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# Installation and Inspection Procedure of Pipe Welding Using GTAW Method Based on ASME Standards

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***Abstract***. *The piping installation process involves connecting pipes based on ASME standards using Schedule 20 and Schedule 40 pipes with diameters ranging from 2" to 32". The pipe joining process is carried out using either electric welding or argon welding methods. Gas Tungsten Arc Welding (GTAW) is applied, utilizing LINCOLN 6010 electrodes for the root pass and LINCOLN 6011 electrodes for the fill pass. After welding, the newly joined pipes must be inspected by a Quality Control (QC) officer using X-ray radiographic testing to detect any internal welding defects. Following radiographic inspection, sandblasting is performed using silica sand once the pipe surface has been properly ground and smoothed. The piping installation follows a circular connection pattern, meaning all pipe ends are continuously joined without interruption. Finally, the piping system is installed on a piperack structure and connected to a storage tank for fluid containment.*

***Keywords:*** *Pipe Installation, GTAW Welding, LINCOLN 6010 Electrode, X-Ray Radiography, Sandblasting, Piperack*

## INTRODUCTION

The construction and engineering industry plays a crucial role in supporting various industrial operations, particularly in the areas of mechanical installation and infrastructure development. Among the many systems required to ensure operational continuity and efficiency, the piping system holds a central function. Piping installations serve as vital channels for the transportation of various types of fluids, including water, fuel, lubricants, and process chemicals. These systems are commonly found in manufacturing plants, marine facilities, and power generation units. The effectiveness of a piping system depends not only on the quality of materials used but also on the precision in fabrication, welding techniques, and compliance with international standards. Poor installation or welding practices can lead to serious operational failures, safety hazards, and increased maintenance costs. Therefore, understanding the technical aspects of pipe installation from material selection to welding and finishing is essential for achieving long-term reliability and safety.

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One of the widely used welding methods in piping fabrication is the Gas Tungsten Arc Welding (GTAW), also known as TIG welding. This method is preferred for its high precision, especially when dealing with stainless steel and thin-wall pipes. The selection of electrodes such as LINCOLN 6010 for the root pass and LINCOLN 6011 for the filling pass plays a significant role in achieving strong and defect-free welds. Furthermore, after welding, the pipe joints undergo quality control inspections using X-ray radiographic testing to detect internal defects. Additional surface treatments, such as grinding and sandblasting with silica sand, are performed to ensure a smooth and clean finish. These steps are critical before the pipes are mounted onto structures such as piperacks or connected to storage tanks. This report aims to examine the complete workflow of piping installation, from the early stages of fabrication to the final finishing process, as observed during field practice in an industrial setting..

## METHODS

This scientific report is compiled using a combination of field observations, document analysis, and interviews. The objective is to thoroughly understand the process of piping installation, from fabrication to inspection. The methods used are as follows:

This method involves collecting information from books, technical references, welding codes, ASME standards, and other documentation relevant to the piping fabrication and installation process. It helps to provide a theoretical foundation and contextual understanding of the procedures observed in the field.

This method was carried out through practical observation and direct involvement in piping installation activities at the project site. The data collected includes process steps such as cutting, bending, grinding, welding (GTAW process), quality control using radiographic testing, sandblasting, and final pipe installation onto structures such as piperacks and tanks.

To complement the observational data, interviews were conducted with field supervisors, welders, and quality control (QC) personnel. These interviews provided practical insights into the challenges, standards, and techniques used in each stage of the pipe installation process.

## RESULTS

The results of the field study conducted during the piping installation process. The observations and findings from each stage are outlined below:

### Pipe Material Selection

The piping material used in the project consisted of carbon steel with ASTM A53 specification, ranging in sizes from 2 inches to 30 inches in diameter. The selection of pipe dimensions and types was based on the required fluid flow capacity and operating pressure. The suitability of the material was confirmed to meet ASME standards, ensuring its compatibility for use in both industrial and marine applications.

**Chemical Composition**

| Element | Content |
|---|---|
| Carbon, C | 0.25 - 0.290 % |
| Copper, Cu | 0.20 % |
| Iron, Fe | 98.0 % |
| Manganese, Mn | 1.03 % |
| Phosphorous, P | 0.040 % |
| Silicon, Si | 0.280 % |
| Sulfur, S | 0.050 % |



**Figure 1.** Specification of Carbon Steel

### Fabrication Process

The pipe fabrication process included three major steps: cutting, bending, and grinding. Cutting was performed using two methods: a mechanical cutting machine for pipes with diameters between 2 to 10 inches, and gas cutting (torch) for larger pipes ranging from 10 to 30 inches. The accuracy of cutting directly affected the alignment and welding quality.

Bending was applied using a pipe bending machine or by using elbows for angles such as 90°. The decision between machine bending and using fittings depended on factors like bend radius, pipe thickness, and schedule.

Grinding was carried out on the pipe ends to ensure smooth surfaces before welding. Proper surface preparation was essential to achieve high-quality weld joints.

(a) Pipe Bending Machine (b) Elbow 90°

**Figure 2.** Bending Components and Equipment

**Welding Process**

The welding process utilized the GTAW (Gas Tungsten Arc Welding) method. For root passes, LINCOLN 6010 electrodes were used, while filling and capping were completed with ESAB 7018 electrodes. Welding was performed using DC for outdoor and AC for indoor operations. Proper joint beveling was done before welding to allow full penetration.

- Key factors affecting weld quality included:
- Welder skill and position (e.g., upper hand, vertical, horizontal),
- Control of current and voltage during welding,
- Continuous adjustment of current to compensate for rising pipe temperature.

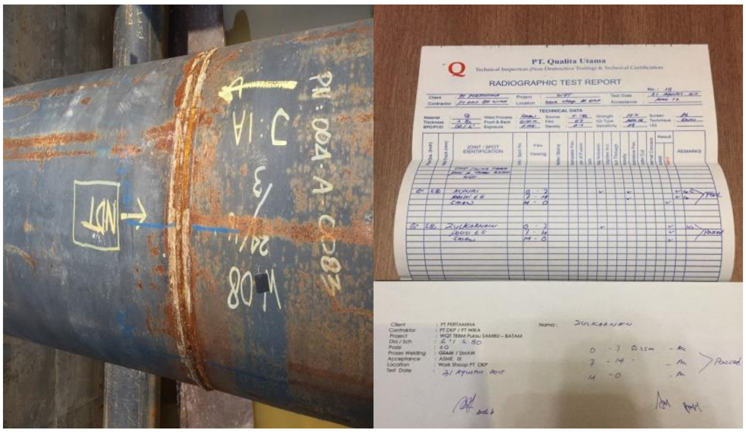
The welding technique applied ensured that joints were durable and met the required tensile strength, as observed from smooth and defect-free weld beads.

**Figure 3.** Upper Hand Welding Technique at a 45° Hand Position

### Quality Control – Phase 1

Post-welding, each joint was inspected using X-ray radiography. The radiographic results helped identify internal defects such as porosity, incomplete fusion, or cracks. Any defect found was marked and documented for repair.

(a) Before X-ray (b) Process of X-ray

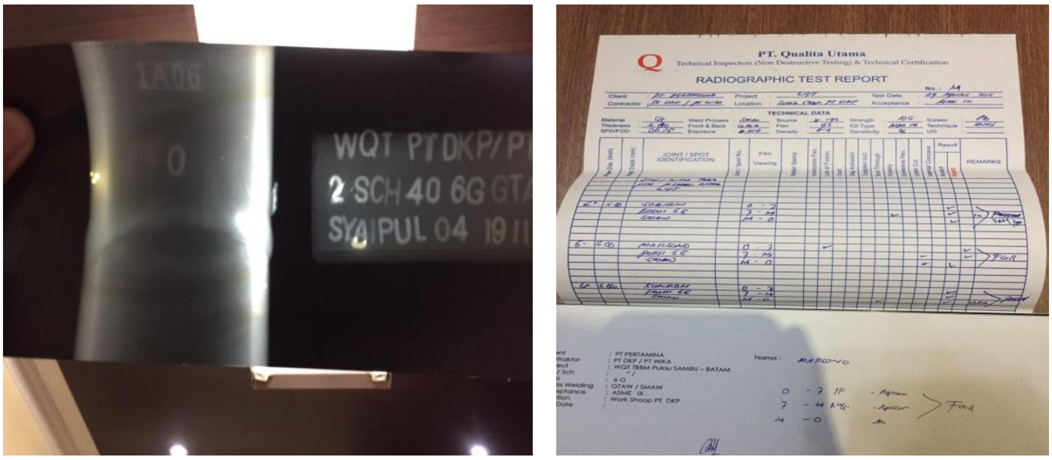



(c) After X-ray (d) Report

**Figure 4.** X-ray Inspection on Pipe Weld Joint

### Welding Repairs

If defects were found, the affected area was ground back to bevel form and re-welded. After the repair weld was completed, another round of X-ray testing was conducted to ensure defect elimination. The process was repeated until the weld passed inspection.




(a) Results of *radiographic* (b) *Report*

**Figure 5.** Radiographic Results and Report

**Sandblasting**

After passing the X-ray inspection, the pipe surface was cleaned using sandblasting with silica sand. This process removed rust, scale, and welding residue, providing a clean and uniform surface for further installation and painting if required.

**Figure 6.** Sandblasting Process

### Installation Process

The piping was installed using a continuous circular joint system, meaning that all pipe ends were fully connected without interruption. The completed pipelines were placed on piperacks and then connected to fluid storage tanks. This layout ensured equal pressure distribution throughout the system and minimized head loss when multiple valves were operated simultaneously.

### Quality Control – Phase 2

A second round of quality control was conducted after installation to verify the integrity of the entire piping system. This included pressure testing and flow checks to ensure that the piping could handle the intended operating conditions without leaks or pressure drops.

### Final Repairs

In the event of leakage, particularly at joints with valves, the cause was often traced to faulty gasket installation. These gaskets were replaced, and the connections were re-tightened and realigned. Repaired sections were then retested to ensure a leak-proof seal.

**Figure 7.** Gasket Inspection on Pipe Connection

## DISCUSSION

The piping installation process observed during the field practice demonstrates the critical importance of technical accuracy, standard compliance, and coordination among various stages—from material selection to final system testing. Each stage contributed directly to the performance, safety, and longevity of the piping system.

Firstly, the selection of ASTM A53 carbon steel pipes was appropriate for high-pressure and industrial applications. The availability of various pipe schedules and diameters allowed for flexible design based on flow requirements and structural constraints. Using standardized materials ensured compatibility with international codes such as ASME, which is crucial in industrial-scale piping systems.

The fabrication phase showed the significant impact of precision cutting, bending, and grinding on the ease of assembly and the quality of weld joints. Manual and machine-based cutting methods had to be carefully chosen based on pipe size, and any deviations could result in misalignment and weak welds. The grinding process, often overlooked, played a crucial role in preparing the surface for defect-free welding, especially when dealing with thicker pipes or irregular cuts.

In the welding process, the use of different electrode types (LINCOLN 6010 and ESAB 7018) in root and cap passes indicated adherence to best welding practices. The welder's skill in controlling heat input, weld angle, and movement speed was essential in achieving high-quality joints. It was observed that the gradual reduction of current during long weld runs helped manage pipe heat buildup and minimized warping or cracking. Additionally, proper joint preparation, including beveling, significantly improved penetration and bonding strength.

Radiographic testing (X-ray) served as a non-destructive method to evaluate the internal integrity of the welds. Its implementation helped identify hidden defects such as porosity, slag inclusion, or incomplete fusion, which are often missed by visual inspection alone. The follow-up repair process demonstrated a commitment to ensuring structural reliability and compliance with safety standards.

The use of sandblasting as a post-welding cleaning process improved surface finish and prepared the pipes for installation and potential coating. This step, though seemingly aesthetic, also prevents corrosion and promotes long-term performance in industrial environments.

During the installation phase, the continuous circular joint design allowed for uniform pressure distribution and efficient fluid flow, especially when multiple valves were operated simultaneously. It also minimized the risk of pressure drop or turbulence, which could otherwise damage the system or reduce performance efficiency.

Finally, the presence of a second quality control stage and leak testing after full assembly ensured the system's operational readiness. Issues such as gasket misalignment were promptly addressed and corrected, highlighting the importance of precision in both welding and mechanical fitting stages.

In conclusion, the successful implementation of a piping system depends heavily on detailed attention at each step. The integration of technical skills, quality standards, and continuous inspection forms the foundation of a durable and efficient fluid transport network in any industrial setting.

## CONCLUSION

Based on the field observations and analysis carried out during the piping installation process, the following conclusions can be drawn:

1. Piping installation is a systematic and multi-stage process that includes material selection, fabrication (cutting, bending, grinding), welding, inspection, finishing, and final assembly. Each stage plays a vital role in ensuring the reliability and safety of the overall system.
2. The use of standard materials such as ASTM A53 carbon steel and adherence to ASME standards significantly contributes to the durability and strength of the pipeline system. The selection of appropriate pipe schedules and diameters allows for operational flexibility.
3. Welding quality is highly influenced by several factors, including the type of electrode (e.g., LINCOLN 6010 for root and ESAB 7018 for fill), welder skills, current control, and joint preparation. Proper welding techniques ensure strong and defect-free joints.
4. Non-destructive testing such as X-ray inspection is essential for identifying internal welding defects and verifying joint integrity. Any detected flaws can be repaired effectively to maintain safety and performance.

5. Final surface treatment and installation (e.g., sandblasting and circular joint fitting) not only enhance aesthetics and corrosion resistance but also improve system functionality by ensuring uniform fluid flow and pressure stability.

In summary, the success of a piping system is determined by attention to detail in each phase, from fabrication to final inspection. A well-executed installation process, supported by competent human resources and quality control procedures, will result in a long-lasting and efficient fluid transport system suitable for industrial applications.

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