

This manual was produced for internal use at Geringhoff Manufacturing LLC. We strongly recommend our suppliers to read and adhere to it. It is of great help to understand our drawings and our expectations.

# FABRICATION/WELDING STANDARD MANUAL

Joe Gossard

GERINGHOFF MANUFACTURING LLC

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## **1.0 PURPOSE AND SCOPE**

- A. This fabrication and welding procedure governs the welding of components to the requirements of AWS D1.1 (Reference 1) and Mechanical and Metal Trades Handbook 3<sup>rd</sup> Edition (Reference 2). The Code edition and addenda for this procedure shall be the latest in effect or as otherwise specified by the engineering requirements.
- B. The use of AWS Standard welding procedure specifications shall be in accordance with AWS D1.1, and additionally Section 3.8 and 6.10 of the *Mechanical and Metal Trades Handbook 3<sup>rd</sup> Edition*.

## **2.0 REFERENCES**

- 1. AWS D1.1, Structural Welding Code
- 2. Mechanical and Metal Trades Handbook 3<sup>rd</sup> Edition

## **3.0 WELDER QUALIFICATION**

- A. Welder/welding operators shall be currently certified, having preformed qualification tests in accordance to a qualified WPS, and adhere to the Qualification Responsibility of AWS D1.1 Section 4.2.2.2.

## **4.0 WELDING PREREQUISITES**

- A. All welding shall comply with the requirements specified in the Welding Procedure Specification (WPS).
- B. Welding shall not be performed when the ambient temperature in the immediate vicinity of the weld is lower than 60 degrees Fahrenheit or when surfaces are wet or exposed to rain, snow, dust, or high wind. The welder and weld joint shall be sufficiently protected from inclement conditions. Care shall be taken to ensure the moisture has not been trapped between members that are to be welded and that moisture has not been introduced into previously tacked joints prior to final welding. Preheating above the minimum specified temperature on the WPS may be necessary to remove any entrapped moisture. The additional preheat should be applied if there is a suspicion of moisture being present.

## **5.0 MATERIALS**

- A. Base Materials
  - 1. Only materials specified in Geringhoff prints may be welded using this procedure.
- B. Filler Materials
  - 1. Welding filler materials to be used with this procedure are to be specified in the WPS.
  - 2. Requirements for the purchase and control of welding filler material shall be in accordance with AWS D1.1 Section 5.3 *Welding Consumables and Electrode Requirements*.
  - 3. Welding filler materials (electrodes, bare filler wire, etc.) must be utilized by welders making weldments with this procedure. Welders shall not preform welds autogenously.

## **6.0 BASE MATERIAL JOINT PREPERATION**

- A. Surfaces and edges to be welded shall be smooth, uniform, and free from fins, tears, cracks, and other discontinuities that would adversely affect the quality of strength of the weld.
- B. Members to be joined may be cut to shape and size by machining, shearing, chipping, grinding, thermal cutting or air carbon arc gouging.

## **7.0 BASE MATERIAL JOINT CLEANING**

- A. Prior to welding, surfaces for welding shall be clean and free of paint, oil, rust, scale, slag, grease, and other foreign materials that are detrimental to welding.
- B. Solvents approved for use on the base material and weld materials are methyl alcohol, ethyl alcohol, isopropyl alcohol, acetone, methyl ethyl ketone, toluene, Varson 4, Dowanol EB, and Stoddard Solvents.

## **8.0 JOINT FIT-UP AND ALIGNMENT**

- A. Root openings and fit up tolerances shall be as specified in AWS D1.1 Section 5.22 *Tolerance of Joint Dimensions*. If the tolerances cannot be achieved, the end preparations may be built up by welding or re-prepared by machining or grinding.
- B. As noted in AWS D1.1 Section 5.22.1, parts to be joined by a tee or fillet weld shall be brought into as close to as is practicable. The maximum gap between these parts shall not exceed 1/16 inch (1.6mm). If the separation is greater than

- 1/16 inch (1.6mm), each leg length of the fillet weld shall be increased by the amount of separation.
- C. As noted in AWS D1.1 Section 5.22.1.1 the separation between faying surfaces of lap joints, butt joints with a backer, and of plug and slot welds shall not exceed 1/16 inch (1.6mm).
  - D. As noted in AWS D1.1 Section 5.22.3 parts to be joined by butt welding shall be carefully aligned to maintain an offset not exceeding 10% of the thickness of the thinner part being joined, but in no case more than 1/8 inch (3.2mm) shall be permitted as a departure from the theoretical alignment. Measurement of offset shall be based upon the centerline of parts unless otherwise shown on the drawing. The degree of angle on the perpendicular member of the joint shall be as specified in engineering standards/documents or drawings.
  - E. The parts being joined by PJP (Partial Penetration) groove welds parallel to the length of the member, shall be brought into as close contact as practicable. The gap between parts shall not exceed 3/16 inch (4.7mm).

## **9.0 PREHEAT**

- A. When base material temperature is below the minimum preheat temperature specified in the WPS, the base material shall be heated to the minimum preheat temperature prior to welding.
- B. The preheat temperature shall be maintained for a distance of at least 3 inches (75mm), or the thickness of the thicker part being joined on each side of the weld joint, and in advance of the welding.
- C. Preheat temperature above 125 degree Fahrenheit, shall be checked by a surface pyrometer, (Tempilstik) or non-mercury-type thermometer. Temperature indicating crayons shall not be used directly in the weld zone.

## **10.0 TACK WELDS**

- A. Tack welds shall be made by a qualified welder in accordance with an approved WPS.
- B. Acceptable tack welds may be incorporated into the final weld.
- C. Defective tack welds shall be removed or repaired prior to welding.

## **11.0 BACKPURGES**

- A. Not Applicable

## **12.0 INTER-PASS TEMPERATURE (IPT)**

- A. Inter-pass temperature shall not exceed the maximum value specified in the WPS and shall be checked on the surface on the component using a surface pyrometer, Tempilstick, or non-mercury-type thermometer. Temperature indicating crayons shall not be used directly in the weld zone.
- B. If the temperature of the weld is above the maximum inter-pass temperature specified in the WPS, the weld shall be allowed to cool to below the maximum inter-pass temperature, prior to the resumption of welding.

## **13.0 WELDING TECHNIQUE**

- A. Welding voltage and amperage shall be in accordance with the limits specified in the WPS. Specified voltage ranges are not mandatory for AWS purposes. Voltage and amperage range gages located on the welding power supply are for reference only and are not mandatory check or hold points. Voltage and amperage range checks for documentation purposes shall be performed by a qualified (CWI or equivalent) inspector using calibrated voltage and amperage meters or approved welding parameter recording equipment.
- B. Cracks or blowholes that appear on the surface of a weld bead shall be removed by filing, grinding, or air carbon arc gouging before depositing the next bead. Oxygen gouging shall not be used on quenched and tempered steels.
- C. Before welding over previously deposited material, all slag and flux shall be removed, and the weld and adjacent base material within 1 inch (25mm) on either side of the weld shall be brushed clean.
- D. For double welded butt joints, the second side to be welded, shall be prepared by suitable methods such as chipping, grinding, or air carbon arc gouging to sound material before welding.
- E. The minimum size of a root pass shall be sufficient to prevent cracking but not less than 1/8 (3.2mm).
- F. The maximum thickness of root passes in groove welds shall be 1/4 inch (6.4mm).
- G. The maximum size of single-pass fillet welds and root beads of multiple-pass fillet welds shall be:
  - 3/8 inch (9.5mm) for the flat (1F) position
  - 5/16 inch (8.0mm) for the horizontal (2F) position and (4F) position
  - 1/2 inch (13mm) for the vertical (3F) position

- H. The maximum thickness of layers subsequent to root passes of groove and fillet welds shall be
- 1/8 inch (3.2mm) for the flat (1G & 1F) position.
  - 3/16 inch (4.7mm) for vertical (3G & 3F), overhead (4G & 4F), and horizontal (2G & 2F) positions.
- I. Peening
1. Peening of Group 1 Materials may be used to control distortion or to relieve residual stresses. Peening shall not be performed until 3/8 inch (9.5mm) of the joint thickness has been deposited. Peening shall not be applied to cover passes, base material, or weld layers requiring nondestructive examination. Peening shall not be used to mask a defect.
- J. Control of Distortion and Shrinkage
1. In assembling and joining parts of a structure or of built-up members and in welding reinforcing parts to members, the procedure and sequence shall only be performed to minimize distortion and shrinkage.
  2. Insofar as practicable, welds shall be deposited in a sequence that will balance the applied heat of welding while the welding progresses.
  3. The welding sequence applied, in conjunction with the WPS and overall fabrication methods, shall produce members or structures meeting the specified quality requirements.
  4. The direction of the general progression in welding on a member shall be from points where the parts are relatively fixed in position with respect of each other toward points where they have a greater relative freedom of movement.
  5. Joints expected to have significant shrinkage should usually be welded before joints expected to have lesser shrinkage. Such joints should be welded with as little restraint as possible.
  6. Making welds under conditions of severe external shrinkage or restraint, the welding shall be continuous to completion or to a point that will ensure freedom from cracking before the joint is allowed to cool below the minimum-specified preheat temperature.
- K. All weld processes may be single pass or multiple pass per side unless otherwise specified in the WPS.

#### **14.0 INSPECTOR QUALIFICATION**

- A. The inspector who performs welding inspection for acceptance to the procedure shall be an AWS-CWI, or in accordance with AWS D1.1 Section 6.1.4.1 Clause 3 an individual who by training or experience, or both in metals fabrication, inspection and testing is competent to perform inspection of the work.

#### **15.0 ACCEPTANCE CRITERIA FOR COMPLETED WELDS** **AWS D1.1 SECTION 5.24 TABLE 6.1**

##### **A. BUTT WELDS**

1. As-welded surfaces are permitted; however, the surface of welds shall be sufficiently free from coarse ripples, grooves, overlaps, abrupt ridges, and valleys.
2. The surface condition of the finished welds shall be suitable for the proper interpretation of radiographic and other nondestructive examinations when nondestructive examinations are required. In those cases where there is a question regarding the surface condition, the film shall be compared to the actual weld surface for interpretation and determination of acceptability.
3. Undercuts shall not exceed 0.01 Inch (0.5mm) and shall not encroach on the minimum required section thickness for shear moment connections and primary members cyclically loaded in tension. For other than shear moment and primary connections cyclically loaded in tension undercut shall not exceed 1/32 inch (0.8mm) and shall not encroach on the minimum required section thickness.
4. Reinforcement shall not exceed 1/8 inch (3.2mm) in height and shall have gradual transition to the plane of base material surface.
5. Groove welds shall be terminated at the ends of a joint in a manner that will insure sound welds. This shall be done by use of extension bars or runoff plates or by grinding starts and stops. After the weld is completed, the extension bars or runoff plates shall be removed and the junction ground flush.



**B. FILLET WELDS**

AWS D 1.1 FIGURE 5.4 TABLE 6.1

1. As-welded surfaces are permitted; however, the surface of welds shall be sufficiently free from coarse ripples, groves, overlaps, abrupt ridges, and valleys. The surface condition of the finished welds shall be suitable for the proper interpretation of nondestructive examinations.
2. Undercuts shall not exceed 0.01 inch (0.5mm) and shall not encroach on the minimum required section thickness for primary members cyclically loaded in tension. For joints other than cyclically loaded in tension, undercut shall not exceed 1/32 inch (0.8mm) and shall not encroach on the minimum required section thickness.  
Fillet welds may vary from convex to concave. The size of a fillet weld is determined by the effective throat with the exception of skewed T joints or specifically noted on the print.
3. Weld beads shall be continuous through high stress areas such as corners.
4. The minimum fillet weld size, except for fillet welds used to reinforce groove welds shall be in accordance with AWS D1.1 Table 6.1 Visual Inspection Acceptance Criteria
5. The minimum length of an intermittent fillet weld shall be 1 inch (25mm) or otherwise specified by the print.

**C. PLUG AND SLOT WELDS**

AWS D1.1 SECTIONS 5.24, 5.22.1.1, 5.24.3.1

1. As-welded surfaces are permitted; however, the surface of welds shall be sufficiently free from coarse ripples, grooves, overlaps, abrupt ridges, and valleys.
2. For materials up to 5/8 (16mm) thick, plugs welds are to be filled flush.
3. The separation between faying surfaces of plug and slot welds shall not exceed 1/16 inch (2mm).
4. Material 1/8 inch (3.2mm) and thicker, that require welds to be finished flush by means of machining or grinding shall be done in such manner to not reduce the thickness of the thinner base material by 1/32 inch. For materials less than 1/8 inch not more than 10% of the thinner base material shall be removed to blend welds.

5. Remaining reinforcement shall not exceed 1/32 inch (0.8mm) and shall blend smoothly into the base metal surface with transition areas free from undercut. However, all reinforcement shall be removed where the weld forms part of a faying or contact surface.

**D. ARC STRIKES**

1. Cracks or blemishes outside the area of permanent welds resulting from arc strikes shall be ground to a smooth contour and checked to ensure soundness. If applicable, then repair using Section 16 of this manual *Weld Repairs*.

**16.0 WELD REPAIRS**  
**AWS D1.1 SECTION 5.26**

- A. Weld repairs shall be performed using the original WPS to restore a weld to an acceptable condition.
- B. The removal of weld material or portions of the base material may be done by machining, grinding, chipping, or air carbon arc gouging. It shall be done in such a manner that the remaining weld material or base material is not nicked or undercut. Oxygen gouging shall not be used on quenched and tempered steel. Unacceptable portions of the weld shall be removed without substantial removal of the base material. Additional weld material to compensate for the deficiency in size shall be deposited using an electrode preferably smaller than that used for making the original weld. The surface shall be cleaned thoroughly before welding.
- C. The weld shall be corrected as follows:
  1. Overlap of excessive convexity = remove excess weld material.
  2. Excessive concavity of weld or crater, undersize welds, undercutting = prepare surfaces and deposit additional weld material using the original welding procedure specification (WPS).
  3. Excessive weld porosity, excessive slag inclusions, incomplete fusion = remove unacceptable portions and re-weld using the original WPS.
  4. Cracks in weld or base material = determine the extent of the crack by use of magnetic particle or liquid penetrant examination. Remove the crack using the "boat" technique to sound material 2 inches (50mm) beyond each end of the crack and re-weld.
- D. The repair weld shall be re-examined by the method and technique originally used, with the same acceptance criteria.

## **17.0 POST WELD HEAT TREATMENT**

- A. Post weld heat treatment, when indicated by the engineering specification or in the WPS shall be performed in accordance with AWS D1.1 Section 5.8 *Stress Relief Heat Treatment*.

## **18.0 ATTACHMENT WELDS**

- A. Attachment welds shall be performed in accordance with an approved WPS.
- B. Material used for welded attachments shall be equal to, or compatible with the base material.
- C. When applying attachments to materials of different thicknesses, the pre-heat and inter-pass requirements of the thicker material shall be observed.
- D. When the specification requires temporary attachments to be removed, a method of removal that will not damage the base material shall be utilized; i.e., cut, grind, plasma, or air carbon arc gouge the attachment off and grind the area flush.

## **19.0 DIN EN 22553 Welding Symbols**

### **1. Differences between AWS 2.4 and DIN EN 22553**

- 1. Arrow Side and Opposite side are flip flopped as shown in diagram 1.
- 2. The pitch or distance between segments is measured from the finish of one segment to the start of the next segment shown in diagram 2. AWS 2.4 measures center to center of segments.
- 3. When measuring fillet welds there are two ways called out to measure. A z in front of the fillet weld size means to measure the leg length. A a in front of the fillet weld size means to measure the effective throat depth shown in diagram 3. If there is no letter designation use the effective throat measurement.

