AN INNOVATIVE LABORATORY PROJECT TO STUDY CORROSION THEORY, CORROSION DETECTION AND THE RESULTING LOSS OF STRUCTURAL STRENGHT DUE TO AN EXFOLIATION CORROSION ATTACK

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Corrosion is a major problem in the aerospace industry

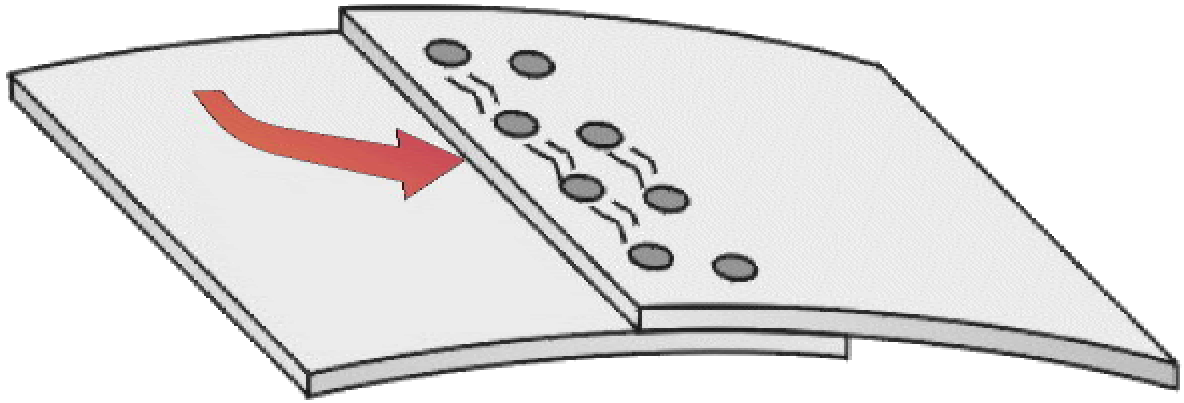
- To understand the possible damage resulting from corrosion of the airframe and components, the engineer and technician need to know what corrosion is, how to detect it, how to remove the corrosion products and how to restore the aircraft to airworthy flight status.

The structural failure of a 19-year-old Boeing 737, operated by Aloha airlines was a defining event in creating awareness of aging aircraft

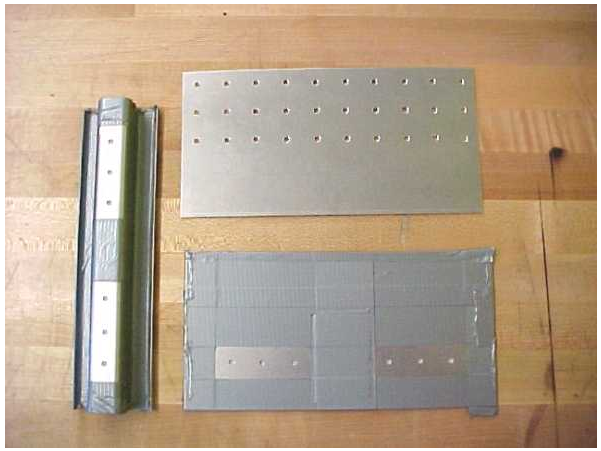
B737 fuselage skin lap joints

- The combination of corrosion, pressurization cycles and knife-edge deep countersinking resulted in fatigue cracks that connected the rivet holes like a zipper.
- National Transportation Safety Board investigation report issued in 1989 attributed the incident to the failure of the operator's maintenance program to detect corrosion damage.

Stress corrosion cracking in lap joints

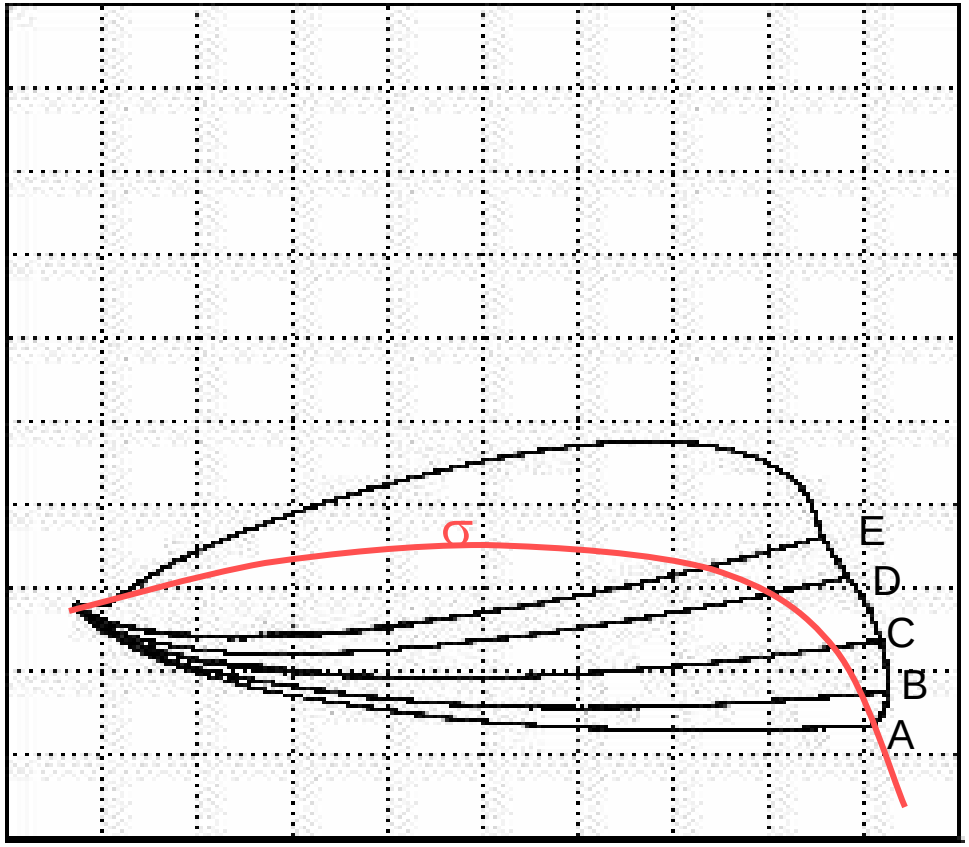


Lap joint fabrication



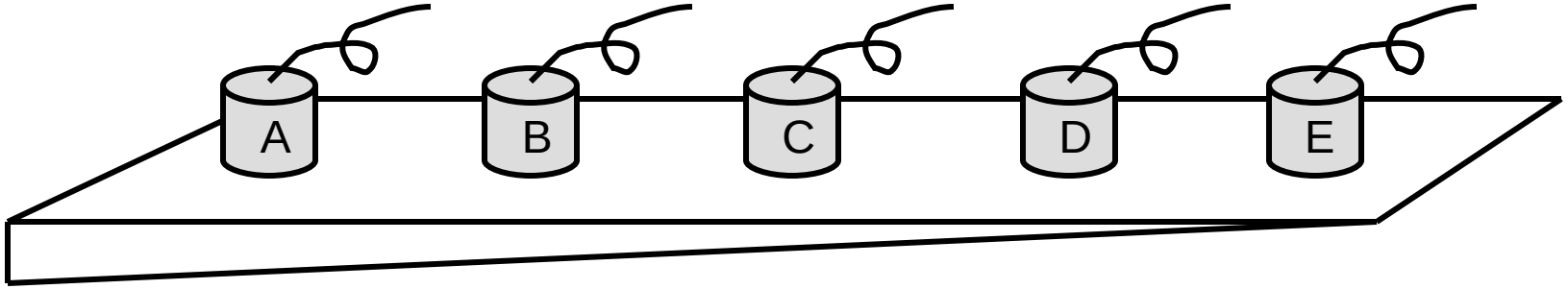
Immersion test

- The ASTM G 34 exfoliation standard was used to create a corrosion attack on the sample lap joint section. This test is an immersion test primarily used in research, but can easily be adapted for a practical experiment. This experiment will create exfoliation corrosion in one to four days, which would take six to twelve years in seacoast atmospheric conditions



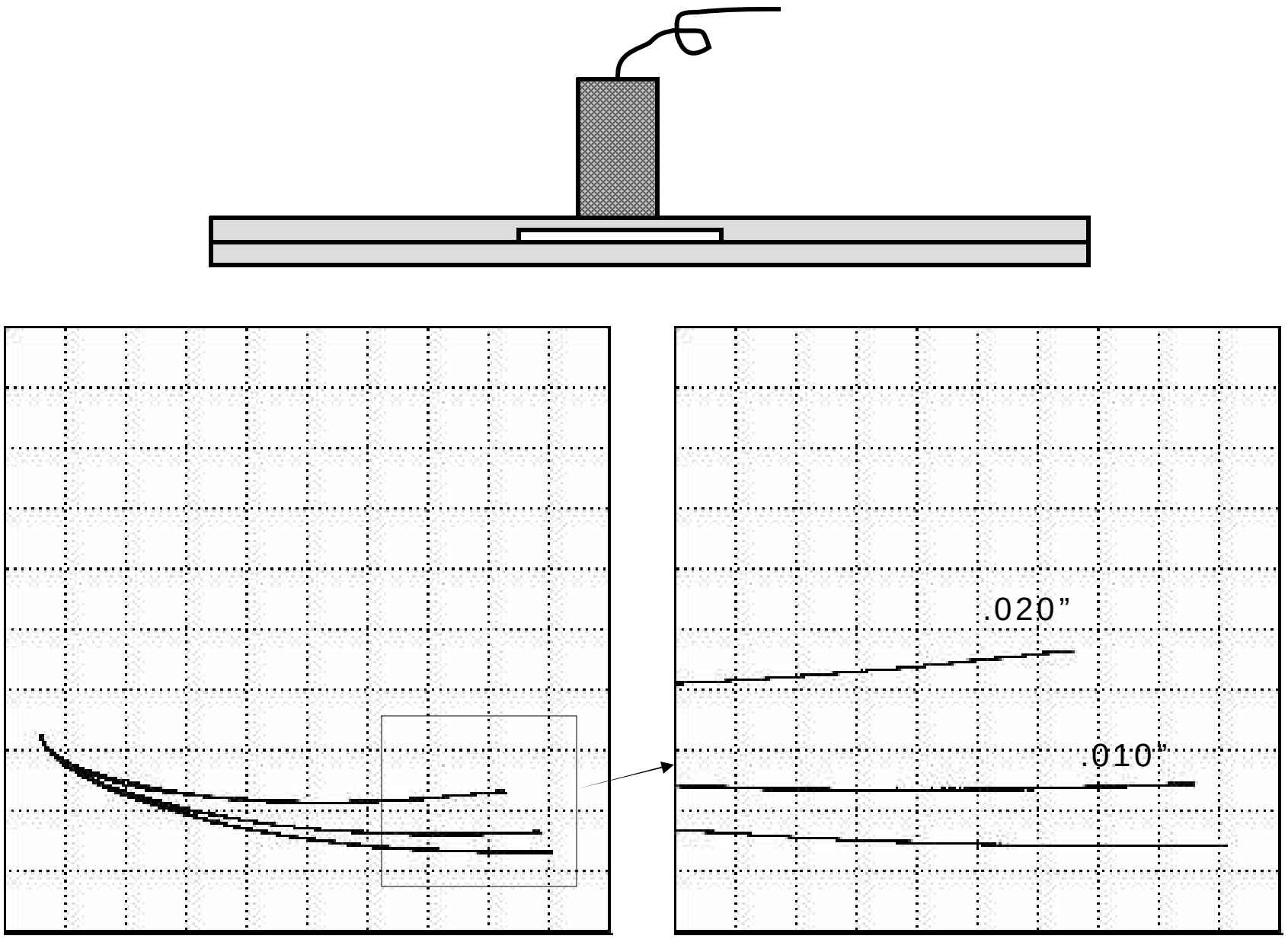
A typical impedance plane display representing the thicknesses at the 5 locations on the thinning standard

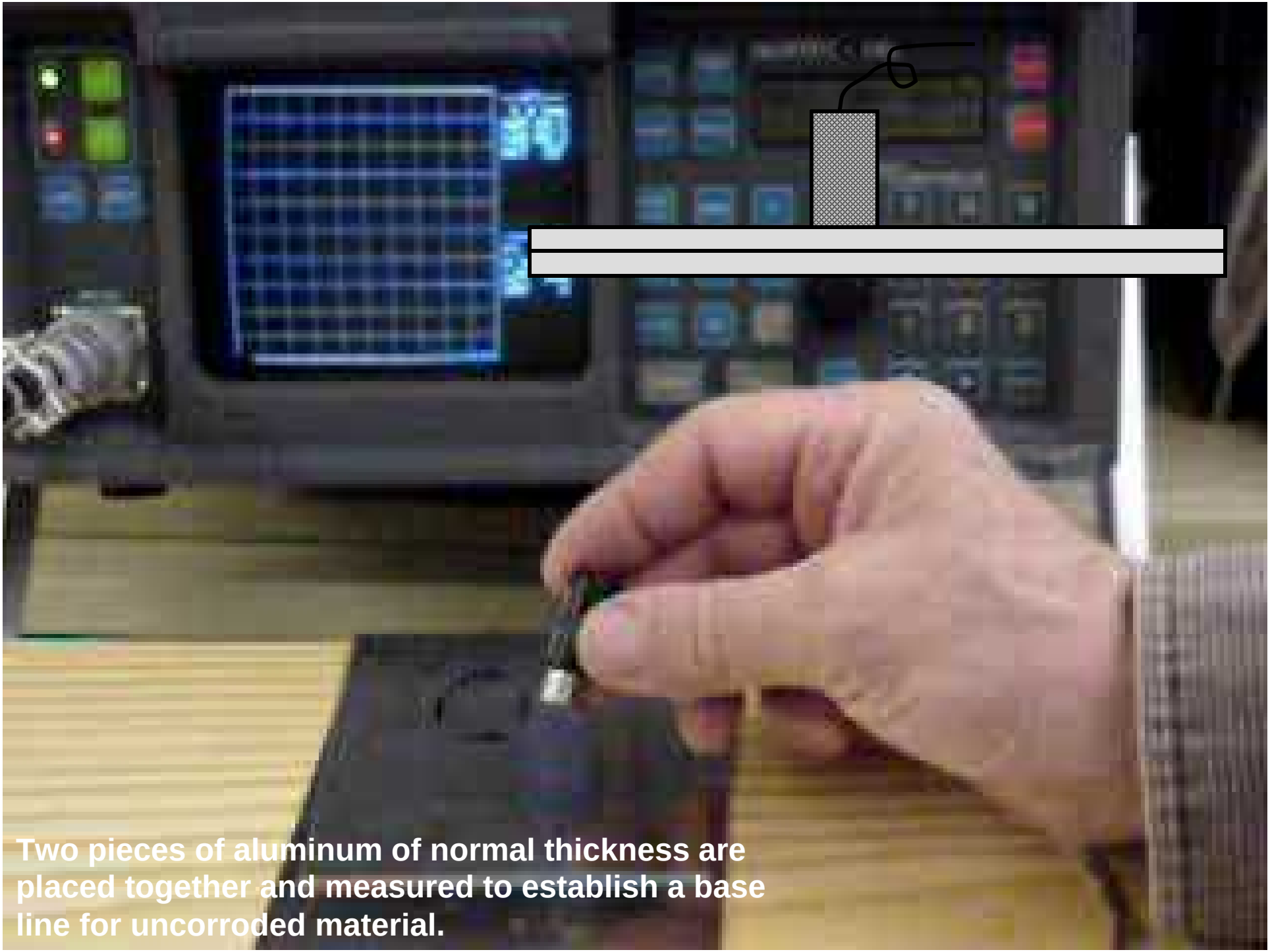
The point where the red curve intersects line A (lower right) represents the conductivity of the material being tested.



REFERENCE STANDARDS

Material is milled away in spots to simulate loss of material due to corrosion


.020”
.010”



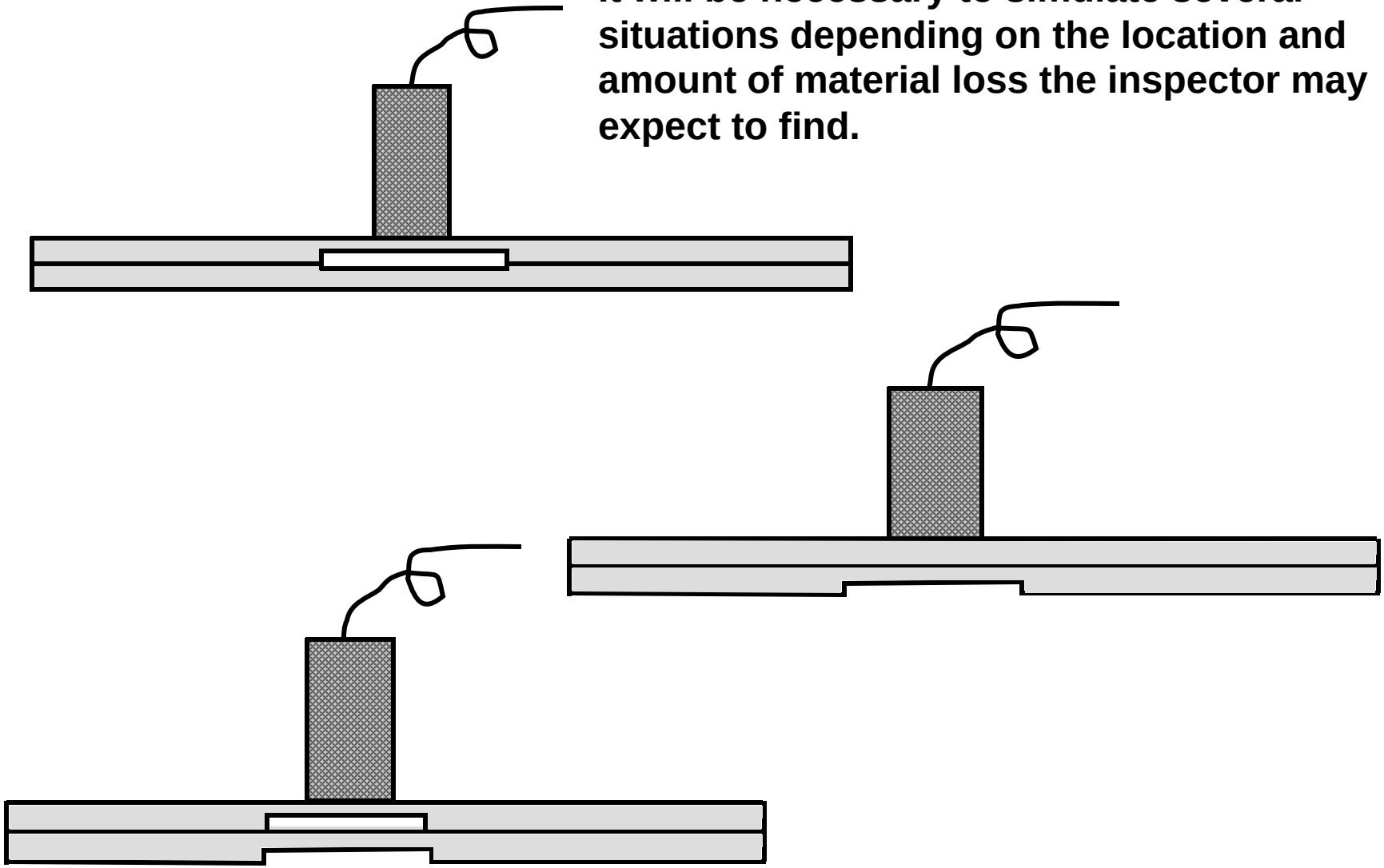
Two pieces of aluminum of normal thickness are placed together and measured to establish a base line for uncorroded material.

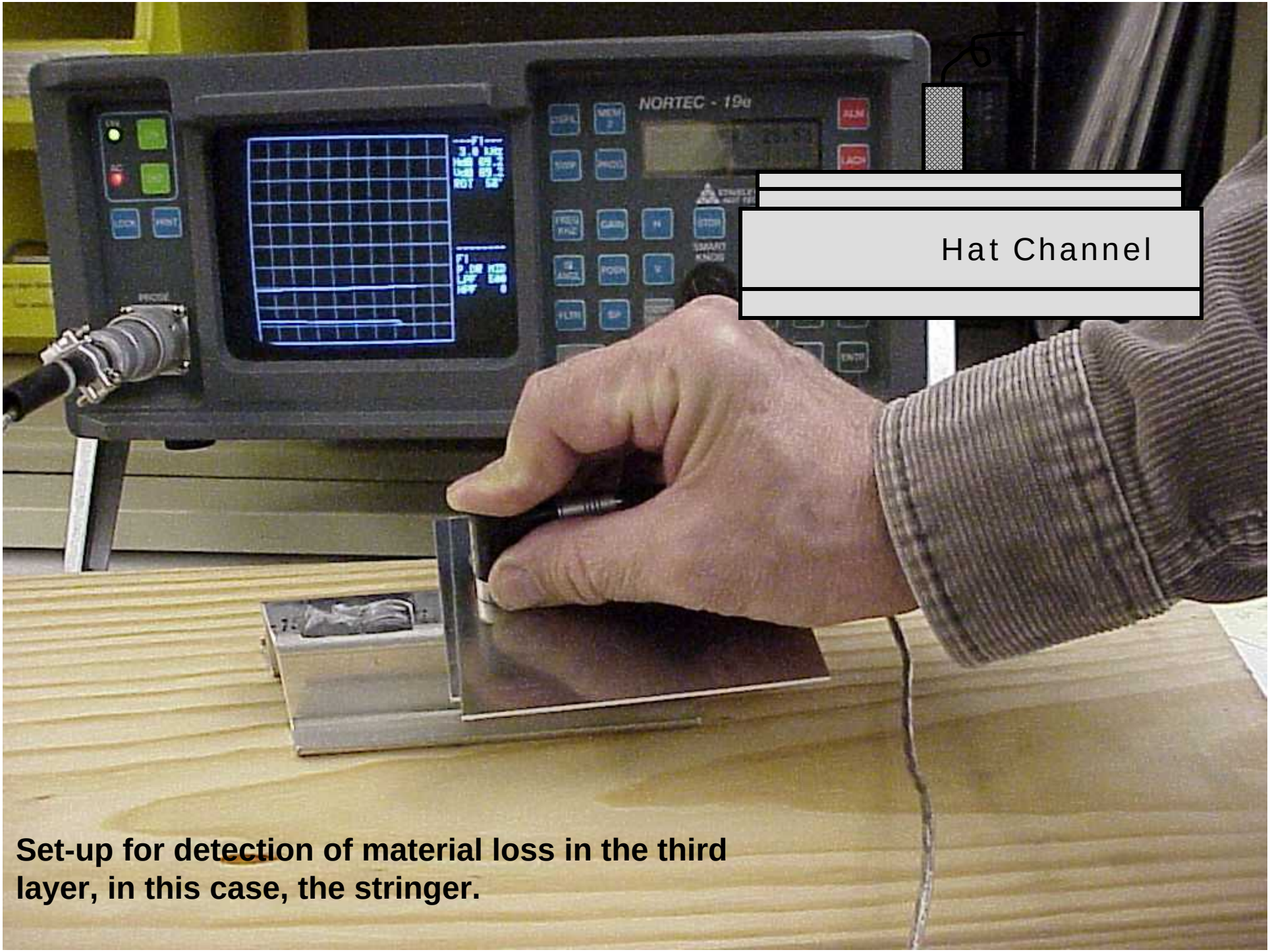

This shows the inspector what .010” of material loss from the inside of the top layer will look like.
.010”


.020”

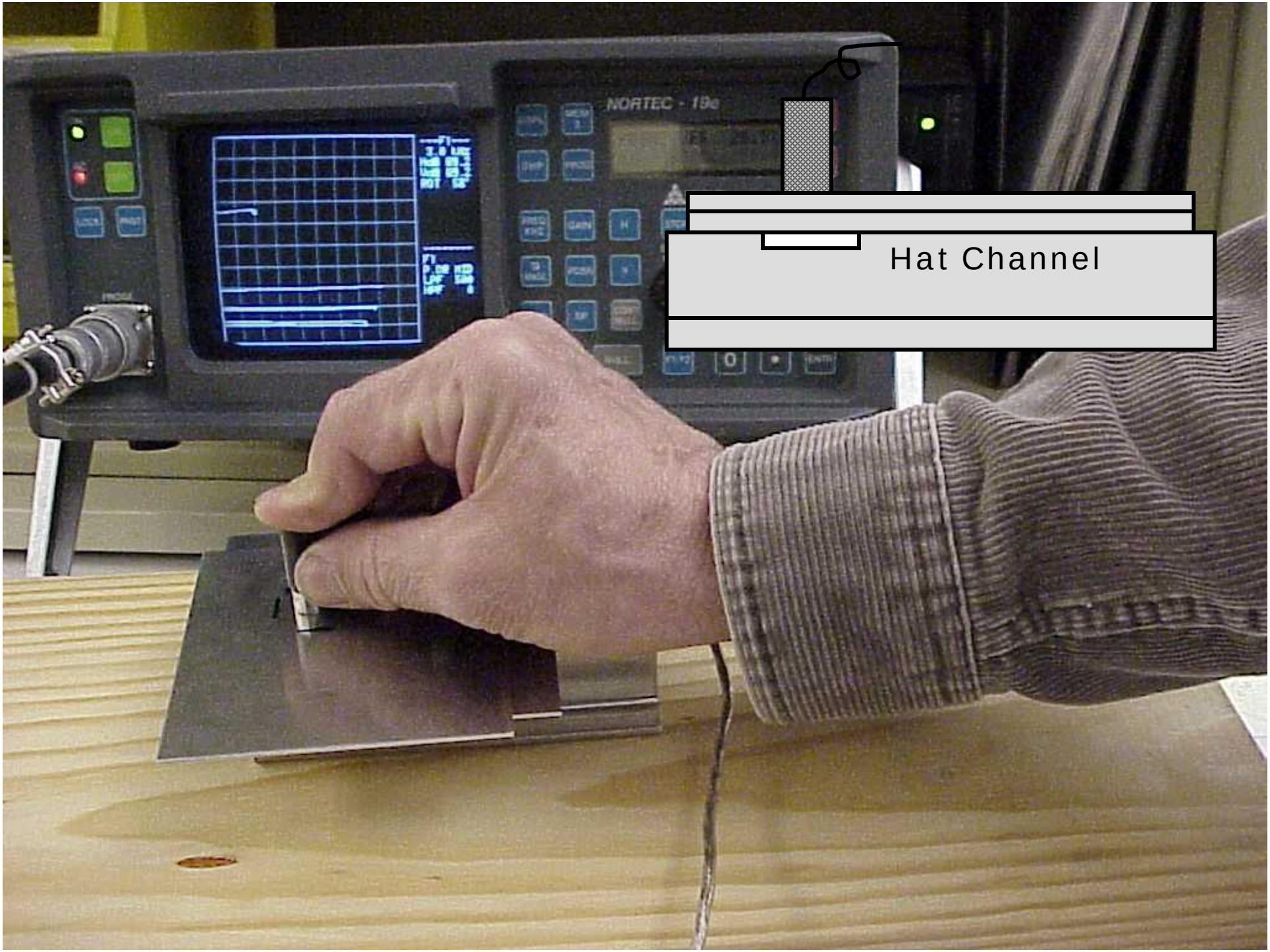

.020”

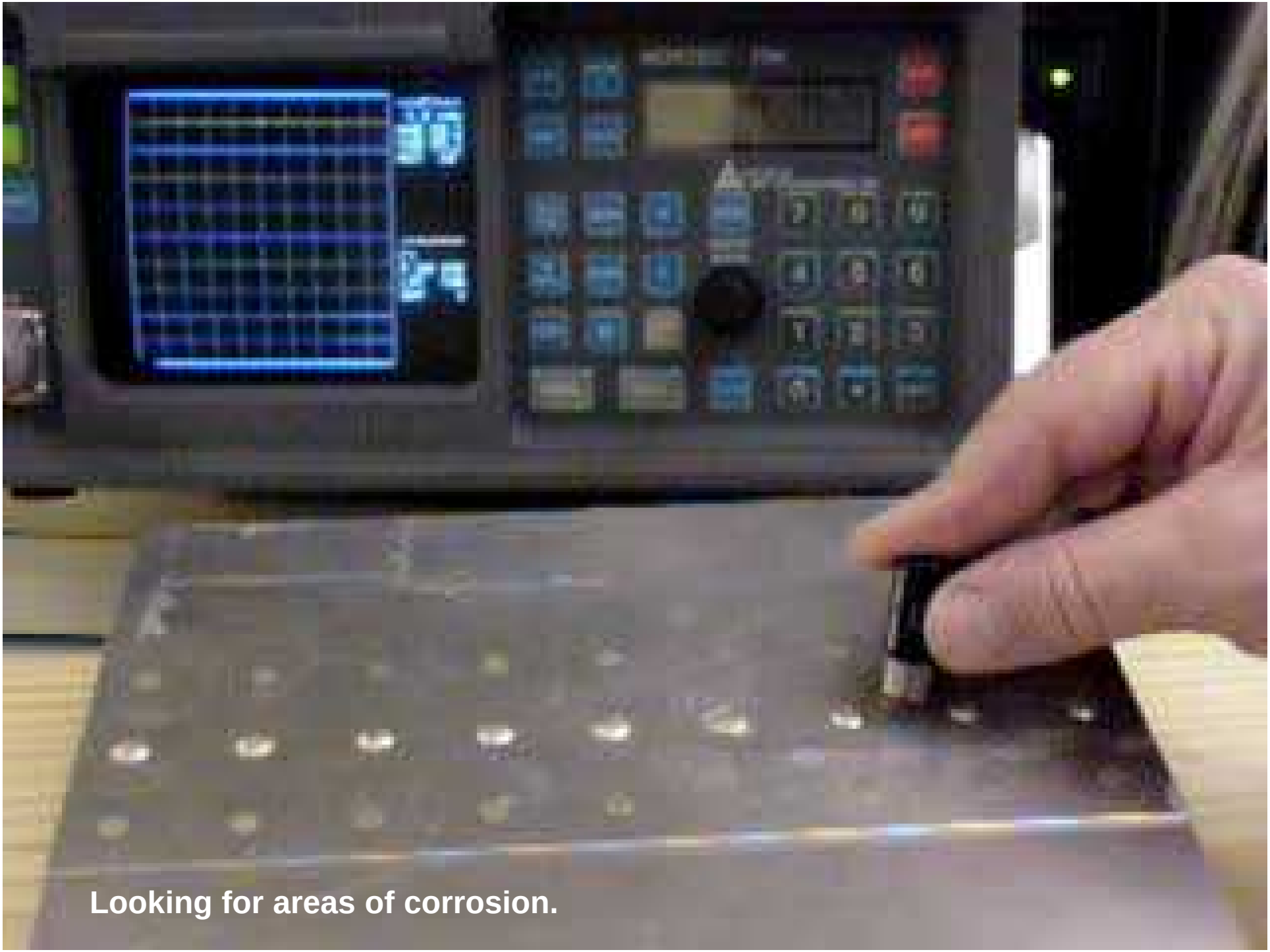
It will be necessary to simulate several situations depending on the location and amount of material loss the inspector may expect to find.



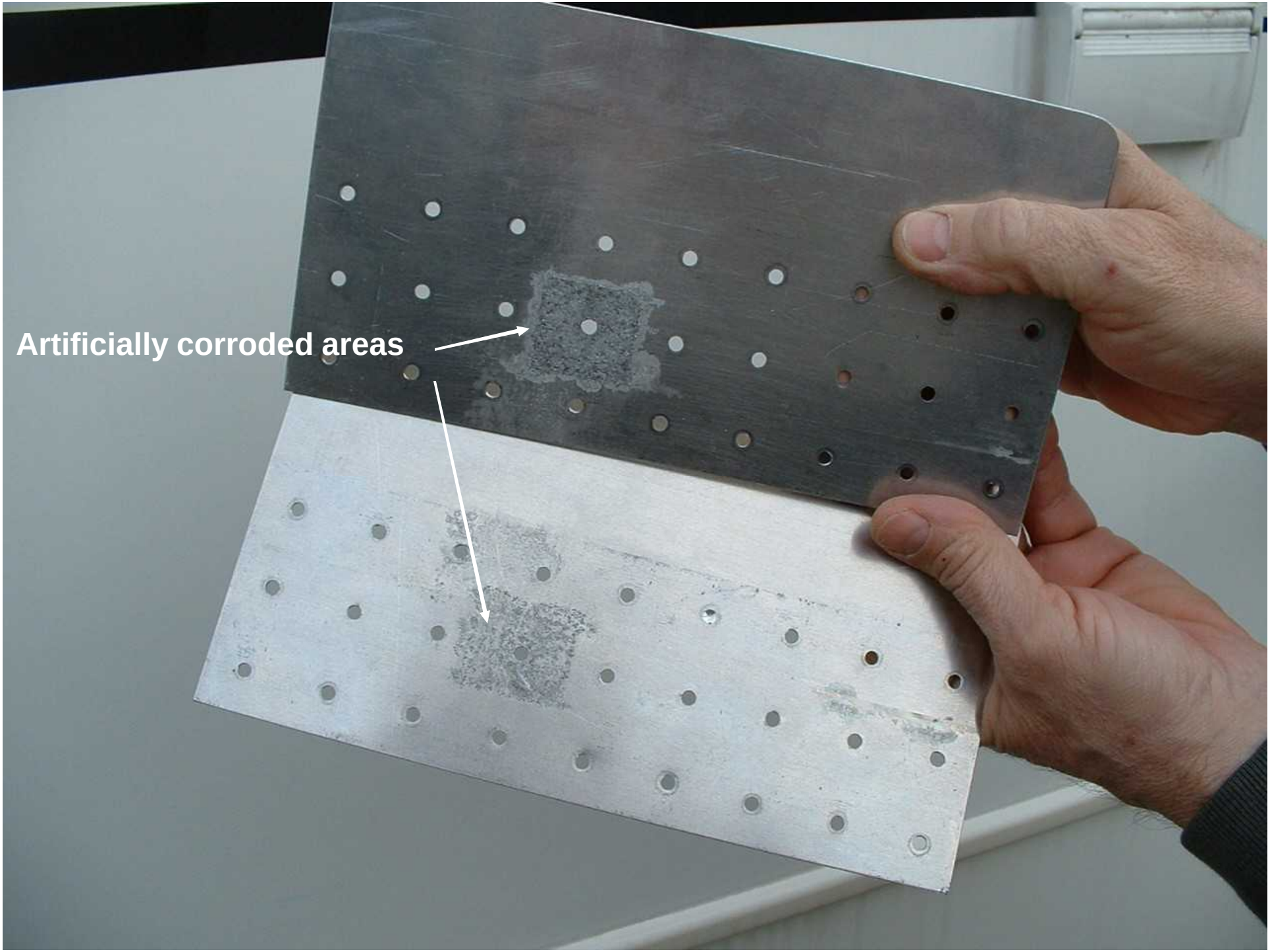


Set-up for detection of material loss in the third layer, in this case, the stringer.

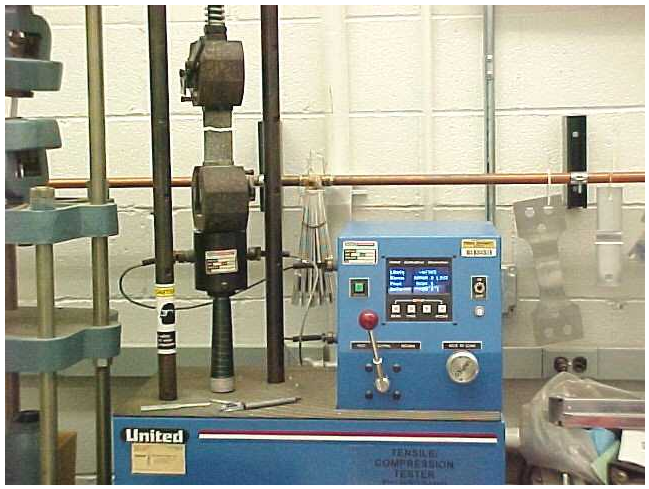

NORTEC - 19e
Hat Channel



Looking for areas of corrosion.


Artificially corroded areas

Tensile testing



- The simulated lap joints were cut in 1.5 wide pieces and tested to destruction in a tensile tester to determine how much strength was lost due to corrosion damage.