

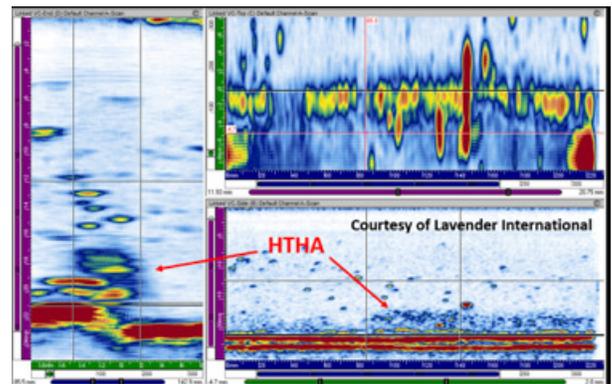
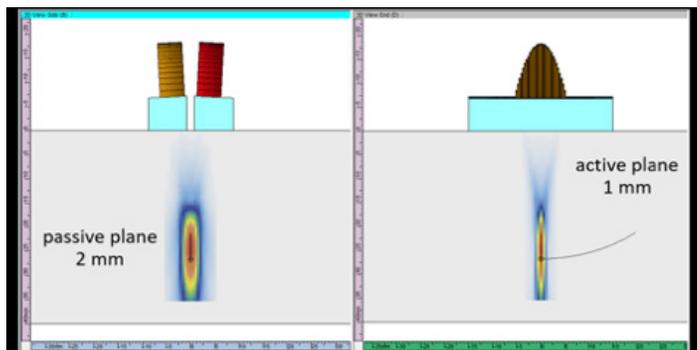
## HTHA - PAUT Detection and Sizing

### Application Note

### *Sensor Networks and Zetec join forces to create a better solution for inspection reliability and productivity.*

High Temperature Hydrogen Attack (HTHA) has been an issue in the Petrochemical industry since the 1930s. After it was first identified in the ammonia industry, other refinery/hydro-processing units were found subject to this type of damage in hydrogen service above 200°C with carbon steels. The time for damage has been guided by the “Nelson Curves” which have been modified many times over the past 30 years. This type of damage can seriously affect the mechanical integrity of pressure equipment on start-up, shut-down and inservice. Often there is no physical change until a significant failure/release.

Although there have been few fatal events, a significant incident occurred in 2010 on older equipment and at the same time, the validity of the “curve” was being challenged by new reported non-fatal incidents. These incidents have prompted the industry to evaluate the mechanical integrity of reactors, heat exchangers and piping in refinery and petrochemical plants. Replacement with higher-alloy components can cost over \$100 - 200M USD/ major operating unit.



The process industry has historically relied on NDE to assess equipment condition but HTHA has remained elusive to identify and characterize. In a Joint Industry Project (JIP) in the early 2010's, the detection rate in a round-robin controlled environment using prescribed methods by a handful of skilled NDE service providers yielded a success rate of less than 1%. Due to industry and independent projects, a new set of NDE Modalities have been developed, proven and instructed to over 100 Technicians in 5 continents and these methods are TOFD, TULA, beam-forming PAUT and TFM/FMC. These methods, developed on ex-service material and widely established and implemented over the past 3 years, have established high confidence in the ability to detect and size HTHA damage in a repeatable, recordable format.

The ability to repeatably and confidently detect and size HTHA has led to the evolution of Fitness for Service methods to safely keep equipment in service with appropriate inspection intervals. This can only be conducted with state-of-the-art PAUT equipment with encoding, data storage and 32-64 Element PAUT scanning. These techniques will soon have industry endorsement and are providing owner/users with higher levels of confidence.

## Inspection Challenges

Early stages of HTHA are very difficult to detect because of the small size of the individual methane voids (typically only 5 to 10 microns), and even clusters of voids are not easy to detect.

### Additional Challenges

- HTHA damage can be highly discreet and may occur in areas of high stress
- Absence of calibration/reference standards
- Requires a plan to identify suspect areas ahead of the physical preparation for inspection
- Need for highly trained and certified technicians

## Recommended Solution

Due to the challenges of inspecting for HTHA, a combination of advanced ultrasonic examination techniques, with carefully selected instruments and probes is recommended in order to achieve a highly efficient, powerful and accurate inspection. API 941 will be incorporating modalities using these techniques.

Also, operators that have been specifically trained with the optimal solution can gain a significant inspection advantage.

The proposed solution includes the following components and techniques:

- ▶ **A powerful and portable PA UT** unit with all tools and features to efficiently set up and deploy the following recommended examination techniques:
  - **TOFD (Time of Flight Diffraction)** - A rapid and robust technique for initial screening of base material and welded regions (HAZ). Increased grain noise (short indications) and clustering (beehive) in A-Scan signals are indicative of early-stage HTHA
  - **TULA (TOFD Ultra Low Angle)** - Well suited for initial screening of thicker base material. Like TOFD, increased back-scattering and clustering in A-Scan signals are indicative of HTHA
  - **Beamforming phased-array UT** - Used for secondary inspection and key to detecting clusters of small methane voids and micro-fissures
  - **Live TFM (Total Focusing Method)** - Provides confirmation and further characterization of HTHA damage
- ▶ **Engineered transducers** for this type of inspection, capable of completing the recommended examination techniques.

# The SNI/Zetec Advantage

## Products

SNI/Zetec offer the optimal solution for this type of inspection challenge, delivering efficient detection and characterization of HTHA damage. The following complete solution kit from Zetec features the necessary components to confidently perform all the examination techniques for the inspection and has been successfully used in Lavender International HTHA Training Certification.

### Zetec TOPAZ64 Fully integrated, portable PA UT unit

- A fully integrated, portable 64 channel Phased Array UT (PAUT) device delivering faster, more reliable inspections. It intelligently combines the power of 64 active channels for PAUT applications with the industry's most advanced live Total Focusing Method (TFM) capabilities.

#### Features include:

- Excellent 64 active element PA UT
- 2 high-SNR TOFD channels at 200 V
- 12" Hi-Res multi-touch display
- Best-in class « live » TFM
- Parallel recording of PA UT & TFM
- Bipolar pulse (150Vpp) optional
- Driven by industry-proven UltraVision Touch software



### DLA 10 MHz Probe

- Pitch & Catch PA 64E with small pitch used in LW mode for improved TFM imaging



### AL-TFM 5 MHz Probe

- Pulse Echo PA 64E with small pitch used in SW mode for improved TFM imaging in HAZ under weld cap

## HTHA Assessment Kit

For Full Detection and Characterization of HTHA damages

Part Number	Acronym	Detailed Description	Qty Required
10058018	ZPA-IUT-TOPAZ-64/128PR-TFM	Fully integrated portable phased array system featuring up to 64 active channels on up to 128-element probe. This instrument can either use the same 64 transmitters and receivers or can be operated in PR mode using up to 64 channels as transmitters and 64 others as receivers for advanced inspections, bipolar pulsers, 256K data points onboard FMC/TFM capability. The kit includes TOPAZ64 unit with UltraVision Touch embedded, 2 batteries, 1 carrying case, 1 power cable (North America), 1 power cable (Europe), 1 AC adapter, 1 Ethernet cable, 1 USB Flash drive and user manual.	1
10048744	ZGN-SCN-WELD CRAWLER	Weld Crawler is a Manual Weld scanner for pipes from NPS 2 1/2 up to flat. ZETEC's WELD CRAWLER is a low clearance design (2' 1/4) embedding four magnetic wheels with individual break system. The WELD CRAWLER also features an integrated lever for easy lift off from pipe or plate. Its dialog encoder provides automatic encoder information programming within Ultra Vision Touch. The WELD CRAWLER features 4 individual probe suspensions with individual tensioning adjustment that allows covering welds up to 2 inches thick.	1
10039141	ZPA-PB1D-LM-5MHZ-REX-5M-ZPAC	1D linear array probe designed for linear scanning - 5 MHz - 64 elements - LM probe casing - active surface of 38.4 mm x 10 mm - ZPAC connector (compatible with ZIRCON and TOPAZ) - 5 m cable	1
10039142	ZPA-PB1D-LM-10MHZ-REX-5M-ZPAC	1D linear array probe designed for linear scanning - 10 MHz - 64 elements - LM probe casing - active surface of 38.4 mm x 10 mm - ZPAC connector (compatible with ZIRCON and TOPAZ) - 5 m cable	1
10038862	ZPA-ACC-W-LM-55LW-IH-FL	Standard wedge for LM-type phased array probe - Designed for linear scanning from 40 to 70 degree using Longitudinal waves - 55-degree LW nominal angle - Irrigation channels and probe holder fixtures.	1
10038863	ZPA-ACC-W-LM-0LW-IH-FL	Standard wedge for LM-type phased array probe - Designed for linear scanning at 0 degree using Longitudinal waves - 0-degree LW nominal angle - Irrigation channels and probe holder fixtures	1
10058571	ZPA-PB1D-TFM-AL-5MHZ-64E-DF-15MM-REX-3.0M-ZPAC	1D Linear phased array probe designed for focused azimuthal scanning and TFM in depth range 5 to 30 mm - 5 MHz - 64 elements - AL probe casing - Active surface of 19.2 mm x 15.0 mm - Curved in the passive plane - ZPAC connector (TOPAZ) - 3.0 m cable length	1
10038857	ZPA-ACC-W-AL-55SW-IH-FL	Standard wedge for AL-type phased array probe - Designed for azimuthal scanning from 40 to 70 degree using shear waves - 55-degree SW nominal angle - Irrigation channels and probe holder fixtures	1
10058569	ZPA-PB1D-TFM-10L2X(64E-24-5)-TR-DF-20MM-REX-3.0M-ZPAC	1D Transmit-Receive linear phased array probe designed for focused linear scanning and TFM in depth range 10 to 35 mm - 10 MHz - 2x 64 elements - Primary axis pitch 0.35 mm- Element elevation 5.0 mm - Active surface (Tx & Rx) of 24 mm x 10.0 mm - 3.0 m cable length - ZPAC connector (TOPAZ)	1
10038328	ZUT-PB-PIEZO-TOFD5-6-LEMO00	TOFD Piezo Composite Transducer, 5MHz, 6mm crystal, M12 thread case, Lemo 00 - Price for 1 probe. Includes Generic Technical Datasheet and Certification Of Conformity - parameters specified in accordance with BSEN 12668 pt2: 2010 Record of the specific transducer individual parameters are not included (characterization report per transducer) - to be specified at order with the additional ZETEC reference 10054725	2
10039848	ZUT-PB-PIEZO-TOFD10-3-LEMO00	TOFD Piezo Composite Transducer, 10MHz, 3mm crystal diameter, M12 thread case, Lemo 00 connector - Price for 1 probe Includes Generic Technical Datasheet and Certification Of Conformity - parameters specified in accordance with BSEN 12668 pt2: 2010 Record of the specific transducer individual parameters are not included (characterization report per transducer) - to be specified at order with the additional ZETEC reference 10054725	2
10038329	ZUT-ACC-WEDGE-TOFD-45LW-M12-IRR	TOFD wedge for M12 type TOFD probe - 45-degree LW nominal angle in carbon steel - Irrigation channels and probe holder fixtures.	2
10038330	ZUT-ACC-WEDGE-TOFD-60LW-M12-IRR	TOFD wedge for M12 type TOFD probe - 60-degree LW nominal angle in carbon steel - Irrigation channels and probe holder fixtures.	2

## Benefits

A fully integrated, portable 64-channel Phased-Array UT (PAUT) device delivering faster, more reliable inspections. It intelligently combines the power of 64 active channels for PAUT applications with the industry's most advanced live Total Focusing Method (TFM) capabilities.

### ▶ Highly Efficient and Powerful

- One instrument handles the entire inspection -- the Zetec TOPAZ64 includes the required tools and features to efficiently set up and deploy all recommended techniques. No additional instruments or software needed.

### ▶ Field Proven

- This solution has been successfully deployed in the field and is referenced in Lavender International's HTHA Training Certification.

### ▶ Accurate and Confident

- Confidently inspect for HTHA using highly-advanced PAUT examination techniques that can detect all flaws including early stages of HTHA.

## The SNI/Zetec Advantage

SNI and Zetec are global leaders in nondestructive testing (NDT) solutions for the critical inspection needs of industries the world counts on every day— including power generation, oil and gas, aerospace, transportation, military, heavy industry and manufacturing. By integrating design and engineering with our own manufacturing, SNI and Zetec deliver solutions that optimize productivity, safety and total cost of ownership.

**For more information about the SNI/Zetec HTHA Inspection solution, TOPAZ64 PAUT instrument or other Zetec products contact your local Zetec representative, email us at [info@zetec.com](mailto:info@zetec.com) or visit [www.zetec.com](http://www.zetec.com).**



Zetec holds ISO 9001 and ISO/IEC 17025 certifications



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