KINT SYMPOSIUM 2019

KINT

Dutch Quality Surveillance and Non-Destructive Testing Society

# JOIN THE KINT SYMPOSIUM 2019

## Phased Array Ultrasonic Testing (PAUT) of welds in thin-walled materials

October 30 and 31, 2019

More information: info@kint.nl

Venue Shell Technology Centre Amsterdam
Symposium language: English

Supported by:

EF NDT European Federation for Non-Destructive Testing

**The Dutch Quality Surveillance and Non-Destructive Testing Society is pleased to announce the KINT Symposium 2019:**

# Phased Array Ultrasonic Testing of welds in thin-walled materials

## The project

With the introduction of small portable Phased Array Ultrasonic Testing (PAUT) systems, the replacement of radiography by ultrasonic inspection techniques for testing of welds in thin-walled steel components has become a promising proposition. PAUT differentiates from Radiographic Testing (RT) as it does not involve ionising radiation and therefore improves safe working conditions. 'Plot clearance' is usually required to mitigate radiation risks connected with RT, preventing other activities to take place. Especially in larger construction projects (heat exchangers, boilers, piping et cetera), the potential of PAUT for improving project efficiency is considerable.

Over the past few years, several equipment suppliers have developed crawler based systems that enable the application of PAUT testing of welds in thin-wall (3.2 –8 mm) ferritic steel material. During a preceding KINT project, a PAUT technique description was developed, which resulted in a base document for ISO Standard (ISO/DIS 20601:2017).

Following on from the technique description, the current PAUT on thin-walled materials project (PAUT-TWM), aims to produce scientific and practical foundation as well as a draft ISO Acceptance Criteria Standard for this application. The project was carried out by SKOP, the research and development foundation of the Dutch society for Quality Surveillance, Inspection and Non-Destructive Testing (KINT).

## The participants in the project

The project was sponsored by a large group of companies and institutes, including all major Dutch NDT service providers, a power plants consortium and leading international oil & gas and chemical companies:

**The Dutch Quality Surveillance and Non-Destructive Testing Society is pleased to announce the KINT Symposium 2019:**

# Phased Array Ultrasonic Testing of welds in thin-walled materials

## The symposium

At this KINT symposium the results of the project will be presented, combined with national and international presentations related to the PAUT inspection in thin-walled materials. The symposium language is English. The Symposium was organised with the support of:

## Why you should attend:

- The results of this unique project will be presented by leading Dutch NDT specialists
- Presentations on related work will be held by renowned international speakers
- Latest developments will be presented in Tabletop sessions by equipment suppliers
- Networking opportunity with your international colleagues
- Special evening on October 30th

## Location

Shell Technology Centre Amsterdam
Grasweg 31
1031 HW Amsterdam

# Final program KINT Symposium

## Day 1: Wednesday 30 October

Chairman for the day: *Erik Zeelenberg, Chairman of the PAUT-TWM Project Steering Committee*

08.30 - 09:30 Arrival and registration

09.30 - 09:45 Welcome presentation by the host

Sieger Terpstra, Shell Research and Technology

09.45 - 10:00 Welcome and Opening

*Jan Verkooijen, President KINT*

10.00 - 10:30 Qualification and Industrial Application of Small Bore Phased Array UT

*Fraser Hardie, Doosan Babcock*

10.30 - 11:00 Break + visit to tabletop sessions

11.00 - 11:45 PAUT-TWM: Reliability study of Phased Array UT on low alloy, thin walled steel welds with wall thickness between 3.2 – 8.0 mm

*Victor Vertregt, Shell*

11.45 - 12:30 PAUT-TWM: Defining rejection criteria for PA based on Probabilistic Fracture Mechanics Assessments

*Stan Kusters, Sintra Engineers*

12.30 - 13:45 Lunch + visit to tabletop sessions

# Final program KINT Symposium

## Day 1: Wednesday 30 October (Continued)

| | | |
|---|---|---|
| 13.45 - 14:30 | PAUT-TWM: Road map to acceptance criteria<br>*Eric van Broekhoven, TIAT* |
| 14.30 - 15:15 | PAUT-TWM: From project plan to draft ISO standard,<br>*Leo Ton, ExxonMobil* |
| 15.15 - 15:45 | Break + visit to tabletop sessions |
| 15.45 - 16:15 | Advantages of applying Phased Array in lieu of Radiography for the inspection of small bore austenitic piping<br>*Fred Gabriëls, TÜV Rheinland Sonovation BV* |
| 16.15 - 16:45 | Array probe signal processing in case of structural noise<br>*Paul Nicolas, EDF* |
| 16.45 - 17:00 | Dinner instruction |
| 17.00 - 18.00 | Visit to the tabletops and drinks |
| 19.00 | Dinner |

# Final program KINT Symposium

## Day 2: Thursday 31 October

Chairman for the day: *Casper Wassink, PAUT-TWM Project QA Officer*

08.30 - 09:30 Walk in

09.30 - 10:00 Ultrasonic Testing in lieu of Radiography: The Business Case, *Martin vd Heuvel, MISI*

10.00 - 10:30 Qualification of phased array ultrasonic (PAUT) welding control of tubular low thickness assemblies *Nicolas Nourrit, Institut de Soudure*

10.30 - 11:00 Break + visit to tabletop sessions

11.00 - 11:30 Comparison of FMC/TFM and Phased Array Ultrasonic Testing of welds in thin walled materials *Casper Wassink, EddyFi & Karolina Galon, Mistras*

11.30 - 12:00 Review and advances of inspection strategies for thin walled girth welds *Niels Portzgen, Applus RTD*

12:00 - 12:30 TIG-Welding and it's challenges on small wall thickness, small bore piping *Frank Smit, NIL (Netherlands Welding Institute)*

12.30 - 13:30 Lunch + visit to tabletop sessions

# Final program KINT Symposium

## Day 2: Thursday 31 October (Continued)

13.30 - 14:00 Development of acceptance criteria for PAUT on thin wall pipeline welds

*Otto Jan Huising, Gasunie*

14.00 - 14:30 Ultrasonic Phased Array Testing in lieu of Radiography Testing for Thin-Walled Heat Exchanger Welds: An In-the-Field User Case

*Andre Lamarre, Olympus*

14:30 - 15:00 Linear and Matrix Phased Array inspection of complex thin wall components

*Thomas Heckel, Daniel Brackrock; BAM Berlin*

15.00 - 15:15 Closing

*Casper Wassink*

15.15 - 16:00 Visit table top sessions and drinks

# Final program KINT Symposium

# Abstracts Day 1, 30 October 2019

**Qualification and Industrial Application of Small Bore Phased Array UT**
***Fraser Hardie, Doosan Babcock***

The rapid evolution of phased array UT equipment over recent years has been exploited for applications previously considered to be beyond the limits of ultrasonic testing. One of these applications is the volumetric inspection of thin wall (<8mm) tube butt welds, where traditionally radiography has been the selected method. The health and safety restrictions associated with radiography can have significant, adverse impacts on the programmes of turnarounds and outages. Alternative, safe inspection methods, such as UT, are commercially attractive since other production activities can continue in parallel.

In 2010 Doosan Babcock became one of the first companies to explore the possibility of replacing radiography with PAUT for thin wall weld inspection, taking advantage of innovative, low profile, miniaturised probes, which could cope with tube geometries and associated space restrictions. In common with most NDT innovations, as soon as the equipment became commercially available, many NDT companies invested and claimed to have the capability.

The NDT team at Doosan Babcock has been involved in cutting edge ultrasonic technology for over 40 years. A strong nuclear heritage means that we also have a detailed understanding of the importance and mechanics of inspection qualification. The PAUT system that we have developed for tube butt welds has been robustly qualified, following the ENIQ methodology, and covers both ferritic and stainless steel welds. The system has been used extensively in the field for the last eight years.

This presentation will cover the scope of Doosan Babcock's qualification and field experience, including metallurgical feedback on reported defects. The need for tailored acceptance criteria will also be introduced.

**PAUT-TWM: Reliability study of Phased Array UT on low alloy, thin walled steel welds with wall thickness between 3.2 – 8.0 mm**
***Victor Vertregt, Shell***

In order to support the KINT project on development of acceptance criteria for Phased Array UT weld examination in low alloy steel with wall thickness 3.2-8.0 mm , a reliability study was performed on approximately150 weld specimen with natural weld defects. These samples were all circumferential piping welds, with varying wall thickness, materials and diameters. All samples were inspected in a blind trial with Phased Array UT, conventional radiography and computed tomography per standardized inspection procedures developed for the KINT project. The results were compared at indication level – in total 700 different indications were reported - and used to determine the reliability of Phased Array UT and conventional radiography in term of detecting, sizing and interpretation capabilities and amount of false calls. The results of this study were used to determine Probability of Detection curves and other required input parameters for the different Phases of the KINT project.

# Abstracts Day 1, 30 October 2019 (continued)

**PAUT-TWM: Road map to acceptance criteria**

***Eric van Broekhoven, TIAT***

A joint industry project initiated by the Dutch society for non-destructive testing and inspection (KINT) has succeeded to developed acceptance criteria for Phased array examination on welds in thin walled products. The KINT project has several working groups that evaluated the results of previous projects where Phased Array has been used and compared results of Phased Array with results of Radiography for a large number of new welds. Interaction between the working groups ensured that all aspects were taken into account and led to a substantiated proposal for an acceptance criteria.

***PAUT-TWM: From project plan to draft ISO standard***

***Leo Ton, Exxon Mobil***

Over the past years, several equipment suppliers have developed mechanized systems that enable the application of PA testing of welds in thin-wall (3.2 – 8 mm) ferritic steel. During a preceding KINT project, a PAUT technique description was developed, which has been accepted as the base document for an ISO Standard (ISO/DIS 20601:2017).
This project was initiated to develop subsequent acceptance criteria of PAUT on thin wall steel welds resulting in an ISO standard. Five phases within the project were defined, each with an own coordinator and clear scope:

- Phase A: Literature survey
- Phase B: Experience based survey (qualification studies and field experience)
- Phase C: Fracture mechanic analysis
- Phase D: Field validation of draft acceptance criteria
- Phase E: Optimization and preparation of NWI ISO

From here the journey begins: how to manage a research project in time, quality and cost? How to deal with various challenges we faced resulting in scope changes and additional work impacting planning and cost? And not the least: how to ensure this standard will be accepted and adopted by the industry?

Since RT is the industry standard for thin wall steel welds, acceptance of alternatives will be mirrored to RT references (like probability of detection, rejection rate, false call rate). Comparing these completely different techniques is almost impossible, but we managed to solve this issue. Probability of Detection (PoD) curves were established. Then ensuring integrity of the accepted weld indications by fracture mechanic analysis and perform a field validation with over 900 welds.

*Continued on next page*

# Abstracts Day 1, 30 October 2019 (continued)

### PAUT-TWM: From project plan to draft ISO standard (continued)

Every phase outcome had its own results. Understanding these differences and tune them to match the project goal (provide a solid basis for a draft ISO, supported by industry) was key element during the last phase as the project due date was nearing. With many thanks to all project participants and devoted phase coordinators with their team members (in most cases providing project support aside their normal jobs) we're proud to present the project outcome after over 3 years of hard work: acceptance criteria of PAUT on thin wall steel welds and how this standard was derived.

### Advantages of applying Phased Array in lieu of Radiography for the inspection of small bore austenitic piping

***Fred Gabriëls, TÜV Rheinland Sonovation BV***

The advantage of applying advanced UT techniques (TOFD/PAUT) in lieu of radiography are large, especially during turn arounds. In this paper, the approach and advantages of applying PAUT for the weld inspection of small bore austenitic inlet header tubes of a reformer in the OCI AFA ammonia plant in Geleen, The Netherlands will be described.

During this project 800 welds NPS 1.5 (42.2mm), 347 stainless steel with a wall thickness of 4.85mm were inspected. A significant decrease of the turnaround time was achieved by replacing X-ray by PAUT. As exact location of the defect was known, partly repair of the weld was possible.

### Array probe signal processing in case of structural noise

***Paul Nicolas, EDF***

This work focuses on non-destructive examinations using array probe ultrasonic waves on complex materials generating a high structural noise on the examined area. During an ultrasonic examination, multiple scattering of the ultrasonic waves on the grain boundaries makes difficult the distinction between this structurally induced noise and a potential defect. The difficulty of the interpretation can moreover be increased in the near surface area because of the sub-surface wave. In order to ease the analysis of these acquisitions, some numerical processing methods are proposed. Statistical properties of the imaging results (for instance Total Focusing Method or Plane Wave Imaging) are first calculated on several sensor positions. These statistical properties are then used to post-process the imaging results and enhance any signals values that do not belong to the structural noise expected statistics. The method has been successfully tested on cast austenoferritic stainless steel coarsed-grainded mock-up, with several dB gain compared to the classical Total Focusing Method.

# Final program KINT Symposium

# Abstracts Day 2, 31 October 2019

**Ultrasonic Testing in lieu of Radiograph: the Business Case**
***Martin van den Heuvel, MISI***

Quality control of welds in projects and repairs is historically done with radiography.

Already in the Dutch welding institute's project 'NDT of thin plate' (1992) the conclusion was:

The detection reliability of mechanized ultrasonic testing techniques is at least as good as but usually better than that of conventional non-destructive testing techniques such as manual ultrasonic testing and standard radiography.

Nowadays mechanized (PA)UT is standardized and thus reliable Automated UT (AUT) and semi-automated UT with encoded scans enables permanent record keeping of UT inspection data. Data storage for UT is now common practice and although much progress has been made with the development of RT as well, the presentation will state that with the development of codes for the application of (PA)UT time has come to start with applying UT in lieu of RT on a larger scale.

The presentation will show examples of business cases and where opportunities have been missed. It will also call for the need to educate and collaborate to benefit from the added value, implementation of the recently developed standard will support that process.

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**Qualification of Phased Array Ultrasonic welding control of tubular low thickness assemblies.**
***Nicolas Nourrit, Institut de Soudure***

As part of the manufacture of exchangers and vaporizer screens and monitoring of assembly welds, EDF wished to have alternative applications to historical practices based on the "radiography" RT method according to the Ministerial Order from March 1978. The NDE implemented on welded joints is a semi-automated process using PAUT technique.

The Group Institut de Soudure has defined and executed a scope of work so as to qualify this process on thicknesses ranging from 3 up to 13mm and tube diameters ranging from 1 "up to 4".

# Abstracts Day 2, 31 October 2019 (continued)

**Comparison of FMC/TFM and Phased Array Ultrasonic Testing of welds in thin walled materials.**
***Casper Wassink, EddyFi & Karolina Galon, Mistras***

Phased Array Ultrasonic Testing (PAUT) has been the rising star in NDT for the last 20 years. Technological development has not stopped in that period however. Is Full Matrix Capture / Total Focusing Method (FMC/TFM) going to be the new star? In this presentation we will compare the work preparation, setup, scanning and reporting process of PAUT and FMC/TFM, performed according to their respective ISO standards (ISO 20601 vs. ISO CD 23864) on samples from the KINT project. What are the advantages and disadvantages..

**Review and advances of inspection strategies for thin walled girth welds**
***Niels Portzgen, Applus RTD***

Over the last decade's technology innovations has influenced the way we think, live and work. To what extent have these innovations influenced the way in which we conduct Non-destructive Testing of welds? What will we be most likely be the way we preform Non-destructive Testing of welds in the near future?

Together with you, we will take a seat in our time capsule and in a straight line return to the past to see how we then carried out Non-destructive inspection of welds and to see how it all started. We will then move forward in time in our time capsule to end up in the here and now.

During this spectacular journey through time, we will stand still by a variety of technological innovation changes that non-destructive testing of welds has experienced at various times in de past. Once we arrive in the here and now we park our time capsule to stretch our legs and to spend a little bit more time on the technological innovation of Phased Array inspection.

After stretching our legs and informing us of the technological innovations of Phased Array weld inspection, we step back into our time capsule to continue our journey into the future. During this journey towards the future we will also stand still by a variety of technological innovation changes that awaits us in the non-destructive inspection of weld. At the end of our time journey through the various future technological innovation changes, we will jointly return to the present in our time capsule to get you back on track.

# Abstracts Day 2, 31 October 2019 (continued)

### TIG-Welding and it's challenges on small wall thickness, small bore piping

***Frank Smit, Netherlands Welding Institute***

The Netherlands Institute of Welding is an independent foundation that looks after the interests of the welding (related) industries. That means: promoting the technology of welding, improving education in the field of welding, helping the welding professional to develop and the companies to continue operations.

One of the most used welding processes is the TIG-welding process (Tungsten Inert Gas). It is a process that can be used mechanically and manually and is characterized by a high quality of the weld. To achieve this high quality the welder needs some level of craftmanship. If not, a lot can go wrong that could lead to all kind of imperfections. Although this provides us with work, we prefer to have flawless welds. And to be sure we have achieved welds to be proud on, we have to do non-destructive-testing, like phased array.

### Development of acceptance criteria for PAUT on thin wall pipeline welds

***Otto Jan Huising, Gasunie***

N.V. Nederlandse Gasunie (Gasunie) started in 2012 to investigate if phased array ultrasonic testing (PAUT) could replace radiographic testing, this to reduce radiation in populated areas and waiting time for crews after completion of tie in welds of valve stations. To implement this phased array technique for pipes with thin walls 4,5mm to 8mm and diameters from 4″ up to 16″ research was performed to verify the feasibility. PAUT systems where qualified to obtain the probability of detection and sizing accuracy on welds with known defects. Since no standard with acceptance criteria for this type of testing was available, acceptance criteria were developed based on the revised EPRG defect assessment criteria. In 2017 the EN-ISO 19285 Phased array ultrasonic testing (PAUT) -- Acceptance levels was released. This standard is also compared to the acceptance criteria as developed by Gasunie. The PAUT system was field tested where comparison was made with radiographic testing. This comparison comprised of a review of welds with both techniques and performance with regard to inspection time and assessment accuracy. After a year application in service of PAUT systems, data from three different NDT companies where re-reviewed with regard to data accuracy and reproducibility. This resulted in revision of procedure requirements. After a further two years of use the interpretation criteria were revised to increase unity in assessment of the data. At this moment phased array s-scan in wall thicknesses of 4,5mm to 8mm is the technique of choice for pipe to pipe connections and almost completely replaced the radiographic testing at Gasunie.

# Abstracts Day 2, 31 October 2019 (continued)

### Ultrasonic Phased Array Testing in lieu of radiography testing for thin-walled heat exchanger welds: an in-the-field-user case

***Andre Lamarre, Olympus***

In this presentation, Olympus will share a user case study that demonstrates Dreifeld Materialprüftechnik GmbH successfully inspected thin-walled heat exchanger welds with phased array ultrasonic testing (PAUT) instead of industrial radiography (RT). Using a solution composed of the COBRA® scanner, the OmniScan® MX2 flaw detector, and VeriPhase® Automated Detection Technology™ (ADT) software, one operator fully inspected and analyzed the data of 1604 welds over a period of 8 days. The solution was used in lieu of radiography to help prevent missing indications such as lack of side wall fusion and to avoid complications related to safety. It was estimated that the project was performed five times faster and at a fraction of the cost of radiographic testing. This presentation will summarize the efforts to develop and validate the inspection method in accordance with ISO-20601. The ultrasonic settings, calibration process, inspection workflow as well as data analysis and reporting will be examined. It also aims to review the benefits of this solution, the challenges faced by its deployment as well as improvement perspectives

### Linear and Matrix Phased Array inspection of complex thin wall components

***Thomas Heckel, Daniel Brackrock, BAM Berlin***

The application of phased arrays in either linear or matrix arrangement in combination with signal processing opens the door for the mechanized inspection of different thin wall materials itself as well as their joining methods.

Modern lightweight components are typically manufactured by a composition of different types of e.g. steels, metals, fiber reinforced plastics and glass. Dependent on the material combinations e.g. welding, brazing, bonding, cladding or coating may be applied during the manufacturing process to join different semi-finished products to form the component.

The resulting complex material composition and different damage mechanisims pose new challenges to non-destructive testing with ultrasound due to the different material properties and the overall arrangement of the materials employed.

The sound field variation capabilities of array probes may be helpful to overcome some of these challenges if adapted to the specific inspection task.

Examples for the non-destructive mechanized phased array inspection of different types of materials and joining methods will be presented.

# Event Registration Form KINT Symposium 2019

Company :

First name :

Last name :

E-mail :

Phone :

Address :

City :

Country :

Price € 650 per person, including 21% BTW (VAT)

Dinner on 30 October, as well as lunch, coffee/tea/refreshments during both days are included.
In order to arrange this please tick the appropriate boxes below.

- ☐ I will be joining for dinner on 30 October
- ☐ I will be joining for lunch on 30 October
- ☐ I will be joining for lunch on 31 October
- ☐ I am a (company-) member of KINT and/or participant in the project and receive a discount of 25% on the Symposium price

Name: Date: Signature:

_____ _____ _____

**Please send your registration to info@kint.nl**
You will receive an invoice. Your registration is valid after payment

# Tabletop Sessions Registration Form
# KINT Symposium 2019

Company :

First name participant 1
Last name participant 1 :

First name participant 2
Last name participant 2 :

E-mail :

Phone :

Address :

City :

Country :

Tabletop price: € 500 for max. 2 persons, including 21% BTW (VAT)
Dinner 30 October: € 150 per person, including 21% BTW (VAT)

Lunch, coffee/tea/refreshments during both days are included.
In order to arrange this please tick the appropriate boxes below.

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- ☐ I / we will be joining for lunch on 30 October
- ☐ I / we will be joining for lunch on 31 October

Name: Date: Signature:

_____ _____ _____

**Please send your registration to info@kint.nl**
You will receive an invoice. Your registration is valid after payment

# Hotel suggestions for the KINT Symposium 2019

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|---|---|
| Double tree by Hilton | Oosterdoksstraat 4, 1011 DK Amsterdam<br>(Amsterdam Central Trainstation ,<br>approx. 25 minutes walk/ferry from the venue)<br>+31 205 300 800, amscs.info@hilton.com |
| Renaissance Amsterdam | Kattengat 1, 1012 SZ Amsterdam<br>(Next to Amsterdam Central Trainstation,<br>approx. 22 minutes walk/ferry from the venue)<br>+31 206 212 223, gs@renaissancehotels.com |
| Sir Adam | Overhoeksplein 7, 1031 KS Amsterdam<br>(11 minutes walk from the venue)<br>+31 202 159 910, hello@siradamhotel.com |
| Park Plaza Victoria | Damrak 1-5, 1012 LG Amsterdam<br>(Opposite Amsterdam Central Trainstation,<br>approx. 21 minutes walk/ferry from the venue)<br>+31 205 240 678, ppvainfo@pphe.com |
| Intell Hotels | Nieuwezijds Kolk 19, 1012 PV Amsterdam<br>(City, approx. 25 minutes walk/ferry from the venue)<br>+31 205 301 818, infoamsterdam@inntelhotels.nl |