
# Effective Throat for Flare Bevel and Flare-V Groove Welds

*Final Report to AISC and STI*

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## 0. EXECUTIVE SUMMARY

An experimental research project has been undertaken to investigate the geometric properties, and in particular the effective throat size, of flare bevel and flare-V partial joint penetration groove welds at the corners of Hollow Structural Sections (HSS). HSS-to-plate (flare bevel) and HSS-to-HSS (flare-V) single-pass welds were carefully performed to Welding Procedure Specifications agreed within a Project Oversight Committee, using ASTM A500 tubing, then cross-sectioned after inspection to produce 180 test welds. Parameters included three HSS sizes (with wall thicknesses ranging from 3/16" to 3/8"), four welding processes (FCAW-G, FCAW-S, GMAW and SMAW) and four welding positions (flat, horizontal, vertical and overhead). All weld cross-sections were polished and etched, then had their profiles digitally recorded and measured. An analysis of the resulting data has shown that the current prequalified effective throat sizes for these two weld types, in AWS D1.1/D1.1M:2002, can be made more liberal for most weld processes, as described below.

• **For flare bevel groove welds, filled flush to the face of the HSS**, test data confirms that, after inclusion of a suitable safety margin, the following effective throat sizes (E) can be justified, in terms of the HSS outside corner radius (R), for flat, horizontal, vertical up and overhead welding positions, depending on the welding process:

E = 0.64R for GMAW and FCAW-G
or E = 0.31R for SMAW and FCAW-S

• **For flare-V groove welds, filled flush to the faces of the HSS**, test data confirms that, after inclusion of a suitable safety margin, the following effective throat sizes (E) can be justified, in terms of the HSS outside corner radius (R), for flat, horizontal, vertical up and overhead welding positions, depending on the welding process:

E = 0.73R for GMAW and FCAW-G
or E = 0.61R for SMAW and FCAW-S

• **For flare bevel groove welds, *not* filled flush to the face of the HSS,** the equations above can be re-written in the following form, using a dimension Df (which must be measured), where Df is the distance from the outer wall of the HSS to the face of the weld:

E = 0.64R - Df for GMAW and FCAW-G
or E = 0.31R - Df for SMAW and FCAW-S

• **For flare-V groove welds, *not* filled flush to the faces of the HSS,** the equations above can be re-written in the following form, using a dimension Df (which must be measured), where Df is the distance from the outer walls of the HSS to the face of the weld:

E = 0.73R - Df for GMAW and FCAW-G
or E = 0.61R - Df for SMAW and FCAW-S

All the above equations entail a knowledge of the square or rectangular HSS outside corner radius, R. For ASTM A500 hollow sections, an outside corner radius of R = 2T can be assumed. The tube wall thickness, T, can either be measured or a "design value" of $0.93T_{nominal}$ may be assumed, as specified by AISC.

## 1.0 INTRODUCTION

Flare groove welds arise when a convex surface makes up the joint preparation in a Partial Joint Penetration (PJP) groove weld (see Figure 1). These welds occur when one or both components of a joint consist of a round bar or 90° bend in a formed section, for example a Hollow Structural Section (HSS). The fabrication of HSS structures involves joints where flare bevel (Figure 1a), and to a lesser extent, flare-V (Figure 1c) groove welds are common. The deposition of sound weld metal to the bottom of the flare is very difficult because the welding puddle bridges between the two surfaces and then penetration into the root is inhibited. Hence, the extent of root penetration in flare bevel groove welds is dependent on the angle between the fusion faces, and therefore the outside corner radius or profile of an HSS is a major parameter determining the geometry of the weld. With the quality of the weld being difficult to control, specifications in many cases require the fabricators to demonstrate the effective weld throats being produced by sectioning random sections of production welds for each weld procedure. By performing trial welds and sectioning, *larger weld sizes can be justified relative to values given in specifications that provide prequalified* PJPs, thereby allowing higher joint design loads, however extra costs will be incurred in the fabrication stage.

In the case of equal-width rectangular HSS welded joints, considerable cost would go into qualifying welds at truss joints. For example, when sections of differing wall thickness are joined the resulting interface between one tube's corner radius (chord member in truss) and the wall of the other tube (truss web member) necessitates a costly adjustment of the root gap. Three options are available to the fabricator to close the root of the joint; (i) profile shaping one of the tubes, (ii) building out with weld metal to produce a "backing" weld, (iii) using a backing steel element, as shown by Figure 2 (AISC, 1997). If the tubes have equal wall thickness (see Figure 3), the root gap will become more favorable for welding, however if the outside corner radius (R) approaches the upper limit, i.e., three times the nominal wall thickness, (ASTM, 2001) , then backing would be required and joint welding would become expensive. A recent experimental project (Teh and *Rasmussen, 2002) has looked at welding equal-width rectangular HSS with the aim of determining* the conditions required to get adequate penetration and full mechanical strength. The minimum root gap between brace and chord (main or thru member), G, recommended for the joint to be prequalified, for flat and horizontal welding positions, was:

$G \geq 3mm$ for GMAW, and
$G \geq 4mm$ for SMAW.

Five North American specifications, listed below, give the following design guidance for flare weld sizes:

### 1.1 AISC ASD (1989) & LRFD (1999b)

Both AISC design specifications establish the effective throat thickness of a flare groove weld, when the weld is flush (tangent) to the surface of a bar or 90° bend in a formed section (see Figure 4), *as a ratio of radius to effective throat, in Table J2.2 as follows:*

| Type of Weld | Radius of Bar or Bend (R) | Effective Throat Thickness |
|---|---|---|
| Flare bevel groove | All | $^5/_{16}R$ |
| Flare V-groove | All | $^1/_2R$ [a] |
| [a] Use $^3/_8R$ for Gas Metal Arc Welding (except short circuiting transfer process) when R ≥ 1 in. (25mm) | | |

Further to the table, the specifications state the following:

> "Random sections of production welds for each welding procedure, or such test sections as may be required by design documents, shall be used to verify that the effective throat is consistently obtained. Larger effective throat thicknesses than those in Table J2.2 are permitted, provided the fabricator can establish by qualification the consistent production of such larger effective throat thicknesses. Qualification shall consist of sectioning the weld normal to its axis, at mid-length and terminal ends. Such sectioning shall be made on a number of combinations of material sizes representative of the range to be used in the fabrication or as required by the designer".

### 1.2 AWS D1.1/D1.1M:2002

Similar to the AISC specifications, the AWS D1.1 specification in Section 2 under design of welded connections, provides Table 2.1 (shown below) for effective weld size, E, of flare groove welds when filled flush to the surface of round bar, a 90° bend in a formed section, or a rectangular tube.

| Flare-Bevel-Groove Welds | Flare-V-Groove Welds |
|---|---|
| $^{5}/_{16}$R | $^{1}/_{2}$R * |
| * Use ⅜ R for GMAW (except GMAW-S) process when R is ½ in. (12mm) or greater. | |

One difference between the AISC and AWS tables is in the ⅜R weld size for the GMAW process which is stated to occur when R ≥ 1in. (25mm) in the AISC specification while in the AWS specification it is stated to occur when R is ½ in. (12mm) or greater.

Figure 5 shows effective throats given in Section 3 of AWS D1.1, namely Figure 3.3, which are pre-qualified and allow a fabricator to avoid the cost associated with qualification procedures required by welding authorities. The flare bevel groove weld size, E, shown in Figure 5 is expressed as a function of wall thickness ( i.e. E = ⅝T) and is equivalent to those in Section 2 of the standard if the nominal relationship holds for the corner radius, i.e. R=2T. Figure 5 includes a "corner dimension", C, with a nominal minimum of 3/2T, however it is not limited to this value and has been shown to be as low as C=T. This dimension acknowledges the true geometry of cold-formed sections where the corner curvature may not be a 90° quadrant of a circle tangent to the sides, and the corner dimension, C, can be less than the radius of the corner.

### 1.3 CSA W59 (1989)

In CSA W59 Section 4.3.1.6 effective throats are prequalified for flare bevel and flare-V groove welds on solid bars but not for HSS. For HSS the effective throat thickness of flare-V and flare bevel groove welds needs to be established by the fabricator by means of trial welds and sectioning. The prequalified effective throat thickness for flare groove welds on solid bars is similar to the AISC and AWS specifications and is presented in CSA W59 Table 4.1 as follows:

| Flare-Bevel-Groove Welds | Flare-V-Groove Welds |
|---|---|
| All Diameter Bars | |
| 0.3R | $^{1}/_{2}$R * |
| Not applicable to GMAW using the short-circuiting transfer mode of metal deposition.<br>* Except 0.4R for GMAW process with bar sizes 25mm (1 in.) and over.<br>Note: R = radius of bar. | |

### 1.4 AISI (2001)

This new North American Cold-Formed Steel Specification uses a prequalified effective throat size for flare groove welds filled flush to the surface as specified by AWS (2002). For flare groove welds "not filled flush" this specification determines an effective throat size by treating the weld as a fillet. The latter is also done in the forthcoming CSA W59 specification (see Section 1.5 below), but is only feasible for small bend radii, such as up to about ⅜", which is appropriate though for light gage steel.

### 1.5 CSA W59 Pre-ballot Draft (2001)

The forthcoming 8th edition of CSA Standard W59 Welded Steel Construction, which is likely to be released in 2003, is presently available in draft form to the specification committee. The section on flare welds has been completely re-written and expanded significantly to cover flare bevel and flare V-groove welds in butt joints and flare bevel groove welds in T-joints, with several configurations of both being taken as pre-qualified. Paolini is the lead author of this new section, which is based on data that he has collected over many years. The focus of the data was on the effective size of welds.

The W59 draft defines the flare bevel groove weld in a T-joint as a joint configuration formed between a member with a curved surface and a surface of a planar member (see Figures 6 and 7). The flare V groove weld in a butt joint results when two curved surfaces make side-by-side longitudinal contact such as the joints formed by side-to-side contact of two round bars or two HSS members, as shown in Figure 8.

The concept of a "flare bevel fillet weld" is introduced for the first time in a major welding specification. A discussion paper on this matter by Paolini for a 1994 CSA W59 committee meeting recommends that for round bars with radii $\leq$ ⅜", and for HSS with wall thicknesses $\leq {}^{3}/_{16}$" (or radii $\leq$ ⅜"), T-joint welds may be designed and detailed as flare bevel fillet welds, and this has now been incorporated into the W59 draft. The root of such a fillet weld is assumed to be the intersection of the planar surface and a tangent to the curve of the flare that is perpendicular to the planar surface (see Figure 6). One research study on this matter was conducted by the Welding Institute of Canada (WIC, 1982). The report acknowledges that it would be necessary to evaluate the variation in HSS corner radii in order to make a recommendation for exactly where to make a definite cut-off point between the two weld types.

In the new draft W59, for T-joints with round bars having radii > ⅜" and square/rectangular HSS members having radii > ⅜", a flare bevel groove weld need not be flush with the tangent to the curve of the flare that is perpendicular to the planar surface (see Figure 7). A designer has the option to consider a weld within the flare, flush with it or extended beyond it by means of a fillet. For design purposes, the effective throat shall be indicated by specifying a weld face ,W, greater than or equal to a factor of $\delta$ times the required effective throat, E, subject to the following criteria:

(a) for the SMAW process: factor $\delta$ = 1.7 (see Figure 9)
(b) for the SAW, FCAW, MCAW and GMAW processes: factor $\delta$ = 1.5 (see Figures 10 and 11)
(c) the effective throat shall be indicated on the welding symbol in brackets to the left of the flare bevel weld symbol and the weld face width (W) noted below the flare bevel symbol (see Figure 7). A detail showing the weld face should be provided on the shop drawing.

For flare bevel groove welds in T-joints using round bars, tubing or HSS members, when filled flush to the surface of the round bars, tubing or HSS members, the effective throats are given by CSA W59 Draft (2001) Table 1 as follows:

| Flare-Bevel-Groove Welds | Flare-V-Groove Welds |
|---|---|
| 0.3R | 0.5R * |
| Not applicable to GMAW using the short-circuiting transfer mode of metal deposition.<br>* Except 0.375R for GMAW process with R ≥ ½ in.<br>Note: R = radius of round bar, tubing, or measured corner radius of HSS member. | |

Figures 9, 10 and 11 summarize details and welding procedure requirements for prequalified Partial Joint Penetration (PJP) flare bevel and flare-V groove welded joints with SMAW, GMAW and FCAW processes.

Jaxa-Rozen (2001), a member of both the CSA W59 Specification Committee and AWS D1.1 Design Subcommittee, has also presented a variation of this design concept utilizing the weld face, which is in use as an internal specification at Bombardier Transportation, Canada.

Figure 12 compares the effective throats specified by some of the afore-mentioned specifications and those produced by a fabricator, namely Canron Construction Corporation East, as reported on welding procedure data sheets, for two different flare bevel groove welds (see Appendix 1). One weld is shown to be made between a plate and a cold-rolled HSS (T=½") and the other weld is shown between a plate and a hot-formed HSS (T=⅜"). For both, the weld geometries produced are in stark contrast to those prequalified by the specifications. The comparisons show that fabricators typically produce a larger effective throat than those prescribed by specifications, along with a smaller Z loss factor.

## 2.0 EXPERIMENTAL WORK

The objective of this research study was to examine flare groove weld geometries more closely and see from the deposited welds the relationship among three different variables; namely, HSS wall thickness/corner geometries, different weld processes and welding position. From the research results, the aim of the study was to quantify the weld effective throat size (or Z loss dimension) by joint variables for specific welding situations, thereby allowing prequalified joints having a larger limit on effective throats.

The HSS sizes for the study consist of three sections representing possible corner geometries due to varying corner profile (see Tables 1 to 3). The acquisition of material has been from two Canadian HSS producers and STI member companies, namely LTV Copperweld (Brampton, Ontario plant) and Atlas Tube (Harrow, Ontario plant). Material for the study was cold-formed, square HSS to ASTM A500 Grade C ($F_y$ = 50ksi nominal). Table 5 summarizes the chemical and mechanical properties of the HSS. Pre-fabrication of 24 tacked specimens was done at the University of Toronto laboratories. Figures 13 and 14 illustrate the configuration of the test specimens for both the 4 x 4 and 6 x 6 HSS, respectively. Specimens were one foot in length for welds produced in the flat, horizontal and vertical positions and one-and-a-half feet in length for welds produced in the overhead position. For the HSS-to-HSS-to-plate assemblies a ½" thick plate was used on one side of the HSS. As shown in Figures 13 and 14, HSS and plates have been tack welded to each other to allow up to 12" (or 18" for overhead welds) of continuous weld. After the specimens were tacked, test weld numbers as shown in Tables 1 to 3 were punched along HSS walls adjacent to the flare bevel or flare-V groove joint. These numbers were punched in four

locations along the joint to maintain permanent records of test weld numbers on each piece of the subsequently saw-cut test specimen, i.e., after the final welding of the specimens.

Four weld processes, namely, FCAW-G (with shielding gas), FCAW-S (without shielding gas), GMAW and SMAW were used to make the test welds, using just single pass welds. These processes are the predominant processes used in the welding of such joints by fabrication shops. Appendix 2 provides the certificate of conformance sheets for the FCAW, GMAW and SMAW weld consumables used to make the test welds. Welding parameters, or Welding Procedure Specifications (WPSs) associated with each particular process (see Tables 4a & 4b) were prescribed to reflect prevalent shop practices, and were the result of considerable consultation amongst the project Oversight Committee. The final WPSs were targeted to be "somewhat below the median" for a typical fabrication shop. (This implies that any results obtained should err on the safe side, as higher degrees of penetration can be achieved if all welding parameters were to be optimized).

In summary, each HSS size was used to produce eight flare bevel and flare-V groove welded specimens made by four different weld processes and four different welding positions, namely horizontal (H), flat (F), vertical, up or down (V) and overhead (OH). The specimen and test weld numbers listed in Tables 1 to 3 are shown figuratively in Figures 15 to 17.

Final welding of the HSS-to-HSS-to-plate assemblies, for the study of flare bevel and flare-V groove welds was carried out by Walters Inc., a fabricator certified to CSA W47.1-92 (CSA, 1992). *During the study, the production of all test welds was supervised by the Authors. All welds were* made by a certified welder and visually inspected by a certified inspector. Welding of the test specimens was performed during two days on January 22 and 23, 2002 at Walters Inc.'s Princeton plant (located near Hamilton, Ontario). Figure 18 shows the 24 HSS-to-HSS-to-plate test specimens ready to receive the 72 test welds. Prior to depositing a particular test weld the welding engineer and welder performed trial welds to verify the welding parameters. Over each particular weld length, the travel speed was noted. The complete documentation for each test weld is in Appendix 4 in the form of 72 Procedure Qualification Record (PQR) sheets. As an aid to collecting welding parameters, a computerized data acquisition system was supplied by the welding engineer, Mr. K. Kerluke, and is shown in Figure 19. Figures 20 and 21 show the welding of a particular specimen in the overhead position, while Figures 22 and 23 show specimens being welded in the horizontal and vertical positions, respectively. Finally, Figure 24 shows the external appearance of two FCAW-G test welds (No. 26 and No. 28) done in the vertical position.

After the production of fully-welded test specimens, a specimen was ready for saw-cuts and this was carried out by Walters Inc. at the fabrication plant. As previously mentioned, Figures 13 and 14 indicate three test specimen saw-cuts to provide up to three weld cross-sections for each test weld. Tables 1 to 3 summarize the total number of weld cross-sections for measurement (180).

Subsequent to the welding phase, all test specimen material was returned to the University of Toronto laboratories where all 180 test weld cross-sections were ground and polished with an industrial die grinder having a rotation speed of 21,000 rpm (Milwaukee model No. 5192). The discs were 2" in diameter and preliminary grinding was done using 100 grit discs with secondary polishing utilizing 240 grit discs. Following this, all 180 cross-sections were macro-etched using an etchant referred to as 10% Nital that was made using proportions of 180 ml ethyl alcohol and 20 ml nitric acid. Technical advice on these two procedures was provided by the welding engineer.

All cross-sections, prior to etching, received a punched test weld number adjacent to the weld itself to carry on the permanent record of test weld numbers within the photographic image that was

used in the measurement phase. This photographic digital image was created by setting the actual HSS-to-HSS-to-plate saw cut test pieces (after polishing and etching the weld measurement area) directly on a scanning machine. Figures 25 and 26 show two scanned images for test weld nos. 17C and 59C; i.e., flare bevel groove welds made on HSS 4x4x$^{3}/_{16}$ and HSS 6x6x$^{3}/_{8}$ test specimens, respectively. It is note worthy to mention the large difference in the Z-loss factor between the two test welds. The Z value is quite large for test weld no. 59C, made by the FCAW-S process in the overhead position, and for test weld no. 17C a small Z dimension is evident, also made in the overhead position however utilizing the GMAW process. The letters A, B and C distinguish between the three different cross-sections for each particular test weld made in the 12" or 18" long joints. The etched cross-sections, as shown in Figures 25 and 26, allow one to examine the degree of root penetration and heat-affected zone (HAZ).

The next phase of the project involved the measurement of weld profile dimensions and angles from 180 photographic scanned images. As indicated in Tables 1 to 3 the flare bevel test welds had three cross-sections and flare-V test welds had two cross-sections, from which a small statistical evaluation of weld dimensions along a length of weld could be made. Weld and HSS dimensions were measured using AutoCAD 2000 drafting software. Using the digitized ruler within each scanned image as a reference length, a scaling factor was applied to the image to regenerate the image into its actual size. A "spline" command was used to contour the corner profile of the HSS. This involved drawing a part circle by specifying three points along the HSS corner arc. A series of trials was needed before the best-fit circle could be obtained, from which the corner geometry could be established; i.e., the corner radius R, and the Bend angle (angle of corner circular arc between two HSS straight faces). The Z dimension was measured horizontally from the back of the weld to where the HSS corner curve met the plate (flare bevel) or the neighboring HSS (flare-V). The HSS-to-HSS-to-plate specimens were generally tacked in a snug fit-up, but in (rare) instances where a root opening occurred (dimension R in Figure 5) one HSS was "digitally moved" to reduce the root opening to zero before measuring Z.

The weld profile data measured can be summarized as follows:

Z = Z loss factor (in.) E = effective throat (in) R = HSS corner radius (in.)
T = HSS wall thickness (in.) W = dimension of weld face (in.)
Bend = angle of HSS corner between two flat sides of a HSS (degrees)

For flare bevel welds only, an additional two measurements are reported, as follows:

Alpha = angle between weld face and plate (degrees)
S = leg dimension of weld along plate (in.)

Typical examples for the above dimensions are shown for a flare-V and a flare bevel weld in Figures 27 and 28, respectively. Similar photographic data sheets for all 180 test weld cross-sections are recorded electronically on a CD ROM, labeled Appendix 5, enclosed in the back cover of this Report.

## 3.0 EXPERIMENTAL RESULTS

HSS geometric properties, namely T, R, Bend and R/T ratio for the three HSS sections used in the test program are given in Table 6a. Statistical values for average and standard deviation were determined from a population size of 60 for T and 84 for both the R and Bend values. Additional

data for R and Bend angles was due to having two measurements taken from each flare-V cross-section; i.e., from two HSS on either side of a flare-V weld.

It can be seen in Table 6a that the measured wall thickness, T, for these three HSS, in all cases exceeds the minimum prescribed by ASTM A500 (ASTM, 2001) which is 0.90T, and also exceeds the 0.93T "design thickness" prescribed by AISC (1997). The corner or bend angle was, on average, 72.7°, which is considerably less than the popularly-assumed corner radius of 90°. Thus, the corner radius in modern HSS does not meet the flat of the section at a tangent. The corner radius-to-thickness ratio shown in Table 6a varies considerably, but the HSS 4x4x$^{3}/_{16}$ was produced by one company whereas the other two were produced by a different company.

Table 6b provides some more recent data on thickness and outside corner radius properties, for seven other HSS produced to ASTM A500 (ASTM, 2001) and measured at the University of Toronto (Lecce and Packer, 2000). This confirms that the outside corner radius is generally greater than 2.0T and that the actual thickness (T) can be as low as $0.90T_{nominal}$.

Tables 7 to 9 summarize the prime welding parameters (extracted from the PQRs in Appendix 4) for all 72 test welds made in this study. A complete summary of measured weld profile and HSS dimensions is presented in Tables 10 to 12. Each table presents a summary of the 24 welds made on one particular HSS with the 12 flare bevel welds separated from the 12 flare-V welds. With Z loss being a prime point of interest, the values of Z have been sorted in descending order. For both flare bevel and flare-V welds an E/W ratio is calculated from the measured dimensions. Values of Z, S, W and E for flare bevel welds are averages from three measurements while the Z, W and E values for flare-V welds are averages from two measurements. (Refer to Figures 9, 10 and 11 for notation).

One noticeable trend from the tables is that the two minimum Z values in each grouping of 12 test welds are for welds done in the overhead position and by either the GMAW or FCAW-G process. Figures 29 to 31 present contrasting scanned images showing the minimum and maximum Z loss among each grouping of 12 welds, for each of the three HSS sizes. The range of Z values in these photographs is as follows:

| HSS size (in.) | Weld Type | Z minimum (in.) | Z maximum (in.) |
|---|---|---|---|
| 4 x 4 x $^{3}/_{16}$ | Flare Bevel | 0.03 (Weld 17) | 0.29 (Weld 8) |
| | Flare-V | 0.00 (Weld 18) | 0.19 (Weld 10) |
| 4 x 4 x $^{1}/_{4}$ | Flare Bevel | 0.12 (Weld 29) | 0.43 (Weld 32) |
| | Flare-V | 0.13 (Weld 30) | 0.45 (Weld 36) |
| 6 x 6 x $^{3}/_{8}$ | Flare Bevel | 0.10 (Weld 53) | 0.49 (Weld 56) |
| | Flare-V | 0.00 (Weld 66) | 0.24 (Weld 60) |

From the above dimension summary and the scanned images in Figures 29 to 31, the range of Z has varied from minimum values of zero up to about ½". Also noticeable is that for the HSS 4x4x¼ welds, a zero or very low value of Z was not produced compared to Z values produced on the other two HSS. To expand on this range of Z, the 36 values of Z for flare bevel and the 36 values of Z for flare-V welds are presented in histogram format in Figure 32. The histograms are shaded to identify the particular HSS. The Z values in the flare-V histogram show the majority (10 of 12) Z values measured on HSS 4x4x¼ welds all greater than those measured on the other two HSS. This has occurred because the HSS 4x4x¼ was found to have a bowed or convex side wall and this exacerbates the Z dimension. Figure 33 shows four flare-V welds made with HSS 4x4x¼ having the largest Z dimensions, where one can see the effect of this type of HSS profile geometry

that leads to a larger Z loss, since Z is measured horizontally from the back of the weld to the point of contact of the two tubes. (Figure 33 also includes the scanned image of Weld No. 40 which is later screened from the database in the Analysis).

The following table summarizes the maximum and minimum E values, alongside their corresponding weld face dimensions, W, for the complete 72 test weld database.

| HSS size (in.) | Weld Type | E min. (in.) | E max. (in.) | W for E min. (in.) | W for E max. (in.) |
|---|---|---|---|---|---|
| 4 x 4 x $^3/_{16}$ | Flare Bevel | 0.15 (20) | 0.36 (17) | 0.21 (20) | 0.32 (17) |
| | Flare-V | 0.16 (12) | 0.27 (15) | 0.40 (12) | 0.41 (15) |
| 4 x 4 x $^1/_4$ | Flare Bevel | 0.19 (44) | 0.39 (41) | 0.22 (44) | 0.33 (41) |
| | Flare-V | 0.08 (40) | 0.39 (30) | 0.25 (40) | 0.31 (30) |
| 6 x 6 x $^3/_8$ | Flare Bevel | 0.17 (68) | 0.43 (65) | 0.28 (68) | 0.28 (65) |
| | Flare-V | 0.19 (69) | 0.40 (66) | 0.33 (69) | 0.36 (66) |

Histograms of E, for the 36 flare bevel and 36 flare-V welds, are shown in Figure 34 and are again shaded to identify the three HSS sizes.

## 4.0 ANALYSIS OF RESULTS

For the purpose of making a direct comparison of test data to AWS rules, for flare bevel and flare-V effective throats filled flush to the HSS face, a predicted AWS value for Z can be back-calculated from the AWS effective throat formulas, which are:

- for Flare Bevel Welds: E = $^5/_{16}$ R, for all HSS
- for Flare-V Welds: E = ½ R, for HSS 4x4x$^3/_{16}$ and HSS 4x4x¼ (see Table 6a for average R)
- for Flare-V Welds: E= ⅜R, for HSS 6x6x⅜ with GMAW (see Table 6a for average R)

If one considers the summation of Z and E to be equal to the corner radius, for welds "filled flush" as shown in Figure 35, and assuming a 90° corner radius, the following predicted Z can be determined:

- for Flare Bevel Welds: Z (predicted) or $Z_{AWS}$ = $^{11}/_{16}$ R, for all HSS
- for Flare-V Welds: Z (predicted) or $Z_{AWS}$ = ½ R, for HSS 4x4x$^3/_{16}$ and HSS 4x4x¼ (see Table 6a for average R)
- for Flare-V Welds: Z (predicted) or $Z_{AWS}$ = ⅝R, for HSS 6x6x⅜ with GMAW (see Table 6a for average R)

The Z values measured in this test program can now be compared to a predicted Z value based on an AWS rule. Figure 36 shows six groups of 12 test welds with their Z values in relation to a predicted Z based on R of the HSS. The rule is shown to be a safe predictor of Z for both the HSS 4x4x$^3/_{16}$ and HSS 6x6x⅜ test welds, however for HSS 4x4x¼ there are some unsafe predictions especially in the flare-V welds where 10 out of 12 welds have Z greater than the predicted Z. For the HSS 4x4x¼ flare bevel welds only 2 out of 12 welds show unsafe Z values. As shown in Figure 33, the convex shape of the HSS 4x4x¼ has had the effect of increasing all the measured values of Z. This illustrates the problem of trying to define effective throat by measuring the Z loss dimension. Furthermore, this method of effective throat and Z prediction seems to be historically related to the habit of cross-sectioning flare groove welds for qualification.

Flare groove welds are frequently not filled flush to the face (or faces) of the HSS, and in such circumstances it would be particularly advantageous if the weld effective throat could be related to the size or location of the weld face. This is even more imperative if the existing weld effective throat rules are to be relaxed, and smaller flare groove welds consequently used. The weld face size or location is also the only dimension that can be determined by external measurement and also verified by an inspector. Thus, the weld effective throat, as a fraction of the weld face dimension, i.e. E/W, is plotted as histograms in Figure 37 (for flare bevel welds ) and Figure 38 (for flare-V welds). Also on these two figures are the Mean of the (E/W) ratio and the Mean minus two standard deviations of this ratio. The Mean minus two standard deviations level is a commonly-accepted level of structural reliability, rather than the absolute lowest bound from any test data point. In Figure 32 it could be seen that anomalously-high values for Z were obtained for the HSS 4x4x¼, because the flats of this section were slightly convex, but analyzing the results in terms of E and W (Figures 37 and 38) has taken care of this manufacturing problem.

Based on the statistical parameters for E/W test data one can now make a direct comparison to the AWS effective throat rule, *for welds filled flush to the HSS face(s)*. Figure 39 shows theoretical weld face dimensions for flare bevel and flare-V welds when welds are filled flush and using the average measured bend angle of the three HSS used in the test program. Using a 72.7° bend angle (Table 6a) the weld face dimension, W, is as follows:

- for Flare Bevel Welds: $W = R(\cos 8.65° - \sin 8.65°) = 0.838R$ ...(1)
- for Flare-V Welds: $W = 2R(\cos 8.65° - \sin 8.65°) = 1.677R$ ...(2)

The E/W Mean and standard deviation for *all* test data (n=72) are as follows:

| Weld Type | E/W |
|---|---|
| Flare Bevel (n=36) | Average = 0.91 |
| | Std. Dev. = 0.27 |
| Flare-V (n=36) | Average = 0.75 |
| | Std. Dev. = 0.23 |

One should also bear in mind that each flare bevel data point is itself the average of three measurements, and each flare-V data point is itself the average of two measurements. Thus, the statistical base is actually a total of 180 flare weld cross-sections.

Expressing an effective throat rule in the form of E = constant x W, and using a constant developed from test data, i.e., Mean E/W – 2 x S.D., the general expression for effective throat, with R and test data combined, is as follows:

- for Flare Bevel Welds:

$$E = \text{constant} \times W$$
$$E = (\text{Mean } E/W - 2 \times \text{S.D.}) \times (0.838R)$$
$$E = (0.91 - 2 \times 0.27) \times (0.838R)$$
$$E = 0.31R \quad \text{...(3)}$$

Note that this E is almost identical to the E predicted by AWS; i.e., $E = {}^{5}/_{16}\,R = 0.3125R$.

- for Flare-V Welds:

$$E = \text{constant} \times W$$
$$E = (\text{Mean } E/W - 2 \times \text{S.D.}) \times (1.677R)$$
$$E = (0.75 - 2 \times 0.23) \times (1.677R)$$
$$E = 0.49R \quad \text{...(4)}$$

Note that this E is again very similar to the E predicted by AWS; i.e., E = 0.50R in general, or E = 0.375R for GMAW with R ≥ ½ in.

### 4.1 Screening and Grouping of Data

The procedure outlined above was also done for each set of nine test welds made with each of the four weld processes. It was also decided to exclude data that pertained to non-prequalified welding procedures. Six of the 72 test welds (3 GMAW flare bevel welds and 3 GMAW flare-V welds) were done in the "vertical down" position; a weld progression that is not prequalified to AWS D1.1. These welds were made in this manner because:
(a) It was actually recommended by the Oversight Committee, and
(b) According to the project's professional welding engineer GMAW cannot be done "vertical up" with the kind of equipment available in a typical structural fabrication shop.
Nevertheless, to derive recommendations in conformance with AWS D1.1 prequalified welding procedures, the GMAW "vertical down" data was omitted.

Based on this analysis, the weld processes that had the highest E/W Mean were grouped together and another calculation was made of an E/W Mean, this time with a grouping of 15 or 18 test welds from two processes. For both the flare bevel and flare-V weld types the processes with the highest E/W Means were FCAW-G and GMAW. The summary of this data is as follows:

| Weld Types | | FCAW-G (n=9) | GMAW (n=6) | SMAW (n=9) | FCAW-S (n=9) | GMAW & FCAW-G (n=15) | SMAW & FCAW-S (n=18) |
|---|---|---|---|---|---|---|---|
| Flare Bevel | Mean (E/W) | 1.12 | 1.19 | 0.83 | 0.61 | 1.15 | 0.72 |
| | S.D. (E/W) | 0.19 | 0.20 | 0.17 | 0.10 | 0.19 | 0.18 |
| | Mean-2xS.D. | 0.75 | 0.79 | 0.49 | 0.41 | 0.76 | 0.37 |
| | E | 0.63R | 0.66R | 0.41R | 0.34R | 0.64R | 0.31R |
| Flare-V | Mean (E/W) | 0.90 | 0.90 | 0.70 | 0.58 | 0.90 | 0.64 |
| | S.D. (E/W) | 0.26 | 0.19 | 0.11 | 0.13 | 0.23 | 0.14 |
| | Mean-2xS.D. | 0.38 | 0.52 | 0.47 | 0.32 | 0.43 | 0.37 |
| | E | 0.64R | 0.88R | 0.79R | 0.53R | 0.73R | 0.61R |

Thus, it would seem possible to recommend design rules, as follows, for flare groove welds filled flush to the HSS face and made with prequalified welding procedures:

- for Flare Bevel Welds: E = 0.64R for GMAW and FCAW-G ...(5)
  or E = 0.31R for SMAW and FCAW-S ...(6)

- for Flare-V Welds: E = 0.73R for GMAW and FCAW-G ...(7)
  or E = 0.61R for SMAW and FCAW-S ...(8)

In the case of **flare bevel welds**, predictions for E by individual welding process are all higher than the AWS rule (E = 0.3125R). For **flare-V welds**, predictions for E by individual welding process are also higher than the AWS rule (E = 0.5R) for FCAW-G, SMAW and FCAW-S weld processes. In the case of GMAW the prediction for E is considerably greater than the AWS rule (E = ⅜R or E = ½R, depending on R).

Using test data to establish an effective throat rule for welds *not filled flush to the HSS face(s)*, the externally measured weld face size (W) can be related to the E value by a constant developed from E/W test data ratios, but excluding "vertical down" welds, as follows:

- for Flare Bevel Welds:

$$E = \text{constant} \times W$$
$$E = (\text{Mean } E/W - 2 \times \text{S.D.}) \times W$$
$$E = (0.91 - 2 \times 0.28) \times W$$
$$E = 0.35W \quad \ldots(9)$$

- for Flare-V Welds:

$$E = \text{constant} \times W$$
$$E = (\text{Mean } E/W - 2 \times \text{S.D.}) \times W$$
$$E = (0.76 - 2 \times 0.23) \times W$$
$$E = 0.30W \quad \ldots(10)$$

As discussed in Section 1.5, the forthcoming CSA W59 has accounted for welds not filled flush, for flare bevel welds only and for just a restricted welding parameter range. The relationship between E and W is expressed (CSA, 2001) as follows:

| Effective Throat Rule | Weld Process | Limitations |
|---|---|---|
| W = 1.5E<br>or<br>E = 0.67W | FCAW | $W_{min.} = 1/4$ "<br>R > 3/8 " for flat and horizontal positions only<br>Alpha = 90° to 140°<br>Gap, G ≤ $5/32$ " |
| W = 1.5E<br>or<br>E = 0.67W | GMAW | $W_{min.} = 1/4$ "<br>R > 3/8 " for flat and horizontal positions only<br>Alpha = 90° to 140°<br>Gap, G ≤ $5/32$ " |
| W = 1.7E<br>or<br>E = 0.59W | SMAW | $W_{min.} = 1/4$ "<br>R > 3/8 " for flat and horizontal positions<br>R > $9/16$ " for vertical and overhead positions<br>Alpha = 90° to 140°<br>Gap, G ≤ 1/8 " |

Comparing E = 0.35W (Equation 9, for flare bevel welds) with CSA effective throat rules tabled above, the effective throats predicted by Equation 9 are 41% (for SMAW) and 48% (for GMAW and FCAW) lower than those predicted by the CSA W59 draft rules. However, one must bear in mind that Equation 9 is developed from data that includes numerous vertical and overhead flare bevel welds, which are only considered by the CSA W59 draft for SMAW when R > $9/16$ ". It is a better evaluation of the CSA (2001) rules to compare measured E values from just those test welds that meet the CSA Limits of Applicability, with E predicted by CSA. Only 11 of the 36 test welds in this current program meet these criteria (after confirmation from Paolini that FCAW covers only FCAW-G and not FCAW-S). The comparison for the 11 test welds is given in Table 13. It can be seen that the E value measured in each case exceeded the E predicted by the new CSA rules, thus confirming that the CSA proposals are indeed safe and conservative.

For flare bevel welds at the "filled flush" limit, the weld face dimension (W) is 0.838R (see Equation 1) for typical contemporary HSS. Thus, the new CSA rules would predict E = 0.667W = 0.56R for such a weld (for GMAW and FCAW-G), which is very similar (but a little more conservative) to that proposed in Equation 5 (E = 0.64R). For flare bevel welds by the SMAW process the new CSA rules, at the "filled flush limit", would predict E = 0.588W = 0.49R, which is considerably more

optimistic than proposed in Equation 6 (E = 0.31R), but one must bear in mind that the range of applicability of Equation 6 is much broader.

An alternative to measuring the weld face dimension (W), for welds not filled flush to the HSS faces(s), would be to measure the setback distance (Df) from the outer wall to the face of the weld. This has the advantage of maintaining weld effective throat size formulas in a consistent and familiar format, by relating to the "filled flush" line. The new CSA rules are lower bounds for quite a range of slope on the weld face (see Figures 9 to 11), and similarly the dimension Df would need to be measured conservatively too for a sloped weld face (i.e. the largest Df distance would be used).

## 5.0 CONCLUSIONS

The experimental results of this test program have been used to make direct comparison to existing rules for flare groove welds, resulting in the following recommendations.

• **For flare bevel groove welds, filled flush to the face of the HSS**, test data confirms that, after inclusion of a suitable safety margin, the following effective throat sizes (E) can be justified, in terms of the HSS outside corner radius (R), for flat, horizontal, vertical up and overhead welding positions, depending on the welding process:

$$E = 0.64R \quad \text{for GMAW and FCAW-G} \qquad \ldots(5)$$

*or* $$E = 0.31R \quad \textit{for SMAW and FCAW-S} \qquad \ldots(6)$$

• **For flare-V groove welds, filled flush to the faces of the HSS**, test data confirms that, after inclusion of a suitable safety margin, the following effective throat sizes (E) can be justified, in terms of the HSS outside corner radius (R), for flat, horizontal, vertical up and overhead welding positions, depending on the welding process:

$$E = 0.73R \quad \text{for GMAW and FCAW-G} \qquad \ldots(7)$$

or $$E = 0.61R \quad \text{for SMAW and FCAW-S} \qquad \ldots(8)$$

• **For flare bevel groove welds, *not* filled flush to the face of the HSS,** equations (5) and (6) above can be re-written in the following form, using a dimension Df (which must be measured), where Df is the distance from the outer wall of the HSS to the face of the weld:

$$E = 0.64R - Df \quad \text{for GMAW and FCAW-G} \qquad \ldots(11)$$

or $$E = 0.31R - Df \quad \text{for SMAW and FCAW-S} \qquad \ldots(12)$$

• **For flare-V groove welds, *not* filled flush to the faces of the HSS,** equations (7) and (8) above can be re-written in the following form, using a dimension Df (which must be measured), where Df is the distance from the outer walls of the HSS to the face of the weld:

$$E = 0.73R - Df \quad \text{for GMAW and FCAW-G} \qquad \ldots(13)$$

or $$E = 0.61R - Df \quad \text{for SMAW and FCAW-S} \qquad \ldots(14)$$

Equations (5) to (8) and (11) to (14) above all entail a knowledge of the square or rectangular HSS outside corner radius, R. For ASTM A500 hollow sections, an outside corner radius of R = 2T can be assumed. (Tables 6a and 6b show that this is nearly always exceeded, hence resulting in a conservative prediction for E). The actual tube wall thickness, T, can either be measured or a "design value" of $0.93T_{nominal}$ may be assumed, as specified by AISC (1997).

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**Table 1. Test Specimen Summary for HSS 4 x 4 x $^{3}/_{16}$**

| HSS Size (in.) | Weld Process | Specimen No. | Weld Type | Weld Position | Weld No. | No. of Weld Cross-sections |
|---|---|---|---|---|---|---|
| 4 x 4 x $^{3}/_{16}$ | FCAW-G | 1 | FB | H | 1 | 3 |
| | | | FB | V | 2 | 3 |
| | | | FV | F | 3 | 2 |
| | | | FV | V | 4 | 2 |
| | | 2 | FB | OH | 5 | 3 |
| | | | FV | OH | 6 | 2 |
| | FCAW-S | 3 | FB | H | 7 | 3 |
| | | | FB | V | 8 | 3 |
| | | | FV | F | 9 | 2 |
| | | | FV | V | 10 | 2 |
| | | 4 | FB | OH | 11 | 3 |
| | | | FV | OH | 12 | 2 |
| | GMAW | 5 | FB | H | 13 | 3 |
| | | | FB | V | 14 | 3 |
| | | | FV | F | 15 | 2 |
| | | | FV | V | 16 | 2 |
| | | 6 | FB | OH | 17 | 3 |
| | | | FV | OH | 18 | 2 |
| | SMAW | 7 | FB | H | 19 | 3 |
| | | | FB | V | 20 | 3 |
| | | | FV | F | 21 | 2 |
| | | | FV | V | 22 | 2 |
| | | 8 | FB | OH | 23 | 3 |
| | | | FV | OH | 24 | 2 |
| TOTALS | 4 | 8 | 2 | 4 | 24 | 60 |

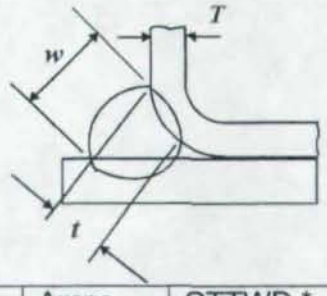
**Table 2. Test Specimen Summary for HSS 4 x 4 x $^1/_4$**

| HSS Size (in.) | Weld Process | Specimen No. | Weld Type | Weld Position | Weld No. | No. of Weld Cross-sections |
|---|---|---|---|---|---|---|
| 4 x 4 x $^1/_4$ | FCAW-G | 9 | FB | H | 25 | 3 |
| | | | FB | V | 26 | 3 |
| | | | FV | F | 27 | 2 |
| | | | FV | V | 28 | 2 |
| | | 10 | FB | OH | 29 | 3 |
| | | | FV | OH | 30 | 2 |
| | FCAW-S | 11 | FB | H | 31 | 3 |
| | | | FB | V | 32 | 3 |
| | | | FV | F | 33 | 2 |
| | | | FV | V | 34 | 2 |
| | | 12 | FB | OH | 35 | 3 |
| | | | FV | OH | 36 | 2 |
| | GMAW | 13 | FB | H | 37 | 3 |
| | | | FB | V | 38 | 3 |
| | | | FV | F | 39 | 2 |
| | | | FV | V | 40 | 2 |
| | | 14 | FB | OH | 41 | 3 |
| | | | FV | OH | 42 | 2 |
| | SMAW | 15 | FB | H | 43 | 3 |
| | | | FB | V | 44 | 3 |
| | | | FV | F | 45 | 2 |
| | | | FV | V | 46 | 2 |
| | | 16 | FB | OH | 47 | 3 |
| | | | FV | OH | 48 | 2 |
| TOTALS | 4 | 8 | 2 | 4 | 24 | 60 |

**Table 3. Test Specimen Summary for HSS 6 x 6 x $^3/_8$**

| HSS Size (in.) | Weld Process | Specimen No. | Weld Type | Weld Position | Weld No. | No. of Weld Cross-sections |
|---|---|---|---|---|---|---|
| 6 x 6 x $^3/_8$ | FCAW-G | 17 | FB | H | 49 | 3 |
| | | | FB | V | 50 | 3 |
| | | | FV | F | 51 | 2 |
| | | | FV | V | 52 | 2 |
| | | 18 | FB | OH | 53 | 3 |
| | | | FV | OH | 54 | 2 |
| | FCAW-S | 19 | FB | H | 55 | 3 |
| | | | FB | V | 56 | 3 |
| | | | FV | F | 57 | 2 |
| | | | FV | V | 58 | 2 |
| | | 20 | FB | OH | 59 | 3 |
| | | | FV | OH | 60 | 2 |
| | GMAW | 21 | FB | H | 61 | 3 |
| | | | FB | V | 62 | 3 |
| | | | FV | F | 63 | 2 |
| | | | FV | V | 64 | 2 |
| | | 22 | FB | OH | 65 | 3 |
| | | | FV | OH | 66 | 2 |
| | SMAW | 23 | FB | H | 67 | 3 |
| | | | FB | V | 68 | 3 |
| | | | FV | F | 69 | 2 |
| | | | FV | V | 70 | 2 |
| | | 24 | FB | OH | 71 | 3 |
| | | | FV | OH | 72 | 2 |
| TOTALS | 4 | 8 | 2 | 4 | 24 | 60 |

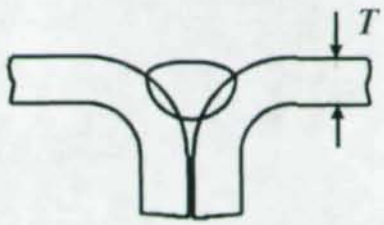
**Table 4a. WPS for Flare Bevel Groove Welds (Tee Joint) before Trial Welding**




| Weld Process | Position | Electrode Dia. (in.) | WFS (in./min.) | Amps | CTTWD * (in.) | Voltage |
|---|---|---|---|---|---|---|
| FCAW-G Lincoln 71M (E71T-9 with $CO_2$) | H (2G) | 1/16 | 225 | 250 | 3/4 | 26-28 |
| | V (3G) - Up | 1/16 | 150 | 200 | 3/4 | 22-24 |
| | OH (4G) | 1/16 | 225 | 250 | 3/4 | 26-28 |
| | | | | | | |
| FCAW-S Lincoln NR232 | H (2G) | 0.072 | 200 | 275 | 3/4 | 20-23 |
| | V (3G) - Up | 0.072 | 170 | 250 | 3/4 | 20-21 |
| | OH (4G) | 0.072 | 170 | 250 | 3/4 | 20-23 |
| | | | | | | |
| GMAW (ER70S-6 with C-10) | H (2G) | 0.045 | 325 | 250 | 1/2 | 26-28 |
| | V (3G) – Down | 0.045 | 325 | 250 | 1/2 | 26-28 |
| | OH (4G) | 0.045 | 325 | 250 | 1/2 | 26-28 |
| | | | | | | |
| SMAW (E7018) | H (2G) | 1/8 | N/A | 125 | N/A | N/A |
| | V (3G) - Up | 1/8 | N/A | 125 | N/A | N/A |
| | OH (4G) | 1/8 | N/A | 125 | N/A | N/A |

* Contact Tube to Work Distance

**Table 4b. WPS for Flare-V Groove Welds (Butt Joint) before Trial Welding**




| Weld Process | Position | Electrode Dia. (in.) | WFS (in./min.) | Amps | CTTWD * (in.) | Voltage |
|---|---|---|---|---|---|---|
| FCAW-G Lincoln 71M (E71T-9 with $CO_2$) | F (1G) | 1/16 | 225 | 250 | 3/4 | 26-28 |
| | V (3G) - Up | 1/16 | 150 | 200 | 3/4 | 22-24 |
| | OH (4G) | 1/16 | 225 | 250 | 3/4 | 26-28 |
| | | | | | | |
| FCAW-S Lincoln NR232 | F (1G) | 0.072 | 200 | 275 | 3/4 | 20-23 |
| | V (3G)- Up | 0.072 | 170 | 250 | 3/4 | 20-21 |
| | OH (4G) | 0.072 | 170 | 250 | 3/4 | 20-23 |
| | | | | | | |
| GMAW (ER70S-6 with C-10) | F (1G) | 0.045 | 325 | 250 | 1/2 | 26-28 |
| | V (3G) - Down | 0.045 | 325 | 250 | 1/2 | 26-28 |
| | OH (4G) | 0.045 | 325 | 250 | 1/2 | 26-28 |
| | | | | | | |
| SMAW (E7018) | F (1G) | 1/8 | N/A | 125 | N/A | N/A |
| | V (3G) - Up | 1/8 | N/A | 125 | N/A | N/A |
| | OH (4G) | 1/8 | N/A | 125 | N/A | N/A |

* Contact Tube to Work Distance

**Table 5. HSS Chemical and Mechanical Properties – Producer Test Report Values**

| HSS Size (in.) | | 4 x 4 x 3/16 | 4 x 4 x 1/4 | 6 x 6 x 3/8 |
|---|---|---|---|---|
| Producer | | Atlas Tube | LTV Copperweld | LTV Copperweld |
| Heat No. | | 0134937 | 864176 | J55962 |
| Mechanical Properties | Yield Strength (psi) | 61,149 | 77,200 | 58,400 |
| | Tensile Strength (psi) | 71,200 | 88,800 | 67,800 |
| | Elongation (%) | 26.5 | 30 | 37 |
| Chemical Analysis | C | 0.18 | 0.20 | 0.21 |
| | Mn | 0.67 | 0.88 | 0.73 |
| | P | 0.010 | 0.007 | 0.012 |
| | S | 0.009 | 0.005 | 0.011 |
| | Si | 0.009 | 0.01 | 0.01 |
| | Al | 0.030 | 0.410 | 0.037 |
| | Cb | | 0.024 | |
| | Cu | 0.020 | 0.039 | |
| | Ni | 0.010 | 0.013 | |
| | Cr | | 0.018 | |

**Table 6a: HSS Geometric Properties of Tubes used in this Study**

| HSS Size (in.) | | 4 x 4 x 3/16 | 4 x 4 x 1/4 | 6 x 6 x 3/8 |
|---|---|---|---|---|
| Thickness – T (n=60) | Average (in.) | 0.183 | 0.241 | 0.372 |
| | Std. Dev. (in.) | 0.001 | 0.001 | 0.001 |
| Radius – R (n=84) | Average (in.) | 0.445 | 0.466 | 0.716 |
| | Std. Dev. (in.) | 0.022 | 0.028 | 0.048 |
| Bend (HSS corner) (n=84) | Average (deg.) | 76.2 | 72.3 | 69.5 |
| | Std. Dev. (deg.) | 2.1 | 2.2 | 1.3 |
| Bend Angle – average (degrees) | | | 72.7 | |
| $T/T_{nominal}$ | | 0.976T | 0.964T | 0.992T |
| R/T | | 2.43 | 1.93 | 1.92 |

**Table 6b: Further Geometric Properties of recent ASTM A500 Tubes**

| Tube ID | HSS Size (in.) | $T/T_{nominal}$ | R/T |
|---|---|---|---|
| LTV1 | 6 x 6 x 3/16 | 0.924 | 2.73 |
| LTV2 | 7 x 7 x 3/8 | 0.913 | 2.64 |
| LTV3 | 8 x 8 x 5/16 | 0.945 | 2.80 |
| LTV4 | 8 x 8 x 3/8 | 0.903 | 2.33 |
| LTV5 | 8 x 8 x ½ | 0.921 | 2.14 |
| LTV6 | 10 x 10 x 5/16 | 0.913 | 2.90 |
| LTV7 | 12 x 12 x ½ | 0.953 | 2.48 |

**Table 7: HSS 4 x 4 x $^{3}/_{16}$ Test Weld Parameters With Dimensions Z and E**

| Flare Bevel | Weld No. | Weld Position | Z (in.) | E (in.) | Amps | Voltage | Wire Feed (ipm) | Travel Speed (ipm) |
|---|---|---|---|---|---|---|---|---|
| FCAW-G | 1 | H | 0.076 | 0.294 | 237 | 25.0 | 225 | 11.5 |
| | 2 | V | 0.077 | 0.271 | 213 | 21.0 | 157 | 7.4 |
| | 5 | OH | 0.057 | 0.319 | 199 | 24.0 | 155 | 7.7 |
| FCAW-S | 7 | H | 0.183 | 0.194 | 237 | 21.0 | 173 | 9.5 |
| | 8 | V | 0.290 | 0.237 | 180 | 17.5 | 115 | 3.7 |
| | 11 | OH | 0.159 | 0.199 | 196 | 17.0 | 115 | 6.1 |
| GMAW | 13 | H | 0.085 | 0.308 | 234 | 26.9 | 330 | 9.9 |
| | 14 | V | 0.108 | 0.228 | 248 | 24.5 | 330 | 15.3 |
| | 17 | OH | 0.031 | 0.358 | 197 | 24.4 | 260 | 7.3 |
| SMAW | 19 | H | 0.182 | 0.201 | 120 | - | N/A | 4.1 |
| | 20 | V | 0.177 | 0.148 | 120 | - | N/A | 5.0 |
| | 23 | OH | 0.124 | 0.273 | 120 | - | N/A | 3.7 |
| Flare–V | Weld No. | Weld Position | Z (in.) | E (in.) | Amps | Voltage | Wire Feed (ipm) | Travel Speed (ipm) |
| FCAW-G | 3 | F | 0.140 | 0.199 | 233 | 25.0 | 225 | 10.9 |
| | 4 | V | 0.040 | 0.238 | 192 | 21.0 | 157 | 8.6 |
| | 6 | OH | 0.000 | 0.260 | 200 | 24.0 | 155 | 10.3 |
| FCAW-S | 9 | F | 0.134 | 0.172 | 235 | 22.0 | 173 | 12.0 |
| | 10 | V | 0.188 | 0.204 | 180 | 17.5 | 115 | 3.7 |
| | 12 | OH | 0.111 | 0.161 | 197 | 17.0 | 115 | 6.5 |
| GMAW | 15 | F | 0.054 | 0.271 | 234 | 26.7 | 330 | 13.7 |
| | 16 | V | 0.054 | 0.193 | 259 | 24.4 | 330 | 19.5 |
| | 18 | OH | 0.000 | 0.238 | 200 | 23.1 | 260 | 10.6 |
| SMAW | 21 | F | 0.100 | 0.164 | 120 | - | N/A | 4.7 |
| | 22 | V | 0.076 | 0.178 | 120 | - | N/A | 4.9 |
| | 24 | OH | 0.084 | 0.171 | 120 | - | N/A | 4.4 |

**Table 8: HSS 4 x 4 x ¼ Test Weld Parameters With Dimensions Z and E**

| Flare Bevel | Weld No. | Weld Position | Z (in.) | E (in.) | Amps | Voltage | Wire Feed (ipm) | Travel Speed (ipm) |
|---|---|---|---|---|---|---|---|---|
| FCAW-G | 25 | H | 0.276 | 0.266 | 251 | 27.0 | 225 | 10.3 |
| | 26 | V | 0.191 | 0.327 | 200 | 21.0 | 157 | 5.4 |
| | 29 | OH | 0.121 | 0.373 | 208 | 24.5 | 175 | 7.8 |
| FCAW-S | 31 | H | 0.327 | 0.198 | 237 | 21.0 | 173 | 9.0 |
| | 32 | V | 0.432 | 0.221 | 180 | 17.5 | 115 | 3.6 |
| | 35 | OH | 0.310 | 0.249 | 225 | 20.0 | 153 | 6.6 |
| GMAW | 37 | H | 0.226 | 0.346 | 206 | 26.8 | 330 | 7.8 |
| | 38 | V | 0.242 | 0.206 | 255 | 24.6 | 330 | 12.6 |
| | 41 | OH | 0.157 | 0.388 | 237 | 25.7 | 330 | 9.2 |
| SMAW | 43 | H | 0.309 | 0.227 | 136 | - | N/A | 3.7 |
| | 44 | V | 0.318 | 0.190 | 132 | - | N/A | 4.8 |
| | 47 | OH | 0.188 | 0.308 | 123 | - | N/A | 2.9 |
| Flare-V | Weld No. | Weld Position | Z (in.) | E (in.) | Amps | Voltage | Wire Feed (ipm) | Travel Speed (ipm) |
| FCAW-G | 27 | F | 0.345 | 0.218 | 244 | 27.0 | 225 | 10.8 |
| | 28 | V | 0.173 | 0.288 | 197 | 21.0 | 157 | 6.8 |
| | 30 | OH | 0.132 | 0.386 | 215 | 24.0 | 175 | 7.2 |
| FCAW-S | 33 | F | 0.379 | 0.208 | 237 | 22.0 | 173 | 11.8 |
| | 34 | V | 0.349 | 0.311 | 180 | 17.5 | 115 | 3.5 |
| | 36 | OH | 0.450 | 0.232 | 225 | 20.0 | 153 | 6.3 |
| GMAW | 39 | F | 0.360 | 0.291 | 214 | 26.0 | 330 | 10.1 |
| | 40 | V | 0.440 | 0.080 | 258 | 26.2 | 330 | 17.3 |
| | 42 | OH | 0.261 | 0.374 | 237 | 24.8 | 328 | 9.4 |
| SMAW | 45 | F | 0.374 | 0.210 | 136 | - | N/A | 3.6 |
| | 46 | V | 0.282 | 0.342 | 133 | - | N/A | 3.0 |
| | 48 | OH | 0.357 | 0.229 | 120 | - | N/A | 3.7 |

**Table 9: HSS 6 x 6 x ⅜ Test Weld Parameters With Dimensions Z and E**

| Flare Bevel | Weld No. | Weld Position | Z (in.) | E (in.) | Amps | Voltage | Wire Feed (ipm) | Travel Speed (ipm) |
|---|---|---|---|---|---|---|---|---|
| FCAW-G | 49 | H | 0.244 | 0.323 | 247 | 26.5 | 225 | 8.3 |
| | 50 | V | 0.225 | 0.343 | 200 | 21.0 | 157 | 5.1 |
| | 53 | OH | 0.096 | 0.432 | N/A | 24.0 | 175 | 5.6 |
| FCAW-S | 55 | H | 0.371 | 0.192 | 227 | 22.0 | 173 | 8.5 |
| | 56 | V | 0.487 | 0.237 | 178 | 17.5 | 115 | 3.7 |
| | 59 | OH | 0.340 | 0.259 | 225 | 20.0 | 153 | 6.2 |
| GMAW | 61 | H | 0.212 | 0.374 | 209 | 27.1 | 330 | 8.5 |
| | 62 | V | 0.372 | 0.214 | 239 | 24.4 | 330 | 10.5 |
| | 65 | OH | 0.128 | 0.433 | 240 | 25.4 | 330 | 8.0 |
| SMAW | 67 | H | 0.410 | 0.234 | 122 | - | N/A | 2.4 |
| | 68 | V | 0.360 | 0.167 | 120 | - | N/A | 3.3 |
| | 71 | OH | 0.196 | 0.349 | 122 | - | N/A | 2.7 |
| Flare-V | Weld No. | Weld Position | Z (in.) | E (in.) | Amps | Voltage | Wire Feed (ipm) | Travel Speed (ipm) |
| FCAW-G | 51 | F | 0.164 | 0.216 | 236 | 26.5 | 225 | 10.0 |
| | 52 | V | 0.122 | 0.295 | 202 | 21.0 | 157 | 5.9 |
| | 54 | OH | 0.086 | 0.339 | 238 | 25.0 | 205 | 10.5 |
| FCAW-S | 57 | F | 0.234 | 0.188 | 245 | 22.0 | 173 | 9.0 |
| | 58 | V | 0.197 | 0.283 | 220 | 22.0 | 164 | 5.9 |
| | 60 | OH | 0.242 | 0.248 | 226 | 20.0 | 153 | 6.6 |
| GMAW | 63 | F | 0.121 | 0.305 | 218 | 26.9 | 330 | 9.9 |
| | 64 | V | 0.137 | 0.200 | 242 | 24.5 | 330 | 15.0 |
| | 66 | OH | 0.000 | 0.402 | 235 | 25.4 | 330 | 7.5 |
| SMAW | 69 | F | 0.227 | 0.186 | 130 | - | N/A | 3.8 |
| | 70 | V | 0.134 | 0.249 | 130 | - | N/A | 2.9 |
| | 72 | OH | 0.147 | 0.234 | 130 | - | N/A | 3.1 |

**Table 10: HSS 4 x 4 x $^{3}/_{16}$ Section and Weld Measurements**

| FLARE BEVEL | 8 | 7 | 19 | 20 | 11 | 23 | 14 | 13 | 2 | 1 | 5 | 17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PROCESS | FCAW-S | FCAW-S | SMAW | SMAW | FCAW-S | SMAW | GMAW | GMAW | FCAW-G | FCAW-G | FCAW-G | GMAW |
| POSITION | V | H | H | V | OH | OH | V | H | V | H | OH | OH |
| Tavg | 0.18 | 0.18 | 0.18 | 0.18 | 0.18 | 0.18 | 0.18 | 0.19 | 0.18 | 0.18 | 0.18 | 0.18 |
| Z | 0.29 | 0.21 | 0.18 | 0.18 | 0.16 | 0.12 | 0.11 | 0.09 | 0.08 | 0.08 | 0.06 | 0.03 |
| S | 0.36 | 0.27 | 0.22 | 0.17 | 0.32 | 0.34 | 0.30 | 0.38 | 0.35 | 0.35 | 0.35 | 0.39 |
| R | 0.42 | 0.45 | 0.47 | 0.44 | 0.42 | 0.46 | 0.47 | 0.41 | 0.43 | 0.46 | 0.47 | 0.41 |
| BEND | 75.7 | 77.3 | 77.0 | 74.0 | 75.3 | 76.3 | 76.7 | 77.3 | 74.0 | 74.3 | 75.0 | 75.7 |
| E | 0.24 | 0.19 | 0.20 | 0.15 | 0.20 | 0.27 | 0.23 | 0.31 | 0.27 | 0.29 | 0.32 | 0.36 |
| W | 0.50 | 0.30 | 0.27 | 0.21 | 0.34 | 0.31 | 0.22 | 0.32 | 0.27 | 0.26 | 0.28 | 0.32 |
| E/W | 0.48 | 0.65 | 0.75 | 0.69 | 0.58 | 0.89 | 1.04 | 0.97 | 1.00 | 1.12 | 1.14 | 1.14 |
| ALPHA | 127.3 | 128.3 | 109.7 | 112.7 | 130.7 | 117.7 | 119.7 | 126.0 | 128.0 | 117.7 | 113.3 | 114.3 |

| FLARE-V | 10 | 3 | 9 | 12 | 21 | 24 | 22 | 15 | 16 | 4 | 6 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PROCESS | FCAW-S | FCAW-G | FCAW-S | FCAW-S | SMAW | SMAW | SMAW | GMAW | GMAW | FCAW-G | FCAW-G | GMAW |
| POSITION | V | F | F | OH | F | OH | V | F | V | V | OH | OH |
| Tavg | 0.18 | 0.18 | 0.18 | 0.18 | 0.18 | 0.19 | 0.18 | 0.18 | 0.18 | 0.18 | 0.18 | 0.18 |
| Z | 0.19 | 0.14 | 0.13 | 0.11 | 0.10 | 0.08 | 0.08 | 0.05 | 0.05 | 0.04 | 0.00 | 0.00 |
| R(top) | 0.46 | 0.48 | 0.46 | 0.44 | 0.44 | 0.46 | 0.45 | 0.44 | 0.46 | 0.44 | 0.43 | 0.45 |
| R(bottom) | 0.43 | 0.47 | 0.45 | 0.46 | 0.44 | 0.47 | 0.45 | 0.44 | 0.45 | 0.44 | 0.44 | 0.46 |
| Ravg | 0.44 | 0.48 | 0.46 | 0.45 | 0.44 | 0.46 | 0.45 | 0.44 | 0.45 | 0.44 | 0.43 | 0.46 |
| BEND(top) | 74.0 | 76.5 | 76.5 | 77.5 | 77.5 | 76.5 | 76.5 | 76.5 | 74.0 | 79.0 | 77.0 | 78.0 |
| BEND(bottom) | 74.0 | 77.5 | 75.5 | 76.0 | 77.5 | 77.0 | 77.0 | 75.0 | 77.5 | 79.5 | 76.5 | 75.5 |
| BENDavg | 74.0 | 77.0 | 76.0 | 76.8 | 77.5 | 76.8 | 76.8 | 75.8 | 75.8 | 79.3 | 76.8 | 76.8 |
| E | 0.20 | 0.20 | 0.17 | 0.16 | 0.16 | 0.17 | 0.18 | 0.27 | 0.19 | 0.24 | 0.26 | 0.24 |
| W | 0.52 | 0.39 | 0.31 | 0.40 | 0.29 | 0.28 | 0.23 | 0.41 | 0.25 | 0.29 | 0.26 | 0.32 |
| E/W | 0.39 | 0.51 | 0.55 | 0.40 | 0.57 | 0.61 | 0.77 | 0.66 | 0.76 | 0.82 | 1.00 | 0.74 |

**Table 11: HSS 4 x 4 x ¼ Section and Weld Measurements**

| FLARE BEVEL | 32 | 31 | 44 | 35 | 43 | 25 | 38 | 37 | 26 | 47 | 41 | 29 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PROCESS | FCAW-S | FCAW-S | SMAW | FCAW-S | SMAW | FCAW-G | GMAW | GMAW | FCAW-G | SMAW | GMAW | FCAW-G |
| POSITION | V | H | V | OH | H | H | V | H | V | OH | OH | OH |
| Tavg | 0.24 | 0.24 | 0.24 | 0.24 | 0.24 | 0.24 | 0.24 | 0.24 | 0.24 | 0.24 | 0.24 | 0.24 |
| Z | 0.43 | 0.33 | 0.32 | 0.31 | 0.31 | 0.28 | 0.24 | 0.23 | 0.19 | 0.19 | 0.16 | 0.12 |
| S | 0.31 | 0.28 | 0.25 | 0.33 | 0.26 | 0.34 | 0.26 | 0.42 | 0.37 | 0.35 | 0.44 | 0.39 |
| R | 0.48 | 0.49 | 0.44 | 0.50 | 0.50 | 0.51 | 0.47 | 0.49 | 0.48 | 0.43 | 0.50 | 0.42 |
| BEND | 73.0 | 70.3 | 72.0 | 73.0 | 68.7 | 74.3 | 72.0 | 70.0 | 76.0 | 71.0 | 71.0 | 70.7 |
| E | 0.22 | 0.20 | 0.19 | 0.25 | 0.23 | 0.27 | 0.21 | 0.35 | 0.33 | 0.31 | 0.39 | 0.37 |
| W | 0.48 | 0.30 | 0.22 | 0.36 | 0.28 | 0.31 | 0.26 | 0.36 | 0.33 | 0.31 | 0.33 | 0.31 |
| E/W | 0.46 | 0.67 | 0.86 | 0.70 | 0.81 | 0.85 | 0.79 | 0.97 | 0.99 | 0.99 | 1.18 | 1.20 |
| ALPHA | 127.7 | 124.7 | 120.7 | 121.7 | 116.3 | 128.0 | 117.0 | 123.7 | 116.3 | 111.7 | 117.7 | 105.3 |

| FLARE-V | 36 | 40 | 33 | 45 | 39 | 48 | 34 | 27 | 46 | 42 | 28 | 30 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PROCESS | FCAW-S | GMAW | FCAW-S | SMAW | GMAW | SMAW | FCAW-S | FCAW-G | SMAW | GMAW | FCAW-G | FCAW-G |
| POSITION | OH | V | F | F | F | OH | V | F | V | OH | V | OH |
| Tavg | 0.24 | 0.24 | 0.24 | 0.24 | 0.24 | 0.24 | 0.24 | 0.24 | 0.24 | 0.24 | 0.24 | 0.24 |
| Z | 0.45 | 0.44 | 0.38 | 0.37 | 0.36 | 0.36 | 0.35 | 0.35 | 0.28 | 0.26 | 0.17 | 0.13 |
| R(top) | 0.45 | 0.48 | 0.44 | 0.43 | 0.47 | 0.45 | 0.44 | 0.45 | 0.46 | 0.46 | 0.42 | 0.47 |
| R(bottom) | 0.44 | 0.46 | 0.45 | 0.43 | 0.49 | 0.45 | 0.47 | 0.48 | 0.45 | 0.47 | 0.45 | 0.47 |
| Ravg | 0.44 | 0.47 | 0.44 | 0.43 | 0.48 | 0.45 | 0.46 | 0.47 | 0.45 | 0.47 | 0.44 | 0.47 |
| BEND(top) | 70.5 | 71.0 | 71.5 | 71.0 | 73.0 | 73.0 | 76.0 | 75.0 | 71.0 | 73.5 | 76.0 | 72.5 |
| BEND(bottom) | 72.0 | 73.5 | 70.0 | 71.0 | 73.0 | 70.5 | 75.0 | 71.5 | 72.5 | 73.5 | 73.0 | 73.5 |
| BENDavg | 71.3 | 72.3 | 70.8 | 71.0 | 73.0 | 71.8 | 75.5 | 73.3 | 71.8 | 73.5 | 74.5 | 73.0 |
| E | 0.23 | 0.08 | 0.21 | 0.21 | 0.29 | 0.23 | 0.31 | 0.22 | 0.34 | 0.37 | 0.29 | 0.39 |
| W | 0.41 | 0.25 | 0.26 | 0.36 | 0.38 | 0.31 | 0.56 | 0.41 | 0.38 | 0.33 | 0.28 | 0.31 |
| E/W | 0.56 | 0.32 | 0.81 | 0.58 | 0.76 | 0.74 | 0.55 | 0.53 | 0.90 | 1.13 | 1.03 | 1.24 |

**Table 12: HSS 6 x 6 x ⅜ Section and Weld Measurements**

| FLARE BEVEL | 56 | 67 | 62 | 55 | 68 | 59 | 49 | 50 | 61 | 71 | 65 | 53 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PROCESS | FCAW-S | SMAW | GMAW | FCAW-S | SMAW | FCAW-S | FCAW-G | FCAW-G | GMAW | SMAW | GMAW | FCAW-G |
| POSITION | V | H | V | H | V | OH | H | V | H | OH | OH | OH |
| Tavg | 0.37 | 0.37 | 0.37 | 0.37 | 0.37 | 0.37 | 0.37 | 0.37 | 0.37 | 0.37 | 0.37 | 0.37 |
| Z | 0.49 | 0.41 | 0.37 | 0.37 | 0.36 | 0.34 | 0.24 | 0.23 | 0.21 | 0.20 | 0.13 | 0.10 |
| S | 0.31 | 0.24 | 0.25 | 0.25 | 0.27 | 0.32 | 0.36 | 0.40 | 0.43 | 0.41 | 0.48 | 0.47 |
| R | 0.82 | 0.82 | 0.73 | 0.71 | 0.73 | 0.72 | 0.66 | 0.81 | 0.79 | 0.67 | 0.77 | 0.66 |
| BEND | 68.3 | 69.7 | 70.7 | 70.3 | 67.7 | 67.7 | 69.3 | 70.0 | 69.7 | 70.0 | 69.7 | 69.0 |
| E | 0.24 | 0.23 | 0.21 | 0.19 | 0.17 | 0.26 | 0.32 | 0.34 | 0.37 | 0.35 | 0.43 | 0.43 |
| W | 0.43 | 0.35 | 0.29 | 0.31 | 0.28 | 0.33 | 0.30 | 0.30 | 0.28 | 0.29 | 0.28 | 0.28 |
| E/W | 0.55 | 0.68 | 0.74 | 0.62 | 0.60 | 0.79 | 1.06 | 1.15 | 1.33 | 1.18 | 1.53 | 1.56 |
| ALPHA | 120.0 | 104.7 | 114.0 | 115.0 | 126.0 | 118.3 | 116.0 | 118.7 | 118.0 | 115.7 | 115.3 | 111.0 |

| FLARE-V | 60 | 57 | 69 | 58 | 51 | 72 | 64 | 70 | 52 | 63 | 54 | 66 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PROCESS | FCAW-S | FCAW-S | SMAW | FCAW-S | FCAW-G | SMAW | GMAW | SMAW | FCAW-G | GMAW | FCAW-G | GMAW |
| POSITION | OH | F | F | V | F | OH | V | V | V | F | OH | OH |
| Tavg | 0.37 | 0.37 | 0.37 | 0.37 | 0.37 | 0.37 | 0.37 | 0.37 | 0.37 | 0.37 | 0.37 | 0.37 |
| Z | 0.24 | 0.23 | 0.23 | 0.20 | 0.16 | 0.15 | 0.14 | 0.13 | 0.12 | 0.12 | 0.09 | 0.00 |
| R(top) | 0.69 | 0.70 | 0.72 | 0.66 | 0.70 | 0.69 | 0.71 | 0.67 | 0.69 | 0.68 | 0.71 | 0.70 |
| R(bottom) | 0.69 | 0.70 | 0.73 | 0.69 | 0.70 | 0.69 | 0.70 | 0.70 | 0.70 | 0.68 | 0.70 | 0.67 |
| Ravg | 0.69 | 0.70 | 0.72 | 0.68 | 0.70 | 0.69 | 0.70 | 0.69 | 0.69 | 0.68 | 0.71 | 0.68 |
| BEND(top) | 70.0 | 69.0 | 70.0 | 70.5 | 69.0 | 68.5 | 70.5 | 71.0 | 68.5 | 71.0 | 70.5 | 70.0 |
| BEND(bottom) | 69.0 | 70.0 | 69.5 | 69.5 | 70.5 | 69.0 | 70.5 | 68.0 | 69.5 | 68.5 | 69.5 | 71.5 |
| BENDavg | 69.5 | 69.5 | 69.8 | 70.0 | 69.8 | 68.8 | 70.5 | 69.5 | 69.0 | 69.8 | 70.0 | 70.8 |
| E | 0.25 | 0.19 | 0.19 | 0.28 | 0.22 | 0.23 | 0.20 | 0.25 | 0.30 | 0.30 | 0.34 | 0.40 |
| W | 0.40 | 0.33 | 0.33 | 0.38 | 0.28 | 0.31 | 0.23 | 0.31 | 0.32 | 0.30 | 0.26 | 0.36 |
| E/W | 0.62 | 0.58 | 0.56 | 0.74 | 0.79 | 0.75 | 0.87 | 0.80 | 0.92 | 1.00 | 1.30 | 1.12 |

**Table 13: Flare Bevel Test Weld Measurements Compared with CSA W59 Draft Effective Throat Rules**

| HSS | WELD NO. | POSITION | PROCESS | Measured Test Data | | | CSA W59 Draft | | $E_{test} / E_{predicted}$ |
|---|---|---|---|---|---|---|---|---|---|
| | | | | E | W | E/W | E/W | $E_{predicted}$ | |
| 4x4x$^{3}/_{16}$ | 19 | H | SMAW | 0.20 | 0.27 | 0.75 | 0.59 | 0.16 | 1.26 |
| | 13 | H | GMAW | 0.31 | 0.32 | 0.97 | 0.66 | 0.21 | 1.47 |
| | 1 | H | FCAW-G | 0.29 | 0.26 | 1.12 | 0.66 | 0.17 | 1.69 |
| 4x4x¼ | 43 | H | SMAW | 0.23 | 0.28 | 0.81 | 0.59 | 0.17 | 1.39 |
| | 25 | H | FCAW-G | 0.27 | 0.31 | 0.85 | 0.66 | 0.20 | 1.32 |
| | 37 | H | GMAW | 0.35 | 0.36 | 0.97 | 0.66 | 0.24 | 1.47 |
| 6x6x⅜ | 67 | H | SMAW | 0.23 | 0.35 | 0.68 | 0.59 | 0.21 | 1.11 |
| | 49 | H | FCAW-G | 0.32 | 0.30 | 1.06 | 0.66 | 0.20 | 1.62 |
| | 61 | H | GMAW | 0.37 | 0.28 | 1.33 | 0.66 | 0.18 | 2.00 |
| | 68 | V | SMAW | 0.17 | 0.28 | 0.60 | 0.59 | 0.17 | 1.03 |
| | 71 | OH | SMAW | 0.35 | 0.29 | 1.18 | 0.59 | 0.17 | 2.05 |

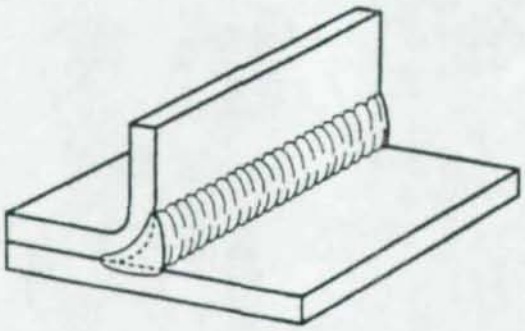


Figure 1a. Flare Bevel Groove Weld (HSS & Plate)

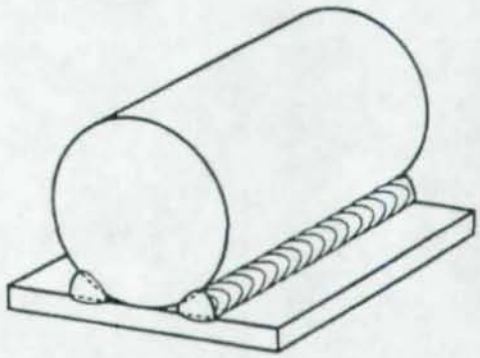


Figure 1b. Flare Bevel Groove Weld (Round Bar & Plate)

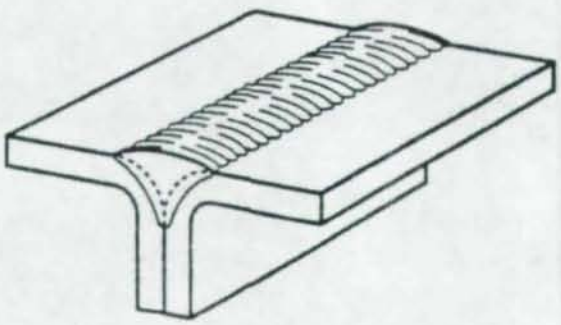


Figure 1c. Flare-V Groove Weld (Two HSS)

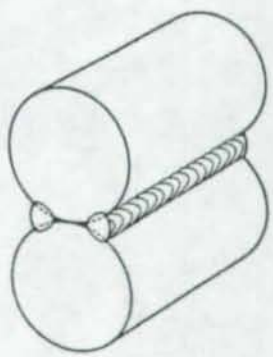


Figure 1d. Flare-V Groove Weld (Two Round Bars)

Figure 1. Flare Groove Welds (CSA, 1989)

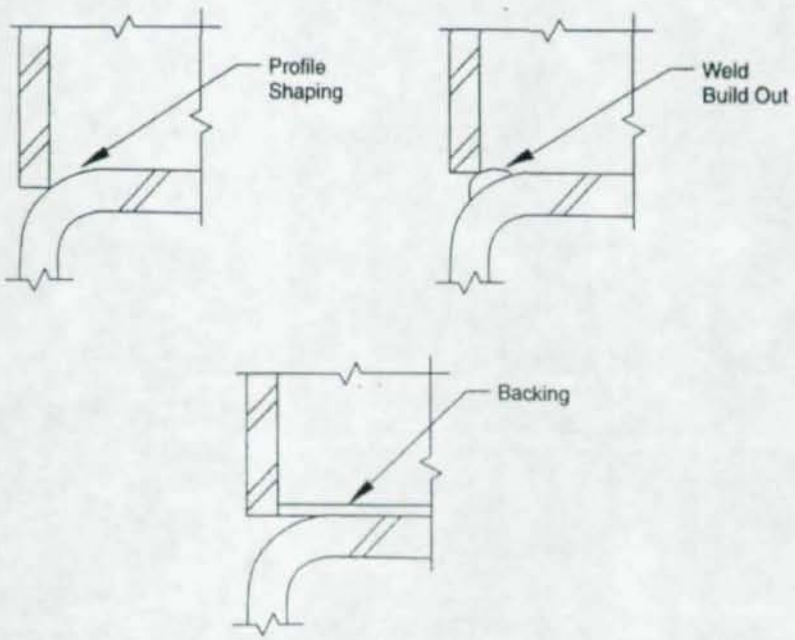
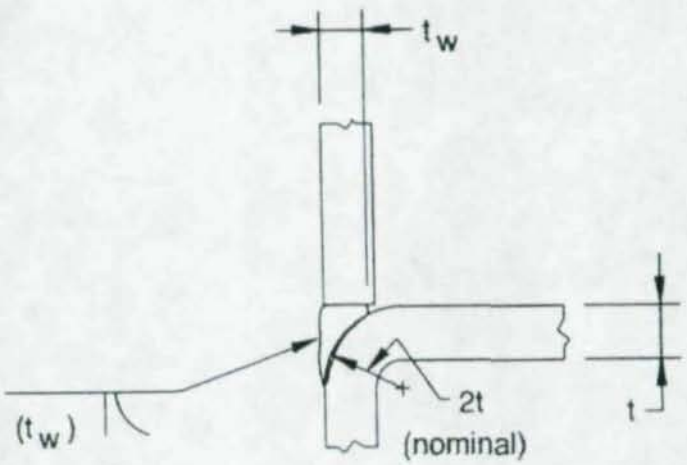



Figure 2. Equal Width HSS Welded Joint: Flare Bevel Groove Weld for HSS with Unequal Wall Thickness (AISC, 1997)




Flare-bevel weld

Figure 3. Equal Width HSS Welded Joint: Flare Bevel Groove Weld for HSS with Equal Wall Thickness (AISC, 1997)

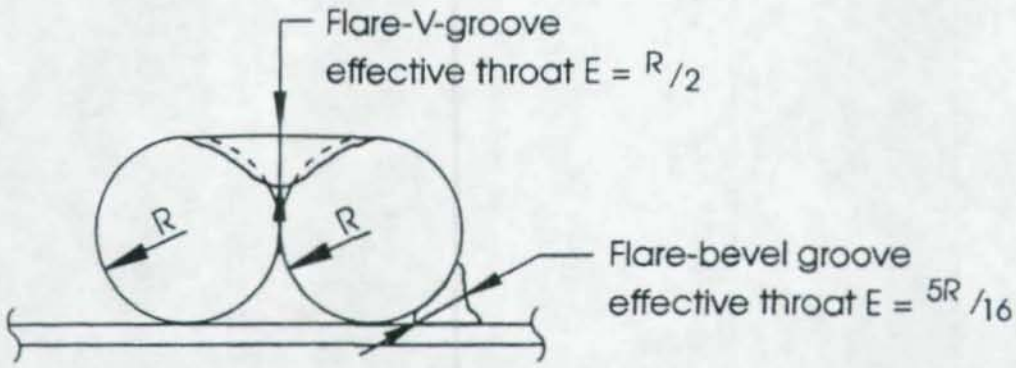
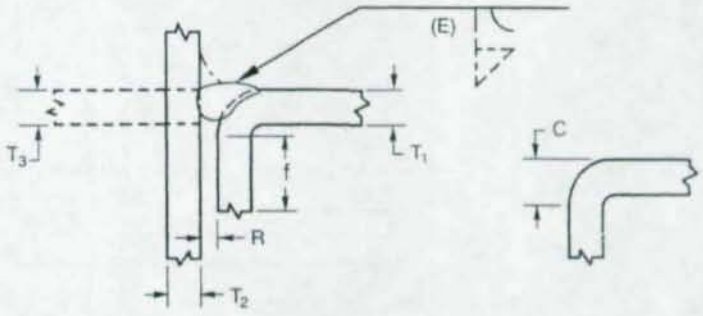



Figure 4. AISC Flare Weld Nomenclature (AISC, 1997; 1999a)

## Effective Throat for Flare Bevel and Flare-V Groove Welds

Flare-bevel-groove weld (10)
Butt joint (B)
T-joint (T)
Corner joint (C)




| Welding Process | Joint Designation | Base Metal Thickness (U = unlimited) | | | Groove Preparation | | | Allowed Welding Positions | Weld Size (E) | Notes |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Root Opening Root Face Bend Radius* | Tolerances | | | | |
| | | $T_1$ | $T_2$ | $T_3$ | | As Detailed (see 3.12.3) | As Fit-Up (see 3.12.3) | | | |
| SMAW | BTC-P10 | 3/16 min | U | $T_1$ min | R = 0<br>f = 3/16 min<br>C = $\frac{3T_1}{2}$ min | +1/16, –0<br>+U, –0<br>–0, +Not-Limited | +1/8, –1/16<br>+U, –1/16<br>–0, +Not-Limited | All | $\frac{5T_1}{8}$ | 5, 7, 10, 12 |
| GMAW FCAW | BTC-P10-GF | 3/16 min | U | $T_1$ min | R = 0<br>f = 3/16 min<br>C = $\frac{3T_1}{2}$ min | +1/16, –0<br>+U, –0<br>–0, +Not-Limited | +1/8, –1/16<br>+U, –1/16<br>–0, +Not-Limited | All | $\frac{5T_1}{8}$ | 1, 7, 10, 12 |
| SAW | T-P10-S | 1/2 min | 1/2 min | N/A | R = 0<br>f = 1/2 min<br>C = $\frac{3T_1}{2}$ min | ±0<br>+U, –0<br>–0, +Not-Limited | +1/16, –0<br>+U, –1/16<br>–0, +Not-Limited | F | $\frac{5T_1}{8}$ | 7, 10,12 |

*For cold formed (A500) rectangular tubes, C dimension is not limited. See the following:

**Effective Weld Size of Flare-Bevel-Groove Welded Joints.** Tests have been performed on cold formed ASTM A 500 material exhibiting a "c" dimension as small as $T_1$ with a nominal radius of 2t. As the radius increases, the "c" dimension also increases. The corner curvature may not be a quadrant of a circle tangent to the sides. The corner dimension, "c," may be less than the radius of the corner.

Notes:

1. Not prequalified for GMAW-S nor GTAW (refer to Annex A).
2. Joint shall be welded from one side only.
3. Cyclic load application limits these joints to the horizontal welding position (see 2.27.5).
4. Backgouge root to sound metal before welding second side.
5. SMAW detailed joints may be used for prequalified GMAW (except GMAW-S) and FCAW.
6. Minimum weld size (E) as shown in Table 3.4. S as specified on drawings.
7. If fillet welds are used in statically loaded structures to reinforce groove welds in corner and T-joints, these shall be equal to $T_1/4$, but need not exceed 3/8 in. [10 mm]. Groove welds in corner and T-joints of cyclically loaded structures shall be reinforced with fillet welds equal to $T_1/4$, but need not exceed 3/8 in. [10 mm].
8. Double-groove welds may have grooves of unequal depth, but the depth of the shallower groove shall be no less than one-fourth of the thickness of the thinner part joined.
9. Double-groove welds may have grooves of unequal depth, provided these conform to the limitations of Note E. Also the weld size (E) applies individually to each groove.
10. 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.
11. 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.
12. Weld size (E) shall be based on joints welded flush.

Figure 5. AWS D1.1/D1.1M:2002, Figure 3.3, Pre-qualified Partial Joint Penetration (PJP) Flare Bevel Groove Welded Joint Details (AWS, 2002)

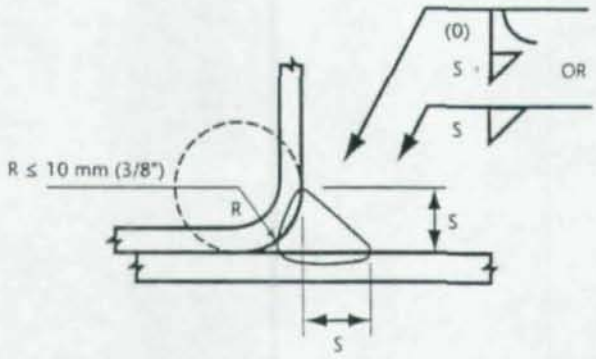



Figure 6. CSA W59 Pre-ballot Draft (Nov. 2001), Figure 4, Flare Bevel Fillet Weld in a T-Joint (CSA, 2001)

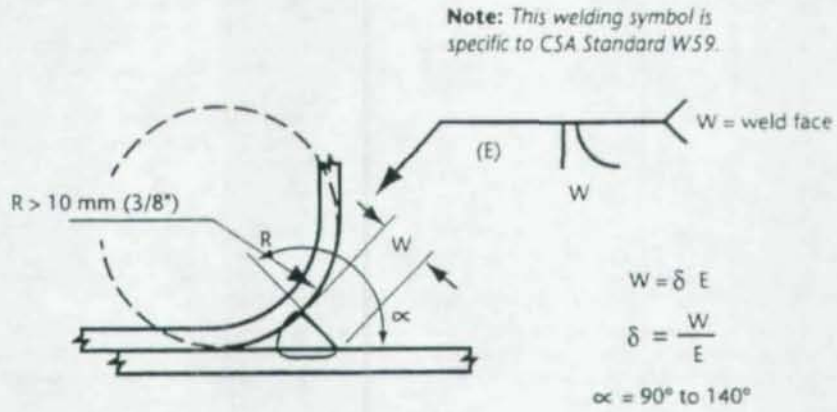



Figure 7. CSA W59 Pre-ballot Draft (Nov. 2001), Figure 5, Partial Joint Penetration Flare Bevel Groove Weld in a T-Joint (CSA, 2001)

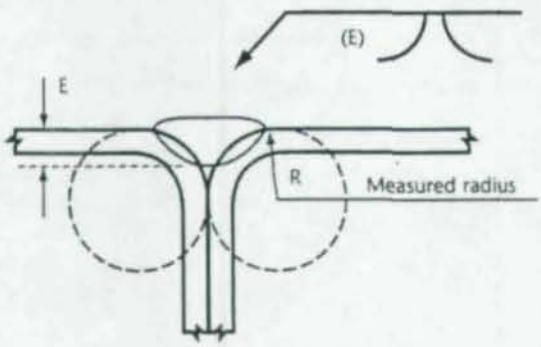



Figure 8. CSA W59 Pre-ballot Draft (Nov. 2001), Figure 6, Partial Joint Penetration Flare-V Groove Weld in a Butt Joint (CSA, 2001)

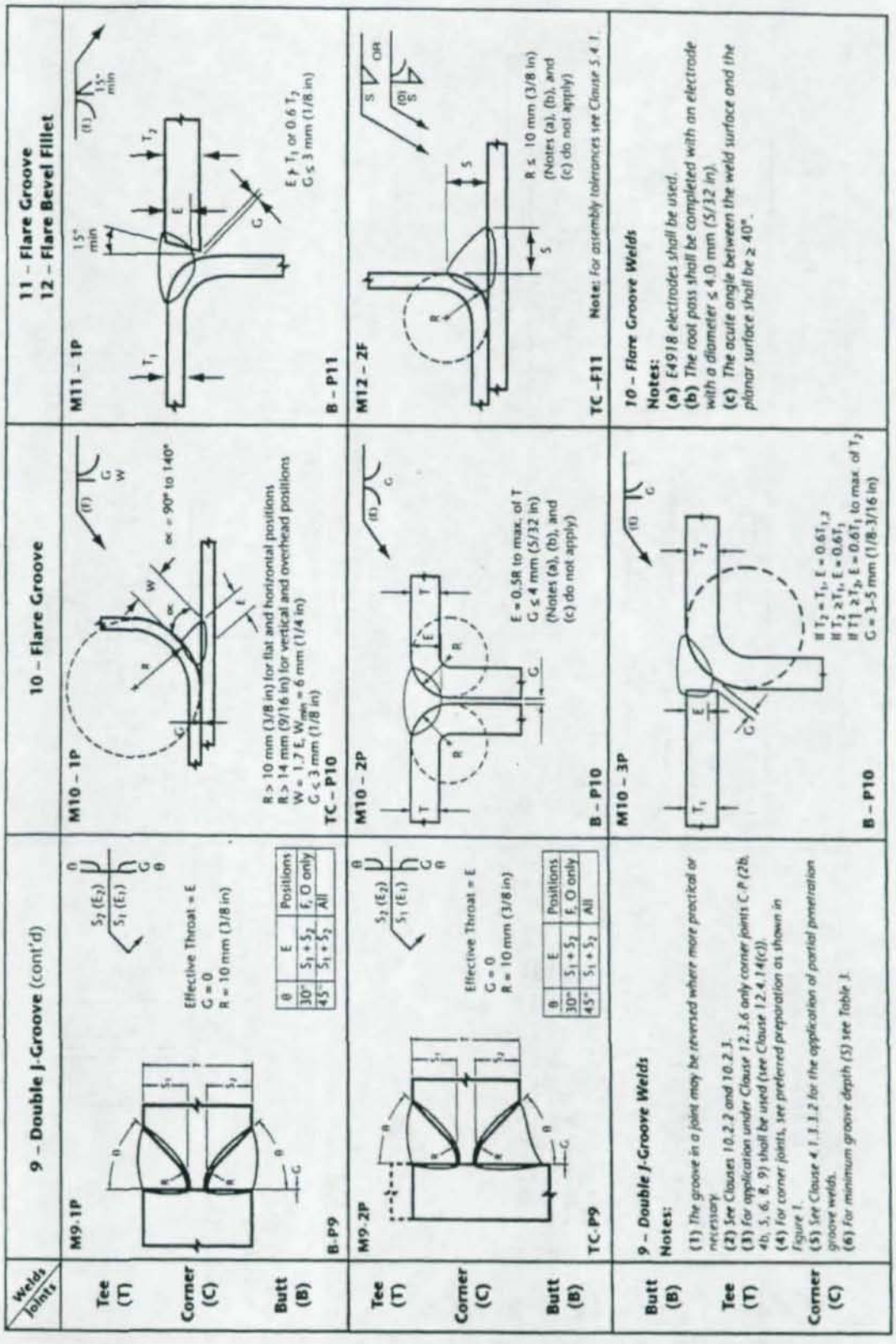



Figure 9. CSA W59 Pre-ballot Draft (Nov. 2001), Figure 32, Pre-qualified Partial Joint Penetration Groove Welds for the Shielded Metal Arc Welding Process (SMAW), (CSA, 2001)

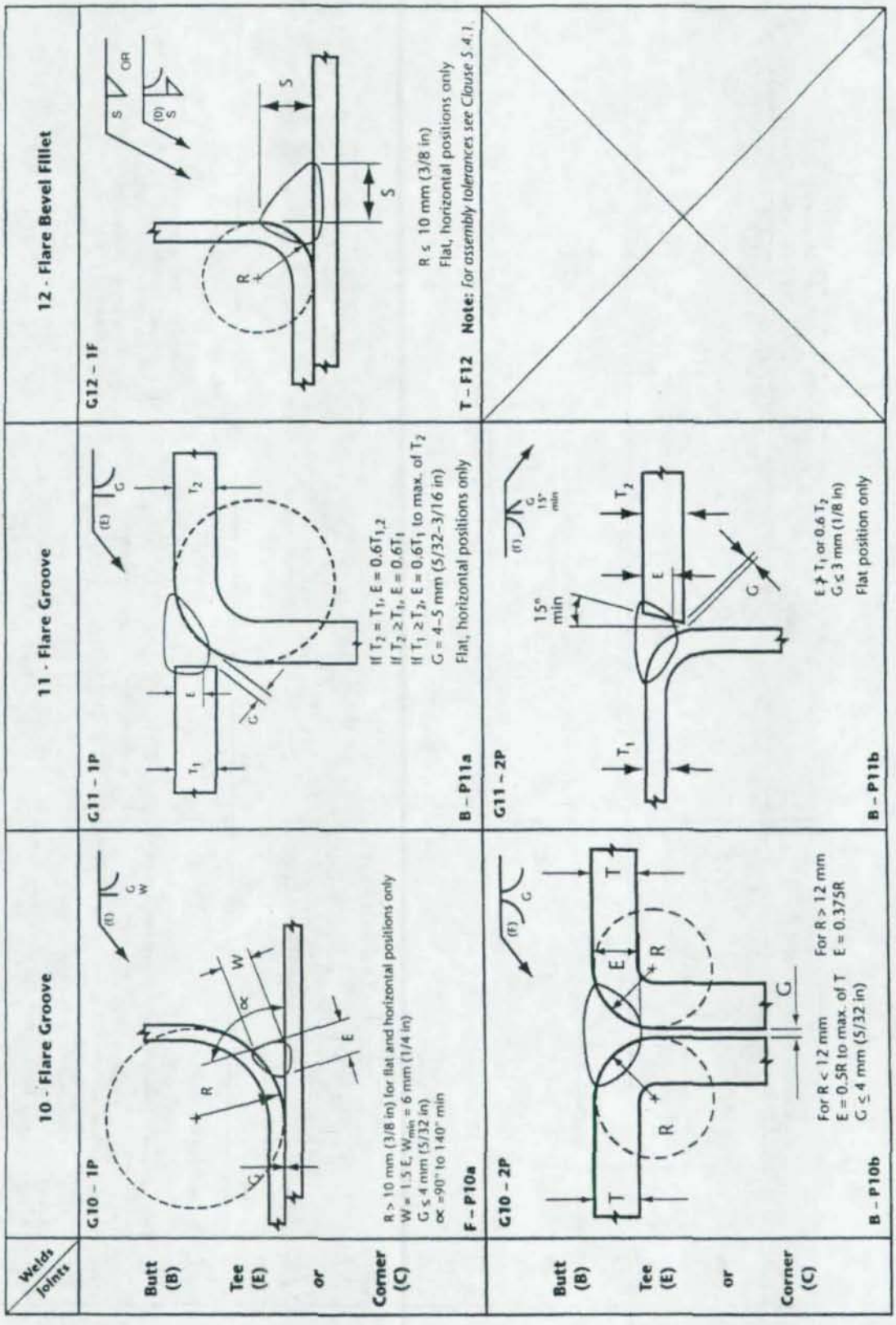



Figure 10. CSA W59 Pre-ballot Draft (Nov. 2001), Figure 38, Pre-qualified Partial Joint Penetration Groove Welds for the Gas Metal Arc Welding Process (GMAW), (CSA, 2001)

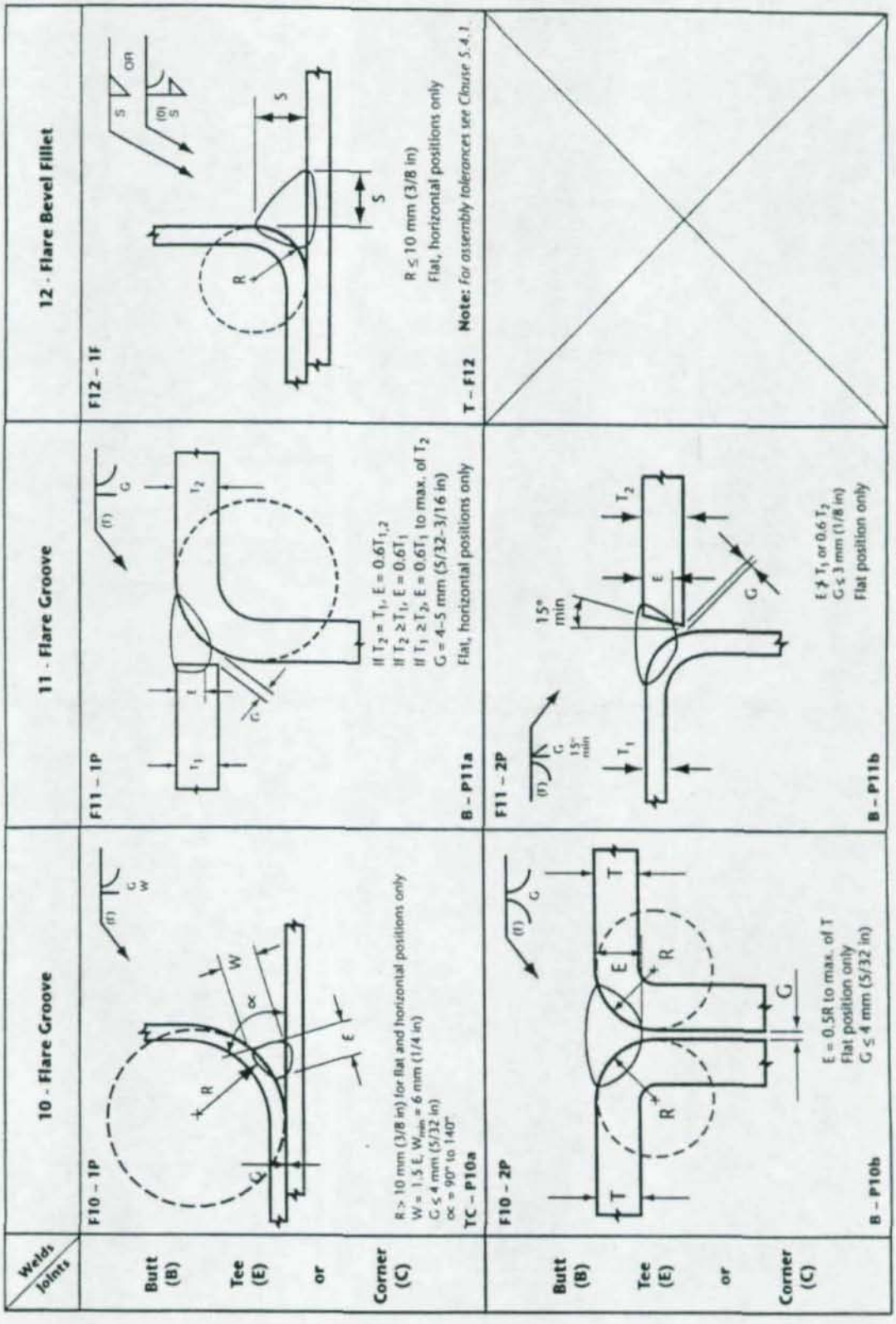
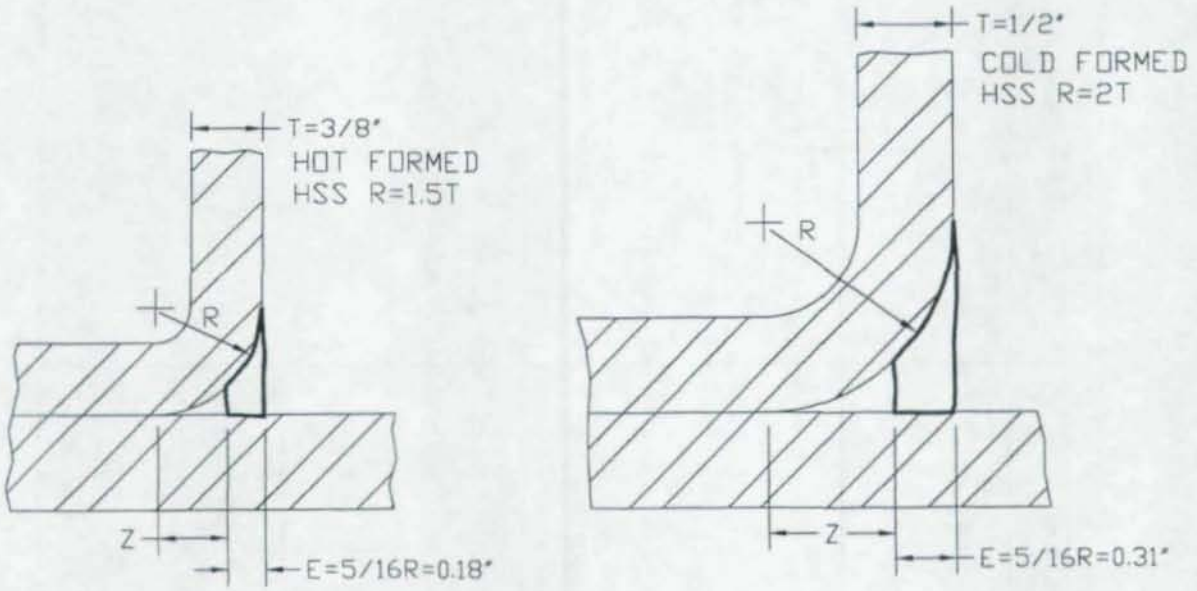



Figure 11. CSA W59 Pre-ballot Draft (Nov. 2001), Figure 36, Pre-qualified Partial Joint Penetration Groove Welds for the Flux-Cored Arc Welding Process (FCAW), (CSA, 2001)

SPECIFICATIONS: AWS (2002), AISC (1989), AISC (1999b) and CSA (1989)




FABRICATOR WELD PROCEDURE DATA SHEETS (see Appendix 1)

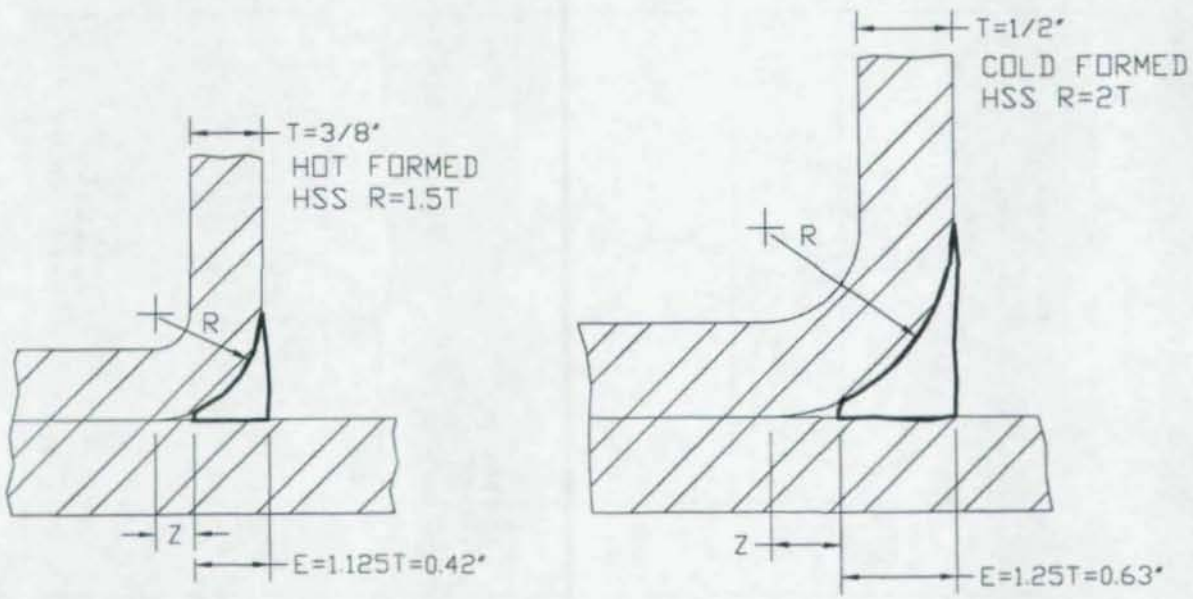
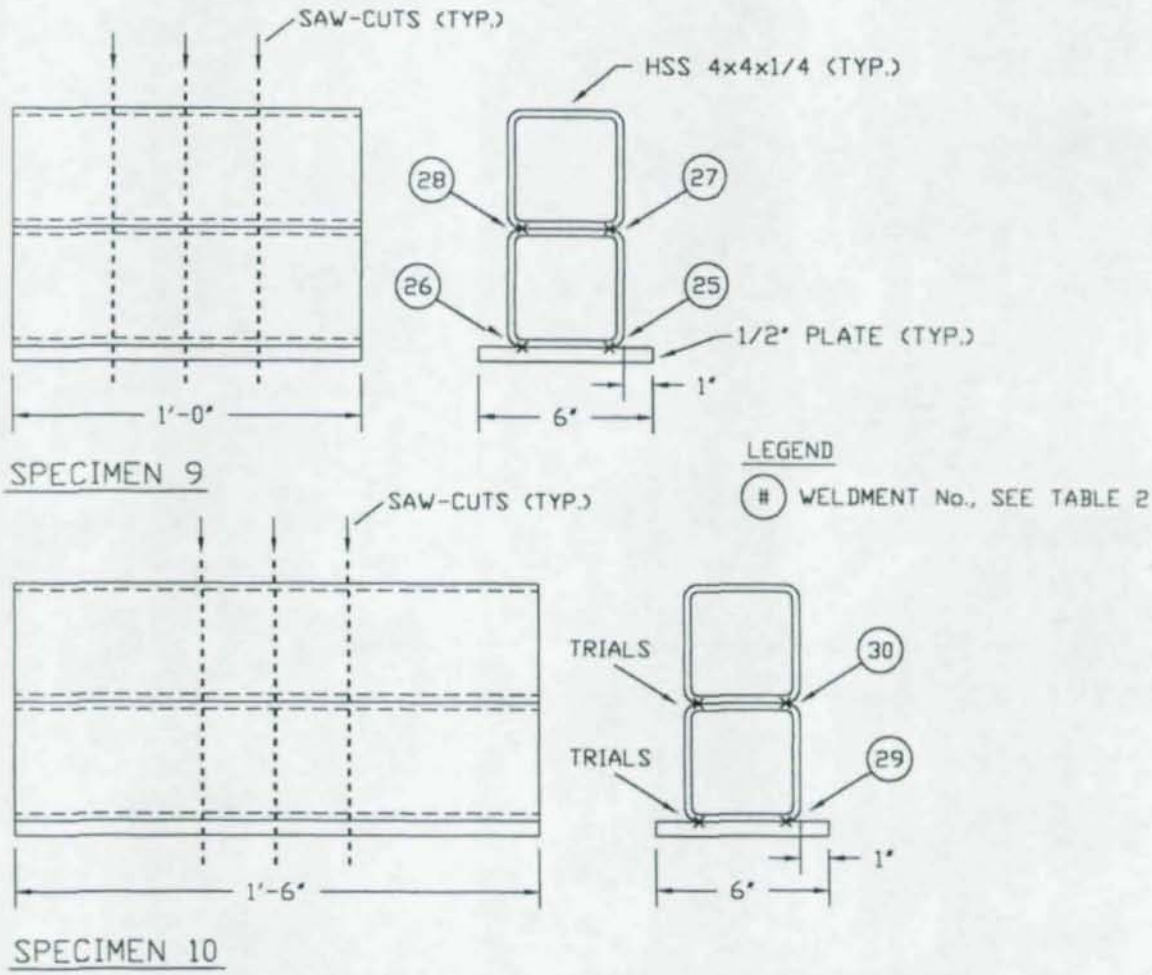
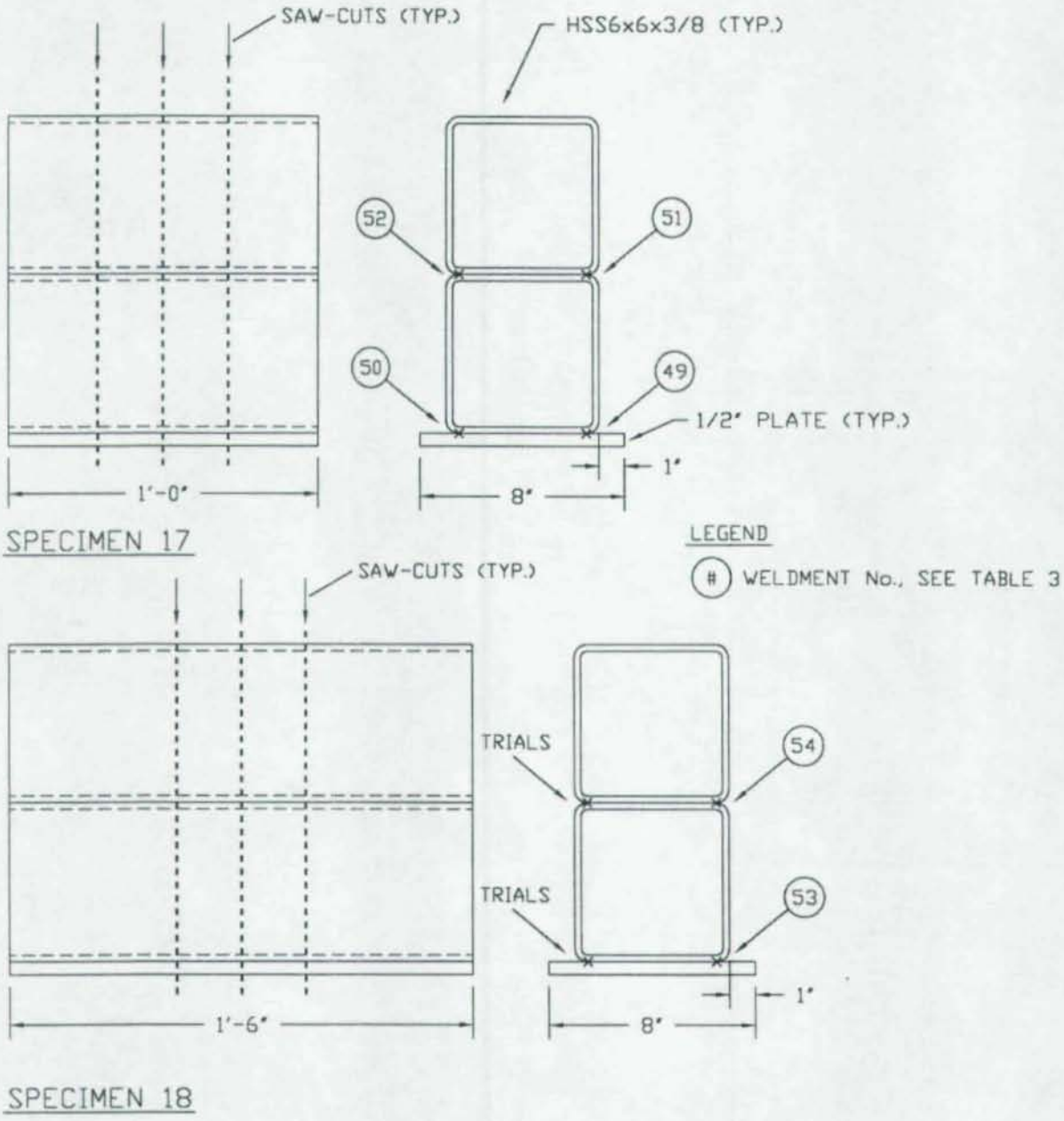



Figure 12. Weld Sizes as per Specifications and Fabricator Weld Procedure Data Sheets




NOTES: 1. "X" DENOTES TACK WELDS LOCATED AT ENDS OF HSS.
2. BEFORE DEPOSITING TACK WELDS, CLAMP HSS TO PLATE AND HSS TO HSS TO ENSURE STEEL TO STEEL CONTACT ALONG THE RUNNING SURFACES.

Figure 13. Typical HSS 4"x 4" x ¼" Test Specimen Configurations (Specimens 9 and 10 using FCAW-G)




NOTES: 1. "X" DENOTES TACK WELDS LOCATED AT ENDS OF HSS.
2. BEFORE DEPOSITING TACK WELDS, CLAMP HSS TO PLATE AND HSS TO HSS TO ENSURE STEEL TO STEEL CONTACT ALONG THE RUNNING SURFACES.

Figure 14. Typical HSS 6"x 6" x ⅜" Test Specimen Configurations (Specimens 17 and 18 using FCAW-G)

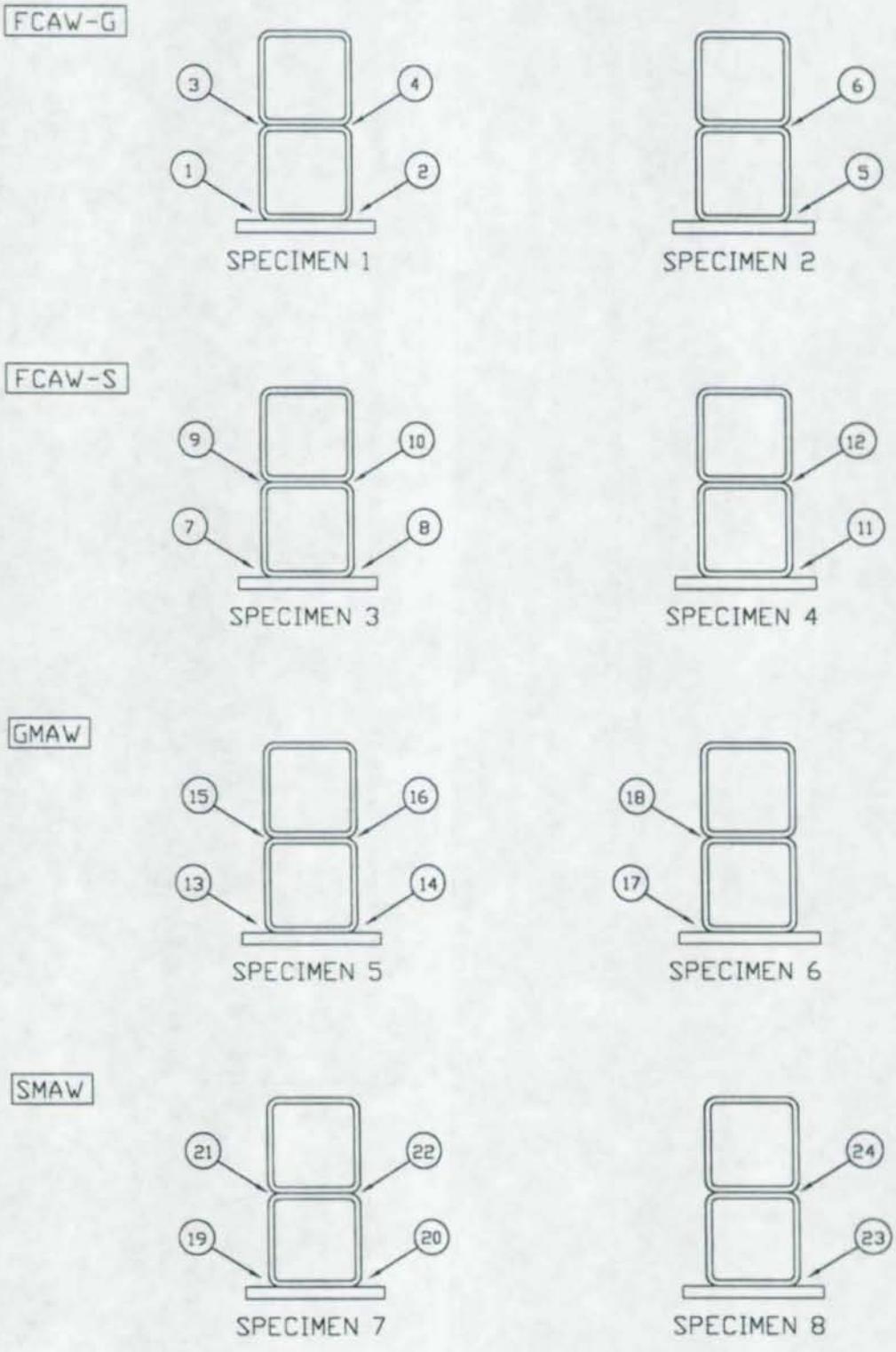



Figure 15. HSS 4"x 4" x $^{3}/_{16}$" Test Specimen Configurations (Specimens 1 to 8)

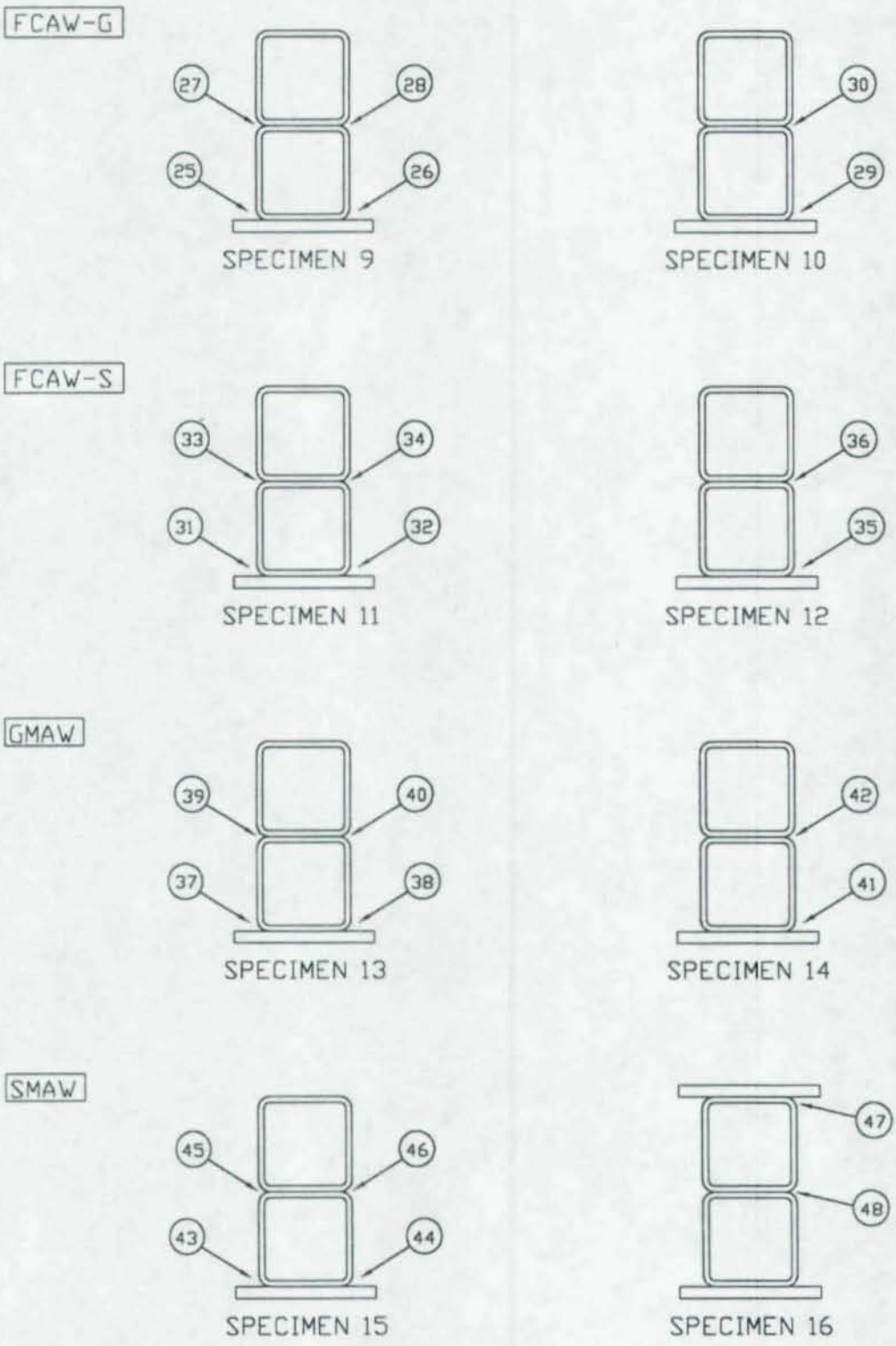



Figure 16. HSS 4"x 4" x ¼" Test Specimen Configurations (Specimens 9 to 16)

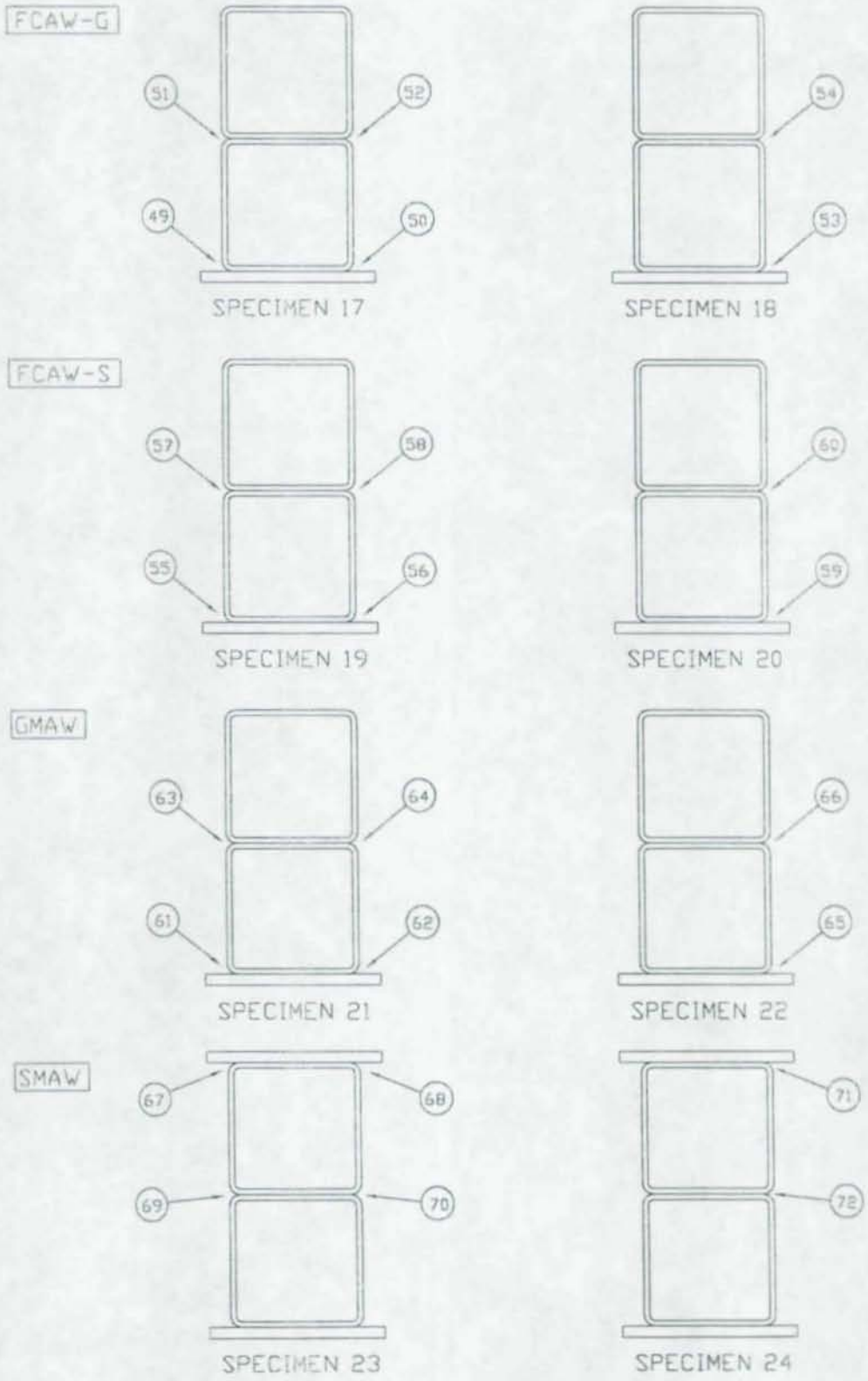



Figure 17. HSS 6"x 6" x ⅜" Test Specimen Configurations (Specimens 17 to 24)

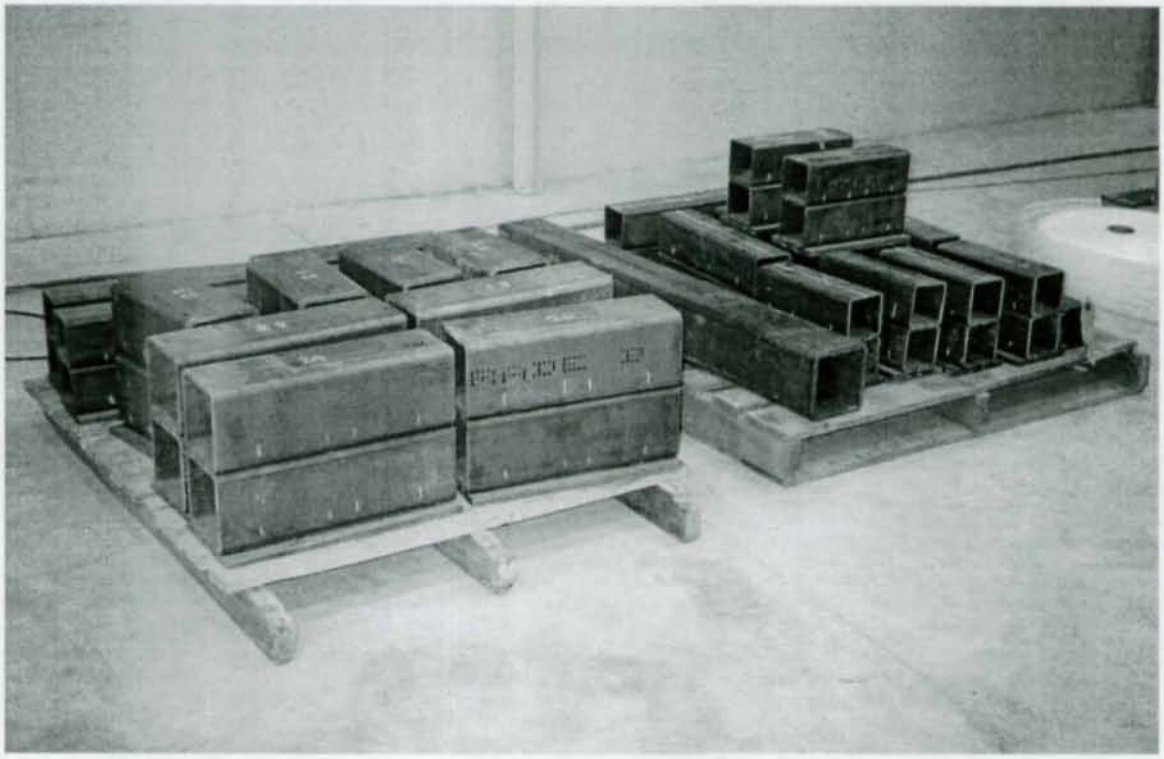


Figure 18. Test Specimens Prior to Final Welding at Walters Inc.

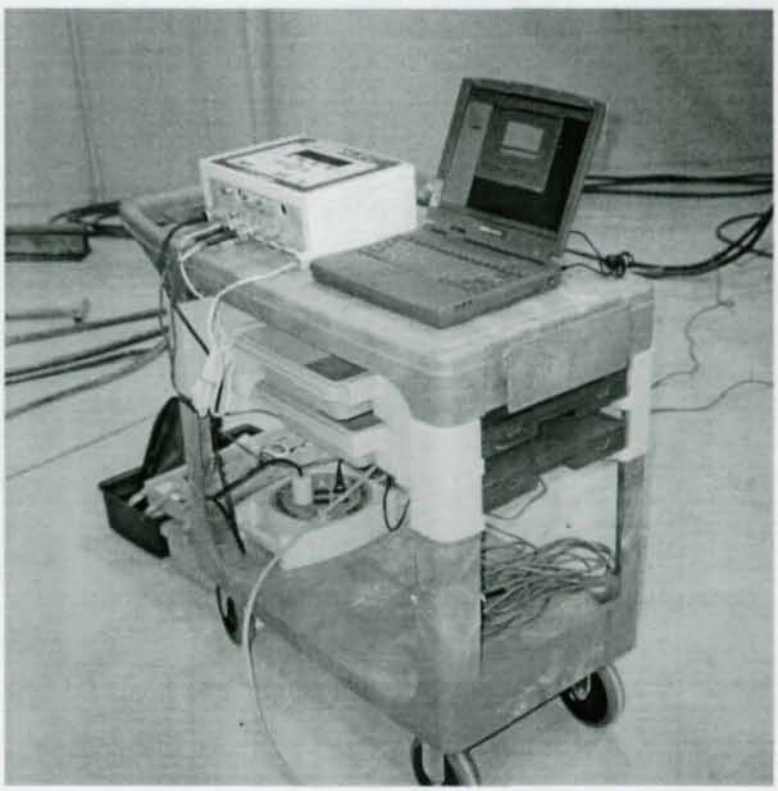


Figure 19. Data Acquisition System for Welding Parameters at Walters Inc.
(Equipment loaned from AccuData Inc.)

Figure 20. Overhead Welding of Test Specimen at Walters Inc.

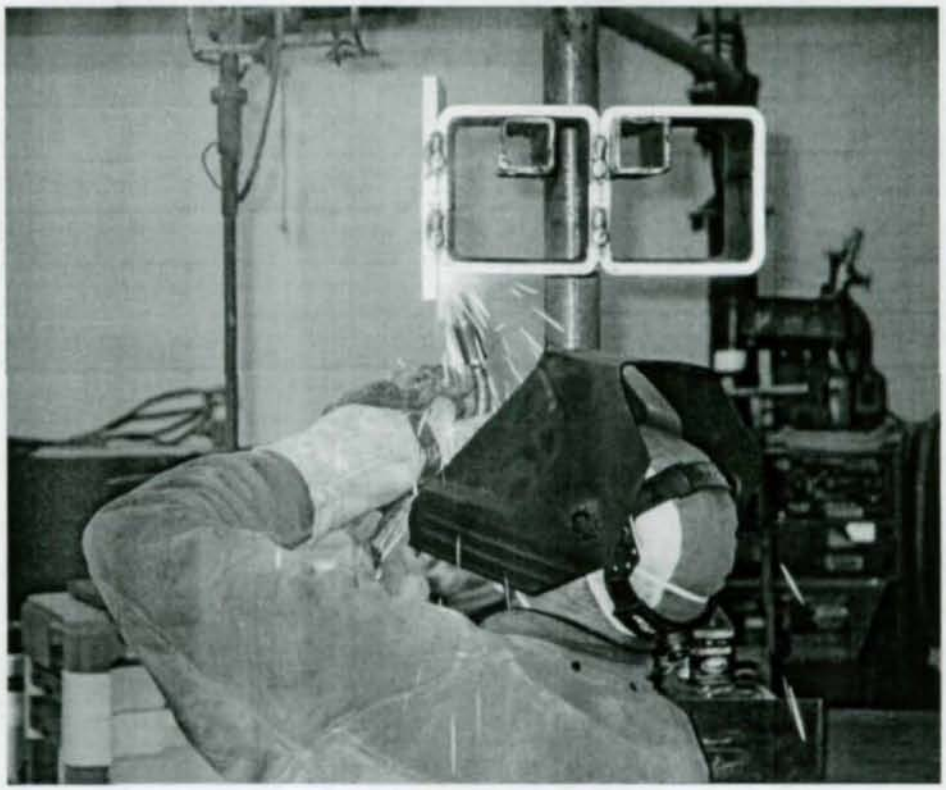


Figure 21. Overhead Welding (Close-up) of Test Specimen at Walters Inc.

Figure 22. Horizontal Welding of Test Specimen at Walters Inc.

Figure 23. Vertical Welding of Test Specimen at Walters Inc.

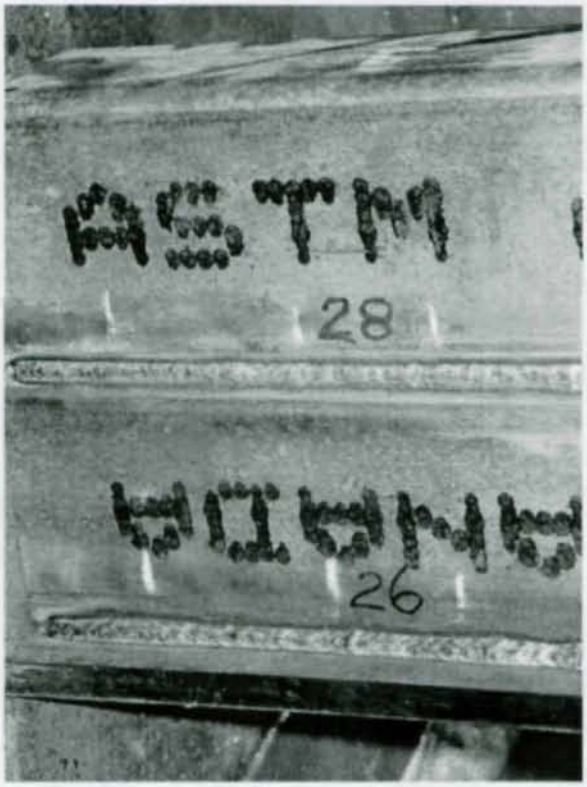



Figure 24. External Appearance of Two FCAW-G Test Welds, No. 26 and No. 28

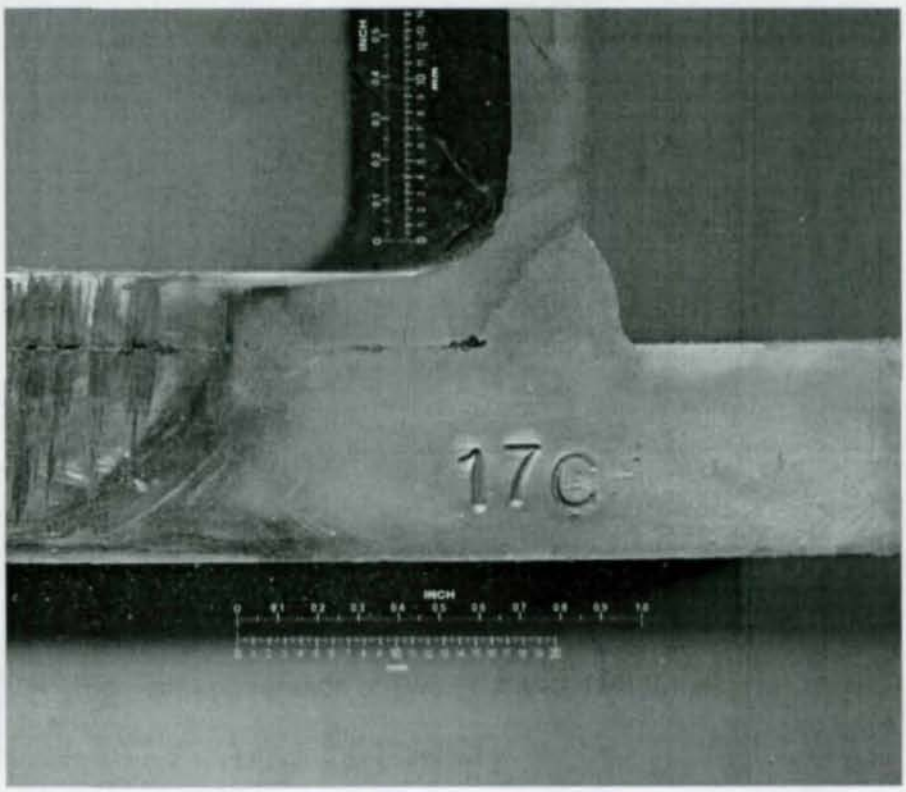



Figure 25. Scanned Image of Test Weld No. 17 Cross-section

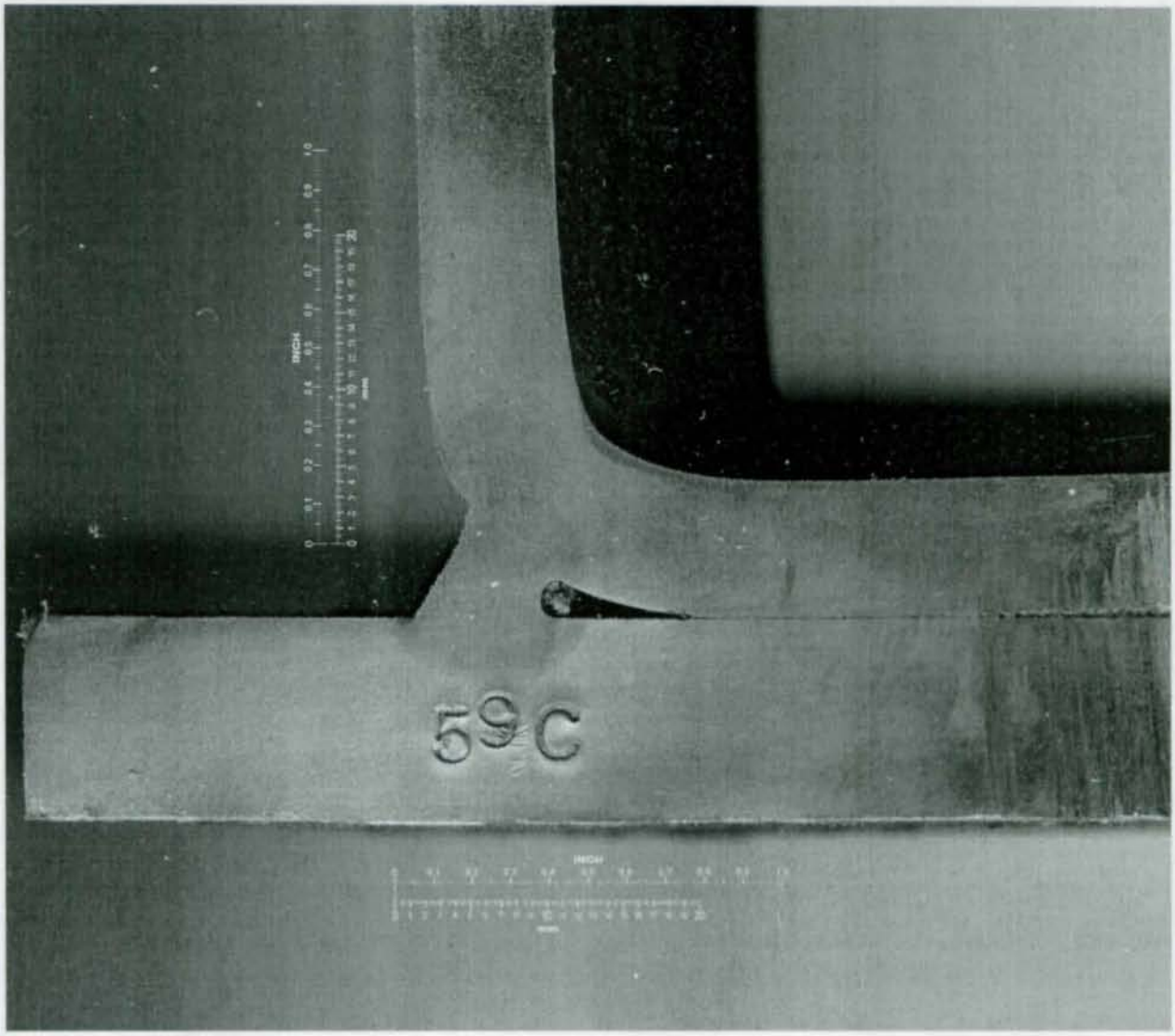
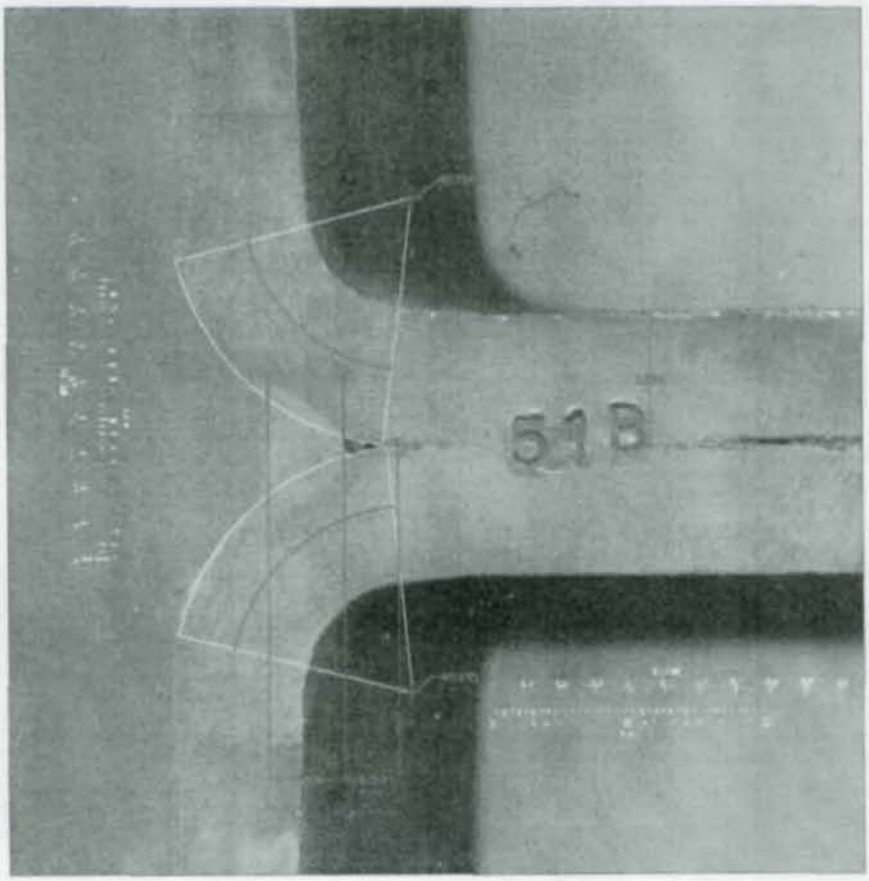



Figure 26. Scanned Image of Test Weld No. 59 Cross-section

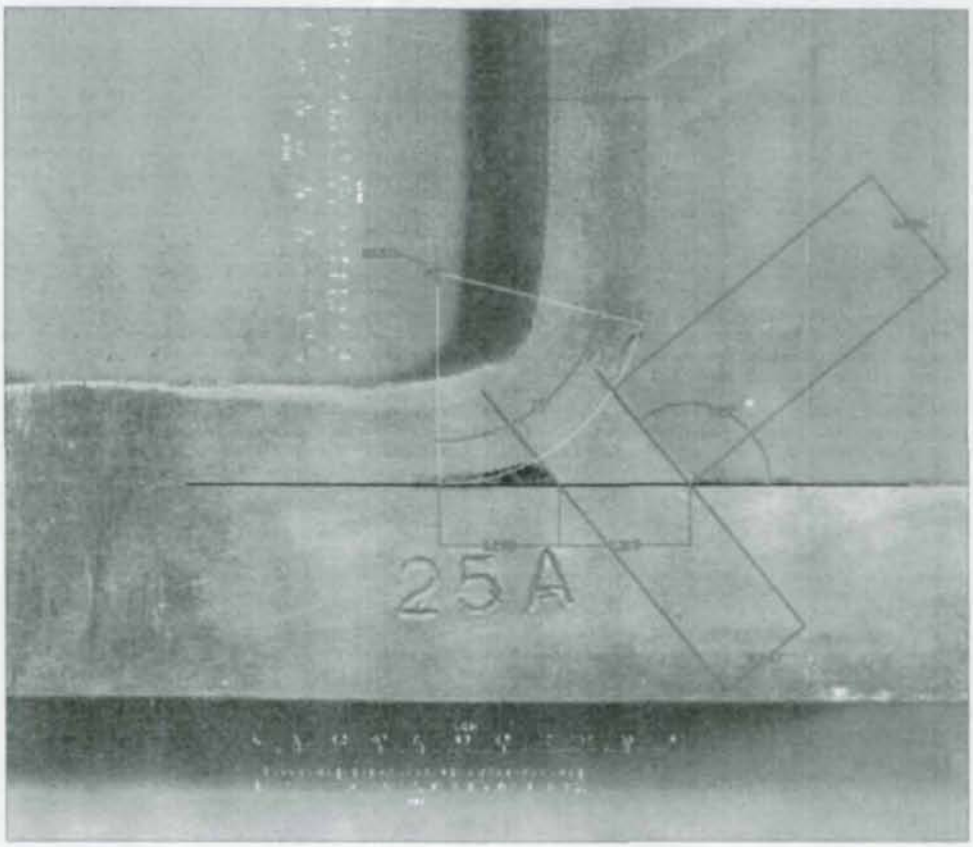
| PROCESS | TYPE | POSITION | HSS SIZE | SECTION | UNIT | Tavg |
|---|---|---|---|---|---|---|
| FCAW-G | FV | FLAT | 6x6x3/8 | 51B | INCH | 0.375 |




| Z | R(up) | R(down) | BEND(up) | BEND(down) | E | ALPHA |
|---|---|---|---|---|---|---|
| 0.157 | 0.704 | 0.695 | 69 | 71 | 0.219 | N/A |

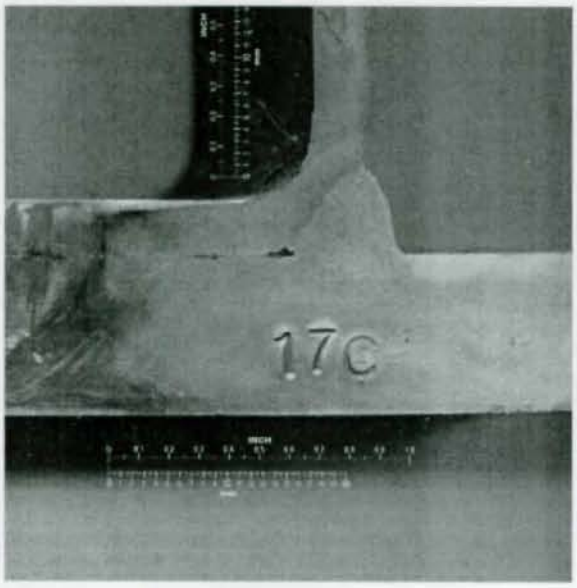
Figure 27. Typical Data Sheet for Measured Weld Dimensions of a Flare-V Weld

| PROCESS | TYPE | POSITION | HSS SIZE | SECTION | UNIT | Tavg |
|---|---|---|---|---|---|---|
| FCAW-G | FB | HORIZONTAL | 4x4x1/4 | 25A | INCH | 0.240 |

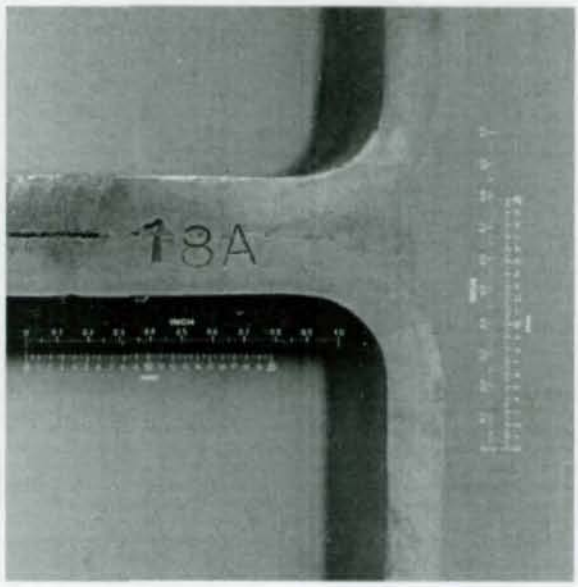



| Z | S | R | BEND | E | W | ALPHA |
|---|---|---|---|---|---|---|
| 0.292 | 0.319 | 0.511 | 75 | 0.247 | 0.296 | 129 |

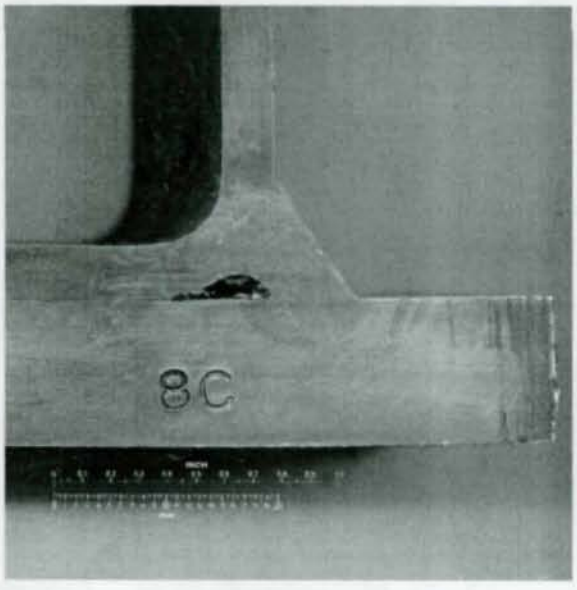
Figure 28. Typical Data Sheet for Measured Weld Dimensions of a Flare Bevel Weld



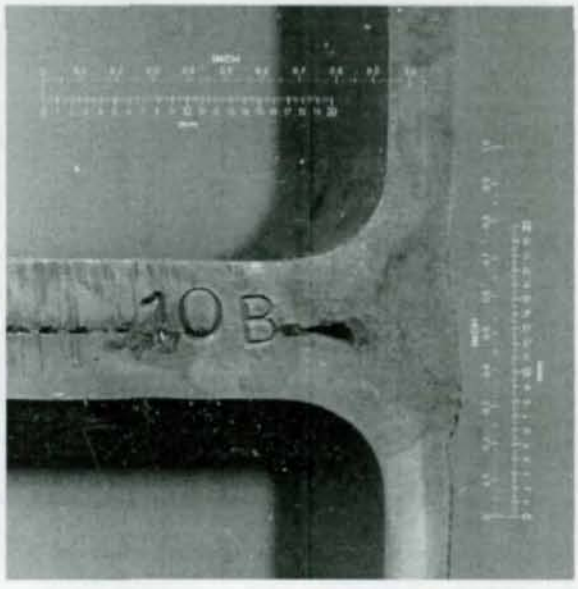

Flare Bevel Weld No. 17C




Flare-V Weld No. 18A

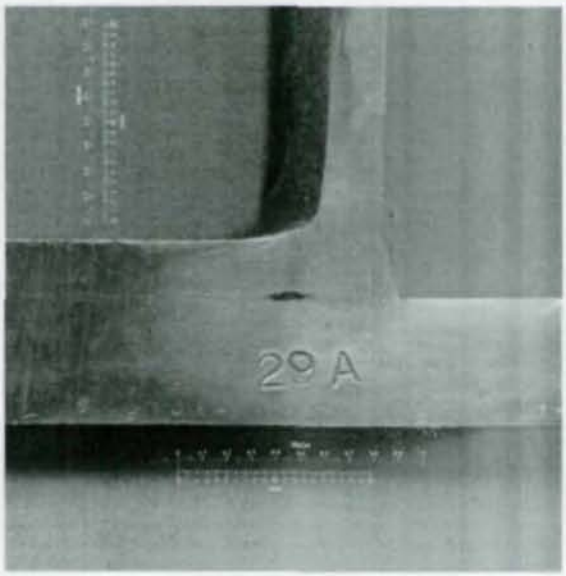



Flare Bevel Weld No. 8C

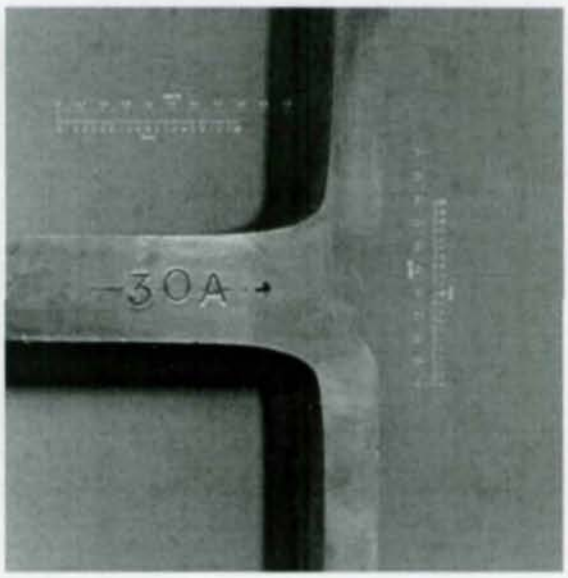



Flare-V Weld No. 10B

Figure 29. Minimum and Maximum Z Loss for HSS 4x4x$^{3}/_{16}$ Flare Bevel and Flare-V Welds

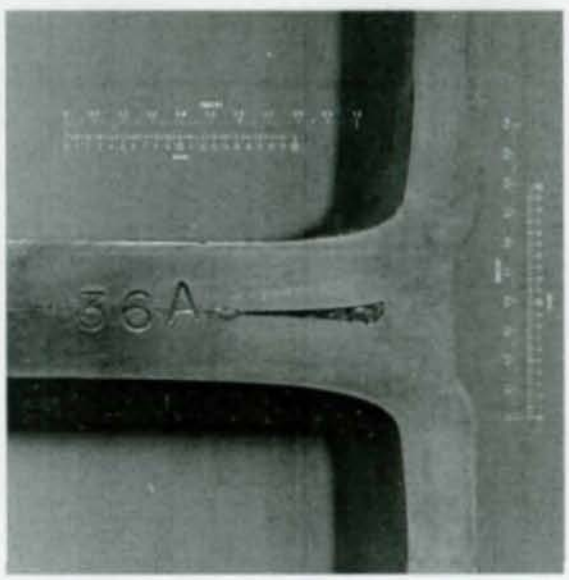



Flare Bevel Weld No. 29A



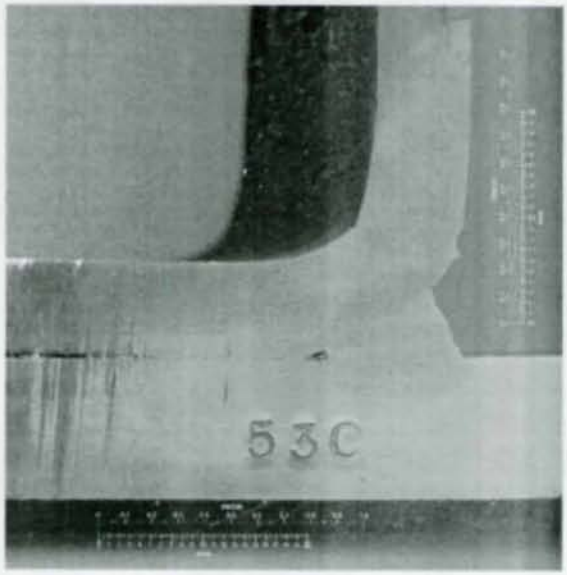

Flare-V Weld No. 30A


Flare Bevel Weld No. 32B

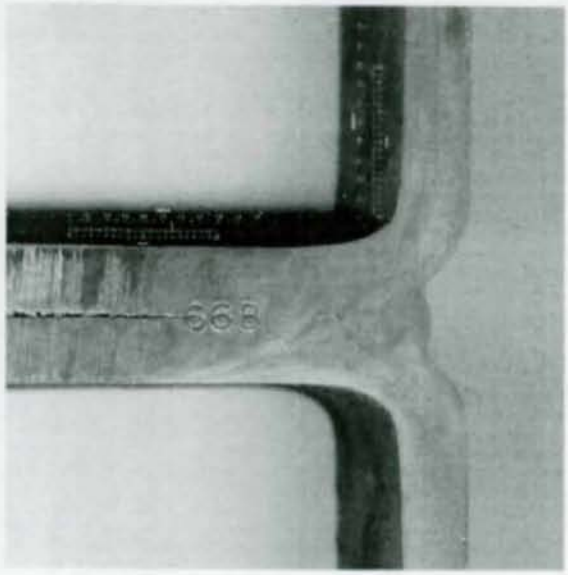



Flare-V Weld No. 36A

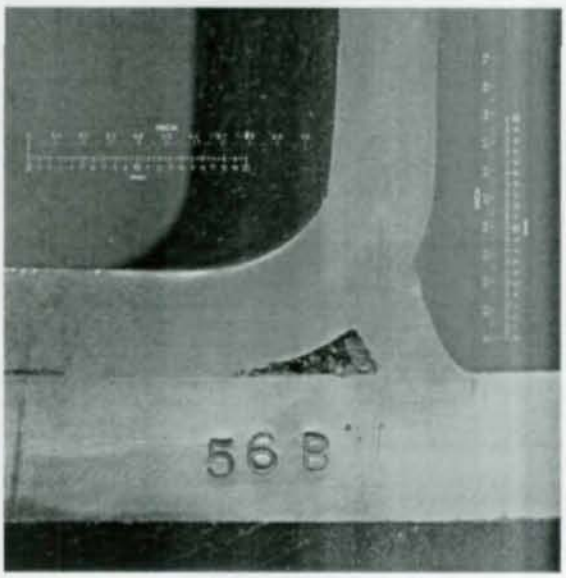
Figure 30. Minimum and Maximum Z Loss for HSS 4x4x¼ Flare Bevel and Flare-V Welds



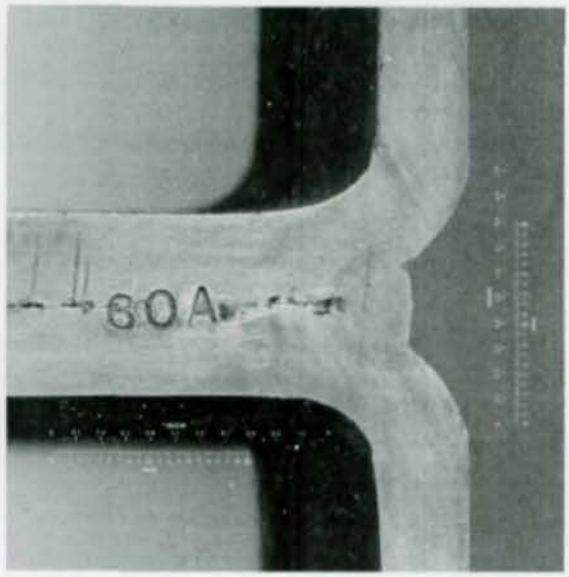

Flare Bevel Weld No. 53C




Flare-V Weld No. 66B




Flare Bevel Weld No. 56B




Flare-V Weld No. 60A

Figure 31. Minimum and Maximum Z Loss for HSS 6x6x⅜ Flare Bevel and Flare-V Welds

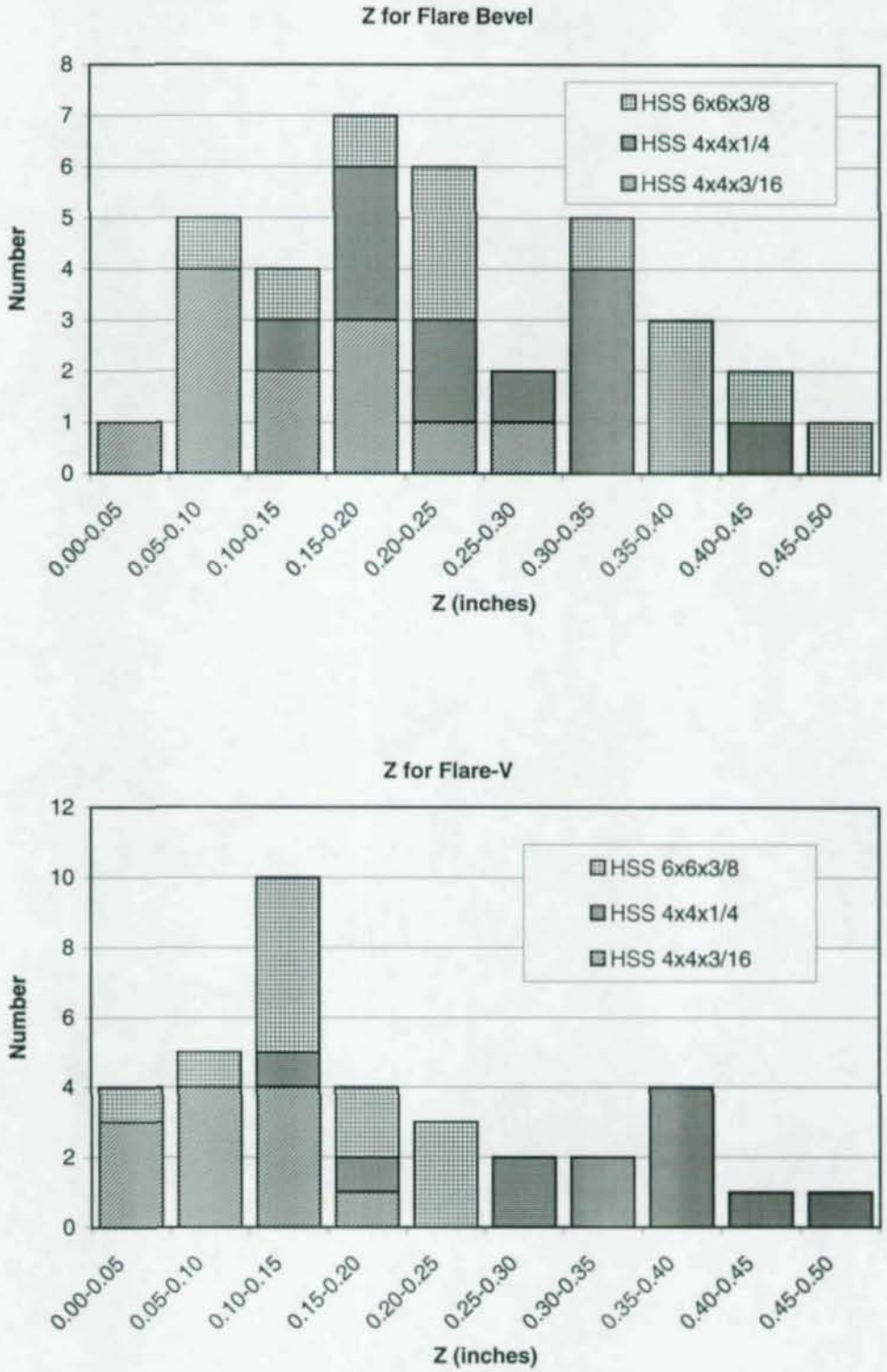
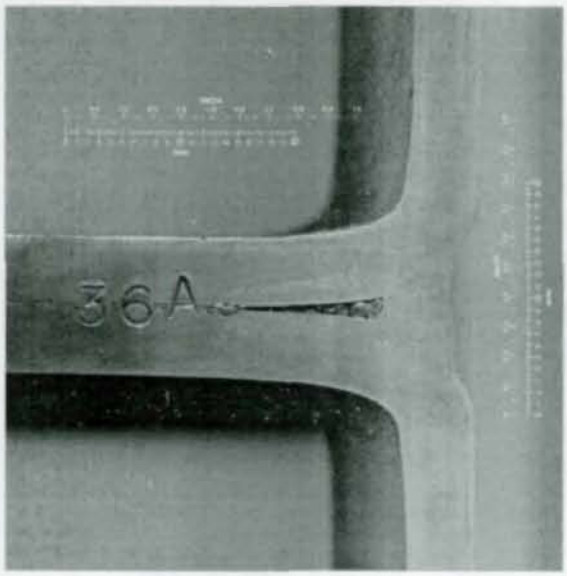
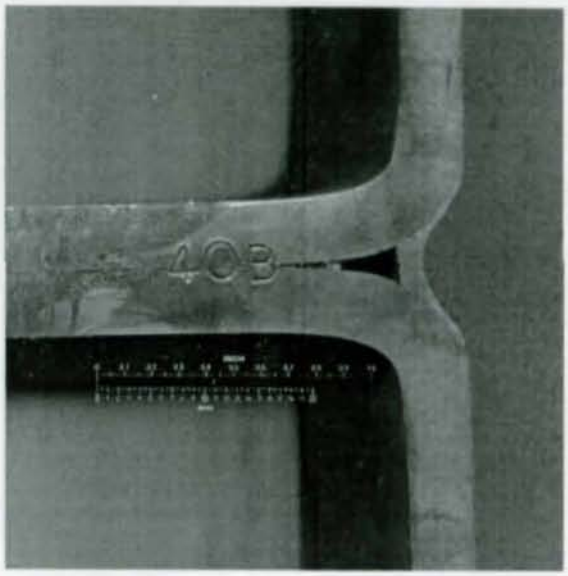


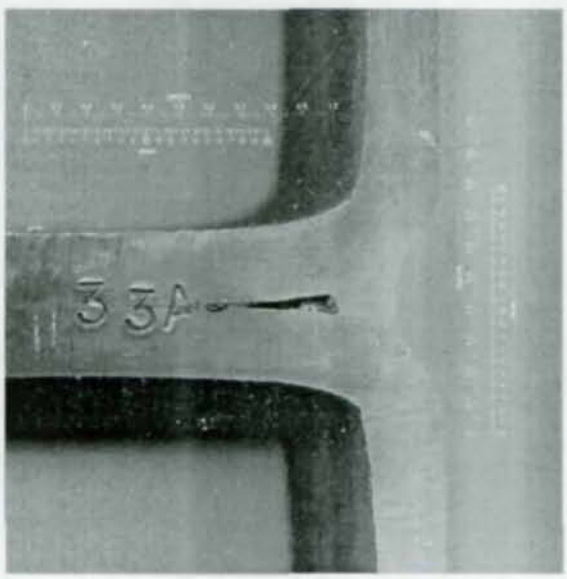

Figure 32. Z for Flare Bevel and Flare-V Test Welds



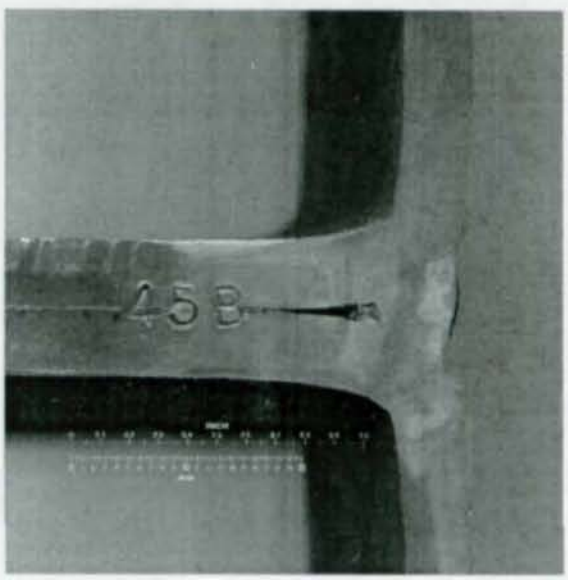

Test Weld No. 36A




Test Weld No. 40B




Test Weld No. 33A




Test Weld No. 45B

Figure 33. HSS 4x4x¼ Flare-V Test Welds With Large Z Values

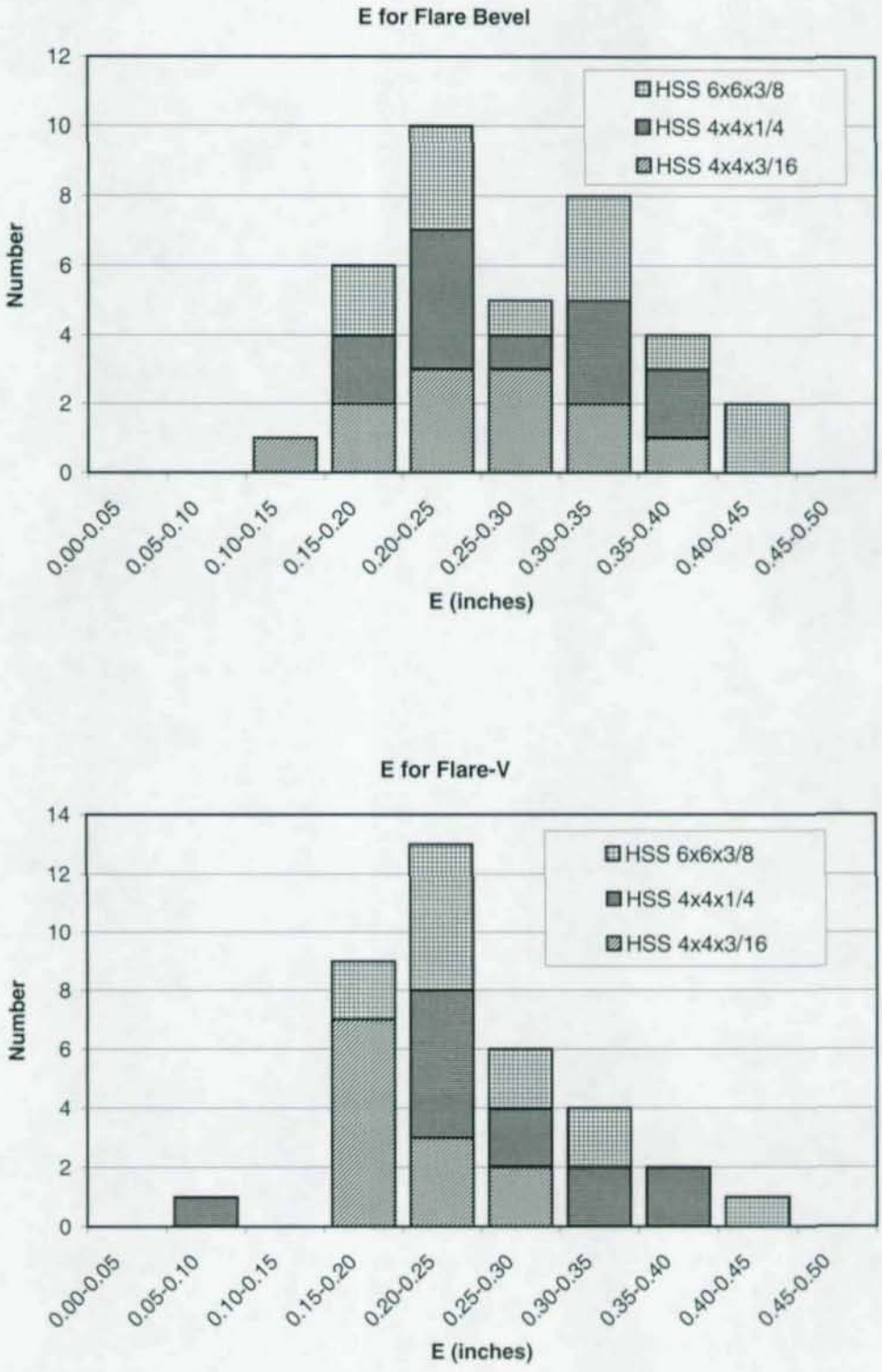



Figure 34. E for Flare Bevel and Flare-V Test Welds

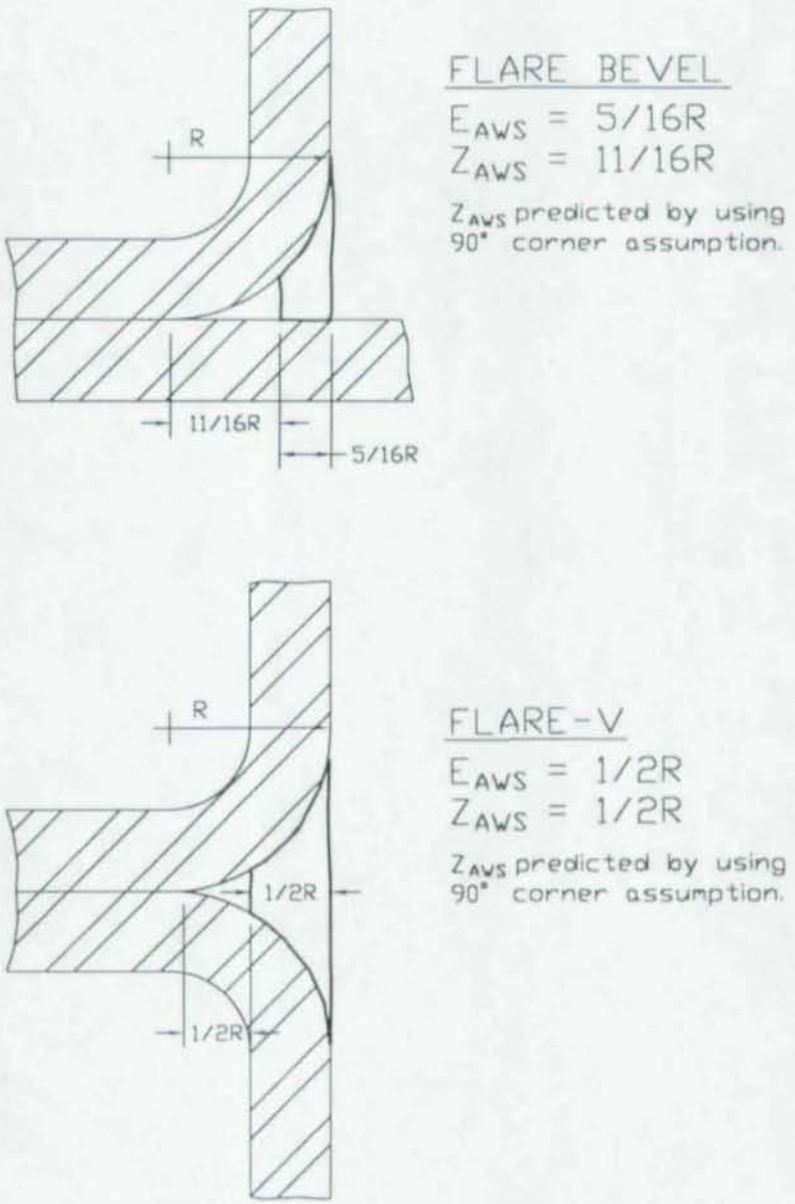



Figure 35. AWS Effective Throats for Flare Bevel and Flare-V Welds Filled Flush to the HSS Face

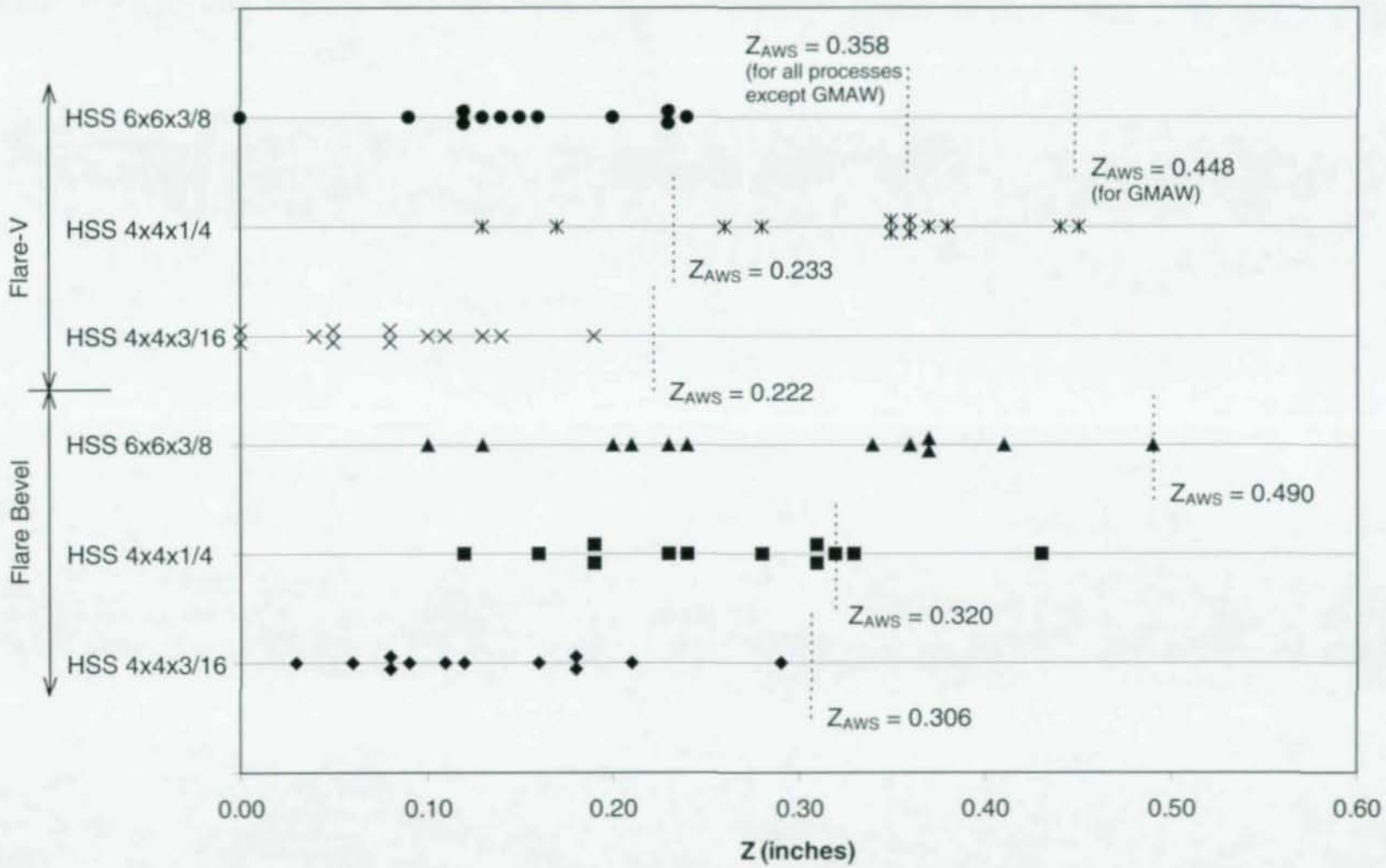



Figure 36. Measured Z Values Compared to $Z_{AWS}$ Predicted

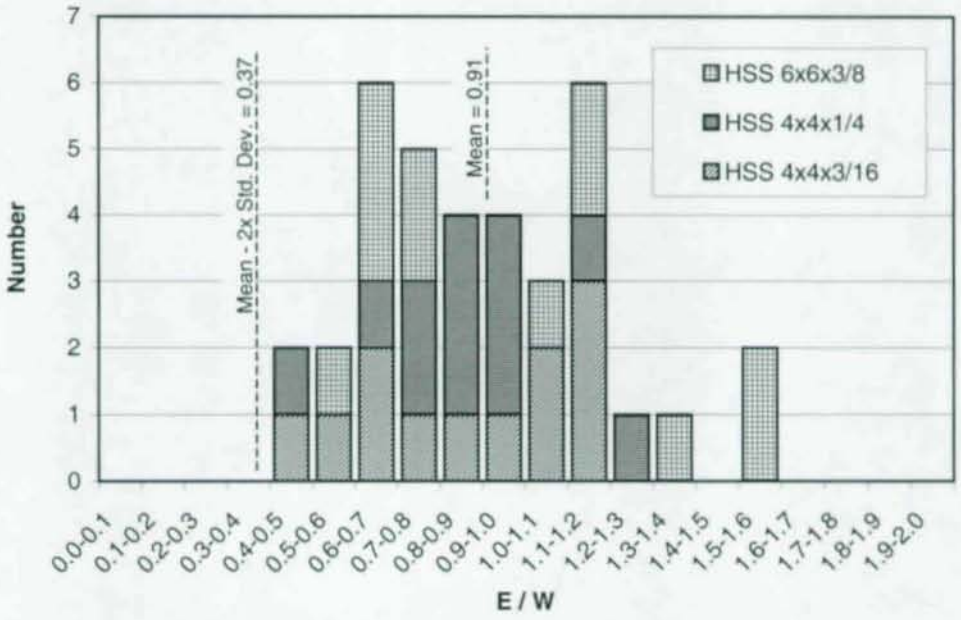



Figure 37. E/W Ratios for all 36 Flare Bevel Welds

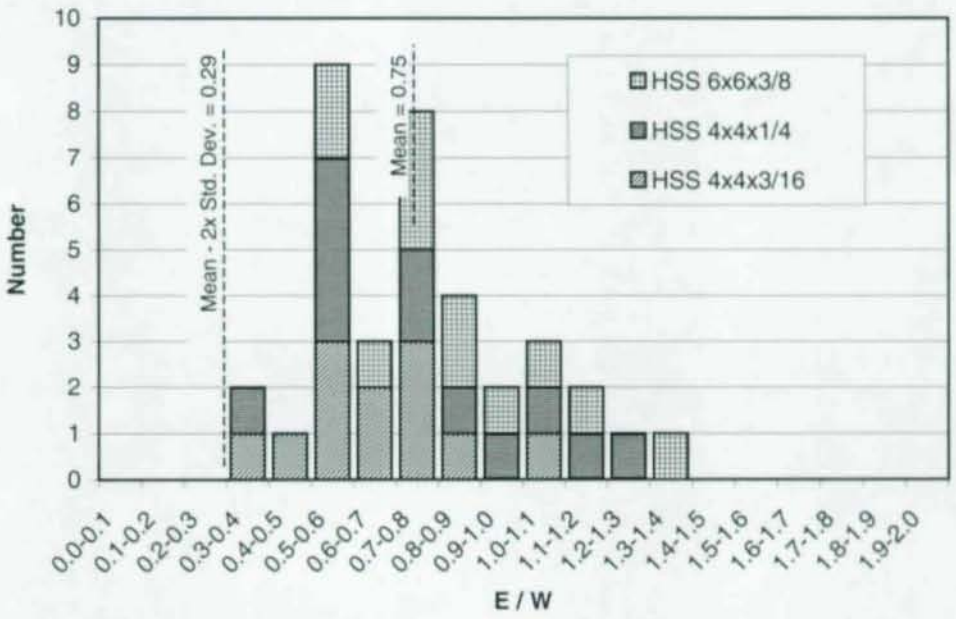



Figure 38. E/W Ratios for all 36 Flare-V Welds

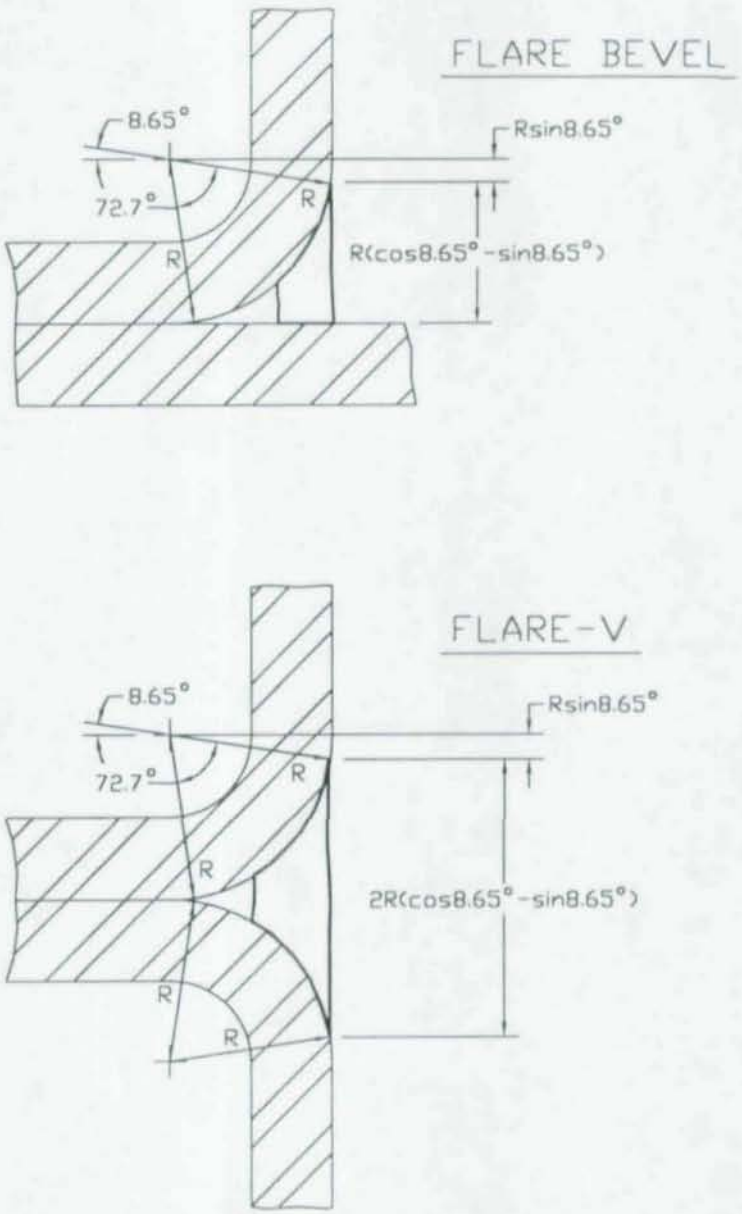



Figure 39. Flare Bevel and Flare-V Weld Face Related to Radius

# APPENDIX 1

Welding Procedure Data Sheets of Canron Limited
(dated December 1984)

CANRON STRUCT. DIVISION TORONTO

# WELDING PROCEDURE DATA SHEET

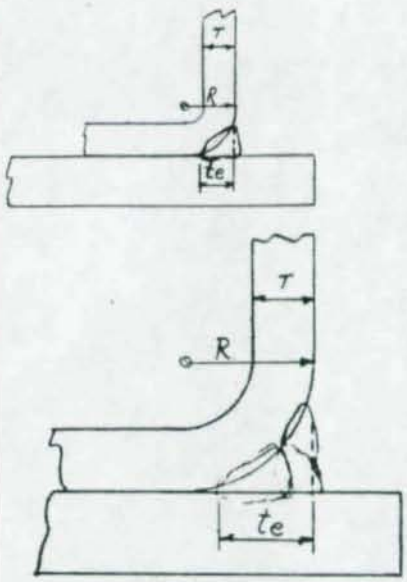
NO.

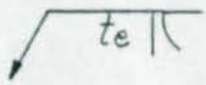
| PREPARED BY | DATE | PROCESS | POSITION | PREPARATION |
|---|---|---|---|---|
| W. Baigent | December 12/84 | | | |
| AUTHORIZED BY W. Baigent Mgr. of Engineering | LATEST REVISION | FCAW WITH $CO_2$ | HORIZONTAL | FLARE BEVEL H.S.S. R = 1½T **** HOT FORMED |
| WLDG. PROC. SPEC. NO. FC(c).(9-82)(3).SFB.H | | | | |

| | |
|---|---|
| Material Specification | G40.21 – Types W and T with Yields up to 55 ksi |
| Electrode | FABCO 81 |
| Flux | N/A |
| Shielding Gas | $CO_2$ 30-35 cfh |
| | |
| Classification | E70T-9-CH |
| Electrode Stickout | 1/2" |
| MANUAL ☐ SEMI-AUTOMATIC ☒ AUTOMATIC ☐ | |
| Current Characteristics | DC+ |
| Voltage Characteristics | Constant |
| | |

NOTES:

1. *See* CANRON *Preheat Specifications:* ☐
2. *Increase Fillet Size if Gap at Root 1/16" or Greater*
3. **GTSM** *indicates "Gouging to Sound Metal"*
4. *Amps., Volts, and Arc Travel are approximate and may vary ±5%*




T = Thickness of H.S.S
"R"adius = 1½T
$t_e$ = 3/4R = effective throat
∴ te = 1.125 x T

| T | ELECTRODE Dia. | ELECTRODE Classific. or Type | Gas Flow | PASS | LAYER | POWER Amps ** | POWER Volts | *** Arc Speed i.p.m. |
|---|---|---|---|---|---|---|---|---|
| .125 | 3/32 | E70T-9 | 35 cfh | 1 | 1 | 360 | 29 | 18 |
| .150 | 3/32 | E70T-9 | 35 cfh | 1 | 1 | 360 | 29 | 15 |
| * .188 | 3/32 | E70T-9 | 35 cfh | 1 | 1 | 360 | 29 | 11.5 |
| .250 | 3/32 | E70T-9 | 35 cfh | 1 | 1 | 360 | 29 | 10 |
| .313 | 3/32 | E70T-9 | 35 cfh | 2 | 2 | 360 | 29 | 11/16 |
| * .375 | 3/32 | E70T-9 | 35 cfh | 3 | 2 | 360 | 29 | 17 |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
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| | | | | | | | | |

REGISTERED PROFESSIONAL ENGINEER
CIVIL
W. W. BAIGENT
PROVINCE OF ONTARIO

P.Eng. Stamp

~~Welding Procedure Data Sheet~~
CWB Approved to CSA W47.1

85 01 02

On the Basis of PROCEDURE QUALIFICATION

Approval Stamp

* Testing Procedure carried out on this specimen by C.W.B.
** Run First Pass with 5% higher amperage than figure shown.
*** Figures shown are average - speed depends on size of bead required. First pass will be approximately 20% slower and final pass 20% faster.
**** Hot Formed - All HSS (Stelco) with a periphery of 16" or less are hot rolled and R = 1½T

Page No.

# APPENDIX 2

Certificate of Conformance for FCAW (classification E71T-1), GMAW (classification ER70S-6) and SMAW (classification E7018-1) Weld Consumables

# CERTIFICATE OF CONFORMANCE

(APPLIES ONLY TO U.S. PRODUCTS)
SUPPLIED TO:

LINCOLN ELECTRIC

**TYPICAL VALUES ONLY**

LINCOLN ELECTRIC COMPANY
[illegible] Clark Avenue
[illegible], Ohio 44117-1199

This is to certify that Outershield® 71M, classification E71T-1, supplied on the above order is of the same classification, manufacturing process and material requirements as the electrode used for this annual test, concluded on May 12, 1995. All tests required by "AWS A5.20-79 and ASME SFA-5.20 were performed in conformance with these specifications and the above material met all requirements. Joint configuration and pass sequence for .072" electrode are shown at lower right.

| Operating Settings. | Required .072 | Information Only 1/16 | .052 | .045 |
|---|---|---|---|---|
| Wire Feed Speed (in/min) | 200 | 250 | 350 | 400 |
| Voltage (volts) DC+ | 25 | 25 | 27 | 28 |
| Shielding Gas | CO2 | CO2 | CO2 | CO2 |

| | Required .072 | Information Only 1/16 | .062 | .045 |
|---|---|---|---|---|
| Electrical Stickout (in) | 7/8 | 3/4 | 3/4 | 3/4 |
| Passes/Layers | 15/8 | 15/8 | 15/8 | 19/9 |
| Interpass Temp. (°F) | 325 | 325 | 325 | 325 |

Mechanical Properties of the weld deposit ( in the as-welded condition ) and Chemical analyses of the weld deposit were as follows:

| | AWS/ASME REQUIREMENTS | Required .072 CO2 | INFORMATION ONLY 1/16 CO2 | .052 CO2 | .045 CO2 |
|---|---|---|---|---|---|
| Tensile Strength | 72,000 min. | 87,100 | 88,900 | 82,400 | 87,800 |
| Yield Strength | 60,000 min. | 83,500 | 85,600 | 79,800 | 87,200 |
| Elongation, % in 2" | 22 min. | 28 | 29 | 32 | 29 |
| Hardness, Rockwell B (avg) | Not Required | 91 | 93 | 90 | 93 |
| Impact Properties (Charpy V-notch), ft-lbs @ 0 °F | 20 min. | 37 (30, 39, 43) | 61 (53, 63, 66) | 45 (40, 45, 51) | 66 (55, 66, 76) |
| ft-lbs @ -20 °F | Not Required | 26 (23, 26, 30) | 43 (40, 42, 46) | 33 (30, 34, 35) | 37 (30, 40, 40) |

| % | AWS/ASME REQUIREMENTS | Required .072 CO2 | INFORMATION ONLY 1/16 CO2 | .052 CO2 | .045 CO2 |
|---|---|---|---|---|---|
| C | Not Req. | .05 | .05 | .05 | .05 |
| Mn | 1.75 max | 1.41 | 1.47 | 1.31 | 1.32 |
| Si | .90 max | .70 | .78 | .64 | .65 |
| S | .03 max | .010 | .007 | .009 | .006 |
| P | .04 max | .009 | .013 | .011 | .010 |

| | |
|---|---|
| Diffusible Hydrogen (1) (AWS A4.3-93) | .072" |
| | 4.8 |

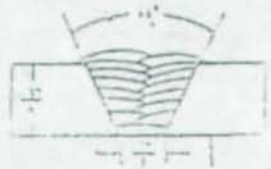
(1) Test atmospheric condition of 24 % Relative Humidity at 69 °F.

Radiographic Test: Met requirements.
Fillet Weld Test (positions as required): Met requirements.
"Per AWS A5.20, Section 3, for the purpose of classification of product, the chemical analysis, radiographic soundness test and required mechanical tests shall be made using 3/32" diameter electrode or the closest size manufactured and CO2 Shielding Gas."

Donald L. Bill
DONALD L. BILL
CERTIFICATION SUPERVISOR

David A. Fink
DAVID A. FINK
ADMINISTRATIVE ENGINEERING MANAGER
CONSUMABLE RESEARCH & DEVELOPMENT

STATE OF OHIO, COUNTY OF CUYAHOGA
SUBSCRIBED AND SWORN TO BEFORE ME THIS
15th DAY OF May 1995
Pat Laurence
NOTARY PUBLIC
My Commission expires July 18, 1999



# CERTIFICATE OF CONFORMANCE

(APPLIES ONLY TO U.S. PRODUCTS)

LINCOLN® ELECTRIC

THE LINCOLN ELECTRIC COMPANY
22801 St. Clair Avenue
Cleveland, Ohio 44117-1199

SUPPLIED TO:

**TYPICAL VALUES ONLY**

This is to certify that Praxair S-6 classification ER70S-6 supplied on the above order number is of the same classification, manufacturing process and material requirements as the electrode used for this annual test, concluded on May 10, 1995. All tests required by AWS A5.18-93 and ASME SFA-5.18 were performed in conformance with these specifications and the above material met all requirements. Joint configuration and pass sequence for .045" electrode are shown at lower right.

Operating Settings:

| | .045 |
|---|---|
| Wire Feed Speed (in/min) | 450 |
| Voltage DC+ | 29 |
| Travel Speed (in/min) | 12-14 |
| Shielding Gas | CO2 |

| | .045 |
|---|---|
| Electrical Stickout (in) | 3/4 |
| Passes/Layers | 13/5 |
| Interpass Temp. (°F) | 300 |

Mechanical Properties of the weld deposit (in the as-welded condition) and Chemical analyses of the weld deposit and electrode were as follows:

| | AWS/ASME REQUIREMENTS | DEPOSIT .045 CO2 |
|---|---|---|
| Tensile Strength | 70,000 min. | 83,400 |
| Yield Strength | 58,000 min. | 69,700 |
| Elongation, % in 2" | 22 min. | 29 |
| Hardness, Rockwell B (avg) | Not Required | 85 |
| Impact Properties (Charpy V-notch), ft-lbs @ -20 °F | 20 min. | 31 [29, 30, 35] |

| | AWS/ASME REQUIREMENTS | ELECTRODE Analysis .045 | AWS/ASME REQUIREMENTS | DEPOSIT Analysis .045 CO2 |
|---|---|---|---|---|
| % | | | | |
| C | .06-.15 | .08 | --- | .08 |
| Mn | 1.40-1.85 | 1.46 | --- | 1.20 |
| Si | .80-1.15 | .88 | --- | .70 |
| S | .035 max | .011 | Not Required | .012 |
| P | .025 max | .013 | | .013 |
| Cu (total) | .50 max | .23 | --- | .19 |
| Ni+Cr+Mo+V | .50 max | 0.07 | --- | 0.07 |

Radiographic Test: Met requirements. Tests are not required for the .025", .030", .035" and .052" sizes. The .045" or 1/16" diameter electrode shall be used for classification purposes.

Donald L. Bill
DONALD L. BILL
CERTIFICATION SUPERVISOR

David A. Fink
DAVID A. FINK
ADMINISTRATIVE ENGINEERING MANAGER
CONSUMABLE RESEARCH & DEVELOPMENT

NOTARY PUBLIC STATE OF OHIO

STATE OF OHIO, COUNTY OF CUYAHOGA
SUBSCRIBED AND SWORN TO BEFORE ME THIS
10th DAY OF May 1995

Peg Lawrence
NOTARY PUBLIC
My Commission expires July 18, 1999

HO-2000-013550
AWDED231012 7018
HEATH R8G305J
ORDER# 248933-00

LINCOLN ELECTRIC COMPANY OF CANADA LIMITED
179 Wicksteed Avenue
Toronto, Ontario
M4G 2B9

TYPICAL VALUES ONLY

## CERTIFICATE OF CONFORMANCE TO REQUIREMENTS FOR WELDING ELECTRODE

This is to certify that EASYARC 528MR Classification E7018-1 supplied on the above order number is of the same classification, manufacturing process and material requirements as the electrodes used for this test, concluded on Nov 15 1999. All tests required by AWS A5.1-91 and SFA-5.1 were performed in conformance with these specifications and the above material met all requirements. Results also conform to CSA W48.1 M requirements.

| | | 2.5 mm | | 3.2 mm | | 4.0 mm | | 5.0 mm | | 6.0 mm | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | AC | DC | AC | DC | AC | DC | AC | DC | AC | DC |
| Tensile Strength | (MPa) | 526 | 612 | 590 | 578 | 583 | 581 | 585 | 568 | 529 | 508 |
| Yield Strength | (MPa) | 533 | 514 | 486 | 447 | 465 | 467 | 502 | 482 | 445 | 417 |
| Elongation % | | 25.5 | 30 | 30.4 | 31.0 | 29 | 30 | 26.75 | 29.5 | 29.5 | 29.5 |
| Charpy V notch @ -50°F (-46°C) | Joules | 77 | 93 | 102 | 61 | 102 | 61 | 106 | 120 | 91 | 71 |
| | Ft. Lbs. | 57 | 69 | 75 | 45 | 75 | 45 | 78 | 88 | 67 | 52 |
| Carbon % | | 0.09 | 0.10 | 0.08 | 0.09 | 0.08 | 0.08 | 0.06 | 0.05 | 0.05 | 0.06 |
| Manganese | | 1.09 | 1.20 | 1.03 | 1.13 | 1.03 | 1.12 | 1.21 | 1.28 | 1.06 | 1.11 |
| Silicon | | 0.53 | 0.58 | 0.05 | 0.58 | 0.44 | 0.49 | 0.48 | 0.48 | 0.39 | 0.37 |
| Nickel | | 0.07 | 0.07 | 0.07 | 0.07 | 0.07 | 0.07 | 0.02 | 0.01 | 0.02 | 0.01 |
| Molybdenum | | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.12 | 0.13 | 0.11 | 0.11 |
| Chromium | | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.04 | 0.04 | 0.04 | 0.04 |
| Vanadium | | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Total (except C, Si) | | 1.23 | 1.34 | 1.16 | 1.17 | 1.17 | 1.26 | 1.40 | 1.47 | 1.26 | 1.29 |
| Coating Moisture | | | | | | | | | | | |
| Diffusible Hydrogen Test Per AWS A4.3 (under mercury) | | | | 5.84 mL / 100G | | 3.54 mL / 100G | | 4.59 mL / 100G | | 4.15 mL / 100G | |

| % Chemistry | Requirements CSA | AWS/ASME |
|---|---|---|
| Carbon Max. | 0.12 | N/A |
| Manganese Max. | 1.6 | 1.6 |
| Silicon Max. | 0.75 | 0.75 |
| Nickel Max. | 0.3 | 0.3 |
| Molybdenum Max. | 0.3 | 0.3 |
| Chromium Max. | 0.2 | 0.2 |
| Vanadium Max. | 0.08 | 0.08 |
| Total (except C, Si) | 1.75 | 1.75 |

| | Requirements CSA | AWS/ASME |
|---|---|---|
| Tensile Strength (MPa) | 480-650 | 482 |
| Yield Strength (MPa) | 400 | 399 |
| Elongation, % | 22% | 22% |
| Hydrogen-ML/100G Weld Metal | 16 | N/A |
| Coating Moisture | N/A | 0.6 |
| Impact Properties | | |
| Ft. Lbs. @ -50 F | N/A | 20 |
| Joules @ -45°C | 27 | |

Radiographic Test Grade I met requirements.
To convert MPa to PSI multiply MPa X 145.03

SEVERALLY SWORN BEFORE
at the City of Toronto in the
Municipality of Metropolitan Toronto
this 17 day of
Nov 19 99

A Notary Public in and for the
Province of Ontario

Operations Supervisor

Quality Assurance Manager

Cert No. 3154-CMP

# APPENDIX 3

Canadian Welding Bureau Letter from J. Craig Martin to Ken Kerluke, dated January 11, 2002

**CANADIAN WELDING BUREAU**
A Division of the CWB Group
2000 Argentia Rd., Plaza 4, Suite 495, Mississauga, Ontario L5N 1W1
(905) 826-5133, Fax: (905) 826-9733; WEB: www.cwbgroup.com

January 11, 2002

VIA FAX: 905-846-8770

Mr. Ken Kerluke, P. Eng.
KMK & Associates Inc.
16 Regan Road, Unit 46
Brampton, ON L7A 1C1

Dear Mr. Kerluke:

**RE: FLARE-BEVEL / FLARE-V WELD SIZE STUDY**

As requested in your facsimile of January 2, 2002, we have reviewed the proposed welding parameters to be used in the upcoming study at Walters Inc.

The proposed parameters were compared with historical PQT information for each configuration. Please note that we could not locate any PQT information for FCAW-S with NR 232 and GMAW in vertical down.

We confirm that the parameters proposed are typical of what is currently being used by our CSA 47.1 Certified fabricators. For the two cases where we did not locate any information, we do agree that the parameters proposed are reasonable.

Please let me know if we can be of further assistance during the study.

Sincerely,
CANADIAN WELDING BUREAU

J. Craig Martin, P. Eng
Manager, Welding Procedures Approval Department
Assistant Manager, Ontario
Email: craig.martin@cwbgroup.com

# APPENDIX 4

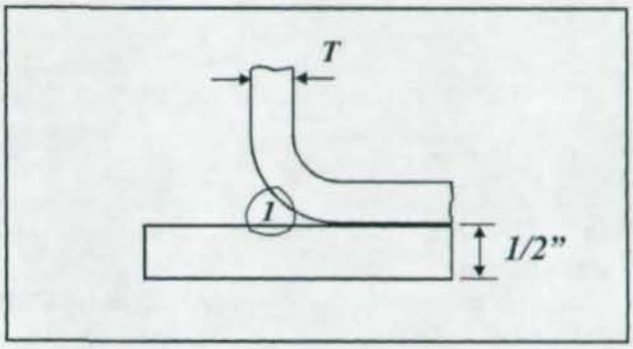
Procedure Qualification Records (PQR) for Test Weld No. 1 to No. 72

# PROCEDURE QUALIFICATION RECORD (PQR)

Company Name: **Walters Inc.**
Authorized By: Ken Kerluke
Welding Process(es): **FCAW-G**
Types: **Semi-automatic**
Date Welded: January 23, 2002

PQR No. 1
Welder's Name: John Williamson
Stamp Number: N/A
ArcScan ID # 136

| **Joint Design** | |
|---|---|
| Type | *Flare Bevel Tee* |
| Single or Double Weld | *Single* |
| Backing | *None* |
| Backing Material | *N/A* |
| Back Gouging | *None* |
| Method | *N/A* |




## Base Metal:

| | | |
|---|---|---|
| Material Spec. | *A500* to | *G40.21* |
| Type or Grade | *C* | *44W* |
| Thickness: | *3/16* | *1/2* |
| Diameter (Pipe) | | *N/A* |

## Filler Metals:

| | |
|---|---|
| AWS Specification _____ | *A5.20* |
| AWS Classification _____ | *E71T-9 (O/S 71M)* |
| Size of Filler Metal _____ | *1/16* |

## Heat Treatment: *None*

Temperature _____
Time _____

## Electrical Characteristics:

| | |
|---|---|
| Current Type _____ | *DC* |
| Mode of Metal Transfer (GMAW) _____ | *N/A* |
| Polarity _____ | *Positive* |
| Tungsten Electrode Size and Type _____ | *None* |

## Position:

Position of Groove: *2G (horizontal)*
Weld Progression _____
Other _____

## Preheat: See General Notes

*Preheat Temperature: 70° F ambient*
Interpass Temperature _____
Other _____

| **Shielding Gas** | | | |
|---|---|---|---|
| | | % Comp. | |
| | Gas | (Mixture) | Flow Rate |
| Shielding: | *$CO_2$* | *100%* | *35 cfh* |
| Trailing: *None* | | | |

| **Technique** | |
|---|---|
| String or Weave Bead | *String* |
| Oscillation | *None* |
| Multi-pass or Single Pass (per side) | *Single* |
| Gas Cup Size | *5/8" Ø* |
| Interpass Cleaning | *None* |
| Peening | *None* |
| Push or Drag Electrode Angle | *Drag* |
| Contact Tube to Work Distance | *3/4"* |

## Welding Data:

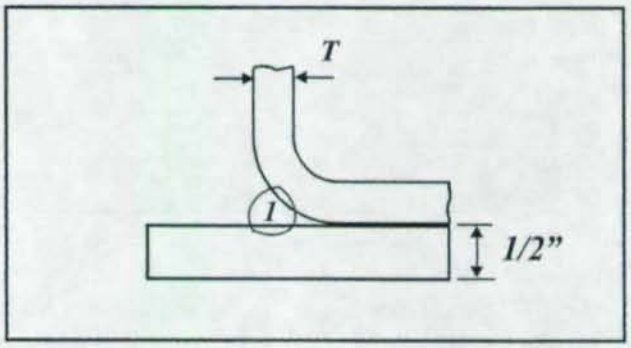
| Wall Size T | Side | Layer | Pass | Filler Metal Class | Filler Metal Ø | Wire Feed Speed (ipm) | Amps. | Volts | Travel Speed (ipm) |
|---|---|---|---|---|---|---|---|---|---|
| *3/16* | *1* | *1* | *1* | *E71T-9* | *1/16* | *225* | *237* | *25.0* | *11.5* |
| | | | | | | | | | |
| | | | | | | | | | |

# PROCEDURE QUALIFICATION RECORD (PQR)

Company Name: **Walters Inc.**
Authorized By: Ken Kerluke
Welding Process(es): **FCAW-G**
Types: **Semi-automatic**
Date Welded: January 23, 2002

PQR No. 2
Welder's Name: John Williamson
Stamp Number: N/A
ArcScan ID # 131

| **Joint Design** | |
|---|---|
| Type | *Flare Bevel Tee* |
| Single or Double Weld | *Single* |
| Backing | *None* |
| Backing Material | *N/A* |
| Back Gouging | *None* |
| Method | *N/A* |




## Base Metal:

| | | |
|---|---|---|
| Material Spec. | *A500* to | Material Spec. *G40.21* |
| Type or Grade | *C* | Type or Grade *44W* |
| Thickness: | *3/16* | *1/2* |
| Diameter (Pipe) | | *N/A* |

## Filler Metals:

AWS Specification _____ *A5.20*
AWS Classification _____ *E71T-9 (O/S 71M)*
Size of Filler Metal _____ *1/16*

## Heat Treatment: *None*

Temperature _____
Time _____

## Electrical Characteristics:

Current Type _____ *DC*
Mode of Metal Transfer (GMAW) _____ *N/A*
Polarity _____ *Positive*
Tungsten Electrode Size and Type _____ *None*

## Position:

Position of Groove: *3G (vertical)*
Weld Progression: *Vertical Up*
Other _____

## Preheat:

Preheat Temperature: *70°F ambient*
Interpass Temperature _____
Other _____

| **Shielding Gas** | | | |
|---|---|---|---|
| | | % Comp. | |
| | Gas | (Mixture) | Flow Rate |
| Shielding: | $CO_2$ | *100%* | *35 cfh* |
| Trailing: *None* | | | |

| **Technique** | |
|---|---|
| String or Weave Bead | *String* |
| Oscillation | *None* |
| Multi-pass or Single Pass (per side) | *Single* |
| Gas Cup Size | *5/8" ∅* |
| Interpass Cleaning | *None* |
| Peening | *None* |
| Push or Drag Electrode Angle | *0°* |
| Contact Tube to Work Distance | *5/8"* |

## Welding Data:

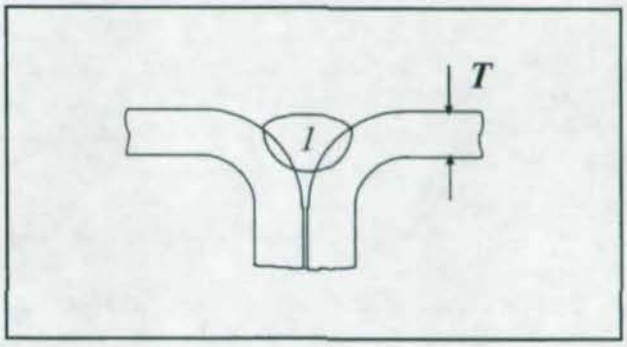
| Wall Size T | Side | Layer | Pass | Filler Metal Class | Filler Metal ∅ | Wire Feed Speed (ipm) | Amps. | Volts | Travel Speed (ipm) |
|---|---|---|---|---|---|---|---|---|---|
| *3/16* | *1* | *1* | *1* | *E71T-9* | *1/16* | *157* | *213* | *21.0* | *7.4* |
| | | | | | | | | | |
| | | | | | | | | | |

# PROCEDURE QUALIFICATION RECORD (PQR)

Company Name: **Walters Inc.**
Authorized By: Ken Kerluke
Welding Process(es): **FCAW-G**
Types: **Semi-automatic**
Date Welded: January 23, 2002

PQR No. 3
Welder's Name: John Williamson
Stamp Number: N/A
ArcScan ID# 135

| **Joint Design** | |
|---|---|
| Type | *Flare Vee Butt* |
| Single or Double Weld | *Single* |
| Backing | *None* |
| Backing Material | *N/A* |
| Back Gouging | *None* |
| Method | *N/A* |




## Base Metal:

| | | | |
|---|---|---|---|
| Material Spec. | *A500* | to | Material Spec. *A500* |
| Type or Grade | *C* | | Type or Grade *C* |
| Thickness: | *3/16* | | *3/16* |
| Diameter (Pipe) | | | *N/A* |

## Filler Metals:

AWS Specification _____ *A5.20*
AWS Classification _____ *E71T-9 (O/S 71M)*
Size of Filler Metal _____ *1/16*

## Heat Treatment:

*None*
Temperature _____
Time _____

## Electrical Characteristics:

*Current Type* _____ *DC*
Mode of Metal Transfer (GMAW) _____ *N/A*
Polarity _____ *Positive*
Tungsten Electrode Size and Type _____ *None*

## Position:

Position of Groove: *1G (flat)*
Weld Progression _____
Other _____

## Preheat:

Preheat Temperature: 70° F ambient
Interpass Temperature _____
Other _____

| **Shielding Gas** | | | |
|---|---|---|---|
| | | % Comp. | |
| | Gas | (Mixture) | Flow Rate |
| Shielding: | $CO_2$ | *100%* | *35 cfh* |
| Trailing: None | - | - | - |

| **Technique:** | |
|---|---|
| String or Weave Bead | *String* |
| Oscillation | *None* |
| Multi-pass or Single Pass (per side) | *Single* |
| Gas Cup Size | *5/8" Ø* |
| Interpass Cleaning | *None* |
| Peening | *None* |
| Push or Drag Electrode Angle | *Drag* |
| Contact Tube to Work Distance | *7/8"* |

## Welding Data:

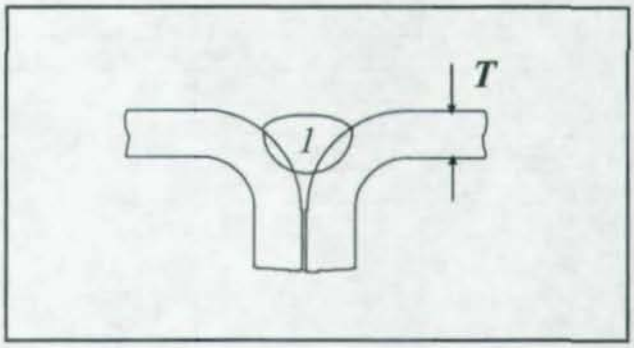
| Wall Size T | Side | Layer | Pass | Filler Metal Class | Filler Metal Ø | Wire Feed Speed (ipm) | Amps. | Volts | Travel Speed (ipm) |
|---|---|---|---|---|---|---|---|---|---|
| *3/16* | *1* | *1* | *1* | *E71T-9* | *1/16* | *225* | *233* | *25.0* | *10.9* |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |

# PROCEDURE QUALIFICATION RECORD (PQR)

Company Name: **Walters Inc.**
Authorized By: Ken Kerluke
Welding Process(es): **FCAW-G**
Types: **Semi-automatic**
Date Welded: January 23, 2002

PQR No. 4
Welder's Name: John Williamson
Stamp Number: N/A
ArcScan ID# 130

| **Joint Design** | |
|---|---|
| Type | *Flare Vee Butt* |
| Single or Double Weld | *Single* |
| Backing | *None* |
| Backing Material | *N/A* |
| Back Gouging | *None* |
| Method | *N/A* |




## Base Metal:

| | | | |
|---|---|---|---|
| Material Spec. | *A500* | to | Material Spec. *A500* |
| Type or Grade | *C* | | Type or Grade *C* |
| Thickness: | *3/16* | | *3/16* |
| Diameter (Pipe) | | | *N/A* |

## Position:

Position of Groove: *3G (vertical)*
Weld Progression: *Vertical Up*
Other _____

## Filler Metals:

AWS Specification _____ *A5.20*
AWS Classification _____ *E71T-9 (O/S 71M)*
Size of Filler Metal _____ *1/16*

## Preheat:

Preheat Temperature: 70° F ambient
Interpass Temperature _____
Other _____

## Heat Treatment:

*None*
Temperature _____
Time _____

## Electrical Characteristics:

Current Type _____ *DC*
Mode of Metal Transfer (GMAW) _____ *N/A*
Polarity _____ *Positive*
Tungsten Electrode Size and Type _____ *None*

| **Shielding Gas** | | | |
|---|---|---|---|
| | | % Comp. | |
| | Gas | (Mixture) | Flow Rate |
| Shielding: | *$CO_2$* | *100%* | *35 cfh* |
| Trailing: None | - | - | - |

| **Technique:** | |
|---|---|
| String or Weave Bead | *String* |
| Oscillation | *None* |
| Multi-pass or Single Pass (per side) | *Single* |
| Gas Cup Size | *5/8" Ø* |
| Interpass Cleaning | *None* |
| Peening | *None* |
| Push or Drag Electrode Angle | *0°* |
| Contact Tube to Work Distance | *3/4"* |

## Welding Data:

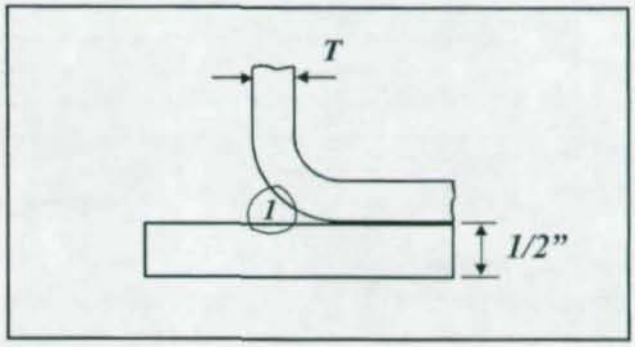
| Wall Size T | Side | Layer | Pass | Filler Metal Class | Filler Metal Ø | Wire Feed Speed (ipm) | Amps. | Volts | Travel Speed (ipm) |
|---|---|---|---|---|---|---|---|---|---|
| *3/16* | *1* | *1* | *1* | *E71T-9* | *1/16* | *157* | *192* | *21.0* | *8.6* |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |

# PROCEDURE QUALIFICATION RECORD (PQR)

Company Name: **Walters Inc.**
Authorized By: Ken Kerluke
Welding Process(es): **FCAW-G**
Types: **Semi-automatic**
Date Welded: January 23, 2002

PQR No. 5
Welder's Name: John Williamson
Stamp Number: N/A
ArcScan ID # 158

| **Joint Design** | |
|---|---|
| Type | *Flare Bevel Tee* |
| Single or Double Weld | *Single* |
| Backing | *None* |
| Backing Material | *N/A* |
| Back Gouging | *None* |
| Method | *N/A* |




## Base Metal:

| | | |
|---|---|---|
| Material Spec. | *A500* to | *G40.21* |
| Type or Grade | *C* | *44W* |
| Thickness: | *3/16* | *1/2* |
| Diameter (Pipe) | | *N/A* |

## Filler Metals:

AWS Specification _____ *A5.20*
AWS Classification _____ *E71T-9 (O/S 71M)*
Size of Filler Metal _____ *1/16*

## Heat Treatment: *None*

Temperature _____
Time _____

## Electrical Characteristics:

Current Type _____ *DC*
Mode of Metal Transfer (GMAW) _____ *N/A*
Polarity _____ *Positive*
Tungsten Electrode Size and Type _____ *None*

## Position:

Position of Groove: *4G (overhead)*
Weld Progression _____
Other _____

## Preheat:

Preheat Temperature: *70° F ambient*
Interpass Temperature _____
Other _____

| **Shielding Gas** | | | |
|---|---|---|---|
| | | % Comp. | |
| | Gas | (Mixture) | Flow Rate |
| Shielding: | $CO_2$ | *100%* | *35 cfh* |
| Trailing: *None* | | | |

| **Technique** | |
|---|---|
| String or Weave Bead | *String* |
| Oscillation | *None* |
| Multi-pass or Single Pass (per side) | *Single* |
| Gas Cup Size | *5/8" Ø* |
| Interpass Cleaning | *None* |
| Peening | *None* |
| Push or Drag Electrode Angle | *Drag* |
| Contact Tube to Work Distance | *5/8"* |

## Welding Data:

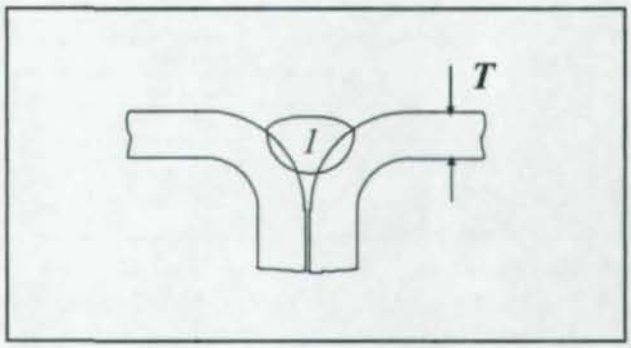
| Wall Size T | Side | Layer | Pass | Filler Metal Class | Filler Metal Ø | Wire Feed Speed (ipm) | Amps. | Volts | Travel Speed (ipm) |
|---|---|---|---|---|---|---|---|---|---|
| *3/16* | *1* | *1* | *1* | *E71T-9* | *1/16* | *155* | *199* | *24.0* | *7.7* |
| | | | | | | | | | |
| | | | | | | | | | |

# PROCEDURE QUALIFICATION RECORD (PQR)

Company Name: **Walters Inc.**
Authorized By: Ken Kerluke
Welding Process(es): **FCAW-G**
Types: **Semi-automatic**
Date Welded: January 23, 2002

PQR No. 6
Welder's Name: John Williamson
Stamp Number: N/A
ArcScan ID# 155

| **Joint Design** | |
|---|---|
| Type | *Flare Vee Butt* |
| Single or Double Weld | *Single* |
| Backing | *None* |
| Backing Material | *N/A* |
| Back Gouging | *None* |
| Method | *N/A* |




**Base Metal:**

| | | | |
|---|---|---|---|
| Material Spec. | *A500* | to | Material Spec. *A500* |
| Type or Grade | *C* | | Type or Grade *C* |
| Thickness: | *3/16* | | *3/16* |
| Diameter (Pipe) | | | *N/A* |

**Filler Metals:**

AWS Specification _____ *A5.20*
AWS Classification _____ *E71T-9 (O/S 71M)*
Size of Filler Metal _____ *1/16*

**Heat Treatment:** *None*

Temperature _____
Time _____

**Electrical Characteristics:**

Current Type _____ *DC*
Mode of Metal Transfer (GMAW) _____ *N/A*
Polarity _____ *Positive*
Tungsten Electrode Size and Type _____ *None*

**Position:**

Position of Groove: *4G (overhead)*
Weld Progression _____
Other _____

**Preheat:**

Preheat Temperature: 70° F ambient
Interpass Temperature _____
Other _____

| **Shielding Gas** | | | |
|---|---|---|---|
| | | % Comp. | |
| | Gas | (Mixture) | Flow Rate |
| Shielding: | *$CO_2$* | *100%* | *35 cfh* |
| Trailing: None | - | - | - |

| **Technique:** | |
|---|---|
| String or Weave Bead | *String* |
| Oscillation | *None* |
| Multi-pass or Single Pass (per side) | *Single* |
| Gas Cup Size | *5/8" Ø* |
| Interpass Cleaning | *None* |
| Peening | *None* |
| Push or Drag Electrode Angle | *0°* |
| Contact Tube to Work Distance | *5/8"* |

**Welding Data:**

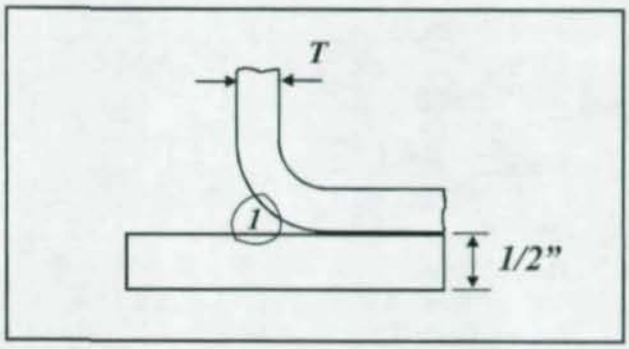
| Wall Size T | Side | Layer | Pass | Filler Metal Class | Filler Metal Ø | Wire Feed Speed (ipm) | Amps. | Volts | Travel Speed (ipm) |
|---|---|---|---|---|---|---|---|---|---|
| *3/16* | *1* | *1* | *1* | *E71T-9* | *1/16* | *155* | *200* | *24.0* | *10.3* |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |

# PROCEDURE QUALIFICATION RECORD (PQR)

Company Name: **Walters Inc.**
Authorized By: Ken Kerluke
Welding Process(es): **FCAW-S**
Types: **Semi-automatic**
Date Welded: January 23, 2002

PQR No. 7
Welder's Name: John Williamson
Stamp Number: N/A
ArcScan ID# N/A

| **Joint Design** | |
|---|---|
| Type | *Flare Bevel Tee* |
| Single or Double Weld | *Single* |
| Backing | *None* |
| Backing Material | *N/A* |
| Back Gouging | *None* |
| Method | *N/A* |




## Base Metal:

| | | |
|---|---|---|
| Material Spec. *A500* | to | Material Spec. *G40.21* |
| Type or Grade *C* | to | Type or Grade *44W* |
| Thickness *3/16* | | *1/2* |
| Diameter (Pipe) | | *N/A* |

## Filler Metals:

AWS Specification _____ *A5.20*
AWS Classification _____ *E71T-8 (NR-232)*
Size of Filler Metal _____ *0.072*

## Heat Treatment:

*None*
Temperature _____
Time _____

## Position:

Position of Groove: *2G (horizontal)*
Weld Progression _____
Other _____

## Preheat:

Preheat Temperature: *70° F ambient*
Interpass Temperature _____
Other _____

## Electrical Characteristics:

Current Type _____ *DC*
Mode of Metal Transfer (GMAW) _____ *N/A*
Polarity _____ *Negative*
Tungsten Electrode Size and Type _____ *None*

| **Shielding Gas** | | | |
|---|---|---|---|
| | | % Comp. | |
| | Gas | (Mixture) | Flow Rate |
| Shielding: *None* | - | - | - |
| Trailing: *None* | - | - | - |

| **Technique** | |
|---|---|
| String or Weave Bead | *String* |
| Oscillation | *None* |
| Multi-pass or Single Pass (per side) | *Single* |
| Gas Cup Size | *N/A* |
| Interpass Cleaning | *None* |
| Peening | *None* |
| Push or Drag Electrode Angle | *Drag* |
| Contact Tube to Work Distance | *3/4"* |

## Welding Data:

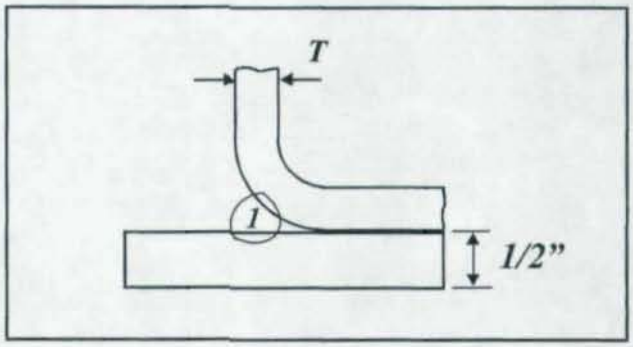
| Wall Size T | Side | Layer | Pass | Filler Metal Class | Filler Metal ∅ | Wire Feed Speed (ipm) | Amps. | Volts | Travel Speed (ipm) |
|---|---|---|---|---|---|---|---|---|---|
| *3/16* | *1* | *1* | *1* | *E71T-8* | *0.072* | *173* | *237* | *21.0* | *9.5* |
| | | | | | | | | | |
| | | | | | | | | | |

# PROCEDURE QUALIFICATION RECORD (PQR)

Company Name: **Walters Inc.**
Authorized By: Ken Kerluke
Welding Process(es): **FCAW-S**
Types: **Semi-automatic**
Date Welded: January 23, 2002

PQR No. 8
Welder's Name: John Williamson
Stamp Number: N/A
ArcScan ID# N/A

| **Joint Design** | |
|---|---|
| Type | *Flare Bevel Tee* |
| Single or Double Weld | *Single* |
| Backing | *None* |
| Backing Material | *N/A* |
| Back Gouging | *None* |
| Method | *N/A* |




## Base Metal:

| | | |
|---|---|---|
| Material Spec. *A500* | to | Material Spec. *G40.21* |
| Type or Grade *C* | to | Type or Grade *44W* |
| Thickness *3/16* | | *1/2* |
| Diameter (Pipe) | | *N/A* |

## Filler Metals:

AWS Specification _____ *A5.20*
AWS Classification _____ *E71T-8 (NR-232)*
Size of Filler Metal _____ *0.072*

## Heat Treatment:

*None*
Temperature _____
Time _____

## Position:

Position of Groove: *3G (vertical)*
Weld Progression: *Vertical Up*
Other _____

## Preheat:

Preheat Temperature: *70°F ambient*
Interpass Temperature _____
Other _____

## Electrical Characteristics:

Current Type _____ *DC*
Mode of Metal Transfer (GMAW) _____ *N/A*
Polarity _____ *Negative*
Tungsten Electrode Size and Type _____ *None*

| **Shielding Gas** | | | |
|---|---|---|---|
| | | % Comp. | |
| | Gas | (Mixture) | Flow Rate |
| Shielding: *None* | - | - | - |
| Trailing: *None* | - | - | - |

| **Technique** | |
|---|---|
| String or Weave Bead | *Weave* |
| Oscillation | *None* |
| Multi-pass or Single Pass (per side) | *Single* |
| Gas Cup Size | *N/A* |
| Interpass Cleaning | *None* |
| Peening | *None* |
| Push or Drag Electrode Angle | *0°* |
| Contact Tube to Work Distance | *1/2"* |

## Welding Data:

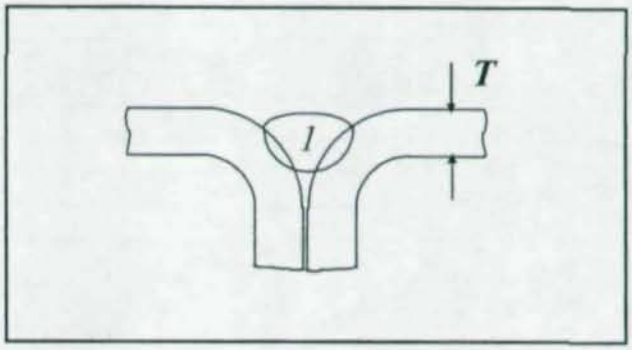
| Wall Size T | Side | Layer | Pass | Filler Metal Class | Filler Metal ∅ | Wire Feed Speed (ipm) | Amps. | Volts | Travel Speed (ipm) |
|---|---|---|---|---|---|---|---|---|---|
| *3/16* | *1* | *1* | *1* | *E71T-8* | *0.072* | *115* | *180* | *17.5* | *3.7* |
| | | | | | | | | | |
| | | | | | | | | | |

# PROCEDURE QUALIFICATION RECORD (PQR)

Company Name: **Walters Inc.**
Authorized By: Ken Kerluke
Welding Process(es): **FCAW-S**
Types: **Semi-automatic**
Date Welded: January 23, 2002

PQR No. 9
Welder's Name: John Williamson
Stamp Number: N/A
ArcScan ID # N/A

| **Joint Design** | |
|---|---|
| Type | *Flare Vee Butt* |
| Single or Double Weld | *Single* |
| Backing | *None* |
| Backing Material | *N/A* |
| Back Gouging | *None* |
| Method | *N/A* |




## Base Metal:

| | | |
|---|---|---|
| Material Spec. *A500* | to | Material Spec. *A500* |
| Type or Grade *C* | to | Type or Grade *C* |
| Thickness *3/16* | | *3/16* |
| Diameter (Pipe) | | *N/A* |

## Filler Metals:

AWS Specification _____ *A5.20*
AWS Classification _____ *E71T-8 (NR 232)*
Size of Filler Metal _____ *0.072*

## Heat Treatment: *None*

Temperature _____
Time _____

## Electrical Characteristics:

Current Type _____ *DC*
Mode of Metal Transfer (GMAW) _____ *N/A*
Polarity _____ *Negative*
Tungsten Electrode Size and Type _____ *None*

## Position:

Position of Groove: *1G (flat)*
Weld Progression _____
Other _____

## Preheat:

Preheat Temperature: *70°F ambient*
Interpass Temperature _____
Other _____

| **Shielding Gas** | | | |
|---|---|---|---|
| | | % Comp. | |
| | Gas | (Mixture) | Flow Rate |
| Shielding: None | - | - | - |
| Trailing: None | - | - | - |

| **Technique:** | |
|---|---|
| String or Weave Bead | *String* |
| Oscillation | *None* |
| Multi-pass or Single Pass (per side) | *Single* |
| Gas Cup Size | *N/A* |
| Interpass Cleaning | *None* |
| Peening | *None* |
| Push or Drag Electrode Angle | *Push* |
| Contact Tube to Work Distance | *3/4"* |

## Welding Data:

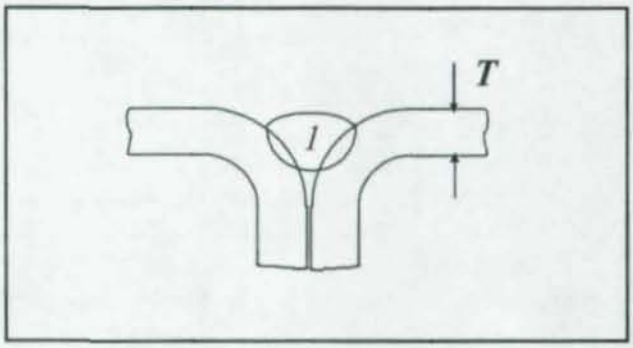
| Wall Size T | Side | Layer | Pass | Filler Metal Class | Filler Metal ∅ | Wire Feed Speed (ipm) | Amps. | Volts | Travel Speed (ipm) |
|---|---|---|---|---|---|---|---|---|---|
| *3/16* | *1* | *1* | *1* | *E71T-8* | *0.072* | *173* | *235* | *22.0* | *12.0* |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |

# PROCEDURE QUALIFICATION RECORD (PQR)

Company Name: **Walters Inc.**
Authorized By: Ken Kerluke
Welding Process(es): **FCAW-S**
Types: **Semi-automatic**
Date Welded: January 23, 2002

PQR No. 10
Welder's Name: John Williamson
Stamp Number: N/A
ArcScan ID # N/A

| **Joint Design** | |
|---|---|
| Type | *Flare Vee Butt* |
| Single or Double Weld | *Single* |
| Backing | *None* |
| Backing Material | *N/A* |
| Back Gouging | *None* |
| Method | *N/A* |




## Base Metal:

| | | |
|---|---|---|
| Material Spec. *A500* | to | Material Spec. *A500* |
| Type or Grade *C* | to | Type or Grade *C* |
| Thickness *3/16* | | *3/16* |
| Diameter (Pipe) | | *N/A* |

## Filler Metals:

AWS Specification _____ *A5.20*
AWS Classification _____ *E71T-8 (NR 232)*
Size of Filler Metal _____ *0.072*

## Heat Treatment:

*None*
Temperature _____
Time _____

## Position:

Position of Groove: *3G (vertical)*
Weld Progression: *Vertical Up*
Other _____

## Preheat:

Preheat Temperature: *70° F ambient*
Interpass Temperature _____
Other _____

## Electrical Characteristics:

Current Type _____ *DC*
Mode of Metal Transfer (GMAW) _____ *N/A*
Polarity _____ *Negative*
Tungsten Electrode Size and Type _____ *None*

| **Shielding Gas** | | | |
|---|---|---|---|
| | | % Comp. | |
| | Gas | (Mixture) | Flow Rate |
| Shielding: None | - | - | - |
| Trailing: None | - | - | - |

| **Technique:** | |
|---|---|
| String or Weave Bead | *Weave* |
| Oscillation | *None* |
| Multi-pass or Single Pass (per side) | *Single* |
| Gas Cup Size | *N/A* |
| Interpass Cleaning | *None* |
| Peening | *None* |
| Push or Drag Electrode Angle | *Push* |
| Contact Tube to Work Distance | *1/2"* |

## Welding Data:

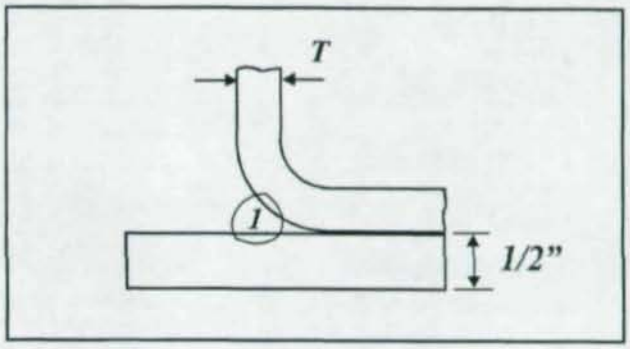
| Wall Size T | Side | Layer | Pass | Filler Metal Class | Filler Metal ∅ | Wire Feed Speed (ipm) | Amps. | Volts | Travel Speed (ipm) |
|---|---|---|---|---|---|---|---|---|---|
| *3/16* | *1* | *1* | *1* | *E71T-8* | *0.072* | *115* | *180* | *17.5* | *3.7* |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |

# PROCEDURE QUALIFICATION RECORD (PQR)

Company Name: **Walters Inc.**
Authorized By: Ken Kerluke
Welding Process(es): **FCAW-S**
Types: **Semi-automatic**
Date Welded: January 23, 2002

PQR No. 11
Welder's Name: John Williamson
Stamp Number: N/A
ArcScan ID# N/A

| **Joint Design** | |
|---|---|
| Type | *Flare Bevel Tee* |
| Single or Double Weld | *Single* |
| Backing | *None* |
| Backing Material | *N/A* |
| Back Gouging | *None* |
| Method | *N/A* |




## Base Metal:

| | | |
|---|---|---|
| Material Spec. *A500* | to | Material Spec. *G40.21* |
| Type or Grade *C* | to | Type or Grade *44W* |
| Thickness *3/16* | | *1/2* |
| Diameter (Pipe) | | *N/A* |

## Filler Metals:

AWS Specification _____ *A5.20*
AWS Classification _____ *E71T-8 (NR-232)*
Size of Filler Metal _____ *0.072*

## Heat Treatment:

*None*
Temperature _____
Time _____

## Electrical Characteristics:

Current Type _____ *DC*
Mode of Metal Transfer (GMAW) _____ *N/A*
Polarity _____ *Negative*
Tungsten Electrode Size and Type _____ *None*

## Position:

Position of Groove: *4G (overhead)*
Weld Progression _____
Other _____

## Preheat:

Preheat Temperature: *70° F ambient*
Interpass Temperature _____
Other _____

| **Shielding Gas** | | | |
|---|---|---|---|
| | | % Comp. | |
| | Gas | (Mixture) | Flow Rate |
| Shielding: *None* | - | - | - |
| Trailing: *None* | - | - | - |

| **Technique** | |
|---|---|
| String or Weave Bead | *String* |
| Oscillation | *None* |
| Multi-pass or Single Pass (per side) | *Single* |
| Gas Cup Size | *N/A* |
| Interpass Cleaning | *None* |
| Peening | *None* |
| Push or Drag Electrode Angle | *Drag* |
| Contact Tube to Work Distance | *5/8"* |

## Welding Data:

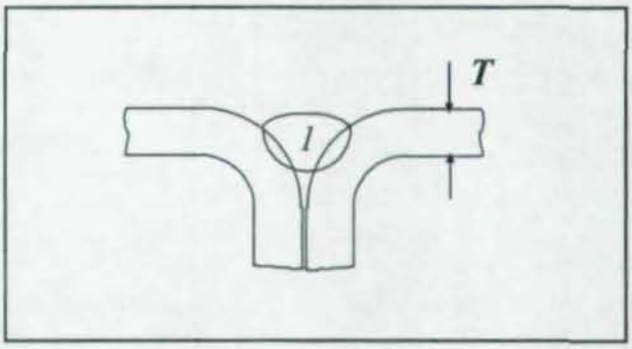
| Wall Size T | Side | Layer | Pass | Filler Metal Class | Filler Metal ∅ | Wire Feed Speed (ipm) | Amps. | Volts | Travel Speed (ipm) |
|---|---|---|---|---|---|---|---|---|---|
| *3/16* | *1* | *1* | *1* | *E71T-8* | *0.072* | *115* | *196* | *17.0* | *6.1* |
| | | | | | | | | | |
| | | | | | | | | | |

# PROCEDURE QUALIFICATION RECORD (PQR)

Company Name: **Walters Inc.**
Authorized By: Ken Kerluke
Welding Process(es): **FCAW-S**
Types: **Semi-automatic**
Date Welded: January 23, 2002

PQR No. 12
Welder's Name: John Williamson
Stamp Number: N/A
ArcScan ID # N/A

| **Joint Design** | |
|---|---|
| Type | *Flare Vee Butt* |
| Single or Double Weld | *Single* |
| Backing | *None* |
| Backing Material | *N/A* |
| Back Gouging | *None* |
| Method | *N/A* |




### Base Metal:

| | | |
|---|---|---|
| Material Spec. | *A500* to | Material Spec. *A500* |
| Type or Grade | *C* to | Type or Grade *C* |
| Thickness | *3/16* | *3/16* |
| Diameter (Pipe) | | *N/A* |

### Filler Metals:

AWS Specification _____ *A5.20*
AWS Classification _____ *E71T-8 (NR 232)*
Size of Filler Metal _____ *0.072*

### Heat Treatment: *None*

Temperature _____
Time _____

### Position:

Position of Groove: *4G (overhead)*
Weld Progression _____
Other _____

### Preheat:

Preheat Temperature: *70° F ambient*
Interpass Temperature _____
Other _____

### Electrical Characteristics:

Current Type _____ *DC*
Mode of Metal Transfer (GMAW) _____ *N/A*
Polarity _____ *Negative*
Tungsten Electrode Size and Type _____ *None*

| **Shielding Gas** | | | |
|---|---|---|---|
| | | % Comp. | |
| | Gas | (Mixture) | Flow Rate |
| Shielding: None | - | - | - |
| Trailing: None | - | - | - |

| **Technique:** | |
|---|---|
| String or Weave Bead | *String* |
| Oscillation | *None* |
| Multi-pass or Single Pass (per side) | *Single* |
| Gas Cup Size | *N/A* |
| Interpass Cleaning | *None* |
| Peening | *None* |
| Push or Drag Electrode Angle | *Drag* |
| Contact Tube to Work Distance | *5/8"* |

### Welding Data:

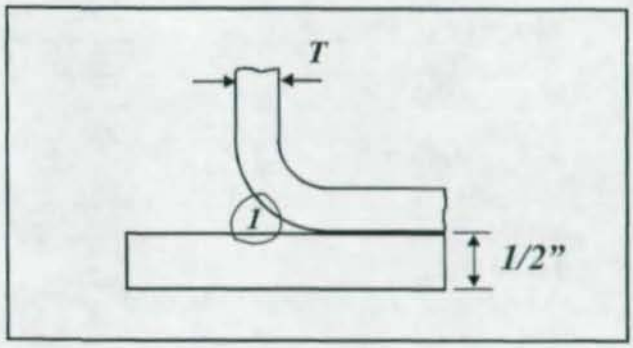
| Wall Size T | Side | Layer | Pass | Filler Metal Class | Filler Metal ∅ | Wire Feed Speed (ipm) | Amps. | Volts | Travel Speed (ipm) |
|---|---|---|---|---|---|---|---|---|---|
| *3/16* | *1* | *1* | *1* | *E71T-8* | *0.072* | *115* | *197* | *17.0* | *6.5* |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |

# PROCEDURE QUALIFICATION RECORD (PQR)

Company Name: **Walters Inc.**
Authorized By: Ken Kerluke
Welding Process(es): **GMAW**
Types: **Semi-automatic**
Date Welded: January 23, 2002

PQR No. 13
Welder's Name: John Williamson
Stamp Number: N/A
ArcScan ID# 110

| **Joint Design** | |
|---|---|
| Type | *Flare Bevel Tee* |
| Single or Double Weld | *Single* |
| Backing | *None* |
| Backing Material | *N/A* |
| Back Gouging | *None* |
| Method | *N/A* |




## Base Metal:

Material Spec. *A500* to Material Spec. *G40.21*
Type or Grade *C* to Type or Grade *44W*
Thickness *3/16* *1/2*
Diameter (Pipe) *N/A*

## Position:

Position of Groove: *2G (horizontal)*
Weld Progression:
Other _____

## Preheat:

Preheat Temperature _____
Other _____

## Filler Metals:

AWS Specification _____ *A5.18*
AWS Classification _____ *E70S-6*
Size of Filler Metal _____ *0.045*

## Heat Treatment:

*None*
Preheat Temperature: *70°F ambient*
Temperature _____
Time _____

## Electrical Characteristics:

Current Type _____ *DC*
Mode of Metal Transfer (GMAW) _____ *Spray*
Polarity _____ *Positive*
Tungsten Electrode Size and Type _____ *None*

| **Shielding Gas** | | | |
|---|---|---|---|
| | | % Comp. | |
| | Gas | (Mixture) | Flow |
| Shielding: | *C-10* | *90% Ar 10-% $CO_2$* | *35 cfh* |
| Trailing: *None* | | | |

| **Technique** | |
|---|---|
| String or Weave Bead | *String* |
| Oscillation | *None* |
| Multi-pass or Single Pass (per side) | *Single* |
| Gas Cup Size | *5/8" Ø* |
| Interpass Cleaning | *None* |
| Peening | *None* |
| Push or Drag Electrode Angle | *Push* |
| Contact Tube to Work Distance | *1/2"* |

## Welding Data:

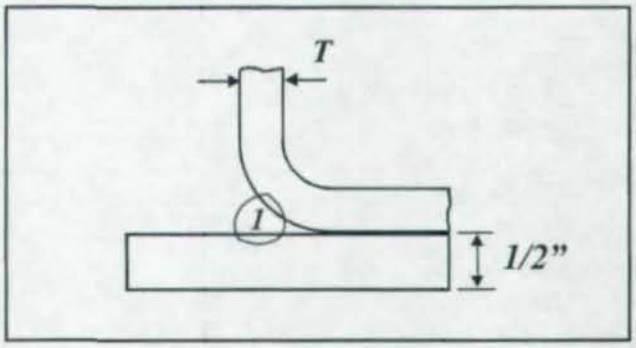
| Wall Size T | Side | Layer | Pass | Filler Metal Class | Filler Metal Ø | Wire Feed Speed (ipm) | Amps. | Volts | Travel Speed (ipm) |
|---|---|---|---|---|---|---|---|---|---|
| *3/16* | *1* | *1* | *1* | *E70S-6* | *0.045* | *330* | *234* | *26.9* | *9.9* |
| | | | | | | | | | |
| | | | | | | | | | |

# PROCEDURE QUALIFICATION RECORD (PQR)

Company Name: **Walters Inc.**
Authorized By: Ken Kerluke
Welding Process(es): **GMAW**
Types: **Semi-automatic**
Date Welded: January 23, 2002

PQR No. 14
Welder's Name: John Williamson
Stamp Number: N/A
ArcScan ID# 112

| **Joint Design** | |
|---|---|
| Type | *Flare Bevel Tee* |
| Single or Double Weld | *Single* |
| Backing | *None* |
| Backing Material | *N/A* |
| Back Gouging | *None* |
| Method | *N/A* |




## Base Metal:

| | | |
|---|---|---|
| Material Spec. | *A500* to | Material Spec. *G40.21* |
| Type or Grade | *C* to | Type or Grade *44W* |
| Thickness | *3/16* | *1/2* |
| Diameter (Pipe) | | *N/A* |

## Filler Metals:

AWS Specification _____ *A5.18*
AWS Classification _____ *E70S-6*
Size of Filler Metal _____ *0.045*
*None*

## Heat Treatment:

Preheat Temperature: *70°F ambient*
Temperature _____
Time _____

## Position:

Position of Groove: *3G (vertical)*
Weld Progression: *Vertical Down*
Other _____

## Preheat:

Interpass Temperature _____
Other _____

## Electrical Characteristics:

Current Type _____ *DC*
Mode of Metal Transfer (GMAW) _____ *Spray*
Polarity _____ *Positive*
Tungsten Electrode Size and Type _____ *None*

| **Shielding Gas** | | | |
|---|---|---|---|
| | | % Comp. | |
| | Gas | (Mixture) | Flow |
| Shielding: | *C-10* | *90% Ar 10-% $CO_2$* | *35 cfh* |
| Trailing: *None* | | | |

| **Technique** | |
|---|---|
| String or Weave Bead | *String* |
| Oscillation | *None* |
| Multi-pass or Single Pass (per side) | *Single* |
| Gas Cup Size | *5/8" Ø* |
| Interpass Cleaning | *None* |
| Peening | *None* |
| Push or Drag Electrode Angle | *Drag* |
| Contact Tube to Work Distance | *1/2"* |

## Welding Data:

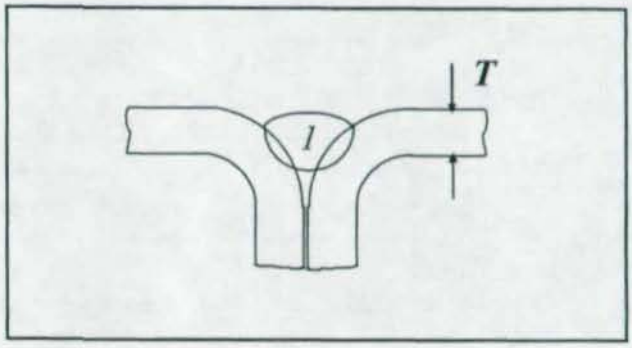
| Wall Size T | Side | Layer | Pass | Filler Metal Class | Filler Metal Ø | Wire Feed Speed (ipm) | Amps. | Volts | Travel Speed (ipm) |
|---|---|---|---|---|---|---|---|---|---|
| *3/16* | *1* | *1* | *1* | *E70S-6* | *0.045* | *330* | *248* | *24.5* | *15.3* |
| | | | | | | | | | |
| | | | | | | | | | |

# PROCEDURE QUALIFICATION RECORD (PQR)

Company Name: **Walters Inc.**
Authorized By: Ken Kerluke
Welding Process(es): **GMAW**
Types: **Semi-automatic**
Date Welded: January 23, 2002

PQR No. 15
Welder's Name: John Williamson
Stamp Number: N/A
ArcScan ID# 108

| **Joint Design** | |
|---|---|
| Type | *Flare Vee Butt* |
| Single or Double Weld | *Single* |
| Backing | *None* |
| Backing Material | *N/A* |
| Back Gouging | *None* |
| Method | *N/A* |




## Base Metal:

| | | |
|---|---|---|
| Material Spec. | *A500* to | Material Spec. *A500* |
| Type or Grade | *C* to | Type or Grade *C* |
| Thickness | *3/16* | *3/16* |
| Diameter (Pipe) | | *N/A* |

## Filler Metals:

AWS Specification _____ *A5.18*
AWS Classification _____ *E70S-6*
Size of Filler Metal _____ *0.045*

## Heat Treatment: *None*

Temperature _____
Time _____

## Electrical Characteristics:

Current Type _____ *DC*
Mode of Metal Transfer (GMAW) _____ *Spray*
Polarity _____ *Positive*
Tungsten Electrode Size and Type _____ *None*

## Position:

Position of Groove: *1G (flat)*
Weld Progression:
Other _____

## Preheat:

Preheat Temperature: *70°F ambient*
Interpass Temperature _____
Other _____

| **Shielding Gas** | | | |
|---|---|---|---|
| | | % Comp. | |
| | Gas | (Mixture) | Flow |
| Shielding: | *C-10* | *90% Ar 10-% $CO_2$* | *35 cfh* |
| Trailing: None | | | |

| **Technique:** | |
|---|---|
| String or Weave Bead | *String* |
| Oscillation | *None* |
| Multi-pass or Single Pass (per side) | *Single* |
| Gas Cup Size | *5/8" Ø* |
| Interpass Cleaning | *None* |
| Peening | *None* |
| Push or Drag Electrode Angle | *Push* |
| Contact Tube to Work Distance | *1/2"* |

## Welding Data:

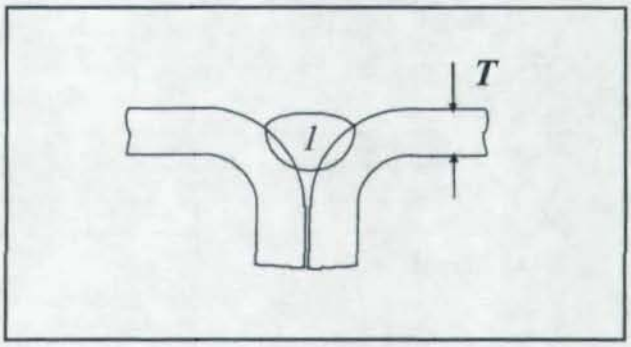
| Wall Size T | Side | Layer | Pass | Filler Metal Class | Filler Metal Ø | Wire Feed Speed (ipm) | Amps. | Volts | Travel Speed (ipm) |
|---|---|---|---|---|---|---|---|---|---|
| *3/16* | *1* | *1* | *1* | *E70S-6* | *0.045* | *330* | *234* | *26.7* | *13.7* |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |

# PROCEDURE QUALIFICATION RECORD (PQR)

Company Name: **Walters Inc.**
Authorized By: Ken Kerluke
Welding Process(es): **GMAW**
Types: **Semi-automatic**
Date Welded: January 23, 2002

PQR No. 16
Welder's Name: John Williamson
Stamp Number: N/A
ArcScan ID# 111

| **Joint Design** | |
|---|---|
| Type | *Flare Vee Butt* |
| Single or Double Weld | *Single* |
| Backing | *None* |
| Backing Material | *N/A* |
| Back Gouging | *None* |
| Method | *N/A* |




## Base Metal:

| | | |
|---|---|---|
| Material Spec. | *A500* to | Material Spec. *A500* |
| Type or Grade | *C* to | Type or Grade *C* |
| Thickness | *3/16* | *3/16* |
| Diameter (Pipe) | | *N/A* |

## Filler Metals:

AWS Specification _____ *A5.18*
AWS Classification _____ *E70S-6*
Size of Filler Metal _____ *0.045*

## Heat Treatment: *None*

Temperature _____
Time _____

## Electrical Characteristics:

Current Type _____ *DC*
Mode of Metal Transfer (GMAW) _____ *Spray*
Polarity _____ *Positive*
Tungsten Electrode Size and Type _____ *None*

## Position:

Position of Groove: *3G (vertical)*
Weld Progression: *Vertical Down*
Other _____

## Preheat:

Preheat Temperature: *70° F ambient*
Interpass Temperature _____
Other _____

| **Shielding Gas** | | | |
|---|---|---|---|
| | | % Comp. | |
| | Gas | (Mixture) | Flow |
| Shielding: | *C-10* | *90% Ar 10-% $CO_2$* | *35 cfh* |
| Trailing: None | | | |

| **Technique:** | |
|---|---|
| String or Weave Bead | *String* |
| Oscillation | *None* |
| Multi-pass or Single Pass (per side) | *Single* |
| Gas Cup Size | *5/8" Ø* |
| Interpass Cleaning | *None* |
| Peening | *None* |
| Push or Drag Electrode Angle | *Drag* |
| Contact Tube to Work Distance | *3/8"* |

## Welding Data:

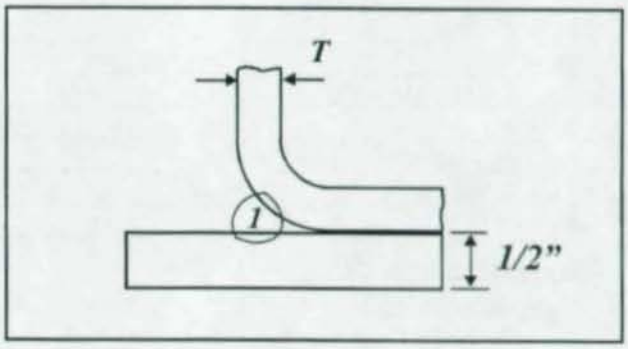
| Wall Size T | Side | Layer | Pass | Filler Metal Class | Filler Metal Ø | Wire Feed Speed (ipm) | Amps. | Volts | Travel Speed (ipm) |
|---|---|---|---|---|---|---|---|---|---|
| *3/16* | *1* | *1* | *1* | *E70S-6* | *0.045* | *330* | *259* | *24.4* | *19.5* |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |

# PROCEDURE QUALIFICATION RECORD (PQR)

Company Name: **Walters Inc.**
Authorized By: Ken Kerluke
Welding Process(es): **GMAW**
Types: **Semi-automatic**
Date Welded: January 23, 2002

PQR No. 17
Welder's Name: John Williamson
Stamp Number: N/A
ArcScan ID# 119

| **Joint Design** | |
|---|---|
| Type | *Flare Bevel Tee* |
| Single or Double Weld | *Single* |
| Backing | *None* |
| Backing Material | *N/A* |
| Back Gouging | *None* |
| Method | *N/A* |




**Base Metal:**

| | | |
|---|---|---|
| Material Spec. | *A500* | to Material Spec. *G40.21* |
| Type or Grade | *C* | to Type or Grade *44W* |
| Thickness | *3/16* | *1/2* |
| Diameter (Pipe) | | *N/A* |

**Filler Metals:**

| | |
|---|---|
| AWS Specification _____ | *A5.18* |
| AWS Classification _____ | *E70S-6* |
| Size of Filler Metal _____ | *0.045* |

**Heat Treatment:** *None*
Preheat Temperature: *70° F ambient*
Temperature _____
Time _____

**Position:**
Position of Groove: *4G (overhead)*
Weld Progression _____
Other _____

**Preheat:**
Interpass Temperature _____
Other _____

**Electrical Characteristics:**

| | |
|---|---|
| Current Type _____ | *DC* |
| Mode of Metal Transfer (GMAW) _____ | *Spray* |
| Polarity _____ | *Positive* |
| Tungsten Electrode Size and Type _____ | *None* |

| **Shielding Gas** | | | |
|---|---|---|---|
| | | % Comp. | |
| | Gas | (Mixture) | Flow |
| Shielding: | *C-10* | *90% Ar 10-% $CO_2$* | *35 cfh* |
| Trailing: *None* | | | |

| **Technique** | |
|---|---|
| String or Weave Bead | *String* |
| Oscillation | *None* |
| Multi-pass or Single Pass (per side) | *Single* |
| Gas Cup Size | *5/8" ∅* |
| Interpass Cleaning | *None* |
| Peening | *None* |
| Push or Drag Electrode Angle | *Push* |
| Contact Tube to Work Distance | *1/2"* |

**Welding Data:**

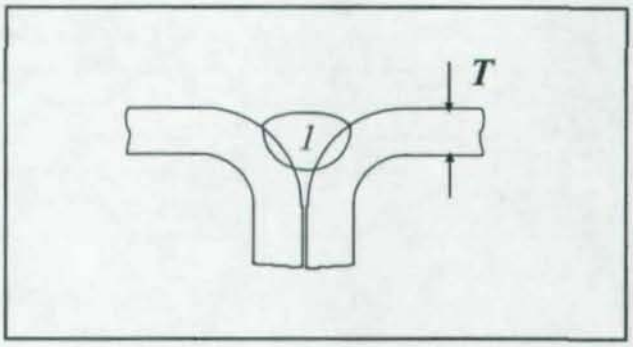
| Wall Size T | Side | Layer | Pass | Filler Metal Class | Filler Metal ∅ | Wire Feed Speed (ipm) | Amps. | Volts | Travel Speed (ipm) |
|---|---|---|---|---|---|---|---|---|---|
| *3/16* | *1* | *1* | *1* | *E70S-6* | *0.045* | *260* | *197* | *24.4* | *7.3* |
| | | | | | | | | | |
| | | | | | | | | | |

# PROCEDURE QUALIFICATION RECORD (PQR)

Company Name: **Walters Inc.**
Authorized By: Ken Kerluke
Welding Process(es): **GMAW**
Types: **Semi-automatic**
Date Welded: January 23, 2002

PQR No. 18
Welder's Name: John Williamson
Stamp Number: N/A
ArcScan ID# 118

| **Joint Design** | |
|---|---|
| Type | *Flare Vee Butt* |
| Single or Double Weld | *Single* |
| Backing | *None* |
| Backing Material | *N/A* |
| Back Gouging | *None* |
| Method | *N/A* |




## Base Metal:

| | | |
|---|---|---|
| Material Spec. | *A500* to | Material Spec. *A500* |
| Type or Grade | *C* to | Type or Grade *C* |
| Thickness | *3/16* | *3/16* |
| Diameter (Pipe) | | *N/A* |

## Filler Metals:

AWS Specification _____ *A5.18*
AWS Classification _____ *E70S-6*
Size of Filler Metal _____ *0.045*

## Heat Treatment:

*None*
Temperature _____
Time _____

## Electrical Characteristics:

Current Type _____ *DC*
Mode of Metal Transfer (GMAW) _____ *Spray*
Polarity _____ *Positive*
Tungsten Electrode Size and Type _____ *None*

## Position:

Position of Groove: *4G (overhead)*
Weld Progression _____
Other _____

## Preheat:

Preheat Temperature: *70° F ambient*
Interpass Temperature _____
Other _____

| **Shielding Gas** | | | |
|---|---|---|---|
| | | % Comp. | |
| | Gas | (Mixture) | Flow |
| Shielding: | *C-10* | *90% Ar 10-% $CO_2$* | *35 cfh* |
| Trailing: None | | | |

| **Technique:** | |
|---|---|
| String or Weave Bead | *String* |
| Oscillation | *None* |
| Multi-pass or Single Pass (per side) | *Single* |
| Gas Cup Size | *5/8" Ø* |
| Interpass Cleaning | *None* |
| Peening | *None* |
| Push or Drag Electrode Angle | *Push* |
| Contact Tube to Work Distance | *1/2"* |

## Welding Data:

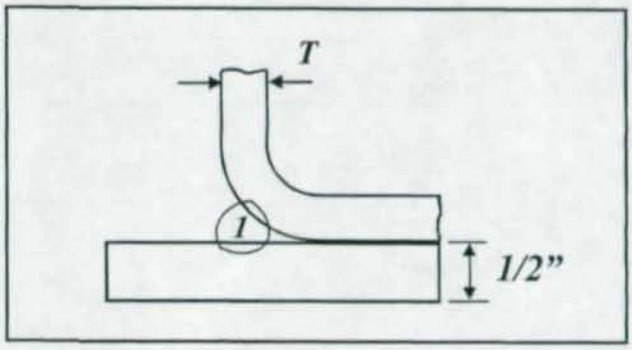
| Wall Size T | Side | Layer | Pass | Filler Metal Class | Filler Metal Ø | Wire Feed Speed (ipm) | Amps. | Volts | Travel Speed (ipm) |
|---|---|---|---|---|---|---|---|---|---|
| *3/16* | *1* | *1* | *1* | *E70S-6* | *0.045* | *260* | *200* | *23.1* | *10.6* |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |

# PROCEDURE QUALIFICATION RECORD (PQR)

Company Name: **Walters Inc.**
Authorized By: Ken Kerluke
Welding Process(es): **SMAW**
Types: **Manual**
Date Welded: January 23, 2002

PQR No. 19
Welder's Name: John Williamson
Stamp Number: N/A
ArcScan ID#: 65, 66

| **Joint Design** | |
|---|---|
| Type | *Flare Bevel Tee* |
| Single or Double Weld | *Single* |
| Backing | *None* |
| Backing Material | *N/A* |
| Back Gouging | *None* |
| Method | *N/A* |




## Base Metal:

| | | |
|---|---|---|
| Material Spec. | *A500* to | Material Spec. *G40.21* |
| Type or Grade | *C* to | Type or Grade *44W* |
| Thickness | *3/16* | *1/2* |
| Diameter (Pipe) | | *N/A* |

## Filler Metals:

AWS Specification _____ *A5.1*
AWS Classification _____ *E7018*
Size of Filler Metal _____ *1/8*

## Heat Treatment: *None*

Temperature _____
Time _____

## Position:

Position of Groove: *2G (horizontal)*
Weld Progression:
Other _____

## Preheat:

Preheat Temperature: 70° F ambient
Interpass Temperature _____
Other _____

## Electrical Characteristics:

Current Type _____ *DC*
Mode of Metal Transfer (GMAW) _____ *N/A*
Polarity _____ *Positive*
Tungsten Electrode Size and Type _____ *None*

| **Shielding Gas** | | | |
|---|---|---|---|
| | | % Comp. | |
| | Gas | (Mixture) | Flow Rate |
| Shielding: *None* | | | |
| Trailing: *None* | | | |
| Backing: *None* | | | |

| **Technique** | |
|---|---|
| String or Weave Bead | *String* |
| Oscillation | *None* |
| Multi-pass or Single Pass (per side) | *Single* |
| Gas Cup Size | *N/A* |
| Interpass Cleaning | *None* |
| Peening | *None* |
| Push or Drag Electrode Angle | *Drag* |
| Contact Tube to Work Distance | *N/A* |

## Welding Data:

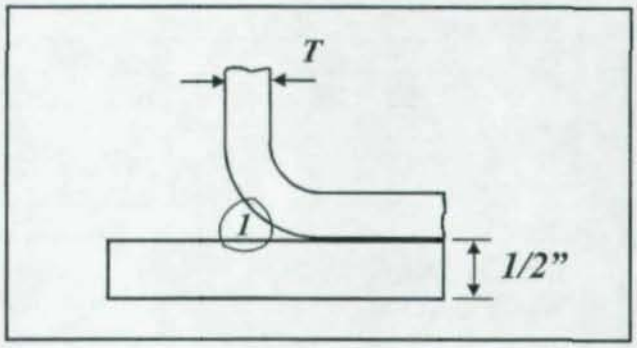
| Wall Size T | Side | Layer | Pass | Filler Metal Class | Filler Metal ∅ | Wire Feed Speed (ipm) | Amps. | Volts | Travel Speed (ipm) |
|---|---|---|---|---|---|---|---|---|---|
| *3/16* | *1* | *1* | *1* | *E7018* | *1/8* | *N/A* | *120* | - | *4.1* |
| | | | | | | | | | |
| | | | | | | | | | |

# PROCEDURE QUALIFICATION RECORD (PQR)

Company Name: **Walters Inc.**
Authorized By: Ken Kerluke
Welding Process(es): **SMAW**
Types: **Manual**
Date Welded: January 23, 2002

PQR No. 20
Welder's Name: John Williamson
Stamp Number: N/A
ArcScan ID#: 69, 70

| **Joint Design** | |
|---|---|
| Type | *Flare Bevel Tee* |
| Single or Double Weld | *Single* |
| Backing | *None* |
| Backing Material | *N/A* |
| Back Gouging | *None* |
| Method | *N/A* |




### Base Metal:

| | | |
|---|---|---|
| Material Spec. *A500* | to | Material Spec. *G40.21* |
| Type or Grade *C* | to | Type or Grade *44W* |
| Thickness *3/16* | | *1/2* |
| Diameter (Pipe) | | *N/A* |

### Filler Metals:

AWS Specification _____ *A5.1*
AWS Classification _____ *E7018*
Size of Filler Metal _____ *1/8*

### Heat Treatment: *None*

Temperature _____
Time _____

### Position:

Position of Groove: *3G (vertical)*
Weld Progression: *Vertical Up*
Other _____

### Preheat:

Preheat Temperature: 70° F ambient
Interpass Temperature _____
Other _____

### Electrical Characteristics:

Current Type _____ *DC*
Mode of Metal Transfer (GMAW) _____ *N/A*
Polarity _____ *Positive*
Tungsten Electrode Size and Type _____ *None*

| **Shielding Gas** | | | |
|---|---|---|---|
| | | % Comp. | |
| | Gas | (Mixture) | Flow Rate |
| Shielding: *None* | | | |
| Trailing: *None* | | | |
| Backing: *None* | | | |

| **Technique** | |
|---|---|
| String or Weave Bead | *String* |
| Oscillation | *None* |
| Multi-pass or Single Pass (per side) | *Single* |
| Gas Cup Size | *N/A* |
| Interpass Cleaning | *None* |
| Peening | *None* |
| Push or Drag Electrode Angle | *Push* |
| Contact Tube to Work Distance | *N/A* |

### Welding Data:

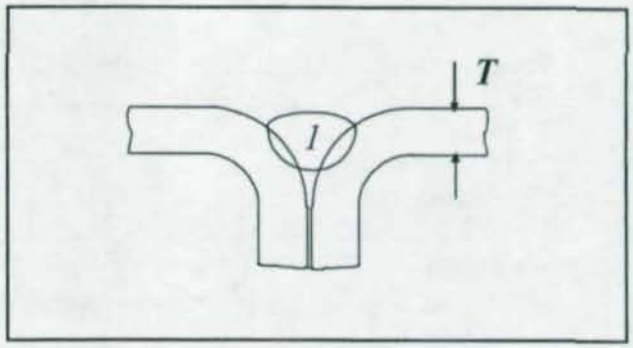
| Wall Size T | Side | Layer | Pass | Filler Metal Class | Filler Metal ∅ | Wire Feed Speed (ipm) | Amps. | Volts | Travel Speed (ipm) |
|---|---|---|---|---|---|---|---|---|---|
| *3/16* | *1* | *1* | *1* | *E7018* | *1/8* | *N/A* | *120* | - | *5.0* |
| | | | | | | | | | |
| | | | | | | | | | |

# PROCEDURE QUALIFICATION RECORD (PQR)

Company Name: **Walters Inc.**
Authorized By: Ken Kerluke
Welding Process(es): **SMAW**
Types: **Manual**
Date Welded: January 23, 2002

PQR No. 21
Welder's Name: John Williamson
Stamp Number: N/A
ArcScan ID #: 62, 64,

| **Joint Design** | |
|---|---|
| Type | *Flare Vee Butt* |
| Single or Double Weld | *Single* |
| Backing | *None* |
| Backing Material | *N/A* |
| Back Gouging | *None* |
| Method | *N/A* |




## Base Metal:

| | | |
|---|---|---|
| Material Spec. *A500* | to | Material Spec. *A500* |
| Type or Grade *C* | to | Type or Grade *C* |
| Thickness *3/16* | | *3/16* |
| Diameter (Pipe) | | *N/A* |

## Filler Metals:

AWS Specification _____ *A5.1*
AWS Classification _____ *E7018*
Size of Filler Metal _____ *1/8*

## Heat Treatment:

*None*
Temperature _____
Time _____

## Electrical Characteristics:

Current Type _____ *DC*
Mode of Metal Transfer (GMAW) _____ *N/A*
Polarity _____ *Positive*
Tungsten Electrode Size and Type _____ *None*

## Position:

Position of Groove: *1G (flat)*
Weld Progression:
Other _____

## Preheat:

Preheat Temperature: 70° ambient
Interpass Temperature _____
Other _____

| **Shielding Gas** | | | |
|---|---|---|---|
| | | % Comp. | |
| | Gas | (Mixture) | Flow Rate |
| Shielding: *None* | | | |
| Trailing: *None* | | | |
| Backing: *None* | | | |

| **Technique** | |
|---|---|
| String or Weave Bead | *String* |
| Oscillation | *None* |
| Multi-pass or Single Pass (per side) | *Single* |
| Gas Cup Size | *N/A* |
| Interpass Cleaning | *None* |
| Peening | *None* |
| Push or Drag Electrode Angle | *Drag* |
| Contact Tube to Work Distance | *N/A* |

## Welding Data:

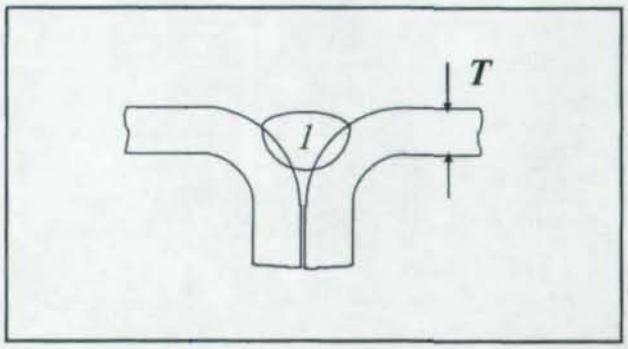
| Wall Size T | Side | Layer | Pass | Filler Metal Class | Filler Metal ∅ | Wire Feed Speed (ipm) | Amps. | Volts | Travel Speed (ipm) |
|---|---|---|---|---|---|---|---|---|---|
| *3/16* | *1* | *1* | *1* | *E7018* | *1/8* | *N/A* | *120* | - | *4.7* |
| | | | | | | | | | |
| | | | | | | | | | |

# PROCEDURE QUALIFICATION RECORD (PQR)

Company Name: **Walters Inc.**
Authorized By: Ken Kerluke
Welding Process(es): **SMAW**
Types: **Manual**
Date Welded: January 23, 2002

PQR No. 22
Welder's Name: John Williamson
Stamp Number: N/A
ArcScan ID #: 67, 68

| **Joint Design** | |
|---|---|
| Type | *Flare Vee Butt* |
| Single or Double Weld | *Single* |
| Backing | *None* |
| Backing Material | *N/A* |
| Back Gouging | *None* |
| Method | *N/A* |




## Base Metal:

| | | |
|---|---|---|
| Material Spec. | *A500* to | Material Spec. *A500* |
| Type or Grade | *C* to | Type or Grade *C* |
| Thickness | *3/16* | *3/16* |
| Diameter (Pipe) | | *N/A* |

## Filler Metals:

AWS Specification _____ *A5.1*
AWS Classification _____ *E7018*
Size of Filler Metal _____ *1/8*

## Heat Treatment: *None*

Temperature _____
Time _____

## Electrical Characteristics:

Current Type _____ *DC*
Mode of Metal Transfer (GMAW) _____ *N/A*
Polarity _____ *Positive*
Tungsten Electrode Size and Type _____ *None*

## Position:

Position of Groove: 3*G (vertical)*
Weld Progression: *Vertical Up*
Other _____

## Preheat:

Preheat Temperature: 70° ambient
Interpass Temperature _____
Other _____

| **Shielding Gas** | | | |
|---|---|---|---|
| | | % Comp. | |
| | Gas | (Mixture) | Flow Rate |
| Shielding: *None* | | | |
| Trailing: *None* | | | |
| Backing: *None* | | | |

| **Technique** | |
|---|---|
| String or Weave Bead | *String* |
| Oscillation | *None* |
| Multi-pass or Single Pass (per side) | *Single* |
| Gas Cup Size | *N/A* |
| Interpass Cleaning | *None* |
| Peening | *None* |
| Push or Drag Electrode Angle | *Push* |
| Contact Tube to Work Distance | *N/A* |

## Welding Data:

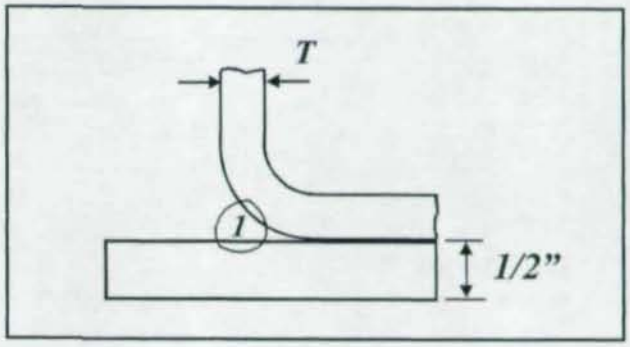
| Wall Size T | Side | Layer | Pass | Filler Metal Class | Filler Metal ∅ | Wire Feed Speed (ipm) | Amps. | Volts | Travel Speed (ipm) |
|---|---|---|---|---|---|---|---|---|---|
| *3/16* | *1* | *1* | *1* | *E7018* | *1/8* | *N/A* | *120* | - | *4.9* |
| | | | | | | | | | |
| | | | | | | | | | |

# PROCEDURE QUALIFICATION RECORD (PQR)

Company Name: **Walters Inc.**
Authorized By: Ken Kerluke
Welding Process(es): **SMAW**
Types: **Manual**
Date Welded: January 23, 2002

PQR No. 23
Welder's Name: John Williamson
Stamp Number: N/A
ArcScan ID#: 73, 74, 75

| **Joint Design** | |
|---|---|
| Type | *Flare Bevel Tee* |
| Single or Double Weld | *Single* |
| Backing | *None* |
| Backing Material | *N/A* |
| Back Gouging | *None* |
| Method | *N/A* |




## Base Metal:

Material Spec. *A500* to Material Spec. *G40.21*
Type or Grade *C* to Type or Grade *44W*
Thickness *3/16* *1/2*
Diameter (Pipe) *N/A*

## Position:

Position of Groove: *4G (overhead)*
Weld Progression:
Other _____

## Filler Metals:

AWS Specification _____ *A5.1*
AWS Classification _____ *E7018*
Size of Filler Metal _____ *1/8*

## Heat Treatment: *None*

Temperature _____
Time _____

## Preheat:

Preheat Temperature: 70° F ambient
Interpass Temperature _____
Other _____

## Electrical Characteristics:

Current Type _____ *DC*
Mode of Metal Transfer (GMAW) _____ *N/A*
Polarity _____ *Positive*
Tungsten Electrode Size and Type _____ *None*

| **Shielding Gas** | | | |
|---|---|---|---|
| | | % Comp. | |
| | Gas | (Mixture) | Flow Rate |
| Shielding: *None* | | | |
| Trailing: *None* | | | |
| Backing: *None* | | | |

| **Technique** | |
|---|---|
| String or Weave Bead | *String* |
| Oscillation | *None* |
| Multi-pass or Single Pass (per side) | *Single* |
| Gas Cup Size | *N/A* |
| Interpass Cleaning | *None* |
| Peening | *None* |
| Push or Drag Electrode Angle | *Drag* |
| Contact Tube to Work Distance | *N/A* |

## Welding Data:

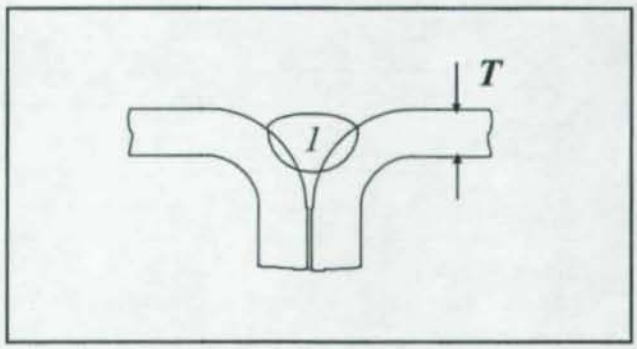
| Wall Size T | Side | Layer | Pass | Filler Metal Class | Filler Metal ∅ | Wire Feed Speed (ipm) | Amps. | Volts | Travel Speed (ipm) |
|---|---|---|---|---|---|---|---|---|---|
| *3/16* | *1* | *1* | *1* | *E7018* | *1/8* | *N/A* | *120* | - | *3.7* |
| | | | | | | | | | |
| | | | | | | | | | |

# PROCEDURE QUALIFICATION RECORD (PQR)

Company Name: **Walters Inc.**
Authorized By: Ken Kerluke
Welding Process(es): **SMAW**
Types: **Manual**
Date Welded: January 23, 2002

PQR No. 24
Welder's Name: John Williamson
Stamp Number: N/A
ArcScan ID #: 71, 72

| **Joint Design** | |
|---|---|
| Type | *Flare Vee Butt* |
| Single or Double Weld | *Single* |
| Backing | *None* |
| Backing Material | *N/A* |
| Back Gouging | *None* |
| Method | *N/A* |




## Base Metal:

| | | |
|---|---|---|
| Material Spec. *A500* | to | Material Spec. *A500* |
| Type or Grade *C* | to | Type or Grade *C* |
| Thickness *3/16* | | *3/16* |
| Diameter (Pipe) | | *N/A* |

## Filler Metals:

AWS Specification _____ *A5.1*
AWS Classification _____ *E7018*
Size of Filler Metal _____ *1/8*

## Heat Treatment: *None*

Temperature _____
Time _____

## Electrical Characteristics:

Current Type _____ *DC*
Mode of Metal Transfer (GMAW) _____ *N/A*
Polarity _____ *Positive*
Tungsten Electrode Size and Type _____ *None*

## Position:

Position of Groove: *4G (overhead)*
Weld Progression _____
Other _____

## Preheat:

Preheat Temperature: 70° ambient
Interpass Temperature _____
Other _____

| **Shielding Gas** | | | |
|---|---|---|---|
| | | % Comp. | |
| | Gas | (Mixture) | Flow Rate |
| Shielding: *None* | | | |
| Trailing: *None* | | | |
| Backing: *None* | | | |

| **Technique** | |
|---|---|
| String or Weave Bead | *String* |
| Oscillation | *None* |
| Multi-pass or Single Pass (per side) | *Single* |
| Gas Cup Size | *N/A* |
| Interpass Cleaning | *None* |
| Peening | *None* |
| Push or Drag Electrode Angle | *Drag* |
| Contact Tube to Work Distance | *N/A* |

## Welding Data:

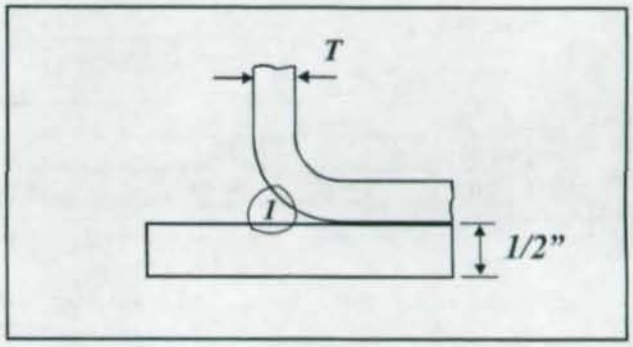
| Wall Size T | Side | Layer | Pass | Filler Metal Class | Filler Metal ∅ | Wire Feed Speed (ipm) | Amps. | Volts | Travel Speed (ipm) |
|---|---|---|---|---|---|---|---|---|---|
| *3/16* | *1* | *1* | *1* | *E7018* | *1/8* | *N/A* | *120* | - | *4.4* |
| | | | | | | | | | |
| | | | | | | | | | |

# PROCEDURE QUALIFICATION RECORD (PQR)

Company Name: **Walters Inc.**
Authorized By: Ken Kerluke
Welding Process(es): **FCAW-G**
Types: **Semi-automatic**
Date Welded: January 23, 2002

PQR No. 25
Welder's Name: John Williamson
Stamp Number: N/A
ArcScan ID # 134

| **Joint Design** | |
|---|---|
| Type | *Flare Bevel Tee* |
| Single or Double Weld | *Single* |
| Backing | *None* |
| Backing Material | *N/A* |
| Back Gouging | *None* |
| Method | *N/A* |




## Base Metal:

| | | |
|---|---|---|
| Material Spec. | *A500* to | Material Spec. *G40.21* |
| Type or Grade | *C* | Type or Grade *44W* |
| Thickness: | *1/4* | *1/2* |
| Diameter (Pipe) | | *N/A* |

## Filler Metals:

AWS Specification _____ *A5.20*
AWS Classification _____ *E71T-9 (O/S 71M)*
Size of Filler Metal _____ *1/16*

## Heat Treatment: *None*

Temperature _____
Time _____

## Electrical Characteristics:

Current Type _____ *DC*
Mode of Metal Transfer (GMAW) _____ *N/A*
Polarity _____ *Positive*
Tungsten Electrode Size and Type _____ *None*

## Position:

Position of Groove: *2G (horizontal)*
Weld Progression _____
Other _____

## Preheat:

Preheat Temperature: *70° F ambient*
Interpass Temperature _____
Other _____

| **Shielding Gas** | | | |
|---|---|---|---|
| | | % Comp. | |
| | Gas | (Mixture) | Flow Rate |
| Shielding: | $CO_2$ | *100%* | *35 cfh* |
| Trailing: *None* | | | |

| **Technique** | |
|---|---|
| String or Weave Bead | *String* |
| Oscillation | *None* |
| Multi-pass or Single Pass (per side) | *Single* |
| Gas Cup Size | *5/8" ∅* |
| Interpass Cleaning | *None* |
| Peening | *None* |
| Push or Drag Electrode Angle | *Drag* |
| Contact Tube to Work Distance | *3/4"* |

## Welding Data:

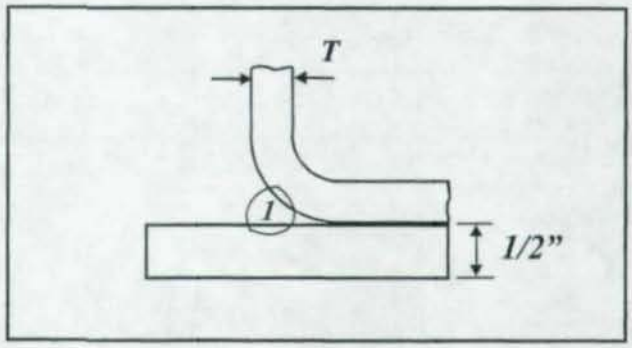
| Wall Size T | Side | Layer | Pass | Filler Metal Class | Filler Metal ∅ | Wire Feed Speed (ipm) | Amps. | Volts | Travel Speed (ipm) |
|---|---|---|---|---|---|---|---|---|---|
| *1/4* | *1* | *1* | *1* | *E71T-9* | *1/16* | *225* | *251* | *27.0* | *10.3* |
| | | | | | | | | | |
| | | | | | | | | | |

# PROCEDURE QUALIFICATION RECORD (PQR)

Company Name: **Walters Inc.**
Authorized By: Ken Kerluke
Welding Process(es): **FCAW-G**
Types: **Semi-automatic**
Date Welded: January 23, 2002

PQR No. 26
Welder's Name: John Williamson
Stamp Number: N/A
ArcScan ID # 126

| **Joint Design** | |
|---|---|
| Type | *Flare Bevel Tee* |
| Single or Double Weld | *Single* |
| Backing | *None* |
| Backing Material | *N/A* |
| Back Gouging | *None* |
| Method | *N/A* |




## Base Metal:

| | | |
|---|---|---|
| Material Spec. | *A500* to | Material Spec. *G40.21* |
| Type or Grade | *C* | Type or Grade *44W* |
| Thickness: | *1/4* | *1/2* |
| Diameter (Pipe) | | *N/A* |

## Filler Metals:

AWS Specification _____ *A5.20*
AWS Classification _____ *E71T-9 (O/S 71M)*
Size of Filler Metal _____ *1/16*

## Heat Treatment: *None*

Temperature _____
Time _____

## Electrical Characteristics:

Current Type _____ *DC*
Mode of Metal Transfer (GMAW) _____ *N/A*
Polarity _____ *Positive*
Tungsten Electrode Size and Type _____ *None*

## Position:

Position of Groove: *3G (vertical)*
Weld Progression: *Vertical Up*
Other _____

## Preheat:

Preheat Temperature: *70° F ambient*
Interpass Temperature _____
Other _____

| **Shielding Gas** | | | |
|---|---|---|---|
| | | % Comp. | |
| | Gas | (Mixture) | Flow Rate |
| Shielding: | *$CO_2$* | *100%* | *35 cfh* |
| Trailing: *None* | | | |

| **Technique** | |
|---|---|
| String or Weave Bead | *String* |
| Oscillation | *None* |
| Multi-pass or Single Pass (per side) | *Single* |
| Gas Cup Size | *5/8" Ø* |
| Interpass Cleaning | *None* |
| Peening | *None* |
| Push or Drag Electrode Angle | *0°* |
| Contact Tube to Work Distance | *3/4"* |

## Welding Data:

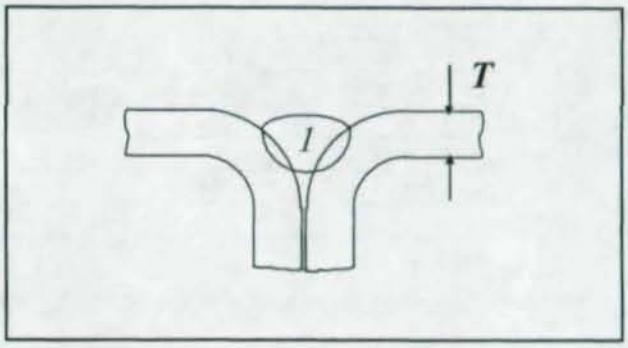
| Wall Size T | Side | Layer | Pass | Filler Metal Class | Filler Metal Ø | Wire Feed Speed (ipm) | Amps. | Volts | Travel Speed (ipm) |
|---|---|---|---|---|---|---|---|---|---|
| *1/4* | *1* | *1* | *1* | *E71T-9* | *1/16* | *157* | *200* | *21.0* | *5.4* |
| | | | | | | | | | |
| | | | | | | | | | |

# PROCEDURE QUALIFICATION RECORD (PQR)

Company Name: **Walters Inc.**
Authorized By: Ken Kerluke
Welding Process(es): **FCAW-G**
Types: **Semi-automatic**
Date Welded: January 23, 2002

PQR No. 27
Welder's Name: John Williamson
Stamp Number: N/A
ArcScan ID# 133

| **Joint Design** | |
|---|---|
| Type | *Flare Vee Butt* |
| Single or Double Weld | *Single* |
| Backing | *None* |
| Backing Material | *N/A* |
| Back Gouging | *None* |
| Method | *N/A* |




## Base Metal:

Material Spec. *A500* to Material Spec. *A500*
Type or Grade *C* Type or Grade *C*
Thickness: *1/4* *1/4*
Diameter (Pipe) *N/A*

## Filler Metals:

AWS Specification _____ *A5.20*
AWS Classification _____ *E71T-9 (O/S 71M)*
Size of Filler Metal _____ *1/16*

## Heat Treatment:

*None*
Temperature _____
Time _____

## Electrical Characteristics:

Current Type _____ *DC*
Mode of Metal Transfer (GMAW) _____ *N/A*
Polarity _____ *Positive*
Tungsten Electrode Size and Type _____ *None*

## Position:

Position of Groove: *1G (flat)*
Weld Progression _____
Other _____

## Preheat:

Preheat Temperature: 70° F ambient
Interpass Temperature _____
Other _____

| **Shielding Gas** | | | |
|---|---|---|---|
| | | % Comp. | |
| | Gas | (Mixture) | Flow Rate |
| Shielding: | *$CO_2$* | *100%* | *35 cfh* |
| Trailing: None | - | - | - |

| **Technique:** | |
|---|---|
| String or Weave Bead | *String* |
| Oscillation | *None* |
| Multi-pass or Single Pass (per side) | *Single* |
| Gas Cup Size | *5/8" Ø* |
| Interpass Cleaning | *None* |
| Peening | *None* |
| Push or Drag Electrode Angle | *Drag* |
| Contact Tube to Work Distance | *3/4"* |

## Welding Data:

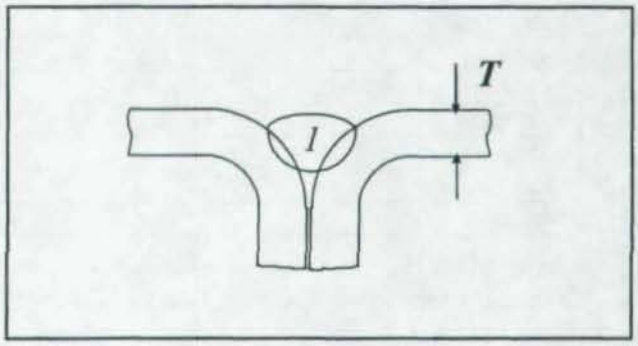
| Wall Size T | Side | Layer | Pass | Filler Metal Class | Filler Metal Ø | Wire Feed Speed (ipm) | Amps. | Volts | Travel Speed (ipm) |
|---|---|---|---|---|---|---|---|---|---|
| *1/4* | *1* | *1* | *1* | *E71T-9* | *1/16* | *225* | *244* | *27.0* | *10.8* |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |

# PROCEDURE QUALIFICATION RECORD (PQR)

Company Name: **Walters Inc.**
Authorized By: Ken Kerluke
Welding Process(es): **FCAW-G**
Types: **Semi-automatic**
Date Welded: January 23, 2002

PQR No. 28
Welder's Name: John Williamson
Stamp Number: N/A
ArcScan ID# 125

| **Joint Design** | |
|---|---|
| Type | *Flare Vee Butt* |
| Single or Double Weld | *Single* |
| Backing | *None* |
| Backing Material | *N/A* |
| Back Gouging | *None* |
| Method | *N/A* |




## Base Metal:

| | | | |
|---|---|---|---|
| Material Spec. | *A500* | to | Material Spec. *A500* |
| Type or Grade | *C* | | Type or Grade *C* |
| Thickness: | *1/4* | | *1/4* |
| Diameter (Pipe) | | | *N/A* |

## Filler Metals:

AWS Specification _____ *A5.20*
AWS Classification _____ *E71T-9 (O/S 71M)*
Size of Filler Metal _____ *1/16*

## Heat Treatment:

*None*
Temperature _____
Time _____

## Electrical Characteristics:

Current Type _____ *DC*
Mode of Metal Transfer (GMAW) _____ *N/A*
Polarity _____ *Positive*
Tungsten Electrode Size and Type _____ *None*

## Position:

Position of Groove: *3G (vertical)*
Weld Progression: *Vertical Up*
Other _____

## Preheat:

Preheat Temperature: 70° F ambient
Interpass Temperature _____
Other _____

| **Shielding Gas** | | | |
|---|---|---|---|
| | | % Comp. | |
| | Gas | (Mixture) | Flow Rate |
| Shielding: | *$CO_2$* | *100%* | *35 cfh* |
| Trailing: None | - | - | - |

| **Technique:** | |
|---|---|
| String or Weave Bead | *String* |
| Oscillation | *None* |
| Multi-pass or Single Pass (per side) | *Single* |
| Gas Cup Size | *5/8" Ø* |
| Interpass Cleaning | *None* |
| Peening | *None* |
| Push or Drag Electrode Angle | *5° Push* |
| Contact Tube to Work Distance | *3/4"* |

## Welding Data:

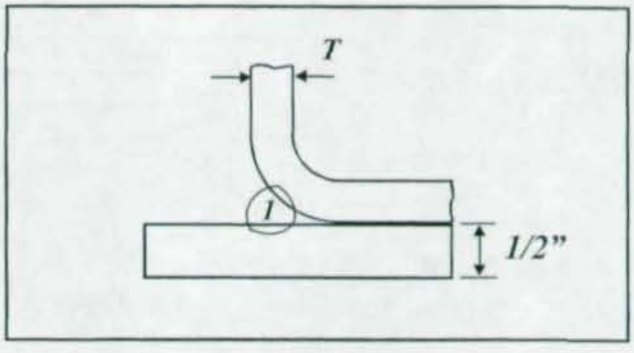
| Wall Size T | Side | Layer | Pass | Filler Metal Class | Filler Metal Ø | Wire Feed Speed (ipm) | Amps. | Volts | Travel Speed (ipm) |
|---|---|---|---|---|---|---|---|---|---|
| *1/4* | *1* | *1* | *1* | *E71T-9* | *1/16* | *157* | *197* | *21.0* | *6.8* |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |

# PROCEDURE QUALIFICATION RECORD (PQR)

Company Name: **Walters Inc.**
Authorized By: Ken Kerluke
Welding Process(es): **FCAW-G**
Types: **Semi-automatic**
Date Welded: January 23, 2002

PQR No. 29
Welder's Name: John Williamson
Stamp Number: N/A
ArcScan ID # 154

| **Joint Design** | |
|---|---|
| Type | *Flare Bevel Tee* |
| Single or Double Weld | *Single* |
| Backing | *None* |
| Backing Material | *N/A* |
| Back Gouging | *None* |
| Method | *N/A* |




## Base Metal:

Material Spec. *A500* to Material Spec. *G40.21*
Type or Grade *C* Type or Grade *44W*
Thickness: *1/4* *1/2*
Diameter (Pipe) *N/A*

## Position:

Position of Groove: *4G (overhead)*
Weld Progression _____
Other _____

## Filler Metals:

AWS Specification _____ *A5.20*
AWS Classification _____ *E71T-9 (O/S 71M)*
Size of Filler Metal _____ *1/16*

## Heat Treatment:

*None*

Temperature _____
Time _____

## Preheat:

Preheat Temperature: *70° F ambient*
Interpass Temperature _____
Other _____

## Electrical Characteristics:

Current Type _____ *DC*
Mode of Metal Transfer (GMAW) _____ *N/A*
Polarity _____ *Positive*
Tungsten Electrode Size and Type _____ *None*

| **Shielding Gas** | | | |
|---|---|---|---|
| | | % Comp. | |
| | Gas | (Mixture) | Flow Rate |
| Shielding: | $CO_2$ | *100%* | *35 cfh* |
| Trailing: *None* | | | |

| **Technique** | |
|---|---|
| String or Weave Bead | *String* |
| Oscillation | *None* |
| Multi-pass or Single Pass (per side) | *Single* |
| Gas Cup Size | *5/8" ∅* |
| Interpass Cleaning | *None* |
| Peening | *None* |
| Push or Drag Electrode Angle | *Drag* |
| Contact Tube to Work Distance | *3/4"* |

## Welding Data:

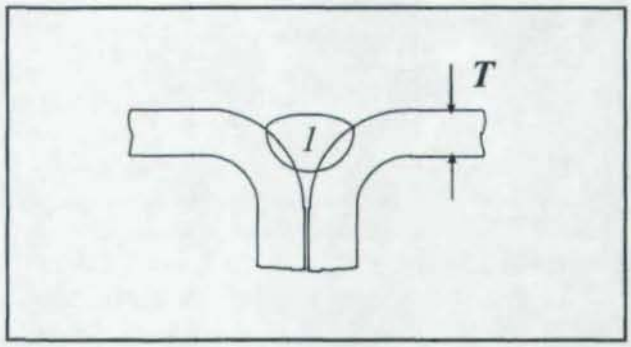
| Wall Size T | Side | Layer | Pass | Filler Metal Class | Filler Metal ∅ | Wire Feed Speed (ipm) | Amps. | Volts | Travel Speed (ipm) |
|---|---|---|---|---|---|---|---|---|---|
| *1/4* | *1* | *1* | *1* | *E71T-9* | *1/16* | *175* | *208* | *24.5* | *7.8* |
| | | | | | | | | | |
| | | | | | | | | | |

# PROCEDURE QUALIFICATION RECORD (PQR)

Company Name: **Walters Inc.**
Authorized By: Ken Kerluke
Welding Process(es): **FCAW-G**
Types: **Semi-automatic**
Date Welded: January 23, 2002

PQR No. 30
Welder's Name: John Williamson
Stamp Number: N/A
ArcScan ID# 147

| **Joint Design** | |
|---|---|
| Type | *Flare Vee Butt* |
| Single or Double Weld | *Single* |
| Backing | *None* |
| Backing Material | *N/A* |
| Back Gouging | *None* |
| Method | *N/A* |




## Base Metal:

| | | | |
|---|---|---|---|
| Material Spec. | *A500* to | Material Spec. | *A500* |
| Type or Grade | *C* | Type or Grade | *C* |
| Thickness: | *1/4* | | *1/4* |
| Diameter (Pipe) | | | *N/A* |

## Filler Metals:

AWS Specification _____ *A5.20*
AWS Classification _____ *E71T-9 (O/S 71M)*
Size of Filler Metal _____ *1/16*

## Heat Treatment: *None*

Temperature _____
Time _____

## Electrical Characteristics:

Current Type _____ *DC*
Mode of Metal Transfer (GMAW) _____ *N/A*
Polarity _____ *Positive*
Tungsten Electrode Size and Type _____ *None*

## Position:

Position of Groove: *4G (overhead)*
Weld Progression _____
Other _____

## Preheat:

Preheat Temperature: 70° F ambient
Interpass Temperature _____
Other _____

| **Shielding Gas** | | | |
|---|---|---|---|
| | | % Comp. | |
| | Gas | (Mixture) | Flow Rate |
| Shielding: | $CO_2$ | *100%* | *35 cfh* |
| Trailing: None | - | - | - |

| **Technique:** | |
|---|---|
| String or Weave Bead | *String* |
| Oscillation | *None* |
| Multi-pass or Single Pass (per side) | *Single* |
| *Gas Cup Size* | *5/8" ∅* |
| Interpass Cleaning | *None* |
| Peening | *None* |
| Push or Drag Electrode Angle | *Drag* |
| Contact Tube to Work Distance | *5/8"* |

## Welding Data:

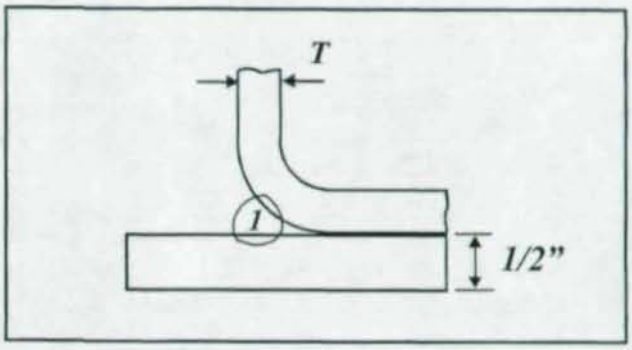
| Wall Size T | Side | Layer | Pass | Filler Metal Class | Filler Metal ∅ | Wire Feed Speed (ipm) | Amps. | Volts | Travel Speed (ipm) |
|---|---|---|---|---|---|---|---|---|---|
| *1/4* | *1* | *1* | *1* | *E71T-9* | *1/16* | *175* | *215* | *24.0* | *7.2* |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |

# PROCEDURE QUALIFICATION RECORD (PQR)

Company Name: **Walters Inc.**
Authorized By: Ken Kerluke
Welding Process(es): **FCAW-S**
Types: **Semi-automatic**
Date Welded: January 23, 2002

PQR No. 31
Welder's Name: John Williamson
Stamp Number: N/A
ArcScan ID# N/A

| **Joint Design** | |
|---|---|
| Type | *Flare Bevel Tee* |
| Single or Double Weld | *Single* |
| Backing | *None* |
| Backing Material | *N/A* |
| Back Gouging | *None* |
| Method | *N/A* |




## Base Metal:

Material Spec. *A500* to Material Spec. *G40.21*
Type or Grade *C* to Type or Grade *44W*
Thickness *1/4* *1/2*
Diameter (Pipe) *N/A*

## Filler Metals:

AWS Specification _____ *A5.20*
AWS Classification _____ *E71T-8 (NR-232)*
Size of Filler Metal _____ *0.072*

## Heat Treatment:

*None*
Temperature _____
Time _____

## Position:

Position of Groove: *2G (horizontal)*
Weld Progression _____
Other _____

## Preheat:

Preheat Temperature: *70° F ambient*
Interpass Temperature _____
Other _____

## Electrical Characteristics:

Current Type _____ *DC*
Mode of Metal Transfer (GMAW) _____ *N/A*
Polarity _____ *Negative*
Tungsten Electrode Size and Type _____ *None*

| **Shielding Gas** | | | |
|---|---|---|---|
| | | % Comp. | |
| | Gas | (Mixture) | Flow Rate |
| Shielding: *None* | - | - | - |
| Trailing: *None* | - | - | - |

| **Technique** | |
|---|---|
| String or Weave Bead | *String* |
| Oscillation | *None* |
| Multi-pass or Single Pass (per side) | *Single* |
| Gas Cup Size | *N/A* |
| Interpass Cleaning | *None* |
| Peening | *None* |
| Push or Drag Electrode Angle | *Drag* |
| Contact Tube to Work Distance | *3/4"* |

## Welding Data:

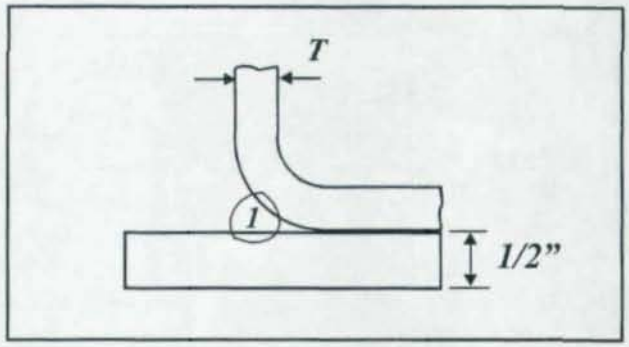
| Wall Size T | Side | Layer | Pass | Filler Metal Class | Filler Metal ∅ | Wire Feed Speed (ipm) | Amps. | Volts | Travel Speed (ipm) |
|---|---|---|---|---|---|---|---|---|---|
| *1/4* | *1* | *1* | *1* | *E71T-8* | *0.072* | *173* | *237* | *21.0* | *9.0* |
| | | | | | | | | | |
| | | | | | | | | | |

# PROCEDURE QUALIFICATION RECORD (PQR)

Company Name: **Walters Inc.**
Authorized By: Ken Kerluke
Welding Process(es): **FCAW-S**
Types: **Semi-automatic**
Date Welded: January 23, 2002

PQR No. 32
Welder's Name: John Williamson
Stamp Number: N/A
ArcScan ID# N/A

| **Joint Design** | |
|---|---|
| Type | *Flare Bevel Tee* |
| Single or Double Weld | *Single* |
| Backing | *None* |
| Backing Material | *N/A* |
| Back Gouging | *None* |
| Method | *N/A* |




## Base Metal:

| | | |
|---|---|---|
| Material Spec. *A500* | to | Material Spec. *G40.21* |
| Type or Grade *C* | to | Type or Grade *44W* |
| Thickness *1/4* | | *1/2* |
| Diameter (Pipe) | | *N/A* |

## Filler Metals:

AWS Specification _____ *A5.20*
AWS Classification _____ *E71T-8 (NR-232)*
Size of Filler Metal _____ *0.072*

## Heat Treatment: *None*

Temperature _____
Time _____

## Position:

Position of Groove: 3*G (vertical)*
Weld Progression: *Vertical Up*
Other _____

## Preheat:

Preheat Temperature: *70° F ambient*
Interpass Temperature _____
Other _____

## Electrical Characteristics:

Current Type _____ *DC*
Mode of Metal Transfer (GMAW) _____ *N/A*
Polarity _____ *Negative*
Tungsten Electrode Size and Type _____ *None*

| **Shielding Gas** | | | |
|---|---|---|---|
| | | % Comp. | |
| | Gas | (Mixture) | Flow Rate |
| Shielding: *None* | - | - | - |
| Trailing: *None* | - | - | - |

| **Technique** | |
|---|---|
| String or Weave Bead | *Weave* |
| Oscillation | *None* |
| Multi-pass or Single Pass (per side) | *Single* |
| Gas Cup Size | *N/A* |
| Interpass Cleaning | *None* |
| Peening | *None* |
| Push or Drag Electrode Angle | *0°* |
| Contact Tube to Work Distance | *1/2"* |

## Welding Data:

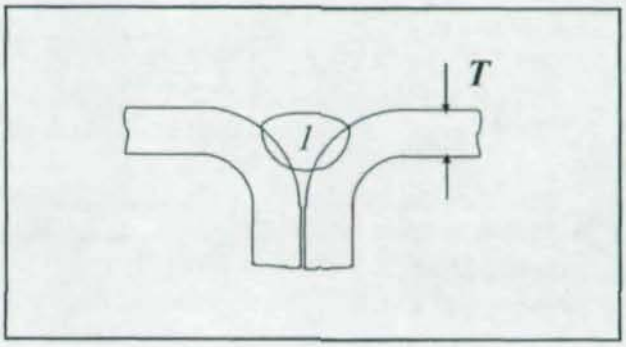
| Wall Size T | Side | Layer | Pass | Filler Metal Class | Filler Metal ∅ | Wire Feed Speed (ipm) | Amps. | Volts | Travel Speed (ipm) |
|---|---|---|---|---|---|---|---|---|---|
| *1/4* | *1* | *1* | *1* | *E71T-8* | *0.072* | *115* | *180* | *17.5* | *3.6* |
| | | | | | | | | | |
| | | | | | | | | | |

# PROCEDURE QUALIFICATION RECORD (PQR)

Company Name: **Walters Inc.**
Authorized By: Ken Kerluke
Welding Process(es): **FCAW-S**
Types: **Semi-automatic**
Date Welded: January 23, 2002

PQR No. 33
Welder's Name: John Williamson
Stamp Number: N/A
ArcScan ID # N/A

| **Joint Design** | |
|---|---|
| Type | *Flare Vee Butt* |
| Single or Double Weld | *Single* |
| Backing | *None* |
| Backing Material | *N/A* |
| Back Gouging | *None* |
| Method | *N/A* |




## Base Metal:

| | | |
|---|---|---|
| Material Spec. *A500* | to | Material Spec. *A500* |
| Type or Grade *C* | to | Type or Grade *C* |
| Thickness *1/4* | | *1/4* |
| Diameter (Pipe) | | *N/A* |

## Position:

Position of Groove: *1G (flat)*
Weld Progression _____
Other _____

## Filler Metals:

AWS Specification _____ *A5.20*
AWS Classification _____ *E71T-8 (NR 232)*
Size of Filler Metal _____ *0.072*

## Preheat:

Preheat Temperature: *70° F ambient*
Interpass Temperature _____
Other _____

## Heat Treatment:

*None*
Temperature _____
Time _____

| **Shielding Gas** | | | |
|---|---|---|---|
| | | % Comp. | |
| | Gas | (Mixture) | Flow Rate |
| Shielding: None | - | - | - |
| Trailing: None | - | - | - |

## Electrical Characteristics:

*Current Type* _____ *DC*
Mode of Metal Transfer (GMAW) _____ *N/A*
Polarity _____ *Negative*
Tungsten Electrode Size and Type _____ *None*

| **Technique:** | |
|---|---|
| String or Weave Bead | *String* |
| Oscillation | *None* |
| Multi-pass or Single Pass (per side) | *Single* |
| Gas Cup Size | *N/A* |
| Interpass Cleaning | *None* |
| Peening | *None* |
| Push or Drag Electrode Angle | *Push* |
| Contact Tube to Work Distance | *3/4"* |

## Welding Data:

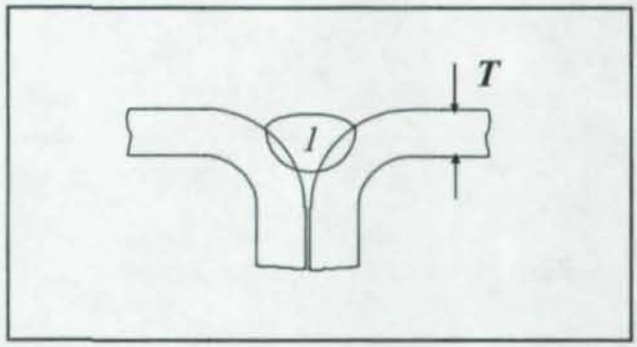
| Wall Size T | Side | Layer | Pass | Filler Metal Class | Filler Metal ∅ | Wire Feed Speed (ipm) | Amps. | Volts | Travel Speed (ipm) |
|---|---|---|---|---|---|---|---|---|---|
| *1/4* | *1* | *1* | *1* | *E71T-8* | *0.072* | *173* | *237* | *22.0* | *11.8* |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |

# PROCEDURE QUALIFICATION RECORD (PQR)

Company Name: **Walters Inc.**
Authorized By: Ken Kerluke
Welding Process(es): **FCAW-S**
Types: **Semi-automatic**
Date Welded: January 23, 2002

PQR No. 34
Welder's Name: John Williamson
Stamp Number: N/A
ArcScan ID # 177

| **Joint Design** | |
|---|---|
| Type | *Flare Vee Butt* |
| Single or Double Weld | *Single* |
| Backing | *None* |
| Backing Material | *N/A* |
| Back Gouging | *None* |
| Method | *N/A* |




## Base Metal:

| | | |
|---|---|---|
| Material Spec. *A500* | to | Material Spec. *A500* |
| Type or Grade *C* | to | Type or Grade *C* |
| Thickness *1/4* | | *1/4* |
| Diameter (Pipe) | | *N/A* |

## Filler Metals:

AWS Specification _____ *A5.20*
AWS Classification _____ *E71T-8 (NR 232)*
Size of Filler Metal _____ *0.072*

## Heat Treatment:

*None*
Temperature _____
Time _____

## Position:

Position of Groove: *3G (vertical)*
Weld Progression: *Vertical Up*
Other _____

## Preheat:

Preheat Temperature: *70° F ambient*
Interpass Temperature _____
Other _____

## Electrical Characteristics:

Current Type _____ *DC*
Mode of Metal Transfer (GMAW) _____ *N/A*
Polarity _____ *Negative*
Tungsten Electrode Size and Type _____ *None*

| **Shielding Gas** | | | |
|---|---|---|---|
| | | % Comp. | |
| | Gas | (Mixture) | Flow Rate |
| Shielding: None | - | - | - |
| Trailing: None | - | - | - |

| **Technique:** | |
|---|---|
| String or Weave Bead | *Weave* |
| Oscillation | *None* |
| Multi-pass or Single Pass (per side) | *Single* |
| Gas Cup Size | *N/A* |
| Interpass Cleaning | *None* |
| Peening | *None* |
| Push or Drag Electrode Angle | *0°* |
| Contact Tube to Work Distance | *1/2"* |

## Welding Data:

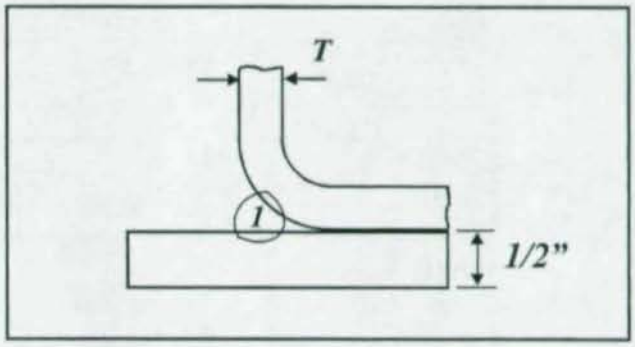
| Wall Size T | Side | Layer | Pass | Filler Metal Class | Filler Metal ∅ | Wire Feed Speed (ipm) | Amps. | Volts | Travel Speed (ipm) |
|---|---|---|---|---|---|---|---|---|---|
| *1/4* | *1* | *1* | *1* | *E71T-8* | *0.072* | *115* | *180* | *17.5* | *3.5* |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |

# PROCEDURE QUALIFICATION RECORD (PQR)

Company Name: **Walters Inc.**
Authorized By: Ken Kerluke
Welding Process(es): **FCAW-S**
Types: **Semi-automatic**
Date Welded: January 23, 2002

PQR No. 35
Welder's Name: John Williamson
Stamp Number: N/A
ArcScan ID# N/A

| **Joint Design** | |
|---|---|
| Type | *Flare Bevel Tee* |
| Single or Double Weld | *Single* |
| Backing | *None* |
| Backing Material | *N/A* |
| Back Gouging | *None* |
| Method | *N/A* |




## Base Metal:

| | | |
|---|---|---|
| Material Spec. *A500* | to | Material Spec. *G40.21* |
| Type or Grade *C* | to | Type or Grade *44W* |
| Thickness *1/4* | | *1/2* |
| Diameter (Pipe) | | *N/A* |

## Filler Metals:

AWS Specification _____ *A5.20*
AWS Classification _____ *E71T-8 (NR-232)*
Size of Filler Metal _____ *0.072*

## Heat Treatment:

*None*
Temperature _____
Time _____

## Position:

Position of Groove: *4G (overhead)*
Weld Progression _____
Other _____

## Preheat:

Preheat Temperature: *70° F ambient*
Interpass Temperature _____
Other _____

## Electrical Characteristics:

Current Type _____ *DC*
Mode of Metal Transfer (GMAW) _____ *N/A*
Polarity _____ *Negative*
Tungsten Electrode Size and Type _____ *None*

| **Shielding Gas** | | | |
|---|---|---|---|
| | | % Comp. | |
| | Gas | (Mixture) | Flow Rate |
| Shielding: *None* | - | - | - |
| Trailing: *None* | - | - | - |

| **Technique** | |
|---|---|
| String or Weave Bead | *String* |
| Oscillation | *None* |
| Multi-pass or Single Pass (per side) | *Single* |
| Gas Cup Size | *N/A* |
| Interpass Cleaning | *None* |
| Peening | *None* |
| Push or Drag Electrode Angle | *Drag* |
| Contact Tube to Work Distance | *1/2"* |

## Welding Data:

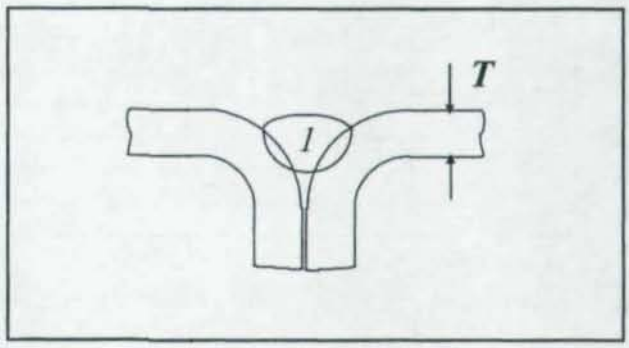
| Wall Size T | Side | Layer | Pass | Filler Metal Class | Filler Metal ∅ | Wire Feed Speed (ipm) | Amps. | Volts | Travel Speed (ipm) |
|---|---|---|---|---|---|---|---|---|---|
| *1/4* | *1* | *1* | *1* | *E71T-8* | *0.072* | *153* | *225* | *20.0* | *6.6* |
| | | | | | | | | | |
| | | | | | | | | | |

# PROCEDURE QUALIFICATION RECORD (PQR)

Company Name: **Walters Inc.**
Authorized By: Ken Kerluke
Welding Process(es): **FCAW-S**
Types: **Semi-automatic**
Date Welded: January 23, 2002

PQR No. 36
Welder's Name: John Williamson
Stamp Number: N/A
ArcScan ID # N/A

| **Joint Design** | |
|---|---|
| Type | *Flare Vee Butt* |
| Single or Double Weld | *Single* |
| Backing | *None* |
| Backing Material | *N/A* |
| Back Gouging | *None* |
| Method | *N/A* |




## Base Metal:

| | | |
|---|---|---|
| Material Spec. | *A500* to | Material Spec. *A500* |
| Type or Grade | *C* to | Type or Grade *C* |
| Thickness | *1/4* | *1/4* |
| Diameter (Pipe) | | *N/A* |

## Filler Metals:

AWS Specification _____ *A5.20*
AWS Classification _____ *E71T-8 (NR 232)*
Size of Filler Metal _____ *0.072*

## Heat Treatment:

*None*
Temperature _____
Time _____

## Position:

Position of Groove: *4G (overhead)*
Weld Progression _____
Other _____

## Preheat:

Preheat Temperature: *70°F ambient*
Interpass Temperature _____
Other _____

## Electrical Characteristics:

Current Type _____ *DC*
Mode of Metal Transfer (GMAW) _____ *N/A*
Polarity _____ *Negative*
Tungsten Electrode Size and Type _____ *None*

| **Shielding Gas** | | | |
|---|---|---|---|
| | | % Comp. | |
| | Gas | (Mixture) | Flow Rate |
| Shielding: None | - | - | - |
| Trailing: None | - | - | - |

| **Technique:** | |
|---|---|
| String or Weave Bead | *String* |
| Oscillation | *None* |
| Multi-pass or Single Pass (per side) | *Single* |
| Gas Cup Size | *N/A* |
| Interpass Cleaning | *None* |
| Peening | *None* |
| Push or Drag Electrode Angle | *Drag* |
| Contact Tube to Work Distance | *1/2"* |

## Welding Data:

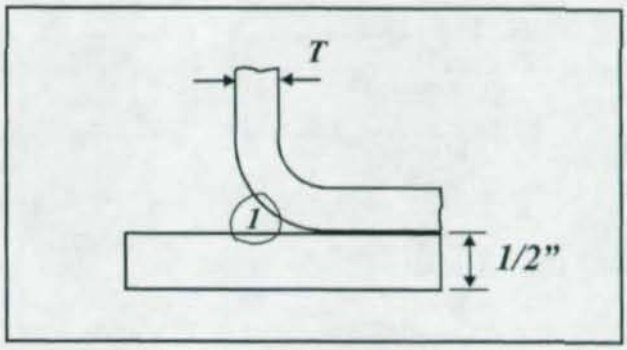
| Wall Size T | Side | Layer | Pass | Filler Metal Class | Filler Metal Ø | Wire Feed Speed (ipm) | Amps. | Volts | Travel Speed (ipm) |
|---|---|---|---|---|---|---|---|---|---|
| *1/4* | *1* | *1* | *1* | *E71T-8* | *0.072* | *153* | *225* | *20.0* | *6.3* |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |

# PROCEDURE QUALIFICATION RECORD (PQR)

Company Name: **Walters Inc.**
Authorized By: Ken Kerluke
Welding Process(es): **GMAW**
Types: **Semi-automatic**
Date Welded: January 23, 2002

PQR No. 37
Welder's Name: John Williamson
Stamp Number: N/A
ArcScan ID# 101

| **Joint Design** | |
|---|---|
| Type | *Flare Bevel Tee* |
| Single or Double Weld | *Single* |
| Backing | *None* |
| Backing Material | *N/A* |
| Back Gouging | *None* |
| Method | *N/A* |




## Base Metal:

| | | |
|---|---|---|
| Material Spec. | *A500* | to Material Spec. *G40.21* |
| Type or Grade | *C* | to Type or Grade *44W* |
| Thickness | *1/4* | *1/2* |
| Diameter (Pipe) | | *N/A* |

## Filler Metals:

AWS Specification _____ *A5.18*
AWS Classification _____ *E70S-6*
Size of Filler Metal _____ *0.045*

## Heat Treatment:

Preheat Temperature: *70°F ambient*
Temperature _____ *None*
Time _____

## Position:

Position of Groove: *2G (horizontal)*
Weld Progression:
Other _____

**Preheat:** Interpass Temperature _____
Other _____

## Electrical Characteristics:

Current Type _____ *DC*
Mode of Metal Transfer (GMAW) _____ *Spray*
Polarity _____ *Positive*
Tungsten Electrode Size and Type _____ *None*

| **Shielding Gas** | | | |
|---|---|---|---|
| | | % Comp. | |
| | Gas | (Mixture) | Flow |
| Shielding: | *C-10* | *90% Ar 10-% $CO_2$* | *35 cfh* |
| Trailing: *None* | | | |

| **Technique** | |
|---|---|
| String or Weave Bead | *String* |
| Oscillation | *None* |
| Multi-pass or Single Pass (per side) | *Single* |
| Gas Cup Size | *5/8" Ø* |
| Interpass Cleaning | *None* |
| Peening | *None* |
| Push or Drag Electrode Angle | *Push* |
| Contact Tube to Work Distance | *5/8"* |

## Welding Data:

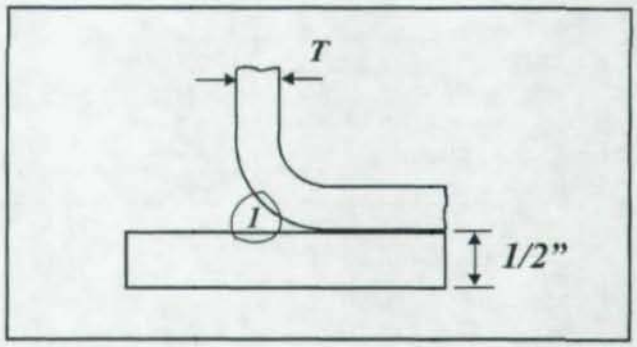
| Wall Size T | Side | Layer | Pass | Filler Metal Class | Filler Metal Ø | Wire Feed Speed (ipm) | Amps. | Volts | Travel Speed (ipm) |
|---|---|---|---|---|---|---|---|---|---|
| *1/4* | *1* | *1* | *1* | *E70S-6* | *0.045* | *330* | *206* | *26.8* | *7.8* |
| | | | | | | | | | |
| | | | | | | | | | |

# PROCEDURE QUALIFICATION RECORD (PQR)

Company Name: **Walters Inc.**
Authorized By: Ken Kerluke
Welding Process(es): **GMAW**
Types: **Semi-automatic**
Date Welded: January 23, 2002

PQR No. 38
Welder's Name: John Williamson
Stamp Number: N/A
ArcScan ID# 104

| **Joint Design** | |
|---|---|
| Type | *Flare Bevel Tee* |
| Single or Double Weld | *Single* |
| Backing | *None* |
| Backing Material | *N/A* |
| Back Gouging | *None* |
| Method | *N/A* |




## Base Metal:

| | | |
|---|---|---|
| Material Spec. | *A500* to | Material Spec. *G40.21* |
| Type or Grade | *C* to | Type or Grade *44W* |
| Thickness | *1/4* | *1/2* |
| Diameter (Pipe) | | *N/A* |

## Filler Metals:

AWS Specification _____ *A5.18*
AWS Classification _____ *E70S-6*
Size of Filler Metal _____ *0.045*

## Heat Treatment:

Preheat Temperature: *70°F ambient* *None*
Temperature _____
Time _____

## Position:

Position of Groove: *3G (vertical)*
Weld Progression: *Vertical Down*
Other _____

## Preheat:

Interpass Temperature _____
Other _____

## Electrical Characteristics:

Current Type _____ *DC*
Mode of Metal Transfer (GMAW) _____ *Spray*
Polarity _____ *Positive*
Tungsten Electrode Size and Type _____ *None*

| **Shielding Gas** | | | |
|---|---|---|---|
| | | % Comp. | |
| | Gas | (Mixture) | Flow |
| Shielding: | *C-10* | *90% Ar 10-% $CO_2$* | *35 cfh* |
| Trailing: *None* | | | |

| **Technique** | |
|---|---|
| String or Weave Bead | *String* |
| Oscillation | *None* |
| Multi-pass or Single Pass (per side) | *Single* |
| Gas Cup Size | *5/8" Ø* |
| Interpass Cleaning | *None* |
| Peening | *None* |
| Push or Drag Electrode Angle | *Drag* |
| Contact Tube to Work Distance | *1/2"* |

## Welding Data:

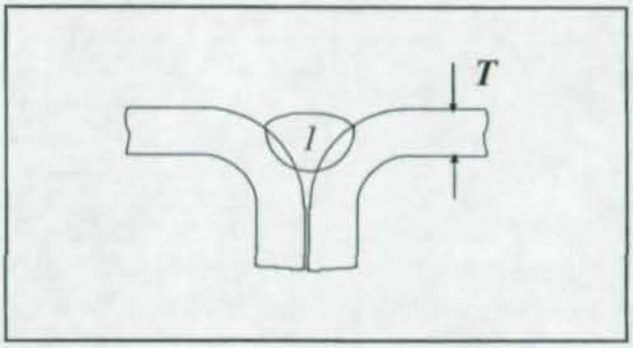
| Wall Size T | Side | Layer | Pass | Filler Metal Class | Filler Metal Ø | Wire Feed Speed (ipm) | Amps. | Volts | Travel Speed (ipm) |
|---|---|---|---|---|---|---|---|---|---|
| *1/4* | *1* | *1* | *1* | *E70S-6* | *0.045* | *330* | *255* | *24.6* | *12.6* |
| | | | | | | | | | |
| | | | | | | | | | |

# PROCEDURE QUALIFICATION RECORD (PQR)

Company Name: **Walters Inc.**
Authorized By: Ken Kerluke
Welding Process(es): **GMAW**
Types: **Semi-automatic**
Date Welded: January 23, 2002

PQR No. 39
Welder's Name: John Williamson
Stamp Number: N/A
ArcScan ID# 100

| **Joint Design** | |
|---|---|
| Type | *Flare Vee Butt* |
| Single or Double Weld | *Single* |
| Backing | *None* |
| Backing Material | *N/A* |
| Back Gouging | *None* |
| Method | *N/A* |




## Base Metal:

| | | |
|---|---|---|
| Material Spec. | *A500* to | Material Spec. *A500* |
| Type or Grade | *C* to | Type or Grade *C* |
| Thickness | *1/4* | *1/4* |
| Diameter (Pipe) | | *N/A* |

## Filler Metals:

AWS Specification _____ *A5.18*
AWS Classification _____ *E70S-6*
Size of Filler Metal _____ *0.045*

## Heat Treatment: *None*

Temperature _____
Time _____

## Position:

Position of Groove: *1G (flat)*
Weld Progression _____
Other _____

## Preheat:

Preheat Temperature: *70° F ambient*
Interpass Temperature _____
Other _____

## Electrical Characteristics:

Current Type _____ *DC*
Mode of Metal Transfer (GMAW) _____ *Spray*
Polarity _____ *Positive*
Tungsten Electrode Size and Type _____ *None*

| **Shielding Gas** | | | |
|---|---|---|---|
| | | % Comp. | |
| | Gas | (Mixture) | Flow |
| Shielding: | *C-10* | *90% Ar 10-% $CO_2$* | *35 cfh* |
| Trailing: None | | | |

| **Technique:** | |
|---|---|
| String or Weave Bead | *String* |
| Oscillation | *None* |
| Multi-pass or Single Pass (per side) | *Single* |
| Gas Cup Size | *5/8" Ø* |
| Interpass Cleaning | *None* |
| Peening | *None* |
| Push or Drag Electrode Angle | *Push* |
| Contact Tube to Work Distance | *5/8"* |

## Welding Data:

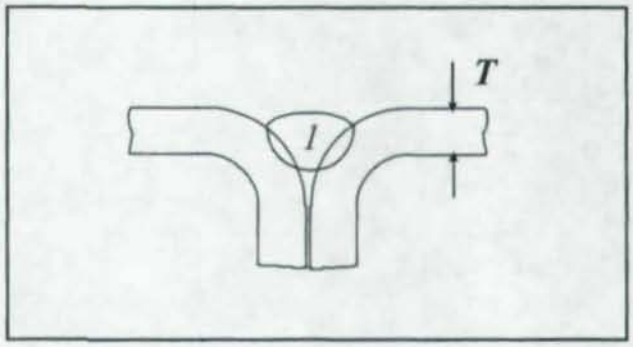
| Wall Size T | Side | Layer | Pass | Filler Metal Class | Filler Metal Ø | Wire Feed Speed (ipm) | Amps. | Volts | Travel Speed (ipm) |
|---|---|---|---|---|---|---|---|---|---|
| *1/4* | *1* | *1* | *1* | *E70S-6* | *0.045* | *330* | *214* | *26.0* | *10.1* |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |

# PROCEDURE QUALIFICATION RECORD (PQR)

Company Name: **Walters Inc.**
Authorized By: Ken Kerluke
Welding Process(es): **GMAW**
Types: **Semi-automatic**
Date Welded: January 23, 2002

PQR No. 40
Welder's Name: John Williamson
Stamp Number: N/A
ArcScan ID# 103

| **Joint Design** | |
|---|---|
| Type | *Flare Vee Butt* |
| Single or Double Weld | *Single* |
| Backing | *None* |
| Backing Material | *N/A* |
| Back Gouging | *None* |
| Method | *N/A* |




## Base Metal:

| | | |
|---|---|---|
| Material Spec. *A500* | to | Material Spec. *A500* |
| Type or Grade *C* | to | Type or Grade *C* |
| Thickness *1/4* | | *1/4* |
| Diameter (Pipe) | | *N/A* |

## Filler Metals:

AWS Specification _____ *A5.18*
AWS Classification _____ *E70S-6*
Size of Filler Metal _____ *0.045*

## Heat Treatment:

*None*
Temperature _____
Time _____

## Electrical Characteristics:

Current Type _____ *DC*
Mode of Metal Transfer (GMAW) _____ *Spray*
Polarity _____ *Positive*
Tungsten Electrode Size and Type _____ *None*

## Position:

Position of Groove: *3G (vertical)*
Weld Progression: *Vertical Down*
Other _____

## Preheat:

Preheat Temperature: *70° F ambient*
Interpass Temperature _____
Other _____

| **Shielding Gas** | | | |
|---|---|---|---|
| | | % Comp. | |
| | Gas | (Mixture) | Flow |
| Shielding: | *C-10* | *90% Ar 10-% $CO_2$* | *35 cfh* |
| Trailing: None | | | |

| **Technique:** | |
|---|---|
| String or Weave Bead | *String* |
| Oscillation | *None* |
| Multi-pass or Single Pass (per side) | *Single* |
| Gas Cup Size | *5/8" Ø* |
| Interpass Cleaning | *None* |
| Peening | *None* |
| Push or Drag Electrode Angle | *Drag* |
| Contact Tube to Work Distance | *1/2"* |

## Welding Data:

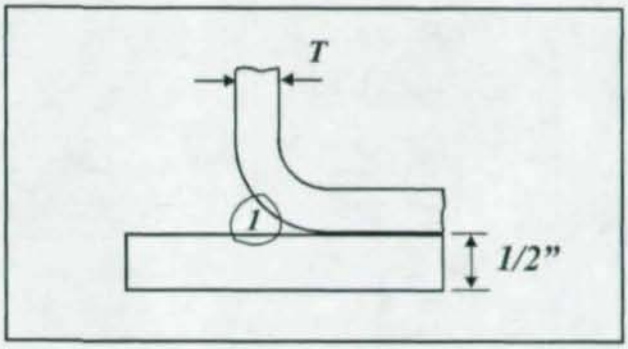
| Wall Size T | Side | Layer | Pass | Filler Metal Class | Filler Metal Ø | Wire Feed Speed (ipm) | Amps. | Volts | Travel Speed (ipm) |
|---|---|---|---|---|---|---|---|---|---|
| *1/4* | *1* | *1* | *1* | *E70S-6* | *0.045* | *330* | *258* | *26.2* | *17.3* |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |

# PROCEDURE QUALIFICATION RECORD (PQR)

Company Name: **Walters Inc.**
Authorized By: Ken Kerluke
Welding Process(es): **GMAW**
Types: **Semi-automatic**
Date Welded: January 23, 2002

PQR No. 41
Welder's Name: John Williamson
Stamp Number: N/A
ArcScan ID# 107

| **Joint Design** | |
|---|---|
| Type | *Flare Bevel Tee* |
| Single or Double Weld | *Single* |
| Backing | *None* |
| Backing Material | *N/A* |
| Back Gouging | *None* |
| Method | *N/A* |




## Base Metal:

| | | |
|---|---|---|
| Material Spec. | *A500* to | Material Spec. *G40.21* |
| Type or Grade | *C* to | Type or Grade *44W* |
| Thickness | *1/4* | *1/2* |
| Diameter (Pipe) | | *N/A* |

## Filler Metals:

AWS Specification _____ *A5.18*
AWS Classification _____ *E70S-6*
Size of Filler Metal _____ *0.045*

## Heat Treatment:

Preheat Temperature: *70°F ambient* *None*
Temperature _____
Time _____

## Position:

Position of Groove: *4G (overhead)*
Weld Progression _____
Other _____

Preheat Temperature _____
Other _____

## Electrical Characteristics:

Current Type _____ *DC*
Mode of Metal Transfer (GMAW) _____ *Spray*
Polarity _____ *Positive*
Tungsten Electrode Size and Type _____ *None*

| **Shielding Gas** | | | |
|---|---|---|---|
| | | % Comp. | |
| | Gas | (Mixture) | Flow |
| Shielding: | *C-10* | *90% Ar 10-% $CO_2$* | *35 cfh* |
| Trailing: *None* | | | |

| **Technique** | |
|---|---|
| String or Weave Bead | *String* |
| Oscillation | *None* |
| Multi-pass or Single Pass (per side) | *Single* |
| Gas Cup Size | *5/8" Ø* |
| Interpass Cleaning | *None* |
| Peening | *None* |
| Push or Drag Electrode Angle | *Push* |
| Contact Tube to Work Distance | *1/2"* |

## Welding Data:

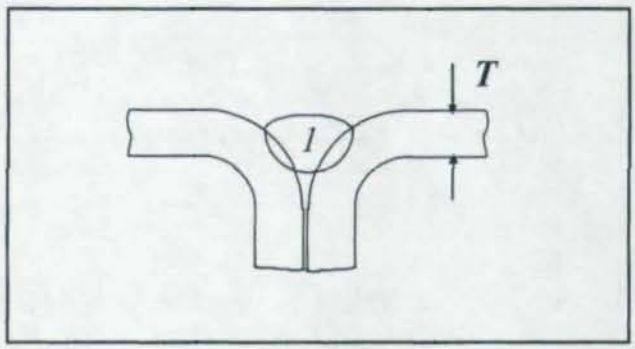
| Wall Size T | Side | Layer | Pass | Filler Metal Class | Filler Metal Ø | Wire Feed Speed (ipm) | Amps. | Volts | Travel Speed (ipm) |
|---|---|---|---|---|---|---|---|---|---|
| *1/4* | *1* | *1* | *1* | *E70S-6* | *0.045* | *330* | *237* | *25.7* | *9.2* |
| | | | | | | | | | |
| | | | | | | | | | |

# PROCEDURE QUALIFICATION RECORD (PQR)

Company Name: **Walters Inc.**
Authorized By: Ken Kerluke
Welding Process(es): **GMAW**
Types: **Semi-automatic**
Date Welded: January 23, 2002

PQR No. 42
Welder's Name: John Williamson
Stamp Number: N/A
ArcScan ID# 105, 106

| **Joint Design** | |
|---|---|
| Type | *Flare Vee Butt* |
| Single or Double Weld | *Single* |
| Backing | *None* |
| Backing Material | *N/A* |
| Back Gouging | *None* |
| Method | *N/A* |




## Base Metal:

| | | |
|---|---|---|
| Material Spec. | *A500* to | Material Spec. *A500* |
| Type or Grade | *C* to | Type or Grade *C* |
| Thickness | *1/4* | *1/4* |
| Diameter (Pipe) | | *N/A* |

## Filler Metals:

AWS Specification _____ *A5.18*
AWS Classification _____ *E70S-6*
Size of Filler Metal _____ *0.045*

## Heat Treatment: *None*

Temperature _____
Time _____

## Position:

Position of Groove: *4G (overhead)*
Weld Progression _____
Other _____

## Preheat:

Preheat Temperature: *70° F ambient*
Interpass Temperature _____
Other _____

## Electrical Characteristics:

Current Type _____ *DC*
Mode of Metal Transfer (GMAW) _____ *Spray*
Polarity _____ *Positive*
Tungsten Electrode Size and Type _____ *None*

| **Shielding Gas** | | | |
|---|---|---|---|
| | | % Comp. | |
| | Gas | (Mixture) | Flow |
| Shielding: | *C-10* | *90% Ar 10-% $CO_2$* | *35 cfh* |
| Trailing: None | | | |

| **Technique:** | |
|---|---|
| String or Weave Bead | *String* |
| Oscillation | *None* |
| Multi-pass or Single Pass (per side) | *Single* |
| Gas Cup Size | *5/8" ∅* |
| Interpass Cleaning | *None* |
| Peening | *None* |
| Push or Drag Electrode Angle | *Push* |
| Contact Tube to Work Distance | *1/2"* |

## Welding Data:

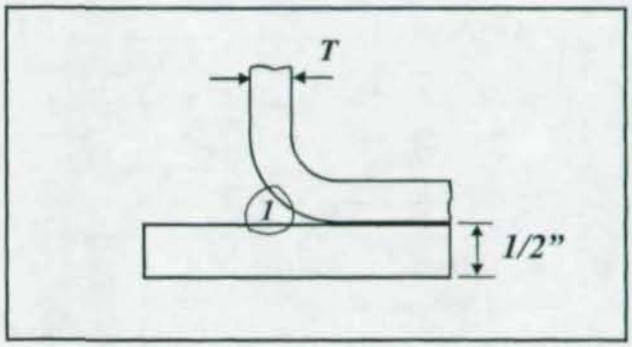
| Wall Size T | Side | Layer | Pass | Filler Metal Class | Filler Metal ∅ | Wire Feed Speed (ipm) | Amps. | Volts | Travel Speed (ipm) |
|---|---|---|---|---|---|---|---|---|---|
| *1/4* | *1* | *1* | *1* | *E70S-6* | *0.045* | *328* | *237* | *24.8* | *9.4* |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |

# PROCEDURE QUALIFICATION RECORD (PQR)

Company Name: **Walters Inc.**
Authorized By: Ken Kerluke
Welding Process(es): **SMAW**
Types: **Manual**
Date Welded: January 23, 2002

PQR No. 43
Welder's Name: John Williamson
Stamp Number: N/A
ArcScan ID#: 42, 43

| **Joint Design** | |
|---|---|
| Type | *Flare Bevel Tee* |
| Single or Double Weld | *Single* |
| Backing | *None* |
| Backing Material | *N/A* |
| Back Gouging | *None* |
| Method | *N/A* |




## Base Metal:

| | | |
|---|---|---|
| Material Spec. | *A500* to | Material Spec. *G40.21* |
| Type or Grade | *C* to | Type or Grade *44W* |
| Thickness | *1/4* | *1/2* |
| Diameter (Pipe) | | *N/A* |

## Filler Metals:

AWS Specification _____ *A5.1*
AWS Classification _____ *E7018*
Size of Filler Metal _____ *1/8*

## Heat Treatment: *None*

Temperature _____
Time _____

## Position:

Position of Groove: *2G (horizontal)*
Weld Progression:
Other _____

## Preheat:

Preheat Temperature: *70°F ambient*
Interpass Temperature _____
Other _____

## Electrical Characteristics:

Current Type _____ *DC*
Mode of Metal Transfer (GMAW) _____ *N/A*
Polarity _____ *Positive*
Tungsten Electrode Size and Type _____ *None*

| **Shielding Gas** | | | |
|---|---|---|---|
| | | % Comp. | |
| | Gas | (Mixture) | Flow Rate |
| Shielding: *None* | | | |
| Trailing: *None* | | | |
| Backing: *None* | | | |

| **Technique** | |
|---|---|
| String or Weave Bead | *String* |
| Oscillation | *None* |
| Multi-pass or Single Pass (per side) | *Single* |
| Gas Cup Size | *N/A* |
| Interpass Cleaning | *None* |
| Peening | *None* |
| Push or Drag Electrode Angle | *Drag* |
| Contact Tube to Work Distance | *N/A* |

## Welding Data:

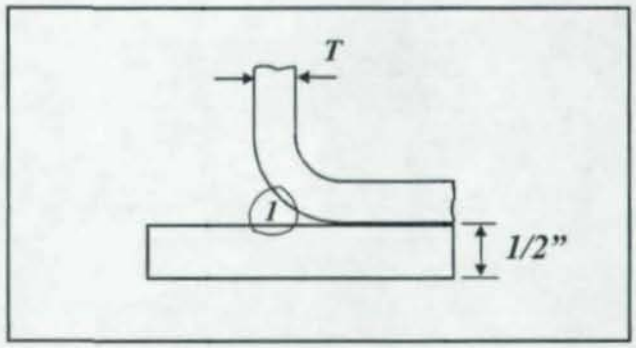
| Wall Size T | Side | Layer | Pass | Filler Metal Class | Filler Metal Ø | Wire Feed Speed (ipm) | Amps. | Volts | Travel Speed (ipm) |
|---|---|---|---|---|---|---|---|---|---|
| *1/4* | *1* | *1* | *1* | *E7018* | *1/8* | *N/A* | *136* | - | *3.7* |
| | | | | | | | | | |
| | | | | | | | | | |

# PROCEDURE QUALIFICATION RECORD (PQR)

Company Name: **Walters Inc.**
Authorized By: Ken Kerluke
Welding Process(es): **SMAW**
Types: **Manual**
Date Welded: January 23, 2002

PQR No. 44
Welder's Name: John Williamson
Stamp Number: N/A
ArcScan ID#: 50, 51

| **Joint Design** | |
|---|---|
| Type | *Flare Bevel Tee* |
| Single or Double Weld | *Single* |
| Backing | *None* |
| Backing Material | *N/A* |
| Back Gouging | *None* |
| Method | *N/A* |




## Base Metal:

| | | | |
|---|---|---|---|
| Material Spec. | *A500* | to | Material Spec. *G40.21* |
| Type or Grade | *C* | to | Type or Grade *44W* |
| Thickness | *1/4* | | *1/2* |
| Diameter (Pipe) | | | *N/A* |

## Filler Metals:

AWS Specification _____ *A5.1*
AWS Classification _____ *E7018*
Size of Filler Metal _____ *1/8*

## Heat Treatment: *None*

Temperature _____
Time _____

## Electrical Characteristics:

Current Type _____ *DC*
Mode of Metal Transfer (GMAW) _____ *N/A*
Polarity _____ *Positive*
Tungsten Electrode Size and Type _____ *None*

## Position:

Position of Groove: *3G (vertical)*
Weld Progression: *Vertical Up*
Other _____

## Preheat:

Preheat Temperature: 70° F ambient
Interpass Temperature _____
Other _____

| **Shielding Gas** | | | |
|---|---|---|---|
| | | % Comp. | |
| | Gas | (Mixture) | Flow Rate |
| Shielding: *None* | | | |
| Trailing: *None* | | | |
| Backing: *None* | | | |

| **Technique** | |
|---|---|
| String or Weave Bead | *String* |
| Oscillation | *None* |
| Multi-pass or Single Pass (per side) | *Single* |
| Gas Cup Size | *N/A* |
| Interpass Cleaning | *None* |
| Peening | *None* |
| Push or Drag Electrode Angle | *Push* |
| Contact Tube to Work Distance | *N/A* |

## Welding Data:

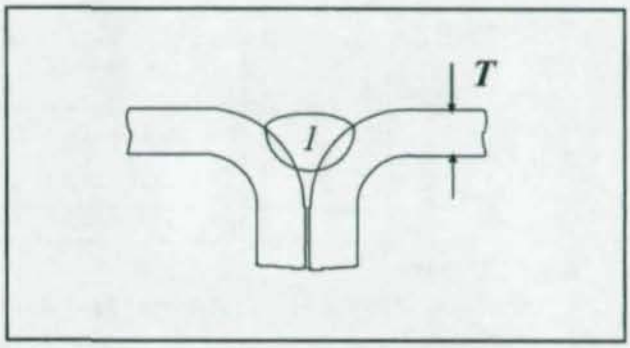
| Wall Size T | Side | Layer | Pass | Filler Metal Class | Filler Metal Ø | Wire Feed Speed (ipm) | Amps. | Volts | Travel Speed (ipm) |
|---|---|---|---|---|---|---|---|---|---|
| *1/4* | *1* | *1* | *1* | *E7018* | *1/8* | *N/A* | *132* | - | *4.8* |
| | | | | | | | | | |
| | | | | | | | | | |

# PROCEDURE QUALIFICATION RECORD (PQR)

Company Name: **Walters Inc.**
Authorized By: Ken Kerluke
Welding Process(es): **SMAW**
Types: **Manual**
Date Welded: January 23, 2002

PQR No. 45
Welder's Name: John Williamson
Stamp Number: N/A
ArcScan ID #: 44, 45, 46

| **Joint Design** | |
|---|---|
| Type | *Flare Vee Butt* |
| Single or Double Weld | *Single* |
| Backing | *None* |
| Backing Material | *N/A* |
| Back Gouging | *None* |
| Method | *N/A* |




## Base Metal:

| | | |
|---|---|---|
| Material Spec. *A500* | to | Material Spec. *A500* |
| Type or Grade *C* | to | Type or Grade *C* |
| Thickness *1/4* | | *1/4* |
| Diameter (Pipe) | | *N/A* |

## Filler Metals:

AWS Specification _____ *A5.1*
AWS Classification _____ *E7018*
Size of Filler Metal _____ *1/8*

## Heat Treatment:

*None*
Temperature _____
Time _____

## Electrical Characteristics:

Current Type _____ *DC*
Mode of Metal Transfer (GMAW) _____ *N/A*
Polarity _____ *Positive*
Tungsten Electrode Size and Type _____ *None*

## Position:

Position of Groove: *1G (flat)*
Weld Progression:
Other _____

## Preheat:

Preheat Temperature: *70° ambient*
Interpass Temperature _____
Other _____

| **Shielding Gas** | | | |
|---|---|---|---|
| | | % Comp. | |
| | Gas | (Mixture) | Flow Rate |
| Shielding: *None* | | | |
| Trailing: *None* | | | |
| Backing: *None* | | | |

| **Technique** | |
|---|---|
| String or Weave Bead | *String* |
| Oscillation | *None* |
| Multi-pass or Single Pass (per side) | *Single* |
| Gas Cup Size | *N/A* |
| Interpass Cleaning | *None* |
| Peening | *None* |
| Push or Drag Electrode Angle | *Drag* |
| Contact Tube to Work Distance | *N/A* |

## Welding Data:

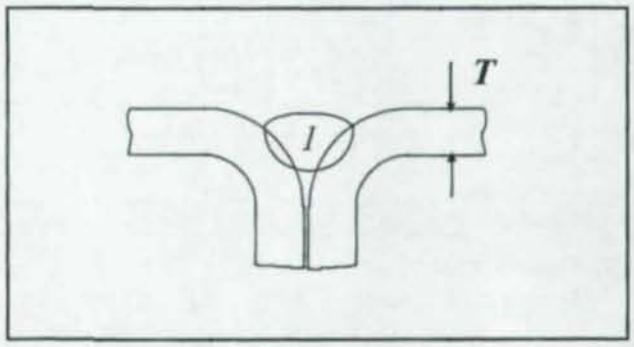
| Wall Size T | Side | Layer | Pass | Filler Metal Class | Filler Metal ∅ | Wire Feed Speed (ipm) | Amps. | Volts | Travel Speed (ipm) |
|---|---|---|---|---|---|---|---|---|---|
| *1/4* | *1* | *1* | *1* | *E7018* | *1/8* | *N/A* | *136* | - | *3.6* |
| | | | | | | | | | |
| | | | | | | | | | |

# PROCEDURE QUALIFICATION RECORD (PQR)

Company Name: **Walters Inc.**
Authorized By: Ken Kerluke
Welding Process(es): **SMAW**
Types: **Manual**
Date Welded: January 23, 2002

PQR No. 46
Welder's Name: John Williamson
Stamp Number: N/A
ArcScan ID #: 47, 48, 49

| **Joint Design** | |
|---|---|
| Type | *Flare Vee Butt* |
| Single or Double Weld | *Single* |
| Backing | *None* |
| Backing Material | *N/A* |
| Back Gouging | *None* |
| Method | *N/A* |




## Base Metal:

| | | |
|---|---|---|
| Material Spec. *A500* | to | Material Spec. *A500* |
| Type or Grade *C* | to | Type or Grade *C* |
| Thickness *1/4* | | *1/4* |
| Diameter (Pipe) | | *N/A* |

## Filler Metals:

AWS Specification _____ *A5.1*
AWS Classification _____ *E7018*
Size of Filler Metal _____ *1/8*

## Heat Treatment:

*None*
Temperature _____
Time _____

## Electrical Characteristics:

Current Type _____ *DC*
Mode of Metal Transfer (GMAW) _____ *N/A*
Polarity _____ *Positive*
Tungsten Electrode Size and Type _____ *None*

## Position:

Position of Groove: 3*G (vertical)*
Weld Progression: *Vertical Up*
Other _____

## Preheat:

Preheat Temperature: 70° ambient
Interpass Temperature _____
Other _____

| **Shielding Gas** | | | |
|---|---|---|---|
| | | % Comp. | |
| | Gas | (Mixture) | Flow Rate |
| Shielding: *None* | | | |
| Trailing: *None* | | | |
| Backing: *None* | | | |

| **Technique** | |
|---|---|
| String or Weave Bead | *String* |
| Oscillation | *None* |
| Multi-pass or Single Pass (per side) | *Single* |
| Gas Cup Size | *N/A* |
| Interpass Cleaning | *None* |
| Peening | *None* |
| Push or Drag Electrode Angle | *0°* |
| Contact Tube to Work Distance | *N/A* |

## Welding Data:

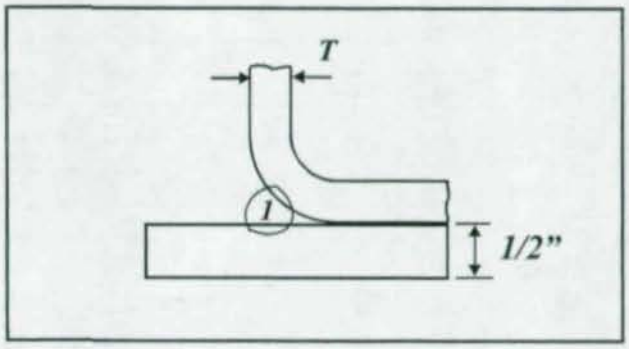
| Wall Size T | Side | Layer | Pass | Filler Metal Class | Filler Metal Ø | Wire Feed Speed (ipm) | Amps. | Volts | Travel Speed (ipm) |
|---|---|---|---|---|---|---|---|---|---|
| *1/4* | *1* | *1* | *1* | *E7018* | *1/8* | *N/A* | *133* | - | *3.0* |
| | | | | | | | | | |
| | | | | | | | | | |

# PROCEDURE QUALIFICATION RECORD (PQR)

Company Name: **Walters Inc.**
Authorized By: Ken Kerluke
Welding Process(es): **SMAW**
Types: **Manual**
Date Welded: January 23, 2002

PQR No. 47
Welder's Name: John Williamson
Stamp Number: N/A
ArcScan ID#: 86

| **Joint Design** | |
|---|---|
| Type | *Flare Bevel Tee* |
| Single or Double Weld | *Single* |
| Backing | *None* |
| Backing Material | *N/A* |
| Back Gouging | *None* |
| Method | *N/A* |




## Base Metal:

| | | | |
|---|---|---|---|
| Material Spec. | *A500* | to | Material Spec. *G40.21* |
| Type or Grade | *C* | to | Type or Grade *44W* |
| Thickness | *1/4* | | *1/2* |
| Diameter (Pipe) | | | *N/A* |

## Filler Metals:

AWS Specification _____ *A5.1*
AWS Classification _____ *E7018*
Size of Filler Metal _____ *1/8*

## Heat Treatment: *None*

Temperature _____
Time _____

## Electrical Characteristics:

Current Type _____ *DC*
Mode of Metal Transfer (GMAW) _____ *N/A*
Polarity _____ *Positive*
Tungsten Electrode Size and Type _____ *None*

## Position:

Position of Groove: *4G (overhead)*
Weld Progression _____
Other _____

## Preheat:

Preheat Temperature: 70° F ambient
Interpass Temperature _____
Other _____

| **Shielding Gas** | | | |
|---|---|---|---|
| | | % Comp. | |
| | Gas | (Mixture) | Flow Rate |
| Shielding: *None* | | | |
| Trailing: *None* | | | |
| Backing: *None* | | | |

| **Technique** | |
|---|---|
| String or Weave Bead | *String* |
| Oscillation | *None* |
| Multi-pass or Single Pass (per side) | *Single* |
| Gas Cup Size | *N/A* |
| Interpass Cleaning | *None* |
| Peening | *None* |
| Push or Drag Electrode Angle | *Drag* |
| Contact Tube to Work Distance | *N/A* |

## Welding Data:

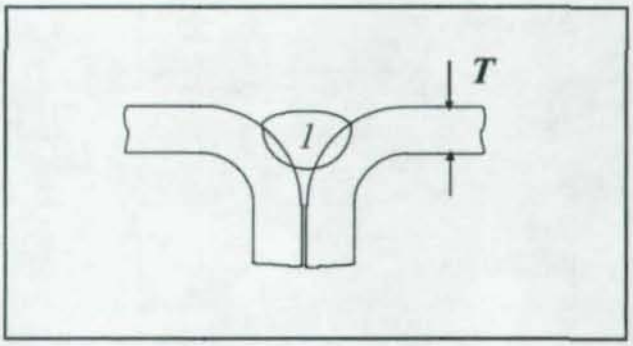
| Wall Size T | Side | Layer | Pass | Filler Metal Class | Filler Metal ∅ | Wire Feed Speed (ipm) | Amps. | Volts | Travel Speed (ipm) |
|---|---|---|---|---|---|---|---|---|---|
| *1/4* | *1* | *1* | *1* | *E7018* | *1/8* | *N/A* | *123* | | *2.9* |
| | | | | | | | | | |
| | | | | | | | | | |

# PROCEDURE QUALIFICATION RECORD (PQR)

Company Name: **Walters Inc.**
Authorized By: Ken Kerluke
Welding Process(es): **SMAW**
Types: **Manual**
Date Welded: January 23, 2002

PQR No. 48
Welder's Name: John Williamson
Stamp Number: N/A
ArcScan ID #: 52, 53, 54, 55

| **Joint Design** | |
|---|---|
| Type | *Flare Vee Butt* |
| Single or Double Weld | *Single* |
| Backing | *None* |
| Backing Material | *N/A* |
| Back Gouging | *None* |
| Method | *N/A* |




## Base Metal:

| | | |
|---|---|---|
| Material Spec. | *A500* to | Material Spec. *A500* |
| Type or Grade | *C* to | Type or Grade *C* |
| Thickness | *1/4* | *1/4* |
| Diameter (Pipe) | | *N/A* |

## Filler Metals:

AWS Specification _____ *A5.1*
AWS Classification _____ *E7018*
Size of Filler Metal _____ *1/8*

## Heat Treatment: *None*

Temperature _____
Time _____

## Electrical Characteristics:

Current Type _____ *DC*
Mode of Metal Transfer (GMAW) _____ *N/A*
Polarity _____ *Positive*
Tungsten Electrode Size and Type _____ *None*

## Position:

Position of Groove: *4G (overhead)*
Weld Progression:
Other _____

## Preheat:

Preheat Temperature: 70° ambient
Interpass Temperature _____
Other _____

| **Shielding Gas** | | | |
|---|---|---|---|
| | | % Comp. | |
| | Gas | (Mixture) | Flow Rate |
| Shielding: *None* | | | |
| Trailing: *None* | | | |
| Backing: *None* | | | |

| **Technique** | |
|---|---|
| String or Weave Bead | *String* |
| Oscillation | *None* |
| Multi-pass or Single Pass (per side) | *Single* |
| Gas Cup Size | *N/A* |
| Interpass Cleaning | *None* |
| Peening | *None* |
| Push or Drag Electrode Angle | *Drag* |
| Contact Tube to Work Distance | *N/A* |

## Welding Data:

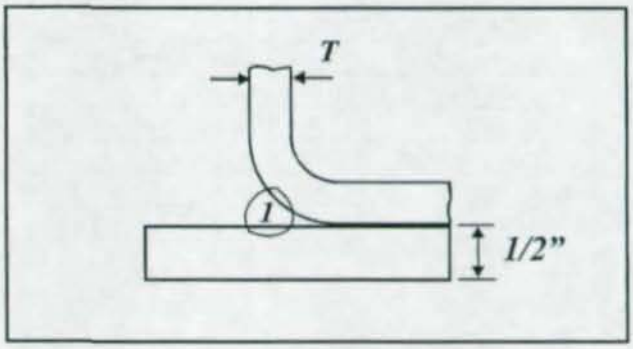
| Wall Size T | Side | Layer | Pass | Filler Metal Class | Filler Metal Ø | Wire Feed Speed (ipm) | Amps. | Volts | Travel Speed (ipm) |
|---|---|---|---|---|---|---|---|---|---|
| *1/4* | *1* | *1* | *1* | *E7018* | *1/8* | *N/A* | *120* | - | *3.7* |
| | | | | | | | | | |
| | | | | | | | | | |

# PROCEDURE QUALIFICATION RECORD (PQR)

Company Name: **Walters Inc.**
Authorized By: Ken Kerluke
Welding Process(es): **FCAW-G**
Types: **Semi-automatic**
Date Welded: January 23, 2002

PQR No. 49
Welder's Name: John Williamson
Stamp Number: N/A
ArcScan ID # 121

| **Joint Design** | |
|---|---|
| Type | *Flare Bevel Tee* |
| Single or Double Weld | *Single* |
| Backing | *None* |
| Backing Material | *N/A* |
| Back Gouging | *None* |
| Method | *N/A* |




### Base Metal:

| | | |
|---|---|---|
| Material Spec. | *A500* to | Material Spec. *G40.21* |
| Type or Grade | *C* | Type or Grade *44W* |
| Thickness: | *3/8* | *1/2* |
| Diameter (Pipe) | | *N/A* |

### Filler Metals:

AWS Specification _____ *A5.20*
AWS Classification _____ *E71T-9 (O/S 71M)*
Size of Filler Metal _____ *1/16*

### Heat Treatment: *None*

Temperature _____
Time _____

### Electrical Characteristics:

Current Type _____ *DC*
Mode of Metal Transfer (GMAW) _____ *N/A*
Polarity _____ *Positive*
Tungsten Electrode Size and Type _____ *None*

### Position:

Position of Groove: *2G (horizontal)*
Weld Progression:
Other _____

### Preheat:

Preheat Temperature: *70° F ambient*
Interpass Temperature _____
Other _____

| **Shielding Gas** | | | |
|---|---|---|---|
| | | % Comp. | |
| | Gas | (Mixture) | Flow Rate |
| Shielding: | *$CO_2$* | *100%* | *35 cfh* |
| Trailing: *None* | | | |

| **Technique** | |
|---|---|
| String or Weave Bead | *String* |
| Oscillation | *None* |
| Multi-pass or Single Pass (per side) | *Single* |
| Gas Cup Size | *5/8" ∅* |
| Interpass Cleaning | *None* |
| Peening | *None* |
| Push or Drag Electrode Angle | *Drag* |
| Contact Tube to Work Distance | *3/4"* |

### Welding Data:

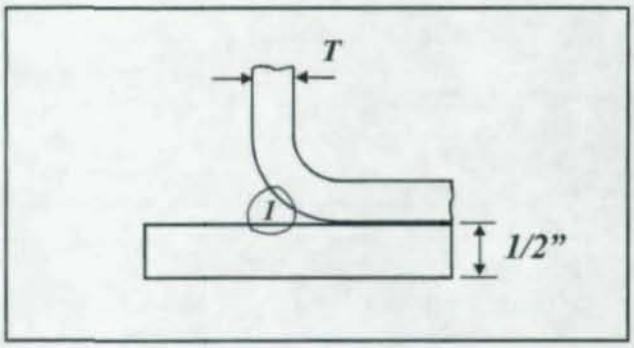
| Wall Size T | Side | Layer | Pass | Filler Metal Class | Filler Metal ∅ | Wire Feed Speed (ipm) | Amps. | Volts | Travel Speed (ipm) |
|---|---|---|---|---|---|---|---|---|---|
| *3/8* | *1* | *1* | *1* | *E71T-9* | *1/16* | *225* | *247* | *26.5* | *8.3* |
| | | | | | | | | | |
| | | | | | | | | | |

# PROCEDURE QUALIFICATION RECORD (PQR)

Company Name: **Walters Inc.**
Authorized By: Ken Kerluke
Welding Process(es): **FCAW-G**
Types: **Semi-automatic**
Date Welded: January 23, 2002

PQR No. 50
Welder's Name: John Williamson
Stamp Number: N/A
ArcScan ID # 124

| **Joint Design** | |
|---|---|
| Type | *Flare Bevel Tee* |
| Single or Double Weld | *Single* |
| Backing | *None* |
| Backing Material | *N/A* |
| Back Gouging | *None* |
| Method | *N/A* |




## Base Metal:

| | | |
|---|---|---|
| Material Spec. *A500* | to | Material Spec. *G40.21* |
| Type or Grade *C* | | Type or Grade *44W* |
| Thickness: *3/8* | | *1/2* |
| Diameter (Pipe) | | *N/A* |

## Filler Metals:

AWS Specification _____ *A5.20*
AWS Classification _____ *E71T-9 (O/S 71M)*
Size of Filler Metal _____ *1/16*

## Heat Treatment: *None*

Temperature _____
Time _____

## Electrical Characteristics:

Current Type _____ *DC*
Mode of Metal Transfer (GMAW) _____ *N/A*
Polarity _____ *Positive*
Tungsten Electrode Size and Type _____ *None*

## Position:

Position of Groove: *3G (vertical)*
Weld Progression: *Vertical Up*
Other _____

## Preheat:

Preheat Temperature: *70° F ambient*
Interpass Temperature _____
Other _____

| **Shielding Gas** | | | |
|---|---|---|---|
| | | % Comp. | |
| | Gas | (Mixture) | Flow Rate |
| Shielding: | $CO_2$ | *100%* | *35 cfh* |
| Trailing: *None* | | | |

| **Technique** | |
|---|---|
| String or Weave Bead | *String* |
| Oscillation | *None* |
| Multi-pass or Single Pass (per side) | *Single* |
| Gas Cup Size | *5/8" ∅* |
| Interpass Cleaning | *None* |
| Peening | *None* |
| Push or Drag Electrode Angle | *5° push* |
| Contact Tube to Work Distance | *3/4"* |

## Welding Data:

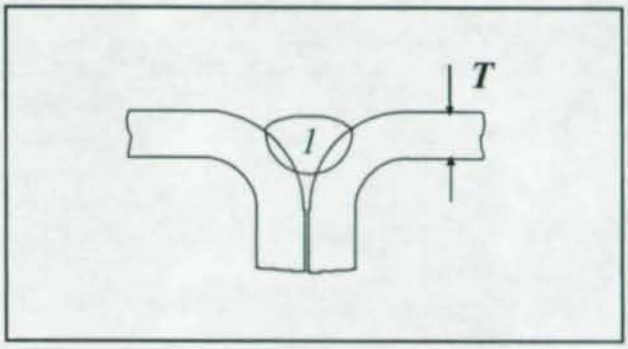
| Wall Size T | Side | Layer | Pass | Filler Metal Class | Filler Metal ∅ | Wire Feed Speed (ipm) | Amps. | Volts | Travel Speed (ipm) |
|---|---|---|---|---|---|---|---|---|---|
| *3/8* | *1* | *1* | *1* | *E71T-9* | *1/16* | *157* | *200* | *21.0* | *5.1* |
| | | | | | | | | | |
| | | | | | | | | | |

# PROCEDURE QUALIFICATION RECORD (PQR)

Company Name: **Walters Inc.**
Authorized By: Ken Kerluke
Welding Process(es): **FCAW-G**
Types: **Semi-automatic**
Date Welded: January 23, 2002

PQR No. 51
Welder's Name: John Williamson
Stamp Number: N/A
ArcScan ID# 120

| **Joint Design** | |
|---|---|
| Type | *Flare Vee Butt* |
| Single or Double Weld | *Single* |
| Backing | *None* |
| Backing Material | *N/A* |
| Back Gouging | *None* |
| Method | *N/A* |




## Base Metal:

| | | | |
|---|---|---|---|
| Material Spec. | *A500* | to | Material Spec. *A500* |
| Type or Grade | *C* | | Type or Grade *C* |
| Thickness: | *3/8* | | *3/8* |
| Diameter (Pipe) | | | *N/A* |

## Filler Metals:

AWS Specification _____ *A5.20*
AWS Classification _____ *E71T-9 (O/S 71M)*
Size of Filler Metal _____ *1/16*

## Heat Treatment:

*None*
Temperature _____
Time _____

## Electrical Characteristics:

Current Type _____ *DC*
Mode of Metal Transfer (GMAW) _____ *N/A*
Polarity _____ *Positive*
Tungsten Electrode Size and Type _____ *None*

## Position:

Position of Groove: *1G (flat)*
Weld Progression: _____
Other _____

## Preheat:

Preheat Temperature: 70° F ambient
Interpass Temperature _____
Other _____

| **Shielding Gas** | | | |
|---|---|---|---|
| | | % Comp. | |
| | Gas | (Mixture) | Flow Rate |
| Shielding: | *$CO_2$* | *100%* | *35 cfh* |
| Trailing: None | - | - | - |

| **Technique:** | |
|---|---|
| String or Weave Bead | *String* |
| Oscillation | *None* |
| Multi-pass or Single Pass (per side) | *Single* |
| Gas Cup Size | *5/8" Ø* |
| Interpass Cleaning | *None* |
| Peening | *None* |
| Push or Drag Electrode Angle | *0°* |
| Contact Tube to Work Distance | *3/4"* |

## Welding Data:

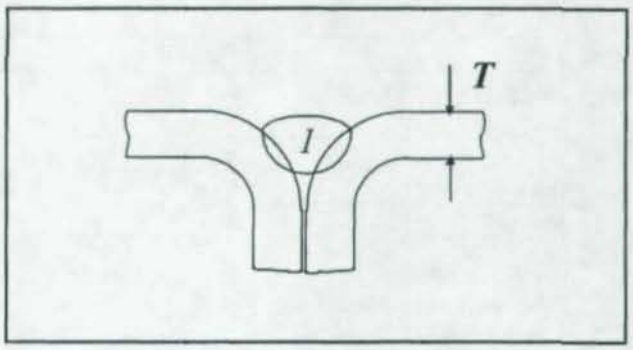
| Wall Size T | Side | Layer | Pass | Filler Metal Class | Filler Metal Ø | Wire Feed Speed (ipm) | Amps. | Volts | Travel Speed (ipm) |
|---|---|---|---|---|---|---|---|---|---|
| *3/8* | *1* | *1* | *1* | *E71T-9* | *1/16* | *225* | *236* | *26.5* | *10.0* |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |

# PROCEDURE QUALIFICATION RECORD (PQR)

Company Name: **Walters Inc.**
Authorized By: Ken Kerluke
Welding Process(es): **FCAW-G**
Types: **Semi-automatic**
Date Welded: January 23, 2002

PQR No. 52
Welder's Name: John Williamson
Stamp Number: N/A
ArcScan ID# 123

| **Joint Design** | |
|---|---|
| Type | *Flare Vee Butt* |
| Single or Double Weld | *Single* |
| Backing | *None* |
| Backing Material | *N/A* |
| Back Gouging | *None* |
| Method | *N/A* |




## Base Metal:

| | | | |
|---|---|---|---|
| Material Spec. | *A500* | to | Material Spec. *A500* |
| Type or Grade | *C* | | Type or Grade *C* |
| Thickness: | *3/8* | | *3/8* |
| Diameter (Pipe) | | | *N/A* |

## Filler Metals:

AWS Specification _____ *A5.20*
AWS Classification _____ *E71T-9 (O/S 71M)*
Size of Filler Metal _____ *1/16*

## Heat Treatment:

*None*

Temperature _____
Time _____

## Electrical Characteristics:

Current Type _____ *DC*
Mode of Metal Transfer (GMAW) _____ *N/A*
Polarity _____ *Positive*
Tungsten Electrode Size and Type _____ *None*

## Position:

Position of Groove: *3G (vertical)*
Weld Progression: *Vertical Up*
Other _____

## Preheat:

Preheat Temperature: 70° F ambient
Interpass Temperature _____
Other _____

| **Shielding Gas** | | | |
|---|---|---|---|
| | | % Comp. | |
| | Gas | (Mixture) | Flow Rate |
| Shielding: | *$CO_2$* | *100%* | *35 cfh* |
| Trailing: None | - | - | - |

| **Technique:** | |
|---|---|
| String or Weave Bead | *String* |
| Oscillation | *None* |
| Multi-pass or Single Pass (per side) | *Single* |
| Gas Cup Size | *5/8" ∅* |
| Interpass Cleaning | *None* |
| Peening | *None* |
| Push or Drag Electrode Angle | *0°* |
| Contact Tube to Work Distance | *3/4"* |

## Welding Data:

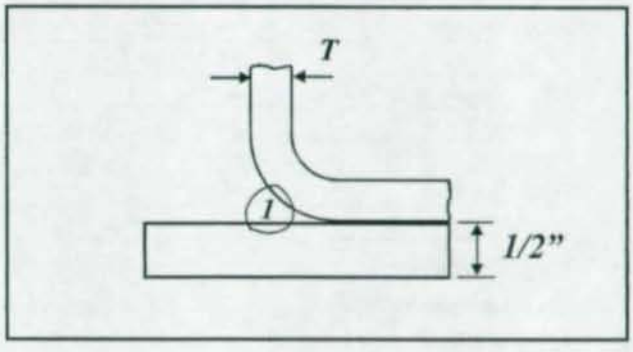
| Wall Size T | Side | Layer | Pass | Filler Metal Class | Filler Metal ∅ | Wire Feed Speed (ipm) | Amps. | Volts | Travel Speed (ipm) |
|---|---|---|---|---|---|---|---|---|---|
| *3/8* | *1* | *1* | *1* | *E71T-9* | *1/16* | *157* | *202* | *21.0* | *5.9* |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |

# PROCEDURE QUALIFICATION RECORD (PQR)

Company Name: **Walters Inc.**
Authorized By: Ken Kerluke
Welding Process(es): **FCAW-G**
Types: **Semi-automatic**
Date Welded: January 23, 2002

PQR No. 53
Welder's Name: John Williamson
Stamp Number: N/A
ArcScan ID # 145

| **Joint Design** | |
|---|---|
| Type | *Flare Bevel Tee* |
| Single or Double Weld | *Single* |
| Backing | *None* |
| Backing Material | *N/A* |
| Back Gouging | *None* |
| Method | *N/A* |




## Base Metal:

| | | |
|---|---|---|
| Material Spec. | *A500* to | Material Spec. *G40.21* |
| Type or Grade | *C* | Type or Grade *44W* |
| Thickness: | *3/8* | *1/2* |
| Diameter (Pipe) | | *N/A* |

## Filler Metals:

AWS Specification _____ *A5.20*
AWS Classification _____ *E71T-9 (O/S 71M)*
Size of Filler Metal _____ *1/16*

## Heat Treatment: *None*

Temperature _____
Time _____

## Electrical Characteristics:

Current Type _____ *DC*
Mode of Metal Transfer (GMAW) _____ *N/A*
Polarity _____ *Positive*
Tungsten Electrode Size and Type _____ *None*

## Position:

Position of Groove: *4G (overhead)*
Weld Progression _____
Other _____

## Preheat:

Preheat Temperature: *70° F ambient*
Interpass Temperature _____
Other _____

| **Shielding Gas** | | | |
|---|---|---|---|
| | | % Comp. | |
| | Gas | (Mixture) | Flow Rate |
| Shielding: | $CO_2$ | *100%* | *35 cfh* |
| Trailing: *None* | | | |

| **Technique** | |
|---|---|
| String or Weave Bead | *String* |
| Oscillation | *None* |
| Multi-pass or Single Pass (per side) | *Single* |
| Gas Cup Size | *5/8" Ø* |
| Interpass Cleaning | *None* |
| Peening | *None* |
| Push or Drag Electrode Angle | *Drag* |
| Contact Tube to Work Distance | *3/4"* |

## Welding Data:

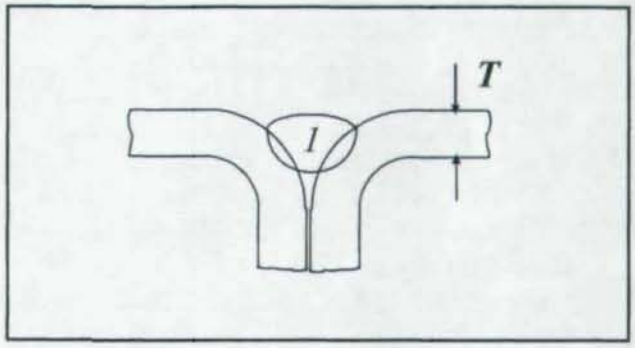
| Wall Size T | Side | Layer | Pass | Filler Metal Class | Filler Metal Ø | Wire Feed Speed (ipm) | Amps. | Volts | Travel Speed (ipm) |
|---|---|---|---|---|---|---|---|---|---|
| *3/8* | *1* | *1* | *1* | *E71T-9* | *1/16* | *175* | *N/A* | *24.0* | *5.6* |
| | | | | | | | | | |
| | | | | | | | | | |

# PROCEDURE QUALIFICATION RECORD (PQR)

Company Name: **Walters Inc.**
Authorized By: Ken Kerluke
Welding Process(es): **FCAW-G**
Types: **Semi-automatic**
Date Welded: January 23, 2002

PQR No. 54
Welder's Name: John Williamson
Stamp Number: N/A
ArcScan ID# 147

| **Joint Design** | |
|---|---|
| Type | *Flare Vee Butt* |
| Single or Double Weld | *Single* |
| Backing | *None* |
| Backing Material | *N/A* |
| Back Gouging | *None* |
| Method | *N/A* |




### Base Metal:

| | | | |
|---|---|---|---|
| Material Spec. | *A500* | to | Material Spec. *A500* |
| Type or Grade | *C* | | Type or Grade *C* |
| Thickness: | *3/8* | | *3/8* |
| Diameter (Pipe) | | | *N/A* |

### Filler Metals:

AWS Specification _____ *A5.20*
AWS Classification _____ *E71T-9 (O/S 71M)*
Size of Filler Metal _____ *1/16*

### Heat Treatment:

*None*

Temperature _____
Time _____

### Electrical Characteristics:

Current Type _____ *DC*
Mode of Metal Transfer (GMAW) _____ *N/A*
Polarity _____ *Positive*
Tungsten Electrode Size and Type _____ *None*

### Position:

Position of Groove: *4G (overhead)*
Weld Progression _____
Other _____

### Preheat:

Preheat Temperature: 70° F ambient
Interpass Temperature _____
Other _____

| **Shielding Gas** | | | |
|---|---|---|---|
| | | % Comp. | |
| | Gas | (Mixture) | Flow Rate |
| Shielding: | $CO_2$ | *100%* | *35 cfh* |
| Trailing: None | - | - | - |

| **Technique:** | |
|---|---|
| String or Weave Bead | *String* |
| Oscillation | *None* |
| Multi-pass or Single Pass (per side) | *Single* |
| Gas Cup Size | *5/8" ∅* |
| Interpass Cleaning | *None* |
| Peening | *None* |
| Push or Drag Electrode Angle | *Drag* |
| Contact Tube to Work Distance | *3/4"* |

### Welding Data:

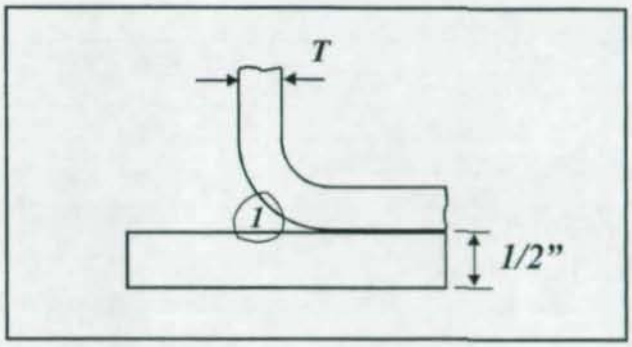
| Wall Size T | Side | Layer | Pass | Filler Metal Class | Filler Metal ∅ | Wire Feed Speed (ipm) | Amps. | Volts | Travel Speed (ipm) |
|---|---|---|---|---|---|---|---|---|---|
| *3/8* | *1* | *1* | *1* | *E71T-9* | *1/16* | *205* | *238* | *25.0* | *10.5* |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |

# PROCEDURE QUALIFICATION RECORD (PQR)

Company Name: **Walters Inc.**
Authorized By: Ken Kerluke
Welding Process(es): **FCAW-S**
Types: **Semi-automatic**
Date Welded: January 23, 2002

PQR No. *55*
Welder's Name: John Williamson
Stamp Number: N/A
ArcScan ID# N/A

| **Joint Design** | |
|---|---|
| Type | *Flare Bevel Tee* |
| Single or Double Weld | *Single* |
| Backing | *None* |
| Backing Material | *N/A* |
| Back Gouging | *None* |
| Method | *N/A* |




## Base Metal:

| | | |
|---|---|---|
| Material Spec. *A500* | to | Material Spec. *G40.21* |
| Type or Grade *C* | to | Type or Grade *44W* |
| Thickness *3/8* | | *1/2* |
| Diameter (Pipe) | | *N/A* |

## Filler Metals:

AWS Specification _____ *A5.20*
AWS Classification _____ *E71T-8 (NR-232)*
Size of Filler Metal _____ *0.072*

## Heat Treatment:

*None*
Temperature _____
Time _____

## Electrical Characteristics:

Current Type _____ *DC*
Mode of Metal Transfer (GMAW) _____ *N/A*
Polarity _____ *Negative*
Tungsten Electrode Size and Type _____ *None*

## Position:

Position of Groove: 2*G (horizontal)*
Weld Progression:
Other _____

## Preheat:

Preheat Temperature: *70° F ambient*
Interpass Temperature _____
Other _____

| **Shielding Gas** | | | |
|---|---|---|---|
| | | % Comp. | |
| | Gas | (Mixture) | Flow Rate |
| Shielding: *None* | - | - | - |
| Trailing: *None* | - | - | - |

| **Technique** | |
|---|---|
| String or Weave Bead | *String* |
| Oscillation | *None* |
| Multi-pass or Single Pass (per side) | *Single* |
| Gas Cup Size | *N/A* |
| Interpass Cleaning | *None* |
| Peening | *None* |
| Push or Drag Electrode Angle | *0°* |
| Contact Tube to Work Distance | *3/4"* |

## Welding Data:

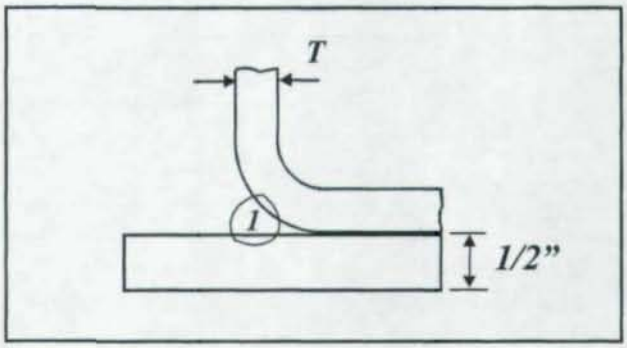
| Wall Size T | Side | Layer | Pass | Filler Metal Class | Filler Metal ∅ | Wire Feed Speed (ipm) | Amps. | Volts | Travel Speed (ipm) |
|---|---|---|---|---|---|---|---|---|---|
| *3/8* | *1* | *1* | *1* | *E71T-8* | *0.072* | *173* | *227* | *22.0* | *8.5* |
| | | | | | | | | | |
| | | | | | | | | | |

# PROCEDURE QUALIFICATION RECORD (PQR)

Company Name: **Walters Inc.**
Authorized By: Ken Kerluke
Welding Process(es): **FCAW-S**
Types: **Semi-automatic**
Date Welded: January 23, 2002

PQR No. 56
Welder's Name: John Williamson
Stamp Number: N/A
ArcScan ID# 175

| **Joint Design** | |
|---|---|
| Type | *Flare Bevel Tee* |
| Single or Double Weld | *Single* |
| Backing | *None* |
| Backing Material | *N/A* |
| Back Gouging | *None* |
| Method | *N/A* |




## Base Metal:

| | | |
|---|---|---|
| Material Spec. *A500* | to | Material Spec. *G40.21* |
| Type or Grade *C* | to | Type or Grade *44W* |
| Thickness *3/8* | | *1/2* |
| Diameter (Pipe) | | *N/A* |

## Filler Metals:

AWS Specification _____ *A5.20*
AWS Classification _____ *E71T-8 (NR-232)*
Size of Filler Metal _____ *0.072*

## Heat Treatment:

*None*
Temperature _____
Time _____

## Position:

Position of Groove: 3*G (vertical)*
Weld Progression: *Vertical Up*
Other _____

## Preheat:

Preheat Temperature: *70° F ambient*
Interpass Temperature _____
Other _____

## Electrical Characteristics:

Current Type _____ *DC*
Mode of Metal Transfer (GMAW) _____ *N/A*
Polarity _____ *Negative*
Tungsten Electrode Size and Type _____ *None*

| **Shielding Gas** | | | |
|---|---|---|---|
| | | % Comp. | |
| | Gas | (Mixture) | Flow Rate |
| Shielding: *None* | - | - | - |
| Trailing: *None* | - | - | - |

| **Technique** | |
|---|---|
| String or Weave Bead | *Weave* |
| Oscillation | *None* |
| Multi-pass or Single Pass (per side) | *Single* |
| Gas Cup Size | *N/A* |
| Interpass Cleaning | *None* |
| Peening | *None* |
| Push or Drag Electrode Angle | *5° Push* |
| Contact Tube to Work Distance | *5/8"* |

## Welding Data:

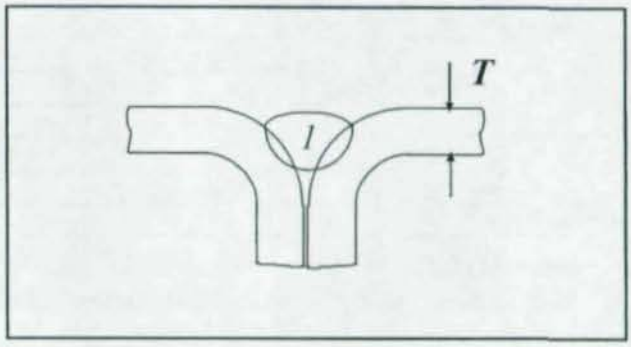
| Wall Size T | Side | Layer | Pass | Filler Metal Class | Filler Metal Ø | Wire Feed Speed (ipm) | Amps. | Volts | Travel Speed (ipm) |
|---|---|---|---|---|---|---|---|---|---|
| *3/8* | *1* | *1* | *1* | *E71T-8* | *0.072* | *115* | *178* | *17.5* | *3.7* |
| | | | | | | | | | |
| | | | | | | | | | |

# PROCEDURE QUALIFICATION RECORD (PQR)

Company Name: **Walters Inc.**
Authorized By: Ken Kerluke
Welding Process(es): **FCAW-S**
Types: **Semi-automatic**
Date Welded: January 23, 2002

PQR No. 57
Welder's Name: John Williamson
Stamp Number: N/A
ArcScan ID # N/A

| **Joint Design** | |
|---|---|
| Type | *Flare Vee Butt* |
| Single or Double Weld | *Single* |
| Backing | *None* |
| Backing Material | *N/A* |
| Back Gouging | *None* |
| Method | *N/A* |




## Base Metal:

| | | |
|---|---|---|
| Material Spec. | *A500* to | Material Spec. *A500* |
| Type or Grade | *C* to | Type or Grade *C* |
| Thickness | *3/8* | *3/8* |
| Diameter (Pipe) | | *N/A* |

## Filler Metals:

AWS Specification _____ *A5.20*
AWS Classification _____ *E71T-8 (NR 232)*
Size of Filler Metal _____ *0.072*

## Heat Treatment:

*None*
Temperature _____
Time _____

## Electrical Characteristics:

Current Type _____ *DC*
Mode of Metal Transfer (GMAW) _____ *N/A*
Polarity _____ *Negative*
Tungsten Electrode Size and Type _____ *None*

## Position:

Position of Groove: *1G (flat)*
Weld Progression _____
Other _____

## Preheat:

Preheat Temperature: *70° F ambient*
Interpass Temperature _____
Other _____

| **Shielding Gas** | | | |
|---|---|---|---|
| | | % Comp. | |
| | Gas | (Mixture) | Flow Rate |
| Shielding: None | - | - | - |
| Trailing: None | - | - | - |

| **Technique:** | |
|---|---|
| String or Weave Bead | *String* |
| Oscillation | *None* |
| Multi-pass or Single Pass (per side) | *Single* |
| Gas Cup Size | *N/A* |
| Interpass Cleaning | *None* |
| Peening | *None* |
| Push or Drag Electrode Angle | *Push* |
| Contact Tube to Work Distance | *5/8"* |

## Welding Data:

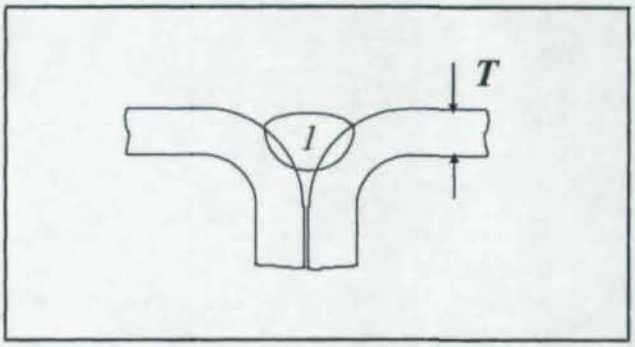
| Wall Size T | Side | Layer | Pass | Filler Metal Class | Filler Metal ∅ | Wire Feed Speed (ipm) | Amps. | Volts | Travel Speed (ipm) |
|---|---|---|---|---|---|---|---|---|---|
| *3/8* | *1* | *1* | *1* | *E71T-8* | *0.072* | *173* | *245* | *22.0* | *9.0* |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |

# PROCEDURE QUALIFICATION RECORD (PQR)

Company Name: **Walters Inc.**
Authorized By: Ken Kerluke
Welding Process(es): **FCAW-S**
Types: **Semi-automatic**
Date Welded: January 23, 2002

PQR No. 58
Welder's Name: John Williamson
Stamp Number: N/A
ArcScan ID # N/A

| **Joint Design** | |
|---|---|
| Type | *Flare Vee Butt* |
| Single or Double Weld | *Single* |
| Backing | *None* |
| Backing Material | *N/A* |
| Back Gouging | *None* |
| Method | *N/A* |




## Base Metal:

| | | |
|---|---|---|
| Material Spec. *A500* | to | Material Spec. *A500* |
| Type or Grade *C* | to | Type or Grade *C* |
| Thickness *3/8* | | *3/8* |
| Diameter (Pipe) | | *N/A* |

## Filler Metals:

AWS Specification _____ *A5.20*
AWS Classification _____ *E71T-8 (NR 232)*
Size of Filler Metal _____ *0.072*

## Heat Treatment:

*None*
Temperature _____
Time _____

## Electrical Characteristics:

Current Type _____ *DC*
Mode of Metal Transfer (GMAW) _____ *N/A*
Polarity _____ *Negative*
Tungsten Electrode Size and Type _____ *None*

## Position:

Position of Groove: *3G (vertical)*
Weld Progression: *Vertical Up*
Other _____

## Preheat:

Preheat Temperature: *70° F ambient*
Interpass Temperature _____
Other _____

| **Shielding Gas** | | | |
|---|---|---|---|
| | | % Comp. | |
| | Gas | (Mixture) | Flow Rate |
| Shielding: None | - | - | - |
| Trailing: None | - | - | - |

| **Technique:** | |
|---|---|
| String or Weave Bead | *String* |
| Oscillation | *None* |
| Multi-pass or Single Pass (per side) | *Single* |
| Gas Cup Size | *N/A* |
| Interpass Cleaning | *None* |
| Peening | *None* |
| Push or Drag Electrode Angle | *0°* |
| Contact Tube to Work Distance | *5/8"* |

## Welding Data:

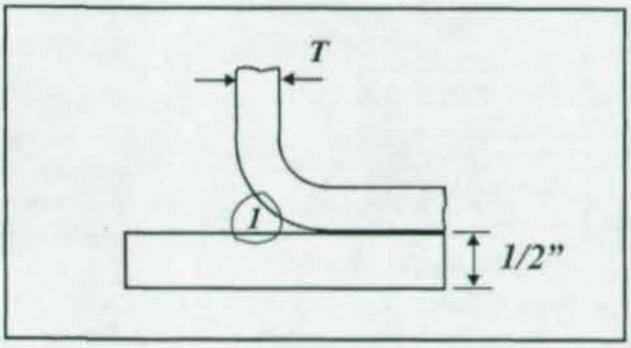
| Wall Size T | Side | Layer | Pass | Filler Metal Class | Filler Metal ∅ | Wire Feed Speed (ipm) | Amps. | Volts | Travel Speed (ipm) |
|---|---|---|---|---|---|---|---|---|---|
| *3/8* | *1* | *1* | *1* | *E71T-8* | *0.072* | *164* | *220* | *22.0* | *5.9* |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |

# PROCEDURE QUALIFICATION RECORD (PQR)

Company Name: **Walters Inc.**
Authorized By: Ken Kerluke
Welding Process(es): **FCAW-S**
Types: **Semi-automatic**
Date Welded: January 23, 2002

PQR No. 59
Welder's Name: John Williamson
Stamp Number: N/A
ArcScan ID# N/A

| **Joint Design** | |
|---|---|
| Type | *Flare Bevel Tee* |
| Single or Double Weld | *Single* |
| Backing | *None* |
| Backing Material | *N/A* |
| Back Gouging | *None* |
| Method | *N/A* |




## Base Metal:

| | | |
|---|---|---|
| Material Spec. *A500* | to | Material Spec. *G40.21* |
| Type or Grade *C* | to | Type or Grade *44W* |
| Thickness *3/8* | | *1/2* |
| Diameter (Pipe) | | *N/A* |

## Filler Metals:

AWS Specification _____ *A5.20*
AWS Classification _____ *E71T-8 (NR-232)*
Size of Filler Metal _____ *0.072*

## Heat Treatment: *None*

Temperature _____
Time _____

## Electrical Characteristics:

Current Type _____ *DC*
Mode of Metal Transfer (GMAW) _____ *N/A*
Polarity _____ *Negative*
Tungsten Electrode Size and Type _____ *None*

## Position:

Position of Groove: *4G (overhead)*
Weld Progression _____
Other _____

## Preheat:

Preheat Temperature: *70° F ambient*
Interpass Temperature _____
Other _____

| **Shielding Gas** | | | |
|---|---|---|---|
| | | % Comp. | |
| | Gas | (Mixture) | Flow Rate |
| Shielding: *None* | - | - | - |
| Trailing: *None* | - | - | - |

| **Technique** | |
|---|---|
| String or Weave Bead | *String* |
| Oscillation | *None* |
| Multi-pass or Single Pass (per side) | *Single* |
| Gas Cup Size | *N/A* |
| Interpass Cleaning | *None* |
| Peening | *None* |
| Push or Drag Electrode Angle | *Drag* |
| Contact Tube to Work Distance | *1/2"* |

## Welding Data:

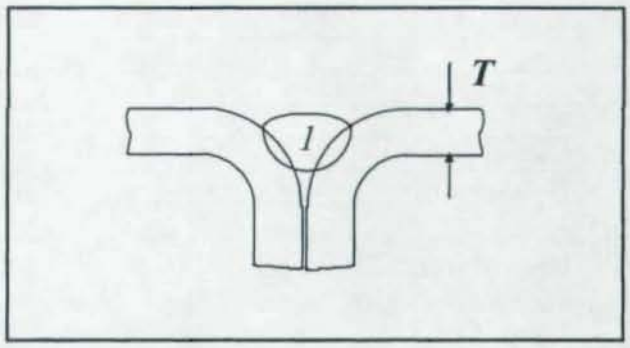
| Wall Size T | Side | Layer | Pass | Filler Metal Class | Filler Metal ∅ | Wire Feed Speed (ipm) | Amps. | Volts | Travel Speed (ipm) |
|---|---|---|---|---|---|---|---|---|---|
| *3/8* | *1* | *1* | *1* | *E71T-8* | *0.072* | *153* | *225* | *20.0* | *6.2* |
| | | | | | | | | | |
| | | | | | | | | | |

# PROCEDURE QUALIFICATION RECORD (PQR)

Company Name: **Walters Inc.**
Authorized By: Ken Kerluke
Welding Process(es): **FCAW-S**
Types: **Semi-automatic**
Date Welded: January 23, 2002

PQR No. 60
Welder's Name: John Williamson
Stamp Number: N/A
ArcScan ID # N/A

| **Joint Design** | |
|---|---|
| Type | *Flare Vee Butt* |
| Single or Double Weld | *Single* |
| Backing | *None* |
| Backing Material | *N/A* |
| Back Gouging | *None* |
| Method | *N/A* |




### Base Metal:

| | | |
|---|---|---|
| Material Spec. | *A500* to | Material Spec. *A500* |
| Type or Grade | *C* to | Type or Grade *C* |
| Thickness | *3/8* | *3/8* |
| Diameter (Pipe) | | *N/A* |

### Filler Metals:

| | |
|---|---|
| AWS Specification _____ | *A5.20* |
| AWS Classification _____ | *E71T-8 (NR 232)* |
| Size of Filler Metal _____ | *0.072* |

### Heat Treatment:

*None*

Temperature _____
Time _____

### Electrical Characteristics:

| | |
|---|---|
| Current Type _____ | *DC* |
| Mode of Metal Transfer (GMAW) _____ | *N/A* |
| Polarity _____ | *Negative* |
| Tungsten Electrode Size and Type _____ | *None* |

### Position:

Position of Groove: *4G (overhead)*
Weld Progression _____
Other _____

### Preheat:

Preheat Temperature: *70°F ambient*
Interpass Temperature _____
Other _____

| **Shielding Gas** | | | |
|---|---|---|---|
| | | % Comp. | |
| | Gas | (Mixture) | Flow Rate |
| Shielding: None | - | - | - |
| Trailing: None | - | - | - |

| **Technique:** | |
|---|---|
| String or Weave Bead | *String* |
| Oscillation | *None* |
| Multi-pass or Single Pass (per side) | *Single* |
| Gas Cup Size | *N/A* |
| Interpass Cleaning | *None* |
| Peening | *None* |
| Push or Drag Electrode Angle | *Drag* |
| Contact Tube to Work Distance | *5/8"* |

### Welding Data:

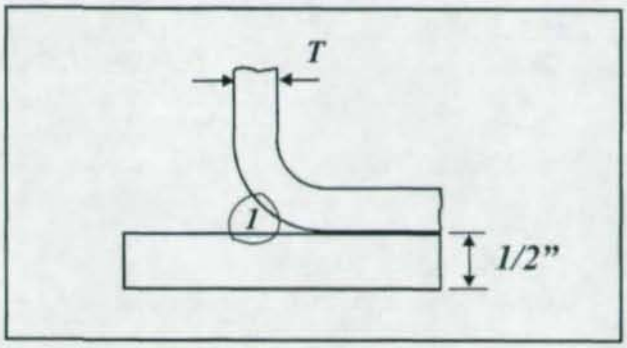
| Wall Size T | Side | Layer | Pass | Filler Metal Class | Filler Metal Ø | Wire Feed Speed (ipm) | Amps. | Volts | Travel Speed (ipm) |
|---|---|---|---|---|---|---|---|---|---|
| *3/8* | *1* | *1* | *1* | *E71T-8* | *0.072* | *153* | *226* | *20.0* | *6.6* |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |

# PROCEDURE QUALIFICATION RECORD (PQR)

Company Name: **Walters Inc.**
Authorized By: Ken Kerluke
Welding Process(es): **GMAW**
Types: **Semi-automatic**
Date Welded: January 23, 2002

PQR No. 61
Welder's Name: John Williamson
Stamp Number: N/A
ArcScan ID# N/A

| **Joint Design** | |
|---|---|
| Type | *Flare Bevel Tee* |
| Single or Double Weld | *Single* |
| Backing | *None* |
| Backing Material | *N/A* |
| Back Gouging | *None* |
| Method | *N/A* |




## Base Metal:

| | | |
|---|---|---|
| Material Spec. | *A500* | to Material Spec. *G40.21* |
| Type or Grade | *C* | to Type or Grade *44W* |
| Thickness | *3/8* | *1/2* |
| Diameter (Pipe) | | *N/A* |

## Filler Metals:

AWS Specification _____ *A5.18*
AWS Classification _____ *E70S-6*
Size of Filler Metal _____ *0.045*

## Heat Treatment:

*None*
Preheat Temperature: *70° F ambient*
Temperature _____
Time _____

## Position:

Position of Groove: *2G (horizontal)*
Weld Progression:
Other _____

**Preheat:** Interpass Temperature _____
Other _____

## Electrical Characteristics:

Current Type _____ *DC*
Mode of Metal Transfer (GMAW) _____ *Spray*
Polarity _____ *Positive*
Tungsten Electrode Size and Type _____ *None*

| **Shielding Gas** | | | |
|---|---|---|---|
| | | % Comp. | |
| | Gas | (Mixture) | Flow |
| Shielding: | *C-10* | *90% Ar 10-% $CO_2$* | *35 cfh* |
| Trailing: *None* | | | |

| **Technique** | |
|---|---|
| String or Weave Bead | *String* |
| Oscillation | *None* |
| Multi-pass or Single Pass (per side) | *Single* |
| Gas Cup Size | *5/8" Ø* |
| Interpass Cleaning | *None* |
| Peening | *None* |
| Push or Drag Electrode Angle | *Push* |
| Contact Tube to Work Distance | *5/8"* |

## Welding Data:

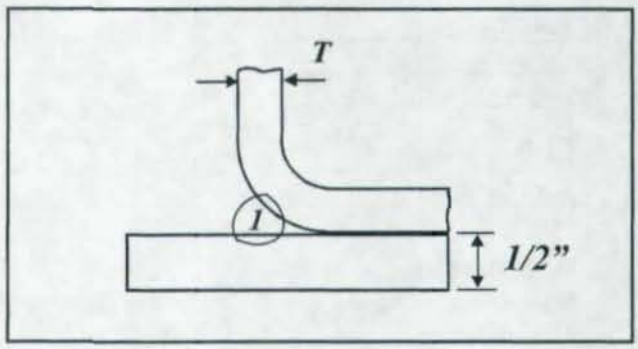
| Wall Size T | Side | Layer | Pass | Filler Metal Class | Filler Metal Ø | Wire Feed Speed (ipm) | Amps. | Volts | Travel Speed (ipm) |
|---|---|---|---|---|---|---|---|---|---|
| *3/8* | *1* | *1* | *1* | *E70S-6* | *0.045* | *330* | *209* | *27.1* | *8.5* |
| | | | | | | | | | |
| | | | | | | | | | |

# PROCEDURE QUALIFICATION RECORD (PQR)

Company Name: **Walters Inc.**
Authorized By: Ken Kerluke
Welding Process(es): **GMAW**
Types: **Semi-automatic**
Date Welded: January 23, 2002

PQR No. 62
Welder's Name: John Williamson
Stamp Number: N/A
ArcScan ID# 097

| **Joint Design** | |
|---|---|
| Type | *Flare Bevel Tee* |
| Single or Double Weld | *Single* |
| Backing | *None* |
| Backing Material | *N/A* |
| Back Gouging | *None* |
| Method | *N/A* |




## Base Metal:

| | | |
|---|---|---|
| Material Spec. | *A500* | to Material Spec. *G40.21* |
| Type or Grade | *C* | to Type or Grade *44W* |
| Thickness | *3/8* | *1/2* |
| Diameter (Pipe) | | *N/A* |

## Filler Metals:

AWS Specification _____ *A5.18*
AWS Classification _____ *E70S-6*
Size of Filler Metal _____ *0.045*

## Heat Treatment:

Preheat Temperature: *70° F ambient*
Temperature _____ *None*
Time _____

## Position:

Position of Groove: *3G (vertical)*
Weld Progression: *Vertical Down*
Other _____

## Preheat:

Interpass Temperature _____
Other _____

## Electrical Characteristics:

Current Type _____ *DC*
Mode of Metal Transfer (GMAW) _____ *Spray*
Polarity _____ *Positive*
Tungsten Electrode Size and Type _____ *None*

| **Shielding Gas** | | | |
|---|---|---|---|
| | | % Comp. | |
| | Gas | (Mixture) | Flow |
| Shielding: | *C-10* | *90% Ar 10-% $CO_2$* | *35 cfh* |
| Trailing: *None* | | | |

| **Technique** | |
|---|---|
| String or Weave Bead | *String* |
| Oscillation | *None* |
| Multi-pass or Single Pass (per side) | *Single* |
| Gas Cup Size | *5/8" Ø* |
| Interpass Cleaning | *None* |
| Peening | *None* |
| Push or Drag Electrode Angle | *Drag* |
| Contact Tube to Work Distance | *1/2"* |

## Welding Data:

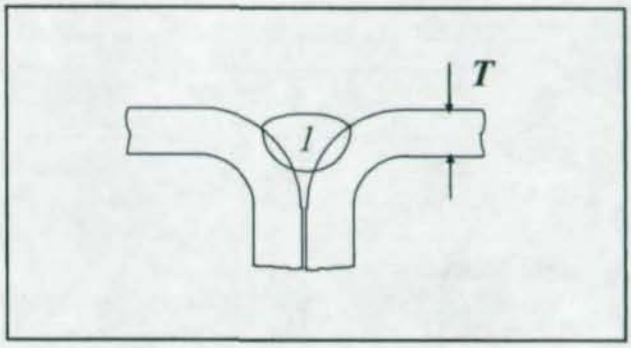
| Wall Size T | Side | Layer | Pass | Filler Metal Class | Filler Metal Ø | Wire Feed Speed (ipm) | Amps. | Volts | Travel Speed (ipm) |
|---|---|---|---|---|---|---|---|---|---|
| *3/8* | *1* | *1* | *1* | *E70S-6* | *0.045* | *330* | *239* | *24.4* | *10.5* |
| | | | | | | | | | |
| | | | | | | | | | |

# PROCEDURE QUALIFICATION RECORD (PQR)

Company Name: **Walters Inc.**
Authorized By: Ken Kerluke
Welding Process(es): **GMAW**
Types: **Semi-automatic**
Date Welded: January 23, 2002

PQR No. 63
Welder's Name: John Williamson
Stamp Number: N/A
ArcScan ID# N/A

| **Joint Design** | |
|---|---|
| Type | *Flare Vee Butt* |
| Single or Double Weld | *Single* |
| Backing | *None* |
| Backing Material | *N/A* |
| Back Gouging | *None* |
| Method | *N/A* |




## Base Metal:

| | | |
|---|---|---|
| Material Spec. | *A500* to | Material Spec. *A500* |
| Type or Grade | *C* to | Type or Grade *C* |
| Thickness | *3/8* | *3/8* |
| Diameter (Pipe) | | *N/A* |

## Filler Metals:

AWS Specification _____ *A5.18*
AWS Classification _____ *E70S-6*
Size of Filler Metal _____ *0.045*

## Heat Treatment: *None*

Temperature _____
Time _____

## Electrical Characteristics:

Current Type _____ *DC*
Mode of Metal Transfer (GMAW) _____ *Spray*
Polarity _____ *Positive*
Tungsten Electrode Size and Type _____ *None*

## Position:

Position of Groove: *1G (flat)*
Weld Progression _____
Other _____

## Preheat:

Preheat Temperature: *70° F ambient*
Interpass Temperature _____
Other _____

| **Shielding Gas** | | | |
|---|---|---|---|
| | | % Comp. | |
| | Gas | (Mixture) | Flow |
| Shielding: | *C-10* | *90% Ar 10-% $CO_2$* | *35 cfh* |
| Trailing: None | | | |

| **Technique:** | |
|---|---|
| String or Weave Bead | *String* |
| Oscillation | *None* |
| Multi-pass or Single Pass (per side) | *Single* |
| Gas Cup Size | *5/8" Ø* |
| Interpass Cleaning | *None* |
| Peening | *None* |
| Push or Drag Electrode Angle | *Push* |
| Contact Tube to Work Distance | *5/8"* |

## Welding Data:

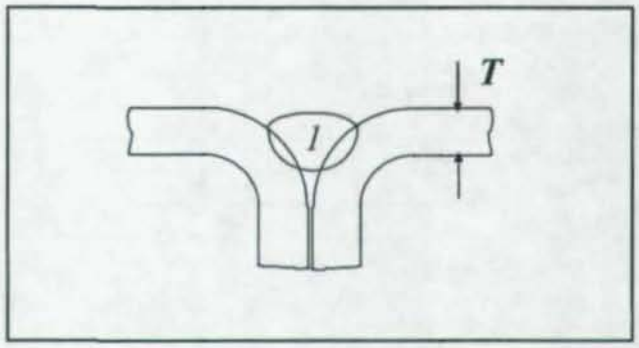
| Wall Size T | Side | Layer | Pass | Filler Metal Class | Filler Metal Ø | Wire Feed Speed (ipm) | Amps. | Volts | Travel Speed (ipm) |
|---|---|---|---|---|---|---|---|---|---|
| *3/8* | *1* | *1* | *1* | *E70S-6* | *0.045* | *330* | *218* | *26.9* | *9.9* |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |

# PROCEDURE QUALIFICATION RECORD (PQR)

Company Name: **Walters Inc.**
Authorized By: Ken Kerluke
Welding Process(es): **GMAW**
Types: **Semi-automatic**
Date Welded: January 23, 2002

PQR No. 64
Welder's Name: John Williamson
Stamp Number: N/A
ArcScan ID# 092

| **Joint Design** | |
|---|---|
| Type | *Flare Vee Butt* |
| Single or Double Weld | *Single* |
| Backing | *None* |
| Backing Material | *N/A* |
| Back Gouging | *None* |
| Method | *N/A* |




### Base Metal:

| | | |
|---|---|---|
| Material Spec. | *A500* to | Material Spec. *A500* |
| Type or Grade | *C* to | Type or Grade *C* |
| Thickness | *3/8* | *3/8* |
| Diameter (Pipe) | | *N/A* |

### Filler Metals:

AWS Specification _____ *A5.18*
AWS Classification _____ *E70S-6*
Size of Filler Metal _____ *0.045*

### Heat Treatment:

*None*
Temperature _____
Time _____

### Electrical Characteristics:

Current Type _____ *DC*
Mode of Metal Transfer (GMAW) _____ *Spray*
Polarity _____ *Positive*
Tungsten Electrode Size and Type _____ *None*

### Position:

Position of Groove: *3G (vertical)*
Weld Progression: *Vertical Down*
Other _____

### Preheat:

Preheat Temperature: *70° F ambient*
Interpass Temperature _____
Other _____

| **Shielding Gas** | | | |
|---|---|---|---|
| | | % Comp. | |
| | Gas | (Mixture) | Flow |
| Shielding: | *C-10* | *90% Ar 10-% $CO_2$* | *35 cfh* |
| Trailing: None | | | |

| **Technique:** | |
|---|---|
| String or Weave Bead | *String* |
| Oscillation | *None* |
| Multi-pass or Single Pass (per side) | *Single* |
| Gas Cup Size | *5/8" Ø* |
| Interpass Cleaning | *None* |
| Peening | *None* |
| Push or Drag Electrode Angle | *Drag* |
| Contact Tube to Work Distance | *1/2"* |

### Welding Data:

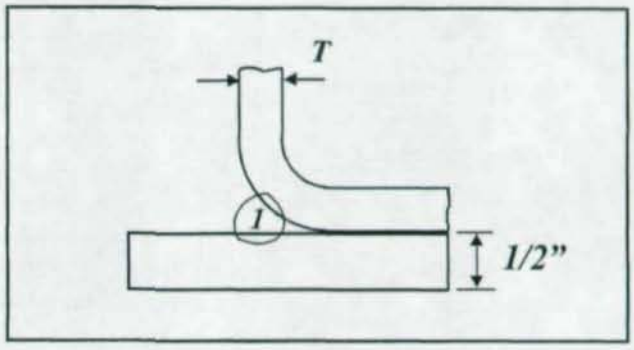
| Wall Size T | Side | Layer | Pass | Filler Metal Class | Filler Metal Ø | Wire Feed Speed (ipm) | Amps. | Volts | Travel Speed (ipm) |
|---|---|---|---|---|---|---|---|---|---|
| *3/8* | *1* | *1* | *1* | *E70S-6* | *0.045* | *330* | *242* | *24.5* | *15.0* |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |

# PROCEDURE QUALIFICATION RECORD (PQR)

Company Name: **Walters Inc.**
Authorized By: Ken Kerluke
Welding Process(es): **GMAW**
Types: **Semi-automatic**
Date Welded: January 23, 2002

PQR No. 65
Welder's Name: John Williamson
Stamp Number: N/A
ArcScan ID# 099

| **Joint Design** | |
|---|---|
| Type | *Flare Bevel Tee* |
| Single or Double Weld | *Single* |
| Backing | *None* |
| Backing Material | *N/A* |
| Back Gouging | *None* |
| Method | *N/A* |




## Base Metal:

| | | |
|---|---|---|
| Material Spec. | *A500* to | Material Spec. *G40.21* |
| Type or Grade | *C* to | Type or Grade *44W* |
| Thickness | *3/8* | *1/2* |
| Diameter (Pipe) | | *N/A* |

## Position:

Position of Groove: *4G (overhead)*
Weld Progression _____
Other _____

## Filler Metals:

AWS Specification _____ *A5.18*
AWS Classification _____ *E70S-6*
Size of Filler Metal _____ *0.045*

## Heat Treatment:

Preheat Temperature: *70°F ambient*
Temperature _____
Time _____

## Preheat:

Interpass Temperature _____
Other _____

## Electrical Characteristics:

Current Type _____ *DC*
Mode of Metal Transfer (GMAW) _____ *Spray*
Polarity _____ *Positive*
Tungsten Electrode Size and Type _____ *None*

| **Shielding Gas** | | | |
|---|---|---|---|
| | | % Comp. | |
| | Gas | (Mixture) | Flow |
| Shielding: | *C-10* | *90% Ar 10-% $CO_2$* | *35 cfh* |
| Trailing: *None* | | | |

| **Technique** | |
|---|---|
| String or Weave Bead | *String* |
| Oscillation | *None* |
| Multi-pass or Single Pass (per side) | *Single* |
| Gas Cup Size | *5/8" Ø* |
| Interpass Cleaning | *None* |
| Peening | *None* |
| Push or Drag Electrode Angle | *Push* |
| Contact Tube to Work Distance | *1/2"* |

## Welding Data:

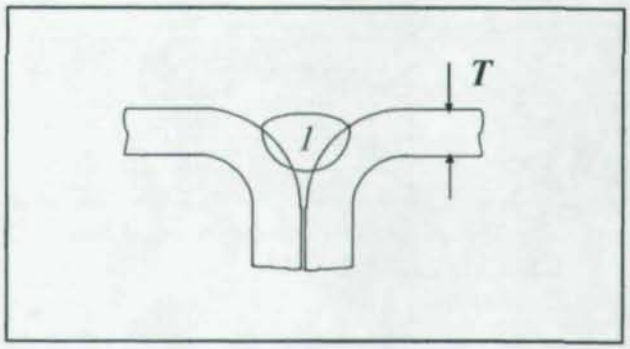
| Wall Size T | Side | Layer | Pass | Filler Metal Class | Filler Metal Ø | Wire Feed Speed (ipm) | Amps. | Volts | Travel Speed (ipm) |
|---|---|---|---|---|---|---|---|---|---|
| *3/8* | *1* | *1* | *1* | *E70S-6* | *0.045* | *330* | *240* | *25.4* | *8.0* |
| | | | | | | | | | |
| | | | | | | | | | |

# PROCEDURE QUALIFICATION RECORD (PQR)

Company Name: **Walters Inc.**
Authorized By: Ken Kerluke
Welding Process(es): **GMAW**
Types: **Semi-automatic**
Date Welded: January 23, 2002

PQR No. 66
Welder's Name: John Williamson
Stamp Number: N/A
ArcScan ID# 098

| **Joint Design** | |
|---|---|
| Type | *Flare Vee Butt* |
| Single or Double Weld | *Single* |
| Backing | *None* |
| Backing Material | *N/A* |
| Back Gouging | *None* |
| Method | *N/A* |




## Base Metal:

| | | |
|---|---|---|
| Material Spec. | *A500* to | Material Spec. *A500* |
| Type or Grade | *C* to | Type or Grade *C* |
| Thickness | *3/8* | *3/8* |
| Diameter (Pipe) | | *N/A* |

## Filler Metals:

AWS Specification _____ *A5.18*
AWS Classification _____ *E70S-6*
Size of Filler Metal _____ *0.045*

## Heat Treatment: *None*

Temperature _____
Time _____

## Position:

Position of Groove: *4G (overhead)*
Weld Progression _____
Other _____

## Preheat:

Preheat Temperature: *70° F ambient*
Interpass Temperature _____
Other _____

## Electrical Characteristics:

Current Type _____ *DC*
Mode of Metal Transfer (GMAW) _____ *Spray*
Polarity _____ *Positive*
Tungsten Electrode Size and Type _____ *None*

| **Shielding Gas** | | | |
|---|---|---|---|
| | | % Comp. | |
| | Gas | (Mixture) | Flow |
| Shielding: | *C-10* | *90% Ar 10-% $CO_2$* | *35 cfh* |
| Trailing: None | | | |

| **Technique:** | |
|---|---|
| String or Weave Bead | *String* |
| Oscillation | *None* |
| Multi-pass or Single Pass (per side) | *Single* |
| Gas Cup Size | *5/8" ∅* |
| Interpass Cleaning | *None* |
| Peening | *None* |
| Push or Drag Electrode Angle | *Push* |
| Contact Tube to Work Distance | *1/2"* |

## Welding Data:

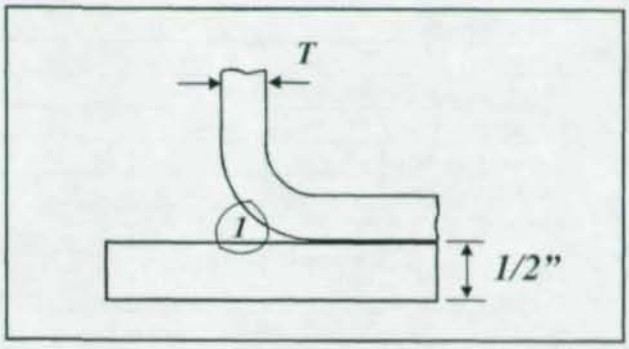
| Wall Size T | Side | Layer | Pass | Filler Metal Class | Filler Metal ∅ | Wire Feed Speed (ipm) | Amps. | Volts | Travel Speed (ipm) |
|---|---|---|---|---|---|---|---|---|---|
| *3/8* | *1* | *1* | *1* | *E70S-6* | *0.045* | *330* | *235* | *25.4* | *7.5* |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |

# PROCEDURE QUALIFICATION RECORD (PQR)

Company Name: **Walters Inc.**
Authorized By: Ken Kerluke
Welding Process(es): **SMAW**
Types: **Manual**
Date Welded: January 23, 2002

PQR No. 67
Welder's Name: John Williamson
Stamp Number: N/A
ArcScan ID#: 76, 77, 78

| **Joint Design** | |
|---|---|
| Type | *Flare Bevel Tee* |
| Single or Double Weld | *Single* |
| Backing | *None* |
| Backing Material | *N/A* |
| Back Gouging | *None* |
| Method | *N/A* |




## Base Metal:

| | | |
|---|---|---|
| Material Spec. *A500* | to | Material Spec. *G40.21* |
| Type or Grade *C* | to | Type or Grade *44W* |
| Thickness *3/8* | | *1/2* |
| Diameter (Pipe) | | *N/A* |

## Filler Metals:

AWS Specification _____ *A5.1*
AWS Classification _____ *E7018*
Size of Filler Metal _____ *1/8*

## Heat Treatment: *None*

Temperature _____
Time _____

## Position:

Position of Groove: *2G (horizontal)*
Weld Progression:
Other _____

## Preheat:

Preheat Temperature: 70° F ambient
Interpass Temperature _____
Other _____

## Electrical Characteristics:

Current Type _____ *DC*
Mode of Metal Transfer (GMAW) _____ *N/A*
Polarity _____ *Positive*
Tungsten Electrode Size and Type _____ *None*

| **Shielding Gas** | | | |
|---|---|---|---|
| | | % Comp. | |
| | Gas | (Mixture) | Flow Rate |
| Shielding: *None* | | | |
| Trailing: *None* | | | |
| Backing: *None* | | | |

| **Technique** | |
|---|---|
| String or Weave Bead | *String* |
| Oscillation | *None* |
| Multi-pass or Single Pass (per side) | *Single* |
| Gas Cup Size | *N/A* |
| Interpass Cleaning | *None* |
| Peening | *None* |
| Push or Drag Electrode Angle | *Drag* |
| Contact Tube to Work Distance | *N/A* |

## Welding Data:

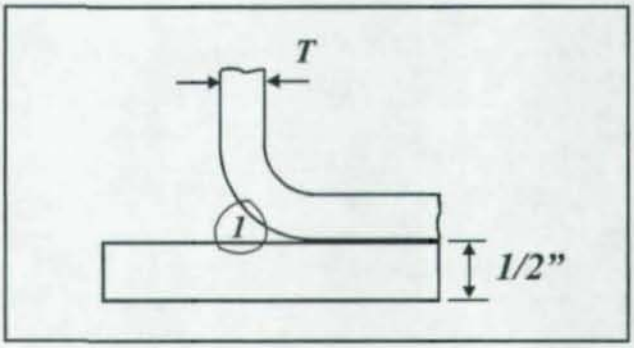
| Wall Size T | Side | Layer | Pass | Filler Metal Class | Filler Metal ∅ | Wire Feed Speed (ipm) | Amps. | Volts | Travel Speed (ipm) |
|---|---|---|---|---|---|---|---|---|---|
| *3/8* | *1* | *1* | *1* | *E7018* | *1/8* | *N/A* | *122* | - | *2.4* |
| | | | | | | | | | |
| | | | | | | | | | |

# PROCEDURE QUALIFICATION RECORD (PQR)

Company Name: **Walters Inc.**
Authorized By: Ken Kerluke
Welding Process(es): **SMAW**
Types: **Manual**
Date Welded: January 23, 2002

PQR No. 68
Welder's Name: John Williamson
Stamp Number: N/A
ArcScan ID#: 79, 80

| **Joint Design** | |
|---|---|
| Type | *Flare Bevel Tee* |
| Single or Double Weld | *Single* |
| Backing | *None* |
| Backing Material | *N/A* |
| Back Gouging | *None* |
| Method | *N/A* |




## Base Metal:

Material Spec. *A500* to Material Spec. *G40.21*
Type or Grade *C* to Type or Grade *44W*
Thickness *3/8* *1/2*
Diameter (Pipe) *N/A*

## Position:

Position of Groove: *3G (vertical)*
Weld Progression: *Vertical Up*
Other _____

## Filler Metals:

AWS Specification _____ *A5.1*
AWS Classification _____ *E7018*
Size of Filler Metal _____ *1/8*

## Preheat:

Preheat Temperature: 70° F ambient
Interpass Temperature _____
Other _____

## Heat Treatment: *None*

Temperature _____
Time _____

## Electrical Characteristics:

Current Type _____ *DC*
Mode of Metal Transfer (GMAW) _____ *N/A*
Polarity _____ *Positive*
Tungsten Electrode Size and Type _____ *None*

| **Shielding Gas** | | | |
|---|---|---|---|
| | | % Comp. | |
| | Gas | (Mixture) | Flow Rate |
| Shielding: *None* | | | |
| Trailing: *None* | | | |
| Backing: *None* | | | |

| **Technique** | |
|---|---|
| String or Weave Bead | *String* |
| Oscillation | *None* |
| Multi-pass or Single Pass (per side) | *Single* |
| Gas Cup Size | *N/A* |
| Interpass Cleaning | *None* |
| Peening | *None* |
| Push or Drag Electrode Angle | *Push* |
| Contact Tube to Work Distance | *N/A* |

## Welding Data:

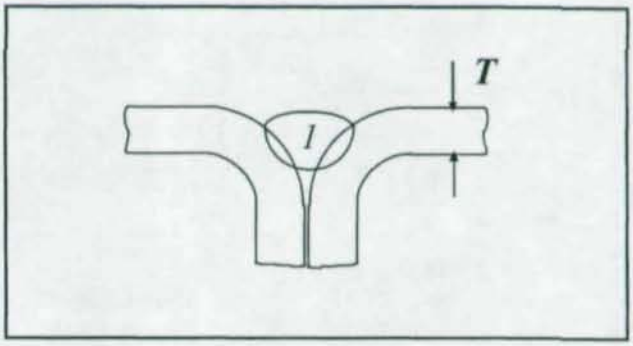
| Wall Size T | Side | Layer | Pass | Filler Metal Class | Filler Metal ∅ | Wire Feed Speed (ipm) | Amps. | Volts | Travel Speed (ipm) |
|---|---|---|---|---|---|---|---|---|---|
| *3/8* | *1* | *1* | *1* | *E7018* | *1/8* | *N/A* | *120* | - | *3.3* |
| | | | | | | | | | |
| | | | | | | | | | |

# PROCEDURE QUALIFICATION RECORD (PQR)

Company Name: **Walters Inc.**
Authorized By: Ken Kerluke
Welding Process(es): **SMAW**
Types: **Manual**
Date Welded: January 23, 2002

PQR No. 69
Welder's Name: John Williamson
Stamp Number: N/A
ArcScan ID #: 36

| **Joint Design** | |
|---|---|
| Type | *Flare Vee Butt* |
| Single or Double Weld | *Single* |
| Backing | *None* |
| Backing Material | *N/A* |
| Back Gouging | *None* |
| Method | *N/A* |




## Base Metal:

| | | |
|---|---|---|
| Material Spec. | *A500* to | Material Spec. *A500* |
| Type or Grade | *C* to | Type or Grade *C* |
| Thickness | *3/8* | *3/8* |
| Diameter (Pipe) | | *N/A* |

## Filler Metals:

AWS Specification _____ *A5.1*
AWS Classification _____ *E7018*
Size of Filler Metal _____ *1/8*

## Heat Treatment: *None*

Temperature _____
Time _____

## Electrical Characteristics:

Current Type _____ *DC*
Mode of Metal Transfer (GMAW) _____ *N/A*
Polarity _____ *Positive*
Tungsten Electrode Size and Type _____ *None*

## Position:

Position of Groove: *1G (flat)*
Weld Progression:
Other _____

## Preheat:

Preheat Temperature: *70° ambient*
Interpass Temperature _____
Other _____

| **Shielding Gas** | | | |
|---|---|---|---|
| | | % Comp. | |
| | Gas | (Mixture) | Flow Rate |
| Shielding: *None* | | | |
| Trailing: *None* | | | |
| Backing: *None* | | | |

| **Technique** | |
|---|---|
| String or Weave Bead | *String* |
| Oscillation | *None* |
| Multi-pass or Single Pass (per side) | *Single* |
| Gas Cup Size | *N/A* |
| Interpass Cleaning | *None* |
| Peening | *None* |
| Push or Drag Electrode Angle | *Drag* |
| Contact Tube to Work Distance | *N/A* |

## Welding Data:

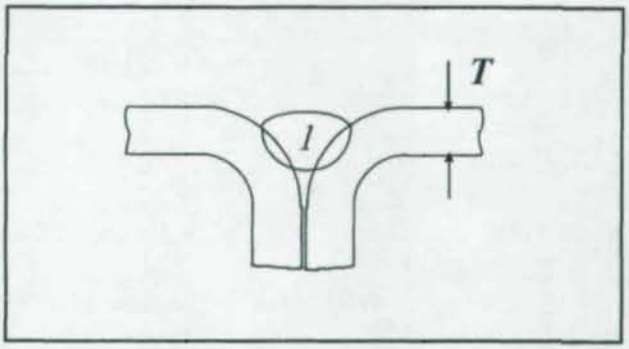
| Wall Size T | Side | Layer | Pass | Filler Metal Class | Filler Metal ∅ | Wire Feed Speed (ipm) | Amps. | Volts | Travel Speed (ipm) |
|---|---|---|---|---|---|---|---|---|---|
| *3/8* | *1* | *1* | *1* | *E7018* | *1/8* | *N/A* | *130* | - | *3.8* |
| | | | | | | | | | |
| | | | | | | | | | |

# PROCEDURE QUALIFICATION RECORD (PQR)

Company Name: **Walters Inc.**
Authorized By: Ken Kerluke
Welding Process(es): **SMAW**
Types: **Manual**
Date Welded: January 23, 2002

PQR No. 70
Welder's Name: John Williamson
Stamp Number: N/A
ArcScan ID #: 37, 38

| **Joint Design** | |
|---|---|
| Type | *Flare Vee Butt* |
| Single or Double Weld | *Single* |
| Backing | *None* |
| Backing Material | *N/A* |
| Back Gouging | *None* |
| Method | *N/A* |




## Base Metal:

Material Spec. *A500* to Material Spec. *A500*
Type or Grade *C* to Type or Grade *C*
Thickness *3/8* *3/8*
Diameter (Pipe) *N/A*

## Filler Metals:

AWS Specification _____ *A5.1*
AWS Classification _____ *E7018*
Size of Filler Metal _____ *1/8*

## Heat Treatment: *None*

Temperature _____
Time _____

## Electrical Characteristics:

Current Type _____ *DC*
Mode of Metal Transfer (GMAW) _____ *N/A*
Polarity _____ *Positive*
Tungsten Electrode Size and Type _____ *None*

## Position:

Position of Groove: 3*G (vertical)*
Weld Progression: *Vertical Up*
Other _____

## Preheat:

Preheat Temperature: *70° ambient*
Interpass Temperature _____
Other _____

| **Shielding Gas** | | | |
|---|---|---|---|
| | | % Comp. | |
| | Gas | (Mixture) | Flow Rate |
| Shielding: *None* | | | |
| Trailing: *None* | | | |
| Backing: *None* | | | |

| **Technique** | |
|---|---|
| String or Weave Bead | *Slight Weave* |
| Oscillation | *None* |
| Multi-pass or Single Pass (per side) | *Single* |
| Gas Cup Size | *N/A* |
| Interpass Cleaning | *None* |
| Peening | *None* |
| Push or Drag Electrode Angle | *Push* |
| Contact Tube to Work Distance | *N/A* |

## Welding Data:

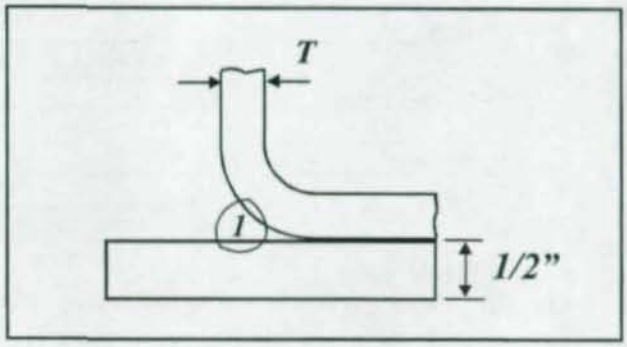
| Wall Size T | Side | Layer | Pass | Filler Metal Class | Filler Metal ∅ | Wire Feed Speed (ipm) | Amps. | Volts | Travel Speed (ipm) |
|---|---|---|---|---|---|---|---|---|---|
| *3/8* | *1* | *1* | *1* | *E7018* | *1/8* | *N/A* | *130* | - | *2.9* |
| | | | | | | | | | |
| | | | | | | | | | |

# PROCEDURE QUALIFICATION RECORD (PQR)

Company Name: **Walters Inc.**
Authorized By: Ken Kerluke
Welding Process(es): **SMAW**
Types: **Manual**
Date Welded: January 23, 2002

PQR No. 71
Welder's Name: John Williamson
Stamp Number: N/A
ArcScan ID#: 83, 84, 85

| **Joint Design** | |
|---|---|
| Type | *Flare Bevel Tee* |
| Single or Double Weld | *Single* |
| Backing | *None* |
| Backing Material | *N/A* |
| Back Gouging | *None* |
| Method | *N/A* |




## Base Metal:

| | | |
|---|---|---|
| Material Spec. *A500* | to | Material Spec. *G40.21* |
| Type or Grade *C* | to | Type or Grade *44W* |
| Thickness *3/8* | | *1/2* |
| Diameter (Pipe) | | *N/A* |

## Filler Metals:

AWS Specification _____ *A5.1*
AWS Classification _____ *E7018*
Size of Filler Metal _____ *1/8*

## Heat Treatment: *None*

Temperature _____
Time _____

## Electrical Characteristics:

Current Type _____ *DC*
Mode of Metal Transfer (GMAW) _____ *N/A*
Polarity _____ *Positive*
Tungsten Electrode Size and Type _____ *None*

## Position:

Position of Groove: *4G (overhead)*
Weld Progression _____
Other _____

## Preheat:

Preheat Temperature: 70° F ambient
Interpass Temperature _____
Other _____

| **Shielding Gas** | | | |
|---|---|---|---|
| | | % Comp. | |
| | Gas | (Mixture) | Flow Rate |
| Shielding: *None* | | | |
| Trailing: *None* | | | |
| Backing: *None* | | | |

| **Technique** | |
|---|---|
| String or Weave Bead | *String* |
| Oscillation | *None* |
| Multi-pass or Single Pass (per side) | *Single* |
| Gas Cup Size | *N/A* |
| Interpass Cleaning | *None* |
| Peening | *None* |
| Push or Drag Electrode Angle | *Drag* |
| Contact Tube to Work Distance | *N/A* |

## Welding Data:

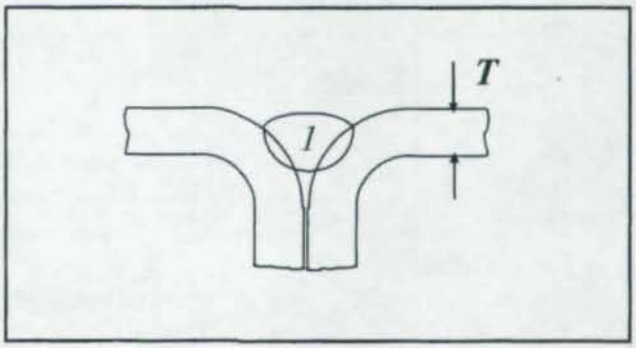
| Wall Size T | Side | Layer | Pass | Filler Metal Class | Filler Metal ∅ | Wire Feed Speed (ipm) | Amps. | Volts | Travel Speed (ipm) |
|---|---|---|---|---|---|---|---|---|---|
| *3/8* | *1* | *1* | *1* | *E7018* | *1/8* | *N/A* | *122* | - | *2.7* |
| | | | | | | | | | |
| | | | | | | | | | |

# PROCEDURE QUALIFICATION RECORD (PQR)

Company Name: **Walters Inc.**
Authorized By: Ken Kerluke
Welding Process(es): **SMAW**
Types: **Manual**
Date Welded: January 23, 2002

PQR No. 72
Welder's Name: John Williamson
Stamp Number: N/A
ArcScan ID #: 39, 40, 41

| **Joint Design** | |
|---|---|
| Type | *Flare Vee Butt* |
| Single or Double Weld | *Single* |
| Backing | *None* |
| Backing Material | *N/A* |
| Back Gouging | *None* |
| Method | *N/A* |




## Base Metal:

| | | |
|---|---|---|
| Material Spec. *A500* | to | Material Spec. *A500* |
| Type or Grade *C* | to | Type or Grade *C* |
| Thickness *3/8* | | *3/8* |
| Diameter (Pipe) | | *N/A* |

## Filler Metals:

AWS Specification _____ *A5.1*
AWS Classification _____ *E7018*
Size of Filler Metal _____ *1/8*

## Heat Treatment: *None*

Temperature _____
Time _____

## Electrical Characteristics:

Current Type _____ *DC*
Mode of Metal Transfer (GMAW) _____ *N/A*
Polarity _____ *Positive*
Tungsten Electrode Size and Type _____ *None*

## Position:

Position of Groove: *4G (overhead)*
Weld Progression:
Other _____

## Preheat:

Preheat Temperature: *70° ambient*
Interpass Temperature _____
Other _____

| **Shielding Gas** | | | |
|---|---|---|---|
| | | % Comp. | |
| | Gas | (Mixture) | Flow Rate |
| Shielding: *None* | | | |
| Trailing: *None* | | | |
| Backing: *None* | | | |

| **Technique** | |
|---|---|
| String or Weave Bead | *String* |
| Oscillation | *None* |
| Multi-pass or Single Pass (per side) | *Single* |
| Gas Cup Size | *N/A* |
| Interpass Cleaning | *None* |
| Peening | *None* |
| Push or Drag Electrode Angle | *Drag* |
| Contact Tube to Work Distance | *N/A* |

## Welding Data:

| Wall Size T | Side | Layer | Pass | Filler Metal Class | Filler Metal Ø | Wire Feed Speed (ipm) | Amps. | Volts | Travel Speed (ipm) |
|---|---|---|---|---|---|---|---|---|---|
| *3/8* | *1* | *1* | *1* | *E7018* | *1/8* | *N/A* | *130* | - | *3.1* |
| | | | | | | | | | |
| | | | | | | | | | |