JAMES BITTNER | SEPT. 18-21, 2023 | WEBSTER, TX

Target Inspection Techniques Using Eddy Current Technology

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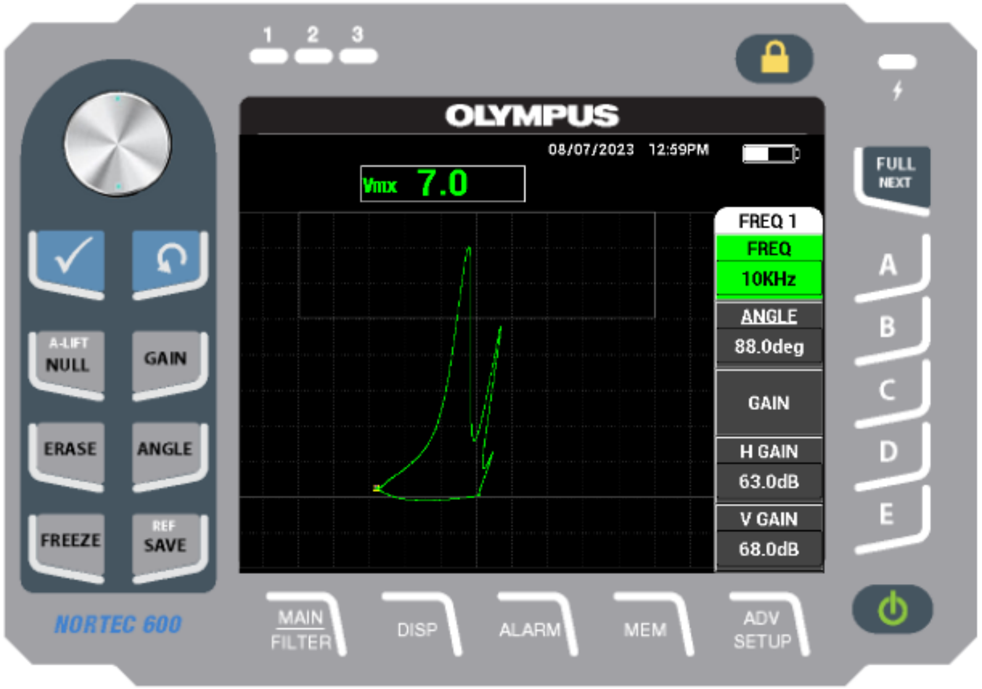
Target Inspection Techniques Using Eddy Current Technology

To take thickness measurements, the most commonly used nondestructive testing (NDT) tools are ultrasonic thickness gauges or flaw detectors. However, there may be a few applications where these technologies are unable to accomplish the task and alternative technologies are needed.

A couple of alternative tools that may be in one's NDT toolbox are eddy current and magnetic Hall-effect thickness gauge technologies. These technologies work on cast, nonferromagnetic alloys. The NORTEC™ 600 flaw detector offers a comparison technique using a reference target or reflector for approximate thickness measurements and the liftoff method. For a higher degree of accuracy, the Magna-Mike™ 8600 uses a similar target technique and offers digital measurement readings.

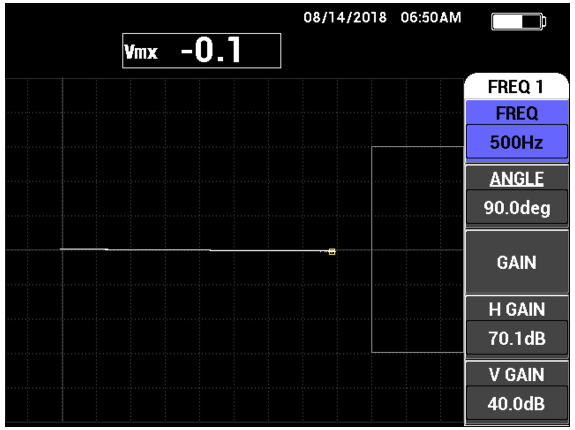
Target Inspection Techniques Using Eddy Current Technology

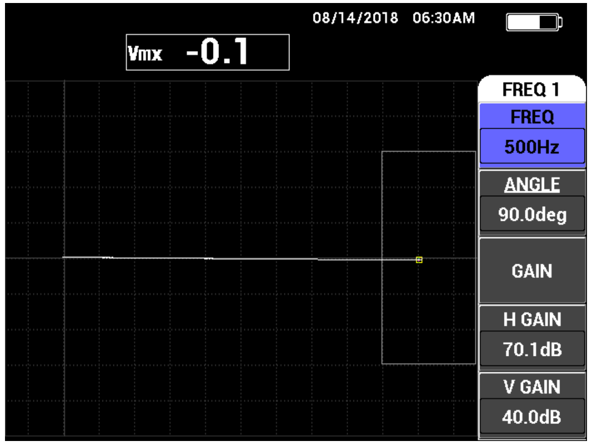
Eddy current target inspection technique for thickness and distance measurement.



Target Inspection Methods Using Eddy Current Technology

We can quantify the thickness of nonferromagnetic components by using the liftoff distance between the probe and the target and the impedance plane X-Y location of the eddy current instrument.





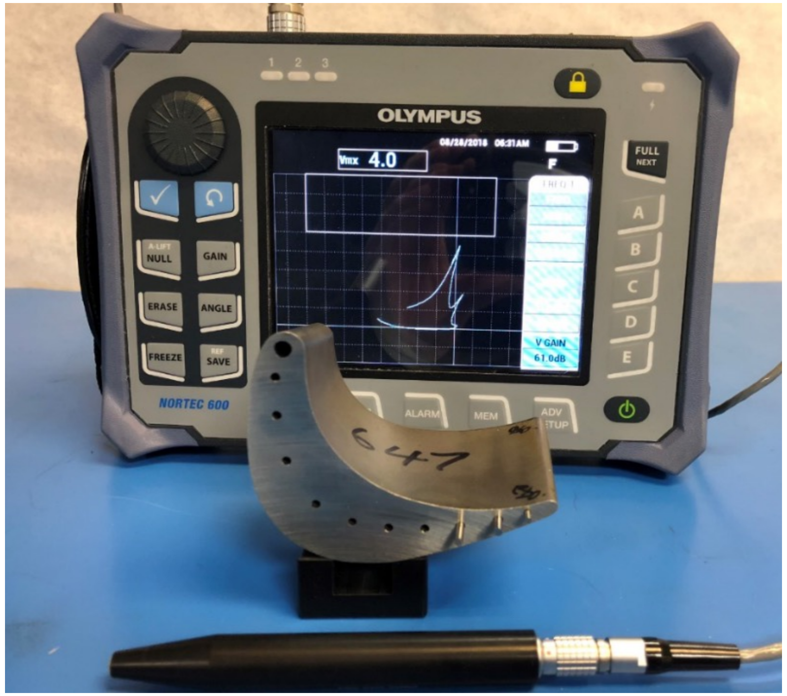
The target’s measured liftoff distance give us an approximate measurement of the part's thickness. This inspection also requires samples or standards to aid in setup calibration and inspection interpretation.

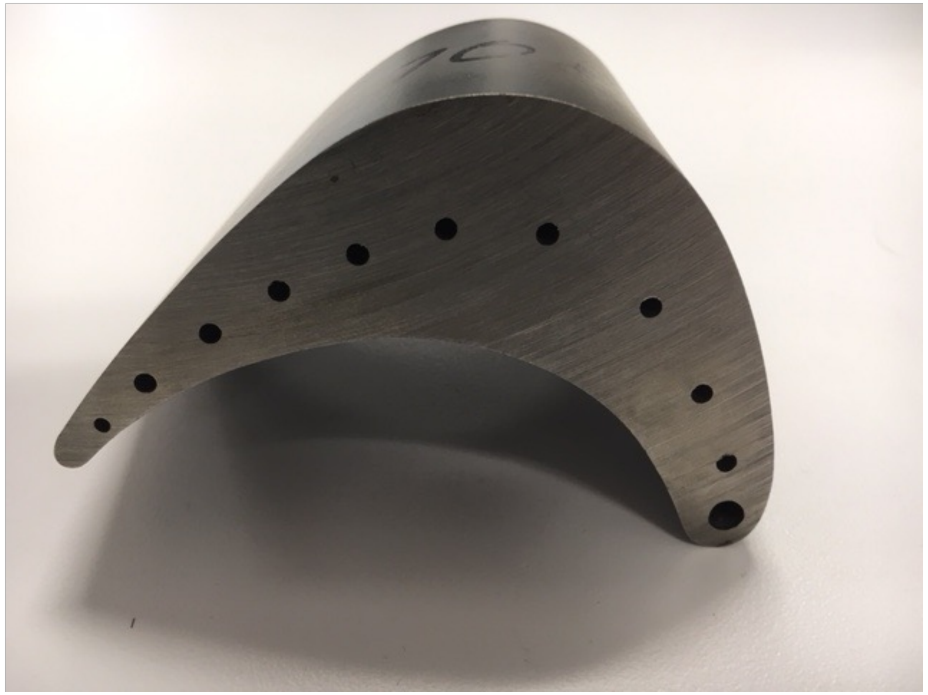
Reference: Boeing procedure for measurement of radome thickness inspection of repaired areas of the radome This is listed in Part 6 of many of their NTM procedures.

Eddy Current Target Inspection Technique

We will examine an example cast turbine blade with a cooling hole at the trailing edge that needs to be confirmed for wall thickness using the eddy current target method.

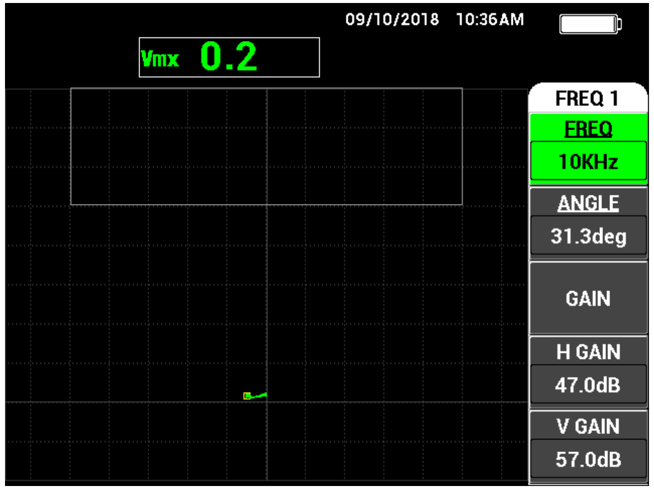
Because the component is made from a nonferromagnetic alloy, a steel target will be required to attract the generated eddy current through the nonferromagnetic alloy to the target. We can use the liftoff distance between the probe and the target to measure the wall thickness.



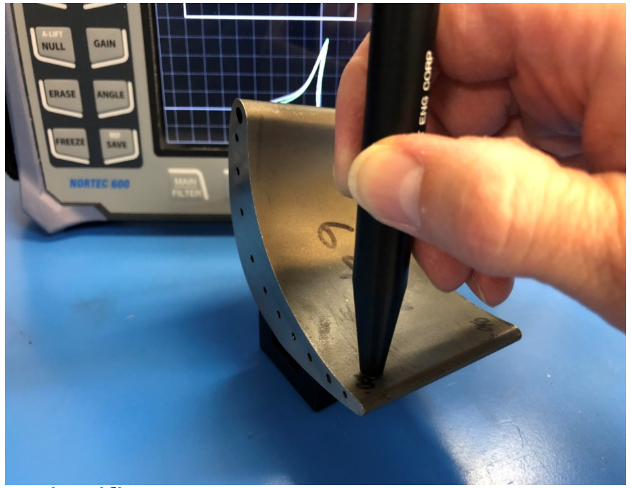


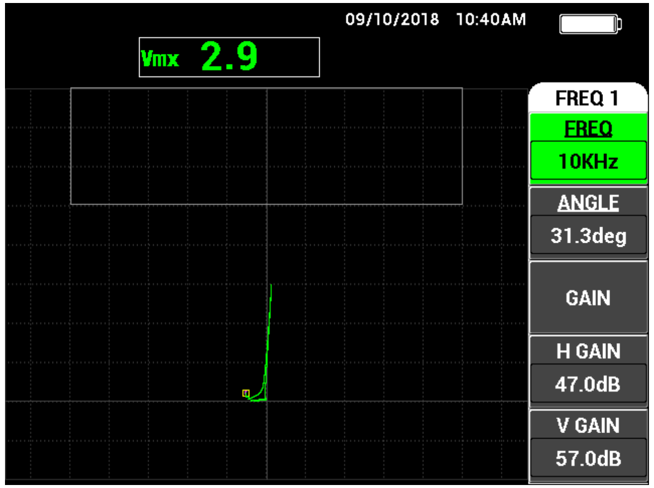
Eddy Current Target Inspection Technique

With the steel target installed in the cooling hole, balance the probe on the turbine blade at safe distances from the target and the edge.



Liftoff

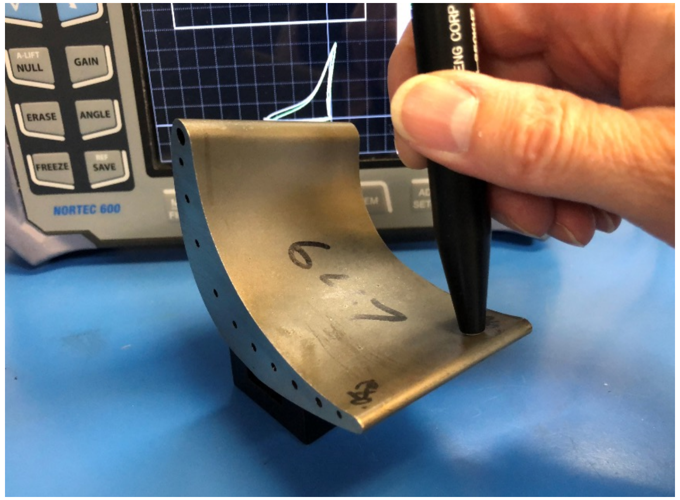


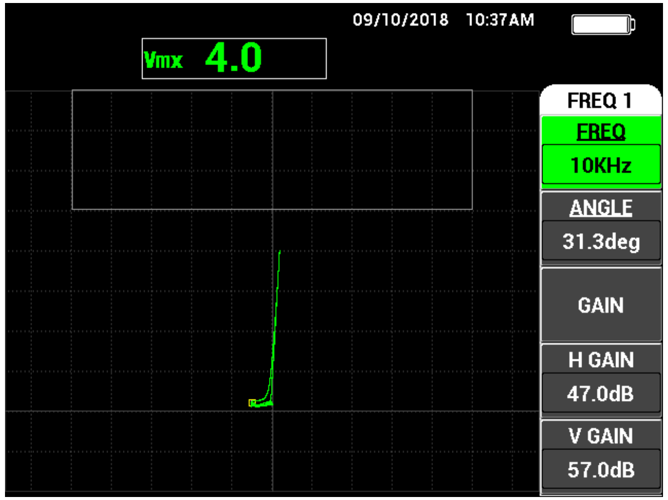


Wall thickness 0.042 in.

Eddy Current Target Inspection Technique

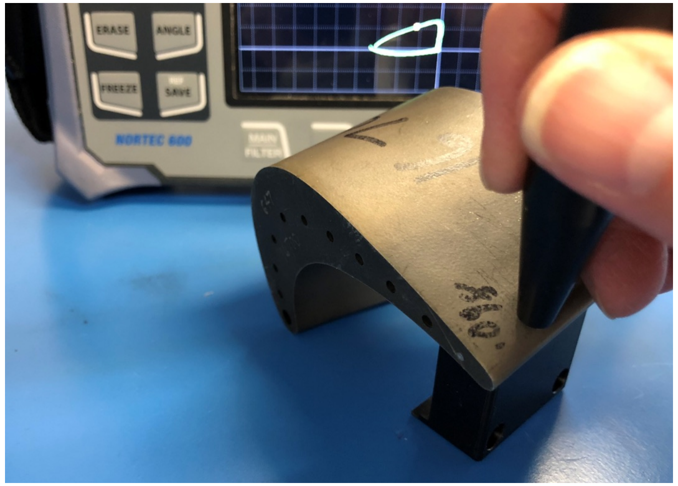
Scanning over the target in the airflow hole.

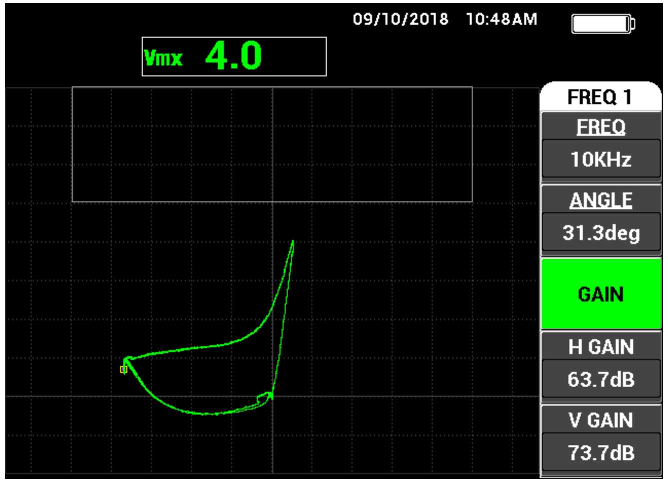




Wall thickness 0.040 in.

Flipping the turbine blade and inspecting the concave side

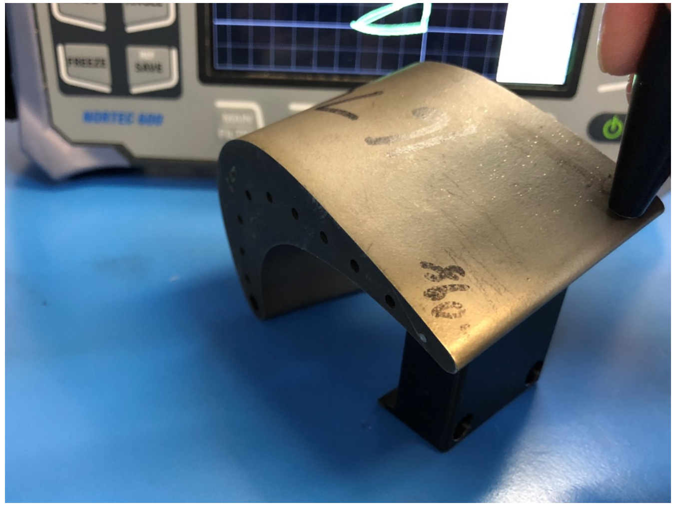


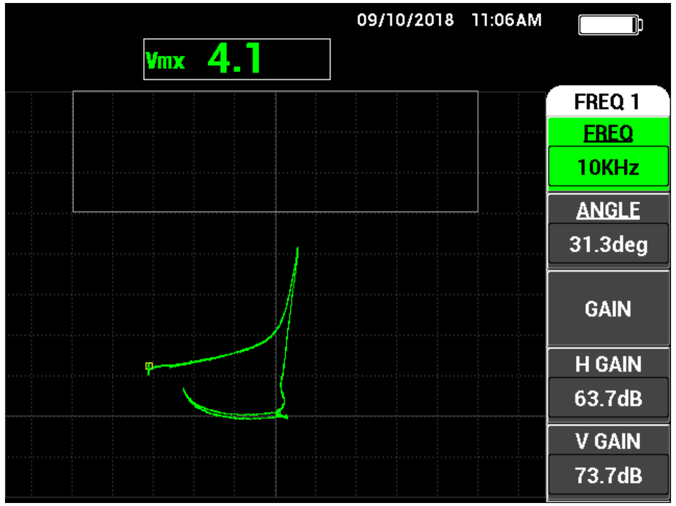


Wall thickness 0.098 in.

Eddy Current Target Inspection Technique

On the concave side, we can obtain a reading by scanning the probe to the opposite side of the blade.

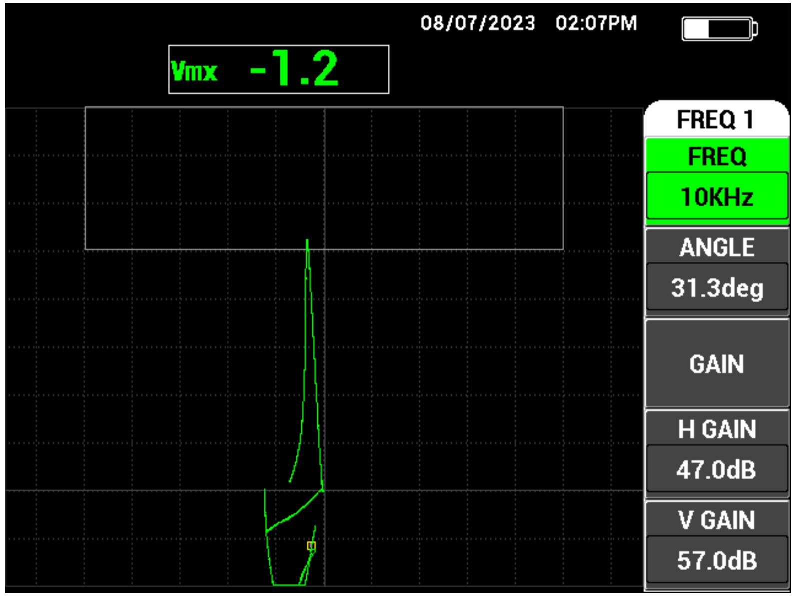




Wall thickness 0.093 in.

Eddy Current Target Inspection Technique

Here is an example of wall thinning. The signal is breaking the alarm gate.



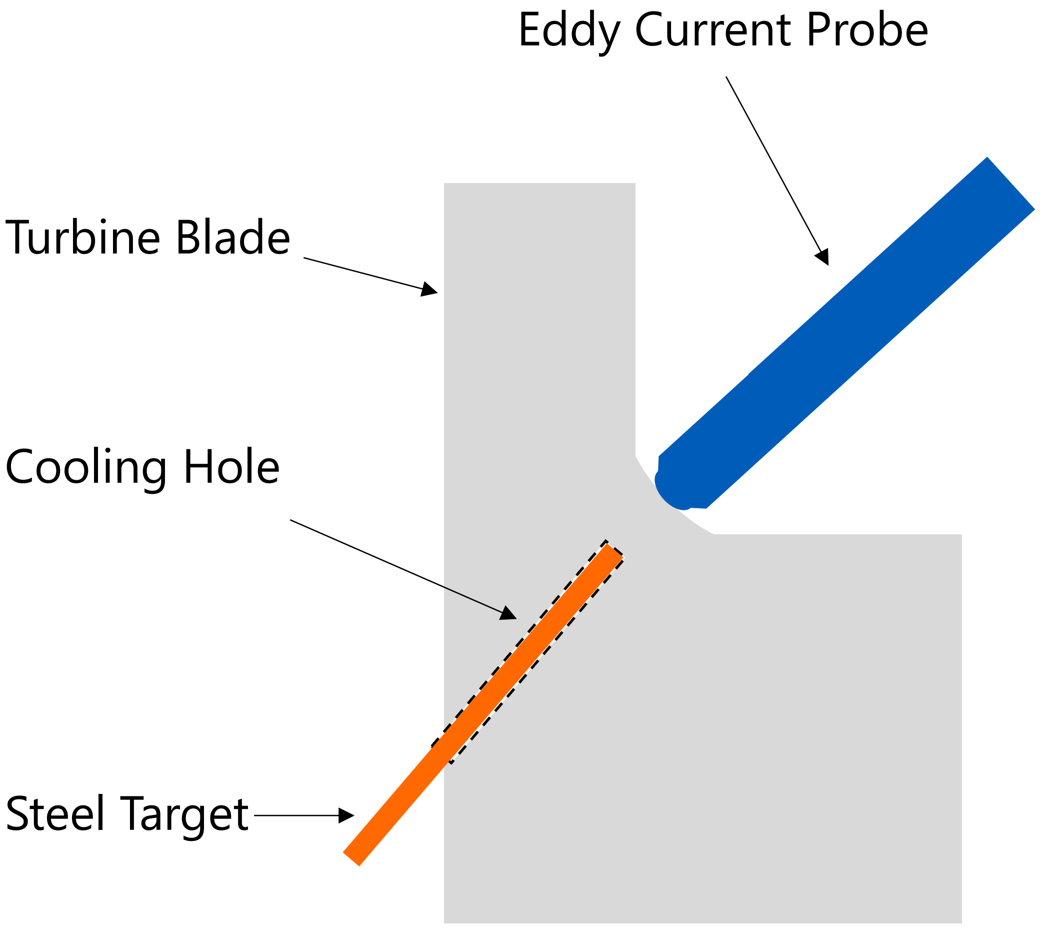
Eddy Current Target Inspection Technique

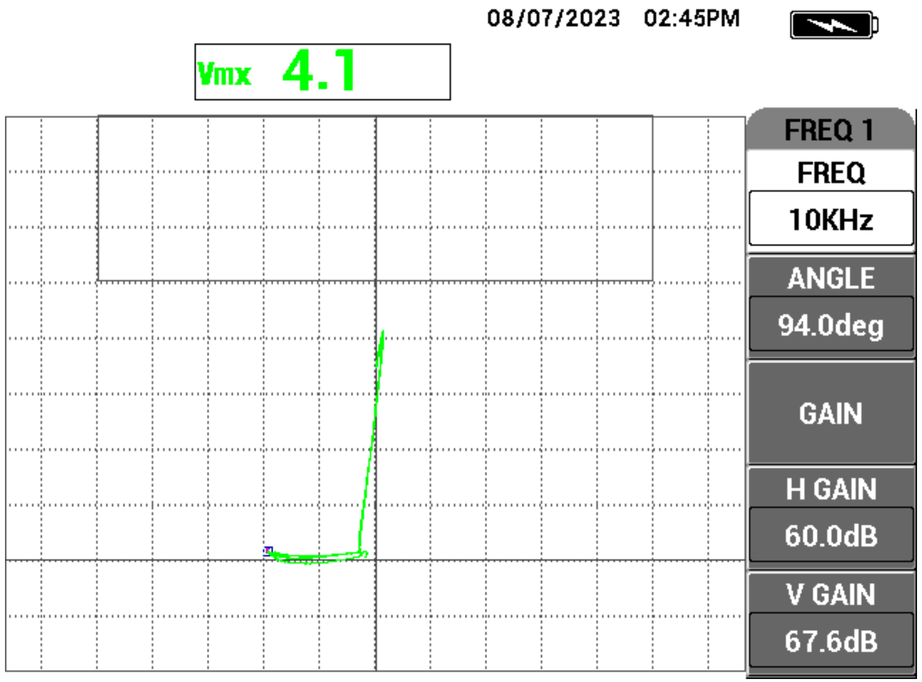
Another cast turbine blade with four cooling holes that are quite close to the outside convex radius will be examined. They need to be examined to make sure that the wall thickness measured from the cooling hole to the convex radius is greater than 0.035 inches (0.889 mm).

The Magna-Mike thickness gauge and other NDT techniques were not able to accurately measure the wall thickness of these cooling holes since they are not through holes and due to the complex geometry. Using these technologies, we cannot get an accurate reading.

Eddy Current Target Inspection Technique

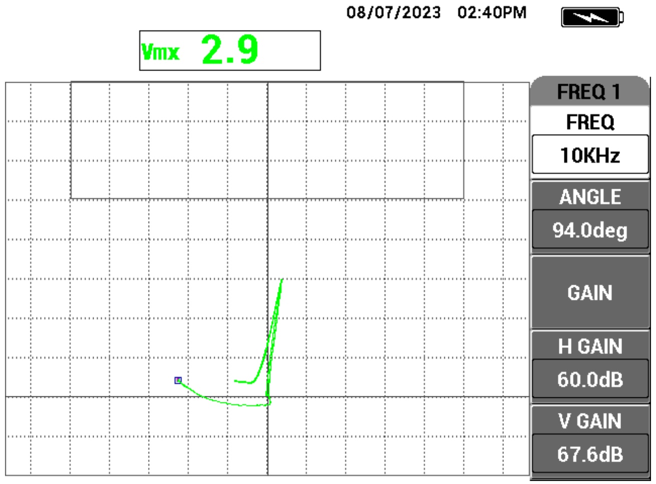
Illustration of the turbine blade with the target installed into the cooling system from the back side of the blade while the eddy probe scans over the radius to detect the target.



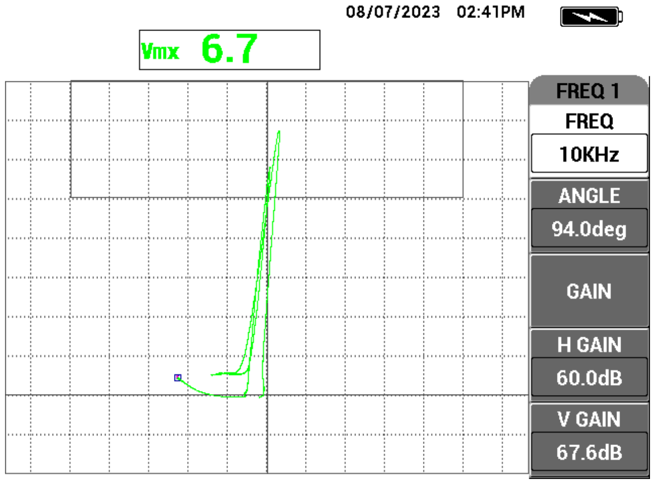


Eddy Current Target Inspection Technique

Eddy current examination of cooling holes in the turbine blade’s radius



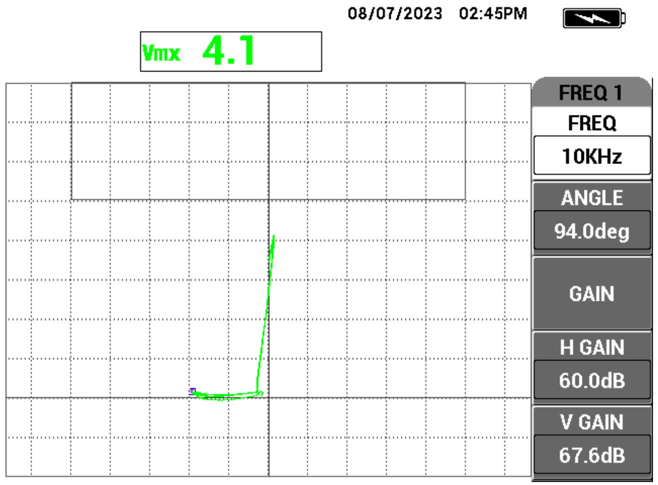
Cooling hole #4 is within tolerance.



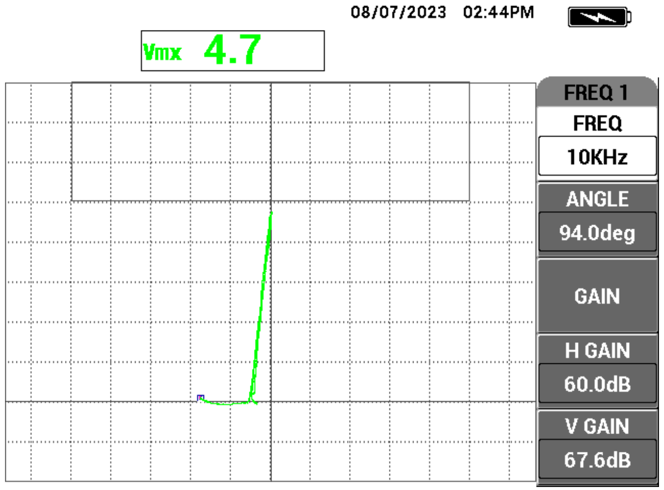
Cooling hole #3 appears to be out of tolerance.

Eddy Current Target Inspection Technique

Eddy current examination of cooling holes in the turbine blade's radius



Cooling hole #2 is within tolerance

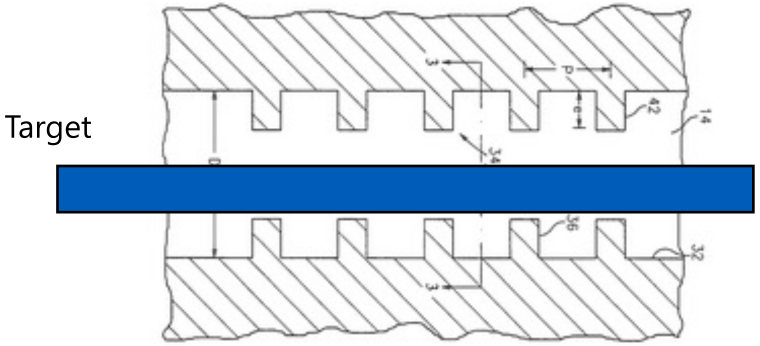


Cooling hole #1 is within tolerance, but very close to being out of tolerance.

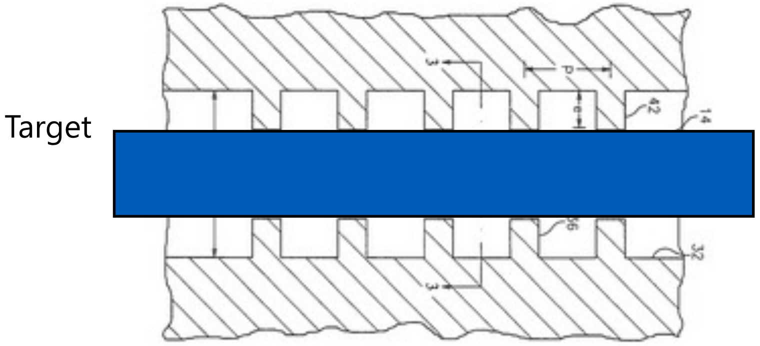
Target Inspection Technique: Tech Note

There are a couple of issues to be aware of when using target techniques.

- If the target is not lying completely flat against or seated properly inside the surface of a part, the probe will measure through the air gap. This can lead to false material thickness measurements and false maximum thickness capture due to liftoff.
- The target may not lie flat against the inside surface of the part due to surface roughness, machined turbulated cooling holes in turbine blades, or bent or kinked wire or targets, which can potentially give inaccurate readings.



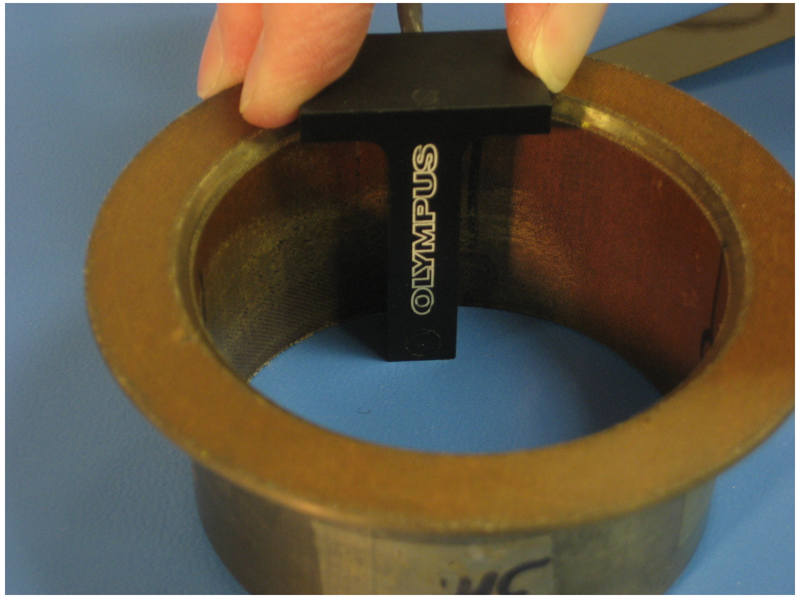
This target is too loose to be an effective target.



The target needs to be as close as possible to the hole size to be inspected.

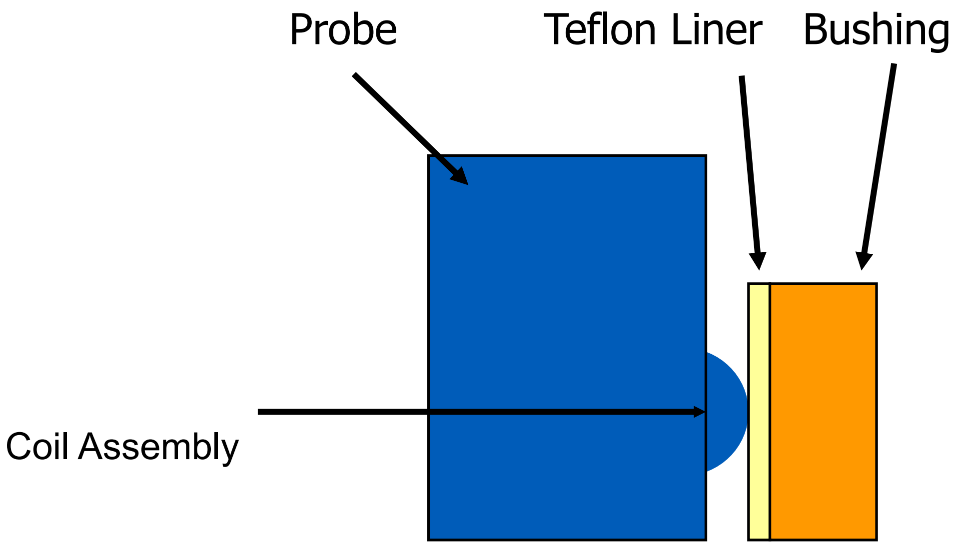
Target Inspection Techniques Using Eddy Current Technology

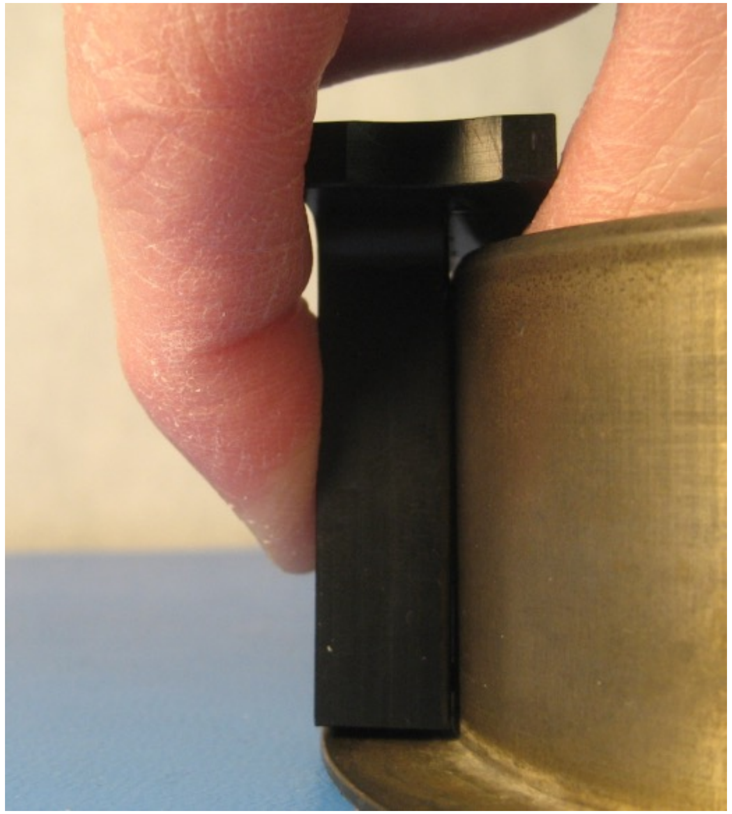
- **Here is an application for a critical helicopter component. During the aircraft's servicing, an inspection is performed of the protective Teflon liner that measures any wear on the Teflon coating.**
- **The target in this case is the base material, the bushing, and the Teflon liner, which need to be greater than 0.007 inches (0.178 mm).**
- **In this application, a custom spring-loaded probe was required to maintain stability for accurate inspection.**



Target Inspection Techniques Using Eddy Current Technology

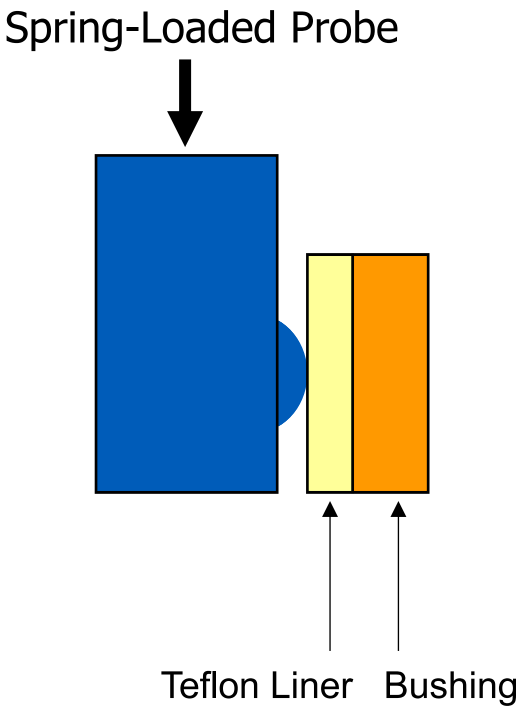
- **The probe generated an eddy current in the material under test. If the thickness of the Teflon liner changes, the spring-loaded probe detects the liftoff measurement, or distance from the target base material, which is the bushing in this case.**



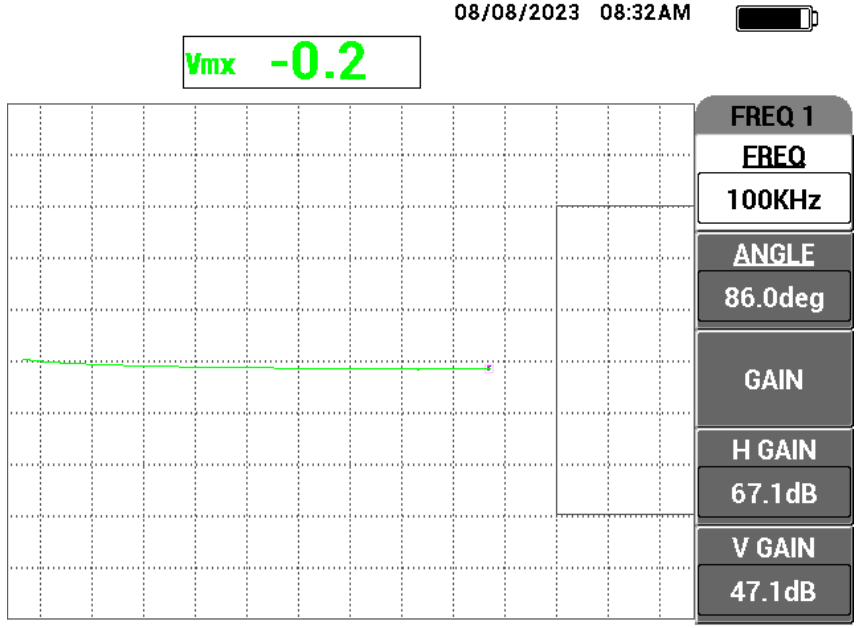


Target Inspection Techniques Using Eddy Current Technology

- **After the NDT technician sets up the instrument and makes all adjustments, they perform the eddy current inspection of the Teflon liner, looking for an indication measuring 0.008 inches (0.203 mm) or less.**

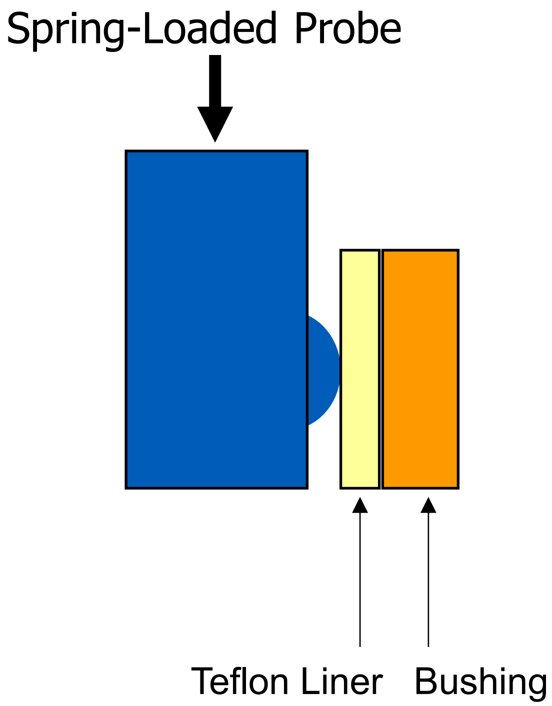


The 0.010-inch (0.254 mm) measurement is "within safe limits."

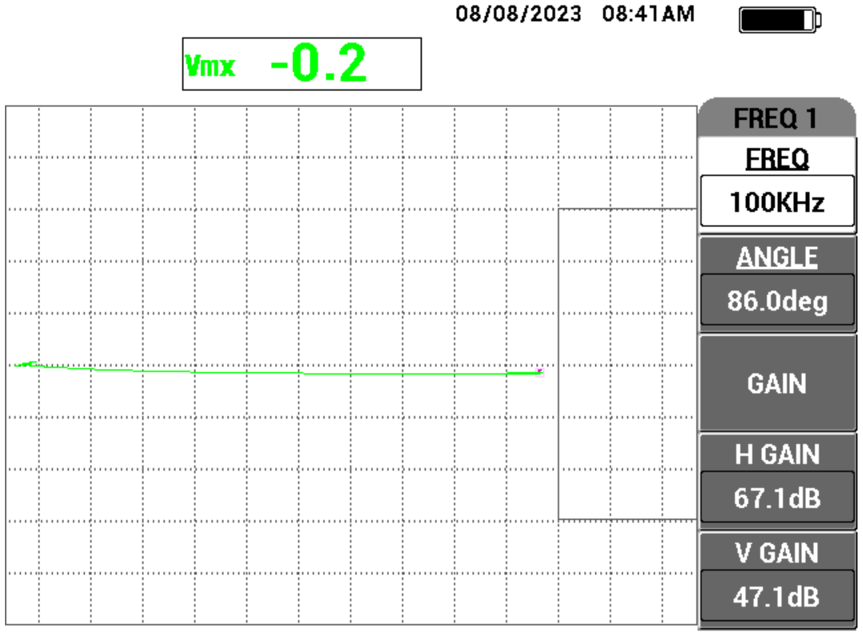


Target Inspection Techniques Using Eddy Current Technology

- **The Teflon liner in this example is just within safe limits.**

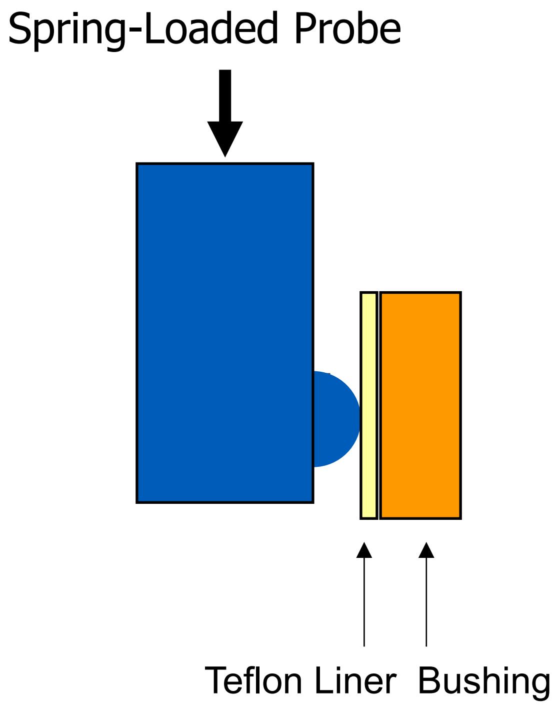


The 0.008-inch (0.203 mm) measurement is "within safe limits."

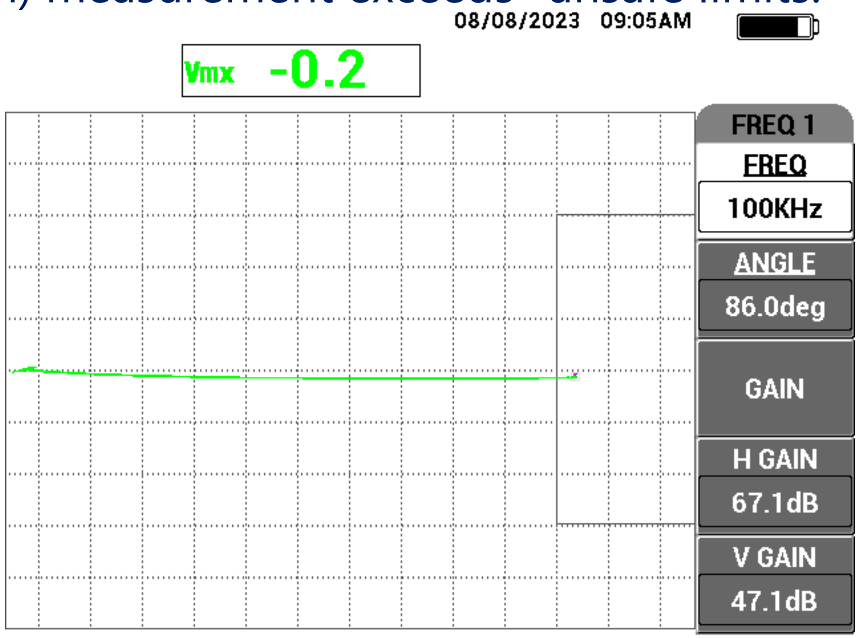


Target Inspection Techniques Using Eddy Current Technology

- **During a service inspection, if the eddy current probe measures the Teflon liner at less than 0.008 in., then the bushings are rejected and taken out of service. If this inspection is not performed, it could lead to damage to the rotor hub assembly and could impact the safe operation of the aircraft.**

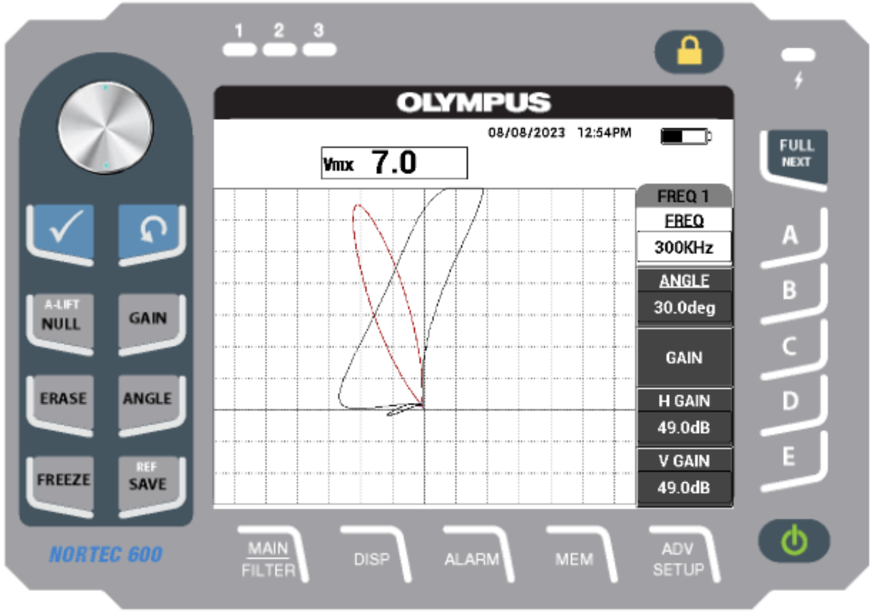


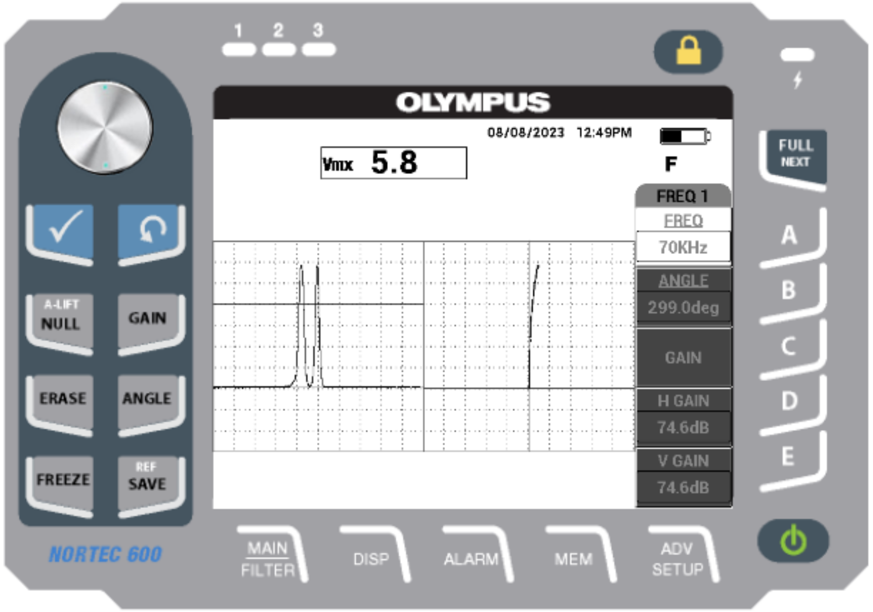
The 0.007-inch (0.178 mm) measurement exceeds "unsafe limits."



Target Inspection Techniques Using Eddy Current Technology

- **We will now review target inspection for quality and configuration control.**





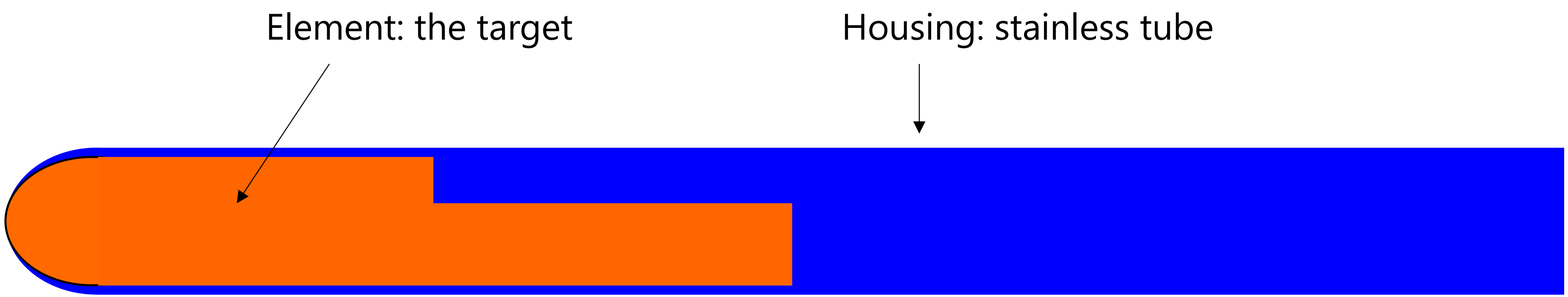
Target Inspection Techniques Using Eddy Current Technology

- **In the manufacturing industry, Quality engineers have turned to eddy current to identify whether components have been properly installed in their assemblies.**

- **We will look at a couple of applications where eddy current is used for configuration control.**

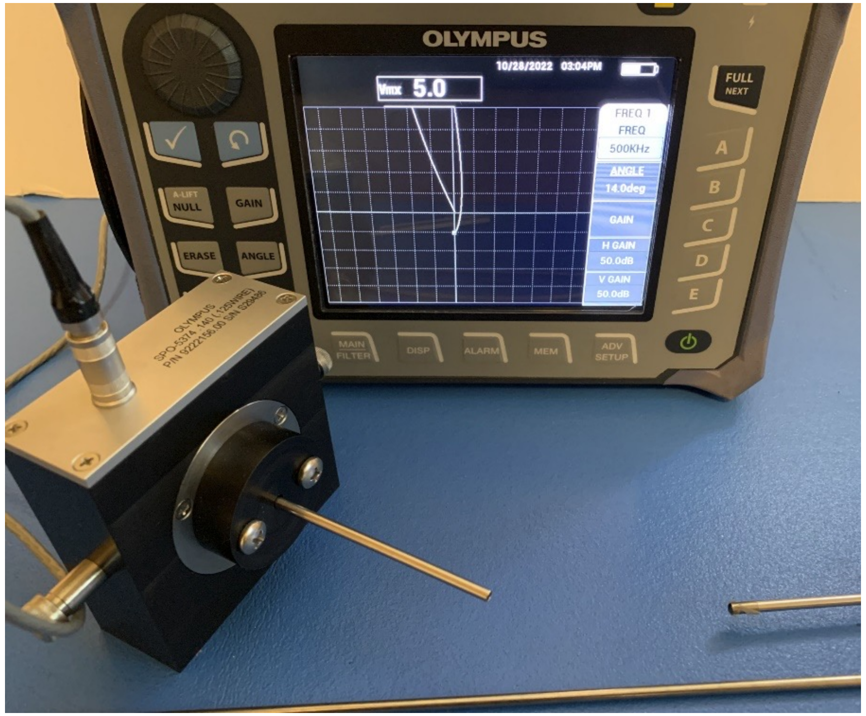
Target Inspection Techniques Using Eddy Current Technology

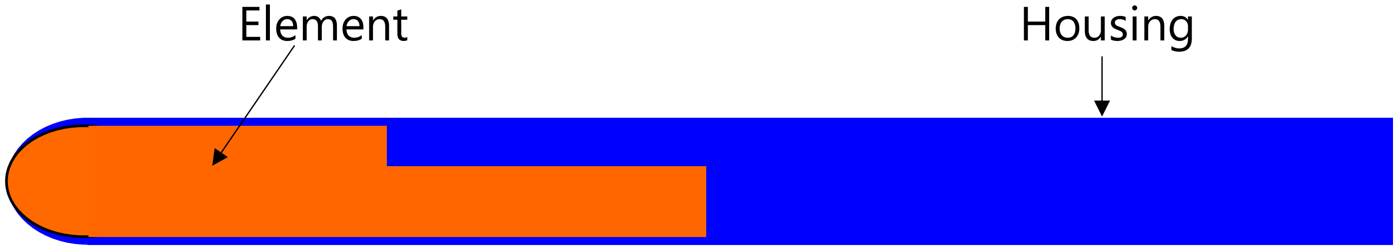
- **Temperature measuring device: The customer needed to identify whether the element was installed in the stainless tube housing. If not, the stainless tube assembly had to be rejected and removed from production before any further costly work was done on it.**
- **The target in this application is the element within the stainless tube.**



Target Inspection Techniques Using Eddy Current Technology

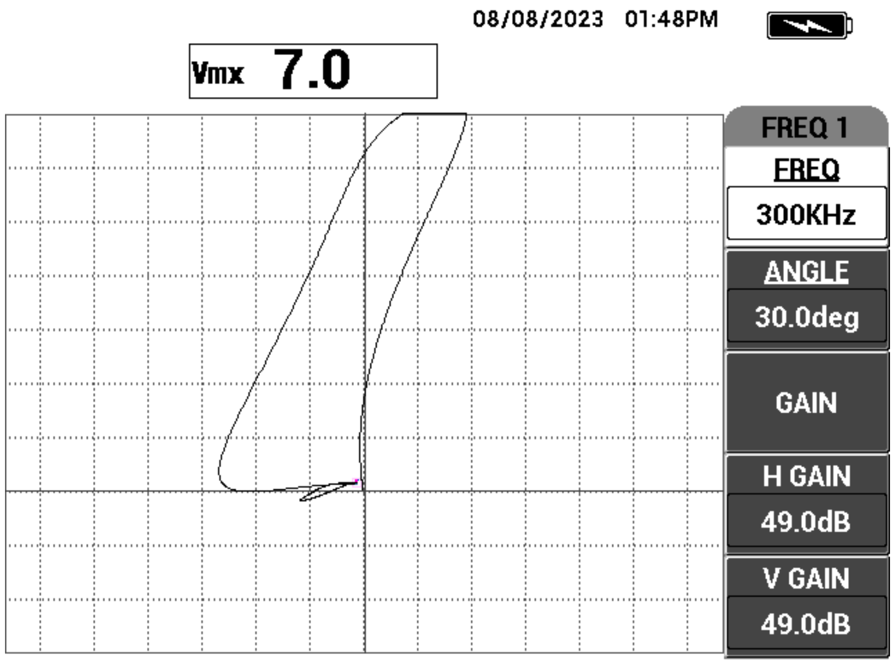
- For this application, an eddy current instrument and an encircling probe were used to help identify whether the element was present in the stainless tube assembly.

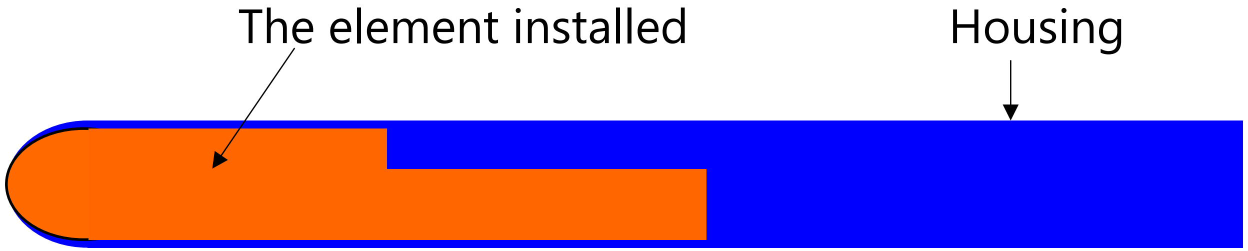




Target Inspection Techniques Using Eddy Current Technology

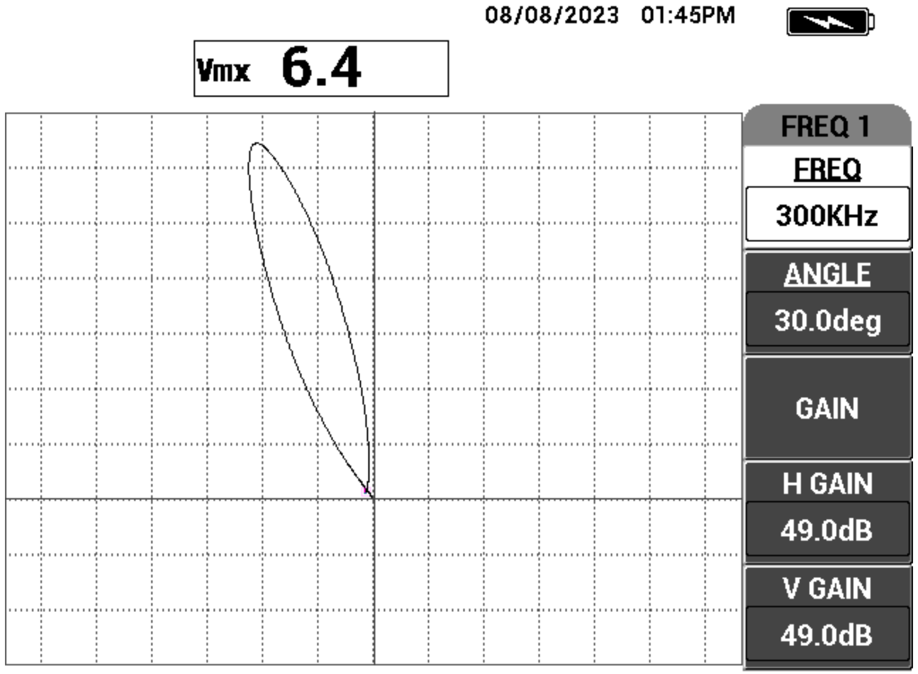
- **Here is an example of a tube assembly with the element correctly installed.**

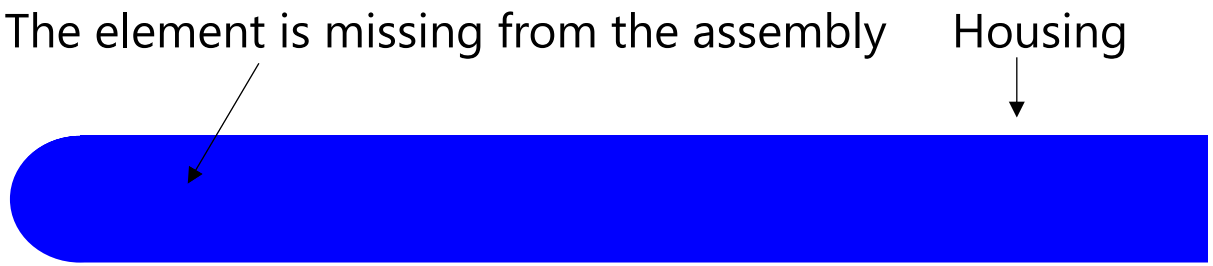




Target Inspection Techniques Using Eddy Current Technology

- **Here is an example of a nonconforming assembly with the element (the target) missing. This is a rejected part.**



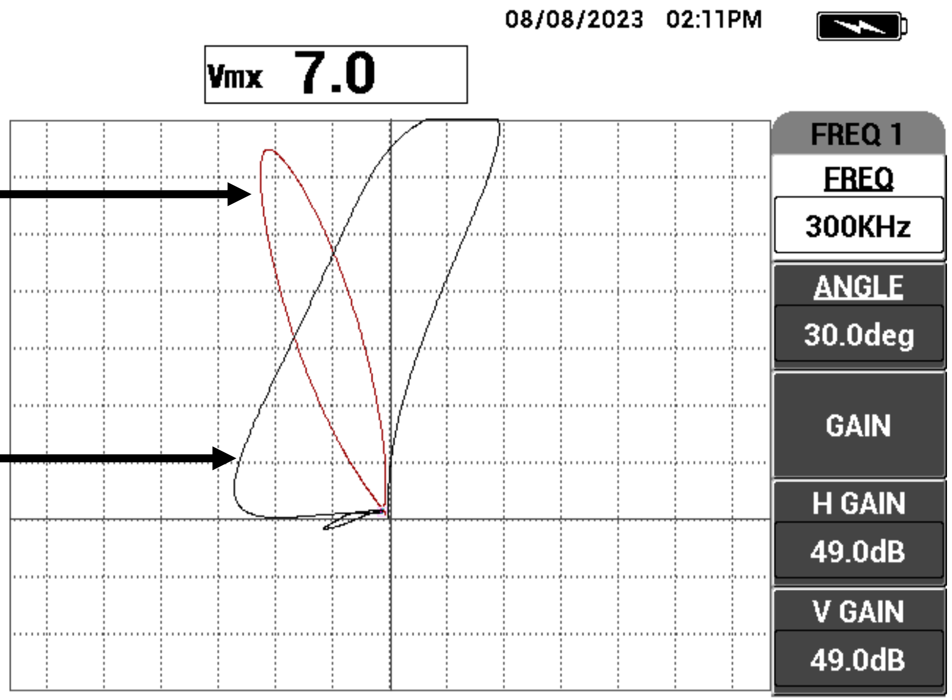


Target Inspection Techniques Using Eddy Current Technology

- **Here is a screen image comparing the two signals.**

Nonconforming assembly

Conforming assembly with target installed

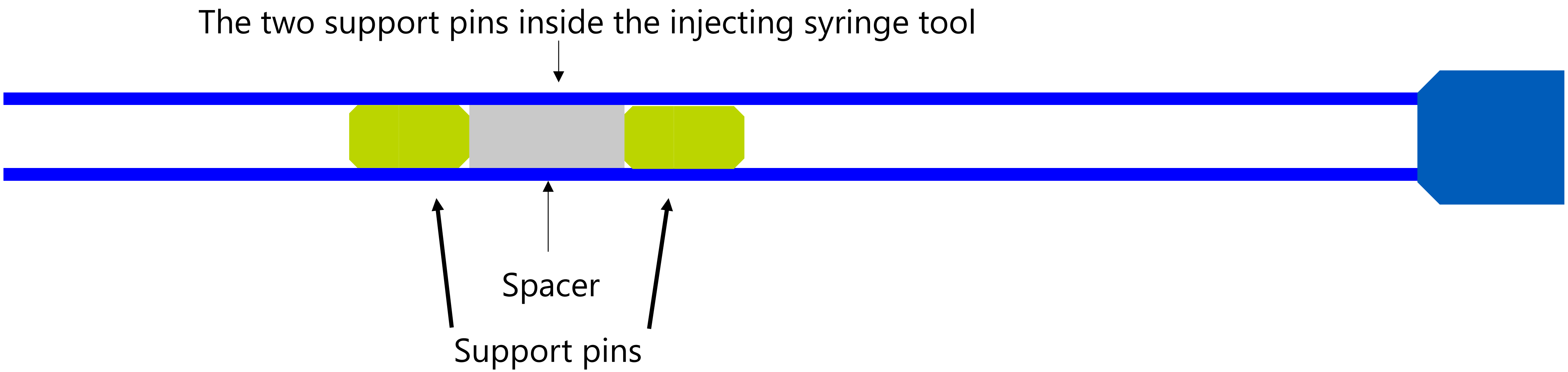


Target Inspection Techniques Using Eddy Current Technology

- **Application: Injector syringe pin tool**

The customer needed a way to confirm the pins were properly installed into a tube housing as part of the injector assembly. The plastic syringe tube housing had two support pins used for a special device.

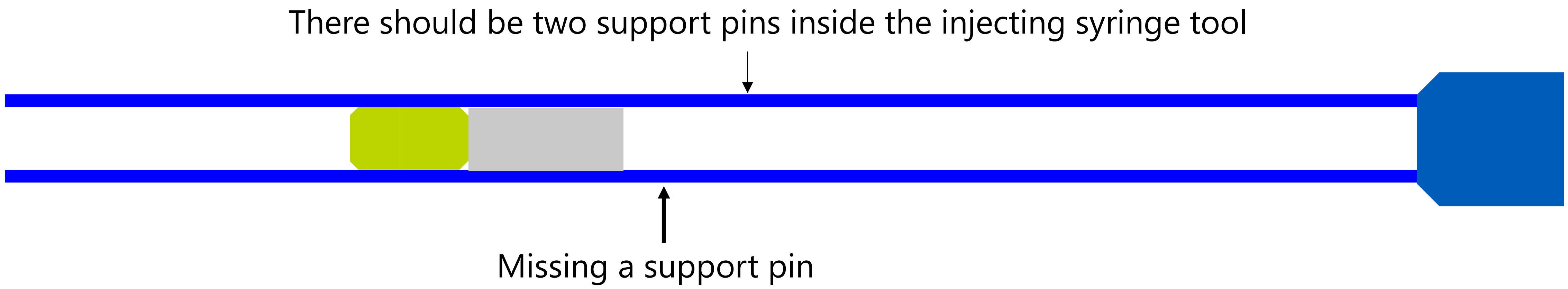
- **The target in this application is the two supporting pins within the plastic syringe tube housing.**



Target Inspection Techniques Using Eddy Current Technology

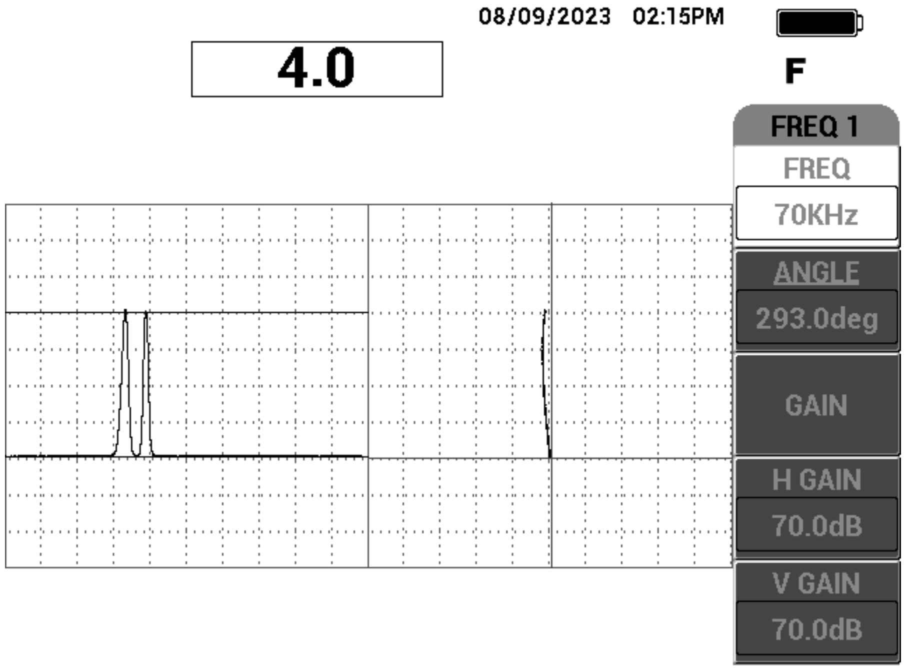
- **The most common and recurring nonconformity is that the injecting syringe tool has only one support pin installed. If the two support pins are not correctly installed, it forces the operator to stop the operation and may require a total rework of the assembly.**

- **The rework process is costly and very time-consuming.**



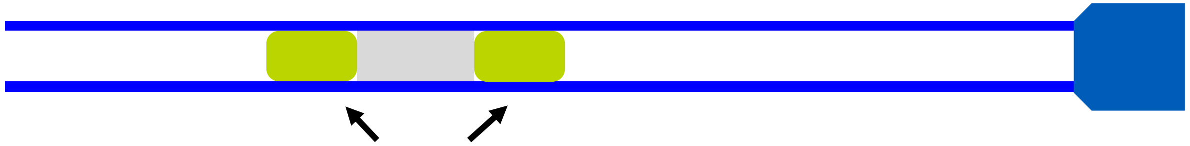
Target Inspection Techniques Using Eddy Current Technology

- **Both the swept and impedance plane screens of an eddy current instrument were used. This offered the customer an easy solution to identify whether the injecting syringe tool had the required two support pins.**



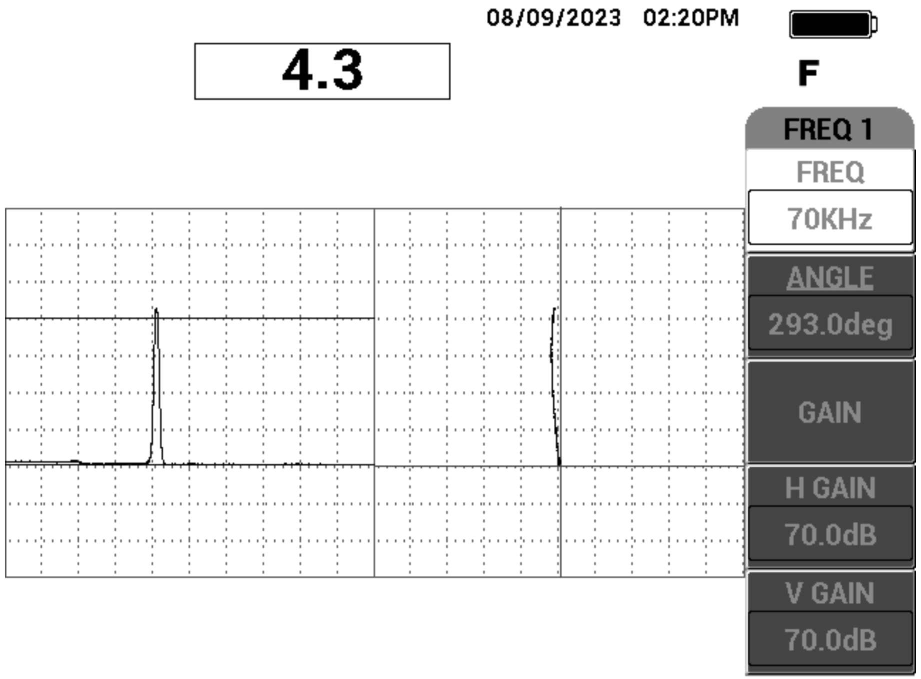
Bactrian signal

The two support pins inside the Injecting syringe tool



Target Inspection Techniques Using Eddy Current Technology

- **This signal indicates there is just one support pin in this injecting syringe tool, which is a nonconformity.**

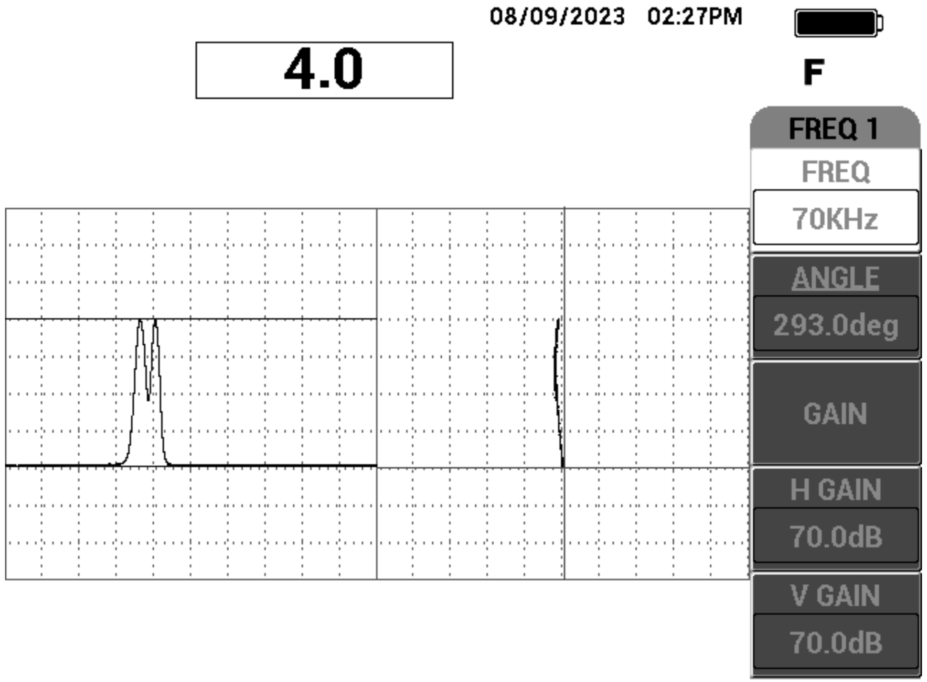


Dromedary signal

Missing a support pin inside the injecting syringe tool

Target Inspection Techniques Using Eddy Current Technology

- **But wait! More nonconformities were discovered while using this eddy current technique.**

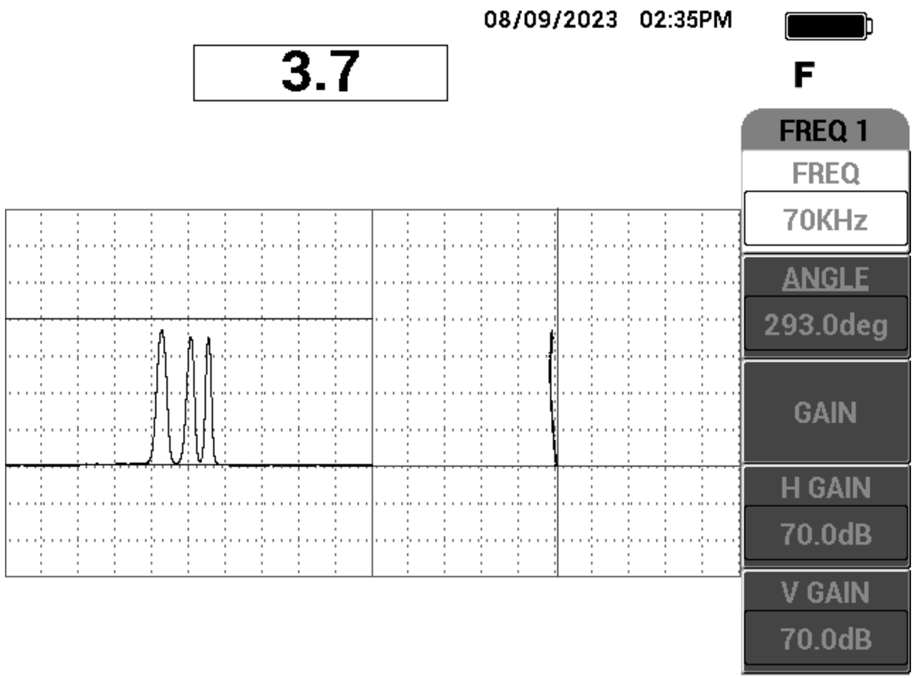


The two support pins inside the syringe tool are too close together

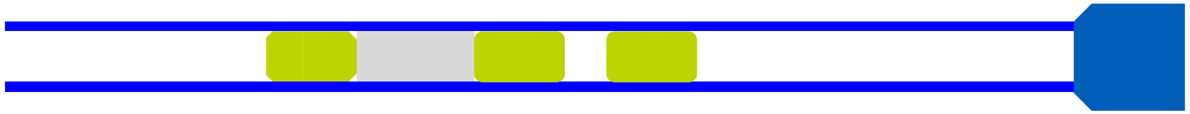
Missing the spacer

Target Inspection Techniques Using Eddy Current Technology

- **Another nonconformity identified.**

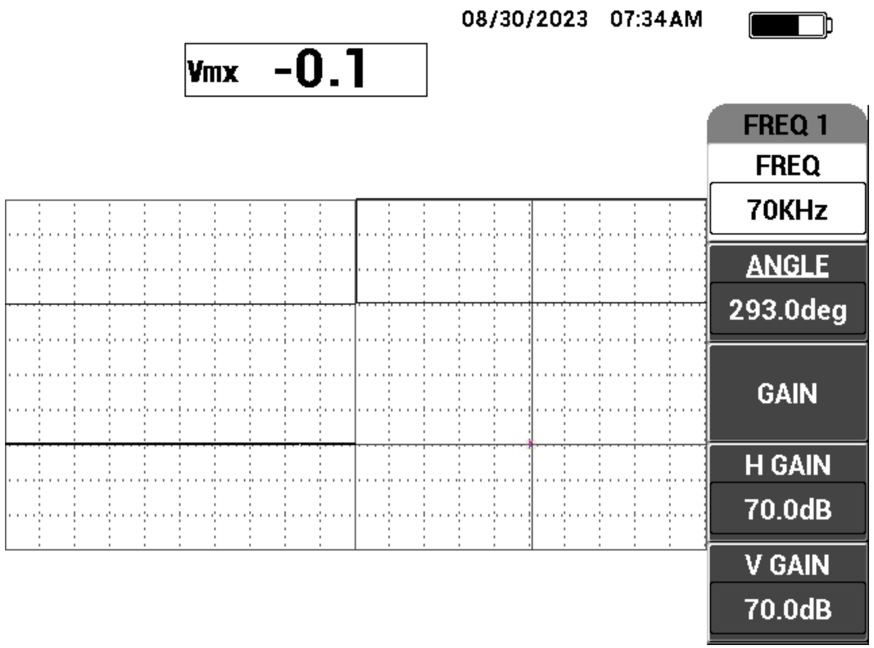


One too many support pins inside the injecting syringe tool



Target Inspection Techniques Using Eddy Current Technology

- **And yet another nonconformity identified.**



An empty syringe tool without support pins or spacers

Target Inspection Techniques Using Eddy Current Technology

Conclusion

Eddy current offers an alternate solution for measuring thickness or configuration control. This technique can be used on nonferromagnetic alloys, plastics, and composite parts when other NDT technologies are unable do the job.

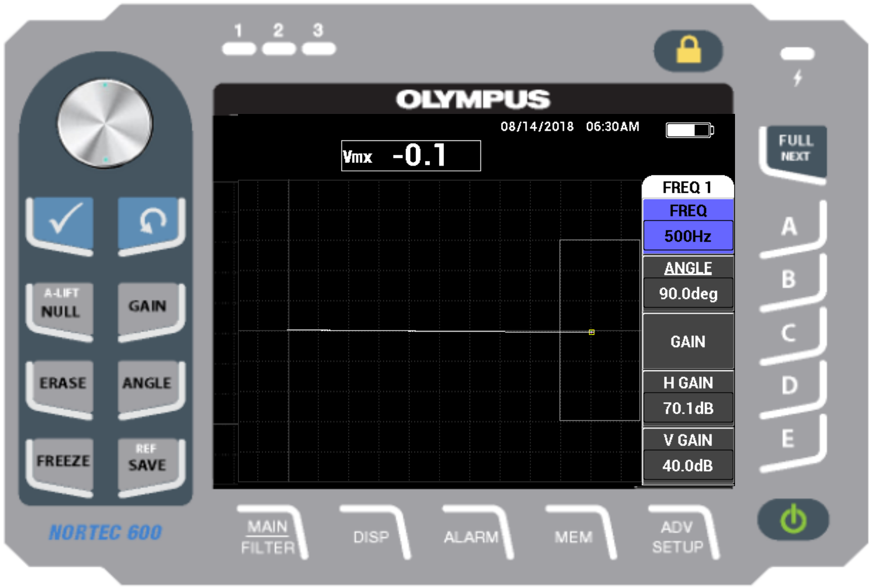
There are both advantages and disadvantages to this technique.

Pros

- **Simple to use and easy to operate.**
- **Cost-affective solution.**
- **Off-the-shelf solution for most applications.**
- **May already have the technology in their NDT toolbox.**

Cons

- **No digital readings.**
- **Not usable on all materials and alloys.**



EVIDENT
SEEING IS SOLVING

Thank you for your attention.

Any questions?