

REQUIRED CLEARANCE FOR WELDED JOINTS

Report for

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INTRODUCTION

Adequate clearance must be provided adjacent to welded joints to ensure proper welding and inspection. If optimal clearance is not provided, fabrication efficiency can be reduced. For small clearances, the weld can be obstructed enough to affect the weld quality, potentially reducing the weld strength. This research project addresses three weld clearance issues:

- 1. Welding near obstructions
- 2. Doubler plate welds
- 3. Acute angle welds

Welding Near Obstructions

Weld clearance recommendations published by Grover (1946) and LEC (1994) are shown in Figures 1 and 2, respectively. According to Shaw (1996), generally "access requires a minimum of at least 18 in. of clear space around the joint." Weld clearance requirements are also discussed on page 8-15 of the AISC *Manual* (AISC, 2011). For horizontal welds using the SMAW process, page 8-15 of the AISC *Manual* recommends a 30° angle as shown in Figure 1, with an absolute minimum angle of 27°. If the proper clearance cannot be attained, the more expensive alternative details in Figure 2 can be used.

Another common weld access problem is shown in Figure 5, where a plate is welded to the web of an I-shape member with a complete-joint-penetration (CJP) weld. In many cases, the arc cannot be properly directed against the base metal due to an obstruction caused by the flange. There is not a direct line of sight for the welder or the inspector to view the beveled weld preparation surface.

The recommendations by Grover (1946), LEC (1994) and AISC (2011) are based on the SMAW process; however, due to the low production rates, SMAW is primarily used only for tack welding. Most structural shops now use FCAW or GMAW for production shop welding. FCAW-g is the most used process for shop fabrication of structural steel, and FCAW-ss is the most used process for field welding of steel structures. The geometry of a FCAW welding gun, including gas nozzle for FCAW-g, is much different from a SMAW stick electrode. Additionally, electrode manipulation techniques may be different between the two processes. Therefore, the historic values previously developed for the SWAW process may need to be updated for use with FCAW. It is believed that clearances required for FCAW-g will be larger than for FCAW-ss due to the presence of the gas nozzle; therefore, the research plan includes only shop welding with the FCAW-g process.

An additional parameter that may affect weld clearance requirements is the "banking" of weld metal to counteract the effect of gravity for welds made in the horizontal position. To obtain equal leg fillet welds, the welder typically rotates the electrode toward the horizontal surface, so the arc is directed more toward the vertical surface. Based on this, a vertical obstruction element may be more critical than a horizontal obstruction in the welding of joints in the horizontal position.

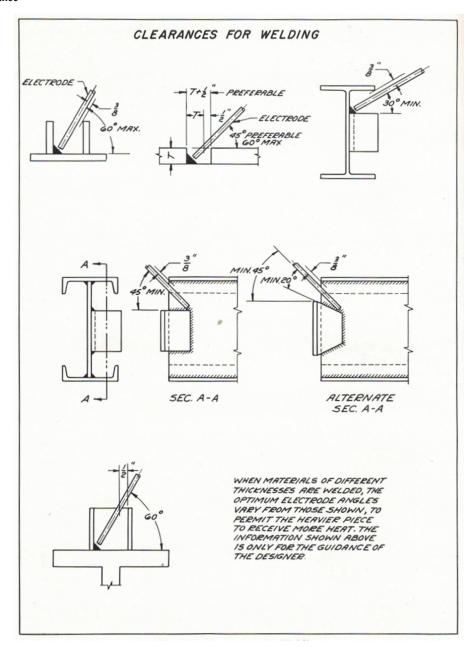


Fig. 1. Weld clearance recommendations by Grover (1946).

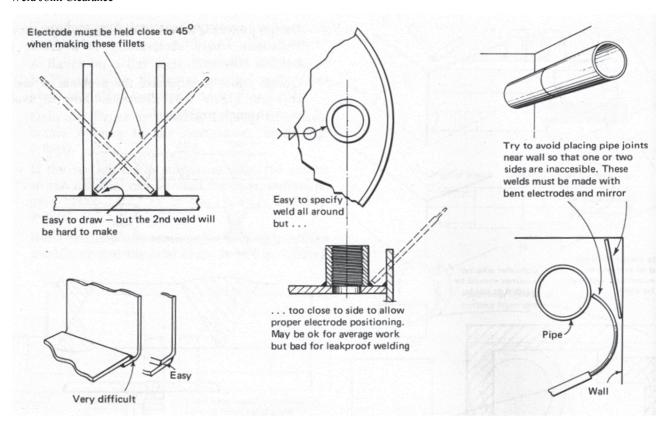


Fig. 2. Weld clearance recommendations by LEC (1994).

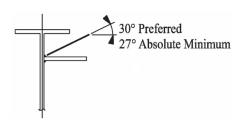


Fig. 3. Clearance for welding and inspection.

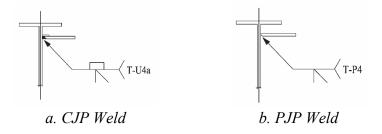


Fig. 4. Alternative welds for joints with clearance on one side only.

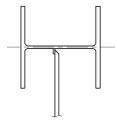


Fig. 5. Complete-joint-penetration weld with access problems.

Doubler Plate Welds

The main function of a weld preparation is to facilitate the required weld metal penetration. The preparation must provide adequate access, so the arc can be directed against the base metal. Figure 6a shows a Tee joint with a square groove preparation that is not prequalified because the arc cannot be directed against the base metal. A similar detail is shown for a corner joint in Figure 6b. For relatively thin materials, the corner joint is prequalified because arc access is not obstructed as it is for the Tee joint. A prequalified Tee joint with a single-bevel weld preparation is shown in Figure 6c, where the arc can be directed against the beveled surface.

Typical doubler plate-to-column flange welds are shown in Figure 7, where Option 1 is fillet-welded and Option 2 is groove-welded. The groove welds are considered full-strength welds, although they are not AWS prequalified joints. For thin doubler plates, fabricators often eliminate the weld preparation by welding the edge of a square-cut plate, relying on the welding heat to provide adequate penetration at both the plate and the column. For thick doubler plates, the 30° preparation shown for Option 2 is often used because the geometry is similar to the prequalified joint in Figure 6c. Fabrication practices vary, but generally, plates less than $\frac{3}{8}$ in. thick are cut square and plates $\frac{3}{8}$ in. and thicker are beveled at 30°. The variables for the weld joint geometry are shown in Figure 8.

Allowing a slight encroachment into the flange-to-web fillet radius reduces the volume of weld metal, which also reduces both the cost of the joint and the weld shrinkage stresses. Distortion of the column due to weld shrinkage at a web doubler plate is shown in Figure 9. The weld metal volume can also be reduced by using square-cut plate edges.

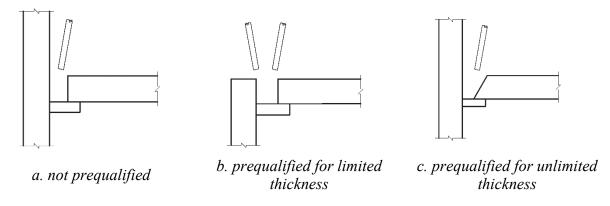


Fig. 6. Arc access.

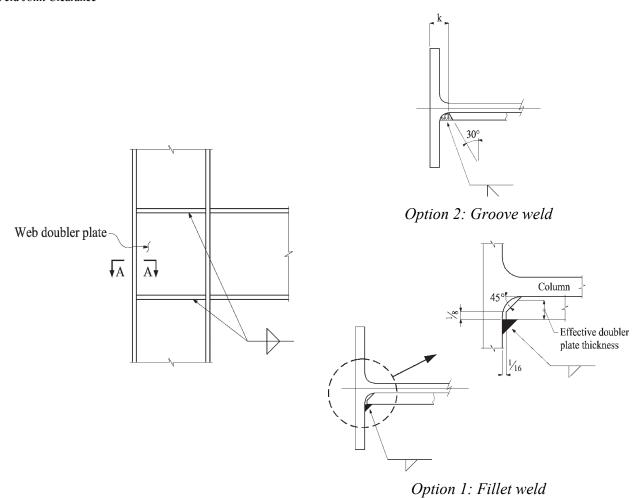


Fig. 7. Web doubler plate welds at column flanges.

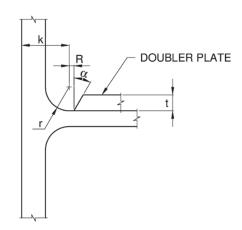


Fig. 8. Doubler plate weld geometry.

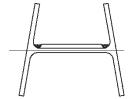
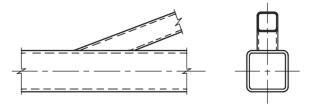


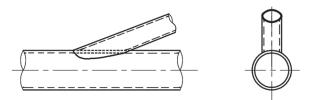
Fig. 9. Exaggerated distortion due to weld shrinkage at a web doubler plate.

Acute Angle Welds

Figure 10 shows typical HSS truss joints, where the heel of the joint must be welded at an acute angle. Acute-angle welds can be problematic when the dihedral angle is less than 30°. AWS D1.1:2015 Subclause 9.15.4.2 discusses the qualification requirements for tubular joints with dihedral angles less than 30°. At small angles, limited access to the joint root causes a lack of penetration and the weld metal near the root can be used only as backup to the sound weld passes. In design, this dimension, known as the z-loss dimension, is subtracted from the theoretical weld throat. Although tapered gas nozzles can be used at joints with small angles, weld quality can be reduced where wider gas coverage is required to protect the arc. Also, production efficiency is reduced when tapered nozzles are used. The effectiveness of welding practices common to structural steel fabricators is unclear at dihedral angles less than 30°.



a. rectangular HSS connection



b. round HSS connection

Fig. 10. HSS truss joints.

OBJECTIVES

The objectives of this research are to determine practical limits on connection geometry for welding near obstructions and welding acute-angle heel joints.

Welding Near Obstructions

The objective of the obstructed fillet weld research is to determine the minimum clearance required for fillet welded joints, and the effect of small clearances on weld quality and production efficiency.

Doubler Plate Welds

The objective of the doubler plate tests is to provide preliminary information regarding the root-pass penetration for square-cut plates, based on the plate thickness and the distance from the inner surface of the flange to the edge of the plate.

Acute Angle Welds

The objective of the acute-angle tests is to provide preliminary information regarding the viability, quality, economy and geometry of skewed joints fabricated according to AWS D1.1 Figure 3.8 Detail D with dihedral angles, ϕ , less than 30°.

PROCEDURE

For the three weld clearance issues discussed, specimens were fabricated, sectioned and inspected. All specimens were fabricated by AISC Certified fabricators using the FCAW-g process. Each shop selected a welder to participate in the project, based on an average level of skill and experience. The selected welders completed a questionnaire and the engineering/production managers were interviewed for further information. All specimens were sectioned into sub-specimens by cold-sawing at two locations perpendicular to the weld. The saw-cut sections were macro-etched with a 10% Nital etchant, which consists of 10 ml nitric acid and 90 ml ethyl alcohol.

Welding Near Obstructions

The weld clearance specimens used a $\frac{1}{4} \times 8$ in. plate to simulate an obstruction. Each specimen was fabricated with seven test welds, as shown in Figure 11. The outermost $\frac{1}{4} \times 2$ in. plate was welded first and the assembly sequence progressed toward the obstruction plate. Figure 12 shows the weld sequences, labeled Location 1 through Location 7, with Location 7 closest to the obstruction plate.

One large fabricator and two medium-size fabricators participated in this part the project. Each fabricator supplied three specimens, with two specimens welded in the horizontal position and one specimen welded in the vertical position. For the specimens welded in the horizontal position, Position A was oriented with the obstruction plate in the vertical direction and Position B had the obstruction plate in the horizontal direction as shown in Figures 13a and 13b, respectively. A specimen welded in the vertical-position, designated Position C, is shown in Figure 14c. The weld position for each specimen was identified by the fabricator. The specimens were inspected by the fabricator and the leg sizes were measured using a fillet weld gage as shown in Figure 15.

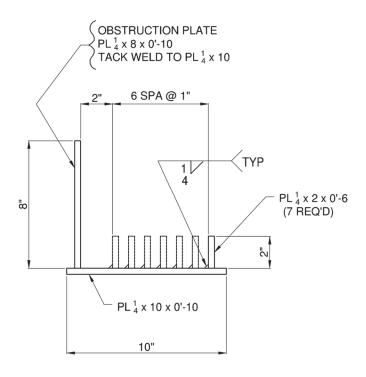


Fig. 11. Weld clearance specimen detail.

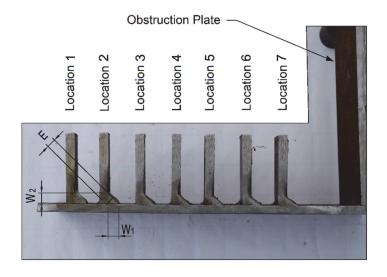


Fig 12. Section of a completed weld clearance specimen.

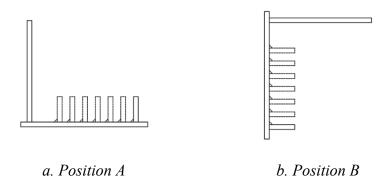


Fig. 13. Orientations for horizontal welding positions.



Fig. 14. Specimen positions.



Fig. 15. Measurement of weld leg size.

Each weld specimen is identified with the designation, FPC-L, where F is the fabricator number, P is the welding position, C designates the cross-sectional cut location along the weld length and L is the weld location number. After sectioning and etching the specimens, the weld leg sizes and effective throat dimensions were measured from a digital image.

Doubler Plate Welds

Fabricator 1 supplied eight simulated doubler plate specimens. Four of the fabricated specimens are shown in Figure 16. The specimens are 9 in. long and were welded in the horizontal position. Drop material from a recent project was used for the W-shape, with extension tabs tack-welded to the flange tips to simulate a W14×90 column.

The simulated doubler plate was square-cut ($\alpha = 0^{\circ}$) with variable dimensions are shown in Figure 17. The distance from the inner surface of the flange to the edge of the plate, x, was either $\frac{5}{8}$ in. or $\frac{1}{4}$ in. and four different plate thicknesses were used: $\frac{1}{4}$, $\frac{3}{8}$, $\frac{1}{2}$ and $\frac{3}{4}$ in. Because the concerns are associated with penetration at the root pass, only the first pass was completed and the remaining passes required to complete the joint were omitted.



Fig. 16. Doubler plate specimens.

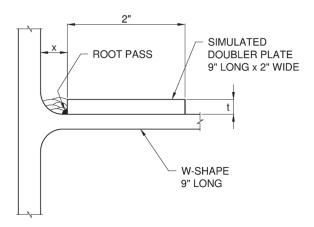


Fig. 17. Doubler plate specimens.

Acute Angle Welds

Fabricator 1 supplied four acute-angle specimens, shown in Figure 18. The specimens are 8 in. long and were welded in the horizontal position. The weld geometry was based on AWS D1.1 (AWS, 2015) Figure 3.8 Detail D (see Figure 19) and Table 3.6 with $t_b = \frac{1}{4}$ in., $t_w = \frac{1}{2}$ in. and $F = \frac{1}{8}$ in. Four different dihedral angles, ϕ , were used: 15°, 20°, 25° and 30°.

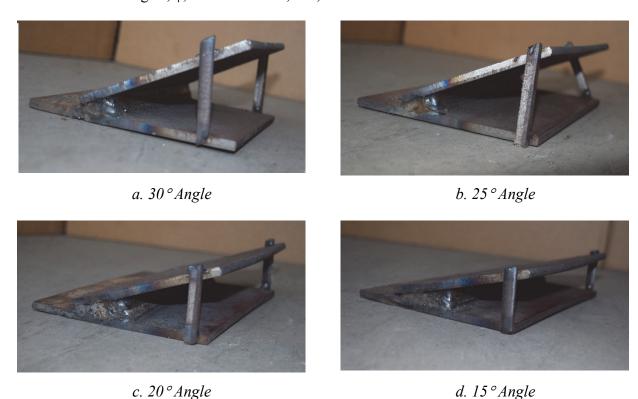


Fig. 18. Acute-angle specimens.

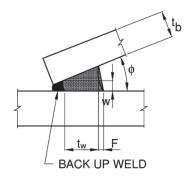


Fig. 19. Acute-angle specimens.

RESULTS

The completed welder interview questionnaires are in Appendix D and the Welding Procedure Specifications for Fabricators 1 and 2 are in Appendix E. The Welding Procedure Specification for Fabricator 3 was not available. The weld inspection report from Fabricator 1 is in Appendix F. Fabricators 2 and 3 verbally reported that all welds were inspected, and accepted as-delivered.

Welding Near Obstructions

All photographs for the sectioned clearance specimens are in Appendix A. Representative samples are shown in Figures 20, 21 and 22 for the specimens welded in Position A, B and C, respectively. The digitally-measured weld leg sizes and effective throat dimensions are listed in Table B-1 of Appendix B. The measured values, shown in Figure 12, are the effective throat, E, and the fillet weld leg sizes, W_1 and W_2 .

As indicated in Table B-1, several of the weld leg measurements are less than the specified size of $\frac{1}{4}$ in. However, these welds passed the fabricator's visual inspection and meet the visual inspection acceptance criteria requirements of AWS D1.1 Table 6.1, which allows a minimum size of $\frac{1}{4}$ in. $-\frac{3}{32}$ in. = 0.156 in. over 10% of the weld length. Based on the specified leg size, the theoretical effective throat is

$$E_t = \frac{1/4 \text{ in.}}{\sqrt{2}} = 0.177 \text{ in.}$$

Specimen 1B2-3 is the only weld with a measured effective throat less than 0.177 in. At this section, the measured dimension is only 4% less than the theoretical value. A reduction in the effective throat at this location could be predicted by evaluating the slightly undersized Leg 1. Because Leg 1 was undersized over less than 10% of the weld length, the slightly undersized effective throat can be considered within tolerance.

The welds for Specimens 1A1-1, 1A1-2, 1A2-1, 1A2-2, 1B1-1, 1B1-2, 1B2-1 and 1B2-2 were rejected by the inspector without repair. The rejected welds were in Positions 1 and 2, which were farthest from the obstruction plate. Several of the rejected specimens have undersized weld legs; however, the effective throat dimensions for these specimens are greater than the theoretical values.

As the distance between the weld and the obstruction plate decreases, the electrode angle changes, causing the arc to be increasingly directed toward the $\frac{1}{4} \times 10$ in. plate and away from the $\frac{1}{4} \times 2$ in. plates. This causes an increase in the leg aspect ratio, w_1/w_2 , and a decrease in the penetration into the base metal at Leg 2. The leg aspect ratios for each specimen are listed in Table B-1. The mean values for all specimens are plotted in Figure 23, which shows approximately equal leg sizes for Locations 1 through 5. For Locations 6 and 7, the mean value for w_1 is approximately 15 to 20% greater than w_2 . This effect is clearly demonstrated in Figures 22d, 22e and 22f, where the specimen locations are 5, 6 and 7, respectively. The aspect ratios for Locations 5, 6 and 7 are 1.20, 1.25 and 1.70, respectively.

Generally, all welds showed good fusion at both plates; however, the penetration depth at the $\frac{1}{4} \times 2$ plates (Leg 2) decreased as the distance between the weld and the obstruction plate decreased. The specimen in Figure 21a, at Location 1, showed normal root penetration. For the weld closest to the obstruction plate, Figure 21b shows a lack of significant penetration at Leg 2.

An estimate of the reduction in efficiency is the area ratio, A_m/A_t , where A_m is the weld metal area calculated with the measured leg sizes and A_t is the theoretical weld metal area calculated with the specified leg size. The area ratios for each specimen are listed in Table B-1. And the mean values for all specimens are plotted in Figure 24. At Location 1, A_m is approximately 20% more than A_t . As the distance between the weld and the obstruction plate decreases the area ratio shows an upward trend to a maximum mean value of 1.33 at Location 5.

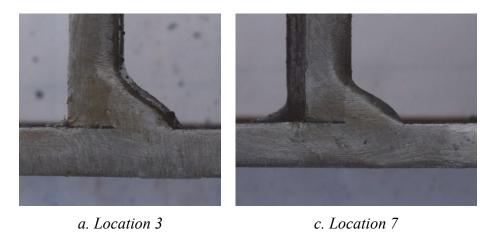


Fig. 20. Clearance specimens-Position A.

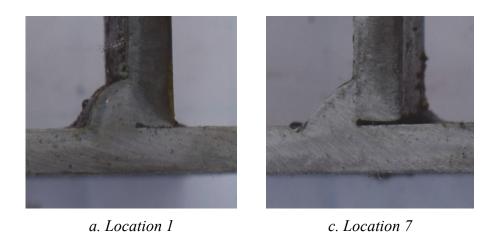


Fig. 21. Clearance specimens-Position B.

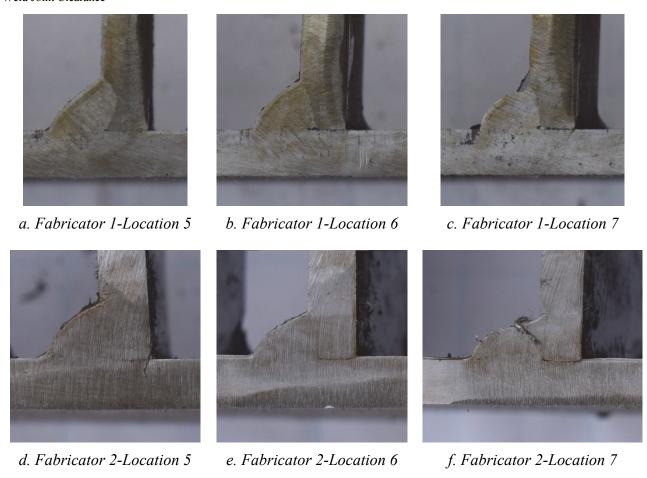


Fig. 22. Clearance specimens-Position C.

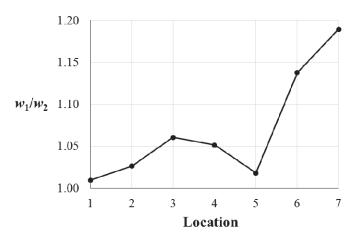


Fig. 23. Mean leg aspect ratio, w_1/w_2 , for each weld location.

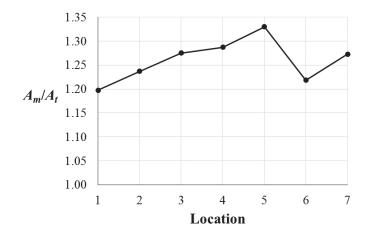


Fig. 24. Mean area ratio, A_m/A_t , for each weld location.

Doubler Plate Welds

All photographs for the sectioned doubler plate specimens are in Appendix C. Representative samples are shown in Figures 25, 26, 27 and 28 for the specimens with ¼, ¾, ½ and ¾ in. simulated doubler plate thicknesses, respectively. As shown in Figure 25, all specimens with a ¼ in. doubler plate showed good fusion and penetration into both the column and the plate. The heat input from welding melted the plate edge, creating adequate access for the welder to direct the arc toward the base metal.

The welding heat did not have the same effect on the thicker specimens. Many of the $\frac{3}{8}$, $\frac{1}{2}$ and $\frac{3}{4}$ in. specimens had adequate fusion and significant penetration, as shown for the $\frac{3}{8}$ in. doubler plate specimen shown in Figure 26b and the $\frac{3}{4}$ in. doubler plate specimen shown in Figure 28a. However, the specimens in Figures 26c, 27b, 28b and 28c, had a lack of root penetration and the specimens in Figures 27c and 28b had a low penetration depth at the doubler plate. Although these problems were more prevalent for the specimens with $x = \frac{5}{8}$ in., they were also present for the specimens with $x = \frac{1}{4}$ in.



 $a. x = 1 \frac{1}{4} in.$

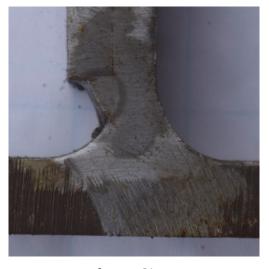


b. $x = \frac{5}{8} in$.

Fig. 25. ¼ in. doubler plate specimens.



 $a. x = 1 \frac{1}{4} in.$







 $c. x = \frac{5}{8} in.$

Fig. 26. ¾ in. doubler plate specimens.

Weld Joint Clearance







b. $x = 1 \frac{1}{4} in$.



 $c. x = \frac{5}{8} in.$

Fig. 27. ½ in. doubler plate specimens.



a. $x = 1 \frac{1}{4}$ in.







c. $x = \frac{5}{8} in$.

Fig. 28. ¾ in. doubler plate specimens.

Acute Angle Welds

The acute-angle weld specimens are shown in Figure 29. In all cases, t_w was significantly greater than $\frac{1}{2}$ in., which is the required value from AWS D1.1 (AWS, 2015) Figure 3.8 Detail D and Table 3.6. The specimens with dihedral angles, ϕ , of 20°, 25° and 30° showed good penetration and fusion throughout the joint. The specimen with $\phi = 15^\circ$ had shallow fusion, but observation of the etched sections revealed no lack of fusion at any of the weld-to-base metal boundaries. A portion of the weld length, shown in Figure 29d, had a lack of penetration at the root of approximately $\frac{1}{4}$ in. maximum.





a. 30°Angle





b. 25° Angle





c. 20°Angle





d. 15° Angle

Fig. 29. Acute-angle specimens.

CONCLUSIONS

Welding Near Obstructions

All welds at Locations 3 through 7 passed the fabricator's visual inspection and meet the visual inspection acceptance criteria requirements of AWS D1.1 Table 6.1. Although one weld section had a measured effective throat that was slightly less than the theoretical value, all welds were deemed adequate. As the distance between the weld and the obstruction plate decreases, the leg aspect ratio, w_1/w_2 , increases and the penetration into the base metal at Leg 2 decreases. The production efficiency, as measured by both the leg aspect ratio and the area ratio, was reduced at Locations 6 and 7, relative to welding at Location 1. Another issue at Location 7 is the 2 in. clearance between the welded plate and the obstruction plate will not allow access to measure Leg 2 with a standard fillet weld gage.

The welder for Fabricator 2 reported no problems except that the angle of the welding gun was restricted for welding in the vertical position at Location 7. This affected the weld leg ratio (see Figure 22f) and the production efficiency. The welder for Fabricator 3 noted that, for all three welding positions, weld quality and production efficiency was affected only for welds at Locations 6 and 7. Although the production efficiency was perceived to be the primary issue, the welder also expressed concerns regarding the potential effects on the weld fusion and penetration.

At locations 6 and 7, if a reduction in efficiency is acceptable, it appears that consistent weld quality is achievable in all three welding positions. Considering all of the issues discussed in this report, the recommended clearance for FCAW welding is $3\frac{1}{2}$ in., with an absolute minimum of 2 in.

Doubler Plate Welds

Based on the results discussed in this report, adequate fusion and penetration for a full-strength weld can be consistently obtained for $\frac{1}{4}$ in. square-cut ($\alpha = 0^{\circ}$) doubler plates welded with the FCAW process. In this case, the root opening, R, had no observable effect on the weld quality; therefore, R = 0 is recommended.

For doubler plates thicker than $\frac{1}{4}$ in., a groove angle, α , of 15° to 30° may be required to ensure consistent weld quality. Based on the results of the $\frac{1}{4}$ in. doubler plate specimens, it is expected that a $\frac{1}{4}$ in. land could be used for these joints to reduce the weld metal while maintaining weld quality.

For Question 1 of the welder questionnaire response (Appendix D1), the welder noted that proper access with a standard (non-tapered) nozzle requires a minimum groove angle of 15° to 30° for ¾ in. doubler plates and thicker. This implies that doubler plates less than ¾ in. can be square-cut. However, the results showed inconsistent fusion and penetration for the ¾ in. and ½ in. square-cut plates. Therefore, adequate welding clearance does not guarantee consistent weld quality.

Acute Angle Welds

Although the specimen with $\phi = 15^{\circ}$ had a lack of penetration at the root for a portion of the weld length, all of the acute-angle specimens met the requirements of AWS D1.1 (AWS, 2015) Figure 3.8 Detail D and Table 3.6. The shallow fusion for the specimen with $\phi = 15^{\circ}$ indicated the lack of proper access for manipulating the electrode.

Based on the welder questionnaire response (Appendix D1), a minimum angle of 15° is required for proper access. All acute-angle specimens required a non-standard nozzle. The 15° specimen was welded with a non-standard stick-out, resulting in a decrease in production efficiency.

Weld Joint Clearance

For question 3 of the questionnaire, the welder explained that acute angle welds are less problematic for round HSS compared to rectangular HSS. This is because the angle changes around the perimeter of the joint, with the smallest angle (at the heel) comprising only a small portion of the total weld length. Also, the curvature allows better access from the side of the joint.

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APPENDIX A WELDING NEAR OBSTRUCTIONS PHOTOGRAPHS OF SPECIMEN SECTIONS





a. Position A





b. Position B





c. Position C

Fig A-1. Specimen sections for Fabricator 1





a. Position A





b. Position B





c. Position C

Fig A-2. Specimen sections for Fabricator 2



a. Position A



b. Position B



c. Position C

Fig A-3. Specimen sections for Fabricator 3

APPENDIX B WELDING NEAR OBSTRUCTIONS MEASURED WELD DIMENSIONS

	Table B-1. Measured Specimen Dimensions					
Specimen	<i>w</i> ₁	w ₂	E	w_1/w_2	A_m	A_m/A_t
1A1-1	0.33	0.31	0.23	1.06	0.051	1.64
1A1-2	0.30	0.31	0.25	0.97	0.047	1.49
1A1-3	0.29	0.28	0.21	1.04	0.041	1.30
1A1-4	0.25	0.23	0.19	1.09	0.029	0.92
1A1-5	0.24	0.27	0.21	0.89	0.032	1.04
1A1-6	0.26	0.24	0.20	1.08	0.031	1.00
1A1-7	0.29	0.24	0.20	1.21	0.035	1.11
1A2-1	0.26	0.27	0.21	0.96	0.035	1.12
1A2-2	0.26	0.31	0.22	0.84	0.040	1.29
1A2-3	0.28	0.24	0.20	1.17	0.034	1.08
1A2-4	0.29	0.30	0.23	0.97	0.044	1.39
1A2-5	0.28	0.26	0.22	1.08	0.036	1.16
1A2-6	0.27	0.24	0.20	1.13	0.032	1.04
1A2-7	0.30	0.28	0.25	1.07	0.042	1.34
1B1-1	0.20	0.26	0.19	0.77	0.026	0.83
1B1-2	0.20	0.30	0.20	0.67	0.030	0.96
1B1-3	0.28	0.27	0.20	1.04	0.038	1.21
1B1-4	0.24	0.26	0.20	0.92	0.031	1.00
1B1-5	0.24	0.30	0.20	0.80	0.036	1.15
1B1-6	0.26	0.29	0.21	0.90	0.038	1.21
1B1-7	0.27	0.25	0.21	1.08	0.034	1.08
1B2-1	0.21	0.24	0.19	0.88	0.025	0.81
1B2-2	0.21	0.26	0.21	0.81	0.027	0.87
1B2-3	0.24	0.25	0.17	0.96	0.030	0.96
1B2-4	0.27	0.24	0.18	1.13	0.032	1.04
1B2-5	0.25	0.27	0.20	0.93	0.034	1.08
1B2-6	0.26	0.25	0.18	1.04	0.033	1.04
1B2-7	0.24	0.22	0.18	1.09	0.026	0.84
1C1-1	0.26	0.29	0.21	0.90	0.038	1.21
1C1-2	0.25	0.23	0.21	1.09	0.029	0.92
1C1-3	0.27	0.24	0.21	1.13	0.032	1.04
1C1-4	0.24	0.28	0.22	0.86	0.034	1.08
1C1-5	0.27	0.23	0.21	1.17	0.031	0.99
1C1-6	0.23	0.25	0.23	0.92	0.029	0.92
1C1-7	0.26	0.22	0.21	1.18	0.029	0.92
1C2-1	0.20	0.23	0.19	0.87	0.023	0.74
1C2-2	0.22	0.25	0.19	0.88	0.028	0.88
1C2-3	0.24	0.21	0.19	1.14	0.025	0.81
1C2-4	0.21	0.23	0.20	0.91	0.024	0.77
1C2-5	0.27	0.28	0.22	0.96	0.038	1.21
1C2-6	0.25	0.25	0.22	1.00	0.031	1.00
1C2-7	0.25	0.21	0.19	1.19	0.026	0.84
2A1-1	0.29	0.28	0.20	1.04	0.041	1.30
2A1-2	0.27	0.30	0.22	0.90	0.041	1.30
2A1-3	0.27	0.30	0.21	0.90	0.041	1.30

2A1-4 0. 2A1-5 0. 2A1-6 0.	29 0.3 29 0.3	32 0.21	0.91	0.046	1.48
		32 0.21	0.91	0.046	1.48
ZA1-0 U				-	
	25 0.2 29 0.2		0.86	0.036	1.16 1.16
				0.030	
	25 0.2		0.93		1.08
	24 0.2			0.032	1.04
	28 0.3		0.93	0.042	1.34
	27 0.3		0.90	0.041	1.30
	26 0.2		0.90	0.038	1.21
	28 0.3		0.93	0.042	1.34
	27 0.2		1.13	0.032	1.04
	28 0.2		1.00	0.039	1.25
	33 0.2		1.18	0.046	1.48
	34 0.3		1.10	0.053	1.69
	38 0.2		1.46	0.049	1.58
	34 0.2		1.21	0.048	1.52
	34 0.2		1.48	0.039	1.25
	33 0.2		1.14	0.048	1.53
	28 0.2		1.04	0.038	1.21
-	31 0.2		1.24	0.039	1.24
	34 0.2		1.26	0.046	1.47
	38 0.2		1.41	0.051	1.64
	32 0.2		1.23	0.042	1.33
2B2-6 0.	35 0.2	0.19	1.67	0.037	1.18
2B2-7 0.	34 0.2	28 0.23	1.21	0.048	1.52
2C1-1 0.	24 0.3	32 0.22	0.75	0.038	1.23
2C1-2 0.	25 0.2	26 0.23	0.96	0.033	1.04
2C1-3 0.	25 0.2	26 0.23	0.96	0.033	1.04
2C1-4 0.	25 0.2	26 0.23	0.96	0.033	1.04
2C1-5 0.	31 0.3	0.26	1.03	0.047	1.49
2C1-6 0.	30 0.2	0.20	1.30	0.035	1.10
2C1-7 0.	40 0.2	26 0.24	1.54	0.052	1.66
2C2-1 0.	40 0.2	0.22	1.67	0.048	1.54
2C2-2 0.	30 0.2	25 0.22	1.20	0.038	1.20
2C2-3 0	27 0.2	0.23	0.96	0.038	1.21
2C2-4 0.	27 0.2	28 0.21	0.96	0.038	1.21
2C2-5 0	26 0.2	28 0.22	0.93	0.036	1.16
2C2-6 0.	26 0.2	0.23	1.08	0.031	1.00
2C2-7 0	23 0.3	0.25	0.77	0.035	1.10
3A1-1 0.	28 0.2	26 0.22	1.08	0.036	1.16
3A1-2 0.	36 0.2	25 0.21	1.44	0.045	1.44
3A1-3 0.	34 0.2	28 0.24	1.21	0.048	1.52
3A1-4 0.	32 0.2	28 0.22	1.14	0.045	1.43
3A1-5 0.	36 0.3	0.23	1.20	0.054	1.73
3A1-6 0.	35 0.2	28 0.22	1.25	0.049	1.57
	39 0.2	23 0.22	1.70	0.045	1.44
3A2-1 0.	24 0.2	27 0.21	0.89	0.032	1.04
	34 0.2		1.31	0.044	1.41
3A2-3 0.	35 0.2	29 0.25	1.21	0.051	1.62
3A2-4 0.	31 0.2	25 0.23	1.24	0.039	1.24
3A2-5 0.	38 0.2	29 0.23	1.31	0.055	1.76
	35 0.2		1.59	0.039	1.23
	39 0.2		1.63	0.047	1.50

3B1-1	0.34	0.30	0.25	1.13	0.051	1.63
3B1-2	0.30	0.28	0.23	1.07	0.042	1.34
3B1-3	0.32	0.29	0.26	1.10	0.046	1.48
3B1-4	0.30	0.31	0.22	0.97	0.047	1.49
3B1-5	0.30	0.32	0.24	0.94	0.048	1.54
3B1-6	0.31	0.29	0.25	1.07	0.045	1.44
3B1-7	0.34	0.27	0.24	1.26	0.046	1.47
3B2-1	0.32	0.29	0.25	1.10	0.046	1.48
3B2-2	0.30	0.31	0.24	0.97	0.047	1.49
3B2-3	0.33	0.28	0.23	1.18	0.046	1.48
3B2-4	0.31	0.30	0.22	1.03	0.047	1.49
3B2-5	0.28	0.31	0.23	0.90	0.043	1.39
3B2-6	0.31	0.31	0.23	1.00	0.048	1.54
3B2-7	0.33	0.27	0.21	1.22	0.045	1.43
3C1-1	0.29	0.26	0.21	1.12	0.038	1.21
3C1-2	0.30	0.29	0.23	1.03	0.044	1.39
3C1-3	0.28	0.28	0.24	1.00	0.039	1.25
3C1-4	0.32	0.31	0.22	1.03	0.050	1.59
3C1-5	0.28	0.29	0.24	0.97	0.041	1.30
3C1-6	0.32	0.28	0.26	1.14	0.045	1.43
3C1-7	0.28	0.31	0.26	0.90	0.043	1.39
3C2-1	0.26	0.26	0.20	1.00	0.034	1.08
3C2-2	0.31	0.30	0.24	1.03	0.047	1.49
3C2-3	0.24	0.30	0.22	0.80	0.036	1.15
3C2-4	0.31	0.30	0.26	1.03	0.047	1.49
3C2-5	0.29	0.30	0.25	0.97	0.044	1.39
3C2-6	0.31	0.30	0.27	1.03	0.047	1.49
3C2-7	0.30	0.32	0.28	0.94	0.048	1.54
D - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 -						

Red shaded cells indicate a weld that was rejected by the CWI

Blue shaded cells indicate the measured dimension is less than the nominal dimension

 A_m = weld metal area calculated with the measured leg sizes, in.² A_t = weld metal area calculated with the nominal specified leg size, in.²

E = effective throat, in.

 w_1 = fillet weld leg size at the $\frac{1}{4} \times 10$ in. plate, in.

 w_2 = fillet weld leg size at the $\frac{1}{4} \times 2$ in. plate, in.

APPENDIX C DOUBLER PLATE WELDS PHOTOGRAPHS OF SPECIMEN SECTIONS







 $a. x = 1 \frac{1}{4} in.$







b. $x = \frac{5}{8} in$.

Fig. C-1. ¼ in. doubler plate specimens.







 $a. x = 1 \frac{1}{4} in.$



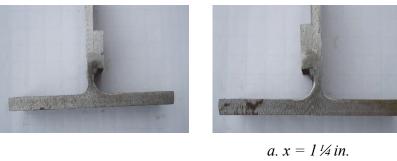




b. $x = \frac{5}{8} in$.

Fig. C-2. ¾ in. doubler plate specimens.

Weld Joint Clearance











 $b. x = \frac{5}{8} in.$

Fig. C-3. ½ in. doubler plate specimens.















b. $x = \frac{5}{8} in$.

Fig. C-4. ¾ in. doubler plate specimens.

APPENDIX D1 WELDER QUESTIONNAIRE FABRICATOR 1



WELDER QUESTIONNAIRE

For AISC Research Project

REQUIRED CLEARANCE FOR WELDED JOINTS

Date: 5/13/2013

Company: Bell Steel Company

Fitter Mike Tanton

Welder Name: Rob Lowe

Inspector: Curtis Smith

Welder Questionnaire Page 2 of 5

WELDING NEAR OBSTRUCTIONS

1) For each of the three welding positions, what is the least clearance that can be provided without affecting the weld quality (See Figure 1)?

Only on the vertical is weld productivity affected. Lower voltage settings and resulting amperage is lower resulting is a slower weld progression throughout the length of the welds.

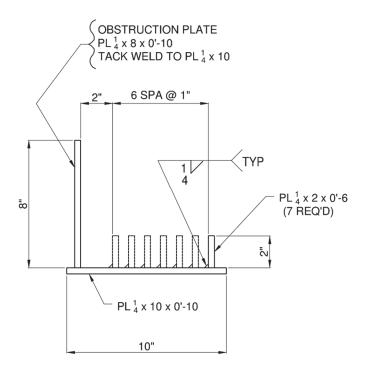


Figure 1

2) For each of the three welding positions, what is the least clearance that can be provided without affecting the production efficiency (See Figure 1)?

Found no real difference in the productivity in any of the welding on these samples that affected productivity. The vertical as stated above was slower, but because it was vertical and not because of a clearance issue

3) For small clearances, what changes in your standard welding techniques and equipment would be required?

No change was required in equipment or technique for any of the clearances provided by the samples.

How do these changes affect the weld quality and production efficiency?

N/A

Welder Questionnaire Page 3 of 5

DOUBLER PLATE WELDS

1) What values of R would you recommend for each plate thickness (See Figure 2)?

Our standard is to use 0". The plate is normally located at the intersection of the fillet with the web, or at the tangent point unless a specific weld detail or instruction is supplied by a connection engineer. On the test samples provided varied form approximately 1/8" to 1" depending on whether X was 5/8" or $1\frac{1}{4}$ ".

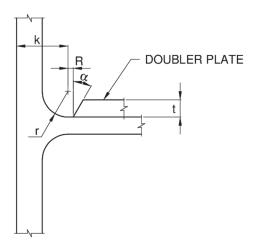


Figure 2.

2) At what doubler-plate thickness would you recommend beveling the edges to provide a groove angle greater than 0°?

On plate thickness ³/₄" (over 5/8") a 15 degrees bevel would be recommended to allow access with the standard weld nozzle tip.

For doubler plates of this thickness and greater, what values of R and α would you recommend (See Figure 2)?

On thicker samples over 3/4" it might require an increase in the bevel angle from 15 to 30 degrees depending on actual thickness of the plate.

3) Would the answer to Questions 1 and 2 change with the welding process? If so, can you provide estimates for other welding processes (SMAW, GMAW)?

We only use FCAW welding on structural steel in our shop. The only SMAW welding is for tack welding only, and then only in some cases. Most fitters are also using FCAW to make tacks; so therefore in our shop we would not require change any processes.

Welder Questionnaire Page 4 of 5

<u>Off-subject comment</u>: There was one exception to this in the past where welding stiffeners in a cruciform column actually required us to use SMAW because the gun would not fit into the space we had to make the weld. We used a E7018 electrode on these welds and welded the joist using a mirror in a handle to be able to see the weld progression. The welds were not pretty and barely passed inspection, but satisfied the requirements.

4) What changes in your standard welding techniques and equipment would be required? How do changes in variables such as electrode stick-out, contact tip-to-work distance and nozzle width affect the weld quality and production efficiency?

None for the doubler plates; however on the acute angle welds in the next section there are some noted changes.

ACUTE ANGLE WELDS

1) What is the minimum dihedral angle that can be properly welded with standard welding techniques and equipment?

Anything any less than 15 degrees might not be weldable form an access standpoint.

In welding the acute angles on the tube sample welds, the welder had to change the welding tip on his gun form the standard tip to a cone shaped welding tip which narrows down to the tip permitting to have the needed access to the weld, particularly the root passes and back welding.

In fact at all sample angles the cone shaped tip had to be utilized in order to get weldability in the joint. The standard nozzle would not allow access or enough freedom of manipulating the weld gun to properly lay in the weld passes.

For angles less than this, what changes in your standard welding techniques and equipment would be required?

Less than 15 degrees in just not feasible for us from a welding standpoint. We would try to have the design of the joint changed to a configuration we could handle fabrication wise.

How do changes in variables such as electrode stick-out, contact tip-to-work distance and nozzle width affect the weld quality and production efficiency?

The tight acute angle did require a change in the normal welding technique. It required a longer than normal stick out resulting in a longer arc, increased tip-to-work piece and slower welding travel speeds as a result, which would affect the time required in making the root pass and several of the additional passes of the back weld. Once the weld is layered in and the back weld completed the stick out is reduced some increasing the weld travel speed slightly. The welder just adjusted stick out when completing the passes as was required and did not really kept any accurate measurement of the stick out during the welding of the

Welder Questionnaire Page 5 of 5

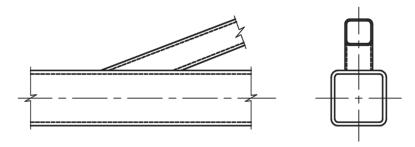
samples.

2) Will the answer to Question 1 change with welding position?

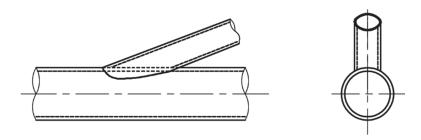
The welding position can be a problem depending on the actual work piece in terms of being able to access the joint in which the acute angle occurs depending on piece geometry. This in itself could dictate a different welding position be used than the one you really would like to use. However, in most circumstances we can manipulate items so as to achieve the best position for the welder prior to starting and completing his welds.

3) For welding the acute angle, are there any differences between rectangular and round HSS (See Figure 3)?

Yes, the round tubing or pipe in general terms is easier to weld as the area where the acute angle occurs is smaller and has better access with some access being form outside the pipe. As you move around the joint once past the small acute angle it becomes easier to weld. There are some special considerations when welding pipe intersections which can require different perpetration on different parts of the pipe to achieve a good weld.



Rectangular HSS Connection



Round HSS Connection

Figure 3.

APPENDIX D2 WELDER QUESTIONNAIRE FABRICATOR 2



WELDER QUESTIONNAIRE

For AISC Research Project

REQUIRED CLEARANCE FOR WELDED JOINTS

Date:

9/27/16 ny: NAFCO

Company:

Welder Name: Jae Pruett



WELDING NEAR OBSTRUCTIONS

1) For each of the three welding positions, what is the least clearance that can be provided without affecting the weld quality (See Figure 1)?

Verticle - affected tourch angle on last plater
Horiz (vert obstruction) - None
Horiz (horiz ob.) - None

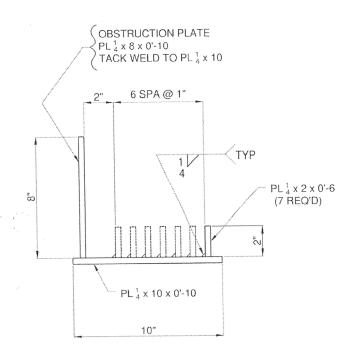


Figure 1

2) For each of the three welding positions, what is the least clearance that can be provided without affecting the production efficiency (See Figure 1)?

No problems

3) For small clearances, what changes in your standard welding techniques and equipment would be required?

None except verticle. The last plate affected the tourch angle somewhat.

How do these changes affect the weld quality and production efficiency?

The change in tourch angle caused the weld to be less uniform and it took a little longer to get in a comfortable welding position.

APPENDIX D3 WELDER QUESTIONNAIRE FABRICATOR 3



WELDER QUESTIONNAIRE

For AISC Research Project

REQUIRED CLEARANCE FOR WELDED JOINTS

Date: 9-14-16

Company: Structural Steel Services, Inc.

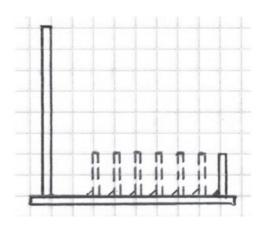
Welder Name: Timmy Boles

Welder Questionnaire Page 2 of 3

WELDING NEAR OBSTRUCTIONS

1) For each of the three welding positions, what is the least clearance that can be provided without affecting the weld quality (See Figure 1)?

For each of the welding samples, issues began at the second last fillet weld location for each of the positions. This location was 3" from the obstruction plate, marked on the sample as position F. All three full samples had this same outcome, fillet welds F & G (measured at 3" & 2" from the obstruction plate, see Figure 1 below).



a. vertical obstruction plate

Samples Marked 1A – 1G

b. horizontal obstruction plate

Samples Marked 2A – 2G

Note: Samples marked 3A - 3G are the samples welded in the vertical position

Welder Questionnaire Page 3 of 3

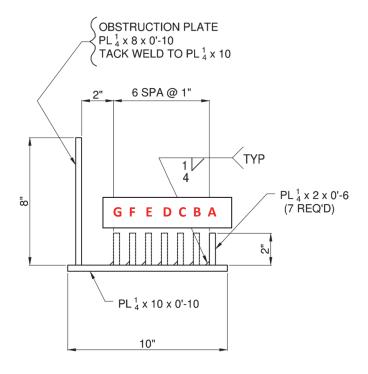


Figure 1

2) For each of the three welding positions, what is the least clearance that can be provided without affecting the production efficiency (See Figure 1)?

At 4" from the obstruction plate (location E), the welds were able to be made without affecting the production efficiency. When the welds were made closer to the obstruction plate, the production efficiency and the quality of the weld appeared to be affected.

3) For small clearances, what changes in your standard welding techniques and equipment would be required?

For the small clearances, we had to adjust the nozzle and our position to accomplish the weld. The obstruction plate forced a limited area for mobility for the welder.

How do these changes affect the weld quality and production efficiency?

The quality of the welds was slightly affected, but the production efficiency was what was affected the most. The welder had to readjust and figure out the best way to make a quality weld for these tight positions. These adjustments were made to hopefully still able to make a quality weld. The size of the welds was able to be achieved, but the penetration and fusion of the weld is what could be affected by these adjustments.

APPENDIX E1 WELDING PROCEDURE SPECIFICATIONS FABRICATOR 1

AWS - Prequalified Welding Procedure Specification (pWPS)

WeldOffice WPS

Come	any nam	10	Bell Steel				cation #				WPS 120-1 Rev.
Weldir	any nam ng proce ss type		FCAW Semi-automatic			Date	ated by			Ron Phillip 5/14/2013 Curtis Smit	
						Date				5/14/2013	
	lesign u	sed				Positio					
Joint to Joint of Backin	lesign		B - Butt joint Single V groove (2) Yes				Welding position: Groove All Fillet All				
Backin	ng mater		Weld metal			Vertical progression Up Electrical characteristics					
	pening		1/8, +1/16, -0 (+1/16	6, -1/8)					CONTROL CO		
Groove	ace (f)* e angle s (J - U)' gouging	(a)* (deg.)	0 to 1/8, +1/16, -0 (N 60, +10, -0 (+10, -5) n/a Yes			Curren Other		(GM/	AVV)	Spray DCEP Constant V	oltage (CV) power supply
	gouging	method	Mechanical or Therm			Stringe	er or wea	ave be	ead	Stringer or	Weave
Base n				* Datum, As De	tailed (As Fit-Up)	Multi/s	ingle pas	ss (pe	er side)	Single or M	lultiple
Thickn		Groove (in.) Fillet (in.)	AWS D1.1 Table 3.1 T1:unlimited All	Group II		Numbe Spacin	er of elec ig: L	Longit L	tudinal (in.) Lateral (in.)	-	trode
	ter (Pipe	e) (in.)	Unlimited			Contac	t tube to		(0.5 - 1	
AWS S	netais Specifica	ation	E 20			Peenin	ıg			Not permitte	
	Classific		5.20 E71T-1C-H8				ss clean	ning		Brushing or	rgrinding
Shieldi	ng					Prehea			N.C.	0	
	de-flux		-				at temp.: iss temp.		Min. (°F)	See notes See notes	
	omposition of the composition of		CO2 (A5.32 SG-C) 35-45			Post we	eld heat	treat	tment		
	ip size		3/8-5/8			Tempe	rature		(°F)	None	
Veldin	a proce	dure		RITE		Time			(hrs)	-	
- c.um	elding procedure Filler Cu				Current		Wire fe	eed		Travel	
Layer	Pass	Process	Filler metal class	metal diameter (in.)	type / polarity	Amps	spee (in./mi	ed	Volts	Travel speed	Joint details
1	All	FCAW FCAW	E71T-1C-H8 E71T-1C-H8	0.045 0.052	DCEP	145-220 165-265	200-6		23-28 24-29	6-12 6-12	
1	All	FCAW	E71T-1C-H8	1/16	DCEP	275-320	200-6		27-31	6-12	
											R
lotes									Designation	n I	B-U2-GF
PREHE For thic	kness 1 /4 thru 1 -1/2 thru -1/2(in.):	-1/2(in.): 50(°F). 2-1/2(in.): 150(°F 225(°F).	F). Preheat to 70(°F) i). for further limitations	if the base me	etal temperal	ture is belov	w 32(°F).				
Over 1- Over 2-	ditional										
Over 1- Over 2- See ad				0	20	Signature	2				
Over 1- Over 2- See ad ignatu	ıre 1		Signature	tonald MP	2000	Signature Name	2			Signa	ture
Over 1- Over 2- See ad ignatu Name Ron Ph	ıre 1		Signave	tonald MP			9.2			Signat	ture
Over 1- Over 2- See ad ignaturians Name Ron Ph	ire 1		Signare	Consid MP	MINDER STATE OF A STAT		2			Signat	ture
Over 1- Over 2- See ad ignatur Name Ron Ph Date	ire 1		Signate	Conglet MP P		Name				Signa	ture
Over 1- Over 2- See ad signatu Name Ron Ph Date ignatu	ire 1		Signature Signature	Consider of P	Miles of					Signat	
Over 1- Over 2-	ire 1	,	And	Consider P	orly for the state of the state	Name Signature					

WeldOffice WPS 2013.02.023 Catalog n° PWP00221

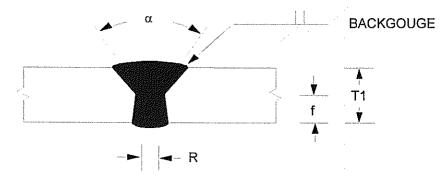
Bell Steel Co.

Welding Procedure Specification

Bell Steel WPS 120

WPS No.	Bell Steel		evision 0		Date 7/15/199		on Phillips			
	By Curtis			Date	7/15/1998	·	ualified 🖾			
Welding Pro		FCAW			Type: Manu	ıal 🗌 Mac	hine 🗌 Semi-A	uto 🛭 Auto 🗌		
Supporting	PQR(s)	AWS D1.1								
JOINT		ON THE RESERVE OF THE PROPERTY				Single-V-groove we But joint (8)	H (7)			
Type Bu	utt					<u> </u>		BACKGOUGE		
Backing '	Yes □ No	Single Weld	☐ Doub	le Weld ⊠				- j. j.		
Backing M	/laterial N/	Α					Lannan and an analysis of the state of the s			
Root Ope	ning 1/8"+/ -1	I/16" Root Face Di	mension 1	1/8"+/-1/16'	•		~ ≠ ₹			
Groove A	ngle 60°	Radius (J-	U) N/A				The kness Root Opening	Toperation Toperation Permitted Gas \$4		
Back Gou	ge Yes	⊠ No □				Wedding				
Meth	nod Gri i	nd or Gouge				FCAVY B-U2-OF		is a Nothment All facility		
BASE MET					POSITION	LALLES MANAGEMENT				
Material S		i to	A-36		Position of G	roove All	Fille	t All		
Type or G		OUP 1 to		1	Vertical Prog	ression:	⊠ Up □ [Down		
Thickness	s: Groove (ir	1/8 ו	- Unlimi	ited	ELECTRICAL	CHARACTE	ERISTICS			
	Fillet (ir	n)Any	- Any		Transfer Mo	de (GMAW):				
Diameter	(Pipe, in)	24	- Unlimi	ited	Short-C	Circuiting [Globular 🗌	Spray □		
FILLER ME	ETALS				Current: A	C DCE	P⊠ DCEN □	Pulsed		
AWS Spe	cification A	5.20			Other N/A	•				
AWS Clas	ssification E	71T-1			Tungsten Ele	ectrode (GTA	\W):			
					Size N/A	1	Type N/A			
SHIELDING					TECHNIQUE					
Flux	3	Gas Carbon	Diovide		Stringer or Weave Bead Both					
N/A		Composition 1			Multi-pass or Single Pass (per side) Multiple					
***************************************	-Flux (Class)	 '	5-45 CFH		Number of E	Number of Electrodes 1				
N/A		Gas Cup Size	10-12		Electrode Sp	pacing: Long	itudinal <u>N/A</u>			
PREHEAT							Lateral <u>N/A</u>	CAAA VAAA AAA AAA AAAA AAAA AAAA AAAA A		
	emp., Min.	SEE MEMO					Angle N/A			
Thicknes	ss Up to 3/4	f" Temperature	SEE MEM	10	Contact Tub	e to Work Di	stance 1/2"-3/4	4 "		
	r 3/4" to 1-1/:	·	50° F	· · · · · · · · · · · · · · · · · · ·	Peening N	/A				
	-1/2" to 2-1/2		150° F		Interpass Cl	eaning Cl	HIP OR GRIND/W	IRE BRUSH		
	Over 2-1/2		225° F		POSTWELD	HEAT TREA	TMENT PWH1	Required		
Interpass	Temp., Min.		x. 350° F		Temp. N/A		Time N/A			
				WELDIN	G PROCEDURE					
Layer/Pass	Process	Filler Metal Class	Diameter	Cur. Type	Amps or WFS	Volts	Travel Speed	Other Notes		
ALL	FCAW	E71T-1	0.045	DCEP	175-220	23-28	8-10 IPM			
ALL	FCAW	E71T-1	0.052	DCEP	180-250	24-29	8-10 IPM	\$ / AAAAAA		
ALL	FCAW	E71T-1	1/16"	DCEP	195-300	26-32	8-10 IPM			
	ometral I am selection at attack the Normalism and a selection of the Normalism and a selection of the Normalism and the		The state of the s							
			try Arrenance			^	ROHALD M.	PHILLIPS		
	, , , , , , , , , , , , , , , , , , ,	THE PROPERTY OF THE PROPERTY O	Transaction of the state of the	:	CANADAM DAMA	AIII	1.3	040091		
						MIL	1 C//	P. 64/01/11		
		gleder all throat Welson and the end obtained a charine and a sub-radial conduction control			1900s - 11900 1900 1900 1900 1900 1900 1900 1		, we see 36.50	**************************************		

Single-V-groove weld (2) Butt joint (B)



		Base Metal Thickness oint (U=unlimited)		Gı	roove Preparatio				
Welding	Joint Designation			Root Opening Root Face	To As Detailed	olerances As Fit Up	Permitted Welding		N o t
Process		T1	T2	Groove Angle	(see 3.13.1)	(see 3.13.1)	Positions	for FCAW	e s
GMAW FCAW	B-U2-GF	U	-	R = 0 to 1/8 f = 0 to 1/8 $\alpha = 60^{\circ}$	+1/16, -0 +1/16, -0 +10°, -0°	+1/16, -1/8 Not limited +10 °, -5°	AH	Not required	A C N

MEMO

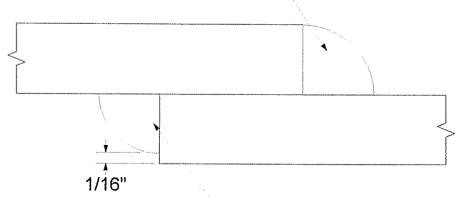
1) When the base metal is below 32 degrees F. (0 Deg. C), the base metal shall be preheated to at least 70 Degrees F (32 Deg. C) and this minimum temprature maintained during welding.

A: Not prequalified for gas metal arc welding using short circuiting transfer nor GTAW. Refer to Annex A.

N: The orientation of the two members in the joints may vary from 135° to 180° for butt joints, or 45° to 135° for corner joints, or 45° to 90° for T-joints.

	illet Weld Sizes I Thickness (T)		ım Size t Weld	
in.	mm	in.	mm	
T <1/4	T < 6.4	1/8	3	
1/4 < T < 1/2	6.4 < T < 12.7	3/16	5	
1/2 < T < 3/4	12.7 < T < 19.0	1/4	6	
3/4 < T	19.0 < T	5/16	8	
Maximum single p Fillet Weld Size Flat 3/ Horizontal 5/1	3		0-1/8" M	ax

Base Metal Less Than 1/4" Thick



Base Metal Greater Than 1/4" Thick

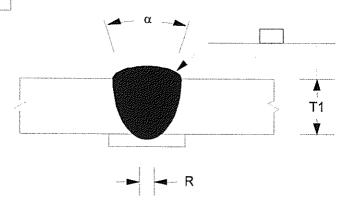
Maximum Detailed Size of Fillet Weld Along Edges

Welding Procedure Specification

Bell Steel WPS 121

M/DC M-	D-11 04							
WPS No.	***************************************		levision <u>(</u>		Date <u>9/8/2008</u>		Ron Phillips	WITHIN THE
	By Curtis			Date	9/8/2008		equalified 🛚	
Welding Pr		FCAW	<u> </u>		Type: Man	ual 🗍 Ma	achine 🗌 Semi-A	Auto ⊠ Auto □
Supporting	PQR(s)	AWS D1.1						**************************************
JOINT						Single-V-groove Butl joint (B)	e weld (2)	
Type B	utt	· · · · · · · · · · · · · · · · · · ·					Ţ <u></u>	<u> </u>
Backing	Yes 🛭 No	Single Weld	⊠ Doub	ole Weld 🗌]			11
Backing I	Material S	TEEL						novoroveniminosvo. 157 Foor.
Root Ope	ning <u>3/16"-3</u>	Root Face D	mension	N/A	****			
Groove A	ngle 30°-45	r Radius (J.	U) N/A				Brise Victor Groove Free Proceeds	Enterpress Permitted Cart 16
Back Gou	ige Yes	No ⊠				Waking José Protess Designa	tion T1 T2 Opening Angle (see	Pitaled As Folip Weiding Shelding (2131) (see 3131) Postons for FCAW 6
Met	hod N/A	\	·			GMAW B-1026	OF U - R+3/6 (3-30) R**	trie o +116 trie Fryces Fistred N to o +10 -5 Fryces Fistred N
BASE ME	TALS				POSITION	Norman and accounts	And the second s	Access of the second se
Material S	Spec. <u>A-30</u>	to	A-36		Position of C	Froove A	<u>II </u>	et All
Type or G	W-AL-7112	OUP 1 to	GROUP	1	Vertical Prog	gression:	⊠ Up □	Down
Thickness	s: Groove (i	·····	- Unlim	ited	ELECTRICAL	. CHARAC	TERISTICS	
		n)Any	- Any		Transfer Mo	de (GMAW	'):	
Diameter	(Pîpe, in)	24	- Unlim	ited	Short-0	Circuiting [☐ Globular ☐	Spray □
FILLER MI	ETALS				Current: A	C DC	CEP 🛛 DCEN 🗆	Pulsed 🗌
AWS Spe	cification A	5.20			Other N/A			a con control and a control an
AWS Cla	ssification E	71T-1			Tungsten El		ΓAW):	
					Size N//		Type N/A	
SHIELDING	G				TECHNIQUE			
Flux	_	Gas Carbon	Dioxide		Stringer or V	Veave Bead	Both	
N/A		Composition 1					ss (per side) 🛚 💆	/lultiple
Electrode	-Flux (Class) Flow Rate 3	5-45 CFH		Number of E	lectrodes	1	
N/A		Gas Cup Size	10-12		Electrode Sp	pacing: Lor		
PREHEAT			***************************************				Lateral N/A	
Preheat 1	emp., Min.	SEE MEMO					Angle <u>N/A</u>	
Thickne	ss Up to 3/4	4" Temperature	SEE MEN	10	Contact Tub		Distance 1/2"-3/	4''
Ove	r 3/4" to 1-1/	2"	50° F		Peening N		CUID OD CDINDS	ADE BOILEIL
Over 1	-1/2" to 2-1/	2"	150° F		Interpass Cl	earning <u>t</u>	CHIP OR GRIND/W	VIKE BRUSH
	Over 2-1/	2"	225° F		POSTWELD	HEAT TRE	ATMENT PWH	T Required □
Interpass	Temp., Min.	50° F Ma	x. 350° F		Temp. N/A	· · · · · · · · · · · · · · · · · · ·	Time N/A	
				WELDIN	IG PROCEDURE			
Layer/Pass	Process	Filler Metal Class	Diameter	Cur. Type	Amps or WFS	Volts	Travel Speed	Other Notes
ALL	FCAW	E71T-1	0.045	DCEP	175-220	23-28	8-10 IPM	
ALL	FCAW	E71T-1	0.052	DCEP	180-250	24-29	8-10 IPM	NATONINO PERPENDIA E E PETERNA ELIMINA
ALL	FCAW	E71T-1	1/16"	DCEP	195-300	26-32	8-10 IPM	American
					1		DOMAIN &	A DAIIIIDS
	** * *******					M	188177	A, PHILLIPS PADADDOI
		ол (9 A 77 A 70 A 70 A 70 A 70 A 70 A 70 A 7			W.		
						~	V VVI	EXP. 04/01/51
		LANGE PARTY AND THE PARTY AND			CONTROL MACHINE MACHIN			*

Single-V-groove weld (2)
Butt joint (B)



		Base Metal			Gro					
Welding Process		Thickn				Tole	erances	Permitted	Gas	N O
		(U=unlimited)		Root	Groove	As Detailed	As Fit Up	Welding	Shielding	t e
	Designation	T1	T 2	Opening	Angle	(see 3.13.1)	(see 3.13.1)	Positions	for FCAW	S
CMANA			U -	R = 3/16	α = 30°	R = +1/16, -0	+1/41/16	F,V,OH	Required	Α
GMAW FCAW	B-U2a-GF	U		R = 3/8	α = 30°	$\alpha = +10^{\circ}, -0^{\circ}$	+10°5°	F,V,OH	Not req.	١
		American major ins		R = 1/4	α = 45°	u , , , -0	. 10 , -0	F,V,OH	Not req.	

MEMO

1) When the base metal is below 32 degrees F. (0 Deg. C), the base metal shall be preheated to at least 70 Degrees F (32 Deg. C) and this minimum temprature maintained during welding.

A: Not prequalified for gas metal arc welding using short circuiting transfer nor GTAW. Refer to Annex A.

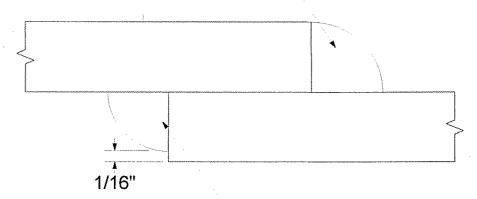
N: The orientation of the two members in the joints may vary from 135° to 180° for butt joints, or 45° to 135° for corner joints, or 45° to 90° for T-joints.

Minir	num Fill	et Weld Sizes	Minimum Size		
Bas	e-Metal ⁻	Thickness (T)	of Fillet Weld		
in.		mm	in.	mm	
T <1/4		T < 6.4	1/8	3	
1/4 < T <	1/2	6.4 < T < 12.7	3/16	5	
1/2 < T <	3/4	12.7 < T < 19.0	1/4	6	
3/4 < T		19.0 < T	5/16	8	
Maximum s Fillet We		38			
Flat	3/8				
Horizontal	5/16				

Note N

0-1/8" Max

Base Metal Less Than 1/4" Thick



Base Metal Greater Than 1/4" Thick

Maximum Detailed Size of Fillet Weld Along Edges

AWS - Prequalified Welding Procedure Specification (pWPS)

WeldOffice WPS

^							Identific	ation #		Bell Steel 1	30 Rev. 1	
ompar	ny name			Bell Steel			Origina	ted by		Ron Phillips	S	
Velding	proces		200	FCAW			Date			5/21/2010 Curtis Smit	h	
rocess	stype			Semi-automatic			Authoriz	zea by		5/21/2010		
oint de	sign us	ed					Position	1				
Joint typ	PARTICIPATE OF THE PARTICIPATE O			B - Butt joint			Welding	g position:	Groove			
Joint de	esign			Single bevel groove (4	4)		No. at a		Fillet	All Up		
Backing		ol.	202	Yes Weld metal			Vertical progression Up Electrical characteristics					
	g materia ening (l		100	0 to 1/8, +1/16, -0 (+1	/16, -1/8)	A LOS TO LEGISLA	NO DOCUMENTO OF THE PARTY OF TH			0		
Root fac	ce (f)*	(1	n.)	0 to 1/8, +1/16, -0 (No			Transfe	er mode (GM	AW)	Spray		
	angle (45, +10, -0 (10, -5) n/a			Other	rtype			oltage (CV) power supply	
Radius Back go	(J - U)* ouaina	(de		n/a Yes			Technic	que				
	ouging r	nethod	0000	Mechanical or Therma	al		EVOQUOUS DIRECT	r or weave b	ead	Stringer or	Weave	
Base m	etals	The second secon			* Datum, As Det	ailed (As Fit-Up)	Multi/si	ngle pass (pe	er side)	Single or N	Multiple	
	type or g			AWS D1.1 Table 3.1	Group II		- NACTOR (000000000000000000000000000000000000	or of electrode	es itudinal (in.)	Single elec	ctrode	
Thickne	ess:			T1:unlimited			Spacin		Lateral (in.)	-		
Diamet	er (Pipe		20054	All Unlimited					Angle (deg.)	-		
iller m	Section Section					THE RESERVE OF THE PARTY OF THE	0.0000000000000000000000000000000000000	t tube to wor	k (in.)	0.5 - 1 Not permit	ted	
-	pecifica	tion		5.20	THE HEAT		Peenin	g ss cleaning		Brushing o		
	lassifica			E71T-1			Prehea					
Shieldir	ng						Tracks appropriate	it temp.:	Min. (°F)	See notes		
Flux				-				ss temp.:	Min. (°F)	See notes		
Electro	de-flux								Max. (°F)	See notes		
Gas co	mposition w rate		ofb)	CO2 (A5.32 SG-C) 35-45			Post w	eld heat trea				
Gas cu	100000000000000000000000000000000000000			1/2"			Tempe	rature	(°F) None (hrs) -			
Malar		4					Time		(nrs)			
velding	g proce	aure			Filler	Current		Wire feed		Travel		
Layer	Pass	Process		Filler metal class	metal diameter	type / polarity	Amps	speed	Volts	speed	Joint details	
					(in.)	polarity		(in./min)		(in./min)	Cotton Commission Control Cont	
1	All	FCAW		E71T-1	0.045	DCEP	175-200	250-500	23-28	8-10		
1	All	FCAW		E71T-1	0.052	DCEP	180-250	250-500	24-29	8-10		
1	All	FCAW		E71T-1	1/16	DCEP	195-300	250-500	26-32	8-10	11	
					The state of the s					The same of the sa		
											+	
										topinetranet	BACKGO	
		man Research Control of the Control									→ V-I+-T ₁	
									I complete.			
				, 100 mm - 1					Designation	n	B-U4b-GF	
Notes									Dosignatio	A CONTRACTOR	12 0,	
PREHE		ERPASS		95) Decke - 11- 70/95)	if the base	atal tages	husa is hal-	32/9E\				
		1/8 to 3/4(in.): 3 1-1/2(in.): 150(°		°F). Preheat to 70(°F)	if the base m	etai temperat	ure is belo	w 32(°F).				
Over 1	-1/2 thru	u 2-1/2(in.): 225										
		: 300(°F).	00	for further limitations								
See ao	unional	ппоннацон ра	9e	ioi iurulei iiiiitatioris								
			O COLOR	TURBURA TURB TOOL TURB TOO TO THE			Signatur	re 2				
	ure 1			Signature	enikin i	Dulline	Name			Sign	nature	
Name				ATTIA		I. PHILLIPS			and the contract of the same and the same an	0000000000000		
Name Ron Ph				(4)11 1161 M	> CWI	76040091	Date					
Name Ron Ph Date	hillips			Tolling .	CIII					177		
Name Ron Ph Date 5/21/20	hillips 010	00137 0020 TOTAL OLD O	01001	ATT OF	OC1	FXP. 04/01/11	0' '					
Name Ron Ph Date 5/21/20 Signatu	hillips 010			alla		EXP: 04/01/11	Signatur	re 4		0.	natura	
Ron Ph Date	hillips 010			Signature		EXP: 04/01/11	Signatur	re 4		Sign	nature	
Name Ron Ph Date 5/21/20 Signatu Name	hillips 010			Signature			Name	re 4		Sign	nature	
Name Ron Ph Date 5/21/20 Signatu	hillips 010			Signature		1000 00 00 00 00 00 00 00 00 00 00 00 00	Signatur	re 4		Sign	nature	

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AWS - Additional Information (pWPS)

WeldOffice WPS

Identification #

Bell Steel 130

Rev. 1

D1.1 Table 3.7 states:

T37-01.3

Maximum GMAW/FCAW electrode diameter for flat and horizontal position is 1/8 in. (3.2 mm).

Maximum GMAW/FCAW electrode diameter for vertical position is 3/32 in. (2.4 mm).

Maximum GMAW/FCAW electrode diameter for overhead position is 5/64 in. (2.0 mm).

T37-02.1

Maximum current shall be within the range of recommended operation by the filler metal manufacturer.

T37-03.1

Maximum root pass thickness:

3/8 in. (10 mm) for Flat,

5/16 in. (8 mm) for Horizontal,

1/2 in. (12 mm) for Vertical,

5/16 in. (8 mm) for Overhead position.

T37-04.3

Maximum GMAW/FCAW fill pass thickness is 1/4 in. (6 mm).

T37-05.3

Maximum GMAW/FCAW single-pass fillet weld size:

1/2 in. (12 mm) for Flat,

3/8 in. (10 mm) for Horizontal,

1/2 in. (12 mm) for Vertical,

5/16 in. (8 mm) for Overhead position.

T37-06.1

Maximum GMAW/FCAW single-pass layer width:

-Root opening > 1/2 in. (12 mm): Split layers.

-Any layer of width w: In the F, H, or OH positions for nontubulars, split layers when the layer width w > 5/8 in. (16 mm). In the vertical position for nontubulars or the flat, horizontal, vertical, and overhead positions for tubulars, split layers when the width w > 1 in. (25 mm).

D1.1 Table 3.7. end of quote.

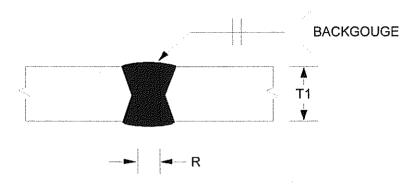
Catalog n° pWPS00134

Welding Procedure Specification

Bell Steel WPS 143

					***************************************		·		
WPS No.	Bell Stee	I WPS 143 F	Revision	0	Date <u>4/24/20</u>	06	By Ron Pierce	•	
Authorized	By Clevel	land Rhoades		Date	4/24/2006		Prequalified 🗵	,	
Welding Pr	ocess(es)	FCAW			Type: Mar	nual 🗌	Machine Semi-	Auto ⊠ Auto □	
Supporting	PQR(s)	AWS D1.1		B-L1b-GF					
JOINT						Squar Buti jo	re-proove weld (1) Int (8)	The state of the s	
Туре В	utt					American de la constitución de l		BACKGORIGE	
Backing	Yes 🗌 No	o ⊠ Single Weld	l 🗌 Dou'	ble Weld ⊠]			7	
Backing	Material N	I/A					<u> </u>	.	
Root Ope	ening 0-1/8 "	Root Face D	imension	N/A	TA CALO PROPERTY AND THE PARTY		~ ~	• ··· R	
Groove A	Ingle N/A	Radius (J	-U) N/A			£	Base Metal Groom	e Proparation	
Back Go	ude Yes	s 🗵 No 🗍	THE PROPERTY OF THE PROPERTY O			Welsing Process	Joint (Ununlimited) Rock A	Tolerances Permitted Gas II #Elvisited As Fallip Westing Shisting 6 em 3 12 11 (see 3 13 1) Positions for FCAW R	
		RIND OR GOUGE				GUAW FCAW	BLIDGE 18 mas - Richs 146 -	tist, o +tist -1% All Required C. N.	
BASE ME					POSITION				
Material :		6 to	A-36		Position of	Groove	All Fill	et All	
Type or C	********	OUP 1 to		1	Vertical Pro			Down	
	s: Groove (i		- 3/8"		-		ACTERISTICS		
		in)Any	- Any		Transfer Mo				
Diameter	(Pipe, in)	24	- Unlim	ited		Circuiting	•	Spray 🗌	
FILLER M	ETALO						DCEP 🖾 DCEN 🗆	` •	
	ecification A	A5.20			Other N/		\ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \	,	
•	ssification E				Tungsten E		(GTAW):		
			***************************************		Size N/		Type N/A		
			***************************************		TECHNIQUE				
SHIELDIN Flux	G	Gas Carbon	Diovido		Stringer or Weave Bead Both				
N/A		Composition 1			Multi-pass or Single Pass (per side) SEE MEMO				
	-Flux (Class		5-45 CFH		Number of Electrodes 1				
N/A	,	Gas Cup Size	10-12		Electrode S	pacing:	Longitudinal N/A		
PREHEAT			***************************************				Lateral N/A		
	Гетр., Min.	SEE MEMO					Angle N/A	,	
			SEE MEN	10	Contact Tut	e to Wo	rk Distance N/A		
	r 3/4" to 1-1/		50° F		_ ~	√A		:	
Over '	1-1/2" to 2-1/	2"	150° F		Interpass C	leaning	CHIP OR GRIND/W	VIRE BRUSH	
	Over 2-1/	2"	225° F		POSTWELD	HEAT T	REATMENT PWH	T Required □	
Interpass	Temp., Min.	. 50 F Ma	x. 350 F		Temp. N/A		Time N/A		
			***************************************	WELDIN	G PROCEDURE				
Layer/Pass	Process	Filler Metal Class	Diameter		Amps or WFS	Volts	Travel Speed	Other Notes	
ALL	FCAW	E71T-1	0.045	DCEP	175-220	23-28	8-10 IPM		
ALL	FCAW	E71T-1	0.052	DCEP	180-250	24-29	8-10 IPM		
ALL	FCAW	E71T-1	1/16"	DCEP	195-300	26-32	8-10 IPM		
			7.10		(20-32	O-10 IF W	!	
and an extension of the second							RONALD M. PHILI	IPS	
	-				The state of the s		CWI 960400	APPER 1994 APPER 1994 APPER 1111 APPER 111 APP	
					nd a the the material access open springers report (1170-1941) 11100/AD	Mall	OC1 EXP. 04	/01/11	
PVIII - 11.1/		3			i	: *			
					<u></u>	:		<u> </u>	

Square-groove weld (1)
Butt joint (B)

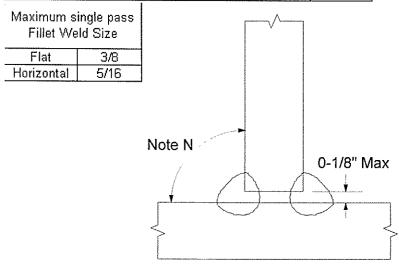


		Base Metal Thickness		G					
					Tolerances		Permitted		N
Welding	Joint Designation	(U=unlim	ited)	Root	As Detailed	As Fit Up	Welding	Shielding for FCAW	
Process		T1	T2	Opening	(see 3.13.1)	(see 3.13.1)	Positions		s
GMAW FCAW	B-L1b-GF	3/8 max	-	R=0 to 1/8	+1/16, -0	+1/16, -1/8	AH	Not Required	A C N
					2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2				· · · · · · · · · · · · · · · · · · ·

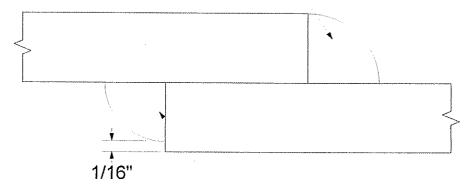
MEMO

- 1) When the base metal is below 32 degrees F. (0 Deg. C), the base metal shall be preheated to at least 70 Degrees F (32 Deg. C) and this minimum temprature maintained during welding.
- A: Not prequalified for gas metal arc welding using short circuiting transfer nor GTAW. Refer to Annex A.
- N: The orientation of the two members in the joints may vary from 135° to 180° for butt joints, or 45° to 135° for corner joints, or 45° to 90° for T-joints.

	Minimum Fillet Weld Sizes Base-Metal Thickness (T)						
in.	in. mm						
T <1/4	T < 1/4 T < 6.4						
1/4 < T < 1/2	6.4 < T < 12.7	3/16	5				
1/2 < T < 3/4	12.7 < T < 19.0	1/4	6				
3/4 < T	19.0 < T	5/16	8				



Base Metal Less Than 1/4" Thick



Base Metal Greater Than 1/4" Thick

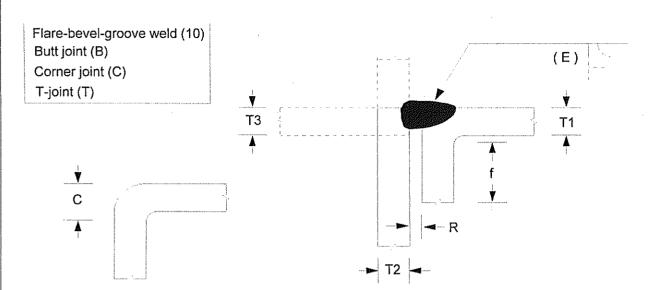
Maximum Detailed Size of Fillet Weld Along Edges

Bell Steel Co.

Welding Procedure Specification

BELL STEEL WPS 144

WPS No.	BELL ST	TEEL WPS 144	Revision	0	Date 7/31/2	2006	By Ron Pierce				
Authorized	d By Cleve	land Rhoades		Date	7/31/2006	***************************************	Prequalified ⊠	THE TAXABLE PARTY OF THE PARTY			
· .	Process(es)	FCAW			Type: Ma			-Auto ⊠ Auto 🗌			
Supporting	g PQR(s)	AWS D1.1		BTC-P10-		andar [_]	Maciline [] Semi	-Auto ⊠ Auto □			
JOINT						Flare-bi	avel-groove weld (10) 1				
_	Butt					Butt jok Corner T-joint (# (B) pint (C)	(E) F			
Backing		o ⊠ Single Wel		-b-1-101.11.5"		14004					
Backing		V/A		uble Weld [j	i i i i i i i i i i i i i i i i i i i				
Root Op	-		\:\	011 0/4011 ==		ĭ	, communication.	[R			
· ·	Angle N/A			0"-3/16" M	AX	ş-a		-= 12			
		Radius (J	-U) N/A			Entre!N	Thekneth Rost Opening Joint (Unintend) Root Face	Nove Preparation Tolerances Premised Weld As Cintaled As FeUp Welding Size			
Back Go		s □ No ⊠				Process Decignation 1s 72 33 Send Robus per 1/22 Send 3/23 Robuston (E.) Todas, COMM BTC-P10-05 TO U Re-0 - 1/19 G +19, 1/18 AL 5/8.11 kg - 1/19 C +19, 1/19 1/19 C					
		A				FÇAW		Q. eskel . Q. eskel . Limited			
BASE ME Material					POSITION			· · · ·			
Type or (*				Position of			let All			
	ss: Groove (N/A - Unlir	mitad	Vertical Pr		hand I hand	Down			
		in)Any	- Any	inteu			CTERISTICS	п			
Diameter	r (Pipe, in)		- Unlin	nited	Transfer M	•	•				
			***************************************		_	Short-Circuiting Globular Spray C					
FILLER M		A 5 20			Current:	Current: AC ☐ DCEP ☒ DCEN ☐ Pulsed ☐ Other N/A					
	ecification Assification E		***************************************		Tungsten E		CTAMA:	The state of the s			
AVV3 CIS	issilication <u>t</u>	=/11-1	***************************************		Size N	•	Type N/A	and the second s			
					TECHNIQUE						
SHIELDIN	IG					Stringer or Weave Bead Both					
Flux N/A		***************************************	Dioxide		Multi-pass or Single Pass (per side) SEE MEMO						
		Composition : Flow Rate	100% 35-45 CFF	<u> </u>	Number of Electrodes 1						
N/A	o i lax (Oldos	Gas Cup Size		1	Electrode Spacing: Longitudinal N/A						
			10-12		······································		Lateral N/A				
PREHEAT Preheat		SEE MEMO					Angle N/A	AND PARKET WHITE THE PROPERTY PROPERTY AND THE PROPERTY HAVE			
		4" Temperature	SEE MEI	WO.	Contact Tu	be to Worl	- Virginia				
	er 3/4" to 1-1/		50° F	VIO	Peening	N/A		TO THE PARTY OF TH			
	1-1/2" to 2-1/		150° F		Interpass C	leaning	CHIP OR GRIND/M	VIRE BRUSH			
	Over 2-1/		225° F		POSTWELD	HEAT TR	EATMENT PWH	T Required []			
Interpass	Temp., Min.		350 F		Temp. N/A		Time N/A				
***************************************		THE PARTY OF THE P		WELDING	PROCEDURE		, erro 14/A				
Layer/Pass	Process	Filler Metal Class	Diamete		Amps or WFS	Volts	Travel Speed	Other Notes			
ALL	FCAW	E71T-1	0.045	ļl.	175-220	23-28	8-10 IPM				
ALL	FCAW	E71T-1	0.052	<u> </u>	180-250	24-29	8-10 IPM				
ALL	FCAW	E71T-1	1/16"	ļ	195-300	26-32	8-10 IPM '				
			***************************************			; 	order on a consequence of the state of the s				
						₿≫ cw					
		The second secon		2011 Marie - Marie - 1941 - 18, 24, 3, 201	- V	/ oc	1EXP. 04/01/11				
					£		, salar, sal				



		Bas	е Ме	tal	G	Froove Preparat	tion			
	See a se	Thi	cknes	s	Root Opening Tolerances			Permitted	Weld	
Welding	Joint	(U=∟	ınlimit	ed)	Root Face	As Detailed	As Fit Up	Welding	Size	
Process	Designation	T1	T2	Т3	Bend Radius	(see 3.12.3	(see 3.12.3)	Positions	(E)	Notes
GMAW FCAW	BTC-P10-GF	3/16 min	U	T1 min	R = 0 f =3/16 min C =3T1 / 2 min	+1/16, -0 +U, -0 -0, +Not - Limited	+1/8, -1/16 +U, -1/16 -0, +Not - Limited	AH	5/8 T1	A, J N, Z

MEMO

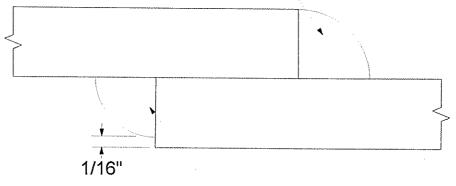
When the base metal is below 32 degrees F. (0 Deg. C), the base metal shall be preheated to at least 70 Degrees F (32 Deg. C) and this minimum temprature maintained during welding.
 Multiple passes on groove side and single pass on back side.

A: Not prequalified for gas metal arc welding using short circuiting transfer nor GTAW. Refer to Annex A.

N: The orientation of the two members in the joints may vary from 135° to 180° for butt joints, or 45° to 135° for corner joints, or 45° to 90° for T-joints.

Minimum Fi	llet Weld Sizes	Minimu	ım Size
Base-Meta	l Thickness (T)	of Fille	t Weld
in.	mm	in.	mm
T <1/4	T < 6.4	1/8	3
1/4 < T < 1/2	6.4 < T < 12.7	3/16	5
1/2 < T < 3/4	12.7 < T < 19.0	1/4	6
3/4 < T	19.0 < T	5/16	8
Maximum single p Fillet Weld Size			
Flat 3/8	}	***	
Horizontal 5/1	5	***************************************	
	Note N		0-1/8" Max

Base Metal Less Than 1/4" Thick



Base Metal Greater Than 1/4" Thick

Maximum Detailed Size of Fillet Weld Along Edges

AWS - Prequalified Welding Procedure Specification (pWPS)

WeldOffice WPS

(a)* (deg method grade Groove (in Fillet (in ation ation (class) on	Bell Steel FCAW Semi-automatic TC - T or corner joint Single bevel groove Yes Weld metal 0 0 to 1/8, +1/16, -0 (+ 0 0 to 1/8, +1/16, -0 (N 0 45, +10, -0 (10, -5) 0 n/a Yes Mechanical or Therm A-992 T1:unlimited T2:unlin ALL 0 -	(4) +1/16, -1/8) Not Limited) nal * Datum, As Deta	alled (As Fit-Up)	Date Author Date Positio Weldir Vertica Electric Transf Currer Other Techni Stringe Multi/s Numbe Spacin Contac Peenin	ng position: Il progression cal characte er mode (GM It type que er or weave b ingle pass (p er of electrod g: Long	ead er side) es tudinal (in Lateral (in la	Spray DCEP Constant Stringer or Single or Single ele	9 nith 9 Voltage (CV) power supply or Weave Multiple
rial (R)* (in (a)* (deg method grade Groove (in Fillet (in ation ation (class)	TC - T or corner joint Single bevel groove Yes Weld metal 0 0 to 1/8, +1/16, -0 (+ 0 45, +10, -0 (10, -5) 1 n/a Yes Mechanical or Therm A-992 T1:unlimited T2:unlin ALL 0 -	(4) +1/16, -1/8) Not Limited) nal * Datum, As Deta	alled (As Fit-Up)	Author Date Position Weldir Vertica Electric Transf Currer Other Techni Stringe Multi/s Numbe Spacin Contac Peenin	ng position: all progression cal characte er mode (GM tt type que er or weave b ingle pass (per of electrod g: Long	Fille ristics AW) ead er side) es tudinal (in. Lateral (in.	Curtis Sm 9/14/2009 All t All Up Spray DCEP Constant Stringer of Single of Single ele	Voltage (CV) power supply or Weave Multiple
rial (R)* (in (a)* (deg method grade Groove (in Fillet (in ation ation (class) on	TC - T or corner joint Single bevel groove Yes Weld metal 0 0 to 1/8, +1/16, -0 (N 0 to 1/8, +1/16, -0 (N 0 45, +10, -0 (10, -5) 0 n/a Yes Mechanical or Therm A-992 T1:unlimited T2:unlin ALL	(4) +1/16, -1/8) Not Limited) nal * Datum, As Deta	alled (As Fit-Up)	Date Position Weldir Vertica Electric Transf Currer Other Techni Stringe Multi/s Numbe Spacin Contac Peenin	ng position: all progression cal characte er mode (GM tt type que er or weave b ingle pass (per of electrod g: Long	Fille ristics AW) ead er side) es tudinal (in. Lateral (in.	9/14/2009 All t All Up Spray DCEP Constant Stringer or Single or Single ele	Voltage (CV) power supply or Weave Multiple
rial (R)* (in (a)* (deg method grade Groove (in Fillet (in ation ation (class) on	Single bevel groove Yes Weld metal 0 0 to 1/8, +1/16, -0 (+ 0 0 to 1/8, +1/16, -0 (N 0 45, +10, -0 (10, -5) 0 n/a Yes Mechanical or Therm A-992 171:unlimited T2:unlin 0 ALL	(4) +1/16, -1/8) Not Limited) nal * Datum, As Deta	alled (As Fit-Up)	Position Weldir Vertica Electric Transf Currer Other Technic Stringe Multi/s Numbe Spacin Contac Peenin	al progression: al progression cal characte er mode (GM tt type que er or weave b ingle pass (p er of electrod g: Long	Fille ristics AW) ead er side) es tudinal (in. Lateral (in.	Spray DCEP Constant Stringer or Single or Single ele	Voltage (CV) power supply or Weave Multiple
(R)* (in (in (a)* (deg (deg (deg (deg (deg (deg (deg (deg	Single bevel groove Yes Weld metal 0 0 to 1/8, +1/16, -0 (+ 0 0 to 1/8, +1/16, -0 (N 0 45, +10, -0 (10, -5) 0 n/a Yes Mechanical or Therm A-992 171:unlimited T2:unlin 0 ALL	(4) +1/16, -1/8) Not Limited) nal * Datum, As Deta	ailed (As Fit-Up)	Vertica Electric Transf Currer Other Techni Stringe Multi/s Numbe Spacin Contac Peenin	al progression cal characte er mode (GM tit type que er or weave b ingle pass (p er of electrod g: Long	Fille ristics AW) ead er side) es tudinal (in. Lateral (in.	Spray DCEP Constant Stringer or Single or Single ele	or Weave Multiple
(R)* (in (in (a)* (deg (deg (deg (deg (deg (deg (deg (deg	Yes Weld metal 0 to 1/8, +1/16, -0 (+ 0 to 1/8, +1/16, -0 (N 0 to 1/	+1/16, -1/8) Not Limited) nal * Datum, As Deta	ailed (As Fit-Up)	Transf Currer Other Techni Stringe Multi/s Numbe Spacin	cal characte er mode (GM it type que er or weave b ingle pass (p er of electrodi g: Long	ristics (AW) ead er side) es tudinal (in. Lateral (in.	Spray DCEP Constant Stringer or Single or Single ele	or Weave Multiple
(R)* (in (in (a)* (deg (deg (deg (deg (deg (deg (deg (deg	Weld metal 0 to 1/8, +1/16, -0 (+ 0 to 1/8, +1/16, -0 (N) 45, +10, -0 (10, -5) 1 n/a Yes Mechanical or Therm A-992 T1:unlimited T2:unlin ALL 1- 5.20	Not Limited) nal * Datum, As Deta	ailed (As Fit-Up)	Transf Currer Other Techni Stringe Multi/s Numbe Spacin	cal characte er mode (GM it type que er or weave b ingle pass (p er of electrodi g: Long	ead er side) es tudinal (in Lateral (in la	Spray DCEP Constant Stringer o Single or Single ele	or Weave Multiple
(a)* (deg method grade Groove (in Fillet (in ation ation (class) on	0 to 1/8, +1/16, -0 (N) 45, +10, -0 (10, -5) n/a Yes Mechanical or Therm A-992 T1:unlimited T2:unlin ALL 5.20	Not Limited) nal * Datum, As Deta	ailed (As Fit-Up)	Transf Currer Other Techni Stringe Multi/s Numbe Spacin	er mode (GM titype que er or weave b ingle pass (p er of electrod g: Long	ead er side) es tudinal (in. Lateral (in.	Stringer of Single or Single ele	or Weave Multiple
(a)* (deg method grade Groove (in Fillet (in ation ation (class) on	A-992 T1:unlimited T2:unlin ALL 5.20	nal * Datum, As Deta	ailed (As Fit-Up)	Currer Other Techni Stringe Multi/s Numbe Spacin Contac Peenin	que er or weave b ingle pass (per of electrode g: Long	ead er side) es itudinal (in Lateral (in	Stringer of Single or Single ele	or Weave Multiple
method grade Groove (in Fillet (in ation ation) (class) on	A-992 T1:unlimited T2:unlin	* Datum, As Deta	ailed (As Fit-Up)	Other Techni Stringe Multi/s Numbe Spacin Contac	que er or weave b ingle pass (per er of electrode g: Long	er side) es itudinal (in Lateral (in	Stringer of Single or Single ele	or Weave Multiple
grade Groove (in Fillet (in ation ation (class)	A-992 T1:unlimited T2:unlin	* Datum, As Deta	ailed (As Fit-Up)	Stringe Multi/s Numbe Spacin Contac Peenin	er or weave bingle pass (per of electrodeg: Long	er side) es itudinal (in Lateral (in	Single or Single ele	Multiple
grade Groove (in Fillet (in ation ation (class)	A-992 T1:unlimited T2:unlin ALL	* Datum, As Deta	ailed (As Fit-Up)	Multi/s Numbe Spacin Contac Peenin	ingle pass (per of electrode g: Long	er side) es itudinal (in Lateral (in	Single or Single ele	Multiple
Groove (in Fillet (in attion attion (class) on	5.20		ынеа (As Fit-Up)	Numbe Spacin Contac Peenin	er of electrode g: Long	es itudinal (in Lateral (in	Single ele	
Groove (in Fillet (in attion attion (class) on	5.20	nited		Spacin Contac Peenin	g: Long	tudinal (in.	-	cuode
Fillet (in	5.20			Contac Peenin		Lateral (in.		
ation ation (class) on	5.20			Peenin	t tube to wor			
ation (class) on				Peenin	TUDE IO WO	Angle (deg.	0.5 - 1	
ation (class) on				Interpa	g	un,	Not permi	itted
(class) on	-			100000000000000000000000000000000000000	ss cleaning			or grinding
on	-			Prehea				
on					it temp.:		See notes	
				interpa	ss temp.:		See notes	
(cft	CO2 (A5.32 SG-C)			Post weld heat treatment				
Gas flow rate (cfn) 25-45 Gas cup size (in.) 1/2-3/4					rature		None	
	1			Time				
dure							For all the second	
Process	Filler metal class	metal diameter	type / polarity	Amps	speed	Volts	speed	Joint details
FCAM								
FCAW	E/11-1 E71T-1							BADXGOUG BADXGOUG
						ALCONOMIC CONTROLS		
								- R
		BRIGHT PROVIDENCE OF THE						2
A CONTRACTOR OF THE CONTRACTOR		- Process Applications	endersols and planting	enternational desired		Designation		TO LIAN OF
						Designatio	п	TC-U4b-GF
/8 to 3/4(in.): 32(-1/2(in.): 50(°F). 12-1/2(in.): 150(° 1225(°F).	=).	if the base met	tal temperat	ture is belov	v 32(°F).			
2	1			Signature	2			
	Signature			Name		0000	Sign	ature
	R	ONALD M. PHII	LUP§					
A CONTRACTOR OF THE CONTRACTOR				Date				
	(m. 1. 10)							
000000000000000000000000000000000000000		CCI CR.O	WHY11		4			
	Signature	more and the construction		Name			Signa	ature
	Transmit and					and brigger segument		
	FCAW FCAW FCAW FCAW FCAW FCAW FCAW FCAW	FCAW E71T-1 FCAW E71T-1 FCAW E71T-1 ERPASS 1/8 to 3/4(in.): 32(°F). Preheat to 70(°F) -1/2(in.): 50(°F). 12-1/2(in.): 150(°F). 12-25(°F). 13-17-11 Signature	Frocess Filler metal class Filler metal class FCAW FCAW FCAW FCAW FCAW FCAW FCAW FCA	Frocess Filler metal class Filler metal type / polarity FCAW E71T-1 0.045 DCEP FCAW E71T-1 0.052 DCEP Signature RONALD M. PHILLIPS CM 96940091 CM 96940091	Filler metal class Filler metal class Filler metal type / polarity FCAW FCAW FCAW FT1T-1 0.045 DCEP 150-290 165-360 DCEP 165-360 ERPASS 1/8 to 3/4(in.): 32(°F). Preheat to 70(°F) if the base metal temperature is below 12-1/2(in.): 50(°F). 12-1/2(in.): 150(°F). 12-1/2(in.): 150(°F). 12-1/2(in.): 150(°F). 12-1/2(in.): 150(°F). 12-1/2(in.): 150(°F). 13-1/2(in.): 50(°F). 13-1	Process Filler metal class Filler metal type / polarity Amps polarity FCAW E71T-1 0.045 DCEP 150-290 200-500 FCAW E71T-1 0.052 DCEP 165-360 150-450 FCAW E71T-1 0.045 DCEP 150-290 200-500 FCAW E71T-1 0.045 DCEP 150-290 200-500 FCAW E71T-1 0.052 DCEP 150-290 200-500 FCAW E71T-1 0.045 DCEP 150-290 FCAW E71T-1 0.045 DCEP 150-290 200-500 FCAW E71T-1 0.045 DCEP 150-290 200-500 FCAW E71T-1 0.045 DCEP 150-290 200-500 FCAW E71T-1 0.045 DCEP 150-290 FCAW E71T-1 0.045 DCEP 150-290 FCAW E71T-1 DCEP 150-290 200-500 FCAW E71T-1 DCEP 150-290 200-500 FCAW E71T-1 DCEP 150-290 200-290 FCAW E71T-1 DCEP 150-290 200-290 FCAW E71T-1 DCEP DCEP 150-290 2	Process Filler metal class Filler metal class Fil	Process Filler metal class Filler metal class Filler metal type / diameter (in.) FCAW E71T-1 0.045 DCEP 150-290 200-500 25-29 9-15 PCEP 165-360 150-450 26-31 9-15 DCEP 165-360 26-31 9-15 DCEP 165-3

AWS - Additional Information (pWPS)

WeldOffice WPS

Identification #

Bell Steel 160

Rev. 1

D1.1 Table 3.7 states:

T37-01.3

Maximum GMAW/FCAW electrode diameter for flat and horizontal position is 1/8 in. (3.2 mm).

Maximum GMAW/FCAW electrode diameter for vertical position is 3/32 in. (2.4 mm).

Maximum GMAW/FCAW electrode diameter for overhead position is 5/64 in. (2.0 mm).

Maximum current shall be within the range of recommended operation by the filler metal manufacturer.

T37-03.1

Maximum root pass thickness: 3/8 in. (10 mm) for Flat, 5/16 in. (8 mm) for Horizontal. 1/2 in. (12 mm) for Vertical. 5/16 in. (8 mm) for Overhead position.

T37-04.3

Maximum GMAW/FCAW fill pass thickness is 1/4 in. (6 mm).

T37-05.3

Maximum GMAW/FCAW single-pass fillet weld size:

1/2 in. (12 mm) for Flat,

3/8 in. (10 mm) for Horizontal,

1/2 in. (12 mm) for Vertical.

5/16 in. (8 mm) for Overhead position.

T37-06.1

Maximum GMAW/FCAW single-pass layer width:

-Root opening > 1/2 in. (12 mm): Split layers.

-Any layer of width w: In the F, H, or OH positions for nontubulars, split layers when the layer width w > 5/8 in. (16 mm). In the vertical position for nontubulars or the flat, horizontal, vertical, and overhead positions for tubulars, split layers when the width w > 1 in. (25 mm).

D1.1 Table 3.7. end of quote.

Page 2 of 2

AWS - Prequalified Welding Procedure Specification (pWPS)

WeldOffice WPS

Company name Bell Steel Originated by Welding process **FCAW** Date Process type Semi-automatic Authorized by Date Joint design used Position Joint type TC - T or corner joint Joint design Single bevel groove (4) Backing Yes Backing material Steel Root opening (R)* (in.) 1/4, +1/16, -0 (+1/4, 1/16) Root face (f)* (in.) n/a Groove angle (a)* (deg.) 45, +10, -0 (+10, -5) Current type Radius (J - U)* (deg.) n/a Other Back gouging No Technique Back gouging method n/a Base metals * Datum, As Detailed (As Fit-Up) Spec., type or grade AWS D1.1 Table 3.1 Group II Thickness: Groove (in.) T1:unlimited T2:unlimited Spacing: Fillet (In.) All Diameter (Pipe) (in.) Unlimited Filler metals Peening **AWS Specification** 5 20 **AWS Classification** E71T-1C-H8 Preheat Shielding Preheat temp. Flux Interpass temp. Electrode-flux (class) Gas composition CO2 (A5.32 SG-C) Gas flow rate (cfh) 25-45 Gas cup size (in.) 1/2-3/4 Temperature Time

Identification # Bell Steel WPS 160-1 Rev Ron Phillips 2/13/2013 Curtis Smith 2/13/2013 Welding position: Groove All Fillet All Vertical progression Up Electrical characteristics Transfer mode (GMAW) Spray Constant Voltage (CV) power supply Stringer or weave bead Stringer or Weave Multi/single pass (per side) Single or Multiple Number of electrodes Single electrode Longitudinal Lateral Angle (in.) -(deg.) -Contact tube to work (in.) 0.5 - 1 Not permitted Interpass cleaning Brushing or grinding Min. (°F) See notes Min. (°F) See notes Max. (°F) See notes Post weld heat treatment (°F) None

(hrs) -

Welding procedure

Layer	Pass	Process	Filler metal class	Filler metal diameter (in.)	Current type / polarity	Amps	Wire feed speed	Volts	Travel speed	Joint details
1	All All	FCAW FCAW	E71T-1C-H8 E71T-1C-H8	0.045 0.052	DCEP DCEP	150-290 165-300	200-500 200-500	24-29 25-29	6-15 6-15	
Notes								Designation	1	TC-U4a-GF

PREHEAT/INTERPASS

For thickness 1/8 to 3/4(in.): 32(°F). Preheat to 70(°F) if the base metal temperature is below 32(°F).

Over 3/4 thru 1-1/2(in.): 150(°F) Over 1-1/2 thru 2-1/2(in.): 225(°F).

Over 2-1/2(in.): 300(°F)

See additional information page for further limitations

Signature 1 Signature 2 Name Name Signature Date Signature 3 Signature 4 Name Signature Name Signature Date Date

WeldOffice WPS 2012.01.003 Catalog n° PWP00215

AWS - Additional Information (pWPS)

WeldOffice WPS

Identification #

Bell Steel WPS 160-1

Rev.

D1.1 Table 3.7 states:

T37-01.3

Maximum GMAW/FCAW electrode diameter for flat and horizontal position is 1/8 in. (3.2 mm).

Maximum GMAW/FCAW electrode diameter for vertical position is 3/32 in. (2.4 mm).

Maximum GMAW/FCAW electrode diameter for overhead position is 5/64 in. (2.0 mm).

T37-02.1

Maximum current shall be within the range of recommended operation by the filler metal manufacturer.

T37-03.1

Maximum root pass thickness: 3/8 in. (10 mm) for Flat, 5/16 in. (8 mm) for Horizontal, 1/2 in. (12 mm) for Vertical, 5/16 in. (8 mm) for Overhead position.

T37-04.3

Maximum GMAW/FCAW fill pass thickness is 1/4 in. (6 mm).

T37-05.3

Maximum GMAW/FCAW single-pass fillet weld size: 1/2 in. (12 mm) for Flat, 3/8 in. (10 mm) for Horizontal, 1/2 in. (12 mm) for Vertical, 5/16 in. (8 mm) for Overhead position.

T37-06.1

Maximum GMAW/FCAW single-pass layer width:

-Root opening > 1/2 in. (12 mm): Split layers.

-Any layer of width w: In the F, H, or OH positions for nontubulars, split layers when the layer width w > 5/8 in. (16 mm). In the vertical position for nontubulars or the flat, horizontal, vertical, and overhead positions for tubulars, split layers when the width w > 1 in. (25 mm).

D1.1 Table 3.7. end of quote.

AWS - Prequalified Welding Procedure Specification (pWPS)

WeldOffice WPS

							Identifi	cation #		BS 164	Rev.
Weldin	any nam			Bell Steel FCAW			Origina Date			Ron Phillip	9
Proces	ss type			Semi-automatic			Author	zed by		Curtis Sm 11/13/200	
Joint d	esign u	sed					Positio	n		11/10/200	<u> </u>
Joint ty				BTC - Butt, T or corne	er joint		Weldin	g position:	Groove	All	
Joint de Backin	g			Single bevel groove (4 No				l progression	Fillet	All Up	
	g mater pening ((in \	n/a 0, +1/16, -0 (+1/8, -1/-		Electric	al character	istics			
Root fa		(14)		1/8 min, +U, -0 (+/-1/1				Transfer mode (GMAW)			
Groove angle (a)* (deg.) Radius (J - U)* (deg.)			45, +10, -0 (+10, -5)			INTERPOSED THE PROPERTY OF THE			DCEP Constant	Voltage (CV) power supply	
	ouging		(deg.)	No			Techni	ane		Contain	rollage (or / power supply
Back g	ouging	method		n/a			E STATE OF THE STA	r or weave be	ead	Stringer o	r Weave
Base m	netals				* Datum, As Det	ailed (As Fit-Up)	Multi/si	ngle pass (pe	er side)	Single or I	Multiple
Thickn	type or ess: ter (Pipe	Groove Fillet	(in.)	A572-50 to A500-B T1:1/4 min T2:unlimite ALL Unlimited	ed		Spacin		tudinal (in.) Lateral (in.) Angle (deg.)	-	ctrode
-iller m	netals						Peenin	t tube to worl	((in.)	0.5 - 1 Not permi	tted
	Specifica			A5.20				ss cleaning			or grinding
	Classific	ation		E71T-1			Prehea	Preheat			
Shieldi	ng							it temp.:	Min. (°F)		
Flux	de-flux	(class)					Interpa	ss temp.:		See notes	
Gas co	omposition			CO2 (A5.32 SG-C)		1	Post w	eld heat trea		occ notes	
Gas flow rate (cth) 30 Gas cup size (in.)					Temperature (°F) No			None			
oas co	ap size		(111.)				Time		(hrs)		
Veldin	g proce	dure									
Layer	Pass	Process		Filler metal class	Filler metal diameter	Current type / polarity	Amps	Wire feed speed	Volts	Travel speed	Joint details
1	All	FCAW	r. Cyalar	E71T-1	0.045	DCEP	175-225		24-26	9-18	861
1	All	FCAW		E71T-1	0.052	DCEP	195-275		25-29	9-18	
									Designation	1	BTC-P4-GF
lotes See ad	Iditional	information p	age	for further limitations							
ignatu Name				Signature	RONALD M. I	PHILLIPS	Signature Name	2		Sign	ature
Name Ron Ph				Signature			Name	2		Sign	ature
Name Ron Ph Date	nillips			Signature	CWI 960	40091	- Contract C	÷2		Sign	ature
Name Ron Ph Date 1/13/2	nillips 2009			Signature	CWI 960		Name Date			Sign	ature
Name Ron Ph	nillips 2009			(III)	CWI 960	40091	Name Date Signature				
Name Ron Ph Date 1/13/2 ignatu	nillips 2009			Signature	CWI 960	40091	Name Date				ature

AWS - Additional Information (pWPS)

WeldOffice WPS

Identification #

BS 164

Rev.

D1.1 Table 3.7 states:

T37-01.3

Maximum GMAW/FCAW electrode diameter for flat and horizontal position is 1/8 in. (3.2 mm).

Maximum GMAW/FCAW electrode diameter for vertical position is 3/32 in. (2.4 mm).

Maximum GMAW/FCAW electrode diameter for overhead position is 5/64 in. (2.0 mm).

T37-02.1

Maximum current shall be within the range of recommended operation by the filler metal manufacturer.

Maximum root pass thickness:

3/8 in. (10 mm) for Flat,

5/16 in. (8 mm) for Horizontal,

1/2 in. (12 mm) for Vertical,

5/16 in. (8 mm) for Overhead position.

Maximum GMAW/FCAW fill pass thickness is 1/4 in. (6 mm).

T37-05.3

Maximum GMAW/FCAW single-pass fillet weld size:

1/2 in. (12 mm) for Flat,

3/8 in. (10 mm) for Horizontal,

1/2 in. (12 mm) for Vertical,

5/16 in. (8 mm) for Overhead position.

T37-06.1

Maximum GMAW/FCAW single-pass layer width:

-Root opening > 1/2 in. (12 mm): Split layers.

-Any layer of width w: In the F, H, or OH positions for nontubulars, split layers when the layer width w > 5/8 in. (16 mm). In the vertical position for nontubulars or the flat, horizontal, vertical, and overhead positions for tubulars, split layers when the width w > 1 in. (25 mm).

D1.1 Table 3.7. end of quote.

WeldOffice WPS 2008.12.016

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Catalog n°

AWS - Additional Information (pWPS)

WeldOffice WPS

Identification #

Bell Steel WPS 120-1

Rev.

D1.1 Table 3.7 states:

T37-01.3

Maximum GMAW/FCAW electrode diameter for flat and horizontal position is 1/8 in. (3.2 mm).

Maximum GMAW/FCAW electrode diameter for vertical position is 3/32 in. (2.4 mm).

Maximum GMAW/FCAW electrode diameter for overhead position is 5/64 in. (2.0 mm).

T37-02.1

Maximum current shall be within the range of recommended operation by the filler metal manufacturer.

T37-03.1

Maximum root pass thickness: 3/8 in. (10 mm) for Flat, 5/16 in. (8 mm) for Horizontal, 1/2 in. (12 mm) for Vertical, 5/16 in. (8 mm) for Overhead position.

T37-04.3

Maximum GMAW/FCAW fill pass thickness is 1/4 in. (6 mm).

T37-05.3

Maximum GMAW/FCAW single-pass fillet weld size: 1/2 in. (12 mm) for Flat, 3/8 in. (10 mm) for Horizontal,

1/2 in (12 mm) for Vertical

1/2 in. (12 mm) for Vertical,

5/16 in. (8 mm) for Overhead position.

T37-06.1

Maximum GMAW/FCAW single-pass layer width:

-Root opening > 1/2 in. (12 mm): Split layers.

-Any layer of width w: In the F, H, or OH positions for nontubulars, split layers when the layer width w > 5/8 in. (16 mm). In the vertical position for nontubulars or the flat, horizontal, vertical, and overhead positions for tubulars, split layers when the width w > 1 in. (25 mm).

D1.1 Table 3.7. end of quote.

APPENDIX E2 WELDING PROCEDURE SPECIFICATIONS FABRICATOR 2



NAFCO

1540 County Road 222 Cullman, AL, 35057

AWS D1.1 Prequalified Welding Procedure Specification (WPS)

Page 1 of 2 WPS No. TFillet Date <u>5/18/2015</u> Rev. No. 0 Date 5/18/2015 QA Manager

Welding Process(es)/Type(s) FCAW/Semiautomatic

Joint Design Used WeldType Fillet welds FilletType T-joint Double Welded No Backing Yes_ Material Base Metal Root Opening 3/16 in. Root Face N/A Groove Angle N/A Radius N/A Back Gouging No Method N/A

BaseMetals

Base Metal ASTM A 572, Grade 50

Thickness: Groove N/A Thickness: Fillet 1/8 in. min. Pipe Diameter _3/8 in. min.

Groups I & II

FillerMetals

AWS Specification 5.20

AWS Classification E71T-1

Weld Size 5/16 in.

Shielding

Gas 100% CO2 Flow Rate 32-60 CFH

Gas Cup Size 5/8-3/4

Electrode-Flux (Class) N/A

Flux Trade Name N/A

Preheat

Preheat Temperature, Min. 32°F

Interpass Temperature, Min. 32°F Max. 500°F

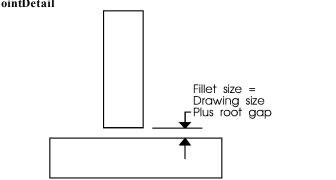
Minimum Preheat and Interpass Temperatures for given thickness:

1/8" thru 3/4" incl.: 32°F (70°F if less than 32°F)

Over 3/4" thru 1-1/2" incl.: 50°F Over 1-1/2" thru 2-1/2" incl.: 150°F

Over 2-1/2": 225°F

JointDetail



Position

Weld Position: Fillet All Positions

Weld Position: Groove N/A

Vertical Progression Vertical up

5/16

ElectricalCharacteristics

Power Source

Output Constant Voltage

Current / Polarity DCEP (reverse)

Transfer Mode Globular arc

Tungsten Electrode: Type N/A

Tungsten Electrode: Size N/A

Technique

Stringer or Weave Bead Stringer or weave bead

Multi/Single Pass Single or multipass

Number of Electrodes 1

Electrode Spacing: Longitudinal N/A

Lateral N/A Angle N/A

Contact Tube to Work Distance 3/8 to 3/4

Peening Not allowed.

Interpass Cleaning Chipping hammer, wire brush and grind as

Postweld Heat Treatment

Temperature None

Time (hr.) None

Welding Procedure

Pass		Filler Meta	Curre	ent		Travel	
or Weld		AWS	Size	Type&			Speed
Layer(s)	Process	Classification	(in.)	Polarity	Amps	Volts	(in/min)
ALL	FCAW	E71T-1	0.052	DCEP (reverse)	220 - 270	26-30	12 - 20
ALL	FCAW	E71T-1	0.045	DCEP (reverse)	200 - 240	25-28	9 - 15

APPENDIX F INSPECTION REPORT FABRICATOR 1

Test sample weld inspection summary for Obstruction fillet weld test:

Note: Samples were cleaned after all fins were welded; and were inspected after all fins were welded in place on all (3) samples. This posed a small problem with access between fins for cleaning and inspection. During inspection the weld gage could be placed on the actual weld except right at the end of the fin samples and eyeballing from the top. So during inspection, the weld size was eyeballed using the gage from both the top and the ends as best as possible and making the best decision based on what could be determined using this method. It is not uncommon to have a situation occasionally where you have make the best educated guess on the size of the weld when proper access after welding gage becomes an issue. I will usually error on the side of caution and call for another pass if the weld appears close to being small. In the case of the samples below, no extra prep or additional passes for repair were made. The welds from a production standpoint would all be accepted once repairs were made. That said the results of my inspection are as follows:

Sample #1 welded in the flat postion:

- Fin #1- Rejected for a small area of possible lack of fusion or cold lap. In production would be ground and another pass added and the obstruction would not prevent this since the presence of any additional fins would not be present..
- Fin #2- Rejected because there are areas that appear to be undersize in excess of 10% of the weld length. Again these would be ground cleaned and repaired if this were a production weld Fins # 3-7 were accepted as is.

Sample #2 welded in the horizontal position:

- Fin #1 Rejected because of appearance and cleaning. (Weld would be re-cleaned in an actual production situation and would then be acceptable).
- Fin #2- Rejected due to an area on weld appears to be undersize. Again in a production situation the weld would be properly cleaned and additional weld added to correct the issue. Access would not be a problem in production even with the obstruction present.
- Fins #3 thru 7- All welds accepted.

Sample #3 welded in the 3G vertical up position:

All fins #1 thru 7 were acceptable as welded with no production repairs to be noted.

Test samples for doubler plates root pass welds:

Two samples created for each respective plate thickness with the X dimension being 5/8" and 1 ¼" and root pass inspected for visual appearance in all cases. *NOTE: In an actual shop inspection of these welds on a couple of the samples I would require the welder to knock off some of the spatter that remained during inspection since addition passes are going to be added to complete the welding to avoid would having to incorporate them in the weld pool upon adding the additional passes.*

Test samples for prequalified tubular heel weld connections:

Sample 1 with acute angle 15degrees:

NAFCO

AWS D1.1 Prequalified Welding Procedure Specification (WPS)

WPS No.	TFillet	Rev. No. <u>0</u>	Page 2 of 2
			_

Additional Notes

Good for any size fillet weld per Clause 3 of AWS D1.1 with a maximum single pass fillet up to and including 5/16".

JOINT NOTES:

(a) Not Prequalified for GMAW-S nor GTAW. (g) If fillet welds are used in statistically loaded structures to reinforce groove welds in the corner and T-joints, these shall be equal to T1/4, but need need not exceed 3/8in. [10mm]. Groove welds in corner and T-joints of cyclically loaded structures shall be reinforced with fillet welds equal to T1/4, but need not exceed 3/8in. [10 mm]. (j) The orientation of the two members in the joints may vary from 135° to 180° for butt joints, or 45° to 135° for corner joints, or 45° to 90° for T-joints. (K) For corner joints, the outside groove preparation may be in either or both members, provided the basic groove configuration is not changed and adequate edge distance is maintained to support the welding operations without excessive edge melting.

- 1. Root pass from the joint side was good & passed inspection.
- 2. Subsequent passes were made to achieve the required back weld and the final passes looked very good. No defects observed. Back weld passed inspection & size requirements.
- 3. The final weld out was then completed to achieve the $\frac{1}{2}$ " tw. The final weld passed visual inspection.

(NOTE from the back side which would be inside of the tube if this were a real joint which not visible after welding was indeed observed as being a good root pass which would probably pass a pipe weld inspection)

Remaining samples followed the same protocol for inspection. All root passes were acceptable, all back welds were accepted and the size was adequate. The final welds passed visual inspection with no viable defects.