GE Aerospace

T700 / CT7 Quality Event Field NDE Response

20 May 2025

Agenda

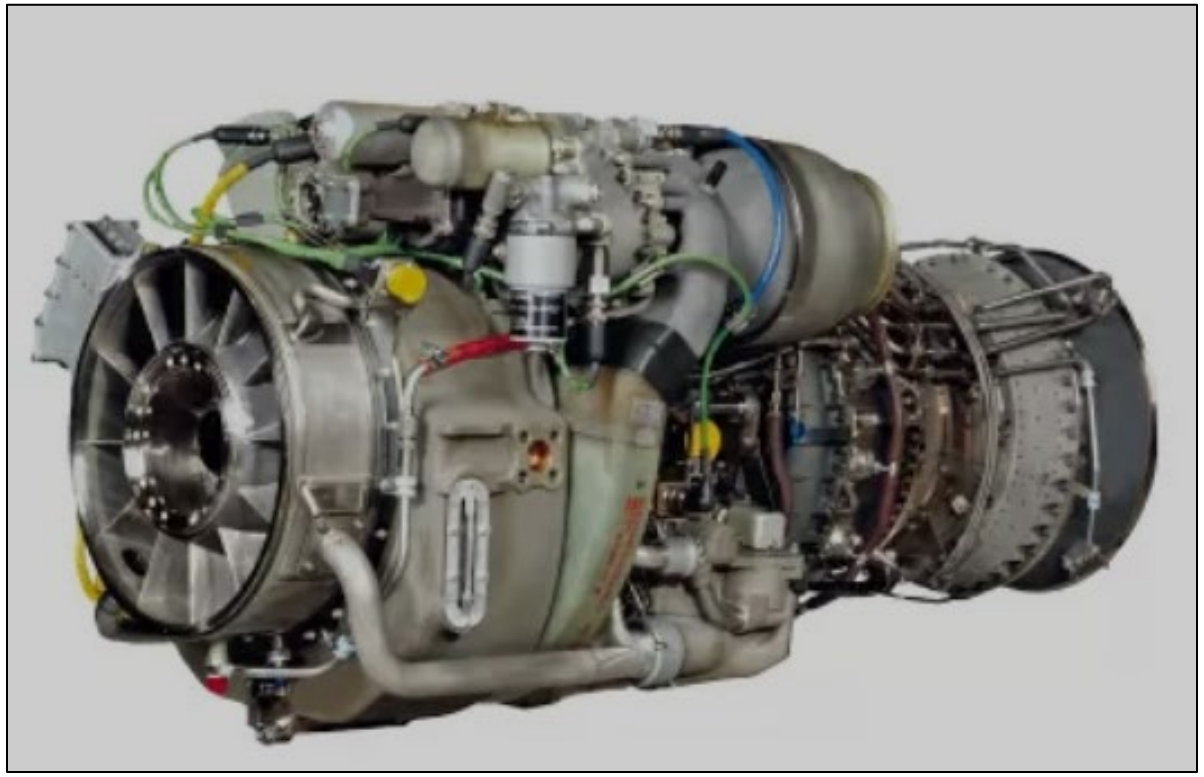
- 01 **Background**
- 02 **Single Element Ultrasound Transducer**
- 03 **UT Field Implementation**
- 04 **Phased Array Ultrasound Transducer**
- 05 **PAUT Field Implementation**

01

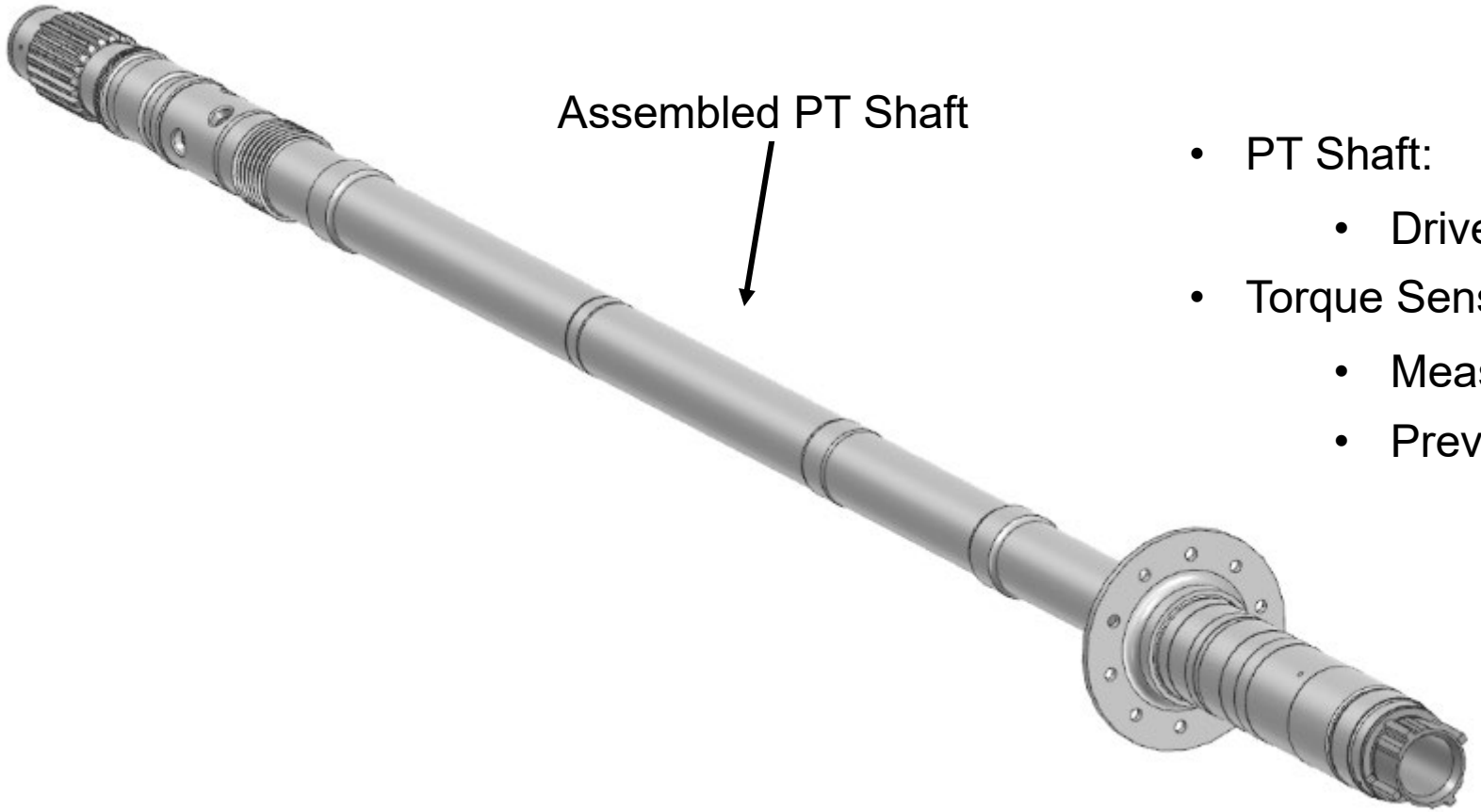
Background

T700 / CT7 Turboshaft Engine

- Developed in response to the United States Army's requirement to deliver added power and improved field maintainability.
- More than 25,000 T700/CT7 engines have now surpassed 100 million flight hours in nearly four decades of service.
- T700/CT7 engines are the power of choice for 50 countries and 130 customers for transport, medical evacuation, air rescue, special operations, and marine patrol.



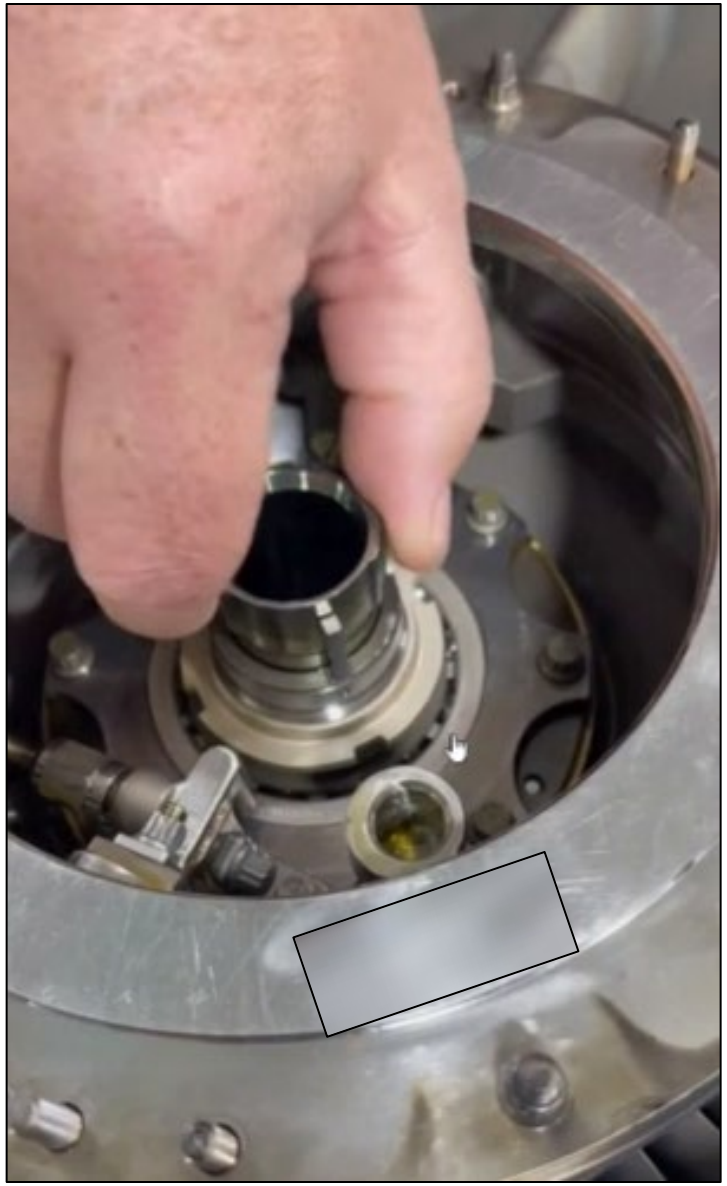
PT Shaft & Torque Sensing Tube



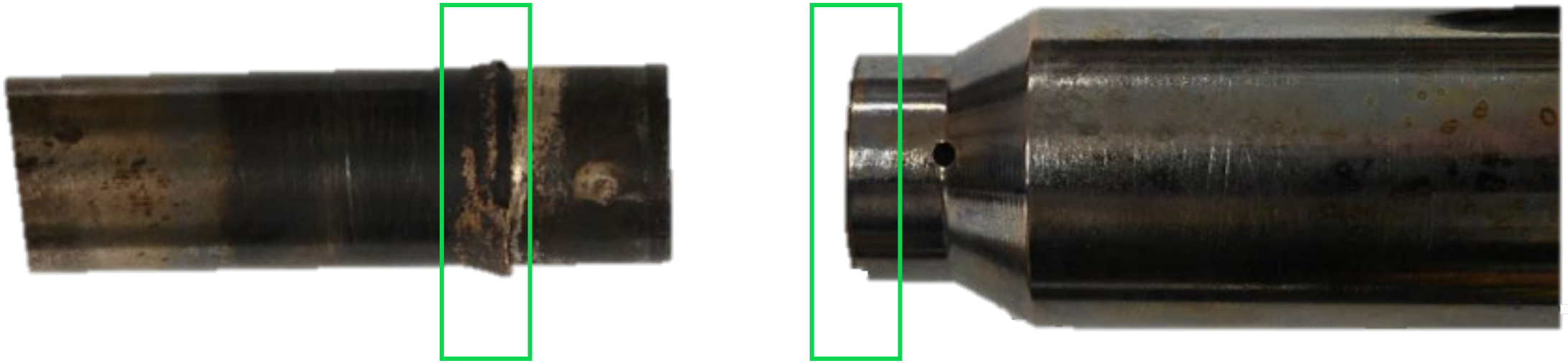
- PT Shaft:
  - Drives Main Rotor
- Torque Sensing Tube:
  - Measures Torque
  - Prevents Overspeed Condition

Quality Event

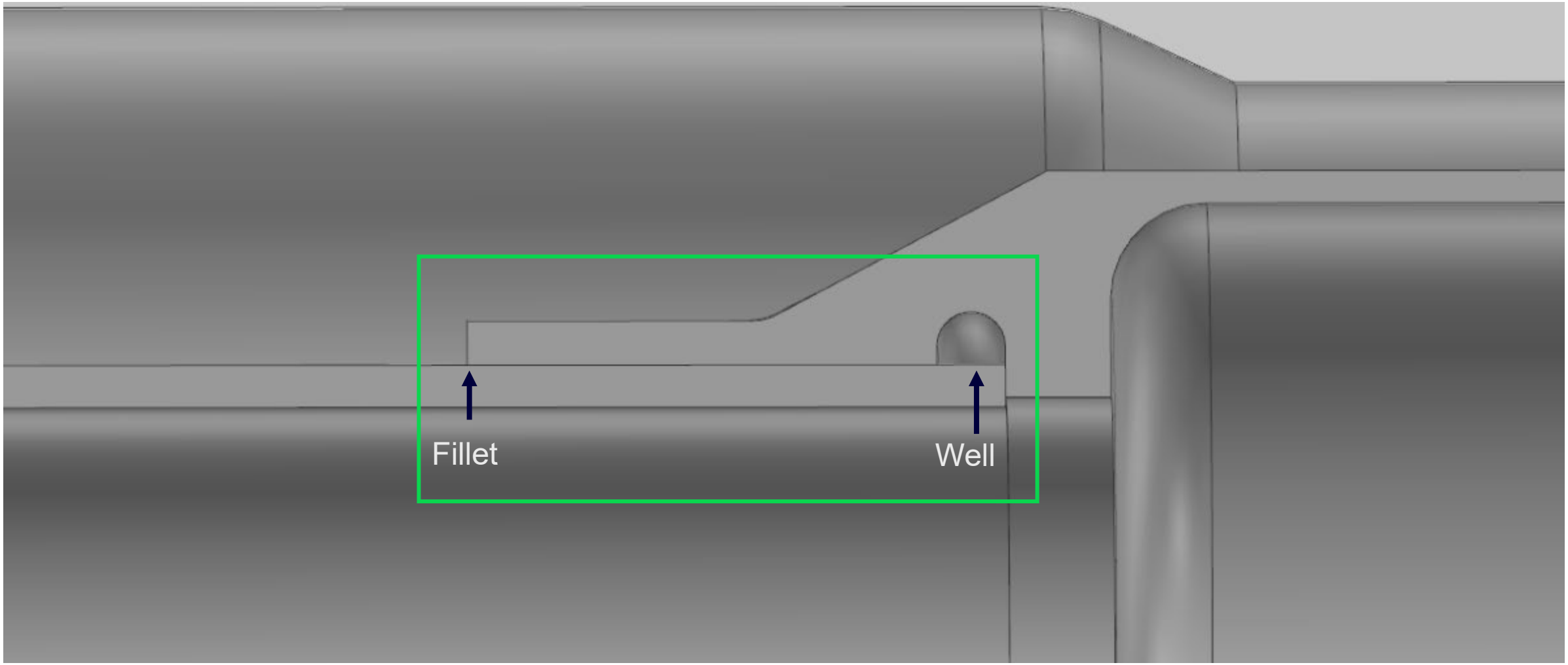
- During a routine maintenance check of the PT Shaft, the mag end of the torque sensing tube was pulled away from the tube body by hand.
- After removal of the remainder of the torque tube it was discovered that the braze joint between the mag end and tube body had failed.

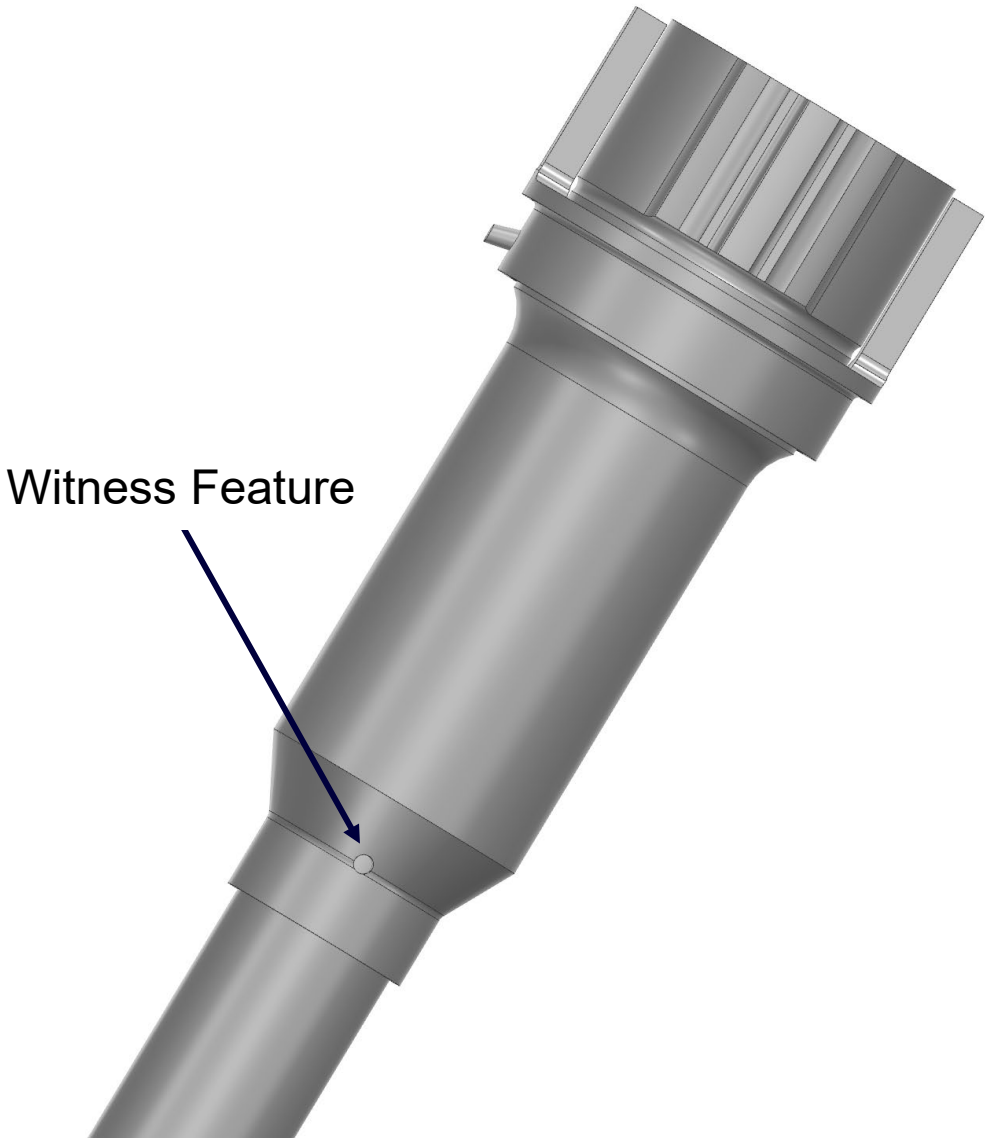


Failed Braze



Braze Joint Location





Prior Braze Acceptance

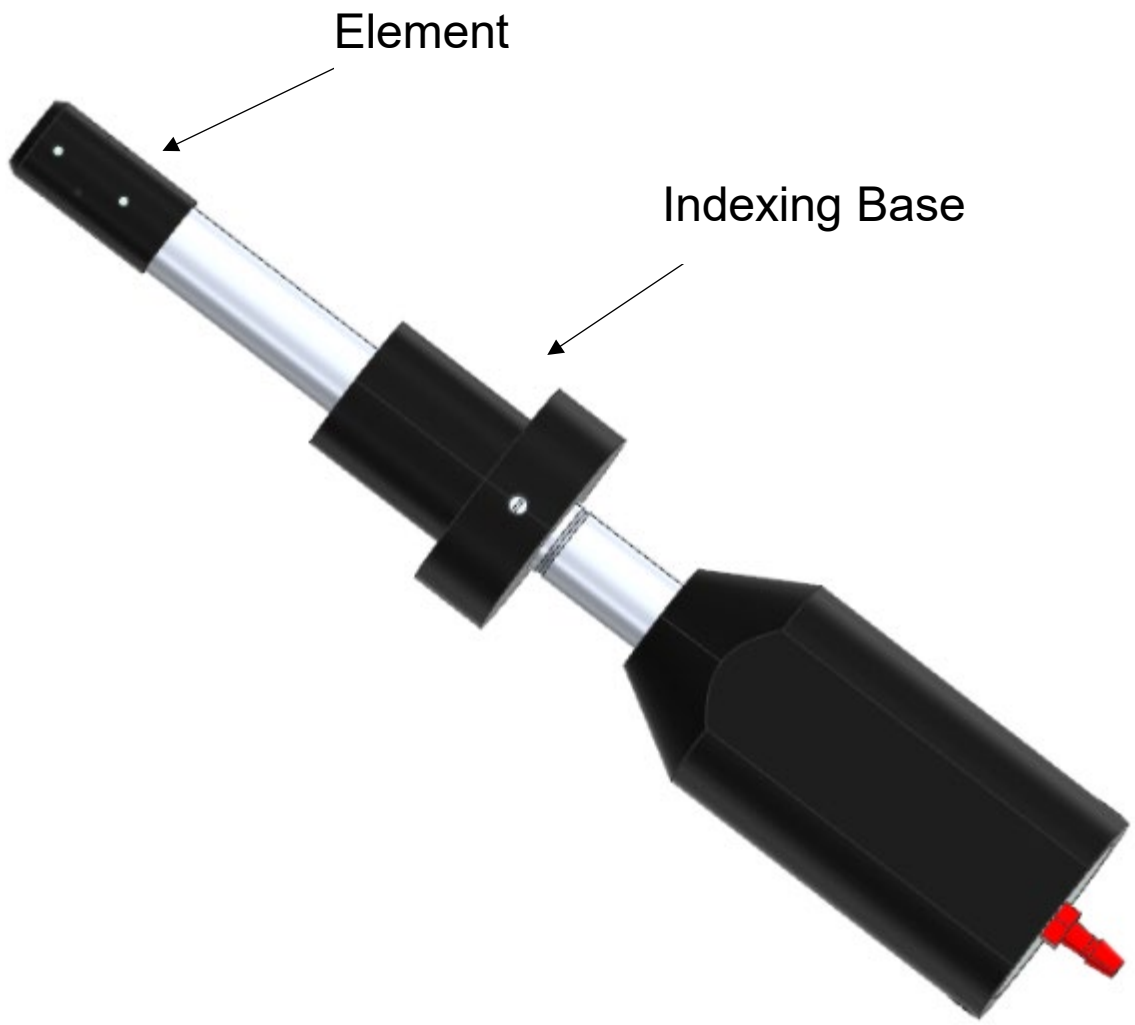
- Utilized Witness Features
- 2 or 3 Witness Features with observed braze was considered acceptable.

02

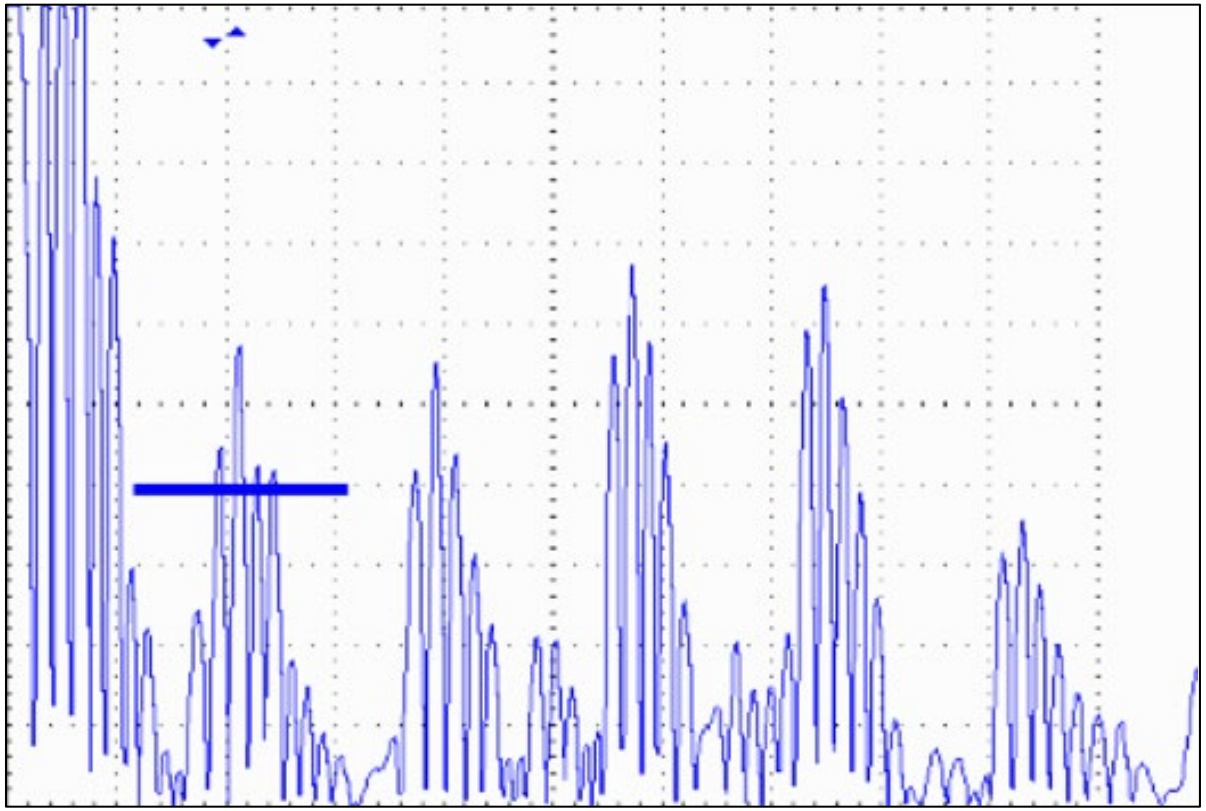
Single Element Transducer

Single Element Transducer

- Manufactured by Sensor Networks Inc.
- Designed to fit the ID of the Torque Tube.
- Utilizes a notched shaft and detent design to index to 4 locations along the braze.
- Indexing base mates to the face of the mag end of the torque tube to ensure proper depth while inspecting.
- Manually rotated by inspector.
- Able to inspect in the piece part, module or engine level.

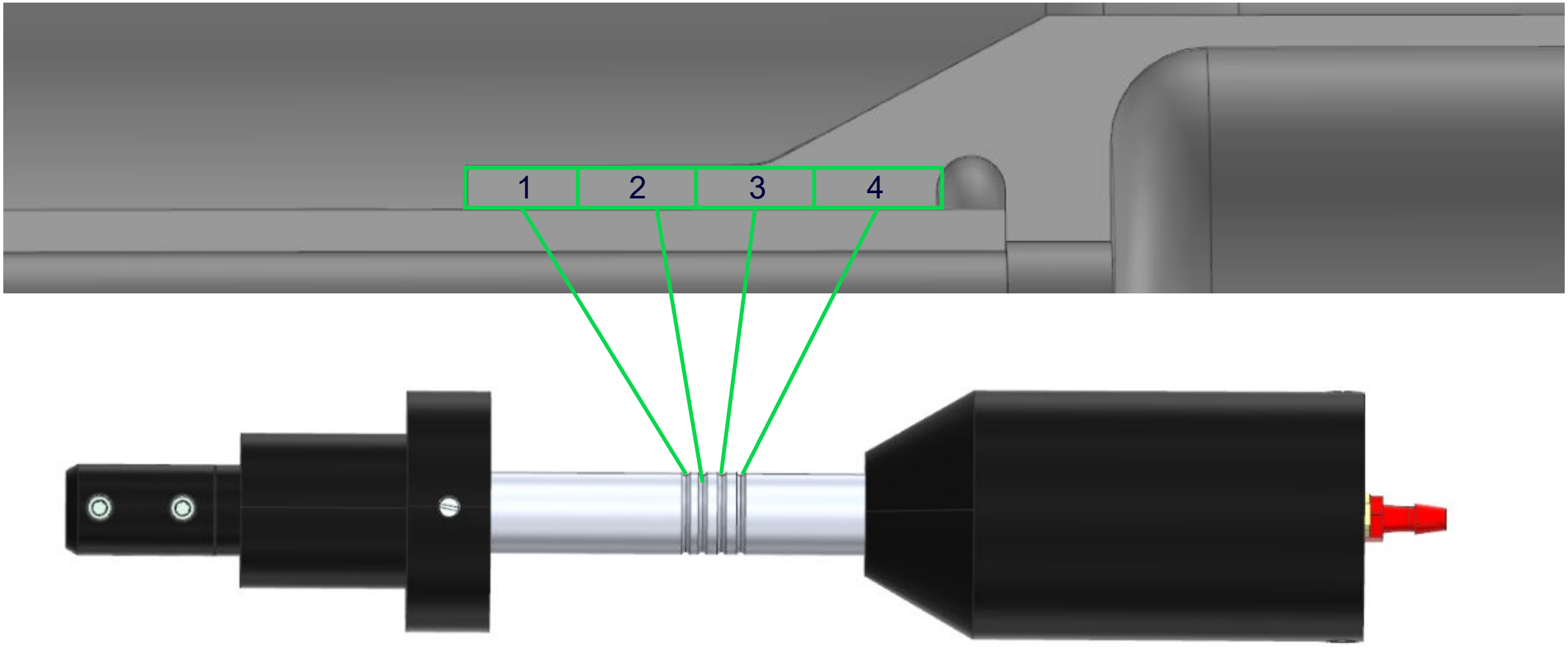


Single Element Transducer A-Scan



- Calibrated on the Torque Tube body past the Braze Fillet which is equivalent to the Transducer pushed forward into the part past all 4 index positions.
- Utilizes Engine Oil (MIL –L-23699) or Glycerin as the Couplant.
- Monitors the backwall of the tube body to determine presence or lack of braze.
- Indication represents tube backwall demonstrating a lack of braze.

Single Element Transducer Index Positions



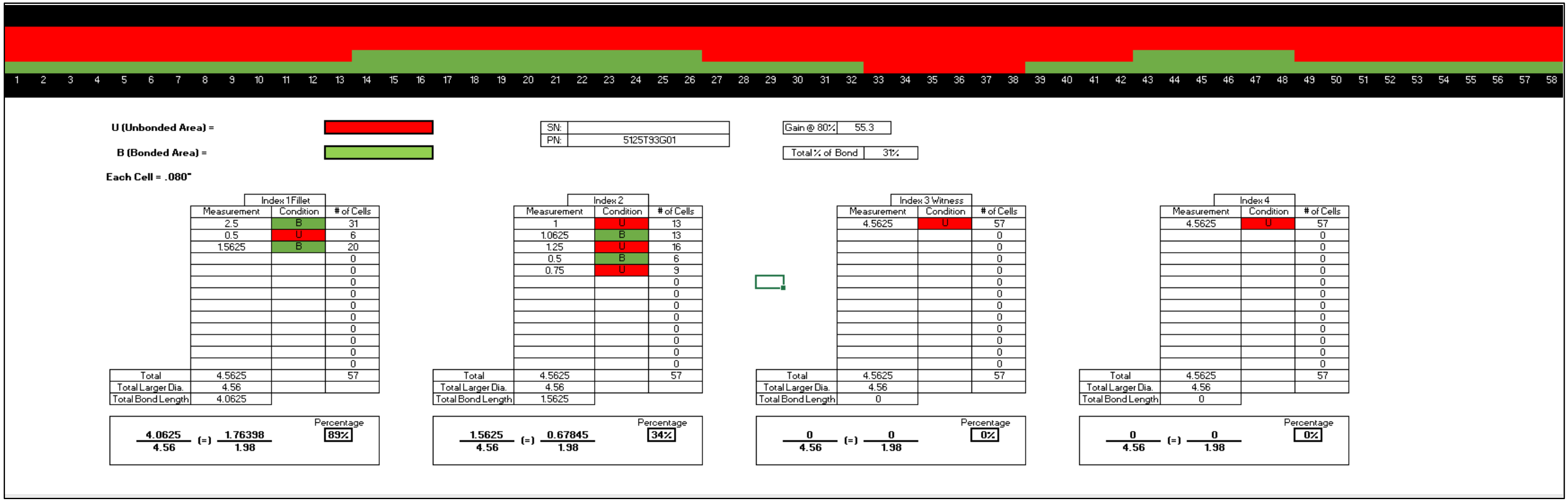
03

UT Field Implementation

Single Element Transducer Inspection

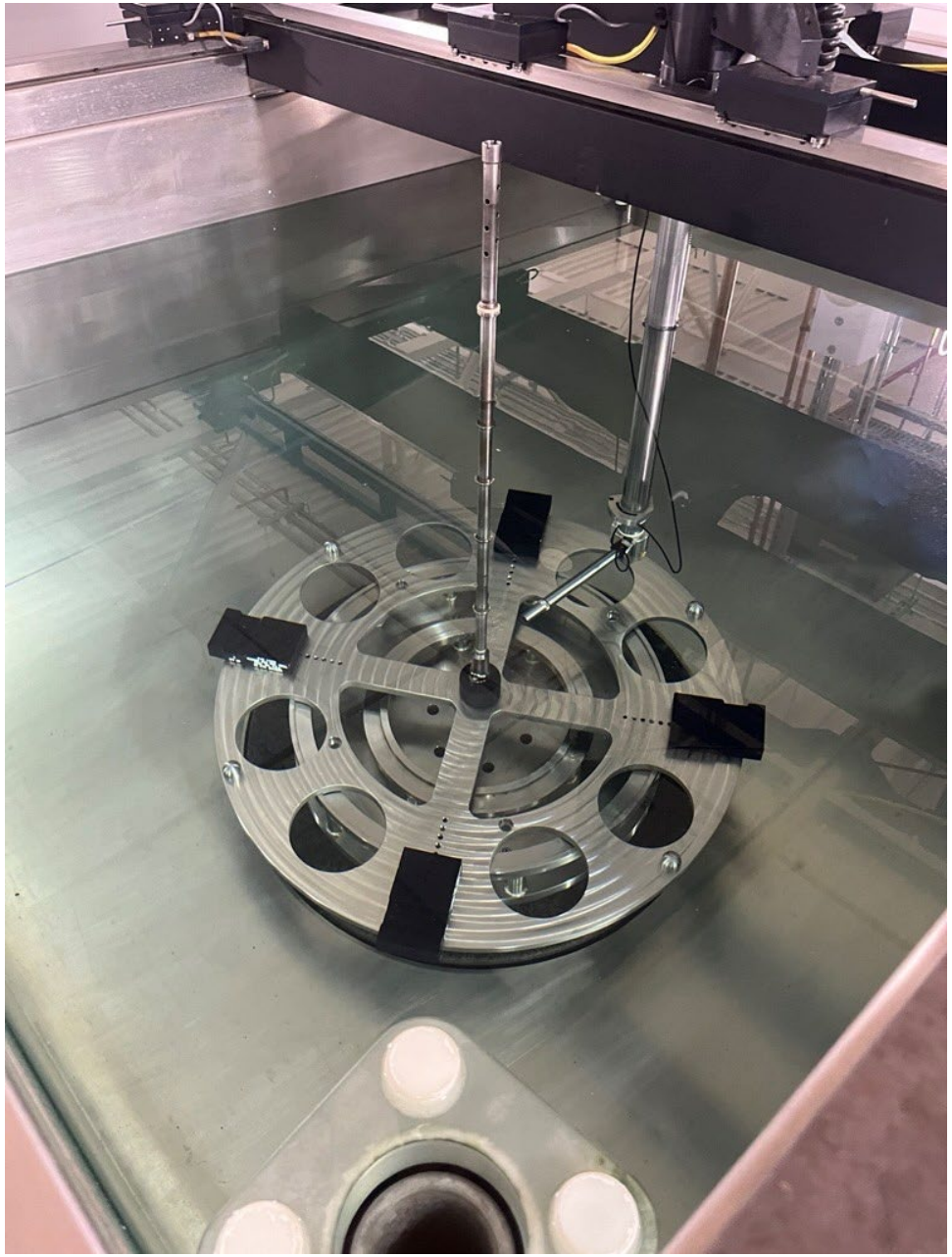
- Inspected by either rotating the transducer or the shaft.
- Inspection is stopped and the circumferential distance is measured between an area of braze and an area of no braze.
- Continuing circumferentially, the inspection process is repeated until 360° coverage is obtained along all 4 index positions
- An Excel Spreadsheet is used to document the distances of braze or lack of braze and used to create a map of the entire braze.
- An overall percentage of braze coverage is provided and used for reject criteria.
- Inspections begin 1 month after concern was brought to the Field NDE group at AIS at 3 different locations.

Example Spreadsheet

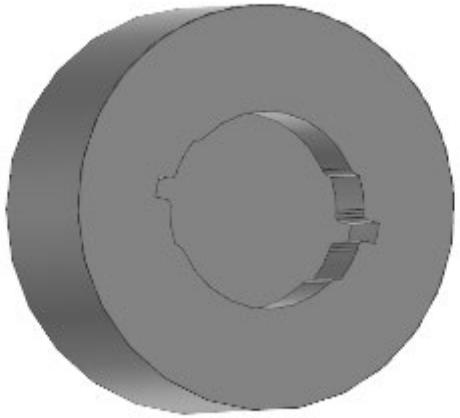


Parallel Immersion Inspection

- All Torque Tubes delivered to AIS for inspection were inspected with both the handheld single element transducer as well as inspected by immersion testing.
- Immersion Test was conducted first to clear unacceptable parts that fell well below the threshold.
- C-Scan data was collected and compared to the single element transducer to confirm results.



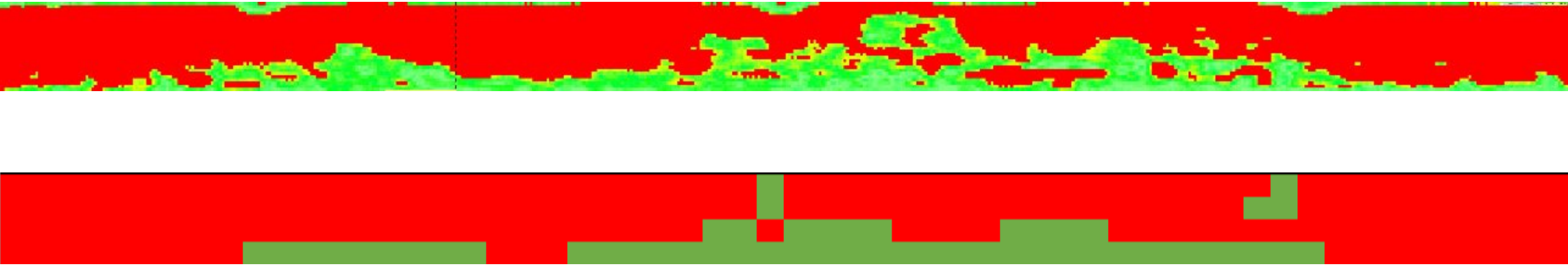
Immersion Fixture



fixture was developed to thread into the
mersion Tanks table base.

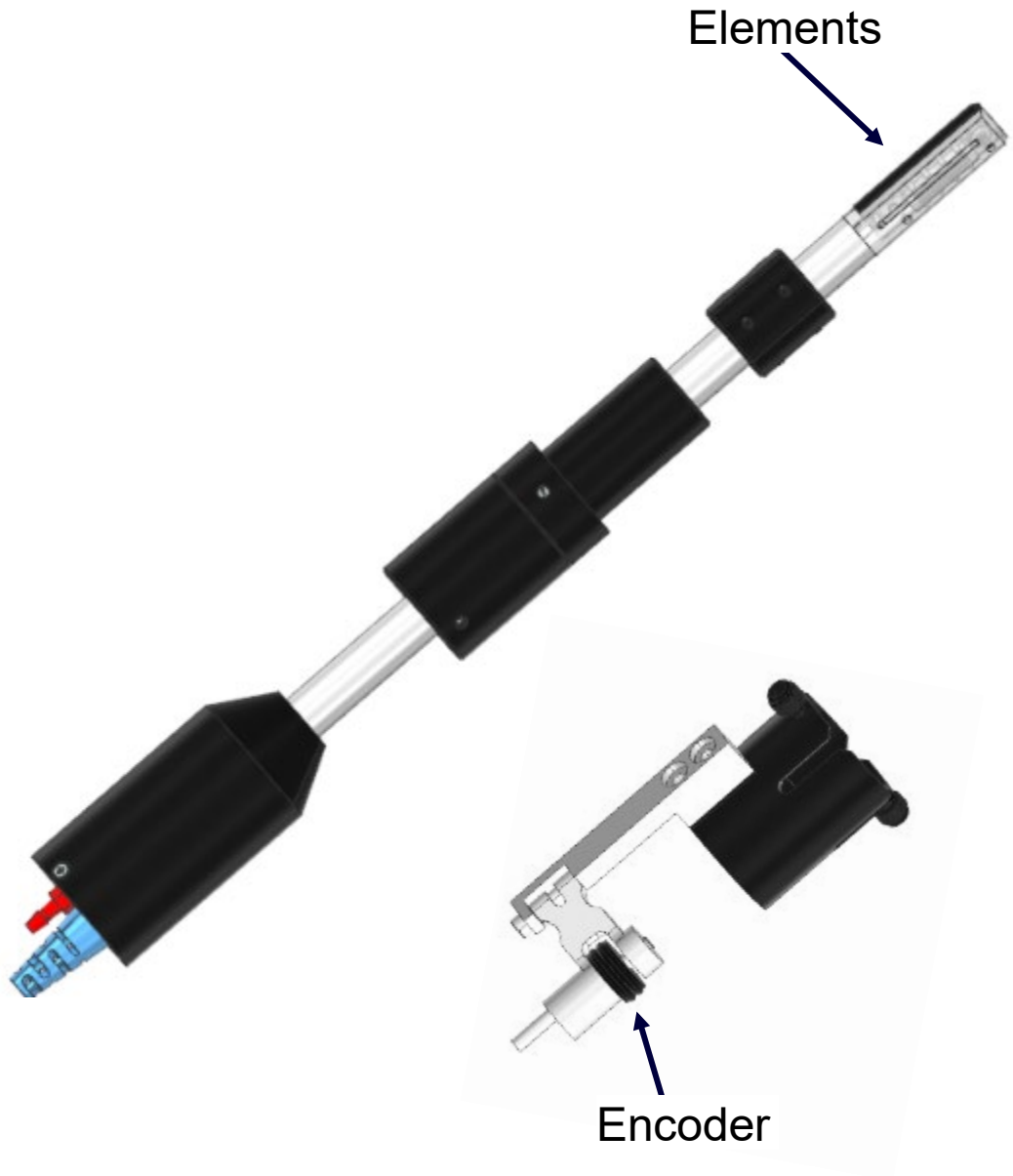
is fixture allowed for the mag end to be inserted
d keep the torque tube in the vertical position
an effective scan.

Comparison of Single Element Transducer & Immersion Identical Torque Tube



04

Phased Array Ultrasound Transducer



Phased Array Ultrasound Transducer

- Manufactured by Sensor Networks Inc.
- 32 Element Array
- Encoded C-Scan Data
- Requires only one 360° Scan
- 2 Piece Design
- Fixtures to Mag end of Torque Tube
- Manually rotated by Inspector
- Uses Glycerin as the couplant
- Reduces Inspection time from an average inspection time of 1 hour to an average inspection time of 5 minutes.
- Topaz software analyses scan & automatically provides total braze percentage.
- Able to inspect in the piece part, module or engine level.

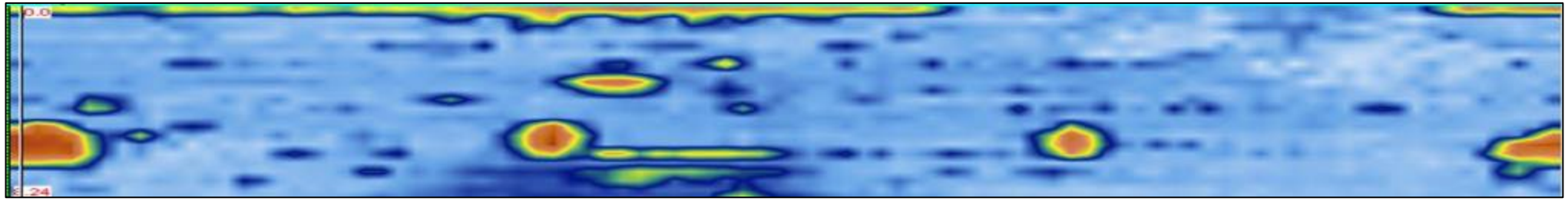
Topaz 16

- Collaboration between Sensor Networks Inc. & Eddyfi Technologies allowed for software development specific for this inspection.
- A simple file selection sets all parameters required for the instrument to begin calibration.

FBH Validation C-Scan Example

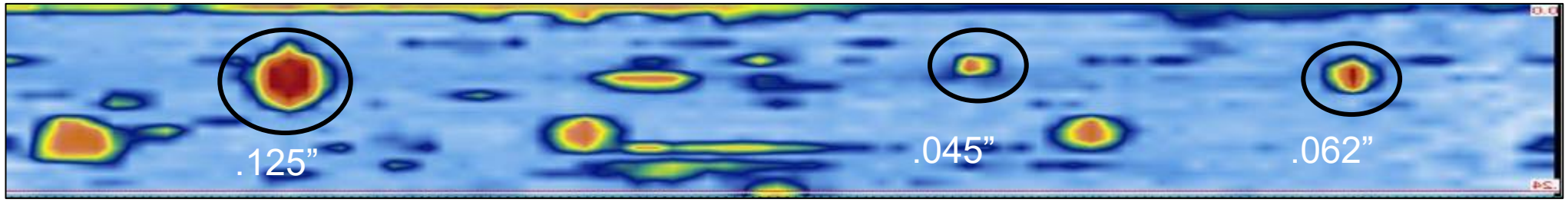
Without FBH

Fillet



With FBH

Fillet

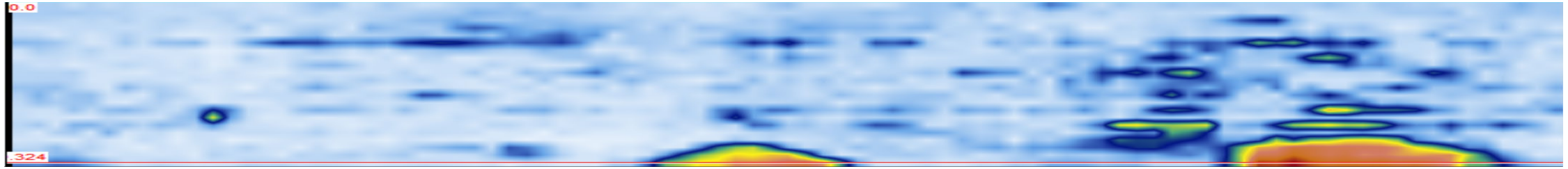


Single Element vs Array vs Immersion
Same Tube

Single Element

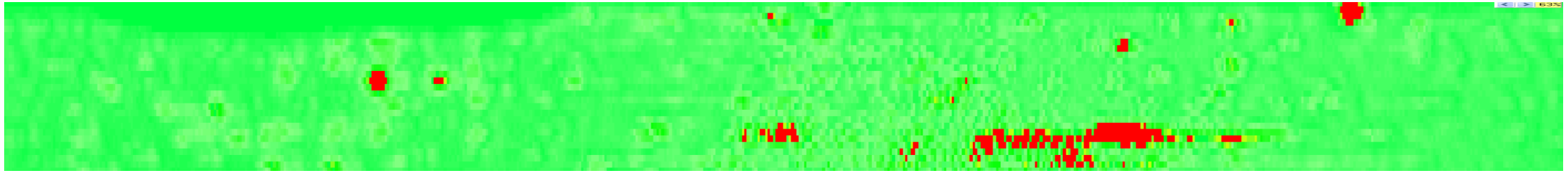
93%

Array



94%

Immersion

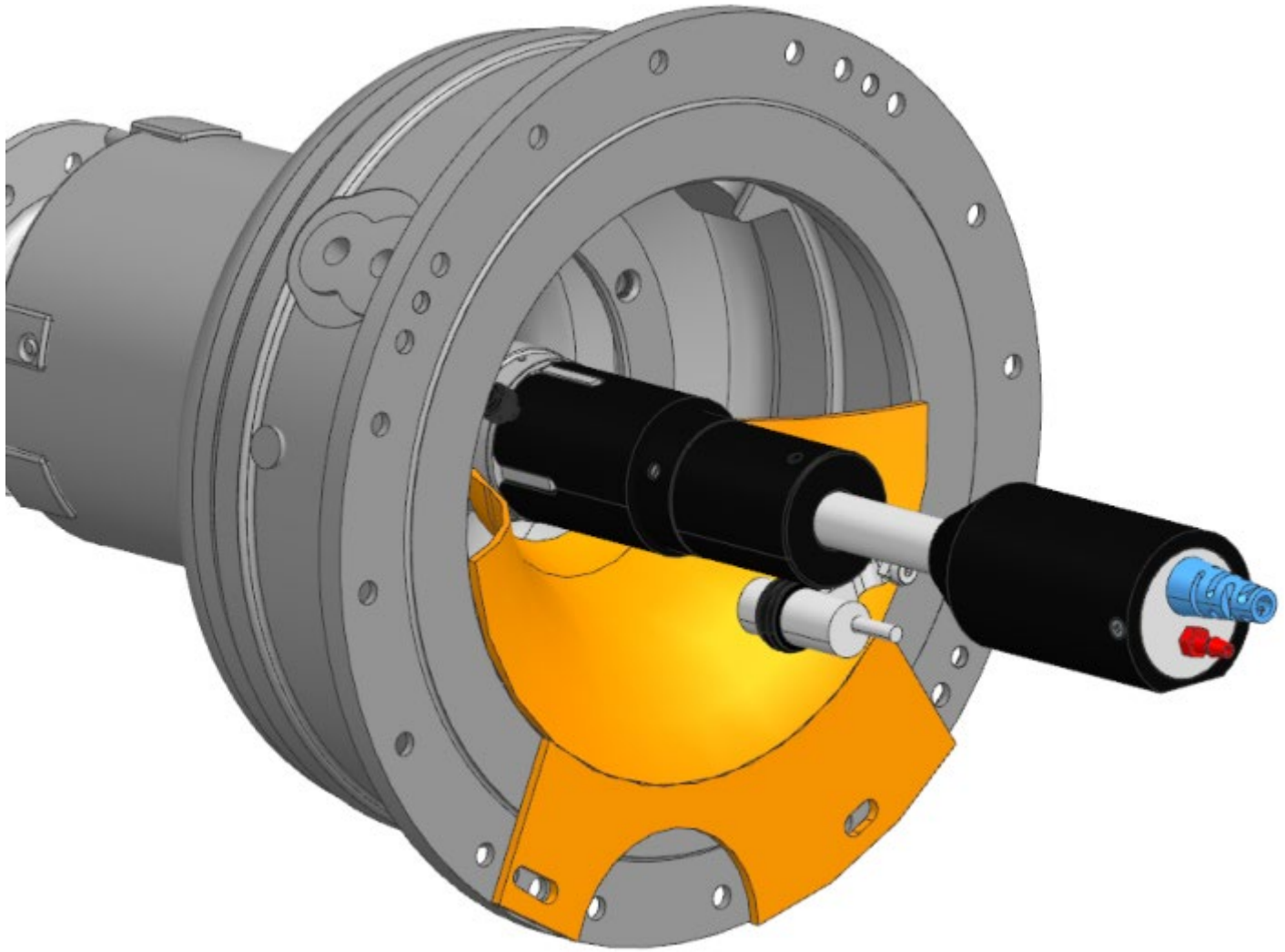


98%

Torque Tube Inspection Tabletop

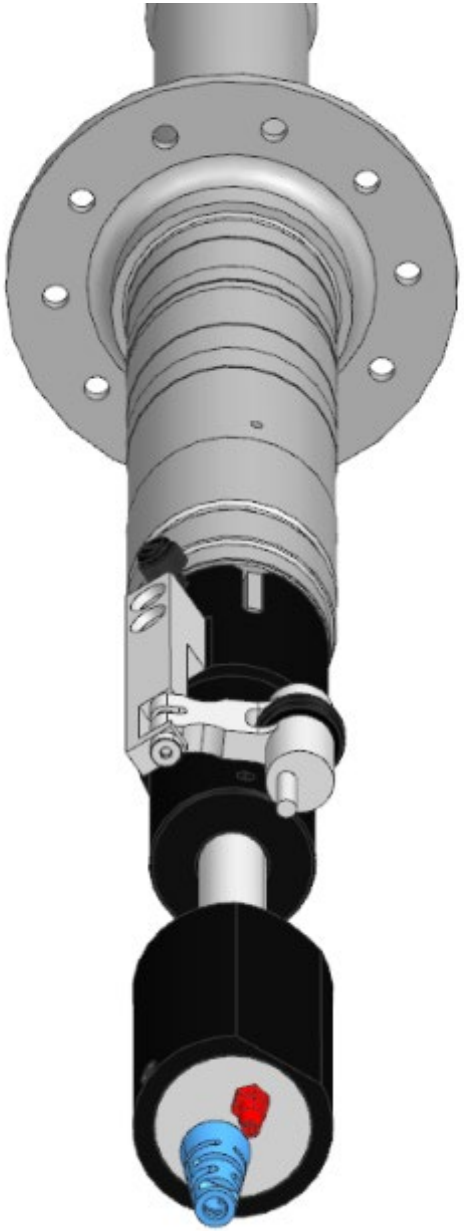
PT Shaft Assembly Inspection Tabletop

Engine Assembly Inspection



05

PAUT Field Implementation



PAUT Inspection

- Inspected by rotating Torque Tube.
- Calibrated on scrap tube body.
- Requires only one scan consisting of a 360° rotation.
- Encoded C-Scan is saved on Topaz Instrument.
- Analysis provides percentage of Braze.
- Inspections began 3 months after issue brought to the Field NDE Team.
- Inspections spanned from Dec 2023 to Feb 2025
- Over 2,000 Tubes inspected including commercial & military engines.
- Team deployed worldwide to meet customer needs.

Example Documentation

T700 / CT7 Torque Tube Braze Ultrasonic Array Inspection Form 2572-1

Table 1 - Operator / Engine Information

Inspector		Date	02-09-2024
Location	AIS	Insp. Kit S/N	Master
Engine SN	NA	TSN / CSN	NA
Module SN	NA	Shaft SN	
Tube SN	NA		

Table 2 – Instrument / Probe / Calibration Information

Instrument PN	Topaz 16	Instrument SN	725980
Probe PN	00-014398	Probe SN	U124OT
Reference Standard PN	UT-2572	Reference Standard SN	MASTER
Pre-Calibration Gain	19.1 dB	Post Calibration Gain	19.3 dB

Table 3 –Inspection Information

Run1			
% Acceptable Braze (Amp %(V-))	14.7	% Un-acceptable Braze (Amp %(V+))	85.3

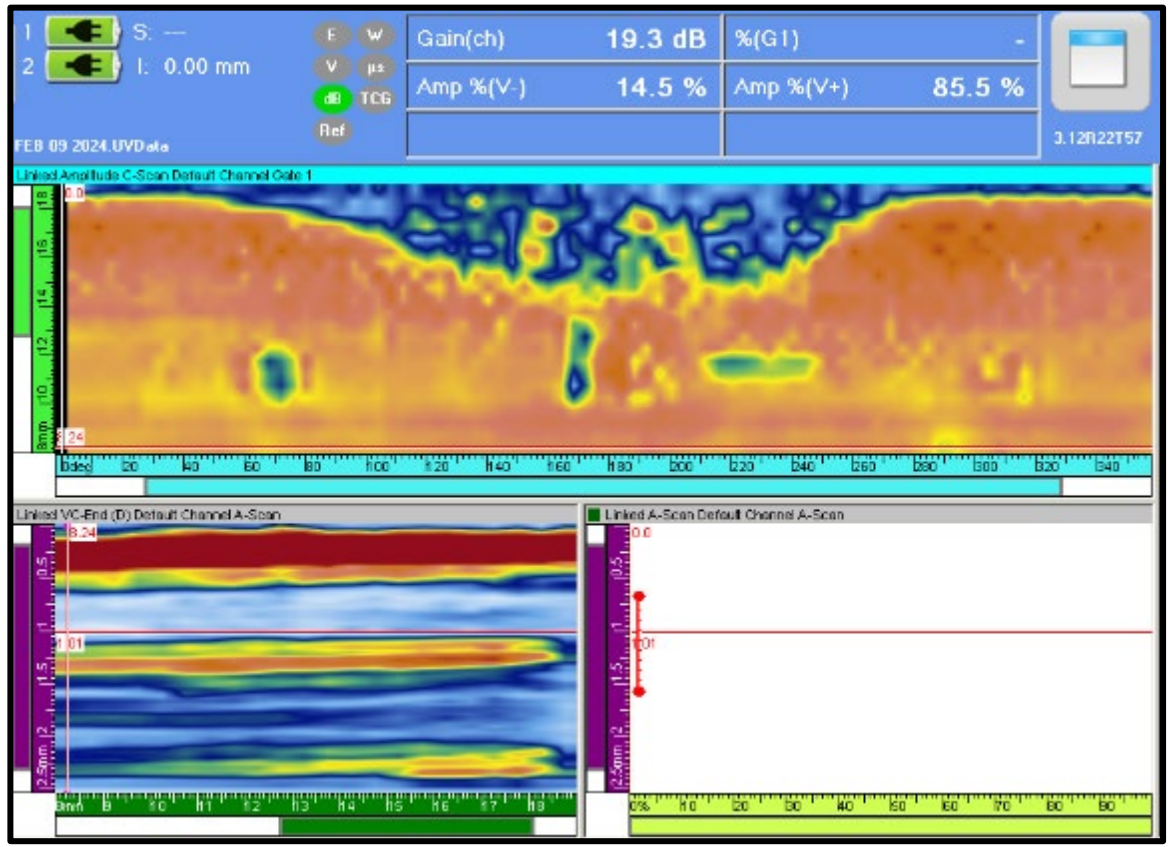
Run2			
% Acceptable Braze (Amp %(V-))	14.5	% Un-acceptable Braze (Amp %(V+))	85.5

Run3 (if needed)			
% Acceptable Braze (Amp %(V-))		% Un-acceptable Braze (Amp %(V+))	

Run4 (if needed)			
% Acceptable Braze (Amp %(V-))		% Un-acceptable Braze (Amp %(V+))	

Run5 (if needed)			
% Acceptable Braze (Amp %(V-))		% Un-acceptable Braze (Amp %(V+))	

Are there two valid Runs within 5% of each other (circle one)	Yes	No	% Difference	.2



PAUT Inspection Example

Acknowledgments

- The Entire Field NDE Team
  - Project was contributed to by all and was successful due to the entire teams' efforts.
- Sensor Networks Inc.
  - Provided full support, expertise, & speed to deliver a quality product that exceeded customer needs.
- Eddyfi Technologies
  - Providing support in quickly producing instruments to include in our inspection kits to deploy across the globe and software support.


GE Aerospace