Western Instruments
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Established 1965

The *Normal* Hole

To keep Finishing Floor operators on their feet, it is often a reasonable practice to send them a controlled test, by drilling a through hole, very close to the end of a pipe. We will assume that the Hydro-Tester operator will easily find such a 3.2mm hole. To ensue a UT operator will find the same hole, the hole must be is drilled normal to the weld. A hole with a transverse angle will mimic a Hook Crack, while a longitudinal angle can mimic several different types of weld interface defects. However, when a hole is introduced with both a transverse and longitudinal angle, we end up with simply a crooked hole that does not represent any type of defect, and will most likely not produce an alarm condition. Let us review the following example.

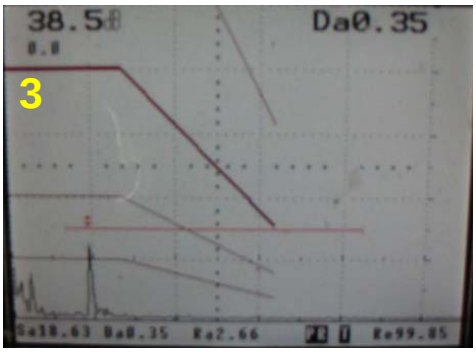
To show a transverse angle, it is often difficult to place any type of square or right angle within the picture to illustrate this. However, in this particular case (1), we can easily see the angle of our indicator. The Transverse Angle of this hole would nicely mimic a hook crack. One could place this type of hole for a test, however it is not practical to reproduce it consistently, or on a timely basis.

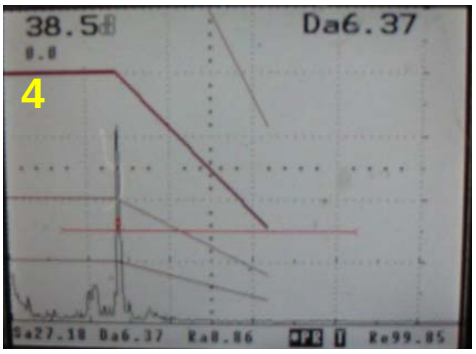
When ultrasonically tested, from either side of the weld, one would expect a hole with this transverse angle to produce a high level indication from one side and a low level indication from the other side, due to the geometry of the defect. This simply illustrates the need to test a weld from both sides.

To illustrate the longitudinal angle (2), it is very easy to place a square within the picture. This angle, like a perpendicular hole, would illustrate a Penetrator or other type of Weld Interface defect. Again however, such a hole would be difficult to reproduce and would have little benefit. The 'trick' for drilling a hole, is to make it normal to the surface of the pipe.

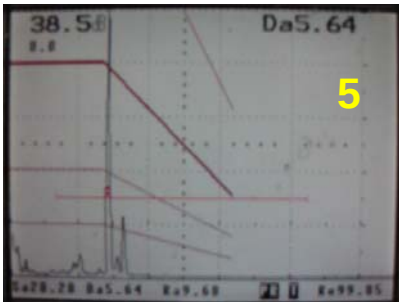
Unfortunately the holes shown in pictures 1 and 2 above are one and the same! This 3.2mm through hole has both transverse and longitudinal angles. Not a consideration for Hydro-Testing, where a 'leaker' is just a hole, but a completely different 'animal' for a UT System. This particular hole was detected by the operator of the Hydro-Tester, however missed by the Final Inspection UT System. When the operator was told of this test, he examined the hole in the UT System again and viewed it both statically and dynamically. Weld alignment was not an issue, however when initially done, the first reaction was that the UT Test Head was not aligned to the weld.

The following A-Scans were digitally photographed, during manual prove up of this hole, as the supervisor wanted to know why the drilled hole was not detected by the UT system. The portable Flaw Detector was Standardized on a 3.2mm Hole, and produced a 100% indication. For the purposes of prove-up, 6dB of Gain is added, to make it easier for operators to find defects. The Reject DAC Gate was set for 80%, and plotted for various skip distances.

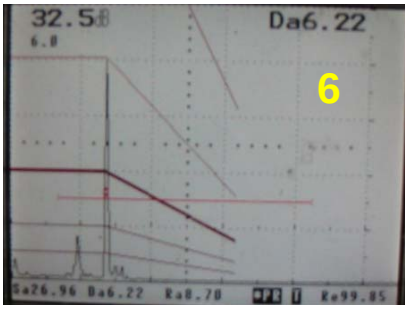


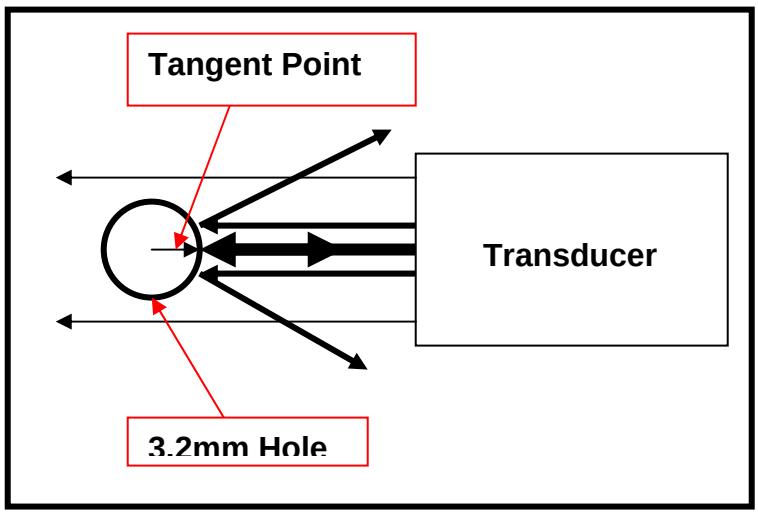


The A-Scan marked 3 shows a low level indication produced from the left side of the indication in picture 1. While A-Scan 4, shows a higher level indication produced from the right side of picture 1. If the extra 6dB of gain were removed, the indication in picture 3 would be 50% lower, and the same holds true for A-Scan 4. This reduction in sensitivity would make the indications below a Reject level.



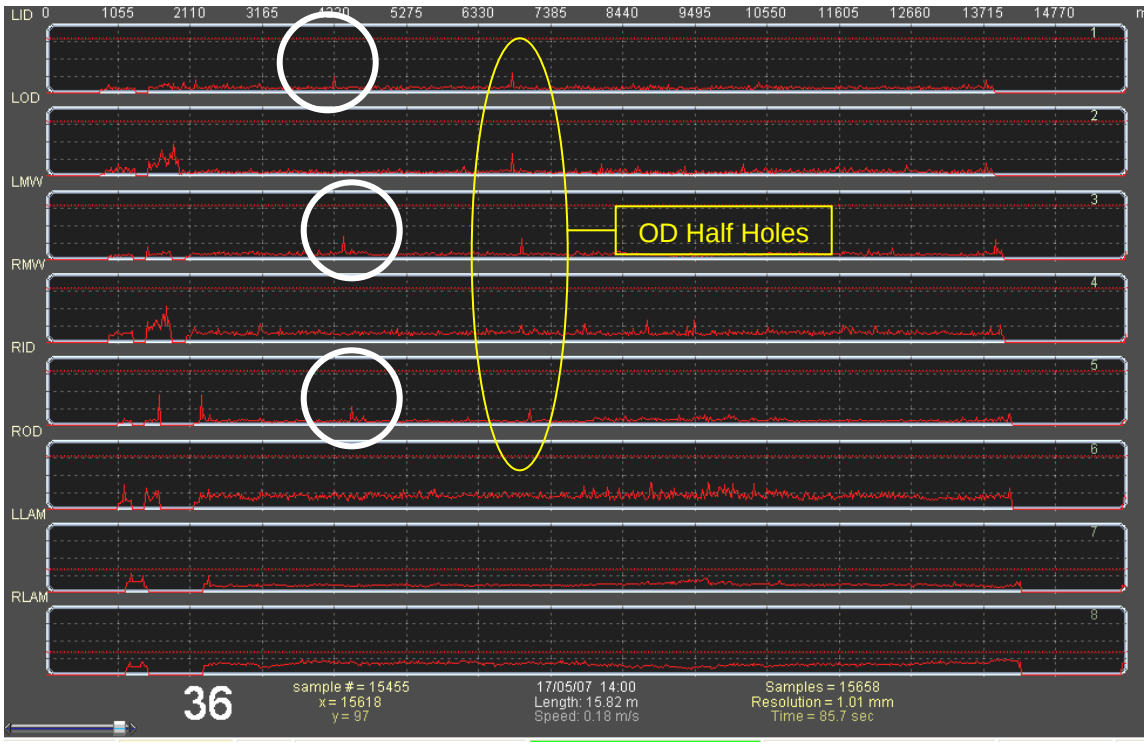
For Comparison, A-Scan 5 shows a manual standardization on 3.2mm hole, Normal to the surface, with the 6dB of Gain Added. A-Scan 6 shows the same hole, with the 6dB removed.



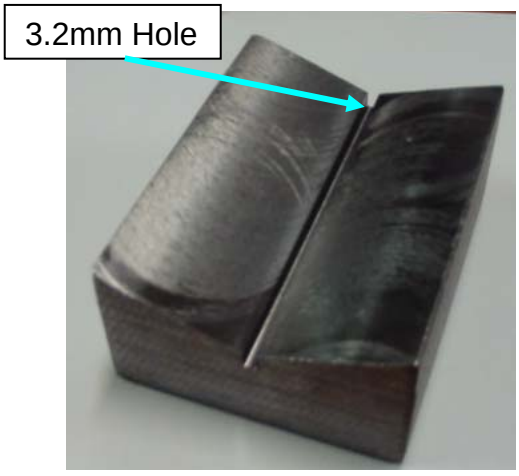


This diagram illustrates the reflective area of a hole. In our example we assume that the hole has been drilled 'Normal' to the surface. The sound that impinges on the Tangent Point of the hole, is reflected back to the transducer. The sound that impinges away from the tangent point, reflects away form the transducer. Calculations have shown that a 3.2mm diameter hole has an effective tangent area of 0.5mm in width. Thus the area of a through hole is 0.5mm times the wall thickness

The following ‘Chart’ has been saved from a test on a 323mm(12 ¾”) OD Pipe with a wall thickness of 6.3mm (0.248”). The Hole that is the subject of this document is approximately 2 meters from the lead end. A second hole, approximately 4 meters further down stream, was drilled to approximately 40% of the wall thickness, but did not have a Flat Bottom*. The longitudinal position of our subject hole is highlighted.



We can see that only our Left Channels show an indication, however they are all well below the reject threshold of 80% of the full screen height. The OD Half Hole has produced a higher indication on the OD channels, which is due to 2 factors; the extra reflective area of the Apex; and the compound angle (transverse and longitudinal) was not as great.



These Holes were simply manually drilled, or “Hand Bombed” as this author refers to them. Obviously, such holes are of little use for checking UT machines, as it is next to impossible to make them normal to the surface. When holes are used for a calibration standard, they are machined by a skilled technician. So what is the ‘trick’ to making these manually drilled holes quickly, easily, and above all, reproducibly? This drilling requires a basic fixture, which is a V-Block, with a hole drilled thought he Apex of the V. When used with a very sharp or new drill bit, and a variable speed drill, a reference hole can be reasonably reproduced.

The author has also trained Mill-Line UT Operators to use these fixtures to verify the effectiveness of their Mill-Line Equipment. While not encouraged, a Mill-Line UT system can be effectively calibrated (standardized) with such holes. Furthermore, with slightly more skill, and the use of a Dial Indicator Pit Gauge, an operator can make Flat Bottom Holes quickly and reliably.

†This article was made possible with the cooperation of Mr. Hossein Mohammadvand, QC Manager, Kalup Corp.

*Review of *Reference Indications for the Verification of Ultrasonic Testing Systems used on Welded Tube and Pipe.* Western Instruments, December 2003