



# Magnetic Particle (Mt) And Penetrant Testing (Pt) Requirements On The Bevel Face Area For Oil And Gas Pipes

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**Abstract:** Cross-country pipelines are robust enough to transport oil and gas. All these pipes are interconnected, and the welds are meticulously examined using advanced techniques such as ultrasound and X-ray. However, there is an issue: imperfections in the pipe ends (bevel area or pipe body) can obstruct the ultrasound signals, masking defects within the weld. To prevent this, rigorous regulations govern the permissible number of defects on the pipe ends

This manuscript examines the requirement for two additional testing techniques, Magnetic Particle (MT) and Penetrant Testing (PT), on the slanted edges (bevels) where the pipes are connected. We will investigate whether these tests are essential even if an ultrasound examination is performed before the creation of the bevels. When an ultrasound examination is used after the bevels are formed, there is an area that is not visible via Ultrasonic Testing. In such instances, MT and PT are essential to guarantee a secure and dependable weld in the field.

**Index Terms** - NDT, Ultrasonic testing, Welding, Magnetic Particle Testing, Penetrant Testing.

## Introduction

Before pipes, plates, or strips are produced, they undergo ultrasonic testing to identify any flaws. However, the standards for acceptance differ for the main body and the edges. After the pipe is produced and cut, a flaw that was once considered acceptable might no longer meet the standards. The ends of the pipes must be free of any minor irregularities to ensure that the welding process can be examined through ultrasonic testing without any issues when the pipes are assembled on-site.

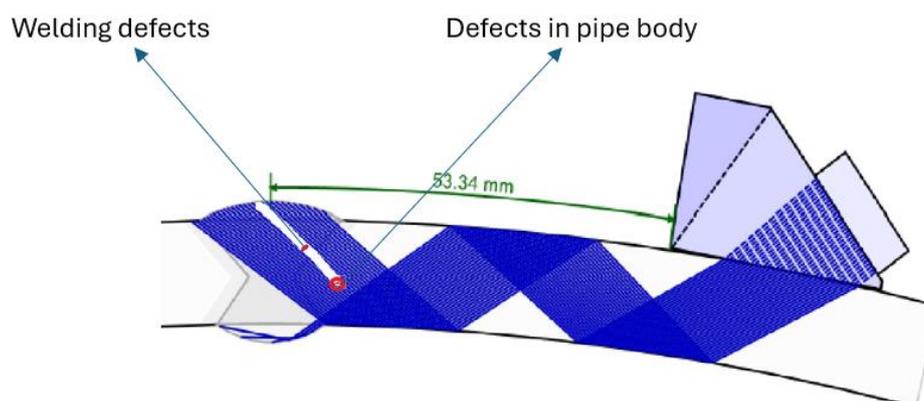


Figure (1) ES beam tool scan plan with a Phased array probe

Figure (1) shows that the defect in the pipe body is a barrier and can partially block ultrasonic waves (the percentage of waves blocked depends on the size of the defect) which hides the original defect in welding.

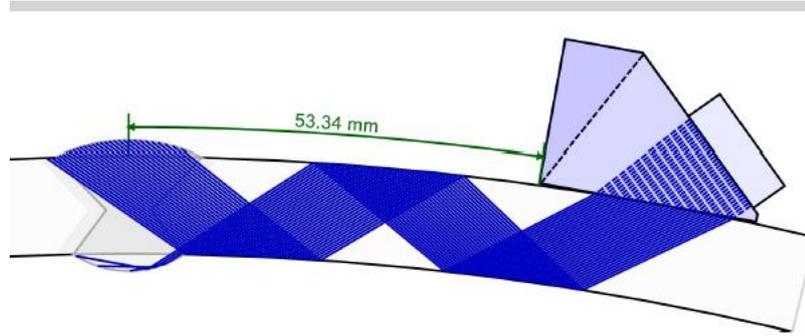


Figure (2) ES beam tool scan plan with a Phased array probe

Figure (2) shows that in the case of a defect-free pipe body, the ultrasonic waves travel without any obstruction, and the welding is tested more effectively without any dead zone or unused parts.

When pipes are manufactured in a manufacturing plant, the ends of the pipes are usually tested via manual ultrasonic testing (OR) via an automated ultrasonic testing system after a hydro tester is used to overcome any problems. This testing is performed either before or after the pipes are beveled. In the upcoming cases, we will determine when a magnetic particle or penetrant testing is required in the bevel area [1,4].

## METHODOLOGY:

### ULTRASONIC TESTING (UT):

- **Definition:** Ultrasonic testing (UT) is a non-destructive technique in which high-frequency sound waves are used to detect internal and surface defects in materials.
- **Process:** A transducer generates ultrasonic waves that are directed into the material being tested. These waves travel through the material and are reflected by internal boundaries, inclusions, lamination, or other defects. By analysing the reflected waves, defects can be identified, and their size and location can be determined. [2,3,6]

### MAGNETIC PARTICLE TESTING (MT):

- **Definition:** Magnetic particle testing (MT) is a non-destructive method used to detect surface and near-surface defects in ferromagnetic materials.
- **Process:** A magnetic field is applied to the material being tested. Magnetic particles (either dry particles or wet suspension) are then applied to the surface. These particles accumulate at locations with surface discontinuities or defects due to magnetic leakage. The particles are then inspected under appropriate lighting conditions (usually black or UV light) to reveal the location and size of defects. [2,3,5]

### PENETRANT TESTING (PT):

- **Definition:** Penetrant testing (PT), also known as dye penetrant testing (DPT) or liquid penetrant testing (LPT), is a non-destructive testing method used to detect surface-breaking defects in nonporous materials.
- **Process:** A penetrant (a liquid with high surface tension) is applied to the cleaned surface of the material. After a specified penetration time, the excess penetrant is removed, and a developer (usually a white powder or aerosol) is applied to find any defects. This makes the defects visible against the background of the developer. [2,3,7]

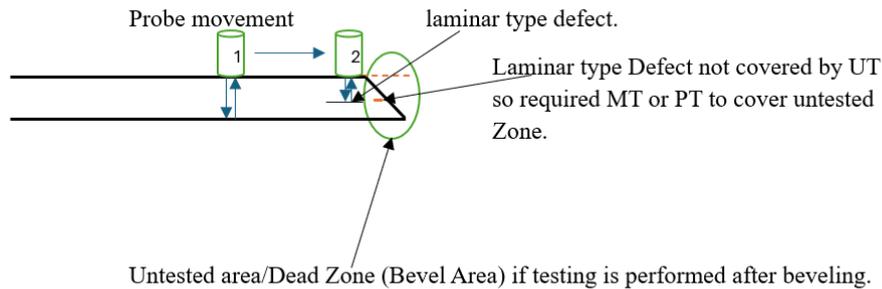
**DISCUSSION:****CASE-1 (IF ULTRASONIC TESTING IS DONE AFTER BEVELING FROM THE OUTER SIDE)**

Figure (3)-Scan Plan of the UT after being beveled from the Outer side

Figure (3)- The area on the bevel face circled in green in Figure 3 has not been tested. If there is a defect in this area, it cannot be detected by the UT. In this case, we need to use MT or PT to cover this untested area from the UT.

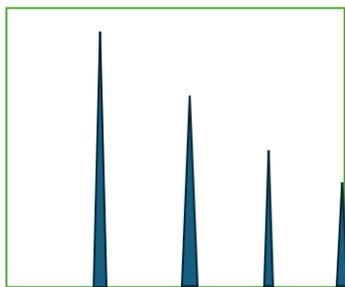


Figure (4)- Manual Ultrasonic Testing machine graphical screen view

Figure 4 displays a graph of the manual ultrasonic testing machine screen. The blue echoes represent multiple back walls. This type of screen appears when the probe is positioned at point 1 (no defect position) in the scan plan.

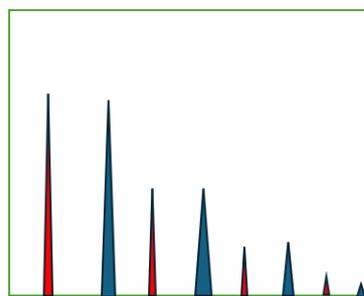


Figure (5)- Manual Ultrasonic testing machine graphical screen view

Figure (5)- In Figure 6, there is a graphical representation of the screen of the manual ultrasonic testing machine. The screen displayed blue color echoes representing multiple back walls and red color echoes indicating multiple reflections from a defect. This type of screen appears when the probe position is at point 2 (partially on the defect) in the scan plan.

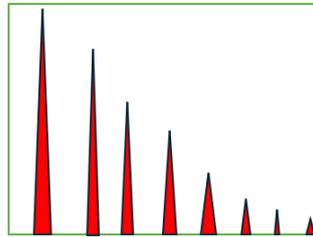


Figure (6)- Manual Ultrasonic testing machine graphical screen view

Figure (6)- Figure 7 shows a graphical representation of the screen of the manual ultrasonic testing machine. The red color echoes indicate multiple reflections from a defect. This type of screen appears when the probe position is at point 2, at which point the defect is completely covered, which is larger than the probe size, in the scan plan.

**Case-2 (If Ultrasonic testing is performed after beveling from the Outer side and on the bevel face)**

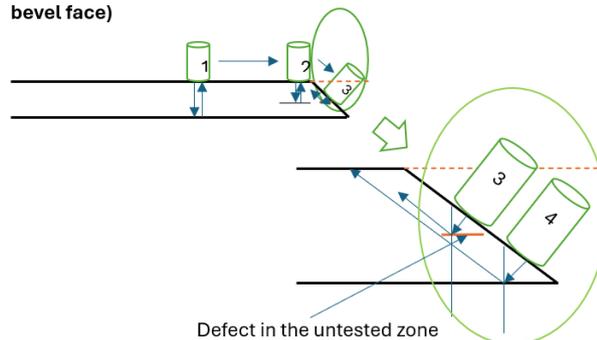


Figure (7)- Scan Plan of UT after beveling from Outer side and parallel to bevel area

Figure 7 demonstrates that even when we scan the bevel area, we are unable to detect the defect (shown in red color) via probe position 3 and cannot find the backwall echo via probe position 4. Therefore, the green-circled area in the bevel remains untested. To cover this area, MT or PT needs to be performed.

We did not obtain any signal via a manual Ultrasonic machine CRT when the probe was on positions 3 and 4.

**Case-3 (If Ultrasonic testing is performed after beveling from the Outer side and the untested area is scanned from Inside OR Scanning is done from inside)**

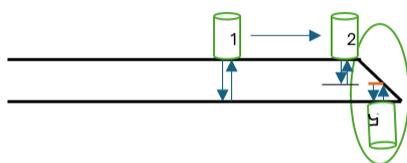


Figure (8) Scan Plan of UT after beveling from the Outer side and untested area (beveled area) from the Inside

Figure (8)- if we scan the unused area from the inside, we can detect the defect (at probe position 5). However, if there is no defect, we won't receive a backwall echo. In this scenario, ideally, we should test the beveled area, but without the back wall echo, other unwanted conditions such as loose coupling, bad cables, or probes might go untested.

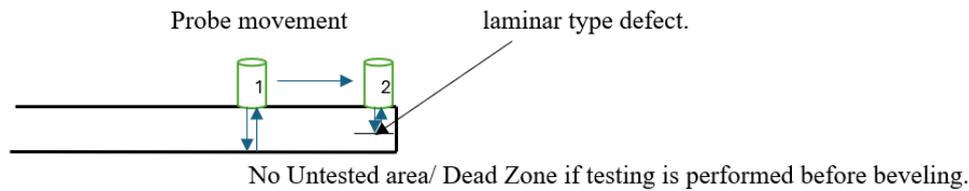
**Case-4 (If Ultrasonic testing is done before beveling from the Outer side or inside)**

Figure (9) Scan Plan of UT before beveling from Outer side OR inside

Figure (9) Shows there is no untested area if UT is done before beveling, so MT or PT is not required on the bevel face.

**Conclusion Table:**

Case-1	If Ultrasonic testing is done after beveling from Outer side	Bevel area is untested so need MT or PT on bevel face
Case-2	If Ultrasonic testing is done after beveling from Outer side and on bevel face	Bevel area is untested so need MT or PT on bevel face
Case-3	If Ultrasonic testing is done after beveling from Outer side and untested area scanned from Inside OR Scanning is done from inside	Bevel area is covered but still results in debt so MT or PT on bevel face is depends on mutual agreement.
Case-4	If Ultrasonic testing is done before beveling from Outer side or inside	Bevel area is covered so MT or PT not required on bevel face

**CONCLUSION:**

In our study, we investigated the need for Magnetic Particle (MT) and Penetrant Testing (PT) on the bevel face area of oil and gas pipes, especially in relation to ultrasonic testing (UT) carried out during various stages of the beveling process. Our findings showed that when UT is performed after beveling, there are significant areas that cannot be inspected properly, potentially hiding defects. This highlights the importance of using MT or PT to ensure the quality of the welds. Specifically, our observations reveal.

1. Post-Beveling UT from the Outer Side (Case 1):
  - The bevel area has not been tested yet, so we need to use MT or PT to inspect that area.
2. Post-Beveling UT from the Outer Side and on the Bevel Face (Case 2):
  - Similar to Case 1, the bevel area remains untested, necessitating MT or PT.
3. Post-Beveling UT from the Outer Side with an Inside Scan (Case 3):
  - While covering the bevel area helps, the test's reliability could still be affected by other factors like loose coupling or equipment issues. The decision to use magnetic particle (MT) or penetrant testing (PT) should be based on mutual agreement and specific circumstances.
4. Pre-Beveling UT (Case 4):
  - Performing UT prior to beveling ensures thorough testing of the bevel area, eliminating the need for MT or PT.

In conclusion, using magnetic particle or penetrant testing is crucial when ultrasonic testing is conducted after beveling. This ensures thorough inspection and detection of potential defects. Performing ultrasonic testing before beveling is the most effective approach, as it eliminates blind spots and the need for additional testing methods on the bevel face. Further research and industry collaboration are recommended to optimize testing protocols and ensure the highest standards of pipeline integrity.

Applying MT or PT is crucial in scenarios where UT is performed after beveling to ensure comprehensive inspection and defect detection. Pre-beveling UT is the most effective approach, for eliminating blind spots and eliminating the subsequent need for additional testing methods on the bevel face.

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