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# Scope

This specification establishes the welding and inspection requirements for the construction and fabrication of all pipelines and piping systems for Owner.

# Codes and Standards

In addition to complying with the requirements of this specification, the following regulations, codes, standards and specifications, latest edition, approved by the U.S. Department of Transportation (DOT) Office of Pipeline Safety (OPS), shall apply:

## American Petroleum Institute (API)

|  |  |
| --- | --- |
| API STD 1104 or API STD 1107 | Welding of Pipelines and Related Facilities |
| API STD 1104 or API STD 1107 | Welding of Pipelines and Related Facilities, Appendix B: In-Service Welding |
| API STD 1104 or  API STD 1107 | Pipeline Maintenance Welding Practices |

## ASME International

|  |  |
| --- | --- |
| ASME Sec IX | Boiler and Pressure Vessel Code, Section IX: Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators |
| ASME B31.3 | Process Piping |
| ASME B31.4 | Pipeline Transportation Systems for Liquid Hydrocarbons |

## American Welding Society (AWS)

|  |  |
| --- | --- |
| AWS A5.1 | Specification for Covered Carbon Steel Arc Welding Electrodes |
| AWS A5.5 | Specification for Low Alloy Steel Covered Arc Welding Electrodes |

## U.S. Department of Transportation (DOT)

|  |  |
| --- | --- |
| 49 CFR 195 | Code of Federal Regulations, Title 49, Part 195, Transportation of Hazardous Liquids By Pipeline |

## Owner Welding Manual

|  |  |
| --- | --- |
| Spec 102 | Welder Performance Qualification |
| Spec 103 | Radiographic Examination of Piping Welds |
| Spec 109 | Arc Burn Removal Procedure |

# Material Requirements

In addition to Owner material specifications and purchase order requirements, all pipe material, steel pipe flanges, fittings, and valves used in the construction of Owner pipelines and related piping systems shall meet the requirements of the following:

## American Petroleum Institute (API)

|  |  |
| --- | --- |
| API SPEC 5L | Line Pipe |
| API SPEC 6D | Pipeline Valves |

## ASME International

|  |  |
| --- | --- |
| ASME B16.5 | Pipe Flanges and Flanged Fittings |

## Manufacturers Standardization Society (MSS)

|  |  |
| --- | --- |
| MSS SP-44 | Steel Pipeline Flanges |

# Welding Procedure Qualification

## General

In accordance with DOT regulations, detailed welding procedures must be established prior to production welding and qualified to demonstrate that welds having suitable mechanical properties and soundness can be made with a particular procedure. The quality of the procedure welds shall be determined by destructive testing in accordance with API 1104 or ASME Section IX, latest editions, as applicable.

Qualification of welding procedures shall be in accordance with API 1104 for the construction of new pipelines and API 1104 Appendix B or API 1107 for welding of “In-Service” pipelines. Welding procedures and welders for Plant piping systems designed in accordance with ASME B31.3 shall be qualified in accordance with ASME Section IX.

The maintenance support personnel shall be responsible for conducting all testing, evaluation and approval of test results for each welding procedure. A welding procedure shall NOT be used for pipeline construction or for repair welding prior to its approval by the Welding Manager.

Unless otherwise specified and approved, the welding procedures to be used will be those provided in this manual. The approved welding procedures shall be adhered to at all times during welding. In the event that the contractor requests a change of essential variables (as defined by API 1104), a new procedure shall be developed.

As required, additional procedures will be established and incorporated into this manual.

## Temperature

The ambient temperature at which the welding procedure qualification was conducted shall be included in the procedure. The approved procedure may be used for construction at temperatures above or below the test temperature provided preheat temperatures specified in the procedure are followed.

# Welder Qualification

Until prior to performing any work, all welders should be inspected by a qualified welder API adopts 1104 Appendix B or API 1107 may be used for “In-Service” welding in accordance with WM Spec 102. All welder qualification testing shall be performed under the direct supervision of a company approved inspector, except for ASME Section 9.

A welder is not allowed to weld on ANY pipelines or pipeline facilities until the welder has been tested and qualified in accordance with WM Spec 102. Once qualified, the welder is then permitted to weld within the essential variables established by the qualification test. These essential variables are detailed in API 1104 for new construction or API 1104 Appendix B or API 1107 “In-Service” welding.

# Welding Process and Controls

The approved field welding process to be used for construction and fabrication is the shielded metal arc welding (SMAW) process.

Welding electrode and ground requirements include, but are not limited to the following:

1. Cellulose coated electrodes (E6010, E7010‑G, E8010‑G, and E7010-PI) shall not be stored in ovens, but shall be maintained in a dry area at a temperature above freezing and below 100 deg. F.
2. Low hydrogen electrodes (EXX16, EXX18) used for maintenance welding shall be stored in holding ovens at 250 deg F. minimum to 350 deg F. maximum temperature.
3. All electrodes that have been exposed to an atmosphere that may affect their operating characteristics or weld quality shall be discarded.
4. Electrode holders shall be of the fully insulated type when used for welding on the inside of the pipe.
5. The ground connection shall be constructed of steel, of similar chemical composition, with respect to the pipe and be of sufficient size to prevent overheating. The ground shall be located and held, if necessary, in a manner that prevents arc burns on the pipe. It shall be insulated on all points contacting the pipe except for the one point of contact that should be located in the weld joint.
6. Commercially available grounding clamps may be used for fabrication and/or field construction as applicable.
7. Ground clamps shall not be welded to the pipe or fittings.

# Pre-alignment Inspection

## General

Prior to alignment, all pipe and/or fittings shall be inspected for defects that would impair the service life of the pipeline.

Pipe wall and bevel discontinuities shall be repaired or removed as described herein.

## Pipe Wall Discontinuities

Pipe wall discontinuities shall be handled as specified in the sections below:

### Laminations

Laminations found in the pipe wall require that the pipe be inspected by an approved ultrasonic thickness gage and the portion of the pipe, which contains the lamination, be cut‑out as a cylinder. If the lamination is determined to be mid-wall, no repair is necessary.

### Cracks

Cracks found in the pipe wall shall require that the portion of pipe containing the crack be cut‑out as a cylinder.

### Dents

All dents exceeding the requirements of API 5L shall be cut‑out as a cylinder. All dents with metal loss shall be repaired.

### Gouges, Grooves, Scratches, and Notches

All gouges, grooves, scratches, and notches that exceed the requirements of API 5L shall be eliminated by grinding, providing the wall thickness is not reduced to below the minimum requirements. For API 5L wall thickness tolerances refer to Paragraph 8.16 of this specification. In the event grinding reduces the wall thickness below the minimum requirements, the area shall be cut‑out as a cylinder of pipe.

## Pipe Bevel Discontinuities

### Laminations

Laminations or other visual defects in the pipe bevel that exceed 1/4 inch shall be removed by cutting out this portion of the pipe as a cylinder.

### Bevel Damage

Bevel damage such as dents, gouges, or depressions shall be repaired if their depth exceeds one‑sixteenth of an inch. Repairs shall be made by grinding or filing to smooth the defect into the existing bevel. Damage that requires grinding to the point where the bevel may be modified, from the tolerances on the welding procedure, shall be rejected and the end shall be re‑beveled.

### Root Face Damage

The root face (land), if damaged, may be restored to its original dimension by filing or grinding. In the event restoration is not possible, the end shall be completely re-beveled.

### Bevel Dents

Denting restricted to the top edge of the bevel shall be ground smooth and shall not be cause for rejection, unless, in the opinion of the welding inspector, the denting extends beyond the area where the cap pass will tie‑in to the bevel edge.

# Welding Requirements

## Electrodes

The specific classification and type of welding electrode used during construction and fabrication shall be as described in the approved welding procedure. Electrodes shall be ordered by their American Welding Society (AWS) classification number (example E6010 and E7010‑G) based on their designation in the applicable procedure. Any change in the AWS classification number requires approval by Owner Maintenance Support.

The Owner inspector has the right to disallow the use of any electrodes brought to the job site that may be of questionable condition or moisture content. Electrodes, which are of obviously questionable condition, shall not be used for any welding including welder qualification.

Welding electrodes shall be stored and handled in accordance with the manufacturers recommended practice. Electrodes should be stored in sealed original metal containers until ready for use. Those in opened containers should be protected from deterioration and excessive moisture changes. Visual inspection of the electrodes should be done prior to welding. Electrodes that show surface oxidation, fractured coatings, or eccentricity of the coating with respect to the electrode core wire should be discarded.

## Line‑Up and Fit‑Up ‑‑

Either internal or external line‑up clamps shall be used for assuring proper alignment for butt welds unless it is impractical due to dimensional differences such as flange or fitting to pipe, etc. The clamps shall remove out‑of‑roundness and shall provide a uniform joint fit‑up. High‑low conditions shall not exceed one‑sixteenth of an inch.

External line‑up clamps may be removed after the root bead is fifty (50) percent complete, provided the completed portion of the root bead is in segments of approximately equal length, and provided the segments are equally spaced around the circumference of the pipe. If conditions are such that it is difficult to prevent movement of the pipe, or if the weld is excessively stressed, the root bead shall be completed to the extent possible before the line‑up clamp is released.

When an internal alignment clamp is used for achieving alignment, it shall be held firmly in position until the root pass is one hundred percent complete and the pipe has been properly supported.

Joint alignment shall have a uniform spacing (root opening) throughout the circumference of the joint. The spacing shall be in accordance with the approved welding procedure.

## Longitudinal Seam Offset

The longitudinal seam shall be offset at 10:00 and 2:00.

## Weld Joint Bevels

Unless otherwise specified, Owner will supply pipe with beveled ends conforming to API 5L. When re-beveling is necessary it may be accomplished using a mechanized oxy‑acetylene beveling machine. When a transition taper is required, it shall be made using a mechanical end preparation machine or by manual preparation and then approved by the Owner Inspector. A rust preventative such as deoxaluminate may be applied to the pipe bevels to prevent rust and corrosion during long-term storage.

## Transition Joints

The transition between pipe ends of unequal thickness (thickness differences greater than 3/32") shall be by mechanical tapering, by welding in accordance with ASME B31.4, or by means of a prefabricated transition nipple not less than one‑half pipe diameter in length.

## Weld Joint Cleaning

The beveled weld joint and the inside and outside surfaces at the end of each pipe to be field welded shall be cleaned for a minimum distance of 1 inch immediately prior to welding.

All traces of foreign material shall be removed by hand or power tools from the weld area. The pipe ends shall be completely dry prior to and during field welding. This may be accomplished by the use of propane or oxy-acetylene torches using a “rosebud” tip regardless of the ambient temperature. There shall be no traces of water at or near the outside or inside pipe surfaces during welding.

## Welding Equipment

Welding equipment used for field welding shall be maintained in good working condition and have the same performance capabilities as that which was used to qualify the welding procedure. Any machine that is not performing satisfactorily shall be removed from service and repaired or replaced.

## Weld Ground Placement

During welding, the placement of welding ground connections shall be on the last finished or unfinished weld. In accordance with DOT 195.226C a ground may not be welded to the pipe or fitting that is being welded. Grounds used for firing line welding shall be placed on the finished or unfinished weld. Arc burns on pipe or on completed welds shall be eliminated in accordance with the Owner Arc Burn Removal Procedure or cut-out as a cylinder, as directed by the company Inspector.

## Weld Joint Clearance

When the pipe is welded above ground, a minimum clearance of 16 inches is recommended. When the pipe is welded in the ditch, the bell hole shall be of sufficient size to provide the welding personnel with ready access to the joint for all welding operations.

## Tack Welds

Tack welds, which are to be incorporated in the final weld, shall be thoroughly cleaned of scale and suitably prepared at each end by means of grinding to ensure complete stringer bead continuity. Tack welds shall be free of cracks.

## Weld Joint Protection

Welding shall not be performed when weather conditions exist which would be detrimental to the quality of the finished weld. Rain, snow, high winds, and moisture from any source, are known to contribute to unfavorable weld quality conditions. Welding may be allowed to continue during inclement weather only after adequate shelters and precautions are implemented to insure proper weld protection. The company Inspector shall determine if the protective measures are adequate prior to welding.

## Weld Pass Requirements

A minimum of two complete weld passes shall be made prior to leaving the weld in the unfinished condition. The purpose of this requirement is to assure weld cracking will not occur. Depending on the pipe wall thickness and/or weld stress level, the company Inspector may require additional passes be made prior to leaving the weld in a temporarily unfinished condition.

## Preheating of Welds

When preheating is required by the procedure, temperature readings shall be taken using temperature indicating crayons or direct reading pyrometers. Measurements shall be made at four locations ninety degrees apart on each side of the weld joint. The location shall be a minimum of 2 inches from the weld joint centerline. Maximum temperature differential between any two points shall not exceed 50 deg F.

Preheating may be performed by propane, induction, or oxy‑acetylene torches with a “rosebud” tip. Preheating shall always be done when the pipe is wet or damp for purposes of drying the pipe prior to welding.

## Filler and Finish Beads

The completed weld shall have a uniform cross‑section around the entire circumference.

At no point shall the weld crown (cap pass) surface be below the outside surface of the pipe, nor should it be raised above the parent metal by more than one‑sixteenth of an inch, except that the height of a weld crown may exceed one‑sixteenth if the weld contour provides a uniform transition into the pipe material on both sides of the weld. Two beads shall not be started at the same location; and the face of the completed weld should be approximately one‑eighth of an inch greater than the width of the original groove. The completed weld shall be thoroughly brushed and cleaned.

## Interpass Cleaning and Removal of Visual Defects

Each pass of the weld metal shall be cleaned of slag or remaining flux using hand or power tools with stainless steel buffer wheels before a further pass is applied.

Visible defects such as slag cavities, cold laps, and other deposition faults shall be removed by grinding.

Clusters of surface porosity, starts and stops, and high points, shall be removed by grinding prior to the deposition of the next pass.

## Arc Burns

Arc burns shall be cut‑out as a cylinder, or at the discretion of the company Inspector, may be eliminated in accordance with the Owner Arc Burn Removal Procedure. In the event the remaining wall thickness is less than the minimum specified in API 5L, Table 9, shown herein, the pipe shall be cut‑out as a cylinder.

|  |  |  |  |
| --- | --- | --- | --- |
| **Wall Thickness Tolerances** | | | |
| Outside Diameter (OD)–in. | Type of Pipe | Tolerance, Percent | |
| Grade B or Lower | Grade X42 or Higher |
| ≤ 2-7/8" | All | +20.0, −12.5 | +15.0, −12.5 |
| > 2-7/8" and < 20" | All | +15.0, −12.5 | +15.0, −12.5 |
| ≥ 20" | Welded | +17.5, −12.5 | +19.5, −8.0 |
| ≥ 20" | Seamless | +15.0, −12.5 | +17.5, −10.0 |

## Weld Stripper Passes

A stripper pass may be used with the approval of a company inspector to eliminate unacceptable external conditions such as external undercut or incomplete fill of a cap pass. Stripper passes, when used, shall be two inches in length minimum, and a minimum of one electrode diameter in width. Prior to the welding of a stripper pass on a weld that has cooled to ambient temperature, the area to be welded shall be preheated to 250 deg F minimum to 350 deg F maximum for a distance of 3 inches on each side of the weld area.

## Back‑Welding ‑

When pipe and/or fitting size permits access to the inside surface, back‑welding may be used to eliminate unacceptable internal conditions or to complete the weld on transitions or fittings to pipe. When pre-heating is required by the welding procedure, prior to back‑welding, the area shall be preheated from the outside to achieve a preheat temperature on the inside surface of 250 deg F minimum to 350 deg F maximum. This preheat requirement applies to all internal back‑welding.

## Pipe Coating Protection

Any pipe coating shall be protected from weld spatter and mechanical abrasion during welding.

## Tie‑In Welds ‑

Tie-in welds, once started, shall be completed without interruption.

## Identification of Multiple Welders

If requested by the company Inspector, each welder shall mark the weld or section of a weld for which he has been responsible with the identification assigned to him by the Inspector using a weatherproof crayon or a permanent ink marker.

## Weld Repairs

Depending on the extent of defective weld areas found during radiographic examination, the Inspector may require the weld be cut‑out as a cylinder of pipe or be repaired in accordance with the following limits:

1. Repair of a crack or of any defect in a previously repaired area must be in accordance with written weld repair procedures that have been qualified under §195.214. Repair procedures must provide that the minimum mechanical properties specified for the welding procedure used to make the original weld are met upon completion of the final weld repair.
2. Defects, except cracks, found by visual examination, magnetic particle, or liquid penetrant that are externally exposed in the cover pass may be repaired.
3. Defects found by radiographic examination, such as slag inclusions, porosity or gas pockets may be repaired in compliance with API 1104 provided the defects can be removed without grinding completely through the weld. Repair of defects that require removal of the root pass require approval of the company Inspector.

Before the above repairs are made, the defective area shall be entirely removed to clean metal by grinding in a manner acceptable to the Inspector. All slag and scale shall be removed by wire brushing.

All repair cavities shall be not less than 2 in. in length unless impractical and approved by the company Inspector. All repairs shall be made with a minimum of two passes. The start and stop of repair passes shall not be superimposed over the start and stop of the preceding pass.

The start and stop of each repair pass shall be ground smooth.

Prior to repair welding, a minimum of 3 in. on each side of the repair area shall be preheated to a temperature of 250 deg F minimum to 350 deg F maximum and maintained during welding. Temperature shall be checked by the use of temperature indicating crayons or pyrometers.

All repairs shall meet the Acceptance Standards for Nondestructive Testing of API 1104.

## Welding Magnetized Pipe

Residual magnetic fields due to pipe handling with electromagnets, inspection of new pipe with electromagnetic fields or smart pigging of existing lines can create significant deflection of the welding arc resulting in welding problems. In the event magnetic fields are suspected or encountered in the field, the company Inspector will measure the individual joint ends and the joint space to determine if degaussing (demagnetizing) of the weld joint is necessary to assure proper weld quality. In general, a gauss level greater than 100, as measured in the joint space, will require degaussing which will be directed by the company Inspector.

# Inspection of Welds

## Recommended Non‑Destructive Testing (NDT) Methods ‑

Owner recognizes there are several NDT methods available for field inspection of fillet and groove welds for new construction. The chart shown herein represents the present Owner NDT recommendations for each type of weld. As NDT methods change or improve, the chart will be revised to reflect the latest technology.

|  |  |  |  |
| --- | --- | --- | --- |
| **Recommended NDT Methods** | | | |
| Weld Type  Joint Design | NDT Methods | | |
| X‑Ray | LPT | MPT |
| Groove | R |  |  |
| Fillet |  | R | A |

LPT=Liquid Penetrant Testing; MPT=Magnetic Particle Testing; R=Recommended; A=Alternate Method

## Visual Weld Inspection

Visual inspection of welds will be conducted to insure that the welding is performed in accordance with the approved welding procedure and the welding meets the requirements of this specification including API 1104.

## Radiographic Inspection

When radiographic examination of groove butt welds is conducted, it shall meet the requirements set forth in the 49 CFR 195. At the option of Owner, the extent of radiographic examination may exceed these requirements to assure quality welding is being achieved throughout the project. Refer to Owner Welding Manual Specification 103, 5.6 for the number of girth welds to be nondestructively tested each day.

## Standard of Acceptability

Unless specified otherwise, the standard of acceptability for the radiographic film interpretation of all regulated pipeline or piping system welds shall be API 1104.

## Production Weld Qualification

At the discretion of the company Inspector, production welds may be cut‑out and tested to confirm the adequacy of the welding procedure under construction conditions.

Welds meeting the requirements of API 1104 will be charged to Owner. Those welds not meeting the requirements of API 1104 will be charged to the pipeline contractor.

## Disqualification of Welders

A welder who makes a weld that fails to comply with the requirements of this section may be disqualified from further welding at the discretion of the company inspector. A welder can also be disqualified for arc burning pipeline.