Western Instruments
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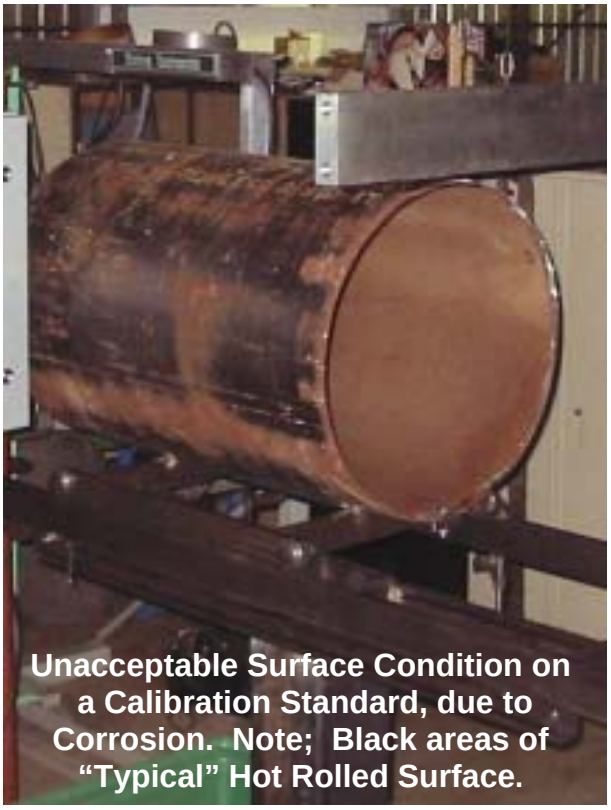
Surface Condition
for Effective Ultrasonic Inspection of Tubular Products

Ultrasonic Waves (2.25 to 7.5 MHz) are transmitted into the workpiece for the detection of Volumetric Defects. These defects can be located in the Weld or the Body of the tube. There are many common reference specification***** for the Ultrasonic Inspection of Tubular Products, however most fall short in identifying or specifying the surface condition of the workpiece, other than being "Typical", thus the inspector must learn 'the hard way' about this important aspect of Ultrasonic Testing.

It is well documented that an Ultrasonic Testing Frequency of 3.5 MHz is optimum for Resistance Weld Testing, and that a Shear Wave Angle of 45° produces acceptable results for virtually all Weld Interface Defects. Reference Specifications do go into great detail on the production of Reference Indications, as well as the typical material to be used (i.e. Diameter and Wall Thickness). Unfortunately, most operators don't consider a Calibration Standard to be a consumable item, as they accept ASTM E317 to be the 'gospel truth', and this specification only requires Test Specimens/Calibration Standards to be tested when they are physically damaged.



Unacceptable Surface Condition on a Calibration Standard, due to Corrosion. Note; Black areas of "Typical" Hot Rolled Surface.

Operator's will have documented procedures for the preparation of a Calibration Standard, but more often than not, there are limited procedures for the Storage and Handling of Standards. Miss-handling of standards can disturb the Typical Surface Finish, weather it be Hot Rolled, Cold Rolled, Pickled and Oiled, and in some cases Shot Blasted for High Performance Applications. Storage and Handling Procedures must be prepared around the mindset of preserving the Surface Condition, thus extending the Standard's service life. Therefore the use of Nylon Slings, as opposed to chain or hooks, for handling large standards, is necessary. Wood or Plastic Lined Shelves or Racking, for storage, are obviously better than steel or concrete. If full length Pipes are employed, for Conveyer Line Equipment, the Conveyer Rolls and Skid Surfaces need to protect the Standard from not only gross mechanical damage, but also for typical handling wear.

Surface Condition, of the Calibration Standard, affects the wave propagation into the Calibration Standard, as well as when a reflection is received from a Reference Indication (Hole or Notch). If the Calibration Standard has a poor finish, the amount of Gain required will be higher than the pipe in the mill (or conveyer) as it will have a Typical Finish. Thus if the Standard has a poor finish, the system will be more sensitive to indications in the pipe, causing alarms to acceptable pipe (false Indications).

- Deteriorated Surface Condition.
- Handling Damage and early *Corrosion Bloom*.

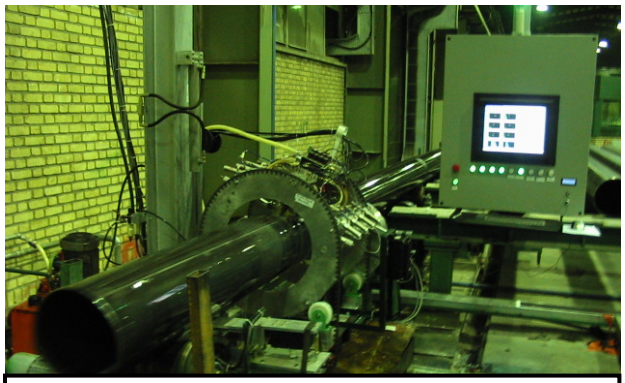
The more often a Calibration Standard is used, the Probes riding over the surface, can deteriorate the area where the wave enters/exists the surface. Typical Probe/Shoe Assemblies are equipped with Anti-Wear Devices, to ensure the longevity of these assemblies, however these same features will affect the surface condition as well. *During Static Calibration* (no Probe or Standard movement), little to no wear will occur. During an actual Test Cycle, the probe only contacts a given area of the surface for a very short period of time. However, with more emphasis being placed on *Dynamic Calibration* (Simulating Testing Speed), the more often the Probes will work at an area, affecting the surface Condition.

With mechanical conditions discussed, we can now move onto the biggest culprit affecting surface condition, that being the type of Couplant. For most applications the operator has two choices; Mill Coolant, or Potable Water. The type of Couplant may require some calculations to Refraction Angles, however in most Water-Wedge or Contact type shoes, the affect of couplant velocity in usually negligible.

Most mills producing high quality tube and pipe (thus having an Ultrasonic Testing Program) have good Emulsion or Mill Coolant Conditioning systems, such as filtering, monitoring procedures for concentration, etc. When the Coolant is of reasonable quality, it typically can be employed for Ultrasonic Couplant. However, it needs to be evaluated for affects to materials used on the Ultrasonic Equipment, such as various Metals (Aluminum, etc.), Plastics or Epoxies (Delay Lines), and Vinyl's (Signal and Control Cables). The most important item to evaluate is the Acoustic Impedance, as experience dictates, that in some cases, Emulsions can cause a drastic impedance to sound waves.

Many operators believe that Potable Water provides the best transmission of sound between the Transducer and the tube surface. Depending on Climatic Conditions (especially very high humidity), water may not be used due to it's immediate affects (Corrosion) on the Surface Condition. The only benefit of Water is that it is typically free of solids, however, it more often that not has a great amount of entrained air. If the Ultrasonic Probes are using antiquated 'Bubbler' or 'Water Column' type fixtures, elaborate deaerating equipment is required. The greatest detriment to Water is corrosion to the Surface.

If the concentration of Mill Coolant is not kept at an acceptable level, after water evaporates, there can be a build-up of oil that has come out of suspension. This build up needs to be kept at a minimum, because it too can cause an attentive surface condition. While Mill Coolant is the best choice for Couplant, to avoid surface corrosion, it tends to build up on the Ultrasonic Equipment, thus it may cause a slight amount more maintenance than perhaps water.



Conveyer-Line UT System with a Full Length Calibration Standard, exhibiting a Typical Surface Condition.

One should not assume that when a calibration standard becomes damaged, from handling or corrosion, that the surface can be restored. Removal of such damage may require the use of abrasives, that will make the surface too smooth or not smooth enough. As an example, if the pipe to be inspected is Hot Rolled, and the surface of the Calibration Standard has had all of the mill scale removed, the Gain Levels may be to low to deal with the Hot Rolled Surface. If this is the case, the reference gain may be low and defects in the pipe might go undetected.

In conclusion, tests have found that a poor Surface Condition on a Calibration Standard is a far greater problem than a surface that is too smooth. The term Typical must be interpreted as “similar to” the tube or pipe under test. To go to the ridiculous end, the author had an inexperienced operator purchase Commercially Available tube for a Calibration Standard, however the product had been varnished!

*****Most Reference Specifications come from the roots of ASTM E317, which is a general outline for equipment and practices for Ultrasonic Testing. Reference Specification for this discussion would typically be ASTM A513 (High Performance Mechanical Tubing), ASTM E273 (Boiler Tubing), and the most common AP!-5L (Pipeline Pipe) / API-5CT (Production Tubing and Casing). All of these Reference Specifications require Ultrasonic Inspection of the Weld Area.