matches and strategic guesses, with our participants showcasing their deep understanding of the game.

Let's take a closer look at the results and celebrate the tipping prowess of this year's champions

The winners were:

AFL

First Prize (\$500) Terry Walls from iTest NDT

Second Prize (\$250) Aaron Baker from Bureau Veritas

Third Prize (\$100) Paul Edwards from Applus Pty Ltd (Bibra Lake)

NRL

First Prize (\$500) Neil Burleigh from ENDETEK

Second Prize (\$250) Terry Walls from iTest NDT

Third Prize (\$100) Levi Greer from CQMS Razer



NDT Certification Board Update

The AINDT NDT Certification Board meets at least four times per year, with three online meetings and the final meeting being face-to-face towards the end of the year.

The recent face-to-face meeting, held on 10 November, was very productive and well attended. Some of the discussion points and outcomes, including proposed changes to the Guide to Qualification and Certification, included:

Approval to move to a stand-alone Certification for RT-2 CR/DR, without first completing and certifying using film. This will increase the training requirement for RT-2 CR/DR to 80 hours for direct entry. For those that are already certified to film, the 40 hour CR/DR Course will remain available while there is a requirement and offered by our AQB's.

Table 3.8 note 6 in the Guide to Certification is to be modified from: "The prerequisite for Radiography Level 2 is completion of a minimum of 40 hours of Radiography and Radiation Safety Training aligned with National Module EA612 or equivalent."

To: "The prerequisite for Radiography Level 2 is completion of a minimum of 35 hours of Radiography Level 1 approved training following the ISO 25107 RT Level 1 Syllabus". This change in syllabus for this prerequisite training to align with ICNDT recommendations to use ISO TS 25107 as the syllabus of choice for approved NDT training for ISO 9712 NDT Certification.

Section 3.7 in the Guide will include a new section on Additional Requirements for Phased Array and TOFD. It will be section similar to the Additional Requirements for Radiography section. The section will include the requirement for experience hours to include a minimum of 40 hours of verified and documented data analysis.

The candidates for the Panel of Examiners were reviewed and selected. Out of 32 applicants 16 were selected, ensuring all the main NDT methods were well covered. It was not an easy task as the applicants were all worthy candidates.

NDT Certification Board Members

In 2024, the AINDT NDT Certification Board farewelled Keith Arcus, after more than 20-years of commitment and service. We all wish Keith a happy and long retirement. The AINDT CB also welcomed three new members: Ahmed Jahanzaib, Andrew Kennedy and Chris Howson. All three Board candidates have spent the past 12 months observing the workings of the AINDT CB, before they were formally accepted onto the Board at this meeting. The members of the AINDT CB are:

Chairman
Barry Cooper

Vice Chairman
Mark Welland (Chair Panel of Examiners)

Honorary Secretary
Vick Mierzwa

AQB Rep
Ahmed Jahanzaib

Industry Rep
Bruce Ham

Technician Rep
Andrew Kennedy

Gen Board Member
Chris Howson (Chair Applications Committee)

The AQB Representative on the Board will now be moved to a three-year term, with the first year as a non-voting observer. This will ensure all AQB's receive an equal opportunity to have a voting representative on the Board. All other AQB's are welcome to send an observer to the yearly face-to-face meeting if they wish, but at their own expense.

Any changes to the make up of the AINDT NDT CB will be updated in the Guide to Certification and only after first notifying the Federal Council of changes before they are published.

On a final note, please have a safe and relaxing Christmas and New Year break. The AINDT CB looks forward to serving the interests of our valued members in 2025.

Barry Cooper
Chair, NDT Certification Board

Condition Monitoring Certification Board Update

The Condition Monitoring Certification Board convened in Melbourne on 11 November 2024 to lay the groundwork for 2025.

During the meeting, key plans and priorities for the upcoming year were outlined. The Board has a full agenda for the next 12 months, with the main objectives including:

- Revision and publication of the certification guide, including clear guidelines on the recertification process.
- Introduction of defined parameters for trainee status, with a five-year timeframe to transition to full certification.
- Enhanced clarity and detail in specific sections of the certification guide.

- Transition of examinations to a tablet-based system, with the ultimate goal of enabling online examination capabilities.
- Development and expansion of the examination database with new, up-to-date assessments.

The Condition Monitoring Certification Board will meet in-person early in the new year to work on more in-depth strategy planning.

A reminder that IRT Cat 2 Mechanical certification is available, with applications already having been issued.

Shawn Moore
Chairperson – AINDT CM Certification Board

2025 Certification Fees

At the latest NDT Certification Board and Federal Council meetings it was agreed that the Institute make a small increase in certification fees to come into effect as of 1 January 2025.

Certification fees have not increased in over a decade, during which time the costs to the Institute have risen dramatically. We've been mindful of the increase in the cost of living and as such will be implementing a 2 per cent increase across all certification fees. The new fee schedule is outlined below.

Non-Destructive Testing

	Current	1 Jan 2025	Current	1 Jan 2025
	Member	2% Increase	Non Member	2% Increase
Application for Initial certification per Method or sector	\$250	\$255	\$500	\$510
Application for Renewal or Re-Certification certification per Method or sector	\$200	\$205	\$500	\$510
Late Renewal/Recertification Fee-Additional	\$150	\$155	\$250	\$255
Expedite Fee	\$200	\$210	\$200	\$210

Condition Monitoring

Application For Examination and Certification (Combined Application)	\$350	\$360	\$500	\$510
Application for Renewal or Re-Certification	250	\$255	\$500	\$510
Late Renewal/Recertification Fee	\$150	\$155	\$250	\$255

Condition Monitoring Training Centres

Unlock the future of your career with top-tier condition monitoring training from trusted providers.

These training centres have earned the endorsement of AINDT, aligning perfectly with the national syllabi approved by the AINDT Certification Board. This ensures that you receive the highest standard of education and training.

To maximise your learning experience, AINDT recommends obtaining a copy of the training module—either directly from the training provider or by downloading it from the AINDT website. This will ensure you are well-prepared for your course.

For those seeking certification, it's crucial to successfully complete the specified training program and required training hours outlined in ISO18436. This is essential for achieving certification in your desired conditioning monitoring method, category, and industry sector.

All examinations are conducted by the AINDT. For exam dates and further details, please contact AINDT via: federaloffice@aindt.com.au.

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Authorised Qualifying Bodies

AQBs are authorised to offer AINDT-approved training and initial and recertification examinations in any Australian state, at any time throughout the year.

The AINDT also conducts scheduled examination rounds twice yearly, with dates advertised in The Industrial Eye and the AINDT e-newsletter.

While the AINDT strives to notify certificate holders of impending certification expirations, it remains the responsibility of the certificate holder to initiate the renewal and recertification process before their certification expires. Please note that late fees apply to overdue certification applications.

South Australia

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NDT methods, levels, and industry sectors offered:

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- Dye Penetrant Level 1, 2 and 3 Multisector (ISO 9712)
- Ultrasonics Level 1, General Engineering (ISO 9712)
- Ultrasonics 2 and 3 Welds (ISO 9712)
- Phased Array Level 2 and 3 Multisector (ISO 9712)
- Time Of Flight Diffraction Level 2 and 3 Multisector (ISO 9712)
- Radiographic Testing Level 2 and 3 Welds (ISO 9712)
- Visual Testing Level 1 and 2 Multisector (ISO 9712)
- Eddy Current Level 1, 2 and 3 Multisector (ISO 9712)
- Level 3 Basic Exam Prep (ISO 9712)
- OCTG drill pipe inspection
- Material Science in NDT – Multisector
- NDT for Managers & Engineers
- Radiation Safety (exceeding the syllabus of national module EA612)

Victoria

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W: attar.com.au

NDT methods, levels, and industry sectors offered:

- Computed and 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 and 3 Ultrasonics 2 Multisector
- Visual/Optical Testing 2 Multisector
- Time of Flight Diffraction (TOFD) levels 2 and 3 Welds
- Heat Treatment
- ISO 9712 UT Level 2 Corrosion/Erosion Detection and Mapping (CDM)

Western Australia

ATTAR
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NDT methods, levels, and industry sectors offered:

- Computed and 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 2, 3 Ultrasonics 2 Multisector
- Visual/Optical Testing 2 Multisector
- Time of Flight Diffraction (TOFD) 2, 3 Welds
- Heat Treatment
- ISO 9712 UT Level 2 Corrosion/Erosion Detection and Mapping (CDM)

SRG Training Academy

T: 08 9232 0300
E: trainingacademy@srgglobal.com
W: srgglobal.com

NDT methods, levels, and industry sectors offered:

- Ultrasonic Testing 1,2 Welds
- Magnetic Particle Testing 1,2 Multisector
- Penetrant Testing 1,2 Multisector
- Phased Array Ultrasonic Testing 2 Multisector

Queensland

Protecs Global

T: 07 3492 9213
E: hamed.madani@protecsglobal.com.au
W: protecsglobal.com.au

NDT methods, levels, and industry sectors offered:

- Ultrasonic Testing 1 (General Engineering) 2 Welds
- Magnetic Particle Testing, 2 Multisector
- Penetrant Testing, 2 Multisector

South Australia Branch Update

Festive Affair to Remember: South Australia's Christmas Party



The AINDT South Australia Branch recently celebrated the festive season with a lively Christmas party at the British Hotel on 29 November. The evening was filled with good cheer, offering a great mix of socialising, delicious nibbles, and a variety of drinks.

The venue provided the perfect backdrop for members to relax and mingle. Conversations flowed as easily as the drinks, with members catching up and discussing the year's successes.

It was a great opportunity for AINDT members to connect outside of the usual professional settings and strengthen their community ties. As the night concluded, members left in high spirits, already looking forward to next year's gathering.

Thanks to all who attended and made it a memorable night. We hope to see even more of you at next year's events.

Events in Early 2025

The South Australia Branch has already started planning a calendar of technical events for 2025.

David Bentley (Managing Director, TICV) will give a highly engaging presentation Ultrasonic Testing of Stainless Steels. David is passionate about NDT, specifically phased array ultrasonics. With over 20 years industry experience, David's reputation speaks for itself. David holds inspection integrity close to his heart and has recently established a training company to share his lifetime of work in the field. TICV fast-tracks real life inspection skills in ultrasonic testing, PAUT and TOFD.

Olympus will host a technical event on Phased Array Ultrasonic Testing (PAUT). The benefits of phased array UT come down to its use of multiple elements in a single transducer, which enables users to steer, focus, and scan beams with relative ease. Sectorial scanning enables users to map the components of tested material at odd angles, something not always achievable with other non-destructive testing methods.

Queensland Branch Update

Springing into the Festive Season – The AINDT Queensland Branch continues to thrive with exciting events and initiatives that reflect our commitment to innovation, collaboration and community in the NDT field.

Tech Night Success: Innovation in MT and DP Chemicals



On 31 October, we held a highly successful technical night featuring a webinar on Innovation in MT and DP Chemicals, hosted by John Duenzl from Simplifi NII.

This session focused on the latest advancements in Magnetic Particle (MT) and Dye Penetrant (DP) inspection chemicals. Simplifi NII's partnership with MR Chemie has brought innovative solutions to Australia, aiming to improve safety by eliminating toxic chemicals and enhancing the effectiveness of inspections and defect sizing.

The event attracted both members and industry professionals. It provided valuable insights into the future of NDT chemicals and showcased how safer and more effective solutions can benefit technicians and inspectors. We appreciate everyone who attended and look forward to further technical sessions that continue to push the boundaries of innovation in our field.

Upcoming Tech Night in Gladstone: Hosted by Duerr and EN DE TEK



We're excited to announce a new tech night in Gladstone on 12 December, hosted by Duerr and EN DE TEK.

This event will provide valuable insights into the latest developments and solutions in NDT, with details on the venue and time to be confirmed.

Stay tuned for more information in the coming weeks, and mark your calendars for what promises to be another informative and engaging session.

HIGH-RES & WIRELESS D-DR SERIES
PORTABLE FLAT PANEL DETECTORS

DÜRR NDT

Advanced Wall Thickness Tool of D-Tect X.

D-DR 3543 NDT
PORTABLE FLAT PANEL DETECTOR

- ✓ 100 µm pixel pitch (5.0 lp/mm)
- ✓ 353 x 430 mm active area
- ✓ Equipped with internal shielding for use up to 450 kV
- ✓ Perfectly suited for profile images and large objects

DÜRR NDT

Christmas Celebrations

The AINDT Queensland Branch hosted its Christmas event on Sunday 1 December. In Brisbane, attendees set sail on the Oasis Cruise for an unforgettable Christmas experience on the Brisbane River. They enjoyed stunning views, lively conversation, and festive cheer as they cruised into the holiday season together.

The Queensland Branch had something special planned for everyone to celebrate the season and connect with colleagues in a relaxed and festive atmosphere. It was a chance to connect with fellow members and spread holiday cheer.

A big thank you to our Gold, Silver, and Bronze sponsors for their generous support, which made these events possible. Your contributions help bring our community together and make these gatherings a success.

Gold Sponsors



Silver Sponsors



Bronze Sponsors



Looking Ahead: Stay Engaged with AINDT Queensland

As we close out the year, the AINDT Queensland Branch remains committed to promoting innovation, learning and community within the NDT field. We encourage all members to stay involved, and we look forward to sharing more exciting opportunities with you in the coming months.



New South Wales Branch Update

Sizing Up the Problem: Ultrasonic Testing and the Art of Finding What Lurks Beneath

At the latest AINDT New South Wales Branch Technical Night, Technical Trainer Chris Howson (State Technical Lead for NDT at SRG Global) hosted a discussion that dove deep—quite literally—into the murky depths of ultrasonic critical defect sizing.

In a room full of NDT professionals with a passion for finding hidden flaws, we spent the evening unpacking this sophisticated science with a healthy side of humour (and snacks).

The Big Question: How Big Is Big?

Let's get one thing clear—ultrasonic testing doesn't just detect defects; it sizes them up like a tailor measuring a suit.

From tiny hairline cracks to intimidating voids, it's all about knowing what we're dealing with and deciding if a flaw is 'critical' or just a minor inconvenience.

After all, a crack might be small, but in the wrong place, it can spell big trouble.

Getting Calibrated

One of the highlights of the night was a discussion on calibration—because without finely tuned, calibrated equipment, we might as well be measuring with a yardstick from a toy store. Calibrations and standards are the unsung heroes, keeping our instruments honest, our measurements precise, and our teams confident.

Techniques to Size By

Chris Howson shared methods on beam spread calculations and go-to methods, each with its own merits.

Amplitude-Based Sizing: Imagine echoes in a canyon, but with precise calculations. In amplitude-based sizing, we rely on the 6dB and 20dB drop methods to help us size defects based on the Last Significant Echo (LSE).

The 6dB drop method works best for defects larger than the ultrasonic beam width, giving us a reliable estimate of defect width by measuring how the signal fades.

For smaller, trickier defects—those sneaky flaws that are narrower than the beam itself—the 20dB drop method is ideal, as it captures fine details beyond the beam's reach. It's not flawless, but it's a rock-solid way to size up even the tiniest of hidden issues.



The Criticality Crisis

After sizing, it's time to tackle the all-important 'criticality' question. Is this flaw a harmless hiccup or a disaster in the making? Defects are assessed according to the compliance codes, backed by rigorous engineering calculations that factor in material tolerance, load, and environmental stress.

This thorough approach allows engineers to decide whether the flaw deserves a watchful eye or a fast-track ticket to the scrap heap, this process ensures safe, data-driven decisions, helping us keep structures standing and operations smooth.

Averting Disaster, One Flaw at a Time

In the end, ultrasonic defect sizing, done right, is all about proactive maintenance and early intervention. By spotting flaws before they escalate, our industry ensures safety, saves money, and makes maintenance teams look like legends.

So here's to the AINDT community, sharing knowledge and a few laughs, as we keep our assets intact and our sanity in check, one ultrasonic ping at a time.

Victoria and Tasmania Branch Update

The AINDT Victoria and Tasmania Branch Technical Night on 18 October 2024, brought together members for a hands-on showcase of the latest in inspection technology from Eddyfi.

Held at The Clayton Hotel for the first time, Duncan Murray and Dean Mason from Eddyfi demonstrated Eddyfi's Sonyk Guided Wave Ultrasonic system, a groundbreaking tool that delivers onboard data analysis in real-time, making it easier for technicians to evaluate and respond to material integrity issues on the spot. The Spynx and Sharck systems were also introduced, showcasing powerful eddy current technology designed to detect surface flaws and assess structural integrity.

Attendees had the opportunity to see these advanced tools in action, and considered how these innovations could solve real-world challenges in their daily work. Events like these foster a close-knit community within AINDT, where our members not only gain access to the latest knowledge but also build valuable connections.

At our recent Branch council meeting, we discussed our commitment to supporting members through regular events, such as sponsoring initiatives that support training, certification and knowledge. Upcoming event ideas, including a Thermography Technical Night, Supplier Night and a Family Day Christmas Function, ensure members have a blend of technical and social gatherings to look forward to.

Becoming a member of AINDT offers access to exclusive technical and social events. Members are encouraged to get involved and even consider taking on roles as branch councillors to help guide AINDT's direction and contribute to important industry initiatives.



Western Australia Branch Update

Manual and Phased Array Ultrasonic Testing of Austenitic Stainless Steels

On Wednesday 9 October 2024, the Western Australia Branch had the pleasure of organising a highly insightful technical evening on Ultrasonic Testing of Stainless Steels.

Kindly hosted and catered by Enermech in Henderson, the event was well attended by 30 industry professionals. Enermech is an international company that provides end-to-end project delivery, including conventional and advanced NDT solutions. Thank you to Kyle Massey for your out-of-hours support.

David Bentley (Managing Director, TICV) gave a highly engaging presentation. David is passionate about NDT, specifically phased array ultrasonics. His reputation speaks for itself, and the presentation was met with widespread appreciation.

All in attendance are now well informed on the challenges associated with ultrasonic testing of austenitic stainless steels, and the Western Australian NDT community is now well placed to be leading the way in this field. Thank you to David and his willingness to share over 20 years of experience in phased array ultrasonic testing.

David holds inspection integrity close to his heart and has recently started a training company to share a lifetime of work in the field. TICV is not a certification centre (ATO/AQB). However, it is a place to fast-track real life inspection skills in ultrasonic testing, PAUT and TOFD. Training is tailored to the student's request.

Kitted out with the latest instrumentation, calibration blocks and real world failed samples, TICV is the place to go for beginner to advanced UT development. Training is available in TFM, PWI, PCI, PAUT, TOFD and UT, as well as corrosion mapping using Hydroform 2/ PAUT and DLA/PAUT. Austenitic UT is David's specialty and the resources available to learn this niche art are second to none.

In David's words, "The training centre is a labour of love, and my way of giving back to the industry in my final years of working. The costs associated with this training are therefore extremely reasonable for individuals and companies alike."

For all enquiries about the training that David offers, please contact dbentley@ticv.com.au.



Western Australia Annual Golf Day

Members of the Western Australia Branch teed off on Thursday 28 November 2024 at Collier Park Golf Course in Como for our Annual Golf Day.

The day included 18 holes of golf, on-course snacks and refreshments, a tasty BBQ to wrap up the day and a trophy presentation in the clubhouse.

As always, prizes were awarded for:

- Closest to the Pin, which went to Jay Sloper
- Longest Drive, which went to Don Rheeders
- 'Broken Yoke' trophy for the Best Team, which went to the Team of Brian Sargent, Matt Campbell, Matt McWilliams and Mike Cicanese

It was a fantastic day of networking with NDT professionals and other supporters.

Special thanks go to all of our sponsors: ALTRAD, Evident Scientific, IRISNDT, OPESON, PCTE, GFS NDT Sonomatic and Vertech Group.



WA Branch President Josh Wilkinson presenting Longest Drive award (\$250 gift voucher sponsored by AINDT WA Branch) to Jay Sloper.



WA Branch President Josh Wilkinson presenting Winning Team Trophy to Matt McWilliams, Brian Sargent, Matt Campbell, and Mike Cicanese.



WA Branch President Josh Wilkinson presenting Longest Drive award (\$400 gift voucher sponsored by GFS NDT) to Don Rheeders.

Standards Update

Standards Australia Committee MT-007 Non-Destructive Testing of Metals and Materials has been very active over the last quarter, with a number of Standards being reviewed or assessed for possible adoption.

These Standards include:

- The revision of AS 3978 Non-destructive testing – Visual inspection of metal products and components is continuing. The working group is completing the review, with input to be included by the Standards Australia Working Committees.
- The 2020 version of ISO 4993 – 2020 Steel and iron castings was still being compared against the new 2024 version to determine if the revision was acceptable to current practices and industry.

There are also several proposed projects, and open or closed ballots, including:

Proposed Projects

- ISO/DIS 16826 Non-destructive testing — Ultrasonic testing — Testing for discontinuities perpendicular to the surface

Current Closed Ballots

- ISO/DIS 2400 Non-destructive testing — Ultrasonic testing — Specification for standard block No. 1
- ISO/NP 25335 Non-destructive testing — Thermographic testing — Mechanical and electrical equipment testing

Current Open Ballots for Voting

- ISO/DIS 16826 (Ed 2) Non-destructive testing — Ultrasonic testing — Testing for discontinuities perpendicular to the surface

- ISO/DIS 16811 Non-destructive testing — Ultrasonic testing — Sensitivity and range setting
- ISO/DIS 16823 Non-destructive testing — Ultrasonic testing — Through-transmission technique

As indicated previously MT-007 nominated for the ISO Working Groups and is awaiting acceptance.

These ISO Committees were as follows:

- ISO/TC 135/SC 3/WG 7
- ISO/TC 135/SC 3/WG 7
- ISO/TC 135/SC 7/WG 10
- ISO/TC 135/SC 7/AHG 1
- ISO/TC 135/SC 6/WG 1

Our activities in many Standards has increased substantially and we are looking forward in keeping everyone up to date with what is occurring with Standards, including the announcement of when public ballots will occur or when active.

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

Angelo Zaccari
MT-007 Standards Chairperson
azaccari@aben-tech.com.au



AICIP Update

Enrolments have opened for the 2025 AICIP examinations.

Recognised nationally, AICIP certification can expand your career options and job opportunities. Examinations assess the level of skill, knowledge and capability of

professionals working in the pressure equipment sector to ensure the integrity and safety of plant and pressure equipment inspection.

Dates and fees

Exam Papers	National Locations	Dates (March)	Dates (September)	Time
Exam Enrolment Deadline	Nationally**	16th February 2025	16th Aug 2025	No Enrolments after this date APPLY HERE .
Exam Onboarding Deadline	Nationally**	11th March 2025	9th Sep 2025	No Onboarding on day of exam
ISI paper A & B - Theory	Nationally**	13th March 2025	11th Sep 2025	AM - PM
ISI paper E - Practical*	Nationally**	14th March 2025	12th Sep 2025	AM
SISI Paper C & D - Theory	Nationally**	15th March 2025	12th Sep 2025	AM - PM

Additional dates for the exams may be added/deleted depending upon the applicant interest.

** Nationally – Sydney, Adelaide, Brisbane, Melbourne, Perth and *Darwin.

* Darwin applicants, please note, for the exams to run, there needs to be a minimum amount of enrolments, therefore candidates may need to opt for a different region to sit their exams. Candidates will be notified accordingly.

**In-Service Inspector (ISI) –
 Pressure Equipment : Sit Papers
 A, B & E**

\$885.00

**Senior In-Service Inspector
 (SISI) – Pressure Equipment : Sit
 Papers C & D**

\$495.00

Suggested Prior Attributes Of Candidates

There are no prerequisites, prior qualifications, training or experience required for AICIP in-service inspectors' examinations. However, candidates with insufficient industry experience will have difficulty passing the theoretical Paper B and practical Paper E.

To have a reasonable likelihood of demonstrating the required competency and passing the exams, it is strongly recommended that applicants have at least the following:

- Qualifications:
 - Year 12 High School, a trade certificate or equivalent knowledge.
 - Knowledge of common pressure equipment types and terminology used in Australian Standards.
 - Basic mathematics ability (for example, to calculate the volume, thickness and hoopsters of a cylinder).
- Training: 100 hours of either self or on-job training in pressure equipment inspection and the application of AS/NZ 3788.

- Experience: five years (full time equivalent) including two years in inspection. Experience should be sufficient to develop basic technical skills and good communication skills.

- Pressure equipment knowledge: an understanding of the main technical inspection terms relating to pressure equipment.

- Personal skills:
 - Ability to read, write and communicate orally in English.
 - Maturity and reliability.
 - Good eyesight and hearing (with or without correction).

For SISI applicants, more in-depth experience, calculation and technical ability is desirable.

To enrol in an AICIP examination, visit: inspectors.aicip.org.au

Thermography in Action

Why you should always do a follow up Thermography survey

BY ERIK THORUP, DIRECTOR IR TECHNOLOGY AUSTRALIA PTY LTD, CATEGORY 3 THERMOGRAPHER, ELECTRICAL/ MECHANICAL (AINDT/BINDT)

The main game of many Thermographers is to find high resistive connections in electrical installations. Since the introduction of the technology to the HV industry using heavy, vehicle mounted infrared (IR) cameras around 60 years ago (in 1965), the development of IR cameras has really exploded. So much so that today we can carry a small 9 gram 'camera' in our pocket and attach it to our smart phone with an app, which may perform almost as well. With the smaller hand held thermal imagers it has become possible and economical to use the technology on low voltage installations as well.

This article presents the history and some thermal images of a cable connection to a contactor for an ammonia compressor in a cold store plant room. The history and trend for this compressor contactor can be seen right. From a slight indication in March 2021, and no indication in October 2022, the compressor was not running at two of the previous surveys, before a major anomaly was found in January 2024.

All cabling between the contactors were replaced and at the survey half a year later, after the compressor had been started up, an anomaly at 88°C was seen at the same connection. This anomaly was still rising after 90 minutes.

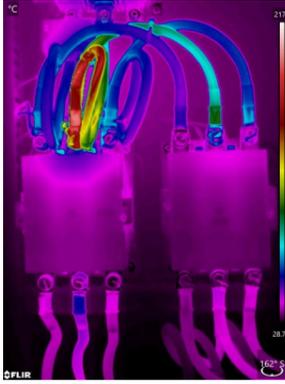
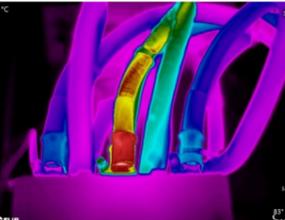
Conclusion

The issue here is that the initial high temperature fault was not found early. This is because we were unable to engage load on the plant, the compressor was not running during the two previous surveys, and there was a change in survey frequency from three per year to two per year. Furthermore, after the service and repair of the high temperature fault, no follow up survey was performed for 18 months.

As such, it is recommended:

1. To make sure that all plant is surveyed under maximum load every time.
2. To measure the load and note the run time of plant at the time of each survey.
3. That when survey scheduling is changed, every piece of plant is checked to determine whether the rescheduling may have implications for individual pieces of plant.
4. To always perform a follow up survey after repairs or changes. This enables the recording of a new baseline, as well as confirmation that the repair has been successful.

Timeline	Status
	
Date: 19/3/2021 Compressor Started	Max: 70°C Others: 60°C & 63°C, 200A DeltaT: 10K (Reported)
Date: 15/7/2021 (OFF)	The Compressor was Locked Out (OFF)
Date: 19/11/2021 Compressor Started	Max: 61°C Not Reported, 140A
Date: 9/3/2022 (OFF)	(OFF)
Date: 21/7/2022 (OFF)	(OFF)

Timeline	Status
Date: 13/10/2022 Compressor Started	No Indication of fault
Date: 15/3/2023 (OFF)	(OFF)
Date: 1/8/2023 (Locked out)	The Compressor had a cracked oil cooler (OFF)
Date: 15/1/2024 Compressor Started	At 9.26, 220A Max: 203°C
	
Date 15/1/2024 After run for 31/2 hour	At 12.55, 220A Max: 334°C
	
Close up of terminations	Visual of the cable after it had been removed
	All cables were replaced
	The Issue should now be fixed
Date: 1/7/24 Compressor Started	Max: 88°C Others: 20°C After run for 11/2 hour
	

White Phase Cable connection to top of Contactor

AINDT Member Q&A

Dr Chris Charlesworth (Principal Engineer – Advanced Inspection, SRG Global)



Dr Chris Charlesworth

With over 25 years of experience, Dr Chris Charlesworth is currently the Principal Engineer of Advanced Inspection at SRG Global and a Level III NDT Specialist. He has in-depth experience in a range of industries, from power generation and mining, through to oil and gas and petro-chemical. Prior this, Chris was at ALS Industrial Power Services for over ten years. Chris holds an Engineering Doctorate in NDE Phased Array and Advanced Ultrasonics and a Bachelor of Engineering (Hon) in Electronic Engineering. Chris took some time to answer a few questions for Industrial Eye.

Where do you work? Describe your job.

I work at SRG Global, a large multi-discipline company involved in care and maintenance of assets across multiple industries

I am the principal Engineer of Advanced Inspection, predominantly in the power generation sector but also involved in advanced NDT (mainly advanced ultrasonics) in the power, mining, oil and gas, and petro-chemical industries across Australia.

My main role is as a senior NDT authority within the asset care business, developing new and current technology and new procedures across many advanced inspection projects and challenges.

Can you share your journey into the NDT industry?

I underwent a trade apprenticeship on leaving school at 16 to become a trained electrical and instrument technician at a glass bottle manufacturer. I was very successful—both practically and academically. After six years of part-time technical college and tertiary education, I left that job to pursue my university education at the University of Hull (in the United Kingdom) where I studied an Honours degree in Electronic Engineering.

After graduating, I had the wonderful opportunity to work for BAe (British Aerospace) Dynamics in the United Kingdom designing missile systems.

I was noticed and poached by a high-end semiconductor distributor who offered me a great career as an Applications Engineer designing firmware for Complex Programmable Logic Devices (CPLDs) and Field-Programmable Gate Arrays (FPGAs) across multi electronic industries.

I worked my way up the ranks for six years, culminating in a senior role managing the entire FPGA franchise as Product Manager.

Unfortunately, lots of the contract manufacturing of electronic systems started to move overseas and it completely changed the business model of our industry. This eventually led to me taking voluntary redundancy. After a period I took to regroup and assess my future I realised I needed to get back to a technical role and needed a new challenge.

I was between careers and one of my close friends had embarked on an apprenticeship program pioneered by the British Institute of Non-Destructive Testing (BINDT), bringing young people into the NDT industry through an accredited apprenticeship program.

While undergoing his training, my friend was enthused by many of the techniques and technologies applied in the power industry. So I decided to take a closer look. There was an Engineering Doctorate program, facilitated by Imperial College London partnered with the Research Centre in Non-Destructive Evaluation (RCNDE) which was sponsored by RWE nPower, where my friend worked.

I approached the director of the RCNDE but was unable to enrol without a sponsor like RWE nPower. So I took an unlikely opportunity to enrol in the apprenticeship program.

Within 18 months an opportunity arose to enrol in the Engineering Doctorate program with the RCNDE and I took it without hesitation. I spent four years in a research and development role with RWE on the program and quickly made my name in the development of inspections of steam turbines.

What motivated you to take on a career in NDT?

The opportunity to take on a new career while advancing my academic education.

Who or what has influenced you most professionally?

Kevin Stamps was my mentor in the early years of my research. He was the development manager at RWE nPower and a much respected name in the inspection management industry.

His drive for excellence and practical approach to development will always guide me in my approach to advanced inspection validation and development.

What has been the most interesting project you've worked on and why?

The most interesting project I've worked on the development of the in-situ inspection of curved axial fir tree roots of steam turbine last row blades.

I developed a novel design for constant ultrasonic beam trajectories and a rexolite wedge for which I secured a patent at the time (since relinquished by RWE).

It was developed out of the desire to normalise beam trajectories to blade root fir trees without the use of expensive and poorly developed 2D matrix arrays that were in their infancy at the time due to lack of hardware and algorithms required to properly drive them.

Rapid Fire

What is your favourite:

- Food: Vindaloo
- Song: Under the Bridge by Chilli Peppers
- Sport: F1

If you could be famous, what would it be for?

Fastest lap in a n F1 car around Albert Park, or cheap clean power for all?

What advice would you give to someone just starting their career in the NDT industry?

Believe in the system, always carry out inspection with the highest integrity, knowing that even the simplest NDT method applied properly can prevent loss of reliability of systems and even loss of life. What you do is critically important at all levels.

What has been your greatest professional achievement?

The patent was a proud moment. I presented a paper at the BINDT conference in around 2010 and won best paper of the conference, as well as best paper by a young engineer. It was the first time that both prizes were won by the same person.

How has being a member of AINDT benefited you professionally or personally?

Being a part of the AINDT is a must in the Australian NDT industry. It ensures you are a part of a wider community of likeminded technicians.

I have recently become a councillor on the AINDT's New South Wales Council and, although I have contributed little to date, I hope it will open a huge networking opportunity as well as my opportunity to contribute back to the industry that has given me such a fulfilling career.

What are the top three things on your bucket list?

- Retire before I am too decrepit to enjoy it
- Visit Vatican City with my wife
- Be good at golf ;->

If you could meet anyone—alive or dead—who would it be?

Danny Ric.

What is your pet peeve?

Road rage and keyboard warriors.

What is your top tip for NDT excellence?

Believe in what you are doing and understand the consequence of not doing it with the upmost integrity.

Leading the Future of Non-Destructive Testing: Vertech Group's Comprehensive Solutions

In today's rapidly evolving industrial landscape, ensuring the safety and integrity of assets and infrastructure is paramount.

Vertech Group understands the critical need for precise and reliable inspection services. The company's extensive range of non-destructive testing (NDT) services is designed to meet the diverse needs of companies across various industries, ensuring they receive first-class deliverables and maintain the highest standards of safety and compliance.

According to Cam Waters, Managing Director of Vertech Group, "Vertech was established in 2008 to provide rope access and inspection services to Western Australia's resource industry. Initially focusing on core services, the company quickly expanded its offerings."

"In 2013, it was acquired by Global Energy Group, which introduced organisational processes and structures to support Vertech's transition from a small to medium-sized business. This acquisition also facilitated the purchase of Geo Oceans, expanding the group's capabilities."

"By 2015, Vertech had entered New Zealand, supporting major oil and gas operators with specialist services. Further growth followed in 2017, with operations established in the USA to support LNG projects like Cameron LNG and Corpus Christi LNG. In 2018, CWL acquired Vertech Group, enabling further expansion on Australia's East Coast, in Karratha, and New Zealand. The acquisition also introduced Sonomatic and specialised departments, including Vertech RDVI, to the group," said Waters.

Unmatched Expertise and Certification

Vertech Group's proven experience in NDT and inspection planning, coupled with their advisory services, positions us as leaders in the field. Vertech's team of experts provides recommendations and solutions that comply with both international and Australian standards. As an NDT inspection body certified to ISO 17025 by the National Association of Testing Authorities (NATA), accreditation number 18112, the company upholds the highest levels of quality and reliability.

Vertech's personnel are not only highly qualified but also bring a wealth of experience to every project. Their expertise spans a variety of NDT inspection services and testing methods, ensuring comprehensive and precise results. Whether you are looking for conventional or

advanced NDT methods, Vertech's team is equipped to deliver outstanding performance and accuracy.

A Proven Track Record in the Asia Pacific

Vertech Group's reputation for excellence extends across the Asia Pacific region. The company has successfully delivered a wide array of conventional non-destructive testing methods, making us a trusted partner for many industries. The company's commitment to innovation and continuous improvement drives us to push the boundaries of what is possible in NDT.

One of Vertech Group's standout capabilities is their integration of specialist access and robotics into their inspection services. This allows Vertech to manage end-to-end solutions, from high mobility specialist access using rope access, engineered decking, and netting systems, to deployment via remotely operated vehicles (ROV), unmanned aerial vehicles (UAV), or crawler-deployed systems. This versatility ensures that we can meet the unique challenges of any inspection scenario.

"Vertech Group collaborates with a network of distinguished service providers, each specialising in various fields, to drive innovation in project execution across diverse market segments," said Waters.

Comprehensive Conventional NDT Services

Vertech Group's conventional NDT services cover a broad spectrum of testing and inspection methods, each designed to provide accurate and reliable results:

- Ultrasonic Testing (UT)
- Magnetic Particle Testing and Inspection (MT)
- Dye Penetrant Testing and Inspection (PT)
- Eddy Current Testing and Inspection (ECI)
- Film Radiographic Testing (RT)
- Digital Radiography (DRT)
- Proof Load Testing (PLT)
- Dimensional and Visual Inspection (VT)
- Positive Material Identification (PMI)
- Laser Testing, Scanning and Mapping (LT)
- Thermographic Inspection (TI)
- Computerised Radiography (CRT)

Pioneering Advanced NDT Services

Sonomatic, a part of Vertech Group, boasts an industry-leading reputation for delivering advanced NDT inspection services. With over 40 years of experience, they are recognised as the world's premier provider of advanced ultrasonic inspection services. Their innovative approach continually pushes the boundaries of visual inspection, integrating current and emerging technologies to deliver cutting-edge solutions.

According to Alex Cesan, General Manager of Sonomatic, "Sonomatic has a history spanning over 40 years, specialising in non-destructive testing inspection services. Since its founding in the 1980s, it has integrated NDT processes with integrity engineering to deliver bespoke inspection solutions, supported by in-house development of equipment, software, and robotics."

"Recognised as a global leader in subsea inspection and non-intrusive inspection technologies, Sonomatic provides innovative and proactive inspection services to ensure the safety and integrity of both mature and newly constructed assets," said Cesan.

The company's capabilities cover in-house instrumentation design and manufacture, in-house software development and bespoke scanner and drive control design and modification. They are also the only company with an active research and development program dedicated to the Non-Intrusive Inspection (NII) process.

"Sonomatic is a relationship-driven company that constantly provides its clients with the best possible service, using the most specialised technology available. We always offer a bespoke solution to individual

Project Case Study: Sonomatic's Non-Intrusive Inspection at WA Gas Plant

As part of the client's proactive maintenance program, Sonomatic was tasked with conducting a Non-Intrusive Inspection (NII) program at a Gas Plant in Western Australia. The NII program formed part of a pre-shutdown campaign, aimed at assessing potential degradation before planned shutdown activities began, ensuring pressure vessel integrity without any interruption to usual process operations.

Tailored Inspection Strategy

Bespoke NII strategies were developed for ten pressure vessels, focusing on areas most susceptible to internal degradation. Each NII was designed to validate a client's corrosion risk assessments and to provide input data for future risk-based inspection updates.

Efficient Methodology

Sonomatic's inspection approach balanced comprehensive coverage with operational efficiency. Each inspection task was performed using industry leading equipment to ensure accurate data capture.



projects by selecting the most appropriate products and techniques from our wide range of equipment and software," said Cesan.

All inspection techniques, deployment tools and data analysis software are updated regularly to provide the most accurate data possible, more efficient data collection times and better data analysis methods. Over the years, Vertech Group has come to understand all the frequently encountered challenges, how they can provide the most value to their clients, and how to perform every job safely.

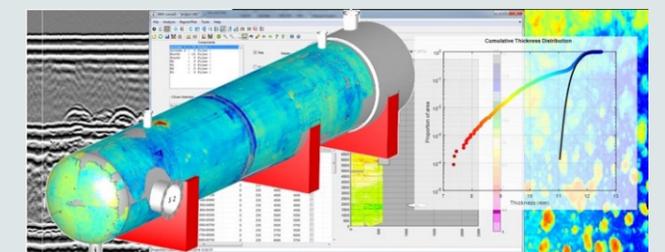
Vertech Group has numerous innovative or improvement solutions that are applied on a daily basis with existing clients.

Supporting Operational Efficiency

Non-intrusive inspections are integral for managing aging infrastructure, as they provide detailed insights into equipment health with minimal disruption. NII provides numerous HSEQ benefits including reduced flaring and operational downtime as well as removing personnel from confined spaces.

Conclusion

Sonomatic's successful NII program demonstrates the effectiveness of targeted inspection strategies for maintaining the reliability and availability of critical infrastructure.



Generic NII photo.

The following examples highlight their capabilities:

- Somatic Integrity Management Software (SIMS)
- Viiper Lifting Equipment Management Platform
- inSite Drone Software Package
- Marine Class 3D reporting
- Computed Tomography – inspect
- Dynamic Response Spectroscopy (DRS)
- Online Internal Inspection of tanks to API 653
- End-Dome Robotic Inspection System (EDRIS)
- Confined Space Drone inspections
- Remote and Robotic Digital Visual Inspections
- Non-Intrusive Inspections (NII) to RP 103
- High Mobility Find and Fix
- Pipe Support Inspection and Remediation Package
- Specialised Access Solutions
- Magnetic Eddy Current (MEC)

Specialised Advanced NDT Services

Vertech Group's advanced NDT services include a range of specialised techniques designed to address complex inspection challenges:

- Time of Flight Diffraction (TOFD)
- Phased Array (PA)
- Long Range Ultrasonic Testing (LRUT)
- Advanced Tube Inspection
- Alternating Current Field Measurement (ACFM)
- Multi-Skip Inspection
- Electromagnetic Testing (EMAT)
- Microwave Testing
- Creeping/Head Wave Inspection Method (CHIME)

Commitment to Excellence and Innovation

At Vertech Group, extensive experience and dedication to innovation underpin their ability to offer innovative solutions to inspection challenges. The company is committed to evolving the scope of what's achievable in inspection services, ensuring clients benefit from the latest advancements in technology and methodology.

Vertech's rigorous development and validation processes guarantee that their inspection services are of the highest quality and reliability. This commitment to technical excellence ensures that the company remains at the forefront of the NDT industry, delivering solutions that meet the most stringent safety and integrity requirements.

Whether you require conventional NDT methods or cutting-edge advanced inspection techniques, Vertech is equipped to meet your needs with precision and excellence.

For further information, visit: vertechgroup.com.au



Project Case Study: Moomba to Cross Border CCS Pipeline

The Moomba to Cross-Border CCS Pipeline runs east from the Santos-owned Moomba gas Plant to depleted reservoirs in the Marabooka and Strzelecki fields. At a diameter of DN250 (10") and a length of approximately 50km, MPC Kinetic engaged Vertech to conduct radiographic inspections throughout the pipeline's construction.

Moomba is a natural gas processing hub in the South Australian portion of the Cooper Basin. It purifies natural gas before distributing it to South Australia, New South Wales, and Queensland via the East Coast domestic gas pipeline network. One processing step at Moomba is removing the CO₂ from the natural gas, which is then vented. The objective of the Moomba CCS project was to capture this vented CO₂ and store it underground within depleted gas reservoirs, avoiding its release into the atmosphere.

Project Overview

Moomba is a natural gas processing hub in the South Australia's Cooper Basin. The facility refines the extracted natural gas before distributing it to various destinations in South Australia, New South Wales, and Queensland via the East Coast domestic gas pipeline network. Among the processes conducted at Moomba is the extraction of carbon dioxide (CO₂) from the natural

gas, which is vented into the atmosphere. The Moomba Carbon Capture and Storage (CCS) initiative aims to, instead of venting CO₂, securely store it underground within depleted gas reservoirs.

To capture the CO₂ vented at Moomba and store it within Cooper Basin depleted gas reservoirs, there are five significant steps:

- **Capture:** A stainless steel header connects the four existing CO₂ removal units, collecting the CO₂ and delivering it to the CCS compressor at near atmospheric pressure.
- **Compression:** A four-stage centrifugal compressor compresses the CO₂ to a pressure of ~13 MPa. Compression of the CO₂ is required to push it through the pipeline and into the depleted gas reservoirs. The first three compression stages also reduce the concentration of water in the CO₂, reducing the load on the Tri-Ethylene Glycol (TEG) dehydrator.
- **Dehydration:** A TEG dehydration package removes moisture from the CO₂ before entering the pipeline. This is to ensure no free water formation within the carbon steel CO₂ pipeline, preventing corrosion and the formation of CO₂ hydrates.
- **Transport:** A 50km carbon steel pipeline transports the compressed, dehydrated CO₂ from Moomba to the injection reservoir.
- **Injection:** Four injection well skids are used to monitor and control the rates of CO₂ injection at each well while

Pipeline and Design Considerations

The Moomba to Cross-Border CCS Pipeline runs approximately 50km east from the Moomba Plant CCS Facility to depleted reservoirs in the Marabooka and Strzelecki fields, which have been selected for the first injection phase.

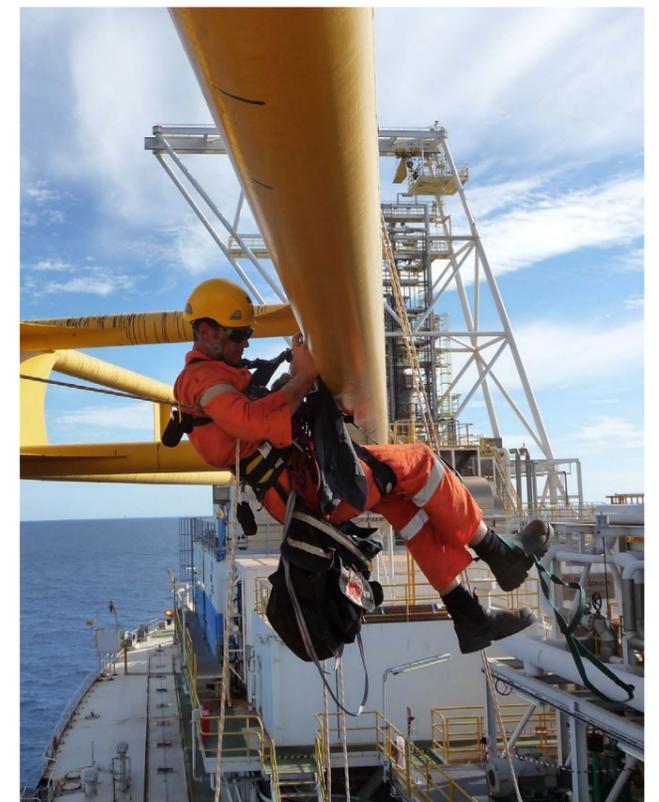
A robust design strategy was implemented following AS 2885, with the project piping specification aiming to mitigate the risk associated with pipeline fracture propagation. To ensure the best available methods were employed, the traditional Two Curve Method calculations and the recently published DNV recommended practice five were used to select the required toughness.

The standard wall pipe selection was governed by fracture control requirements considering penetration resistance, fracture control, NACE requirements, minimum temperatures, cost, and material availability.

Scope

MPC Kinetic contracted Vertech Group's Roma operations to perform Radiography and Non-Destructive Testing (NDT) on the 50km DN250 (10") Moomba to Cross Border CCS Pipeline. Digital radiography and internal JME crawlers were used for the mainline section, resulting in substantial time and cost savings compared to traditional radiography. This approach also ensured quick result turnaround, enabling MPC's construction team's seamless progression to the next project phase.

The assessment of tie-in welds involved conventional



radiography using Rigaku 300kV X-ray tubes, supported by mobile darkroom facilities on custom-made, rugged four-wheel-drive trucks designed explicitly for Cooper Basin's harsh and sometimes challenging conditions.

The need for reliability and timely test results drove the deployment of high-powered X-ray equipment and mobile darkrooms.

The Vertech team, comprising a supervisor, specialised crawler technician, non-destructive testing technicians, and trades assistants, was multi-disciplined. This versatile team was equipped to conduct onsite ultrasonic and hardness testing as needed, reducing the requirement to mobilise additional staff and ultimately lowering the overall execution costs.

Improving the Integrity of Rail Weld Evaluation Using Advanced NDT Techniques

Rail welds join the rails of a railway track, so they are a critical part of railways that must be inspected for flaws. Non-destructive testing (NDT) technology is used to inspect rail welds both during their construction and while in-service to help maintain the integrity and safety of railways.

BY NICK ELEFThERIOUS, PRODUCT MANAGER NDT APPLICATIONS, EVIDENT TEST & MEASUREMENT

This article highlights current NDT techniques used for weld inspection during rail corridor construction and in-service maintenance, shares the challenges of these methods, and offers ways to improve rail weld evaluation using the latest advanced NDT innovations.

Challenges of Inspecting Rail Welds Using Conventional Ultrasonic Testing

The current construction standards for testing rail welds used in Australasia involve a combination of inspection and test methods:

- Visual inspection (weld) and straight edge measurements
- Magnetic particle testing (MT) of the web, under head radius, and upper foot section
- Conventional ultrasonic testing (UT) using procedures derived from AS1085.20 Railway track materials — Part 20: Welding of steel rail
- Tensile testing of full thickness test specimens
- Macroscopic examination of fracture surfaces

Following initial visual compliance testing of rail welds during construction, weld internal examinations using conventional UT generally rely on a trained operator to interpret the A-scan waveform signal. This is specified in the referenced standards, with most regions having similar requirements.

An example of a conventional UT application is shown on the right (Figure 1).

Conventional UT techniques use a long-standing and proven method for evaluating the integrity of the weld material and heat affected zone, as well as for evaluating rail discontinuities during the manufacture of rail sections.

For many years, non-destructive testing methods such as UT have been used as a part of construction compliance testing and maintenance programs on rail networks. This has been implemented to control the influence of construction integrity and in-service



Figure 1. Conventional ultrasonic testing.

conditions for safety-relevant performance, helping ensure that the inspected part will be used in-service in a safe condition.

Generally, rail asset owners rely on service companies with specialised equipment and qualified staff. For non-destructive testing, there are numerous competency standards available for technicians. Many of these standards used locally require appropriately trained and capable personnel undertaking these NDT tasks in accordance with ISO 9712 Non-destructive testing — Qualification and certification of NDT personnel.

However, these conventional test methods introduce various challenges for railway inspections, such as:

- Reliance on service companies to provide the quantity and quality of rail industry experience for trained NDT technicians
- Non-recordable digital data interpretation in the field using a UT A-scan (waveform)
- No standardised permanent digital record of ultrasonic test data is available due to manual UT methods (see Figure 1)



- Growing demand for certified and skilled NDT operators and for frequent peer review technical assessments
- Acceptance of new technologies, digital transformation, and data perennity

Adopting Advanced NDT Techniques for Rail Weld Inspection: PAUT, TFM and PCI

Relying on the interpretation of conventional ultrasonic A-scan data in the field to identify and evaluate a known subsurface indication may be problematic for many applications, such as the identification of the flaw type, flaw sizing, and cross-sectional geometry evaluation.

Adopting phased array technologies, which include the total focusing method (TFM) and phase coherence imaging (PCI) using geometry overlays (Figure 2), provides greater evaluation accuracy, simplifying interpretation and leading to efficiency and safety improvements within the rail industry.

Damage mechanisms, also referred to as degradation mechanisms, is a general term referring to any source or problem of failures within rail and other assets. These mechanisms can range from manufacturing installation issues, cracking, cyclic fatigue, heat damage, and everything in between.

Phased array ultrasonic testing (PAUT) methods deliver far greater detail to the extent of any discontinuities and damage mechanisms within a weld or rail section, which

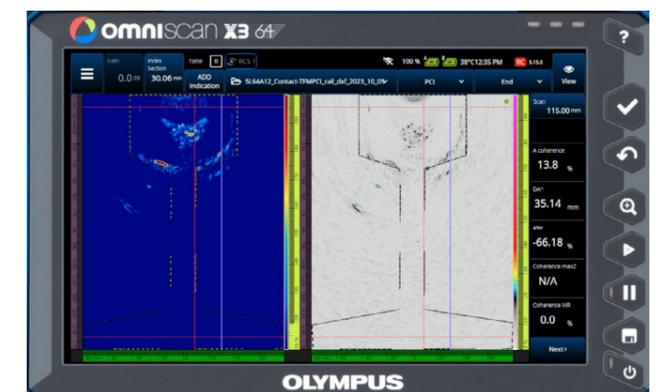
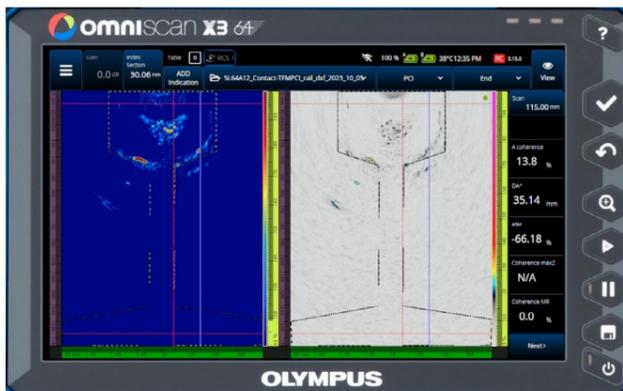


Figure 2. OmniScan X3 64 flaw detector using TFM and PCI on a 160 mm rail displaying cluster porosity in an aluminothermic weld.

may assist with evaluation and engineering assessment and any integrity program. Track engineers can review the PAUT data using baseline assessment records and ongoing periodic testing to better evaluate maintenance schedules. This reduces overall unforeseen costs of rail corridor downtime with greatly improved accuracy.

The phased array TFM and PCI image shown above (Figure 2) shows evidence of a weld-related issue in the rail head section. The benefits of this advanced test method are:

- TFM amplitude-based assessment
- PCI phase-based assessment (Hilbert transform)



Wireless capabilities further enhance this evaluation. The ability to store data directly to and from a wireless-network-connected OmniScan X3 flaw detector to OneDrive for evaluation and permanent data storage provides flexibility for both service providers and asset owners.

Additionally, the ability to connect remotely to the flaw detector using the X3 Remote Collaboration Service (X3 RCS) in the field delivers a practical solution for ongoing training and quality assessment. Off-site specialists can offer guidance from any location to resolve on-site issues immediately, support beginner inspectors, and improve internal communication.

References

AS 1085 series – AS 1085.20:2020 Railway track materials, Part 20: Welding of steel rail ISO 9712:2021 Non-destructive testing—Qualification and certification of NDT personnel

Inspection Solutions for Railways

EPOCH™ 650 Flaw Detector for Rail Testing: www.olympus-ims.com/en/rail-inspection-using-ndt-ultrasonic-technologies/

OmniScan X3 64 Flaw Detector: www.olympus-ims.com/en/video/power-you-can-carry-introducing-the-omniscan-x3-64-flaw-detector/

X3 Remote Collaboration Service: www.olympus-ims.com/en/video/x3-remote-collaboration-service-for-the-omniscan-x3-series-virtual-collaboration-virtually-anywhere/

PCI and TFM: www.olympus-ims.com/en/video/exploring-advanced-ultrasonic-inspection-techniques-total-focusing-method-tfm-and-phase-coherence-imaging-pci/

Figure 3. Weld indication is identified in both TFM and PCI. Length and cross-sectional measurements may be assessed with greater accuracy.

- Permanent record of test data available for post-inspection assessment
- Rail profile image overlay provides immediate evaluation as to the cross-sectional loss of weld volume

Innovations in Non-destructive Testing for More Efficient Rail Weld Inspection

Innovations in non-destructive testing using phased array ultrasonics, which includes onboard TFM and PCI using the OmniScan™ X3 64 flaw detector, deliver a range of benefits for rail asset owners.

These benefits are substantial improvements in the integrity of rail weld evaluation, along with a streamlined workflow. Equipment setup is simple—the application setup can be saved and loaded remotely, recalled onboard the equipment in the field, and immediately calibrated by the field technician.



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Introduction to Computed Tomography

Computed Tomography (CT) is a non-destructive 3D imaging technique that is increasing in popularity. This is being driven by increased adoption of advanced manufacturing processes such as additive manufacturing and the constant pursuit of improved product quality, especially for critical components in the aircraft and automotive industry, lifting hooks, wheels and more, where 100% inspection is required.

BY DR CAMERON CHAI AND PETER AIREY

Computed Tomography (CT) is a non-destructive 3D imaging technique that is increasing in popularity. This is being driven by increased adoption of advanced manufacturing processes such as additive manufacturing and the constant pursuit of improved product quality, especially for critical components in the aircraft and automotive industry, lifting hooks, wheels and more, where 100% inspection is required.

In these applications, CT can identify defects beneath the surface that are invisible to external inspection techniques.

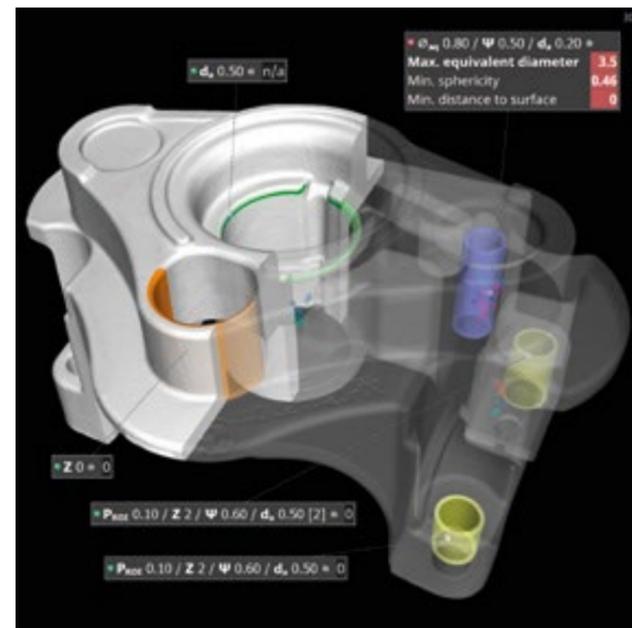


Figure 1. CT inspection allows users to recognise and characterise porosity in three dimensions.

In other applications, it can be used on a batch basis. Alternatively, CT is also used for failure investigations or process control and optimisation.

Origins of CT

Originally used in medical applications (commonly known as CAT scans), CT is now being used more extensively in areas such as materials science, non-destructive testing (NDT), quality control, failure analysis and to investigate geological materials. In these applications, it is ideally suited to revealing sub-surface defects or checking the dimensional accuracy of internal structures and features that would otherwise go undetected by surface inspection techniques and metrology techniques.

CT has been used in medical applications for over 50 years, earning its inventors (British engineer Godfrey Hounsfield and South African Physicist Allan Cormack) a Nobel Prize in 1979.

However, it has taken much longer for the process to become more widely accepted by the materials science and NDT communities. This is largely due to the fact that these applications required much higher resolutions compared to medical applications to produce meaningful data.

With higher resolution comes much larger file sizes. This, in turn, requires better data storage and more powerful computers to process the increasing amounts of data. In more recent times, Artificial Intelligence (AI) has also played a role and helps processing the data.

Modern CT Systems

Now, with the miniaturisation of electronics and mechanical componentry, CT systems can range from small benchtop instruments and run through to much larger systems that cater for components and assemblies in the metre-plus size range. There are also systems that are designed for quality control applications in industrial environments and will happily live out on the factory floor where they can be integrated into your workflow. Also, depending on the smallest feature you need to detect, CTs can offer sub-micron resolutions.



Figure 2. The Diondo d5 CT system which can cater for samples up to 500mm dia. x 1300mm tall.

CT and Radiography

In NDT, a CT system is similar to a digital radiography (DR) setup, in that a sample is mounted on a stage, or manipulator, in between an X-ray source and detector. Images are collected on the detector as X-ray photons pass through the sample. For DR, generally one image is collected at a time; it only shows one particular slice, or projection, through the sample.

How Does CT Work?

CT runs on the same principle as DR. However, after each image or tomograph is acquired, the sample (or sometimes the source and detector) is rotated slightly and another image taken. This effectively slices up the 360 degrees (sometimes less) of rotation. The finer the slicing, or more projections you have, the better the resolution. As mentioned, higher resolution images result in more data, and also requires more time to collect.

High resolution scans can easily run into 2,000 to 3,000 projections, generating large amounts of data. Once a full rotation is completed and you have collected your data set (such as a tiff stack) you can then use reconstruction algorithms to 'rebuild' the combined stack of projections generating a 3D image of your sample. DR is a powerful tool in its own right. However, CT enables you to precisely locate specific features within your sample.

Powerful software then allows the operator to analyse and manipulate the data in many ways. Packages such as Volume Graphics can easily rotate and look inside for cracks and defects, reconstruct and deconstruct regions of interest and take measurement and perform other metrological operations.

These software packages also enable automation of repetitive tasks and often incorporate Automated Defect Recognition (ADR). As the name suggests, ADR can analyse a 3D dataset, looking for particular flaws, and

CT Sample Scanning

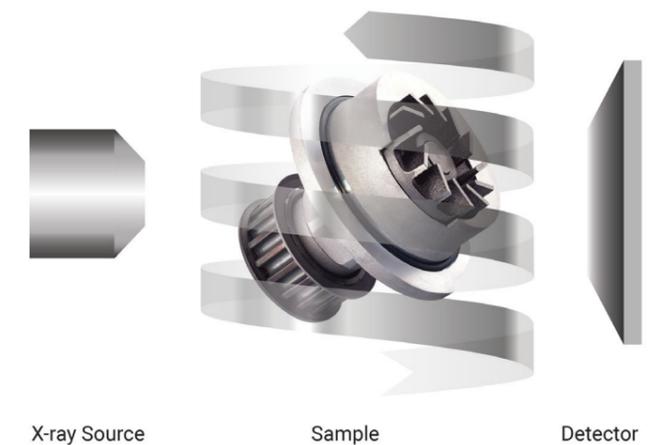


Figure 3. Schematic representation of how a sample is scanned in a CT.

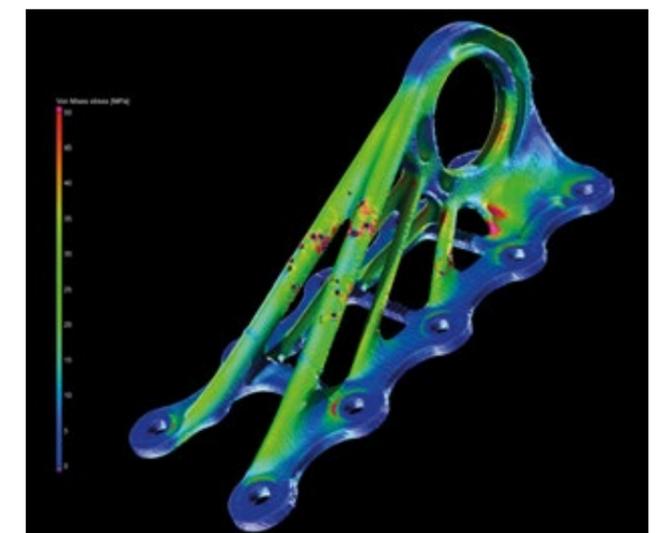


Figure 4. Finite elements stress simulation performed directly on a CT scan.

then report back to the operator, potentially with pass/fail options. More sophisticated packages also offer finite element analysis capabilities that can be beneficial in product design.

Resolution and Voxels

With 2D digital graphics, their dimensions are often referred in terms of pixels, with a pixel being the smallest single definable element. With 3D computer generated renderings, the smallest element is a voxel, which can be likened to a 3D pixel, or a combination between volume and pixel.

In industrial systems for larger parts, a typical voxel size of 50µm to 200µm and can be used on items like automotive gearboxes. Micro CT voxel sizes in the sub-micron range can be achieved but on smaller samples

in the range of pharmaceutical tablets, but a series of images can be stitched together effectively providing analysis of larger objects.

These higher resolutions require high magnifications and the X-ray source typically very close (as close as possible) to the sample. Variables such as field of view, detector pixel size, X-ray focal spot size, magnification and so on can influence the resolution of a CT scan.

There is also temporal resolution, which relates to how quickly a CT can create a full image slice. In industrial environments, temporal resolution may be viewed more critically as it will influence throughput. Otherwise, it can be important when monitoring processes in real time, where high temporal resolutions could be beneficial to prevent missing a rapid event such as brittle failure.

Application Areas for CT

As mentioned, CT is most commonly used in quality control applications where it is ideal for manufacturers of low volume, high value components. In these environments it is uneconomical to destructively test small percentages of parts, while it can also be used to compare the dimensional accuracy of a manufactured part to the engineering or CAD drawings.

Another alternative application is reverse engineering of existing parts. By scanning existing parts (including those no longer being produced), 3D models can be produced. These 3D models can be converted into CAD files, enabling reverse engineering of components.

CT has also found application in product development where it can be used to see inside components such as cast components to show pores that may result from improper mould filling. This knowledge can then help manufacturers alter processing parameters of mould designs to encourage better molten metal flow

Why is CT Such A Valuable Tool?

Compared to other more commonly used techniques, CT has the advantages over other NDT inspection techniques in that it can:

- Penetrate through complex 3D structures
- Easily reveal internal structures and features
- See below the surface
- Reveal defects such as pores of cracks
- Be used to check dimensional tolerances against specifications

Summary

CT is becoming an increasingly popular method to non-destructively inspect components with a wide variety of systems now available that can cater for parts of varying size. CT instruments are primarily being used to rapidly perform quality control checks, but may also find application in product development or even reverse engineering.

Unlike most other imaging and metrology techniques, CT can non-destructively see beneath the surface of components revealing cracks, flaws, pores and other defects, making it an invaluable NDT tool and will no doubt experience increased usage in coming years, especially in Australia where advanced manufacturing and additive manufacturing is gaining momentum.

NDT World Event Calendar

NDE 2024

12 to 14 December 2024 | Chennai, India

The 34th Annual Conference and Exhibition on Non Destructive Evaluation will be hosted by the Indian Society for Non-destructive Testing (ISNT) in Chennai in December. With over 50 keynote talks, 40 technical sessions and over 120 exhibitors, it is shaping up to be an engaging event. It is set to attract over 2,000 delegates. Chennai is one of India's largest and most vibrant cities, known for its rich cultural heritage, historical landmarks, and thriving economy. The city is a major economic hub in India, with a diverse economy that includes industries such as automobile manufacturing, information technology, healthcare, and the film industry, contributing significantly to India growth.

For further information, visit: isnt.in

SINCE 2025

27 to 28 February 2025 | Singapore

Hosted by the Non-Destructive Testing Society Singapore (NDTSS), the fifth Singapore International NDT Conference and Exhibition will take place in February 2025. The conference includes a technical program that will present the latest research and technology developments as well as practical applications of NDT in all major industrial areas. The technical programme will feature keynote presentations from internationally-renowned industry leaders. The associated exhibition will emphasise the close links between research and development and the equipment and instruments used in the industry, focused on Industry 4.0 and additive manufacturing.

For further information, visit: www.since2025.org

3rd International Conference and Exhibition on NDE 4.0

3 to 6 March 2025 | Bengaluru, India

The International Conference on NDE 4.0, a pivotal event initiated by ICNDT's Special International Group, focuses on the integration of Industry 4.0 technologies in non-destructive evaluation and inspection. This conference highlights advancements in robotics, drones, AI, machine learning, IIOT, augmented reality, and

digital twins, revolutionising industrial inspections. Following successful events in 2021 and 2022, the third conference will be held in Bengaluru, India. It will feature an exhibition showcasing cutting-edge products and services, offering attendees opportunities to share knowledge, network, and accelerate NDE 4.0 adoption in their industries.

For further information, visit: 2025.nde40.com

Pan-American Conference for Non-destructive Testing

9 to 12 June 2025 | Ontario, Canada

The next Pan-American Conference for Non-destructive Testing (VIII PANNDT) will be held at the Fallsview Casino Resort at Niagara Falls in Ontario, Canada from 9 to 12 June 2025. The exhibition area will have space for over 100 booths. This valuable conference is a must-attend event for inspection, quality assurance, quality control, manufacturing, and non-destructive testing personnel. The program will feature presentations from leading researchers, technicians, companies, and organisations who will demonstrate the latest technologies, trends, tools, and techniques. The conference is being hosted by the Canadian Institute for Non-Destructive Evaluation.

For further information, visit: www.panndt.org/panndtconference

ASNT Research Symposium

23 to 27 June 2025 | Indianapolis, United States

Hosted by the American Society for Non-destructive Testing, the ASNT Research Symposium is the premier event for the Non-destructive Evaluation Community. Make plans now to attend, present, and network as we hear about cutting edge research from some of the best minds in the field, spotlight up and coming researchers, listen to engaging award lectures, and network with peers and friends. With the theme of New Horizons: The intersection of technology, community, and collaboration, the symposium will look at how digitalisation, artificial intelligence, and automation are enhancing efficiency and accuracy in NDE.

For further information, visit: asnt.eventsair.com/rs2025

Acoustic Emission Monitoring of Additive Manufacturing Processes

Additive manufacturing processes have accelerated the production of a wide range of components. However, there have been many failures as a result of manufacturing defects.

DR GARY MARTIN, ATTAR

A method for discriminating between good and defective components is required to ensure the longevity of the technology. Numerous NDT techniques have been considered and trialled for this purpose with success. Early discrimination at the manufacturing stage may be done using Acoustic Emission for monitoring the condition of the component as it is produced. Basic AE parameters recorded during manufacture have been shown capable of sorting the good from the bad. Now it remains to apply this condition monitoring technology to industrial production situations.

Introduction

Following earlier work in in the 70's and 80's the first real Additive Manufacturing

(AM) started in the USA in the mid-1980s with the invention of a process called to create geometrically precise 3D objects layer by layer in contrast to traditional manufacturing that often requires machining or other techniques to remove surplus material.

Because of the complex geometries involved and complicated processing parameters, there is a high probability of manufacturing defects in AM due to changes in process parameters or quality of feedstocks. If these anomalies can be found during the manufacturing process, rather than after completion, manufacturing costs can be reduced.

Failure of AM components has occurred in service, for example [2], with the potential for serious consequences. Many factors may contribute reduced integrity of AM components including surface roughness, lack of fusion, porosity, solidification cracking, keyhole collapse, design deficiencies that result in stress concentrations and the quality of the materials used [3]. To avoid wasting time and materials an in-situ monitoring tool that assesses the quality of the structure as it is built is required.

Acoustic emission has a history of use for condition monitoring during manufacturing processes and in-service. There are Standards in place for AE monitoring of welds [4, 5] during production and a wide range of structures in-service, covered in an earlier paper [6]

Previous reviews [7-14] have been carried out and provide a wide range of information on equipment and techniques used for monitoring a variety of AM processes. This brief paper looks at the information already available to enable meaningful research into the application of AE to Additive Manufacturing processes to improve the quality of the end product and avoid wastage of energy, time and material. Ideally this could be real time continuous monitoring potentially providing feedback to enable better control of the operating parameters and improving quality. Perhaps before that thought sorting the good from the bad is a start.

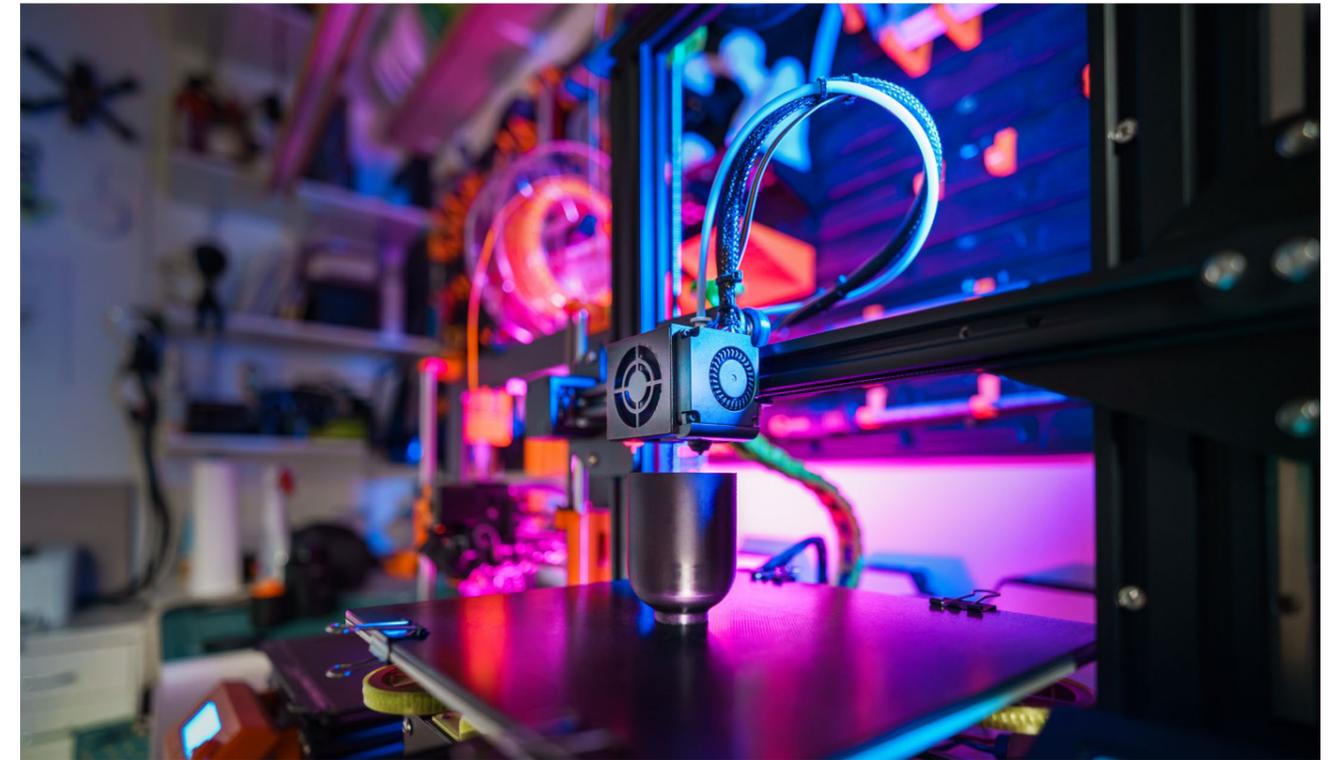
Additive Manufacturing Processes

There are a number of processes [15] currently in use including:

1. Binder Jetting that uses a 3d printing style head moving on x, y and z axes to deposit alternating layers of powdered material and a liquid binder as an adhesive.
2. Directed Energy Deposition may be used with a wide variety of materials including ceramics, metals and polymers. A laser, electric arc or an electron beam gun mounted on an arm moves horizontally melting wire, filament feedstock or powder to build up material as the supporting bed moves vertically.



Figure 1. Direct Energy Deposition (DED) additive manufacturing.



3. Material Extrusion which uses spooled polymers which are either extruded or drawn through a heated nozzle which is mounted on a movable arm. This builds melted material layer by layer as the nozzle moves horizontally and the bed moves vertically. The layers adhere through temperature control or chemical bonding agents.
4. Powder Bed Fusion encompasses a variety of AM techniques including direct metal laser melting (DMLM), direct metal laser sintering (DMLS), electron beam melting (EBM), selective laser sintering (SLS) and selective heat sintering (SHS). Electron beams, lasers or thermal print heads are used to melt or partially melt fine layers of material after which excess powder is blasted away.
5. Sheet Lamination may be split into two technologies; laminated object manufacturing (LOM) and ultrasonic additive manufacturing (UAM). Laminated object manufacturing is suited to creating items with visual or aesthetic appeal and uses alternate layers of paper and adhesive. UAM uses ultrasonic welding to join thin metal sheets; a low energy, low temperature process, UAM can be used with various metals such as aluminium, stainless steel and titanium.
6. Vat Polymerisation which uses a vat of liquid resin photopolymer to create an object layer by layer. Mirrors are used to direct ultraviolet light which cures the successive layers of resin through photopolymerisation.
7. Wire Arc Additive Manufacturing (Now known as Directed Energy Deposition-Arc (DED-arc)). DED uses arc welding power sources and manipulators

to build 3D shapes through arc deposition. This process commonly uses wire as a material source and follows a predetermined path to create the desired shape. This method of additive manufacture is usually performed using robotic welding equipment.

AM technologies can be broadly divided into three types[16].

The first of which is sintering whereby the material is heated without being liquified to create complex high resolution objects. Direct metal laser sintering uses metal powder whereas selective laser sintering uses a laser on thermoplastic powders so that the particles stick together.

The second AM technology fully melts the materials, this includes direct laser metal sintering which uses a laser to melt layers of metal powder and electron beam melting, which uses electron beams to melt the powders.

The third broad type of technology is stereolithography, which uses a process called photopolymerisation, whereby an ultraviolet laser is fired into a vat of photopolymer resin to create torque-resistant ceramic parts able to endure extreme temperatures.

AE in Additive Manufacturing

AE differs from other NDT techniques in that it does not introduce energy or liquid into the part, rather it relies on detecting the high frequency sound waves generated as discontinuities form in the structure. Thus sensors have to be placed so that they will detect these sound waves. In a recent review [7] of the monitoring of the AM process, the type and number of sensors

and the AE signal processing technique used have been summarized. Those that relate to discontinuity detection and location are included in Table 1. Also shown in Table 1 are more recent applications of AE to AM.

When monitoring AM processes the sensors have to be attached to the supporting substrate. The technique of attachment and location of sensor has varied depending upon the AM process studied. High temperature cyanoacrylate adhesives were used with selective laser welding (SLM) of Hastelloy X powder [21]. Vacuum grease was used with polymer material extrusion, also known as fused deposition modelling

(FDM), of ABS [24]. Significantly different sensor types have been used, both flat response and resonant frequency. The resonant frequency response sensors are best used when accurate location of potential discontinuities is required. Flat response or wideband sensors are best suited to assessing spectral waveform characteristics, bearing in mind that they do have lower sensitivity than the resonant frequency sensor.

Couplant is always required when bonding the sensor to the working surface and the type used will be dependent upon the temperature to which the sensor and couplant are exposed. It may even be necessary to use high temperature sensors [17] or even waveguides.

Table 1 A summary of type of AM process, type, frequency and number of AE sensor(s), method of bonding and data processing technique for in situ acoustic monitoring of AM after [7]

Type of AM process	Type and number of AE sensor(s)	Couplant/ Bond	Data processing technique
Laser Powder Bed Fusion (LPBF)	Differential flat response 100-900 kHz PZT sensor-1	Magnaflux Sono 600	RMS value of acoustic emission signals [17]
Laser Powder Bed Fusion (LPBF)	Unknown f PZT sensor-4	N/A	Hsu-Nielsen technique was used to locate the defect signal on the build plate [18]
Laser Powder Bed Fusion (LPBF)	Unknown f PZT sensor-1	N/A	Fast Fourier Transform (FFT) of acoustic signals fed to an Artificial Neural Network (ANN) [19]
Laser Powder Bed Fusion (LPBF)	150KHz, Flat response PZT sensor-3	N/A	RMS value of acoustic emission signals [20]
Laser Powder (SLM)	250KHz PZT -2	Cyano acrylate	Source location via surface waves [21]
Direct Energy Deposition (DED)	Unknown f PZT 1	N/A	Time-domain and frequency-domain features of AE signals are used as the indicators and analyzed. [22]
Direct Energy Deposition (DED)	Flat response? PZT-4	N/A	Spectral feature-based clustering method. [23]
Fused Deposition Modeling (FDM)	Differential flat response 100-900 kHz PZT sensor-1	Vacuum Grease	Time-domain features of AE signals are used as the indicators and analyzed using Support Vector Machines (SVM) [24]

Sensors have been attached to the top of the working surface as shown in Figure 2 or on the back of the working surface as shown in Figure 3. Placing sensors on the back will remove them from higher temperature area but will result in a small loss of AE signal but may enable the use of normal rather than high temperature sensors.

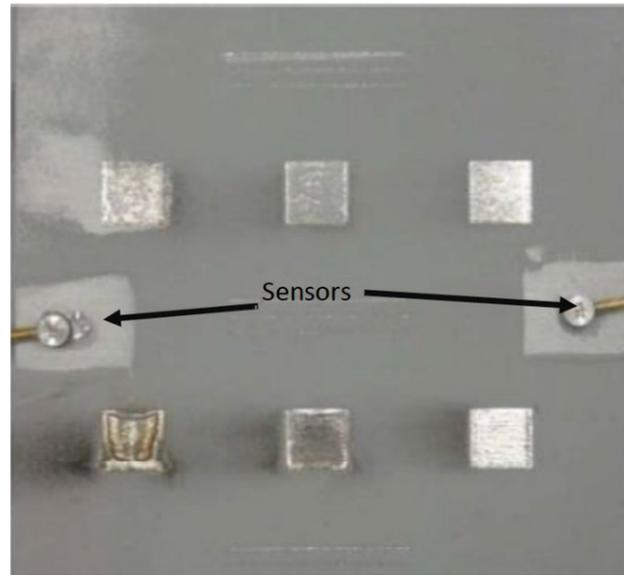


Figure 2. Sensors attached to the working surface. From [21]

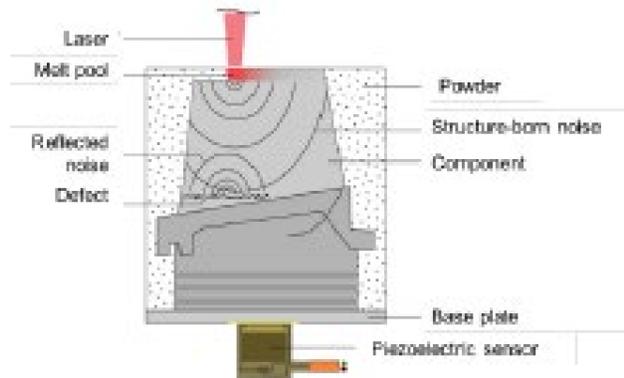


Figure 3. A single PZT sensor fixed to the back of the working plate. From [9]

Discussion

Although most of the studies reviewed have been based on the use of single sensors and qualitative tools such as spectral analysis, where multiple sensors and location techniques have been used the results appear promising for finding defects. A range of defects were observed and there appeared to be a correlation between the AE parameters and crack propagation in the AM components. One study observed that the focussing on a couple of parameters such as amplitude, counts, ABS Energy or RMS signal level was sufficient to discriminate between good printing and bad printing [24]. In the same study it was also observed that spectral analysis and K-means clustering enabled characterisation of defect types. Yet another study [22] in which common defect mechanisms were tested, and the K-Means clustering mechanism was also used for analyzing the data, porosity and cracks were able to be identified. Porosity signals had shorter decay time and less amplitude whereas cracks had short duration and high amplitude.

A considerable amount of research has gone into the application of AE to condition monitoring of the AM process using a variety of sensors, attachment methods and couplants, as well as data analysis programs. The results appear promising for discriminating between good and bad printing runs using basic AE measurement parameters. There is evidence also that defect types may be characterised through more sophisticated spectral analysis programs. AI programs may also prove applicable.

Initially the goal should be to apply AE to determination of the good print and to stop the bad print so as not to waste time, energy and material. Whether it is necessary to be able to determine defect type on the production line is, as yet, unclear and requires further discussion with additive manufacturers.

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