

ULTRASONIC PHASED ARRAY SIMULATIONS ON SPACE FLIGHT HARDWARE COMPONENT



Advances in composite manufacturing technology have led to the widespread application of composites owing to their very less weight strength ratio compared to metals. They are used as substitutes for metals like in aircraft wings, casings like for satellites, and a variety of other applications. One of the important applications of composites is in thermal insulation as in the case of rockets and missiles. The motor tube which encloses the propulsion motor or the fuel is lined with a composite layer to give protection as well as thermal insulation. In this particular case, the steel motor tube is lined with a sheet of high silica cloth and phenolic resin which is baked in an autoclave for a perfect bonding of

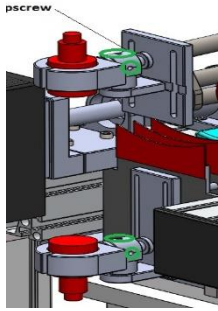
the composite to the metal. Due to several variables like poor vacuuming, poor mixing of composites, temperature and pressure variations, etc. there are chances of improper bonding leading to dis-bonds between the metal and composites. The interface between the metal and lining is inspected in pulse-echo as well as through transmission modes using Squirted UT and air-coupled UT. Two air-coupled transducers scan the sample through transmission mode while an immersion probe scans the sample in a squirted mode where water is continuously pumped in between the probe and sample.

After the inspection, the data is subjected to an automatic defect reporting algorithm

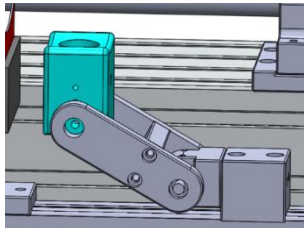
according to the party's acceptance criteria resulting in complete computer-generated reports.

UT Transducers used	
Air Coupled UT	225KHz transducers
Squirted UT	5 MHz transducers

Both the inspections are carried out at the same time with the air-coupled inspection leading to the squirted mechanism as the presence of water on the surface may result in variations with the air-coupled readings and also any drop of water falling on the transducer surface may permanently damage it.



Air-coupled probes(red)

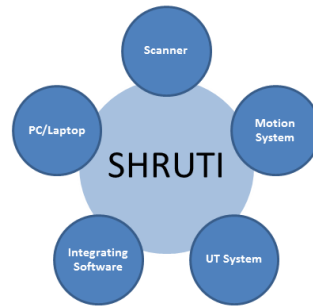


Squirted UT probe (blue)

The cycle time for one barrel is 30 minutes. The system used for the inspection is **SHRUTI**[®]. Scanning High-Resolution Ultrasonic Inspection System is an indigenously developed customizable, automated, multi-axis robotic scanner. Along with ultrasonic probe, advanced data analysis (*extut*[®]) and image analysis packages (*imagine*[®], *SimScan*[®], *SimSonic*[®]), SHRUTI facilitates easy inspection of samples and components.

SHRUTI[®] offers very high-resolution images of the test coupon with very high scanning speeds. The complete instrument control is through the software. Skelton of the system is being built from lightweight aluminum

extrusions which are upgraded to Stainless Steel for heavy-duty applications. All the electrical connections are rugged and properly routed following industrial standards offering very durable and reliable running.



The system employs rugged servo motors for motion requirements and had industrial standard safety interlocks.



System with sample

The system employs a centralized lubrication system to cater to the lubrication requirements, centering rollers, pendent mechanism, and auto cycle to reduce human intervention. The system is capable of running 24 x 7 with minimal human intervention. Both the pulser receivers are synchronized and interfaced with a central computer which controls both the pulser receivers and

motion hardware at the same time and records the data to a central repository.

ULTRASONIC TEST REPORT
(Through Transmission Technique)

Supply Agency / Class:	Component: Motor tube Liner Assembly
Lot No / Tube No: calibration tube	Project: PDNAEA
Tube Dimension: ID 202 mm, OD 204.4 mm, Length 1360 mm	Coilplant: Air
Ref. used:	Equipment: RETEC RPK-6000
Probe: 100 kHz Chassette 28 mm	Ref. Scan Setting: 70 dB
Defect classification:	Count:

	A	B	C	D	E	F	G	H
1	*	*	*	*	*	*	*	*
2	*	*	*	*	*	*	*	*
3	*	*	*	*	*	*	*	*
4	*	*	*	*	*	*	*	*
5	*	*	*	*	*	*	*	*
6	*	*	*	*	*	*	*	*
7	*	*	*	*	*	*	*	*
8	*	*	*	*	*	*	*	*
9	*	*	*	*	*	*	*	*
10	*	*	*	*	*	*	*	*
11	*	*	*	*	*	*	*	*
12	*	*	*	*	*	*	*	*
13	*	*	*	*	*	*	*	*

95% of screen height *
60% of screen height *

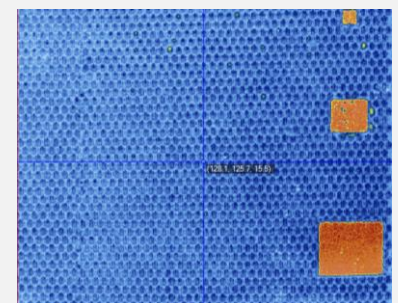
Results:	Report (X)
INSPECTING AUTHORITY:	
DATE:	
APPROVING AUTHORITY:	
DATE:	

Sample Inspection report

The machine is calibrated with a reference sample that has simulated defects using Teflon inserts. The baseline data obtained from the reference sample is fed to the reporting algorithm for automatic defect identification

A Typical C Scan Of Honey Comb Structure with defects

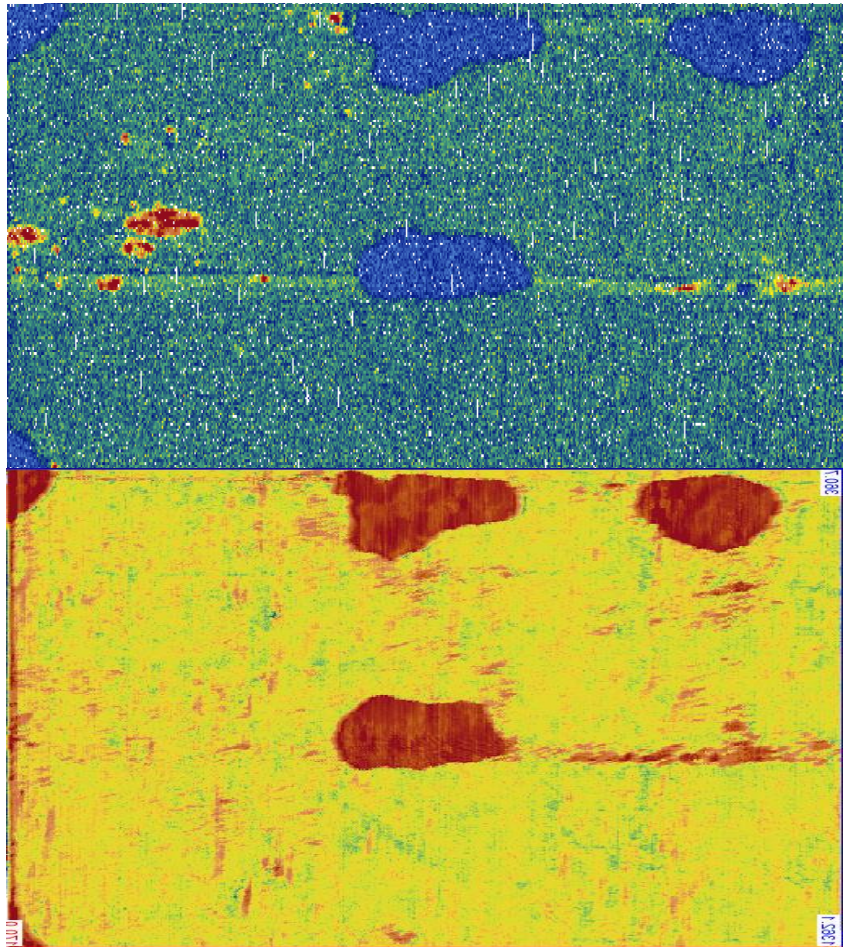
Honeycomb structures sandwiched between composite faceplates are found in very wide applications in all areas below is a C Scan of the same.



Ultrasonic Phased Array Simulations on Space Flight Hardware Component

A Dhvani Research Application Note

Chennai, INDIA



Air coupled and squirted UT C Scan images. The lengthier portion is along the axis and the width is along the circumference

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