

Bond Testing Shadow Variations

Technique Overview

Ultrasonics (UT) is routinely used to inspect the integrity of bonds in multi-layered materials. It is also not an uncommon practice to monitor a backwall signal to detect a volumetric flaw such as an incomplete bond and/or delamination. Such backwall monitoring is also known as a “shadow” technique as an interruption in front of the backwall, shadows its signal.

Shadowing is acceptable for detection, but is not recommended for accurate sizing. The observed backwall shadow size will vary depending upon the thickness of the overall material and size and location of the flaw within that volume. Typically, the shadow will be larger than the actual defect (i.e., conservatively sized). Such a situation is the subject of this technical brief. Note, however, there are also cases in thick materials and flaws closer to the front surface where the observed shadow can be detected as smaller than the actual flaw.

The best practice is to be aware of beam spread conditions, and avoid applying a shadow technique for applications that require accurate sizing.

Thin Wall Multi-Layer Example

An example where such sizing is important (to the point of false calls resulting in rejecting otherwise good parts) is as follows.

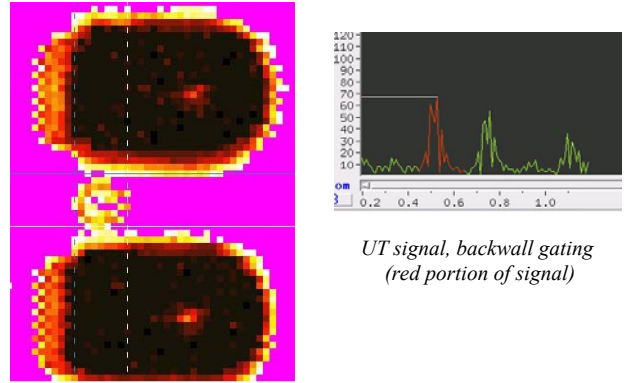
The subject part is an aerospace component made of two thin metal sheets joined together via diffusion bonding. The total thickness of the bonded part is less than .075 inches. The front sheet also includes raised surfaces that result in a ligament between them.

Due to edge effects, only 60% of the distance between the raised surfaces remains unobstructed to measure a completely good bonded area. The acceptance criterion is that a minimum bonded width of 20% must exist between the raised surfaces. Hence, an unbond up to 40% of the ligament width is allowable.

Note that system used at Metals Testing Company to acquire this data allows both gated volumes to be provided on the same raw data. Hence, as long as the RF waveform (A-Scan) was saved over the volume of interest, either gated window could be recreated after the data was acquired.

Backwall Shadowing Results

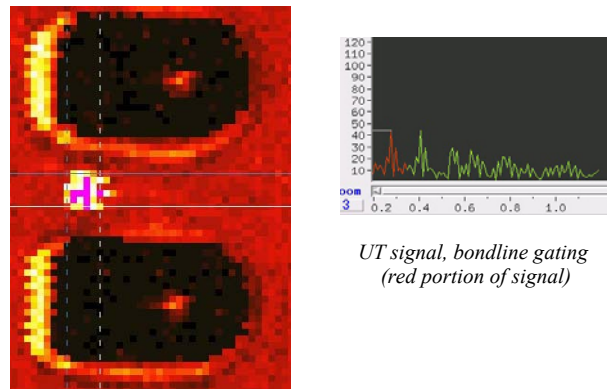
Using a shadow technique, a 30% width flat bottom hole (FBH) on a calibration standard is readily detected. Its size, however, is conservatively measured to be over 50% width. As a result, an otherwise acceptable part is “overcalled” (i.e., greater than 40% width) and rejected.



Backwall Shadow based C-Scan Image resulting in an overcall/rejection

Bondline Gating Results

The solution is to instead gate at the bondline depth within the volume of the material. By gating at that depth, the dimension of an unbond can be more accurately sized. The same 30% width hole is shown in the image below.



Bondline Gate of the same FBH correctly showing an acceptable remaining ligament

In conclusion, it is important to correctly gate on a bondline of interest rather than use the short cut practice of a backwall shadowing. The latter can result in overcalling indications and subsequent rejection of otherwise acceptable parts.

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