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June 7, 2004

Calibration Blocks
for
Ultrasonic Thickness Gauges

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Calibration Blocks (Step Wedges) are used to Standardize Ultrasonic Thickness Gauges, to ensure the equipment's accuracy and capability for a given thickness test. The most common Calibration Blocks are either 5 Step (0.100" to 0.500" in 0.100" increments), or 4 Step (0.250" to 1.00" in 0.250" increments). Common Metric Blocks are also furnished in 4 & 5 Steps, with similar thickness ranges. Calibration Blocks are normally furnished in Carbon Steel, 300 Series Stainless Steel, or Aluminum. One of these common Calibration Blocks, made in an appropriate material, will work just fine for most applications.

Figure 1

Illustration of Standard and custom made Step Blocks.

When Ultrasonic Thickness Testing is of a more critical nature, variables can be introduced to simulate the workpiece. An example of this is the T.H. Hill DS-1 Specification, which goes beyond API's RP-7G for Pipe. DS-1 requires the use of

Figure 2

Illustration of a 6 5/8" Curved Calibration Block fabricated to meet the T.H. Hill DS-1 Specification. This particular Sample was machined from a piece of Heavy Wall Pipe, so the maximum thickness is in excess of 0.500".

Curved Calibration Blocks. These Calibration Blocks are typically machined from typical samples of Tube and Pipe at represent the shape of the Work Piece. The different steps machined from the inside of the tubular, before it is segmented, so the OD of the Sample is similar to the curvature of the Pipe/Tube being measured.

In the early 1980's, Exxon prepared the most meaningful Supplementary Specification that ensures sensitivity to Pitting Corrosion. The "Exxon Spec" requires Flat Bottom Holes (FBH) be placed in each thickness of a Step Block, to a depth of 50% of the thickness. The Exxon Specification goes further to specify 3/64" (1.2mm) diameter FBH on thicknesses 0.500" or less, and 5/64" (2mm) on thicknesses greater than 0.500". Like any good specification, the Exxon one remains as a standard to manufacturers to this very day.

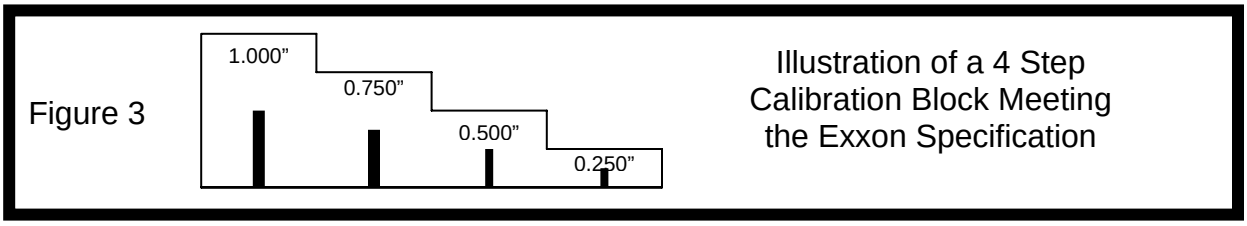


Figure 3 Illustration of a 4 Step Calibration Block Meeting the Exxon Specification

We have discusses some of the background of Ultrasonic Calibration Blocks for Thickness Gauges, however the following outlines more relative characteristics that can be induced into Step Wedges.

Vessel Manufacturers have been asked to keep material 'Coupons', receiving the same Stress Relieving, as a vessel being manufactured. One surface of the coupon receives the same preparation (if any) as the new vessel, and the coupon is then prepared as a Calibration Block. This ensures the Calibration Block is of an identical Chemistry as the workpiece, and that the Surface Condition is also typical. All too often Ultrasonic Testing Equipment is Calibrated (Standardized) on a finely Ground Surface, which is not typical of the workpiece. The surface of the workpiece normally causes the greatest amount of problems in getting reliable results from Ultrasonic Thickness Gauges.

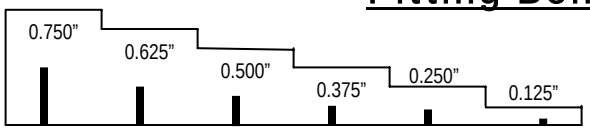
This same methodology can be applied to other expensive workpieces, such as Exchanger Tubes or Pipeline Pipe. A Structural Steel component, from a bridge for example, can be coated in the same manner as a workpiece, attached to a critical component, and left to weather. These workpiece specific Calibration Blocks can also have Artificial Defects, such as FBH's, induced into them which will ensure greater confidence in both the 'Baseline' and Service Life Ultrasonic Thickness Testing results.

The Exxon Specification was specific to Downhole Tubulars and Drillpipe, and is often used for Downhole Tools as well. While it is relatively good specification for a single 'Isolated Pit', it falls short in the Corrosion Allowance for Pressure Equipment. Typical Corrosion Allowance are 0, 1/16", 1/8", or 12%, regardless if it is Isolated Pitting or Lake Type Corrosion. With these small allowances, a 50% Flat Bottom Hole is rather superfluous, and should be closer to typical Corrosion Allowances. Therefore, the *Pitting Boiler Block*, illustrated in Figure 4, was developed.

A trend, in the Pressure Vessel industry, over the last few years has seen Certified Inspectors (CGSB Level 2 or higher) using Single Element Delay-Line Pencil Probes (Designed for Aircraft Skin) on Ultrasonic Flaw Detectors. These Pencil Probes have a Contact Point of 1/16" and are used to measure the remaining wall from the bottom of a pit (Isolated or Lake Type). While this technique is 'hit and miss' at the best of times, due to the surface condition of the bottom of the pit, the author has yet to see a specific Calibration Block for the technique. To make this type of testing more reproducible and reliable for a Qualified Operator of an Ultrasonic Thickness Gauge, a Block will be designed and machined with examples of Cylindrical and Conical Pit Bottoms. However, the cost of such a block would far exceed the cost a 'State of the Art' Pit Gauge.

Pitting Boiler Block

Figure 4



The Pitting Boiler Block is a Standard *Boiler Block* (6 Step, 0.750" to 0.125" In 0.125" increments) with various FBH's machined into the bottom side of the block. The chart below outlines the depths and diameters of Flat Bottom Holes are listed below;

Step Thickness	0.750"	0.625"	0.500"	0.375"	0.250"	0.250"
Hole Diameter	5/64"	5/64"	5/64"	3/64"	3/64"	3/64"
Hole Depth	0.150"	0.125"	0.100"	0.075	0.050"	0.025"

The Flat Bottom Holes are positioned in the middle of the particular Step, which allows a standard ¼" Diameter Probe to be positioned for measuring the overall thickness or to test sensitivity over the FBH.

The permutations and combinations of Calibration Blocks for use with Ultrasonic Thickness Gauges are endless. Figure 5 shows a Calibration Block that was made from a Vessel Head that was rejected due to the 'Knuckle' area being too thin. This sample is used for demonstration and training purposes. Part of the Head was coated with a variable thickness of Fusion Bonded Epoxy to test Coating Thickness Gauges, and the Coating Null Feature on some Ultrasonic Thickness Gauges (Echo to Echo Mode).

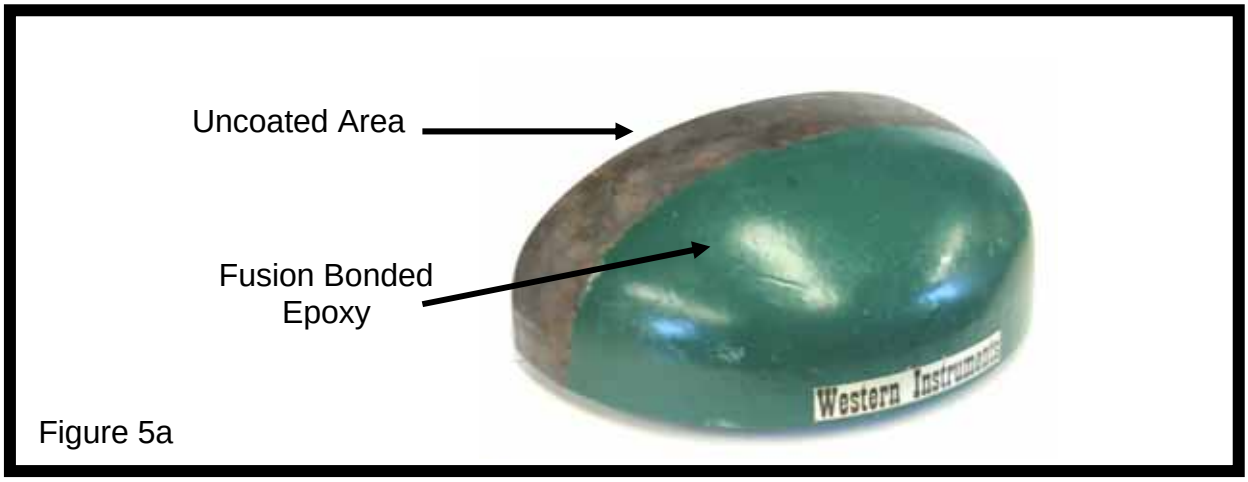


Figure 5a

In the Transition Area of the Dome to Knuckle, there are three 50% Flat Bottom Holes of various diameters, to check Pitting Sensitivity in Echo to Echo mode. A Step Wedge (0.250" to 0.750") was machined on the top edge of the Dome, as a quick reference. Lastly, a series of 7 Flat Bottom holes, at 50%, were also induced. These 7 FBH's again are various diameters from 0.064" down to 0.025".

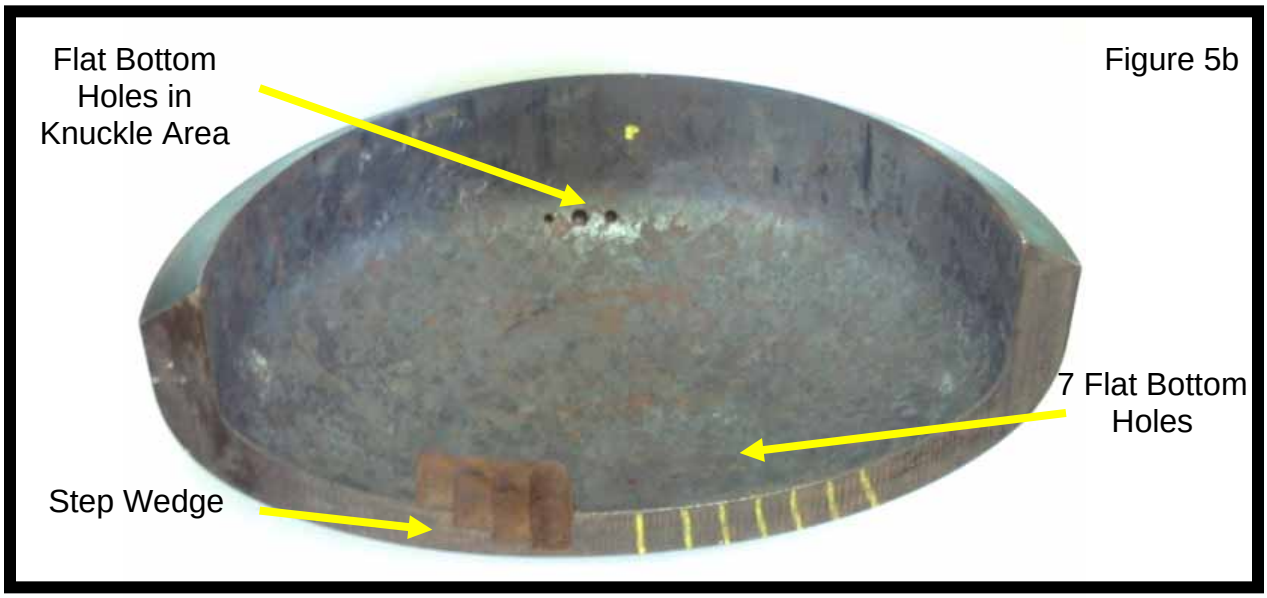


Figure 5b

Such a sample is time consuming and expensive to prepare, however is an excellent training and demonstration aid.

Conclusion

Calibration standards, wherever possible, should mimic the workpiece, ensuring more accurate measurements. While costing somewhat more, they simply tilt the odds in the operator's favor, for the most accurate thickness tests possible.