

# EVANS METAL PRODUCTS SHOP FABRICATION PROCEDURES

May 28, 2018

## 1.12.6 FABRICATING PROCEDURES

### 1.12.6.1 **FLAME CUT, SHEARED AND SAW CUT EDGES**

#### A. FLAME CUT EDGES (Plasma or Torch)

- (1) Edges are to be reasonably free from gouges. Occasional gouges, not more than 3/16" deep are permitted. Gouges 3/16" - 7/16" are to be ground out and filled with weld then ground smooth. Any Gouges needing repairs are logged in the Fabricator's Log kept by each fabricator and turned in DAILY to Metrics. (Use 1.12.2.6.10- LOG)
- (2) All re-entrant corners should be notch free and Cut to radiuses (AWS 3/4") of at least 1/2" (AISC).
- (3) All flame cut edges should be cleaned and free from burrs or slag by grinding.
- (4) Galvanizing - If the member is hollow (i.e. Pipe or HSS) vent or lifting holes must be added. No nicks are allowed. These holes also must be cleaned and free from burrs or slag by grinding. Solid material shipped as 20' or cut length material may also need lifting holes added. These holes are normally 7/16". Lengths UNDER 6'-6" require one hole. Lengths OVER 6'6" require 2 holes, one at each end.
- (5) In the event the client asks that the vent holes be filled, you must DRILL a 3/8" hole and NOT BURN them. The drawings will show that vent holes are to be filled.
- (6) In the event that the vent holes which will be filled must be added and will be larger than 7/16", it is allowed to burn a larger hole. Filling of this hole will be required after galvanizing and will require special respirator and ventilation if done so.

#### B. SHEARED EDGES

- (1) Edges should be free of any burrs or lip which may result from shearing. A lip or knife edge may occur in heavier plates. These should be removed by grinding. Burrs of less than 1/16" may be ignored unless the work is cosmetic in nature and marked on the drawings. If a burr or lip is 1/16 or greater, grind burr or lip.

#### C. SAW CUT EDGES

- (1) In general, all material is saw cut. Saw cuts ensure that the squareness of parts is maintained.
- (2) Allowable tolerance in members that will become load bearing material, and not columns is +1/8" or - 1/8"
- (3) When material will be used as a column, the tolerance is 1/2 that for other load bearing material. Thus +1/16 and -1/16".
  - (a) All detail parts dimensions will be taken from the theoretical end of the column member.

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## D. MATERIAL INCORRECTLY CUT

(1) Material that is not within tolerance is either

- (a) Reordered and cut again following the cut list.
- (b) Placed in inventory and used on either the same project in a different location, or a different project.
- (c) If this part is placed in inventory, then care is taken to identify the part by either a printed label or a hand written label showing 1) the original job number and 2) length.
- (d) Inventory which can both trace and track purchased material is maintained using our Document Management Software.
- (e) A record is kept of such mistakes on our Fabrication Log 1.12.2.9.

### 1.12.6.2 OPEN HOLES

- A. Check detailed drawing for location and size of open holes. Holes less than or equal to 1/16" out and not require repair. Holes more than 1/16" out require repair.
- B. Our Log is kept by the QC process within our Document Management software.
- C. Edge distances should be checked. Minimum allowable edge distances are as follows:

<b>Bolt Diameter (inches)</b>	<b>MINIMUM EDGE DISTANCE FOR PUNCHED, REAMED, OR DRILLED HOLES (INCHES)</b>		
	<b>Sheared Edges</b>	<b>Rolled or Flange edges, ex. Flanges of Beams or Channels</b>	<b>Flanges of Beam or Channel</b>
	<b>AISC</b>	<b>AISC</b>	<b>AISC</b>
1/2"	7/8"	3/4"	3/4"
5/8"	1"1/8	7/8"	7/8"
3/4"	1"1/4 1/4	1"	1"
7/8"	1"1/2*	1"1/8	1"1/8
1"	1"3/4*	1"1/4	1"1/4
1" 1/8	2"	1"1/2	1"1/2
1"1/4	2"1/4	1"5/8	1"5/8
Over 1"1/4	1.75 x dia.	1.25 x dia	1.25 x dia
* These may be 1"1/4 at the ends of a beam connection angle.			

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<b>MINIMUM EDGE DISTANCE FOR PUNCHED, REAMED, OR DRILLED HOLES (INCHES) AT FLAME CUT EDGES</b>	
<b>Bolt Diameter (inches)</b>	<b>Distance from Edge</b>
1/2"	3/4"
5/8"	7/8"
3/4"	1"
7/8"	1"1/8
1"	1"1/4
1"1/8	1"1/2
1"1/4	1"5/8
Over 1"1/4	1.25 x dia.

### 1.12.6.3 MARKING

- A. The following information should be marked at the near side left end of all shipped pieces: Use the shipping label shown at the right.
- B. This label includes
- (1) Part Mark
  - (2) The Job or Contract Number
  - (3) The Weight
  - (4) The Material Profile
  - (5) The Length
  - (6) The Quantity
- C. If the label is not available please ask our PA or ENG for a new label.
- D. During the finishing process, this label and the information it contains is to be preserved.
- E. The Log that is kept is our Delivery Ticket.



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## 1.12.6. 4 DIMENSIONS

- A. The following dimensions should be checked closely with the detail drawings: Out-to-out of beam end connection holes or back to back of connection angles may vary by +/- 1/16" to 30'-0" out to out and +/- 1/\*" over 30'-0" out to out.
- B. The 1/16" tolerance, where applicable on overall length of members framed to other steel parts, or the 1/16" clearance on size of standard holes shall not be construed as implying that the tolerance also applies to the maximum tolerance on hole location within a pattern of holes, the position of intermediate connections, the position of intermediate stiffeners, the depths of girders and trusses, etc.
- C. All dimension marked "HOLD" on drawings should be checked to assure they are correct.
- D. Columns or any piece milled on both ends should be checked closely and the dimensions held to within 1/32". (At this time, Evans Metal does not Mill any columns)
- E. Members that do not have their ends finished may vary by 1/16" for members 30'-0" long or less and by 1/9" for members over 30'-0" in length. If the out-to-out of end connection holes is within the 1/16" tolerance and the edge distance is within the tolerance given under the "Open Holes" section of this procedure, the piece may be acceptable even though it is more than 1/8" or 1/4" short.

## 1.12.6. 5 FITTING

### A. WELDED CONSTRUCTION

- (1) All surfaces which are to be welded must be free from loose scale, slag, rust, grease, paint or any other foreign material.
- (2) Parts which are to be fillet welded should be as close to contact as possible. They should never be separated by more than 3/16" in plates under 3" thick. A maximum gap of 5/16" is allowed in plates 3" thick or greater. This also applies to partial penetration welds. If separation is 1/16" or greater, the leg of the fillet weld shall be increased by the amount of the separation. This increased weld size must be marked on the piece for the welder.
- (3) The separation between fraying surfaces of lap joints and butt welds landing on a backing must not exceed 1/16" thick.
- (4) Fillet Welds, CJP and PJP welds follow the requirements of Prequalified Joints found in the AISC Manual for Steel Construction (see tables 8.2pgs 34-64 14<sup>th</sup> ed. And sample at the end of this procedure.)

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- (5) The following items should be checked prior to welding:
- (a) Groove angle
  - (b) The Root Opening
  - (c) Gap (The Separation between parts)
  - (d) "f" or the fusion face dimension (See table 8.23 at the end of this document.)

## B. COLUMN FITTING

- (1) All column detail material is to be fit, using the column theoretical center lines, established from the ends of the column. If the column has flanges over 2" thick, or is a box column use the process shown in Diagram 1.12.6.5.B. If the column is smaller than this, the actual center lines at the connections may be used. The following procedure should be used in establishing theoretical center lines:
- (2) Establish column center lines on both ends - material with no twist. (Diagram 1.12.6.5.B)
- (a) Center point of web - split web thickness in half at 2 points, as close to the flange fillets as possible. Scribe a line through these two points.
  - (b) Center point of flanges - Measure one-half depth on web centerline and scribe a line through this point perpendicular to web centerline
  - (c) Check all dimensions for detail material from these center lines.

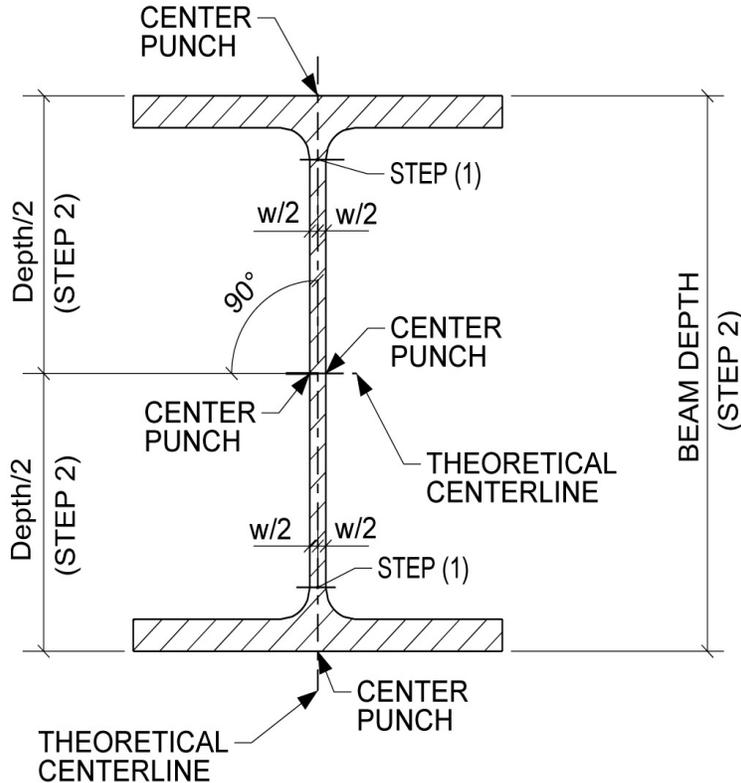
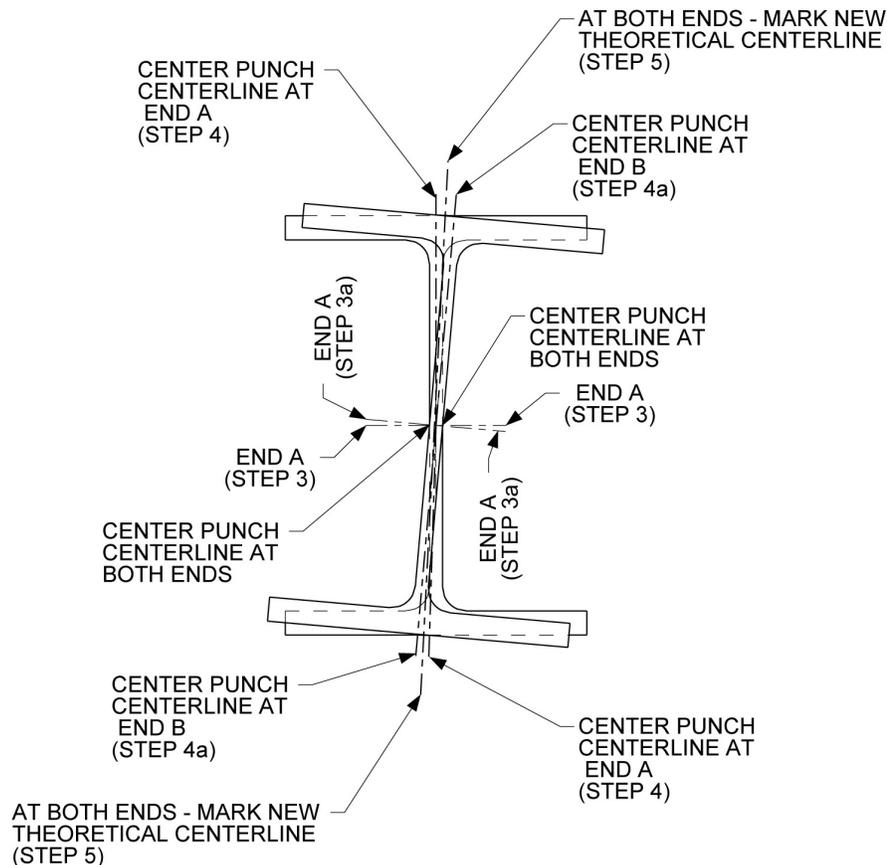


DIAGRAM 1.12.6.5.B

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- (3) Column Fitting - material that has a "Twist."
  - (a) Adjust center lines for twist. (Diagram 1.12.6.5.C)
  - (b) Do this only if outermost gauge of holes in moment plate is more than 2'-6" from the centerline of columns.
  - (c) Check column for twist by having a plumb bob on each end of column with the web vertical. Let string run through the center point and check how much offset the web centerline is from the string at the face of the flange. Knowing this offset at each end, the difference can be divided in half, and a new centerline scribed.
  - (d) Center punch columns on all four faces at each end using those center lines from Steps 3 and 3a as well as Step 4 and 4a. Snap theoretical center lines on all four faces.



1.12.6.5.C - COLUMN  
MATERIAL WITH A TWIST

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### 1.12.6. 6 **GIRDERS, STIFFENERS, AND FITTING TOLERANCES**

- A. Bearing ends of bearing stiffeners shall be flush and square with web, and at least 75% in contact with the inner surface of the flanges.
  - (1) Outer surface of flanges when bearing against steel base or seat shall fit within 1/8" for 75% of web and stiffener area and not more than 1/32" for remaining 25%.
  - (2) Girders without stiffeners shall bear on outer flange surfaces within 1/8" and the included angle between web and flange shall not exceed 90 degrees in the bearing length.
- B. Fit of intermediate stiffeners
  - (1) Where tight fit is specified, a gap of up to 1/16" is allowed between stiffener and flange.
- C. Straightness
  - (1) Intermediate Stiffeners
    - (a) Out-of-straightness variation shall not exceed 1/2", with regard to members which frame into them.
  - (2) Bearing Stiffeners
    - (a) Out-of-straightness variation shall not exceed 1/4" up to 6 feet or 1/2" over 6'-0"
  - (3) Location of Bearing Stiffeners
    - (a) Actual centerline of the stiffener shall lie within the thickness of the stiffener, as measured from the theoretical centerline locations.

### 1.12.6. 7 **WELDS - VISUAL INSPECTION**

Only Visual inspection requirements will be covered here. If other Non-Destructive testing is required, then our Welding Inspector (CWI) will be called upon.

#### A. PROPER SIZE AND LENGTH

- (1) Check all welds to see that they are made in accordance with the detail drawings. A fillet weld in any single continuous weld shall be permitted to underrun the nominal fillet size required by 1/16" (.6mm) without correction, provided that the undersize portion of the weld does not exceed 10% of the length of the weld. On web-to-flange welds on girders, no underrun is permitted at the ends for length equal to twice the width of the flange.
- (2) Overlap or Excessive Convexity
  - (a) See diagrams x and z for acceptability
- (3) Excessive Concavity and Undercutting (See Diagram 1.12.6.7)
  - (a) As a general rule, undercutting should not be deeper than 1/32" which can be measured with gages available in Quality control. (Please see the training video on Gages - complex). There are cases which it could be other than 1/32" which will be brought to the QC inspectors attention.
- (4) Cracks
  - (a) No cracks are permitted.
- (5) Pin Holes or Porosity
  - (a) Fillet or groove welds, piping porosity shall not exceed 3/8" in any lineal inch of weld and shall not exceed 3/4" in any 12" of weld length.

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(b) Complete joint penetration groove welds in joints transverse to the direction of computed tensile stress shall have no piping or porosity.

(6) Craters

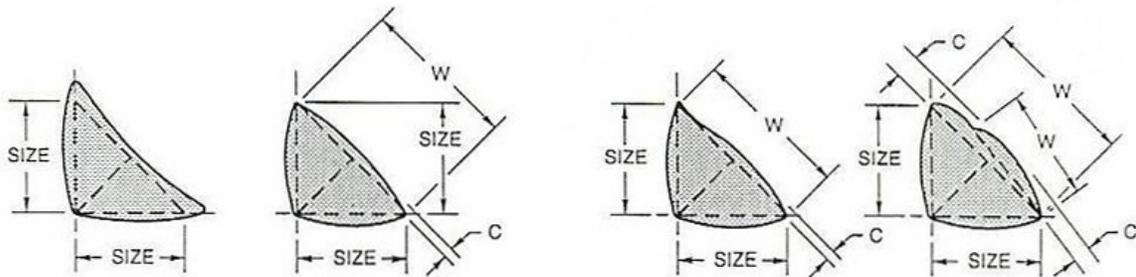
(a) Craters or depressions in the weld, are to be filled by over welding.

(7) Cleaning

(a) All slag and spatter should be removed from welds.

(b) In the event that multi weld passes are made, each intermediate layer needs to be cleaned.

(8) Overall Appearance

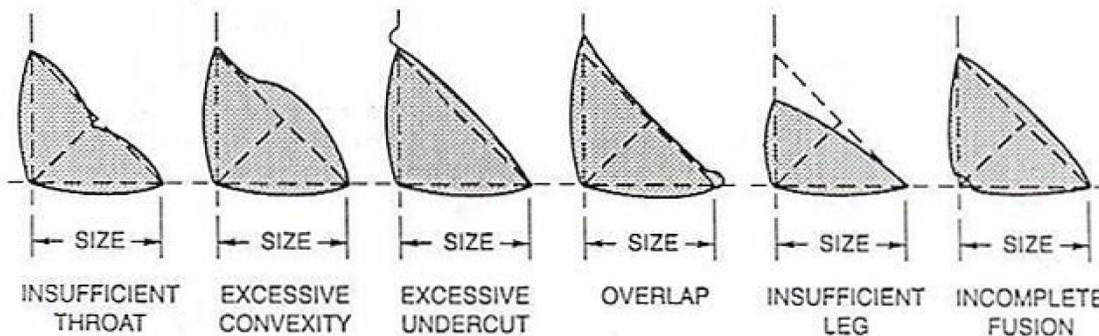


(A) DESIRABLE FILLET WELD PROFILES

(B) ACCEPTABLE FILLET WELD PROFILES

NOTE: CONVEXITY, C, OF A WELD OR INDIVIDUAL SURFACE BEAD WITH DIMENSION W SHALL NOT EXCEED THE VALUE OF THE FOLLOWING TABLE:

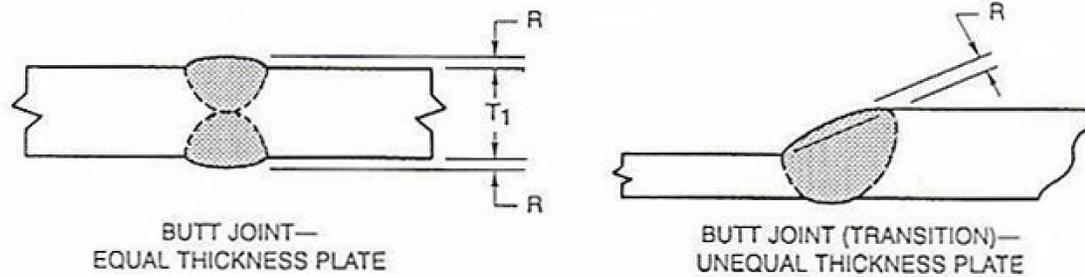
WIDTH OF WELD FACE OR INDIVIDUAL SURFACE BEAD, W	MAX CONVEXITY, C
$W \leq 5/16$ in. (8 mm)	1/16 in. (1.6 mm)
$W > 5/16$ in. TO $W < 1$ in. (25 mm)	1/8 in. (3 mm)
$W \geq 1$ in.	3/16 in. (5 mm)



(C) UNACCEPTABLE FILLET WELD PROFILES

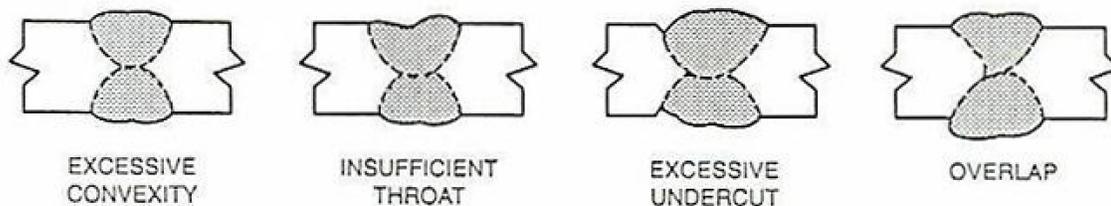
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NOTE: REINFORCEMENT R SHALL NOT EXCEED 1/8 in. (3 mm). SEE 5.24.4.

**(D) ACCEPTABLE GROOVE WELD PROFILE IN BUTT JOINT**



**(E) UNACCEPTABLE GROOVE WELD PROFILES IN BUTT JOINTS**

**1.12.6.8 STUD WELDING**

**A. WORKMANSHIP**

- (1) Studs shall be welded to steel members with automatically timed stud welding equipment, except as permitted in ss below.
- (2) The studs and the are where the studs are to be welded shall be free of scale, rust, or any injurious material that would prevent successful welding.
- (3) No welding is allowed when the base metal temperature is below 0 degrees F.
- (4) Longitudinal and lateral spacing of shear stud connections may vary a maximum of 1" from the detailed location, provided that the adjacent studs are at least 1 1/2" apart and the distance from the edge of a flange is at least equal to the diameter of the stud plus 1/8"
- (5) At the option of the EMP studs may be fillet welded by GMAC (gas metal arc) process as follows:
  - (a) Minimum fillet welds

<b>Minimum Fillet Welds for STUDS</b>	
<b>Weld Size</b>	<b>Stud Diameter</b>
5/16"	3/8" to 7/8"
1/4"	1/2"
3/16"	1/4" to 7/16"

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- (b) Use 0.045" welding wire and the same settings for our welder.
- (c) Prepare the stud base so that the stud fits tight against the steel.
- (d) Use preheat as required by base metal thickness.

### B. INSPECTION AND TESTING

- (1) The first two shear stud connections welded on each member after being allowed to cool, shall be bent to an angle of 30 degrees from their original axis by striking with a hammer.
- (2) Studs shall have a full 360 degrees of weld fillet.
- (3) If unacceptable studs have been both discovered and removed from the component, the area from which the stud was removed shall be made flush and smooth. Weld if required.
- (4) If visual inspection reveals any shear stud lacks a 360 full weld, or if a stud is repaired by welding, then each stud shall be struck with a hammer and bent to an angle of 15 degrees from its original axis. For studs with less than 360 degree fillet weld, the direction of bending shall be opposite the missing fillet.

### C. REPAIR

- (1) If a shear stud connector fails during bend testing, make the area smooth and flush and replace the stud.
- (2) Studs without a full 360 degrees of fillet welds may be prepared by adding a fillet weld in place of the missing weld extending the fillet 3/8" beyond each end of the missing weld. Use the GMAW process for welding.
  - (a) Use our standard welding procedure.

### 1.12.6.9 ERROR LOG

- A. A Log is kept of various mistakes in the fabrication process.
- B. See 1.12.2.6.9 for the log itself
- C. A log is kept for 1) Gouges, 2) Miss-Cut material, 3) Material punched incorrectly, 4) Weld Repairs.
- D. All logs are initialed by QC Personnel.

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1.12.6.9 FABRICATORS ERROR LOG				Name _____	Date _____		
JOB #	PART MARK#	DEEP GOUGES NEEDING REPAIR OVER 3/16"-7/16"	MATERIAL CUT WRONG AND PLACED IN INVENTORY	MATERIAL PUNCHED WRONG	WELD REPAIRS NEEDED. (Describe what was Done)	QC INITIALS	
<b>Turn this report in Daily to Metrics.</b>							

## 1.12.6. 10 REPAIRS

The following is a list of typical repairs and how they should be carried out. Before these repairs can be made, approval from ENG should be obtained.

### A. PLUGGING OF HOLES WITH WELD.

- (1) Weld Metal should be built up above the surface of the material
- (2) Excess weld should then be ground smooth and flush with adjacent material. The filled holes should not be concave or convex after grinding. No gouges should appear in the weld metal from grinding.

### B. REPAIR OF EDGE DEFECTS

- (1) Defects that are 3/16" deep or less can in most cases be ground out. When grinding, the defect should be faired at a slope of 1:10.
- (2) Defects which are deeper, may be welded. If this is done, the defect should be cleaned out before the weld metal is deposited. The weld metal should also be ground smooth and flush after being completed.

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## C. REPAIRS OF SURFACE DEFECTS

- (1) When it is permissible to repair surface defects by welding, the weld metal should be built up 1/16" above the adjacent surface. The excess metal should then be ground flush and smooth with no gouges.
- (2) Areas that can be repaired by grinding alone should be faired out, leaving no abrupt changes in contour.
- (3) See Receiving Training and Receiving document for these defects.

## D. WELD REPAIRS (See section 1.12.2.7.(8))

- (1) If the fillet welds show excessive convexity or overlap, the excess weld metal may be removed by grinding.
- (2) If the welds show excessive concavity, craters, undercutting, or are undersized, the area with the defect may be cleaned and additional weld metal deposited. (See general notes below.)
- (3) When welds have excessive porosity, excessive slag, inclusions, or incomplete fusion, the defective portions MUST be removed and re-welded. (See general notes below.)
- (4) If there are cracks in the weld metal or base metal, the crack should be removed along with 2" of sound metal beyond each end of the crack and re-welded. (See general notes below.)

## E. GENERAL NOTES

- (a) Weld metal may be removed either by machining, grinding, chipping, oxygen gouging, or air carbon-arc gouging. The adjacent weld metal or base metal must not be undercut.
- (b) Additional weld metal may be deposited, using smaller electrodes than used for the original weld. Also, surface should be weld cleaned before welding.

## F. HEAT STRAIGHTENING

- (1) When applying heat to straighten material, the temperature of the material should not exceed 1200 degrees F for most steel.
- (2) The temperature should be carefully checked by temperature indicating crayons or optical thermometers during the heating process.

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## 1.12.6. 11 ADDITIONAL PROCEDURES

Additional procedures not presently in this booklet but available on our website or in our AISC Manual..

A. WELDING HABITS

B. BOLTING HABITS

C. PRE-TENSIONING INFORMATION

(1) Skidmore usage

D. LOADING HABITS

E. PAINTING HABITS

(1) Surface Conditions

**CJP**

**Table 8-2 (continued)**  
**Prequalified Welded Joints**  
**Complete-Joint-Penetration Groove Welds**

Single-bevel-groove weld (4) Butt joint (B)		Tolerances	
		As Detailed (see 3.13.1)	As Fit-Up (see 3.13.1)
		$R = +1/16, -0$	$+1/4, -1/16$
		$\alpha = +10^\circ, -0^\circ$	$+10^\circ, -5^\circ$

Welding Process	Joint Designation	Base Metal Thickness (U = unlimited)		Groove Preparation		Allowed Welding Positions	Gas Shielding for FCAW	Notes
		T <sub>1</sub>	T <sub>2</sub>	Root Opening	Groove Angle			
SMAW	B-U4a	U	—	R = 1/4	$\alpha = 45^\circ$	All	—	3, 5, 10
				R = 3/8	$\alpha = 30^\circ$			
GMAW FCAW	B-U4a-GF	U	—	R = 3/16	$\alpha = 30^\circ$	All	Required	1, 3, 10
				R = 1/4	$\alpha = 45^\circ$			
				R = 3/8	$\alpha = 30^\circ$	F, H	Not req.	1, 3, 10
SAW	B-U4a-S	U	U	R = 3/8	$\alpha = 30^\circ$	F	—	3, 10
				R = 1/4	$\alpha = 45^\circ$			

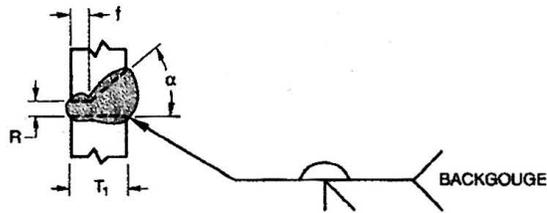
Single-bevel-groove weld (4) T-joint (T) Corner joint (C)		Tolerances	
		As Detailed (see 3.13.1)	As Fit-Up (see 3.13.1)
		$R = +1/16, -0$	$+1/4, -1/16$
		$\alpha = +10^\circ, -0^\circ$	$+10^\circ, -5^\circ$

Welding Process	Joint Designation	Base Metal Thickness (U = unlimited)		Groove Preparation		Allowed Welding Positions	Gas Shielding for FCAW	Notes
		T <sub>1</sub>	T <sub>2</sub>	Root Opening	Groove Angle			
SMAW	TC-U4a	U	U	R = 1/4	$\alpha = 45^\circ$	All	—	5, 7, 10, 11
				R = 3/8	$\alpha = 30^\circ$			
GMAW FCAW	TC-U4a-GF	U	U	R = 3/16	$\alpha = 30^\circ$	All	Required	1, 7, 10, 11
				R = 3/8	$\alpha = 30^\circ$			
				R = 1/4	$\alpha = 45^\circ$	All	Not req.	1, 7, 10, 11
SAW	TC-U4a-S	U	U	R = 3/8	$\alpha = 30^\circ$	F	—	7, 10, 11
				R = 1/4	$\alpha = 45^\circ$			

**CJP**

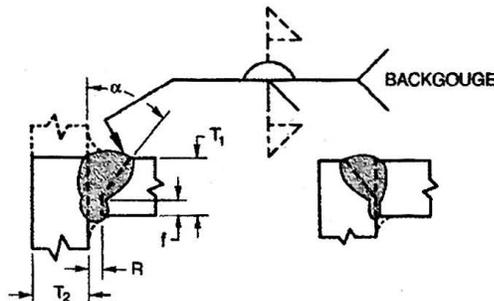
**Table 8-2 (continued)**  
**Prequalified Welded Joints**  
**Complete-Joint-Penetration Groove Welds**

Single-bevel-groove weld (4)  
 Butt joint (B)



Welding Process	Joint Designation	Base Metal Thickness (U = unlimited)		Groove Preparation			Allowed Welding Positions	Gas Shielding for FCAW	Notes
		T <sub>1</sub>	T <sub>2</sub>	Root Opening Root Face Groove Angle	Tolerances				
					As Detailed (see 3.13.1)	As Fit-Up (see 3.13.1)			
SMAW	B-U4b	U	—	R = 0 to 1/8 f = 0 to 1/8 α = 45°	+1/16, -0 +1/16, -0	+1/16, -1/8 Not Limited	All	—	3, 4, 5, 10
GMAW FCAW	B-U4b-GF	U	—	R = 0 f = 1/4 max α = 60°	±0 +0, -1/8 +10°, -0°	+1/4, -0 ±1/16 10°, -5°	All	Not Required	1, 3, 4, 10
SAW	B-U4b-S	U	U	R = 0 f = 1/4 max α = 60°	±0 +0, -1/8 +10°, -0°	+1/4, -0 ±1/16 10°, -5°	F	—	3, 4, 10

Single-bevel-groove weld (4)  
 T-joint (T)  
 Corner joint (C)



Welding Process	Joint Designation	Base Metal Thickness (U = unlimited)		Groove Preparation			Allowed Welding Positions	Gas Shielding for FCAW	Notes
		T <sub>1</sub>	T <sub>2</sub>	Root Opening Root Face Groove Angle	Tolerances				
					As Detailed (see 3.13.1)	As Fit-Up (see 3.13.1)			
SMAW	TC-U4b	U	U	R = 0 to 1/8 f = 0 to 1/8 α = 45°	+1/16, -0 +1/16, -0	+1/16, -1/8 Not Limited	All	—	4, 5, 7, 10, 11
GMAW FCAW	TC-U4b-GF	U	U	R = 0 f = 1/4 max α = 60°	±0 +0, -1/8 +10°, -0°	+1/4, -0 ±1/16 10°, -5°	All	Not Required	1, 4, 7, 10, 11
SAW	TC-U4b-S	U	U	R = 0 f = 1/4 max α = 60°	±0 +0, -1/8 +10°, -0°	+1/4, -0 ±1/16 10°, -5°	F	—	4, 7, 10, 11