provided here. *Additional links may exist in the document.*

CAUTION: *This icon identifies possible safety hazards and/or serves as a reminder to take necessary precautions.*

8. Skidding/Cribbing

Pipe skidding shall be in the form of cribs spaced to adequately support the pipe. Skids shall be made of hardwoods with dimensions (h x w x l) four (4") inches by six (6") inches by four (4') feet or equivalent. Softwoods such as landscape timbers or pine 4x4's are not allowed. Crotched cribs shall be installed at the start of each section and thereafter at a minimum of one every tenth joint on single random lengths (single joints) and every fifth joint on double random lengths (double joints). Crotched cribs shall also be installed at all overbends and side bends. For pipe smaller than twenty (20") inch OD, semi-cribs may be used except that a full crotched crib shall be installed at the start of each section (every 400 feet minimum and at all overbends and side bends). Installer shall provide tie off equipment or device deadman as deemed necessary by terrain or the NGBU Representative.

Skidding of the line after completion of the root bead (and hot pass when applicable) shall be performed in a manner that will minimize stress on the weld and render the line safe for workers.

When, in the opinion of the NGBU Representative, the skidding has become unsafe due to movement caused by temperature changes or for any reason, the installer shall re-skid such sections to render them safe.

9. Qualification of Welding Procedure Specifications and Welders

9.1. Welding Procedure Specification Qualifications

9.1.1. All welding shall conform to NGBU's welding procedures found in WEL-PR-1010. Specific welding procedures will be furnished to installer prior to the start of construction. In lieu of or in the absence of these procedures, installer may propose welding procedures developed or used by installer; however, all procedures proposed by installer shall be submitted for approval. NGBU will recommend welding procedures for peculiar or uncommon materials when requested by installer. A written record of the welding procedure, approved by NGBU, shall be retained by NGBU. Installer shall assume liability and be responsible for the adaptation of his welding techniques to the welding procedures furnished and/or approved by NGBU.

9.1.2. Automatic welding process shall be permitted with the express permission of Gas Engineering and with prior procedure qualification. NGBU reserves the right to withdraw such permission if the weld quality does not meet NGBU standards.

9.1.3. With prior procedure approval, the installer may use semi-automatic CO, gas metal arc, gas tungsten arc, shielded metal arc or a combination of CO, gas metal arc or gas tungsten arc for the root pass and shielded metal arc for the remaining passes.

9.1.4. Any changes in non-essential variables as defined in the applicable welding code shall only be made upon agreement between the Welding Procedure Qualifier and installer. Changes in essential variables shall require a new procedure to be qualified.

9.2. Welder Qualifications

Welders shall be qualified in accordance with WEL-ST-1000.

9.3. Qualification Materials and Equipment

NGBU shall furnish the pipe used for testing Duke Gas Welders. The contractor shall furnish and be responsible for all labor, materials, and equipment, as applicable, associated with their welder testing. Testing equipment shall be approved by the NGBU Representative.

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10. Construction Field Welding Practice

10.1. Welding Equipment

CAUTION: *All welding equipment shall be of a size and type suitable for the work and shall be maintained in a condition that ensures acceptable welds, continuity of operation, and safety of personnel. Equipment that does not meet these requirements shall be repaired or replaced.*

10.1.1. Arc welding equipment shall be operated in accordance with the amperage and voltages ranges specified in the welding procedure. Gas welding equipment shall be operated in accordance with the flame characteristics and tip sizes specified in the welding procedure.

10.2. Storage and Handling of Welding Electrodes

10.2.1. Filler metals and fluxes shall conform to the appropriate American Welding Society (AWS) specification.

10.2.2. Filler metals and fluxes shall be stored and handled to avoid damage to them and to the containers in which they are shipped. Filler metals and fluxes that show signs of damage or deterioration shall discarded.

10.2.3. Pieces of welding rod are to be placed in a container immediately after use by installer at the time the pipe is welded. They shall be removed from the pipeline right-of-way and disposed at an appropriate location. Under no condition shall the welding rod be placed into an open ditch or left to lay along the right-of-way.

10.2.4. Cellulosic SMAW Electrodes (EXX10 type)

Prior to use cellulosic electrodes shall be stored in unopened containers and shall be handled in a manner to avoid damage to the coating. During use, the opened container shall be protected to ensure the coating is not damaged and there is not an excessive loss or absorption of moisture to the coating.

10.2.5. Low-hydrogen SMAW Electrodes (EXX18 type)

Prior to use low-hydrogen electrodes shall be stored in unopened containers and shall be handled in a manner to avoid damage to the coating. During use, the opened container shall be protected to ensure the coating is not damaged and there is no excessive absorption of moisture to the coating. Low-hydrogen electrodes have a manufacturer recommended exposure limit, which must be strictly followed. The low-hydrogen electrodes that have exceeded the manufacturer recommended exposure limit must be stored in a rod oven between 250 - 300ºF. Upon removal from the rod oven, they must be used within 4 hours or discarded. It is recommended that welders purchase rods in 1, 5 or 10-pound packs to minimize the risk of exceeding the manufacturer recommended exposure limit.

10.3. Storage and Handling of Welding Gases

CAUTION: *Shielding gases shall be kept in the containers in which they are supplied, and the containers shall be stored away from extremes of temperature. Gases shall not be field intermixed in their containers. Gases of questionable purity and those in containers that show signs of damage shall not be used.*

10.4. Protection from Weather

CAUTION: *Welding shall not be done when the weather conditions could adversely affect the weld quality.*

10.4.1. Such weather conditions include but are not limited to rain, snow or high winds, unless such welding operations can be properly protected by the use of windshields or other shelter. Shelters could be used to permit welding in adverse weather conditions as long as the weld region is adequately protected. The Welding Inspector shall be the sole authority as to the conditions under which welding may be performed.

10.4.2. Additional precautions shall be taken to prevent excess heat loss when welding in cold weather conditions, strong winds or a combination of these two factors. Such precautions include the use of windscreens or increasing the minimum preheat temperature specified in the welding procedure with approval by a Welding Inspector.

10.5. Joint Preparation

10.5.1. Acceptable Welding Joint Types

Butt weld joint types for equal wall thickness joints are shown in **Figure 1**. Butt weld joint types for unequal wall thickness joints are shown in **Figure**

2. For unequal wall thickness, joints Figure 2b or Figure 2f are preferred. Branch groove weld joint types and minimum dimensions for fillet welds used in branch connections are shown in **Figure 3**. The minimum dimensions for fillet welds used for welding socket-welded joints are shown in **Figure 4**. The pipe ends shall be beveled by machine tool or oxygen cut with grinding.

10.5.2. Pipe Bevels

Pipe ends shall be beveled in accordance with the specific WPS being used. Field bevels of pipe ends shall be made by means of machine tools, a beveling machine using an oxy-acetylene cutting torch or other approved method in a manner to the satisfaction of the Welding Inspector. Bevels shall be thoroughly cleaned of any rust and foreign materials and free of deformities that may be injurious to the weld. Foreign materials and deformities shall be removed by hand filing or power tools. The Welding Inspector shall approve prior to its use, any solvents used for the removal of foreign materials.

10.5.3. Joint Cleaning

Prior to being aligned and welded into the line, each pipe joint, fitting or valve shall be thoroughly inspected and, if required, the welding surface swabbed from both internal and external surfaces of the pipe to a distance of six (6) inches from each side of the proposed weld to remove any conditions that may be detrimental to the weld. These conditions include, but are not limited to laminations, tears, scale, slag, grease, paint, moisture, dirt, snow, or ice. The bevel faces shall be relatively smooth and uniform. If, in the opinion of the Welding Inspector, conditions warrant internal swabbing to accomplish the removal of such debris and undesirable materials, installer shall provide the equipment and labor required.

No two-weld beads shall be started at the same location on the weld. All scale or slag shall be removed from each pass before the next pass is made. Cleaning shall be done with hand or power tools as directed by the Welding Inspector. Surface porosity and weld starts shall be ground prior to depositing subsequent passes.

Power wire brushing shall be used to clean the hot pass immediately after completion. All filler passes and the cover pass shall be cleaned by power wire brushing or as specified by the Welding Inspector. As a clarification, welding helpers may assist the welder by brushing and/or grinding the weld, but only the qualified welder is allowed to perform the actual welding of the joint.

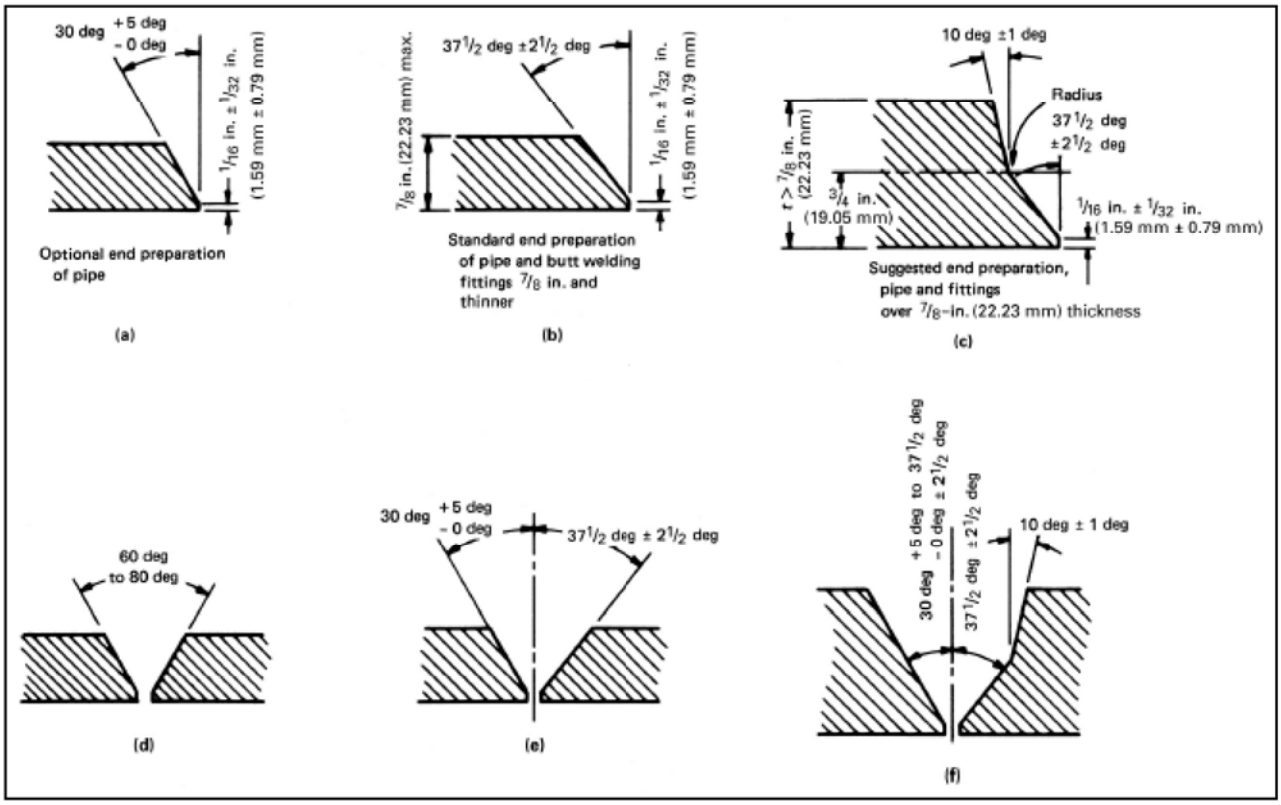


Figure 1. Butt Weld Joint Types for Equal Wall Thickness Components

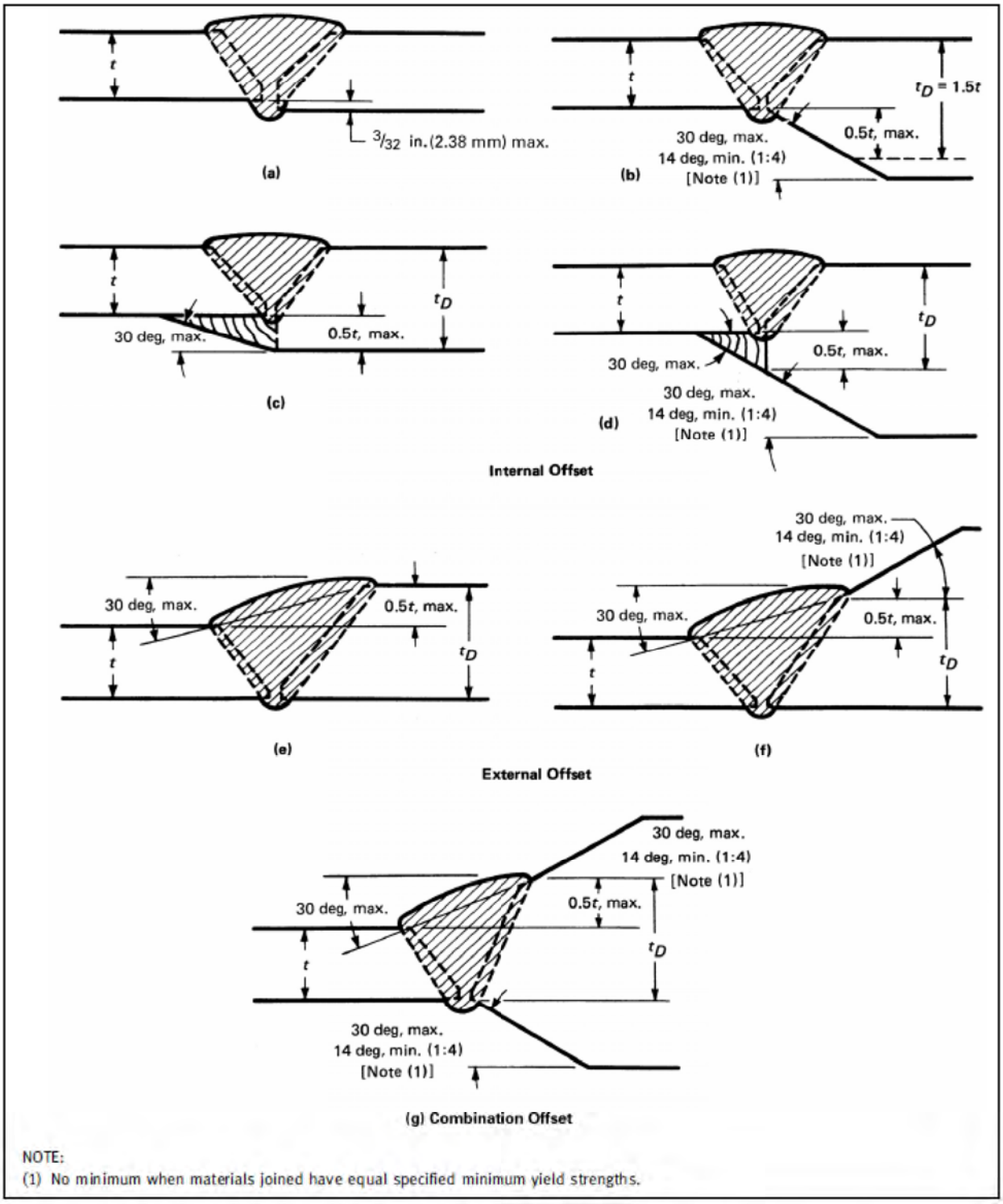
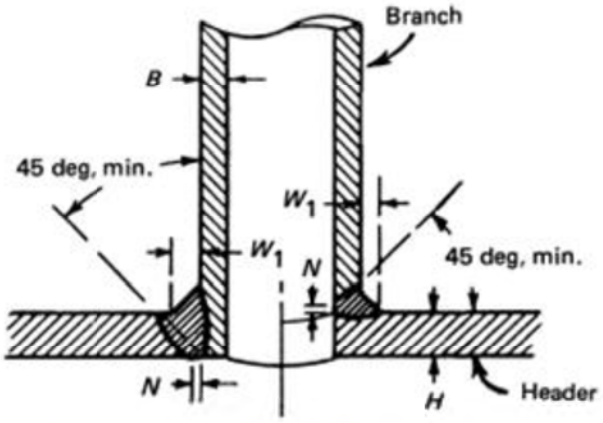
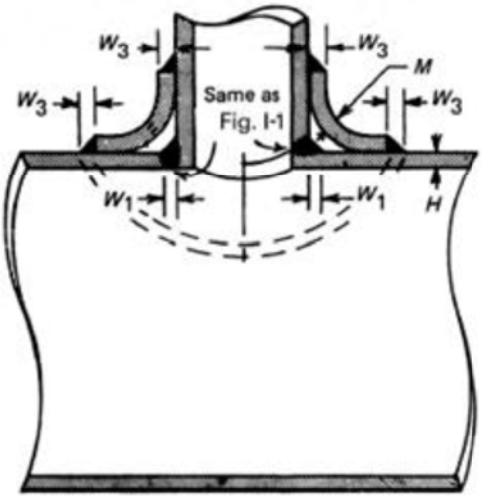


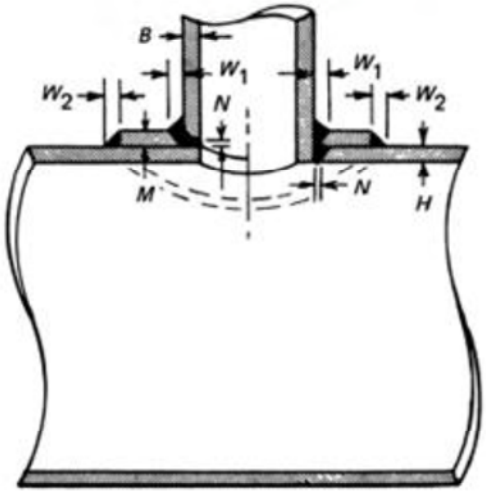
Figure 2. Butt Weld Joint Types for Unequal Wall Thickness Components



GENERAL NOTES:
(a) When a welding saddle is used, it shall be inserted over this type of connection.
(b) $W_1 = {}^{3B}/_{8}$, but not less than $^1/_4$ in. (6.35 mm).
(c) $N = {}^1/_{16}$ in. (1.59 mm) min., $^1/_8$ in. (3.18 mm) max., unless back welded or backing strip is used.



Saddle



Pad

W_1 min. = $^{3B}/_{8}$, but not less than $^1/_4$ in. (6.35 mm)
W_2 min. = $^M/_2$, but not less than $^1/_4$ in. (6.35 mm)
W_3 min. = M, but not greater than H
$N = {}^1/_{16}$ in. (1.59 mm) min., unless back welded or backing strip is used

GENERAL NOTES:
(a) All welds to have equal leg dimensions, and a minimum throat = 0.707 × leg dimension.
(b) If M is thicker than H, the reinforcing member shall be tapered down to the header wall thickness.
(c) Provide hole in reinforcement to reveal leakage in buried welds and to provide venting during welding and heat treatment [see para. 831.4.1(h)].

Figure 3. Branch Groove Weld Joint Types with or without Reinforcement

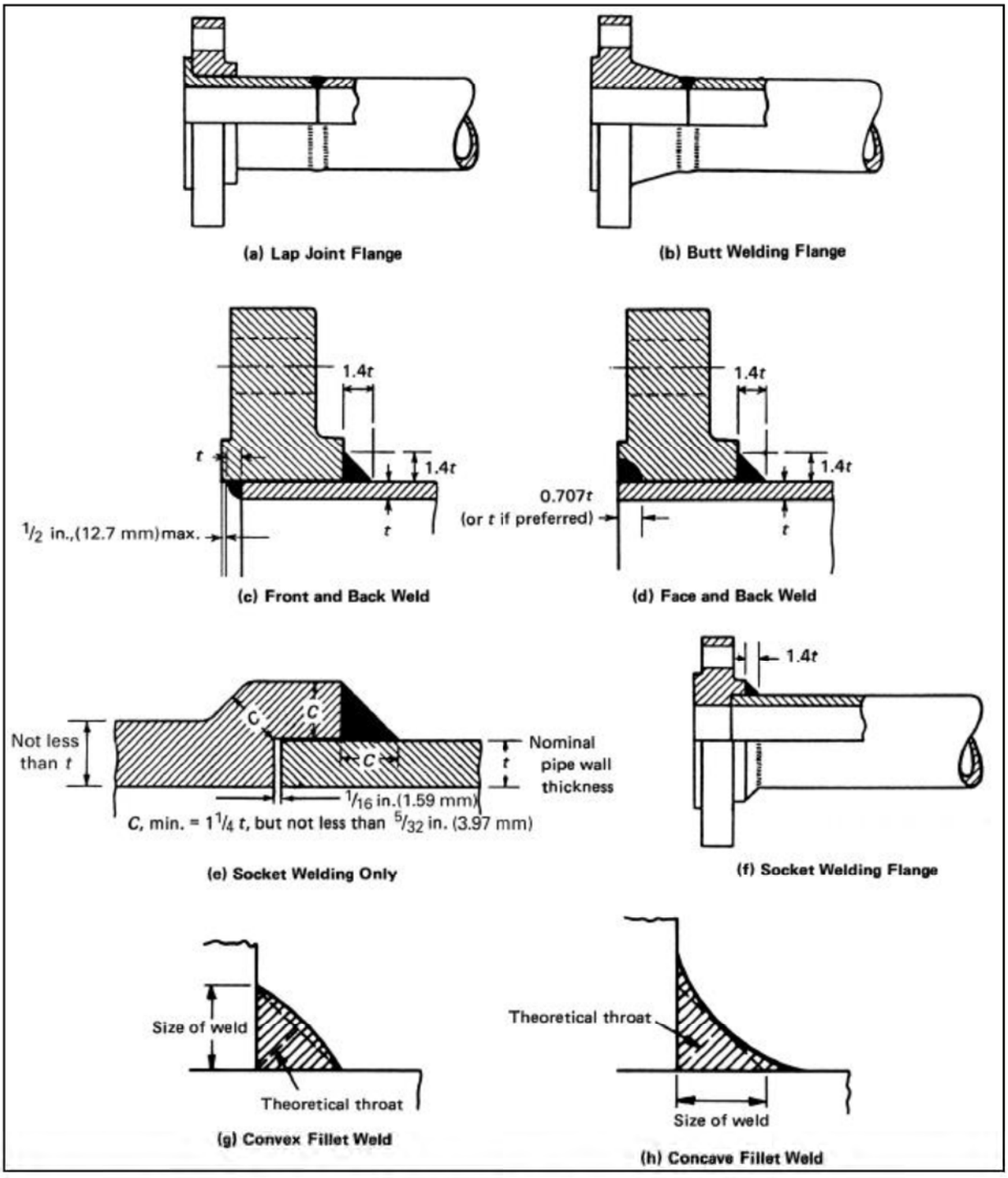


Figure 4. Recommended Attachment Details for Flanges and Socket Welds

10.6. Joint Fit-Up

10.6.1. Joint Alignment and Fit-Up

The pipe or fitting shall be aligned to provide the most favorable condition for depositing the root bead. The space between abutting pipe ends shall be such as to ensure complete penetration of the weld without burn-through. The alignment of abutting pipe ends shall be such as to minimize the offset between joining surfaces. For pipe of the same nominal wall thickness, the offset, or misalignment, shall not exceed 1/16 inch. Any greater offset or misalignment caused by dimensional variations shall be equally distributed around the circumference of the pipe. The alignment must be preserved until as much of the root bead as practical has been deposited; minimum is 50% of the root bead. A spacing tool can be used to maintain the proper root gap during welding.

Longitudinal welded pipe seams shall be located in the top quarter of the pipeline. Seams in adjacent sections of pipe shall be on opposite sides of the top center, when practical, and shall be separated by at least six (6) inches. Welding Inspector may approve exceptions for bends and short fabricated assemblies.

Hammering of pipe to obtain proper lineup prior to welding shall be held to a minimum. When used, the faces of metal hammers used to strike the pipe shall be nickel overlaid (AWS A5.15, Class Eni-CI, such as Ni-Rod by Huntington Alloys or Softwell 99Ni by Lincoln Electric). Copper or brass hammers shall not be used to strike the pipe.

10.6.2. Alignment Clamps

Line clamps should be used to improve the pipe alignment. When using internal line up clamps the root pass shall be completely deposited prior to clamp removal. An internal line-up clamp shall be considered for pipe 20 inch O.D. and larger except for fabrication and tie-in welds or where the Welding Inspector specially authorizes use of an external line-up clamp. The internal lineup clamps shall be pneumatic and shall be equipped with fiber or rubber rollers so that the internal coating on pipe, if so furnished, will not be scratched or marred in any way.

When using external line up clamps where it is not possible to completely deposit the root pass, then the root pass shall encompass equally spaced segments around the circumference of the pipe and be an aggregate length of at least 50% of the pipe circumference prior to removal of the external line up clamp.

Movement or hammering of pipe during stringer bead welding shall be prohibited, except as approved by the Welding Inspector. When required by the Welding Inspector, internal or external line up clamps shall be held in place until the root pass has been completed. Otherwise, after the alignment clamps are removed the weld joint shall remain in the fixed position until the root and hot pass are complete. Any deflections shall be kept at a minimum when placing the weld joint on skids.

Firing line welders will be no more than 5,000 feet from the pipe gang unless otherwise approved by the Welding Inspector.

10.6.3. Tack Welds

Tack welds shall be used to ensure a proper joint configuration. Tack welds shall be limited to only the root region and shall be equally spaced into four separate quadrants. Prior to depositing the root bead, tack welds shall be ground at the start and stop locations to ensure a smooth transition and proper tie-in. Tacks welds shall be deposited following the welding procedure used to deposit the construction weld.

10.6.4. Tie-In Welds

Tie-in welds tend to experience higher levels of restraint and misalignment. Care shall be taken to ensure proper fit up including an acceptable amount of high low in accordance with Section 10.6.1. During welding, the pipe shall be properly supported from the start of making the root pass until the weld is completed. In addition to ensuring proper alignment and support the weld shall be deposited with a minimum preheat temperature of 200°F in accordance with Section 10.15.

10.7. Pipeline Clearance

A clearance of at least sixteen (16") inches should be provided in all directions from the weld joint when pipe is welded above the ground or in the trench. Any deviation from this rule shall be at the discretion of the welder. When welding in a trench, bell holes shall be of sufficient size to prevent undue restraint on the welder and provide access around the entire circumference of the pipe.

10.8. Welder Information

10.8.1. Procedure Access for Welders

Each welder qualified to work on the project shall have access to a copy of each welding procedure to be used in the performance of the work.

10.8.2. Number of Welders

For pipe sizes with an outside diameter less than or equal to 12.75 inch one or two welders may be used to complete the weld. For pipe sizes with an outside diameter greater than 12.75 inch a minimum of two welders shall be used to complete the weld.

10.9. Oxy-acetylene Welding Process Limitations

Oxy-acetylene welding (OAW) shall be limited to pipe with a maximum outside diameter of 2.375 inches.

10.10. Welding onto Threads

NGBU does not permit seal welding onto any pipe threads unless any of the following exceptions apply:

- The threads are below grade
- The joint is not to be unscrewed/unthreaded for safety reasons.

When seal welds are made, the welds shall not be considered as contributing to the strength of joints. Additionally, seal welds shall be made with low hydrogen electrodes under 125 psig.

10.11. Welding onto Different Strength Materials

When welding materials with different strength levels the welding procedure qualified to the highest strength material shall be used.

10.12. Time Between Passes

NOTE: *After the root pass has been completed, a second bead or "hot pass" shall be welded so that the elapsed time between passes shall not exceed the specified length of time in the Welding Procedure being used.*

10.13. Chill (Backing) Rings

The use of chill rings (backing rings) for welding is prohibited without the consent of the Welding Inspector.

10.14. Specific Pass Requirements

10.14.1. Root Pass (Stringer Bead)

Installer shall clean and contour grind the root pass to remove undercutting, rough surface and other defects, as follows:

10.14.1.1. A 1/8" thick grinding wheel shall be used to prepare the surface for welding the root pass when stick electrode size is 1/8" diameter or less

10.14.1.2. A 5/32" or 3/16" thick grinding wheel shall be used when the root pass is welded with CO, gas metal arc process or when using stick electrodes with a diameter greater than 1/8".

Skating technique shall not be used in root pass welding and the welding speed shall be as specified in the qualified procedure.

Grinding shall be required for all starts, stops and convex surfaces when the root bead is made using CO, gas metal arc process.

Burn through areas shall be feathered before welding (filling).

10.14.2. Filler and Finish Beads

The number of filler passes shall be such that the groove formed by the pipe bevel is completely filled and flush with the outside surface of the materials being joined.

NOTE: *At no point shall the crowned surface be below the outside surface of the pipe, nor should it be raised above the parent metal by more than 1/8 inch ± 1/16 inch. The width of the cover pass should be approximately 1/8 inch greater than the width of the original groove.*

Weld metal of all passes shall be thoroughly fused to previously deposited metal and to the parent metal of the pipe. The completed weld shall be thoroughly brushed and cleaned.

10.15. Preheat and Interpass Temperature Requirements

Preheating may be accomplished by any suitable methods provided the temperature is uniform and does not fall below the minimum temperature specified in the welding procedure. The preheat temperature shall be checked by any suitable means to ensure the temperature is maintained during the welding operation. The temperature shall be checked at a minimum distance of 2 inches from the center of the weld groove on both sides of the groove and equally spaced around the circumference.

When dissimilar materials are welded that require different preheat temperatures the highest preheat temperature shall be used

10.16. Stress Relieving Requirements

Stress relieving shall be applied in accordance with code requirements and as specified in the welding procedure. When stress relieving is required, stress relieving may be accomplished by any suitable means provided the required temperature is uniform and remains within the range specified in the welding procedure. The stress relieving temperature and time shall be checked by any suitable means to ensure the proper stress relieving cycle has been accomplished.

10.17. Pup Joints

The Installer shall promptly collect, clean, rebevel, haul ahead and weld into the pipeline all useable "pup" joints. Acceptable pup joint lengths are as follows:

10.17.1. For above ground piping, a minimum of 1.5 times the outside diameter (1.5*OD) is acceptable.

10.17.2. For below ground piping, a minimum of either 1.5 times the outside diameter (1.5*OD) or 3 feet, whichever is longer, is acceptable.

10.17.3. Pups shorter than described above in 10.17.1 and 10.17.2 shall not be used for line welding without prior approval of Gas Engineering.

Where joints of pipe are cut, the installer shall ensure that the pipe stencil information from the parent joint are transferred to the cut end or ends of the parent joint, as well as to both ends of all pups resulting from the cutting. Pipe information from the stencil shall be transferred to both ends of each pup joint immediately after it has been cut from any joint of pipe. The parent joint shall also be left with the pipe-stencil identification numbers on both ends.

10.18. Welding on Magnetized Pipelines

Welding onto magnetized pipe can result in arc blow. Arc blow can affect the welder's ability to deposit a satisfactory weld leading to increased repairs. Magnetic field tends to be higher in the weld joint root opening therefore the greatest risk of arc blow will be when depositing the root pass. Magnetism is measured in Gauss and shall be measured with a Gauss meter probe (Hall-effect Gauss meter). The Gauss

level produced when joining two pipe sections together is generally 10 times higher than with the pipe sections separated. For example, two pipe sections averaging 8 Gauss will result in a magnetism of 80 Gauss when butted together. The effect of the magnetism has on the welding arc is dependent on the strength of the field. The relative field strength and associated welding problems are:

- 20 Gauss and below – Welding can take place without concern
- 21 – 30 Gauss – The welding arc may be affected by magnetism
- 31 – 100 Gauss – The welding arc will likely be affected by magnetism, but may be manageable by the welder depending on their level of skill, amperage, arc length, diameter, and joint design
- 100 Gauss and above – The welding arc will be affected by magnetism and demagnetization efforts need to be taken to reduce the magnetic field.
- 150 – 300 Gauss – Serious weld defects are likely, including weld induced cracked welds.
- 300 Gauss and above – Welding will seem almost impossible at times combined with severe weld defects

NOTE: *When an excessive magnetic field is present, the magnetized pipe shall be demagnetized according to the procedure WEL-PR-1030 Demagnetization of Pipe.*

10.19. Arc Burns

All arc burns shall be cut out and replaced by a new pipe section, except when allowed below. When removal of an arc burn is not practical on in-service piping, then the arc burn shall be repaired in accordance with OM-PR-8020. The area shall be inspected by using a suitable etchant (dilute nitric acid, ammonium persulfate solution, etc.) to ensure complete removal of the heat-affected zone of the arc strike. The ground area shall be inspected by MT to ensure there are no weld-induced cracks in the arc strike area. The remaining pipe wall thickness shall be measured to ensure the remaining wall is adequate for the pipeline design.

10.20. Numbering and Identification of Welds

10.20.1. Installer shall consecutively number welds completed during each day with a grease free crayon to ensure an accurate count. Each welder shall mark his welds or portions of welds using chalk or grease free crayon. The use of a keel will not be permitted.

10.20.2. Each welder shall identify the welder's work. The welder's identification shall be recorded on the inspection report.

10.20.3. The Welder ID will consist of the welder's Employee ID.

10.21. Completing Welds

For production welding of mainline pipelines up to and including 0.500" wall thickness, the preference is for a weld to be completed by the end of the production day in which the weld was started. If circumstances such as weather prevent this from being done, the contractor may request an extension to complete the weld by the end of the following, successive production day provided the root bead and hot pass have been completed. In extenuating circumstances, such as not being able to

access the R.O.W., the contractor may request additional hold time not to exceed 48 hours, unless approved by Gas Engineering, from when the root bead and hot pass were deposited. All extensions must be approved by the chief welding inspector.

In cases where hold times are extended, the contractor shall wrap each weld in ceramic blankets to slow cooling. In addition, when welding resumes each unfinished weld shall be preheated to at least 200 °F. Tie-in welds are an exception in that once the weld is started, successive weld layers shall be deposited without delay, and each weld finished the same day it was started.

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11. In-Service Field Welding Practice

11.1. General

11.1.1. *In-service welding shall be performed in accordance with the prior section, "Construction Field Welding Practice", as applicable, in addition to the requirements listed in this section*.

CAUTION: *All welders performing in-service welding shall be familiar with the safety precautions associated with cutting and welding on piping that contains or has contained natural gas or liquids.*

11.1.2. Tap connections shall be located so that they do not intersect a longitudinal or girth weld.

11.1.3. All in service welds shall be made using a low hydrogen electrode with the following exceptions:

11.1.3.1. If the pipe is less than or equal to 2.375" O.D. and has a wall thickness less than or equal to 0.188", then a qualified cellulosic procedure may be used.

11.1.3.2. If the pipe has a wall thickness of less than or equal to 0.188" and the pressure is less than 25 psig, then a qualified cellulosic procedure may be used.

11.2. Operating Conditions

The pipeline operating conditions shall be confirmed prior to in-service welding to ensure that there is a minimal risk of burning through the pipeline and the minimal occurrence of hydrogen cracking. Both risks shall be evaluated in selecting the appropriate In-Service Welding Procedure

11.2.1. Hydrogen Cracking Risk

The risk of hydrogen cracking can be controlled by determining the cooling conditions of the operating pipeline. The cooling conditions of the pipeline can be determined by measuring the heat sink capacity. The heat sink capacity measurement consists of heating a small circle of the pipe wall to a temperature between 300°C and 325°C and measuring the time it takes for the pipeline to cool between 250°C to 100°C. The time it takes to cool

from 250°C to 100°C is the heat sink capacity time and shall be compared to the heat sink capacity time reported on the in-service welding procedure. The specific procedure that shall be used for measuring the heat sink capacity is provided in the procedure WEL-PR-1040 *Heat Sink Capacity Measurement*.

11.2.2. Burn-Through Risk

Burn-through risk is not a significant risk when welding attachments onto a pipeline with a minimum wall thickness of 0.25 inch. If the wall thickness reading is less than the API 5L tolerances for wall thickness for the pipeline (**Table 1**), then a burn through risk shall be evaluated by Gas Engineering.

Table 1. API 5L Wall Tolerances, 45th edition.

Wall thickness *t* mm (in)	Tolerances [a] mm (in)
SMLS pipe [b]	
≤ 4,0 (0.157)	+ 0,6 (0.024) – 0,5 (0.020)
> 4,0 (0.157) to < 25,0 (0.984)	+ 0.150 *t* – 0,125 *t*
≥ 25,0 (0.984)	+ 3,7 (0.146) or + 0,1 *t*, whichever is the greater – 3,0 (0.120) or – 0,1 *t*, whichever is the greater
Welded pipe [c,d]	
≤ 5,0 (0.197)	± 0,5 (0.020)
> 5,0 (0.197) to < 15,0 (0.591)	± 0,1 *t*
≥ 15,0 (0.591)	± 1,5 (0.060)

[a] If the purchase order specifies a minus tolerance for wall thickness smaller than the applicable value given in this table, the plus tolerance for wall thickness shall be increased by an amount sufficient to maintain the applicable tolerance range.

[b] For pipe with $D \geq 355{,}6$ mm (14.000 in) and $t \geq 25{,}0$ mm (0.984 in), the wall-thickness tolerance locally may exceed the plus tolerance for wall thickness by an additional 0,05 *t*, provided that the plus tolerance for mass (see 9.14) is not exceeded.

[c] The plus tolerance for wall thickness does not apply to the weld area.

[d] See 9.13.2 for additional restrictions.

Monitoring welding heat input is essential to the success of in-service welding applications. The welding heat input can be monitored by one of two methods. The first method requires the use of hand held meters, which monitor the amperage and voltage during welding and a stopwatch and tape measure to measure the welding speed in inches per minute. Once the amperage, voltage, and welding speed are known the heat input can be calculated by the following equation. The calculated heat input shall be compared to the required minimum heat input recorded on the in-service welding procedure to ensure compliance.

Heat Input = Amps * Volts * 60/Travel Speed (i.p.m.)/1000

The second method uses a run-out ratio which is based on the relationship of the between the total energy produced during welding and the amount of energy required to melt a specific volume of welding electrode. The run-out ratio is the length of weld divided by the length of electrode consumed and the relationship between the run-out ratio and the corresponding welding heat input is illustrated in **Figure 5**. The calculated run-out ratio shall be compared to the maximum run-out ratio recorded on the in-service welding procedure to ensure compliance.

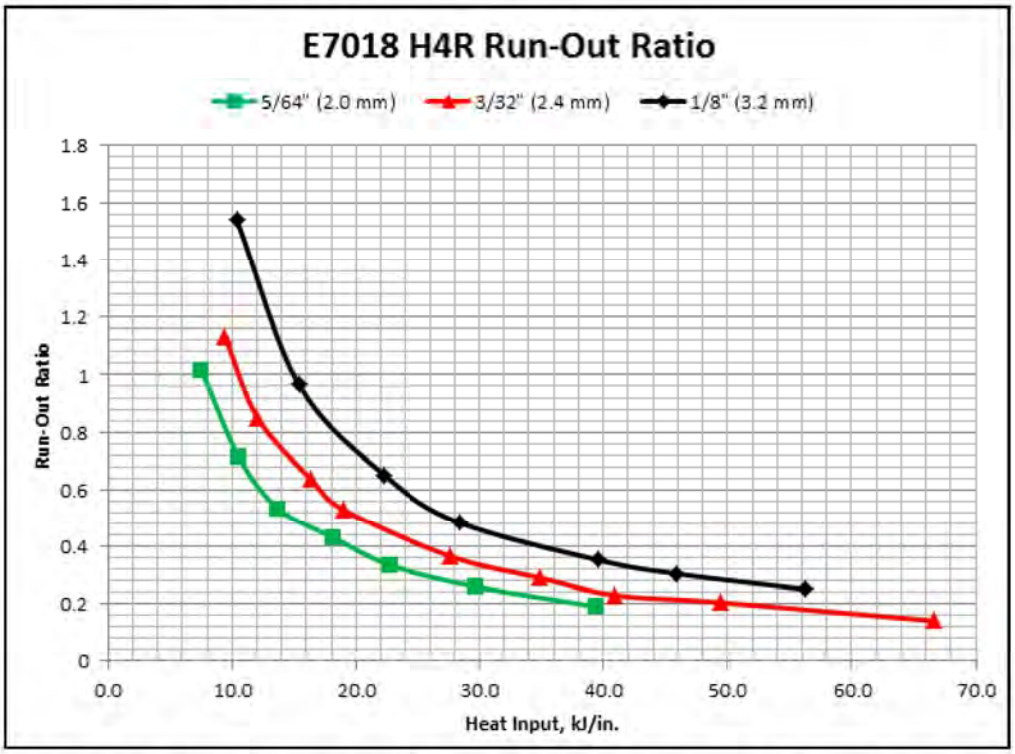

Figure 5. Run-out Ratio for Controlling Welding Heat Input for In-service Welding Applications

11.3. Chemical Composition Determination

11.3.1. The chemical composition of the operating pipeline and the fittings to be welded should be determined prior to in-service welding. If it is impractical to determine the chemical composition of the material prior to welding, then the welding procedure shall be based on the assumed highest chemical composition.

11.3.2. The chemical composition could be determined from mill test reports, portable chemical analysis equipment, by removing a sample of the material to be welded and sending the sample to a laboratory or other means approved by Gas Engineering. When removing a sample material for a laboratory analysis the total volume of material should be between 10 and 20 grams. If the hot-tap reinforcement or repair sleeve straddles a pipeline butt weld, then a material sample shall be removed from both pipe joints. The area where the material is to be removed shall be inspected to ensure there is sufficient wall thickness

and located on a portion of the pipeline that will be removed by the hot-tap coupon or covered by the hot-tap reinforcement or repair sleeve. The remaining wall thickness of the pipeline, after material removal, shall not be less than nominal wall thickness minus the mill tolerance. Prior to sending the material to the lab the material shall be evaluated to ensure no foreign material is present that could affect the chemical composition analysis.

11.4. Pipe Seam Inspection

11.4.1. When an in-service welding application requires welding over the pipeline seam the seam shall be inspected to ensure there are no defects present. If defects are present, the design or location of the component to be welded onto the operating pipeline shall be re-evaluated.

11.5. Ultrasonic Wall Thickness Measurement

11.5.1. The pipeline wall thickness shall be confirmed by ultrasonic inspection prior to in-service welding. Wall thickness measurements shall be made every 20 degrees around the weld area circumference to ensure adequate wall thickness and no pipe body defects are present (e.g., laminations). If the wall thickness is less than expected the probability of burning through the pipeline shall be re-evaluated in accordance with Section 11.2.2. If laminations are detected, then the location of the in-service weld shall be moved to a defect free area.

11.6. Joint Cleaning

11.6.1. Pipeline coatings shall be removed a distance at least equal to the cutback on new pipe of the same diameter. Power or hand tools may be used for coating removal with power tools being preferred. Chisels shall not be used for coating removal.

11.7. Sleeve or Branch Reinforcement Fit-Up

11.7.1. The gap between the hot-tap reinforcement or repair sleeve shall not be so excessive to require the welder to alter the welding technique to deposit the weld.

11.8. Welding Sequence

11.8.1. The hot-tap reinforcement or repair sleeve long seams shall be welded first. Once the long seams are completed and allowed to cool, then one circumferential fillet weld shall be completed prior to welding the second circumferential fillet weld.

11.9. Long Seam Welding

11.9.1. All hot-tap reinforcements or repair sleeve long seams that are in contact with the pipeline shall be welded with a backing bar. The only exceptions to this requirement are Mueller split-fittings and Type A reinforcement sleeves for which all long seam welds shall be deposited following a qualified welding procedure. If the welding procedure is qualified using cellulosic (EXX10) type electrodes, etc., then a minimum preheat temperature of 200°F shall be used

unless the qualified welding procedure specifies a higher minimum preheat temperature.

11.10. Circumferential Fillet Weld Sizes

11.10.1. The circumferential fillet welds of hot-tap reinforcement or Type B repair sleeves shall meet the requirements specified in **Figure 6** .

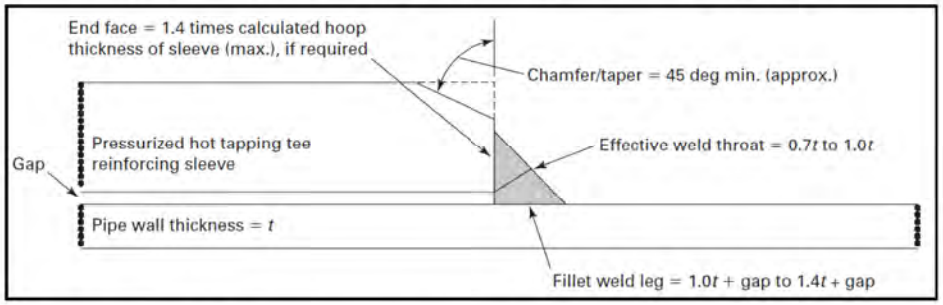

Figure 6. Fillet Weld Size Requirements for Hot-tap Reinforcement Connections and Type B Reinforcement Sleeves

11.11. Inspection Delay Time

A minimum of 24 hours shall elapse prior to inspecting all in-service welds when inspection is required by WEL-ST-1060 Non-Destructive Evaluation and Inspection of Steel Pipeline Welds, and WEL-PR-1080 Visual Inspection of Welds, unless this requirement is waived by Gas Engineering using form WEL-FORM-1070 Welding Cooling Time Reduction Request.

11.11.1. Pipeline Support Prior to Backfill

Prior to backfilling, the exposed pipeline shall be adequately supported so as not to allow additional stresses to be induced onto the in-service weld (e.g., soil induced loading or bending loads).

12. Weld Inspection and Acceptability

Welds shall be examined and found acceptable in accordance with API 1104 and WEL-ST-1060 Non-Destructive Evaluation and Inspection of Steel Pipeline Welds, and WEL-PR-1080 Visual Inspection of Welds.

13. Repair of Steel Pipe and Weld Repair Criteria

13.1. General Repair Requirements

13.1.1. Weld defects may be identified on-site by either the Welding Inspector or the NDT Inspection Personnel. Weld quality shall meet the requirements of API 1104, any weld not meeting that acceptance criteria shall be cut out or repaired.

13.1.2. In addition to requirements within this standard, specifications for the repair of welding defects in NC, SC and TN shall be in accordance with OM-PL-8000 and repairs in OH and KY shall be in accordance with GD55.1311-1.

13.1.3. Only single repairs are allowed. Repairs of repairs (multiple repairs) are not allowed.

13.1.4. Documentation of all weld repairs shall be on the daily weld examinations report. All repairs shall be performed in accordance with this section.

13.1.5. Pipe showing laminations beyond those accepted in the latest edition of API Line Pipe Specification 5L shall not be used in the pipeline or the compressor station. Pipe showing split ends or other defects shall be removed from the line as directed by the Welding Inspector.

13.2. Authorization for Repair

13.2.1. The Welding Inspector shall authorize and witness the repair of defects (except cracks) in the root, hot pass and filler beads.

13.2.2. Any weld having a weld-induced crack shall be cut out and replaced. Any weld that shows evidence of repair work having been done without authorization by the Welding Inspector may be rejected.

13.2.3. Repairs may be made to pin holes and undercuts in the cap pass without authorization but the repaired weld must meet with the approval of the Welding Inspector. Pin holes in the final cap must be repaired by recapping. Stripping or spot welding is not allowed.

13.3. Repair of Steel Pipe

13.3.1. Installer shall remove all defects in the unwelded pipe or welded pipeline that meet or exceed the following requirements. A defect shall include:

13.3.1.1. Any gross deformation in or near a beveled end that is to be welded which causes an unweldable joint.

13.3.1.2. Any dent occurring in 12-3/4" OD or smaller pipe that is greater than 0.250" deep, and one-half (1/2) the pipe diameter long in any direction or judged unacceptable by Welding Inspector. The depth shall be determined by the gap between the lowest point of the defect and the original contour of the pipe.

13.3.1.3. Any dent occurring in >12-3/4" OD pipe that is deeper than 2% of the nominal diameter and 1/2 of the pipe diameter in any direction or judged unacceptable by Welding Inspector.

13.3.1.4. Any dent containing a stress concentrator, such as a scratch, gouge or groove.

13.3.1.5. Any dent affecting a longitudinal or girth weld.

13.3.2. Installer shall remove the damaged portion by cutting it out as a cylinder. Any defect caused by the installer shall be removed by the installer. Repair by insert patching or pounding out is prohibited.

13.4. Repair of Construction Welds

13.4.1. Any weld defect that exceeds the acceptability requirements of API 1104 shall be ground out to sound material. When approved by the Chief Welding Inspector, carbon air arc gouging is allowed. All slag and scale shall be removed by wire brushing. If the defect is only located in the cap pass or root pass of the weld, then it may be repaired by grinding. The total number of grinding repairs and the individual length of grind repairs is not limited but shall conform to the following criteria.

- Free of undercut and other imperfections
- Provide a smooth transition between the ground area and the weld and the pipe surface
- Maintain the minimum wall and weld thickness requirements. If the minimum wall and weld thickness is not known, the grinding depth is limited to the excess root or cap pass reinforcement.

13.4.2. After the grinding is complete, the excavation shall be inspected to ensure that the entire defect has been removed. If the excavation exceeds the limits stated previously, then a repair weld shall be deposited. When repair welding is required, the excavation shall allow a smooth transition with properly sloped sides and ends to permit the repair welder to deposit a sound weld. If the repair requires more than a single pass, then the groove sides shall be ground back to pipe material to ensure that the repair weld is not deposited in previously deposited weld metal except for the root region. The appropriate repair welding procedure shall be based on the following criteria.

- All repairs shall follow the original welding procedure to deposit the repair weld with the additional requirement of a minimum preheat temperature of 200°F in accordance with Section 10.15.
- All other repair welds shall be deposited by a qualified repair welder in accordance with Section 11.4 of WEL-ST-1000 and following a qualified repair welding procedure in accordance with Section 10.6 of WEL-ST-1000.

NOTE: *The minimum weld repair length shall be 2 inches and the total weld repair length shall be specified by a Welding Inspector. Upon completion, the repair weld shall be allowed to air cool prior to inspection in accordance with Section 14.4.3.*

13.4.3. Weld repairs on the same construction weld, at different circumferential locations, are permitted as long the distance between adjacent weld repairs is not less than two (2) inches. Repair of a defect in a previously repaired area on the same weld at the same circumferential location are not allowed under any circumstances and shall be cut out. Weld induced cracks are not permitted and shall be cut out. All repaired areas shall be radiographed or inspected by the same means previously used to find the defect.

13.5. Repair of In-Service Welds

13.5.1. This section does not cover welds that need to be repaired when discovered during routine O&M inspection. Such repairs in NC, SC and TN shall follow the requirements of OM-PL-8000. Prior to welding the wall thickness shall be measured in accordance with Section 11.5 to ensure there is no increased risk of burning through the pipeline.

13.5.2. A qualified in-service welder can follow the original in-service welding procedure to deposit the repair in-service weld. The minimum weld repair length shall be two (2) inches and the total weld repair length shall be specified by a Welding Inspector. Weld induced cracks are not permitted and shall be cut out. Upon completion, the repair weld shall be allowed to air cool prior to inspection (in accordance with Section 13.6).

13.6. Weld Repair Inspection Requirements

13.6.1. Repairs shall be considered acceptable when the repair area meets the acceptance criteria in accordance with API 1104.

14. Fabrication

14.1. General

14.1.1. All materials that are to be or have been fabricated into assemblies or are to be welded directly into the line shall be handled in such a manner as to prevent damage. When lifting lugs are provided on a component, only those lugs may be used for lifting of that component. All materials shall be handled or stored so that they are not sitting in mud or water and shall be adequately skidded where necessary to prevent such occurrence.

14.1.2. The installer shall ensure that all assemblies are fabricated so that they will fit correctly into the pipeline or other assemblies. The installer shall note that some adjustments to the dimensions shown on construction drawings are normally required to compensate for variations in terrain, depth of cover and alignment of existing facilities when applicable.

14.1.3. Unless constructed in place, tie-overs should normally be fabricated with each leg at least 18 inches longer than shown on the drawing to allow for fit-up. Alignment of parts and prefabricated sections shall be performed with a minimum use of mechanical force.

14.1.4. Pipe, valves, and fittings shall be fabricated within plus or minus 1/16" of deviations from the dimensions, locations, and positions shown on furnished drawings. All fabrication changes will be approved by the Gas Engineering Representative prior to the start of fabrication.

14.1.5. Drawings shall be used as a guide to prefabrication with the installer fully utilizing field measurements and random lengths to prevent over-fabrication.

14.1.6. Installer shall install high point vents and low point drains as approved by the Gas Engineering Representative to facilitate hydrostatic testing unless otherwise provided for on the drawings.

14.1.7. Prior to the attachment of pipe to the weld ends of a ball valve (12" and larger), suitable tape shall be applied in the bore of the valve, covering the whole circumference at each end of the valve bore. When preheating and welding on valve ends, installer shall protect valve seat areas from heat damage by covering seat area openings on the inside of the valve. Options for protecting the seat include, but are not limited to, one of more of the following: heat resistant tape and damp gunnysacks.

14.1.8. Reinforcing saddles shall be installed with a snug fit and in no case with a gap greater than 1/8 inch.

14.1.9. Wrought steel welding elbows and transverse segments of these elbows shall not be used for changes in direction of steel pipe that is 2 inches or more in diameter unless the arc length, as measured along the crotch is at least 1 inch. Any fittings that will be trimmed must be segmentable.

14.1.10. Prior to being welded into any assembly, all flanges shall be inspected for possible damage to the "raised face". Nicks or gouges are not acceptable and shall, when detected, be brought to the attention of the Welding Inspector so that remedial action can be taken. Flanges shall be protected at all times (except at time of two-holing) preferably with plastic covers or temporary plywood blind flanges either bolted or wired in place. Grounding of the welding work connections to flanges is not permitted.

14.1.11. All flanges shall be installed with the imaginary intersecting line between the top two bolt holes in a vertical plane ("two-holed") unless otherwise specified on the drawings. At the time of alignment, the face of flanges shall be "wire brushed" clean, free from dirt, grease or rust. A final inspection shall be made at this time to ensure that no damaged flanges are installed into the pipeline system. Flanges shall be brought into parallel and lateral alignment with bolt holes lined up. If the flanges cannot be aligned precisely, the bolts on the side having the greater opening shall be tightened first until the flanges have been perfectly mated. The bolts shall then be tightened in an accepted sequence.

14.1.12. Only new gaskets shall be used. Gaskets with protrusions, depressions or any other surface defects shall be discarded. Under no circumstances shall a gasket be lubricated.

14.1.13. Nuts and bolts shall be inspected for possible defects. Any nut or bolt having burrs, nicks, metallic slivers, severe galling or pitted threads or incomplete threads shall be discarded. At the time of installation, threads and nut faces shall be lubricated. Threads of bolts shall be evenly distributed across the width of the connection such that the same number of threads extend past the nut on each side.

14.1.14. Upon being welded into a fabricated assembly, all valves supplied without operators shall have a covering placed over the open end of the torque-tube to prevent ingress of rainwater, snow, ice, or debris. Heavy-duty garbage bags or

similar NGBU approved material shall be firmly affixed and left in place until the operator is available for installation.

14.1.15. After completion of the welding process, debris and any welding spatter shall be thoroughly cleaned from the bore of the valve and attached pipe by wire brushing and vacuuming. Afterwards, the tape shall be removed.

14.1.16. Recycled and/or trimmed fittings may be used in the fabrication of piping systems if they have not been excessively trimmed causing mismatching of wall thickness, misalignment of piping, or weakening of the fitting. Any fittings that will be trimmed must be segmentable.

14.2. Backwelding

14.2.1. Installer may be required to backweld all welds on fittings and/or valves twenty (20) inches in outer diameter and larger, and on smaller sizes where practical, when it is required to meet the butt-weld joining type, as shown in Figure 2. Installer shall further be required to backweld all pipe welds where the difference in nominal wall thickness between adjacent pipes is greater than 3/32" inch unless an alternate method is approved by the Gas Engineering.

14.2.2. Backwelding of the fittings and/or valves shall be performed immediately after the completion of the stringer bead, prior to grinding, and before the pipe has an opportunity to cool. The filler pass conditions of the WPS being used for the original weld shall be used to perform the backwelding.

14.2.3. Backwelding shall not be permitted to repair a root pass defect discovered after final inspection of the completed weld.

14.2.4. Backwelding shall only be performed after adequate ventilation has been ensured.

14.3. Weld Completion

14.3.1. In order to prevent cracking, care shall be taken by the installer in welding fitting materials with a wall thickness in excess of 0.500". The entire weld area shall be preheated to a minimum of 200 °F metal temperature for a distance of three (3) inches on each side of the weld area before welding commences. This minimum temperature shall be maintained at the weld throughout the welding period.

NOTE: *In-service welding and fabrication work such fitting welds, valves and other thick wall weldments with a wall thickness greater than 0.500" shall be treated the same as tie-in welds; once a weld is started, it must be completed without delay and each weld finished the same day it was started.*

14.3.2. The metal temperature shall be checked using temperature indicator crayons opposite to the side on which the preheat is being applied when practical.

15. Contact

Gas Engineering

16. Revision Log

The table below documents the history of each revision issued and identifies the following: Revision Number, Date, Summary of Changes (including reason for change, and a list of Legacy Duke/Piedmont Documents used to integrate this document), Responsible Party (person or group facilitating changes).

Rev #	Date	Summary of Changes	Responsible Party
0.0	03/31/2019	• Initial Issue Legacy Documents incorporated into this Standard: • CM-ST-2170 *Fabrication* • CM-PL-4000 PNG Welding Manual, Sections relating to welding procedures only.	Members of Work Process Integration Team
1.0	05/01/2019	• Revised the "WHO" section, added Gas Engineering, Gas Field Operations, and Technical Field Operations • Added references for region specific procedures on sections: ▪ 11.11. Inspection Delay Time ▪ 12 - Weld Inspection & Acceptability • Corrected referenced document on section 10.19 Arc Burns	Work Process Integration Team
2.0	7/08/2020	• Revised sections 11.11 and 12 to reflect new integrated Welding document references. • Made minor edits to sections 11.2.1, 13.1.2 and 13.5.1.	Robert Mohler

Table of Contents

1. Purpose

To comply with Federal (PHMSA) and State regulations, as well as industry guidance, the Duke Energy Natural Gas Business Unit (NGBU) has established this Welding Standard to provide guidelines and responsibilities for the welding of steel pipelines covered by 49 CFR 192 and API 1104 in order to produce sound welds and support safe, reliable operations. This includes the qualification of welding procedures and welders across construction, repair, and in-service applications. Following these requirements is imperative in the prevention of failed welds during the course of operations. The requirements set forth in the Welding Standard shall not be applied to existing facilities retroactively.

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2. Governing Code and References

Title 49, Code of Federal Regulations, Part 192, *Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards*

American Petroleum Institute, API Standard 1104, *Welding of Pipelines and Related Facilities*

American Society of Mechanical Engineers, ASME B31.8 – *Gas Transmission and Distribution Piping Systems*

American Society for Testing and Materials, ASTM E23 – *Standard Test Methods for Notched Bar Impact Testing of Metallic Materials*

American Society for Testing and Materials, ASTM E165 – *Standard Test Method for Liquid Penetrant Examination*

American Society for Testing and Materials, ASTM E384 – *Standard Test Method for Knoop and Vickers Hardness of Materials*

American Society for Testing and Materials, ASTM E709 – *Standard Guide for Magnetic Particle Testing*

National Association of Corrosion Engineers, ANSI/NACE MR0175/ISO 15156 – *Petroleum and Natural Gas Industry – Materials for use in H2S-containing Environments in Oil and Gas Production*

American Society for Nondestructive Testing, ASNT Recommended Practice SNT-TC-1A – *Personnel Qualification and Certification in Nondestructive Testing.*

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3. State Specific Requirements

N/A

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4. Environmental Information

Refer to the Environmental Health and Safety Handbook or contact Duke Environmental Support at 1-800-527-3853.

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5. Who

- Gas Engineering
- Major Projects
- Gas Field Operations
- Technical Field Operations

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6. Standard Summary

The Welding Standard provides guidelines for welding steel pipelines covered by 49 CFR 192 and API 1104 and associated welding responsibilities, including the qualification of welding procedures and welders across construction, repair, and in-service applications. The requirements set forth in the Welding Standard shall not be applied to existing facilities retroactively.

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7. Safety Requirements

At Duke Energy, Health and Safety is a Core Company Value. Employees and contingent workers are responsible for maintaining the highest regard for safety while planning and conducting work. Employees and contingent workers are also responsible for ensuring a safe work environment exists for themselves, their coworkers, and their surrounding community.

Icon Key:

NOTE: *This icon raises awareness to important non-safety related information.*

Keys to Life: *This icon references Duke Energy's "Keys to Life" safety information to note significant or life threatening hazards and related precautions to be taken. A link to the Keys to Life Gas Operations document is provided* here. *Additional links may exist in the document.*

CAUTION: *This icon identifies possible safety hazards and/or serves as a reminder to take necessary precautions.*

8. Definitions/Acronyms

Welding Procedure Qualifier – A designated NGBU Employee or third party representative authorized to qualify welding procedures for use on NGBU system. This individual must possess at a minimum a Certified Welding Inspector (CWI) certification.

Welding Procedure Approver – A designated NGBU Employee that is responsible for approving the welding procedures and answering any welding procedure related questions. This individual must have the following credentials:

- Minimum 5 years of pipeline construction welding knowledge
- Certified Pipeline Welding Inspector, degreed Metallurgist, or Welding Engineer

Welder Qualifier – A designated NGBU Employee or third party representative that is responsible for qualifying all employee and contract welders. This individual must have the following credentials:

- Minimum 5 years of pipeline construction welding knowledge or Level II NDT Technician
- Certified Pipeline Welding Inspector or Certified Welding Inspector

Welding Inspector – An individual responsible for overseeing all the on-site welding tasks and ensuring that procedures are being properly followed. Major projects Welding Inspectors must meet one of the following criteria: possess a CWI, hold a CPWI and have 5 years pipeline welding/inspection experience, or have 15 years pipeline welding experience.

Third Party Fabrication Contractor – Any fabrication shop contractor hired to build skid mounted piping systems.

Construction Weld – A weld in a pipeline system that has not been commissioned

In-Service Weld – A weld that fuses directly to the wall of an in-service (contains product that may be pressurized and/or flowing) pipeline or piping system that has previously been commissioned. In-service welding is performed in accordance with API 1104 Appendix B.

Repair Weld – A construction or in-service weld requiring additional work due to defects outside the standards identified in this document. Such additional work amounts to a repair weld only if the defect is identified by non-destructive testing after the original weld was completed.

9. Qualifications/Certifications

Operator Qualifications:

- TWELD001 – Welding (on Physically Connected Pipe)
- TWELD002 – Non-Destructive Testing of Welds
- TWELD003 – Visual Examination of Welds

10. Welding Procedure Qualifications

10.1. General

10.1.1. Prior to welding, all welding procedures shall be qualified in accordance with API 1104 and the following applicable sections to ensure the welding procedure produces welds with suitable mechanical properties. The applicable sections may exceed, but in no instance shall reduce, the requirements specified in API 1104. Wherever there is a contradiction the requirements the more stringent requirement shall govern. Unless otherwise indicated, welding procedures are made to the 20th edition of API 1104, which is the current edition incorporated by reference into 49 CFR 192/195. Procedures qualified under a previous version of API 1104 do not need to be requalified. When a new welding procedure is required, a Welding Procedure Qualifier shall develop and qualify it in accordance with this standard.

10.1.2. All welding procedures shall be supported by destructively testing a qualification weld. A welding procedure qualification record (PQR), also known as a coupon test report, shall record the actual welding procedure variables used to deposit the qualification weld and the results of destructive tests. Procedure qualification welds and all required tests to confirm the acceptability of the resulting welds shall be performed in the presence of a Welding Procedure Qualifier. The required form for a PQR is referenced in Section 10.9. Any deviation from the welding procedure involving essential variables is strictly prohibited. Also, welding miter joints are prohibited.

10.1.3. The material to be used for qualifying welding procedures shall be representative of the material that is to be welded in the field. If the total length of a single qualification weld is insufficient to remove all the required destructive test samples than an additional qualification weld shall be made.

10.2. Welding Procedure Variables

10.2.1. Each welding procedure shall provide sufficient detail to the welder on the form referenced in Section 10.9 manual SMAW (stick), OAW (oxyacetylene), or GMAW (MIG) procedures shall address all the applicable welding procedure variables listed in

10.2.2. **Table *1*** that are shaded based on the welding application. Variables that are marked with an "X" are variables that if changed shall require the qualification of a new welding procedure. Qualification of other manual welding processes, semi-automatic welding, mechanized welding or automatic welding procedures shall be approved by welding SME's within NGBU.

10.2.3. The current, voltage and travel speed recorded on the procedure qualification record are the basis for the permitted range of welding procedure variables so a wide range of current, voltage and travel speed shall be used during the procedure qualification weld. A Welding Procedure Qualifier shall provide guidance on how other welding procedure variables shall be addressed.

Table 1. Welding Procedure Variables

Variable Description	Construction Welding Procedure	Repair Welding Procedure	In-Service Welding Procedure
Welding Process (SMAW, OAW, or GMAW)/Method of Application (Manual, Semi-Auto, Mechanized, Auto)	X	X	X
Base Material Strength Grouping	X	X	
Material Diameters			
Material Thicknesses	X	X	
Joint Design Information	X	X	X
Fillet Weld Size and Classification Number			
Filler Metal Group	X	X	X
Filler Metal Diameter			
Minimum Number of Beads			
Sequence of Beads			
Current Type (AC or DC)	X	X	X
Current Polarity (Electrode + or -)	X	X	X
Voltage (per filler metal rod and diameter)			
Amperage (per filler metal rod and diameter)			
Flame Characteristics (OAW only) (Neutral, Carburizing or Oxidizing)			
Torch Tip Orifice (OAW only)			
Position (Roll or Fixed)	X	X	X
Welding Direction (Uphill, Downhill)	X	X	X
Time between Root Bead and 2nd Bead	X	X	X
Time between 2nd Bead and Start of Rem. Beads			
Lineup Clamp Type (Internal, External or None)			
% of Completed Root Bead when Lineup Clamp is Used			
Cleaning (Hand or Power Tools)			
Preheat Temperature	X	X	X
Preheat Method and Temperature Control Method			
Minimum Ambient Temperature Preheat should Apply			
Stress Relief	X	X	X
Stress Relief Method			

Variable Description	Construction Welding Procedure	Repair Welding Procedure	In-Service Welding Procedure
Stress Relief Time and Temperature	X	X	X
Stress Relief Temperature Control Method			
Welding Speed	X	X	X
Method of Cooling after Welding (Air or Forced Cooling)*			
Temperature at which Forced Cooling is Applied*			
Repair Location (Weld centerline or Fusion line) and Method for Exploration of Defect		X	
Defect Removal Method			
Inspection Method			
Interpass Temperature (min/max), Location, and Extent		X	
Interpass Temperature Application Method			
Interpass Inspection			
Filler Metal Storage, Handling, & Usage			
Repair Type		X	
Repair Procedure Limitations			
Time Delay Prior to Inspection			
Material Carbon Equivalent			X**
Pipeline Operating Conditions			X
Heat Input Ranges			
Bead Spacing Tolerances			X**

*Only required in API 1104 21st Edition
**Only essential variables in API 1104 21st Edition.

10.3. Welding Procedure Selection

10.3.1. A summary of approved NGBU welding procedures is provided in **Table 2**. The welding procedures are provided in WEL-PR-1010. The supporting procedure qualification records are provided in WEL-PR-1020. Selection of the appropriate construction welding procedure(s) shall be made by the welder(s) performing the welds and based on the following criteria:

- Welding Process
- Welding Application
    - Construction welding, repair of construction welds or in-service welding
- Material

- SMYS for construction and repair of construction welds
- Carbon equivalent (CE) for in-service welds
- If materials of different SMYS or CE are to be welded then the welding procedure qualified for the higher SMYS or CE shall be used
- In the event that CE or SMYS of existing facilities are not known, NGBU construction staff shall make every effort to determine these properties as part of the construction planning process. This includes, but is not limited to looking at records and the stencil on the pipe. If this information cannot be found, material Grade A and a CE of 0.50 will be assumed.

- Pipeline Outside Diameter
- Pipe Wall Thickness
- Joint Type

CAUTION: *When welding on a pipeline with an MAOP greater than 125 psig an in-service welding permit shall be approved by Gas Engineering (See WEL-PR-1050 Welding on In-Service Piping). When welding on an in-service pipeline with a MAOP 125 psig or lower, the welder(s) is(are) responsible for selecting their own procedure.*

Table 2. Approved NGBU Welding Procedures

New WPS Number	Old WPS Number	SMYS Range, ksi	Outside Diameter Range	Nominal Wall Thickness Range	Rod Material	Joint Type
OAW (Oxy-Acetylene) Construction Butt Welding Procedures						
WPS 10	WPS 1	API 5L X52 or less	2.375 inch or less	0.218 inch or less	RG60 or RG65	Butt
OAW (Oxy-Acetylene) Construction Fillet Welding Procedures						
WPS 20	WPS 2	API 5L X52 or less	2.375 inch or less	0.218 inch or less	RG60 or RG65	Fillet
SMAW (Stick) Construction Cellulosic Butt Welding Procedures						
WPS 30	WPS 3	API 5L X42 or less	All	All	E6010, E7010	Butt
WPS 40	WPS 4	> API 5L X42 and < API 5L X65	All	0.188 inch or greater	E6010, E7010, E8010	Butt
WPS 50	WPS 5	API 5L X65	All	0.188 inch to 0.750 inch	E6010, E8010-P1	Butt
WPS 60	WPS 6	API 5L X70	All	0.188 inch to 0.750 inch	E6010, E8010-P1	Butt

New WPS Number	Old WPS Number	SMYS Range, ksi	Outside Diameter Range	Nominal Wall Thickness Range	Rod Material	Joint Type
SMAW (Stick) Construction Low Hydrogen Butt Welding Procedures						
WPS 70	WPS 7	API 5L X42 or less	All	0.188 inch or greater	E7016, E7018	Butt
WPS 80	WPS 8	> API 5L X42 and < API 5L X65	All	0.188 inch or greater	E7016, E7018	Butt
SMAW (Stick) Construction Cellulosic Fillet Welding Procedures						
WPS 90	WPS 9	API 5L X42 or less	All	0.750 inch or less	E6010, E7010	Branch Groove or Fillet
WPS 100	WPS 10	> API 5L X42 and < API 5L X65	All	0.188 inch to 0.750 inch	E6010, E7010, E8010	Branch Groove or Fillet
WPS 110	WPS 11	API 5L X65	All	0.188 inch to 0.750 inch	E6010, E8010-P1	Branch Groove or Fillet
WPS 120	WPS 12	API 5L X70	All	0.188 inch to 0.750 inch	E6010, E8010-P1	Branch Groove or Fillet
SMAW (Stick) Construction Low Hydrogen Fillet Welding Procedures						
WPS 130	WPS 13	API 5L X42 or less	All	0.188 inch to 0.750 inch	E7016, E7018	Fillet
SMAW (Stick) In-Service Cellulosic Butt Welding Procedures						
WPS 140	WPS 23A	> API 5L X42 and < API 5L X65	2.375 inch or greater	≤ 0.188 inches	A5.1	Long Seam
SMAW (Stick) In-Service Cellulosic Fillet Welding Procedures						
WPS 150	WPS 17A	> API 5L X42 and < API 5L X65	2.375 inch or greater	≤ 0.188 inches	A5.1	Fillet
SMAW (Stick) In-Service Low Hydrogen Fillet Welding Procedures						
WPS 160	WPS 14	Less than or equal to API 5L X70	All	0.188 inch to 0.750 inch	E7018 H4R, E7016 H4	Branch Groove

New WPS Number	Old WPS Number	SMYS Range, ksi	Outside Diameter Range	Nominal Wall Thickness Range	Rod Material	Joint Type
WPS 170	WPS 15	Less than or equal to API 5L X70	All	0.250 inch to 0.750 inch	E7018 H4R, E7016 H4	Branch Groove
WPS 180	WPS 16A	Less than or equal to API 5L X70	All	0.157 inch to 0.750 inch	E7018 H4R, E7016 H4	Branch Groove
WPS 190	WPS 16B	Less than or equal to API 5L X70	All	0.125 inch to 0.156 inch or 0.125 inch to 0.750 inch	E7018 H4R, E7016 H4	Branch Groove
WPS 200	WPS 17B	Less than or equal to API 5L X70	All	0.188 inch to 0.750 inch or 0.188 inch to 1.25 inch	E7018 H4R	Fillet
WPS 210	WPS 18	Less than or equal to API 5L X70	All	0.250 inch to 0.750 inch or 0.188 inch to 1.25 inch	E7018 H4R	Fillet
WPS 220	WPS 19A	Less than or equal to API 5L X70	All	0.157 inch to 0.750 inch or 0.157 inch to 1.25 inch	E7018 H4R	Fillet
WPS 230	WPS 19B	Less than or equal to API 5L X70	All	0.125 inch to 0.156 inch or 0.188 inch to 0.750 inch	E7018 H4R	Fillet
WPS 240	WPS 20A	Less than or equal to API 5L X70	All	0.188 inch to 0.750 inch	E6010, E7018 H4R	Branch Groove
WPS 250	WPS 20B	Less than or equal to API 5L X70	All	0.188 inch to 0.750 inch or 0.188 inch to 1.25 inch	E6010, E7018 H4R	Fillet
WPS 260	WPS 21	Less than or equal to API 5L X70	All	0.250 inch to 0.750 inch or 0.188 inch to 0.750 inch	E6010, E7018 H4R	Branch Groove or Fillet

New WPS Number	Old WPS Number	SMYS Range, ksi	Outside Diameter Range	Nominal Wall Thickness Range	Rod Material	Joint Type
SMAW In-Service Low Hydrogen Butt Welding Procedures						
WPS 270	WPS 22	API 5L X42 or less	All	0.188 inch to 1.25 inch	E7018 H4R	Long Seam
WPS 280	WPS 23B	> API 5L X42 and ≤ API 5L X60	All	0.188 inch to 1.25 inch	E7018 H4R	Long Seam
WPS 290	WPS 24	API 5L X65	All	0.188 inch to 1.25 inch	E7018 H4R	Long Seam
WPS 300	WPS 25	API 5L X65	All	0.188 inch to 1.25 inch	E8018-C3 H4R	Long Seam
WPS 310	WPS 26	API 5L X70	All	0.188 inch to 1.25 inch	E7018 H4R	Long Seam
WPS 320	WPS 27	API 5L X70	All	0.188 inch to 1.25 inch	E8018-C3 H4R	Long Seam
GMAW (MIG) Construction Butt Welding Procedures						
WPS 330	M-BW-1-A-I	API 5L X42 or less	Less than 2.375 inch	Less than 0.188 inch	ER70S-3	Butt
WPS 340	M-BW-2-A-I	API 5L X42 or less	2.375 inch to 12.750 inch	Less than 0.188 inch	ER70S-3	Butt
WPS 350	M-BW-1-B-I	> API 5L X42 and ≤ API 5L X52	Less than 2.375 inch	Less than 0.188 inch	ER70S-3	Butt
WPS 360	M-BW-2-B-I	> API 5L X42 and ≤ API 5L X52	2.375 inch to 12.750 inch	Less than 0.188 inch	ER70S-3	Butt
WPS 370	M-BW-2-B-II	> API 5L X42 and ≤ API 5L X52	2.375 inch to 12.750 inch	0.188 inch to 0.750 inch	ER70S-3	Butt
GMAW (MIG) Construction Fillet Welding Procedures						
WPS 380	M-FW-A-I	API 5L X42 or less	All	Less than 0.188 inch	ER70S-3	Fillet
WPS 390	M-FW-B-I	> API 5L X42 and ≤ API 5L X52	All	Less than 0.188 inch	ER70S-3	Fillet

New WPS Number	Old WPS Number	SMYS Range, ksi	Outside Diameter Range	Nominal Wall Thickness Range	Rod Material	Joint Type
WPS 400	M-FW-B-II	> API 5L X42 and ≤ API 5L X52	All	0.188 inch to 0.750 inch	ER70S-3	Fillet

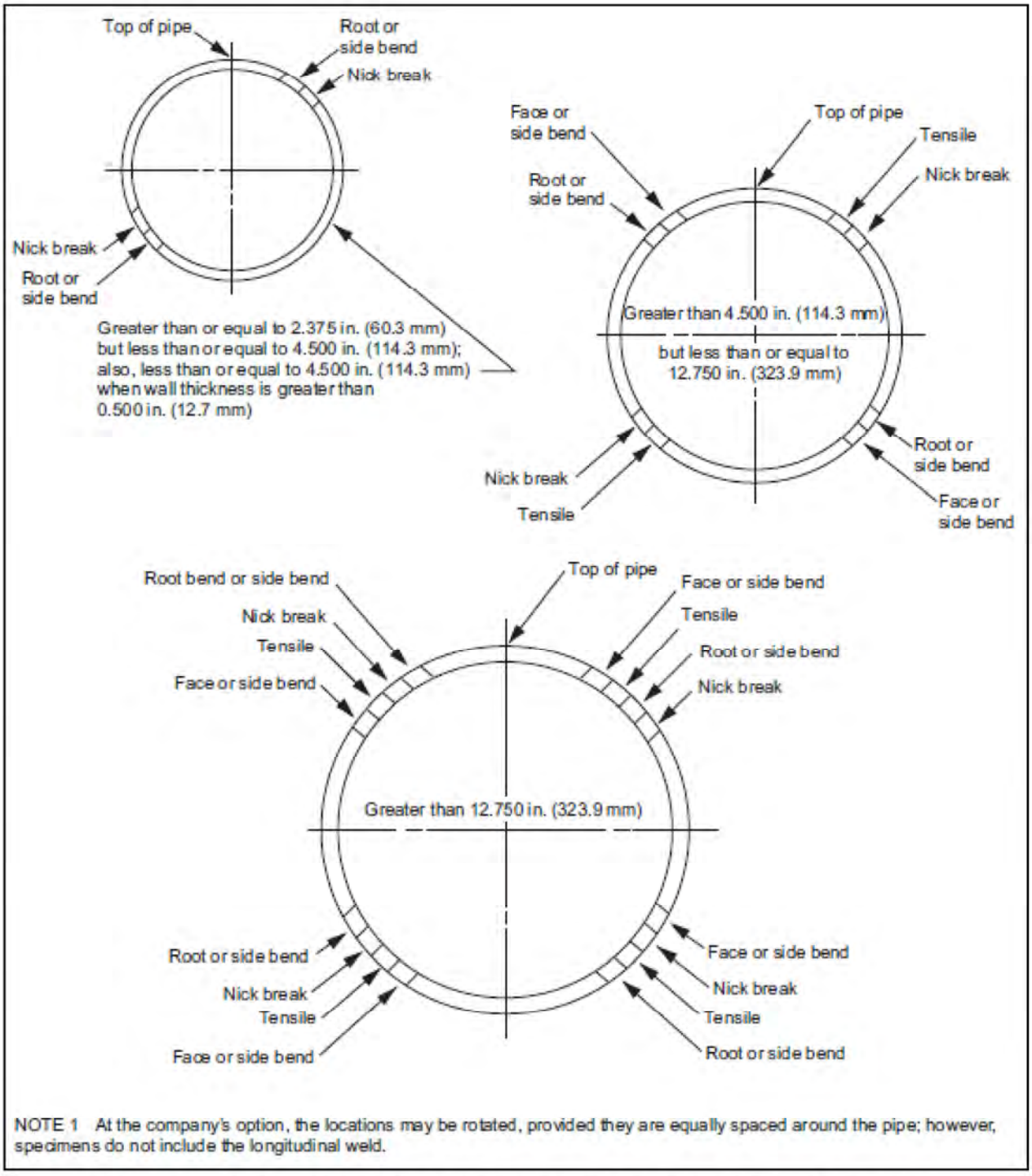
10.4. Qualification and Testing of Construction Butt Welding Procedures

The completed qualification weld shall be allowed to air cool to ambient temperature prior to destructive testing. The destructive test specimens shall be removed from the weld in accordance with **Table 3** and **Figure 1**. None of the destructive test specimens shall include a portion of the pipe seam weld. The destructive test specimens shall be tested in accordance with Section 10.4.1 through Section 10.4.4, as applicable.

Table 3. Type and Number of Construction Butt Welding Procedure Qualification Test Specimens

Outside Diameter of Pipe		Number of Specimens					
in.	mm	Tensile Strength	Nick Break	Root Bend	Face Bend	Side Bend	Total
Wall Thickness ≤ 0.500 in. (12.7 mm)							
2.375 to 4.500	60.3 to 114.3	0 [b]	2	2	0	0	4
>4.500 to 12.750	>114.3 to 323.9	2	2	2	2	0	8
>12.750	>323.9	4	4	4	4	0	16
Wall Thickness > 0.500 in. (12.7 mm)							
≤4.500	≤114.3	0 [b]	2	0	0	2	4
>4.500 to 12.750	>114.3 to 323.9	2	2	0	0	4	8
>12.750	>323.9	4	4	0	0	8	16

[b] For materials with SMYS's greater than the material specified as API 5L Grade X42, a minimum of one tensile test is required.



NOTE 1 At the company's option, the locations may be rotated, provided they are equally spaced around the pipe; however, specimens do not include the longitudinal weld.

Figure 1. Location of Butt Welding Procedure Qualification Test Specimens

10.4.1. Tensile-Strength Test

The tensile-strength test specimens shall be prepared in accordance with **Figure 2**. They may be machine cut or oxygen cut, and no other preparation is needed unless the sides are notched or are not parallel. If necessary, the specimens shall be machined so that the sides are smooth and parallel.

Prior to testing the smallest cross-sectional area of the specimen shall be determined. The tensile-strength specimen shall then be loaded until failure, using equipment capable of measuring the load at which failure occurs. The tensile strength shall be computed by dividing the maximum load by the measured cross-sectional area of the specimen.

The tensile-strength specimen shall be considered acceptable if one of the following requirements is met.

- The specimen breaks in the parent pipe material and meets the specified minimum tensile strength of the pipe material. It does not need to be greater than or equal to the actual tensile strength of the material
- The specimen breaks in the weld or fusion zone and meets the specified minimum tensile strength of the pipe, the exposed surfaces of each nick-break specimen shall show complete penetration and fusion, and the fracture surface is acceptable in accordance with Form O of WEL-PR-1000. It does not need to be greater than or equal to the actual tensile strength of the material.

A new qualification weld shall be deposited if the specimen does not meet the requirements specified above.

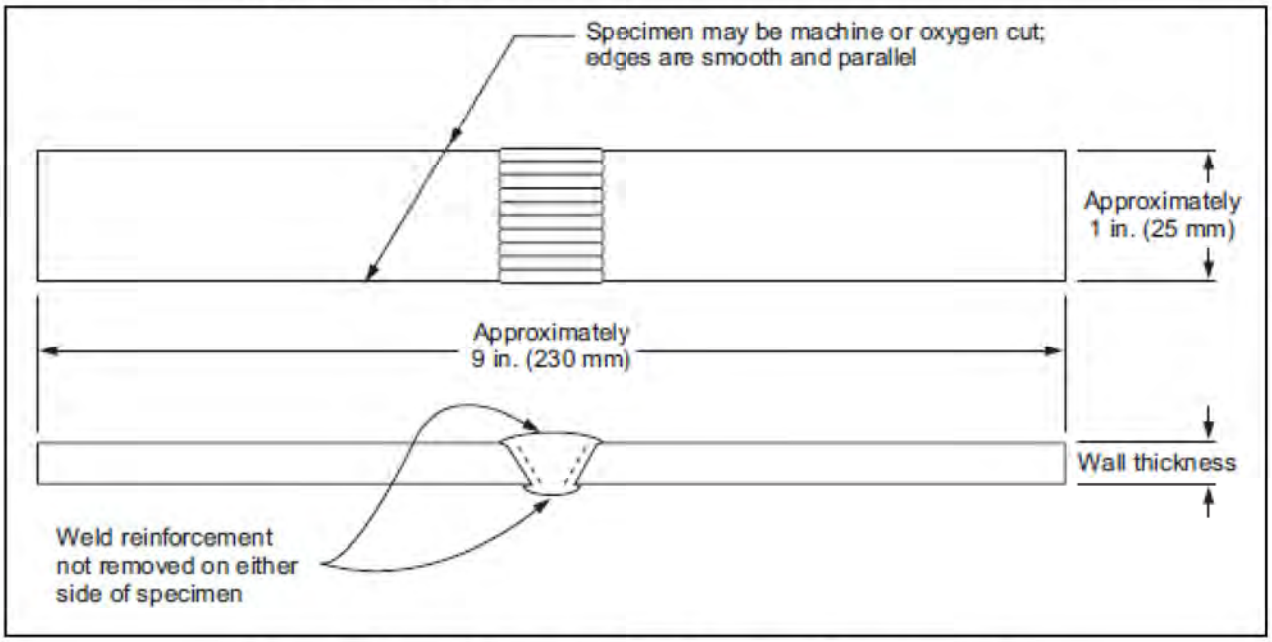


Figure 2. Tensile-Strength Test Specimen Preparation

10.4.2. Nick Break Test

The nick-break test specimens shall be prepared in accordance with **Figure 3**. They shall be machine cut or oxygen cut, they shall be notched with a hacksaw on each side at the center of the weld, and each notch shall be approximately 1/8" deep. Notching the face of the nick-break test specimen is permitted when failure in the pipe is expected. After notching, the specimen shall be loaded until failure. The exposed fracture surface shall be at least 3/4 inch wide.

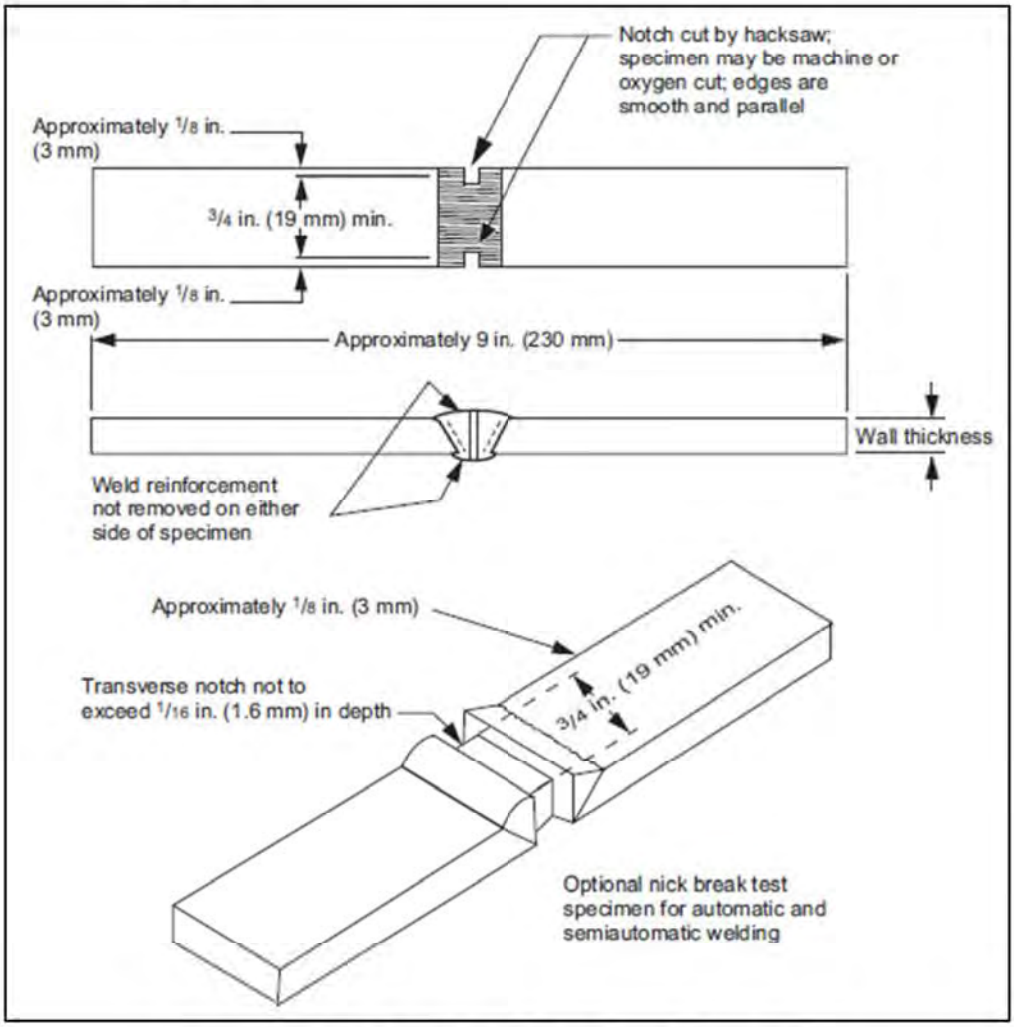


Figure 3. Nick-Break Test Specimen Preparation

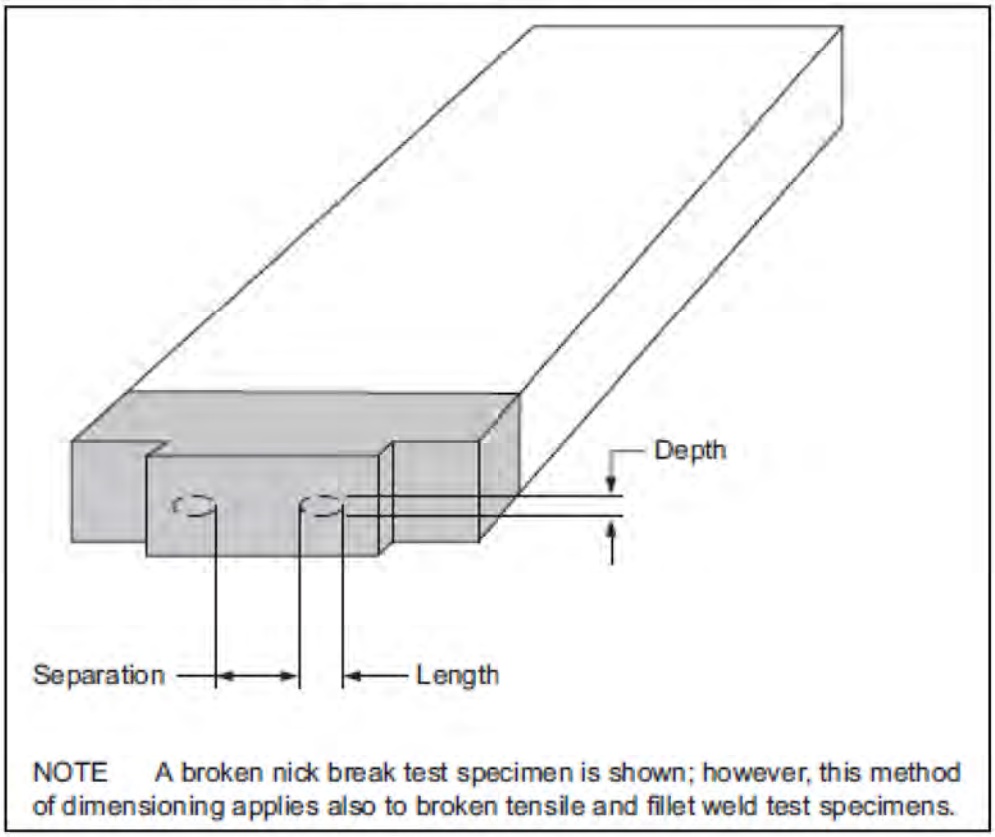
The nick-break specimen shall be considered acceptable if all of the following requirements are met.

- The fracture surface shows complete penetration and fusion.
- The greatest dimension of any gas pocket does not exceed 1/16 inch and the combined areas of all gas pockets shall not exceed 2% of the fracture surface area.

- Any slag inclusions shall not exceed 1/32 inch in depth, shall not exceed 1/8 inch or one-half the nominal wall thickness in length, whichever is smaller and there is at least 1/2 inch separation between adjacent slag inclusions as defined in **Figure 4**.
- Fisheyes, as defined in AWS A3.0, are not cause for rejection.

With approval by the Welding Procedure Qualifier, if one nick-break test specimen fails during the testing of a qualification weld that is deposited in a 12.75 inch or greater outside diameter pipe then two additional nick-break specimens could be taken from the same approximate location and tested. If both of the additional nick-break specimens pass then the weld could be considered acceptable.

A new qualification weld shall be deposited if the specimen does not meet the requirements specified above.



NOTE A broken nick break test specimen is shown; however, this method of dimensioning applies also to broken tensile and fillet weld test specimens.

Figure 4. Dimensions of Indications in Nick-Break and Tensile Test Specimens

10.4.3. Bend Test

There are three types of bend tests, which are defined by the portion of the weld that is put in tension. Root bends place the root portion of the weld in tension. Face bends place the face portion of the weld in tension. Side bends place the through thickness portion of the weld in tension.

The bend test specimen shall be prepared in accordance with **Figure 5** or **Figure 6** depending on the wall thickness of the qualification weld and the long edges shall be rounded. All surfaces shall be smooth with any scratches being light and transverse to the weld. Any undercut that is present shall not be removed. The bend test specimen shall be bent in a bend test fixture similar to what is shown in **Figure 7**. The weld shall be located in the middle of the span with the surface of interest opposite the plunger. Face-bend specimens shall be placed with the face of the weld toward the gap, and root-bend specimens shall be placed with the root of the weld toward the gap. The specimen shall be bent until the curvature of the specimen is approximately U-shaped.

The bend specimen shall be considered acceptable if all of the following requirements are met.

- No weld induced crack or other imperfection exceeding 1/8 inch or one-half the nominal wall thickness, whichever is smaller, in any direction, is present in the weld of between the weld and the fusion zone after bending.
- Weld induced cracks that originate on the edge of the specimen that are less than 1/4 inch, measured in any direction shall not be considered unless obvious imperfections are observed.

With approval by the Welding Procedure Qualifier, if one bend specimen fails during the testing of a qualification weld deposited that is deposited in 12.75 inch or greater outside diameter pipe then two additional bend specimens of the same orientation could be taken from the same approximate location and tested. If both of the additional bend specimens pass then the weld could be considered acceptable.

A new qualification weld shall be deposited if the specimen does not meet the requirements specified above.

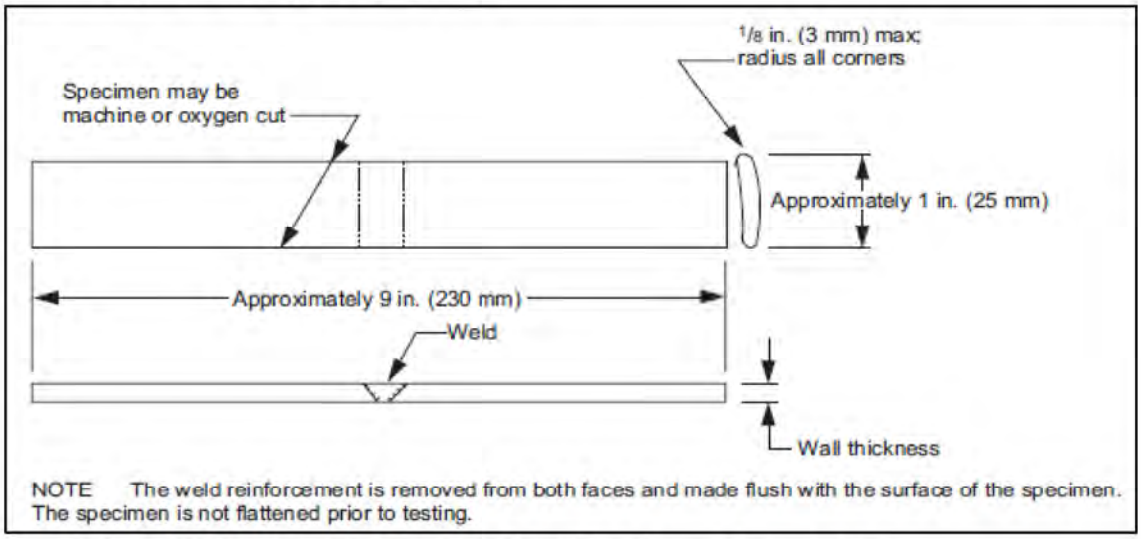
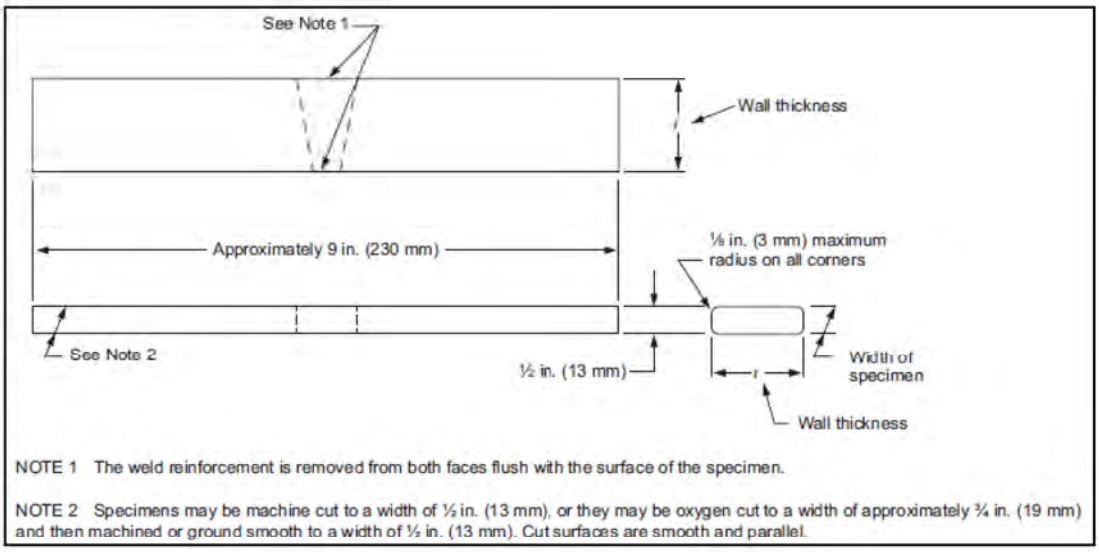


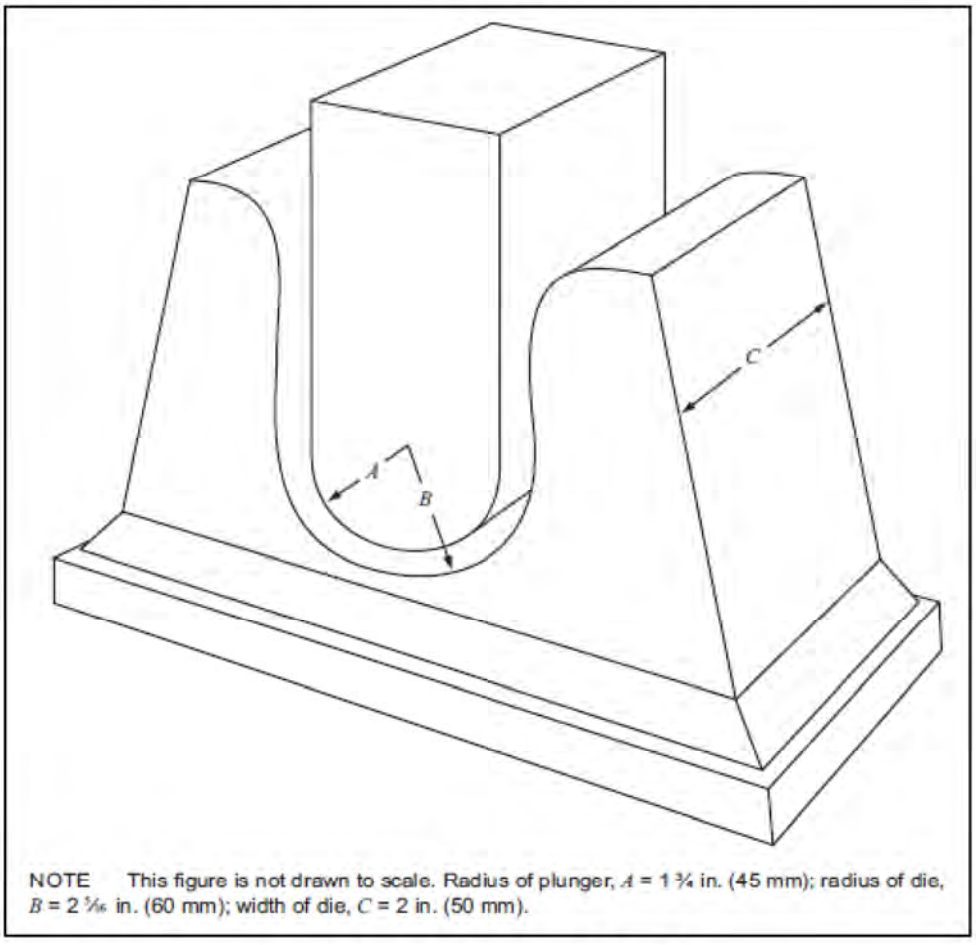
Figure 5. Root and Face Bend Test Specimen Preparation



NOTE 1 The weld reinforcement is removed from both faces flush with the surface of the specimen.

NOTE 2 Specimens may be machine cut to a width of ½ in. (13 mm), or they may be oxygen cut to a width of approximately ¾ in. (19 mm) and then machined or ground smooth to a width of ½ in. (13 mm). Cut surfaces are smooth and parallel.

Figure 6. Side Bend Test Specimen Preparation



NOTE This figure is not drawn to scale. Radius of plunger, A = 1 ¾ in. (45 mm); radius of die, B = 2 $\frac{5}{16}$ in. (60 mm); width of die, C = 2 in. (50 mm).

Figure 7. Example Bend Test Jig

10.4.4. Additional Construction Butt Welding Procedure Qualification Tests

Additional destructive tests may be required based on the operating conditions of the pipeline when requested by Gas Engineering. These tests may include but are not limited to Macro-section Tests in accordance with Section 10.4.4.1, Hardness Tests in accordance with Section 10.4.4.2, and Charpy V-Notch Impact Energy Tests in accordance with Section 10.4.4.3. Contact Gas Engineering for approval and to ensure that the proper tests are performed during qualification.

10.4.4.1. Macro-Section Tests

One weld macro-section shall be removed from the 3 o'clock or 9 o'clock positions of the qualification weld and prepared using standard metallographic techniques and shall be polished to at least a 600-grit finish and etched with a suitable etchant to give a clear definition of the weld. The macro-section shall allow for visual examination of the weld cross-section including the weld metal and adjacent base material.

The macro-section specimen shall be considered acceptable if:

- The weld is free of weld induced cracks
- The weld is completely fused to the adjacent base material and/or weld metal at the root and between weld passes.
- There are no other obvious defects that would cause a weld to be considered unacceptable by other inspections

10.4.4.2. Hardness Test

The macro-section test specimen shall be used for hardness test in accordance with ASTM 384. The hardness test shall be performed using a Vickers hardness indenter with a 10 kg load. The location of the hardness indents are shown in **Figure 8**. The test results shall be approved by Gas Engineering.

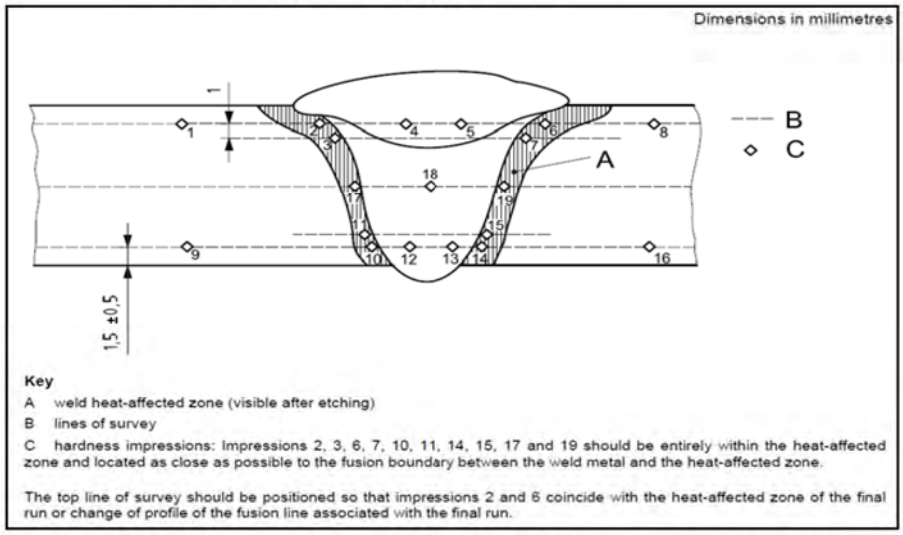


Figure 8. Hardness Indent Locations for a Butt Welding Procedure Qualification

10.4.4.3. Charpy V-Notch Impact Energy Test

A minimum of six Charpy V-notch impact test specimens shall be removed from the 3 o'clock or 9 o'clock positions of the qualification weld, prepared and tested in accordance with ASTM A370 and ASTM E23. The specimen length shall be parallel to the pipe axis with the notch orientated in the through thickness direction of the sample. Three samples shall be notched in the weld centerline and three samples shall be notched in heat-affected zone of the weld in accordance with **Figure 9**. The test temperature for the Charpy V-notch impact test shall be a maximum of 0°C or as approved by Gas Engineering. The test results shall be approved by Gas Engineering.

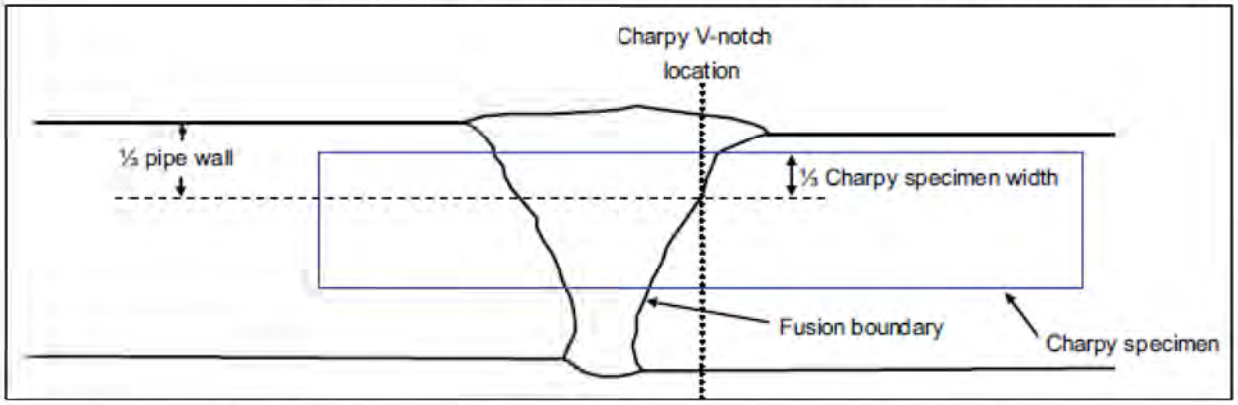


Figure 9. Charpy V-Notch Impact Specimen Location for Heat-Affected Zone Toughness Test for a Butt Welding Procedure Qualification

10.5. Qualification and Testing of Construction Branch Groove of Fillet Welding Procedures

After the inspection is completed, four nick-break test specimens shall be removed from the weld in accordance with **Figure 10**. After sectioning, the destructive test specimens shall be allowed to air cool to ambient temperature prior to testing. None of the test specimens shall include a portion of the pipe seam weld. The destructive test specimens shall be tested in accordance with Section 10.5.1. and Section 10.5.2, as applicable.

10.5.1. Nick Break Test

The nick-break test specimen shall be prepared in accordance with **Figure 10**. Notching the face of the nick-break test specimen is permitted when failure in the pipe is expected. After the specimen has been notched, the specimen shall be loaded until failure. The exposed fracture surface shall be at least 3/4 inch wide. The specimen shall be considered acceptable if they meet the requirements of Section 10.4.2.

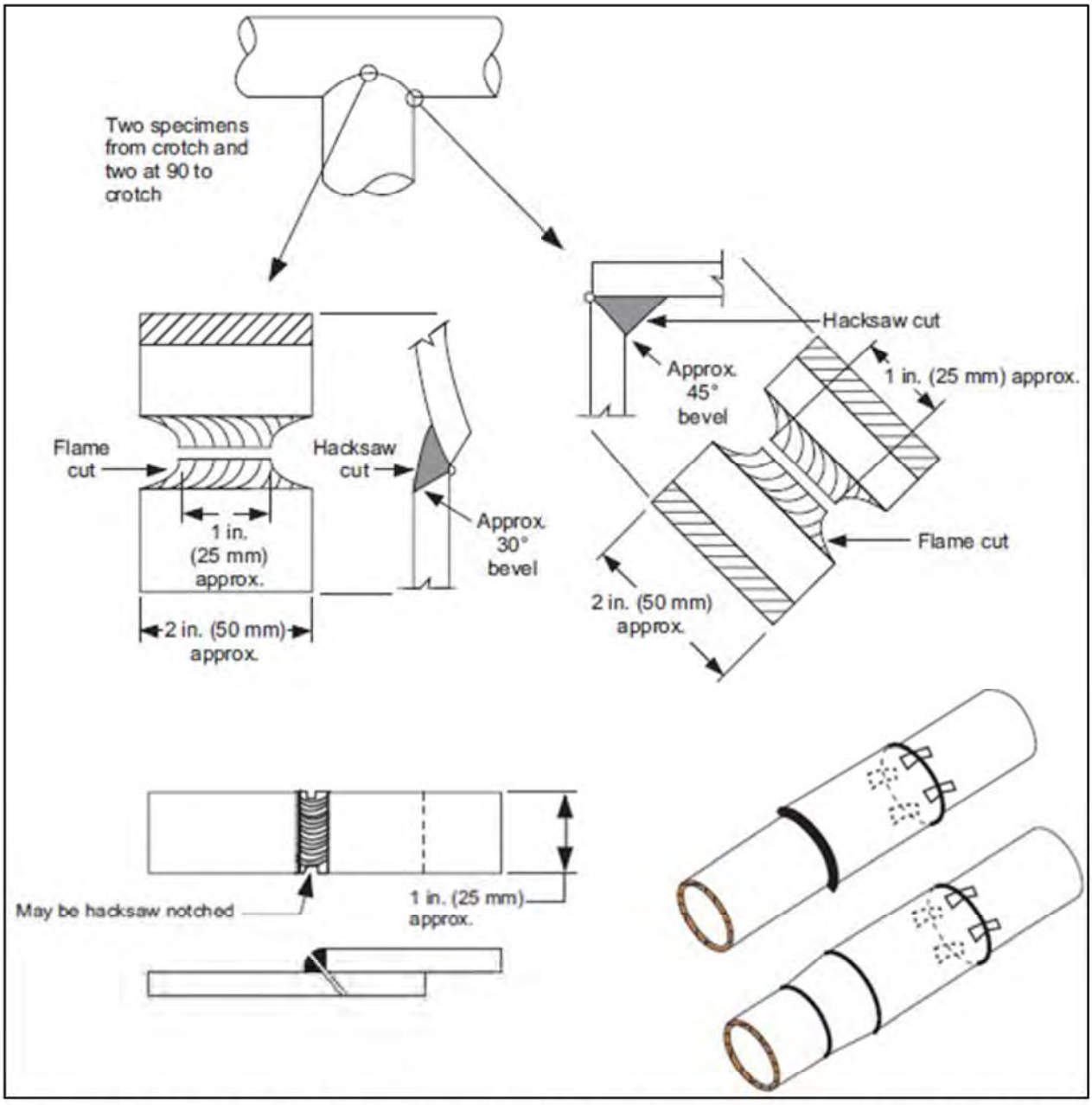


Figure 10. Location and Preparation of Nick-Break Branch Groove and Fillet Welding Procedure Qualification Test Specimens

10.5.2. Additional Branch Groove or Fillet Welding Procedure Qualification Test

Additional destructive tests may be required based on the operating conditions of the pipeline when requested by Gas Engineering. Additional tests may include but are not limited to Macro-section Tests in accordance with Section 10.5.2.1 and Hardness Test in accordance with Section 10.5.2.2.

Contact Gas Engineering for approval and to ensure that the proper tests are performed during qualification.

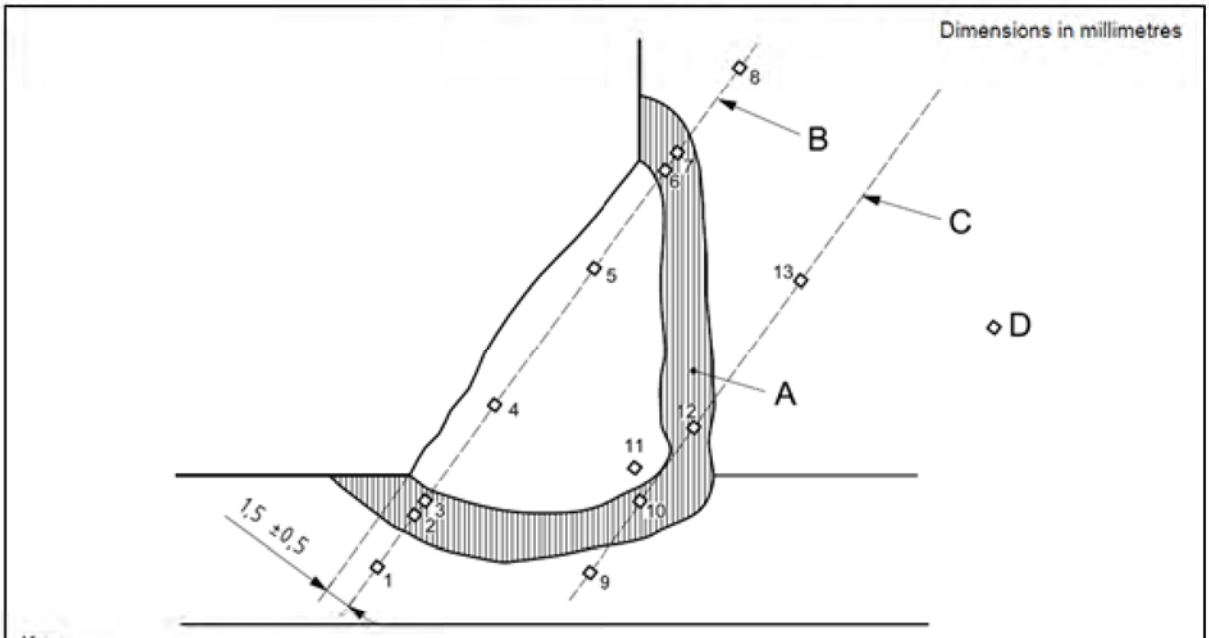
10.5.2.1. Macro-Section Test

One weld macro-section shall be removed from near the crotch location of the qualification weld, prepared, and evaluated in accordance with Section 10.4.4.1.

10.5.2.2. Hardness Test

The macro-section test specimen shall be used for the hardness test in accordance with Section 10.4.4.2 with the following exception.

- The location of the hardness indents for a branch groove weld or fillet weld shall be in accordance with **Figure 11**.



Key

A weld heat-affected zone (visible after etching)

B line of survey

C line of survey, parallel to line B and passing through the fusion boundary between the weld metal and the heat-affected zone at the throat

D hardness impressions: Impressions 3, 6, 10 and 12 should be entirely within the heat-affected zone and located as close as possible to the fusion boundary between the weld metal and the heat-affected zone.

Figure 11. Hardness Indent Locations for a Branch Groove or Fillet Welding Procedure Qualification

10.6. Qualification and Testing of Repair Welding Procedures (API 1104 21st Ed. Only)

Qualification of repair welding procedures requires testing repair welds deposited in previously deposited construction welds, for which the repair welding procedure is be used. This section was written to conform to Section 10 of the 21st edition of API 1104, though currently neither Section 10 of any edition or the 21st Edition of API 1104 are incorporated by reference into CFR 192/195. NGBU currently does not qualify separate repair procedures, but has written this section for future use should Section 10 of the 21st Edition of API 1104 become incorporated by reference.

The construction welds shall be deposited in a 12.75 inch or greater outside diameter, minimum 0.375 inch thick pipe oriented in the horizontal position. Two sections of the construction weld shall be ground out resulting in two repair grooves that shall be used to qualify a full-thickness, weld-centerline repair and a fusion-line, cover-pass repair.

The full-thickness, weld-centerline repair groove shall include the removal of the entire construction weld including the root pass. The repair groove shall have a minimum length of 8 inches of removed root pass. The total repair groove length shall be longer than 8 inches to allow a gradual transition from the outside diameter to the bottom of the repair groove to allow the welder access to the bottom of repair groove.

The fusion-line, cover-pass repair groove shall be on the opposite half of the pipe diameter from the full-thickness, weld-centerline repair groove. The repair groove shall be located at the weld toe of the cap pass. The depth of the groove shall be approximately 0.100 inch deep to allow the groove to be filled with a single layer. The minimum length of the full-thickness, weld-centerline repair groove shall be 8 inches.

10.6.1. Qualification of Repair Butt Welding Procedures

The completed qualification welds shall be inspected in accordance with WEL-ST-1060 Non-Destructive Evaluation and Inspection of Steel Pipeline Welds, and WEL-PR-1080 Visual Inspection of Welds, not less than 24 hours after welding has been completed. After the inspection is completed, the destructive test specimens shall be removed from the weld and tested in accordance with Section 10.4 with the following exceptions.

- The destructive test specimens required for qualifying full thickness weld centerline and fusion-line, cover-pass repair of butt welding procedures are provided in **Table 4**.
- The destructive test specimens shall be removed from the each repair weld in sequence starting in the center of the repair welds and tested in accordance with Section 10.4
- If the macro-section test shows a defect not associated with the repair weld, an additional macro-section test can be performed. If the second macro-section test contains other defects then the repair qualification weld is rejected.
- The hardness indent locations shall be in accordance with **Figure 12** or **Figure 13** as applicable.

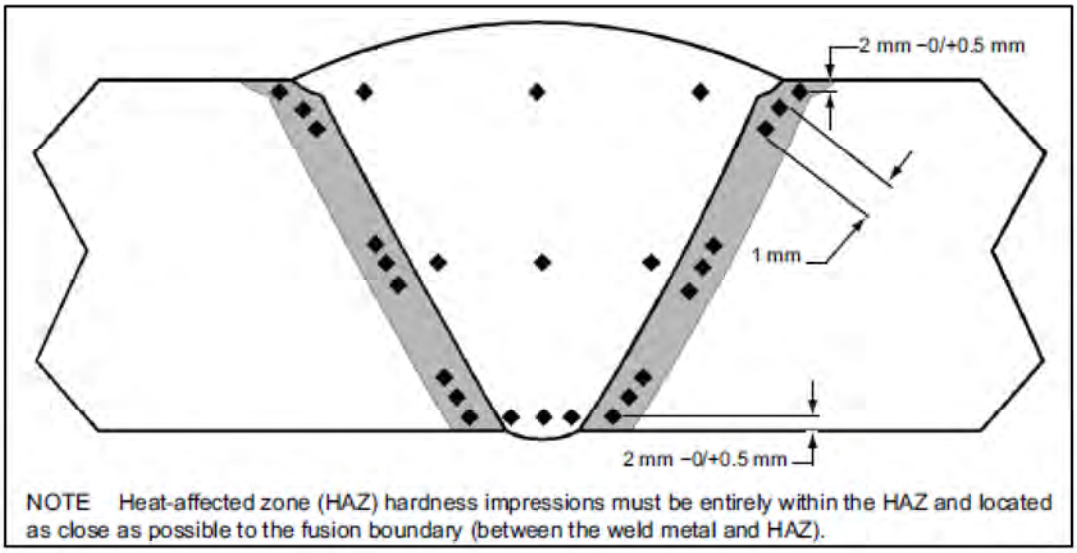
Table 4. Type and Number of Test Specimens for Repair Butt Welding Procedure Qualifications

Repair Type	Tensile Strength	Nick Break	Root Bend	Face Bend	Side Bend	Macro/ Hardness [b]	Total (Minimum)	Charpy Impact
Full thickness	1	1	1 [a]	1 [a]	0	1	5	Note c
Cover pass	0	0	0	1	0	1	2	0

[a] Side bend tests are substituted for face bend or root bend tests when wall thickness is over 0.500 in. (12.7 mm).

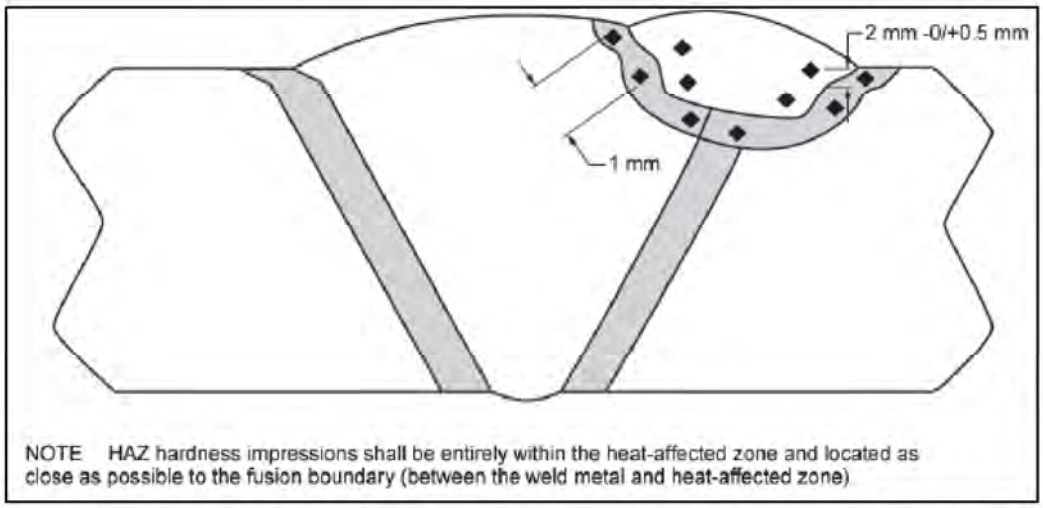
[b] The hardness survey is made on the macrosection test specimen.

[c] When required by the company.



NOTE Heat-affected zone (HAZ) hardness impressions must be entirely within the HAZ and located as close as possible to the fusion boundary (between the weld metal and HAZ).

Figure 12. Hardness Indent Locations for a Full Thickness Centerline Repair Welding Procedure Qualification for Butt Weld Repairs



NOTE HAZ hardness impressions shall be entirely within the heat-affected zone and located as close as possible to the fusion boundary (between the weld metal and heat-affected zone)

Figure 13. Hardness Indent Locations for a Cover Pass Fusion Line Repair Welding Procedure Qualification for Butt Weld Repairs

10.6.2. Qualification of Repair Branch Groove or Fillet Welding Procedures

The completed qualification welds shall be inspected in accordance with WEL-ST-1060 Non-Destructive Evaluation and Inspection of Steel Pipeline Welds, and WEL-PR-1080 Visual Inspection of Welds, not less than 24 hours after welding has been completed. After the inspection is completed, the destructive test specimens shall be removed from the weld and tested in accordance Section 10.5 with the following exceptions.

- The destructive test specimens required for qualifying a full thickness weld centerline repair of a branch groove weld or fillet welding procedure is two nick-break specimen, one macro-section specimen and one hardness test specimen
- The destructive test specimens required for qualifying a fusion line cover pass repair of a branch groove weld or fillet welding procedures include one macro-section specimen and one hardness test specimen
- The destructive test specimens shall be removed from the each repair weld in sequence starting in the center of the repair welds
- If the macro-section test shows a defect not associated with the repair weld, an additional macro-section test can be performed. If the second macro-section test contains other defects then the repair qualification weld is rejected.
- The hardness indent for the fusion line cover pass repair shall be located in the following locations:
    - Three indents in the heat-affected zone of the fusion line cover pass repair located in the construction weld
    - Three indents in the heat-affected zone of the fusion line cover pass repair in the pipe or attachment material

- Two indents in the intersection of the heat-affected zones of the fusion line cover pass repair and construction weld
- Four indents in the fusion line cover pass repair weld metal

10.7. Qualification and Testing of In-Service Welding Procedures

CAUTION: *In-service welding procedures are required separately from standard welding procedures because of the inherent safety issues and special circumstances required to weld on pressurized pipelines. The goal of in-service welding procedures are to avoid burn-through of the pipe wall and hydrogen cracking of the weld.*

10.7.1. In-service welding procedures shall be performed in accordance with API 1104 Appendix B and considered either a heat input control in-service welding procedure or a temper bead welding procedure. Heat input control in-service welding procedures rely on the heat from the welding process to counteract the cooling aspects of the operating pipeline. Temper bead in-service welding procedures rely on the welding heat from subsequent weld pass to temper the previously deposited weld pass.

10.7.2. All in-service welding procedures shall be qualified as an in-service branch groove weld or an in-service sleeve fillet welding procedure. Qualification of in-service weld metal deposition welding procedures shall be approved by Gas Engineering.

10.7.3. All in-service welding procedures shall be qualified with water or flowing motor oil to simulate the cooling conditions of a natural gas operating pipeline. The heat sink capacity shall be measured for all qualification welds in accordance with WEL-PR-1040 "Heat Sink Capacity Measurement."

10.7.4. The material used during qualification shall have a representative CE of the material that is to be welded in the field. The welding heat input shall be calculated using hand held meters, a stopwatch, and tape measure in accordance with Section 11.2.2 of WEL-ST-1010. The average heat input per weld pass used to deposit the in-service qualification weld shall be considered the minimum allowable welding heat input for the in-service welding procedure.

The completed qualification welds shall be inspected in accordance with WEL-ST-1060 Non-Destructive Evaluation and Inspection of Steel Pipeline Welds, and WEL-PR-1080 Visual Inspection of Welds, not less than 24 hours after welding has been completed. After the inspection is completed, the destructive test specimens shall be removed from the weld and tested in accordance with Section 10.5 with the following exceptions:

- The destructive test specimens required for qualifying an in-service branch groove or sleeve fillet welding procedure are provided in **Table 5**.
- The test specimens shall be removed from the weld in accordance with **Figure 14**, as applicable.
- Two of the macro-section tests shall be used for hardness testing.

- The face bend specimen shall be prepared in accordance with **Figure 15** and tested in accordance with Section 10.4.3 with the weld toe area being placed opposite the plunger
- The remaining portion of the nick-break specimen could be used for the face bend specimen with approval by the Welding Procedure Qualifier.
- For temper bead welding procedures, the distance from the weld toe on the first layer to the weld toe on the subsequent pass shall be measured and recorded on the in-service welding procedure as the maximum weld bead spacing permitted.
- The hardness indent locations shall be in accordance with **Figure 16** and there should be a minimum of five indents in the area, which is expected to have the highest expected hardness.

Table 5. Type and Number of Test Specimens for In-Service Welding Procedure Qualifications

Wall Thickness	Weld Type	Number of Specimens [a]						
		Tensile	Nick Break	Root Bend	Face Bend	Side Bend	Macro Test	Total
All	Sleeve		4 [b]		4		4	12
	Branch		4 [b]		4		4	12

[a] For pipe or branch OD less than or equal to 4.500 in. (114.3 mm), two welds may be required.

[b] At the owner's option, the remaining portion of these specimens may be prepared for and submitted to the face bend test after they are submitted to the nick break test.

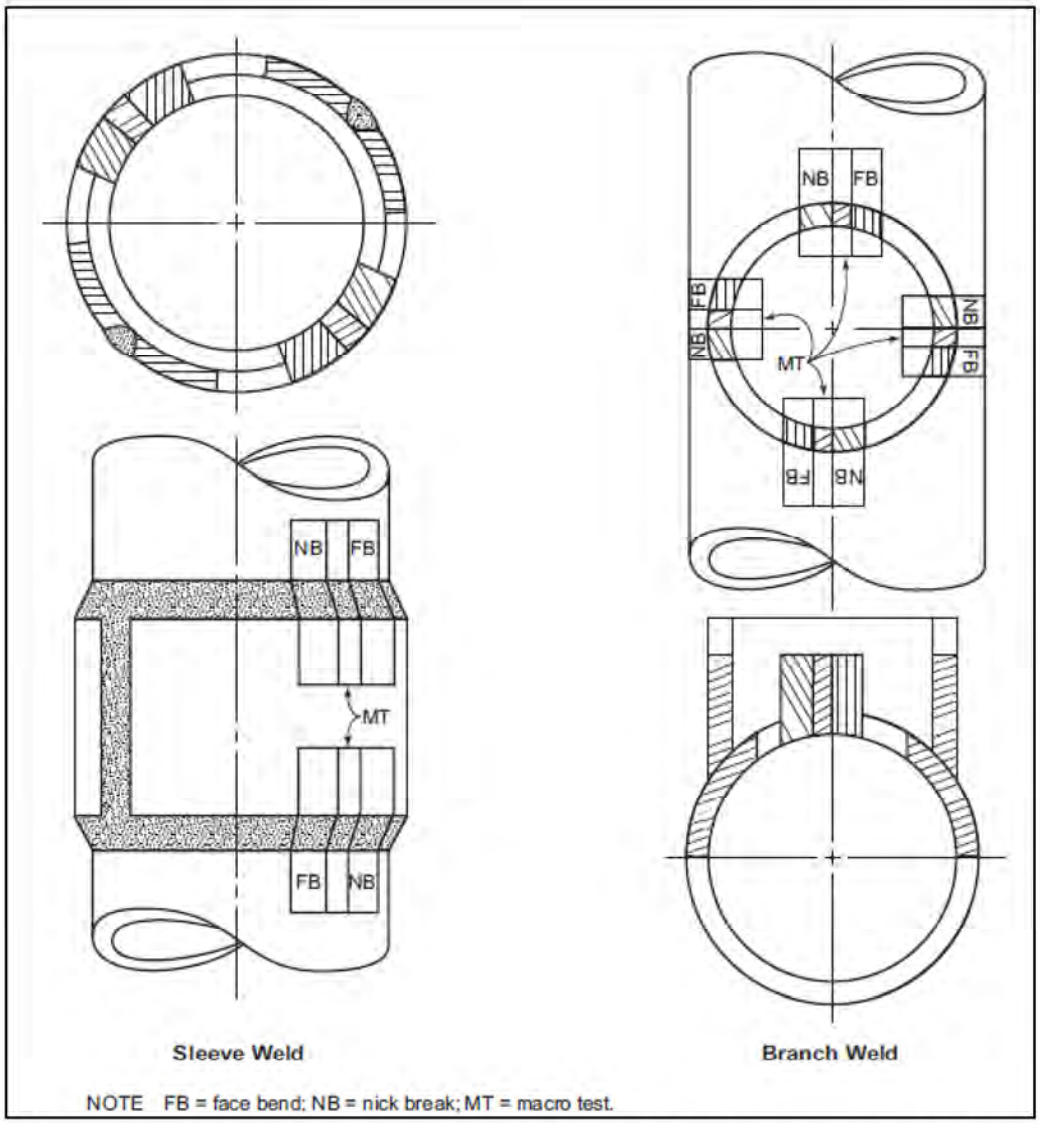


Figure 14. Location of Test Specimens for In-Service Welding Procedure Qualification

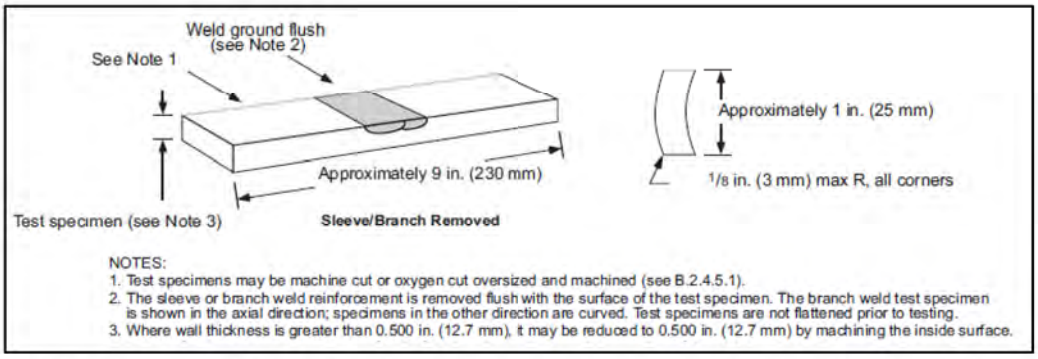


Figure 15. Face Bend Test Specimen Preparation for In-Service Welding Procedure Qualification

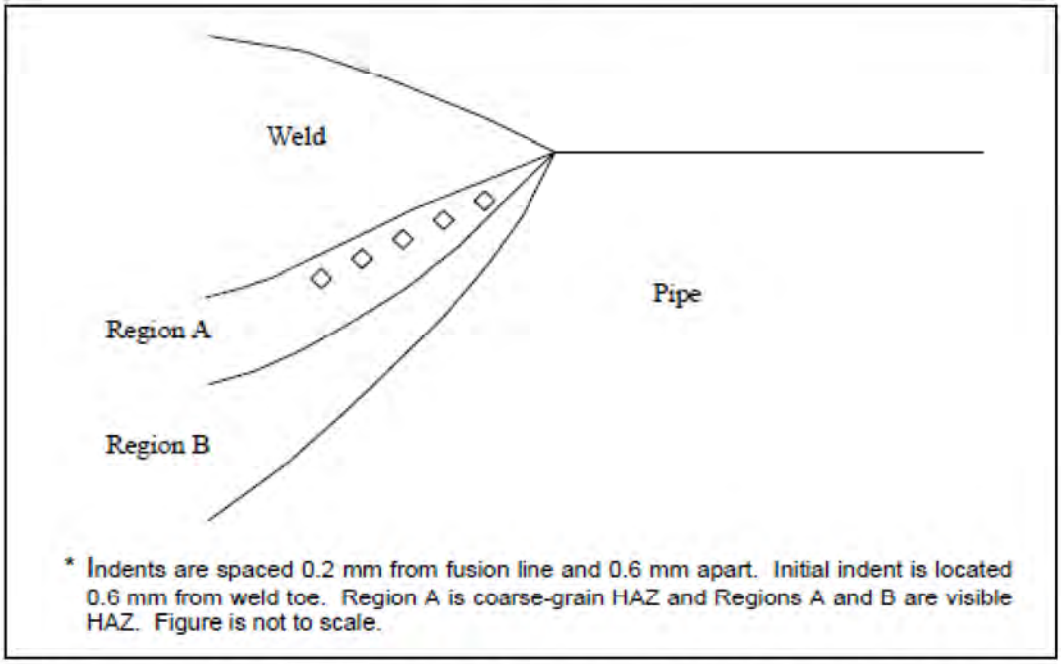


Figure 16. Hardness Indent Locations for In-Service Welding Procedure Qualification

10.8. Approval of Third Party Fabrication Contactor Welding Procedures

Contractor welding procedures can be used when welding on NGBU facilities upon review and approval by a Welding Procedure Approver. Contractor procedures shall be qualified to either API 1104 or ASME Section IX. The Contractor Qualification Approval Form provided in Appendix C shall be signed and dated by a Welding Procedure Evaluator accepting responsibility of the contractor's welding procedure. Appendix C and the contractor's welding procedures shall be filed in the job book.

10.9. Documentation and Recordkeeping Requirements for Welding Procedure Qualifications

Once all documentation is complete showing the weld procedure to comply with this standard, the new procedure will be signed off and accepted by the Welding

Procedure Approver and the standard will be updated by Asset Safety Management. The PQR shall be signed by the Welding Procedure Qualifier and the Welding Procedure Approver. The procedure qualification record shall be maintained by Asset Safety Management.

Form A (for welding procedures) and Form B (for PQRs) in WEL-PR-1000 provide the required forms for appropriate documentation. Other forms will be considered acceptable upon approval by the Welding Procedure Approver.

The welding procedure shall be retained for the lifetime of the pipeline it was used on and followed whenever the procedure is used. The PQR shall be maintained as long as the welding procedure is in use.

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11. Welder Qualifications

11.1. General

11.1.1. This section covers the operator qualification of welders (both NGBU and Contract welders). New welders shall be qualified to the edition of API 1104 that is referenced in 49 CFR 192 at the time of qualification and the following applicable sections. The applicable sections may exceed, but shall in no instance reduce, the requirements specified in API 1104. Wherever there is a contradiction, the more stringent requirement shall govern.

11.1.2. Welders qualified under a previous version of API 1104 may continue welding, however their welder qualification maintenance shall be in compliance with the edition of API 1104 which is referenced in the most recent version of 49 CFR 192. The welders shall be qualified using the qualified welding procedures included in the Welding Standard that have been qualified to produce sound ductile welds. Before starting the qualification test, the welder shall be given a reasonable time to adjust the welding equipment to be used. The welder shall use the same welding technique and proceed with the same speed used during field welding.

11.1.3. Qualified welders shall be given a Welders Certificate that will specify the welder endorsement in accordance with Section 11.2 and the test date. The required format for a Welders Certificate is provided in Form M of WEL-PR-1000. Welders shall keep the Welding Certificate with them when welding for NGBU as proof of their qualification. The Welders Certificate shall be completed, signed, and issued by the welding supervisor or designate. All NGBU employees holding a Welding Certificate shall be within the reporting structure of the Fabrication Resources Group. Any deviation from the range of conditions for which the welder is qualified is strictly prohibited.

11.2. NGBU Welder Endorsements

NOTE: *Welder endorsements (formerly designations) are based on experience and associated work restriction as defined in Table 6.*

11.2.1. The highest welder endorsement (A Welder) is a welder who is considered to have achieved the greatest technical skill based on documented experience and testing. The lowest welder endorsement (C Welder) is a welder who is considered to require significant skill development based on experience and testing. Welder endorsements apply to SMAW construction welders using cellulosic electrodes. In addition to the welder endorsements defined in **Table 6**, a welder can designated as a oxy-acetylene construction welder in accordance with Sections 11.3.4, a gas metal arc weld (GMAW/MIG) construction welder in accordance with 11.3.5, a repair welder (R Welder) in accordance with Section 11.4, a low-hydrogen in-service welder (IN-A Welder) in accordance with Section 11.5.1, or a cellulosic in-service welder (IN-B Welder) in accordance with Section 11.5.2.

11.2.2. All contract welders shall meet the qualification requirements of an "A" Welder in accordance with this section. Any contract welder can be disqualified in accordance with Section 11.8.

Table 6. NGBU Specific Welder Endorsements

Welder Endorsements	Work Restrictions		
	Welding Process	Pipe Outside Diameter	Pipe Pressure
A	Cellulosic SMAW	All	All
AO	Oxy-acetylene	≤ 2.375"	All
AM	GMAW (MIG)	≤ 6.625"	All
B	Cellulosic SMAW	≤ 8.625"	400 psig
BO	Oxy-acetylene	≤ 2.375"	400 psig
BM	GMAW (MIG)	≤ 6.625"	All
C	Cellulosic SMAW	≤ 6.625"	125 psig
CO	Oxy-acetylene	≤ 2.375"	125 psig
CM	GMAW (MIG)	≤ 6.625"	All

11.3. Construction Welder Qualification Requirements (A, B, C Welders)

11.3.1. SMAW A Welder Qualification Requirements

The welder shall complete a butt weld following WPS 40 and a branch groove qualification weld following WPS 100 using 12.75 inch outside diameter, greater than or equal to 0.250 inch to 0.500-inch thick pipe. The SMAW butt weld shall be deposited in the 5G position. For the branch groove weld the welder shall lay out, cut, and fit the branch pipe to the second pipe. The branch pipe shall be vertical located underneath the second pipe, which shall be positioned horizontally. Prior to welding the branch groove weld a hole shall be cut into the second pipe equivalently equal to the inside diameter of the branch pipe.

At a minimum the joint configuration, including the joint bevel and root opening, travel speed, and corresponding welding parameters shall be monitored to ensure compliance with the corresponding welding procedure.

11.3.1.1. Inspection and Testing of All SMAW Welder Qualification Welds

The completed qualification weld shall be allowed to air cool to ambient temperature prior to inspection. The weld shall be visually inspected by personnel qualified in accordance with Section 12 and to the acceptance criteria in accordance with Section 12.

After the visual inspection is completed, the qualification weld shall be destructively tested if it is for a compressor station welder or an entry-level welder (initial qualification). Qualification extensions may be tested by radiographic testing (RT). The completed qualification butt weld shall be tested in accordance with Section 10.4 with the following exceptions.

- The type and number of destructive test specimens are provided in **Table 7**.
- The destructive test specimens shall be removed from the weld in accordance with **Figure 17**.

Table 7. Type and Number of SMAW Welder Qualification Butt Weld Test Specimens

Outside Diameter of Pipe		Number of Specimens					
in.	mm	Tensile Strength	Nick Break	Root Bend	Face Bend	Side Bend	Total
>4.500 to 12.750	>114.3 to 323.9	2	2	2	0	0	6

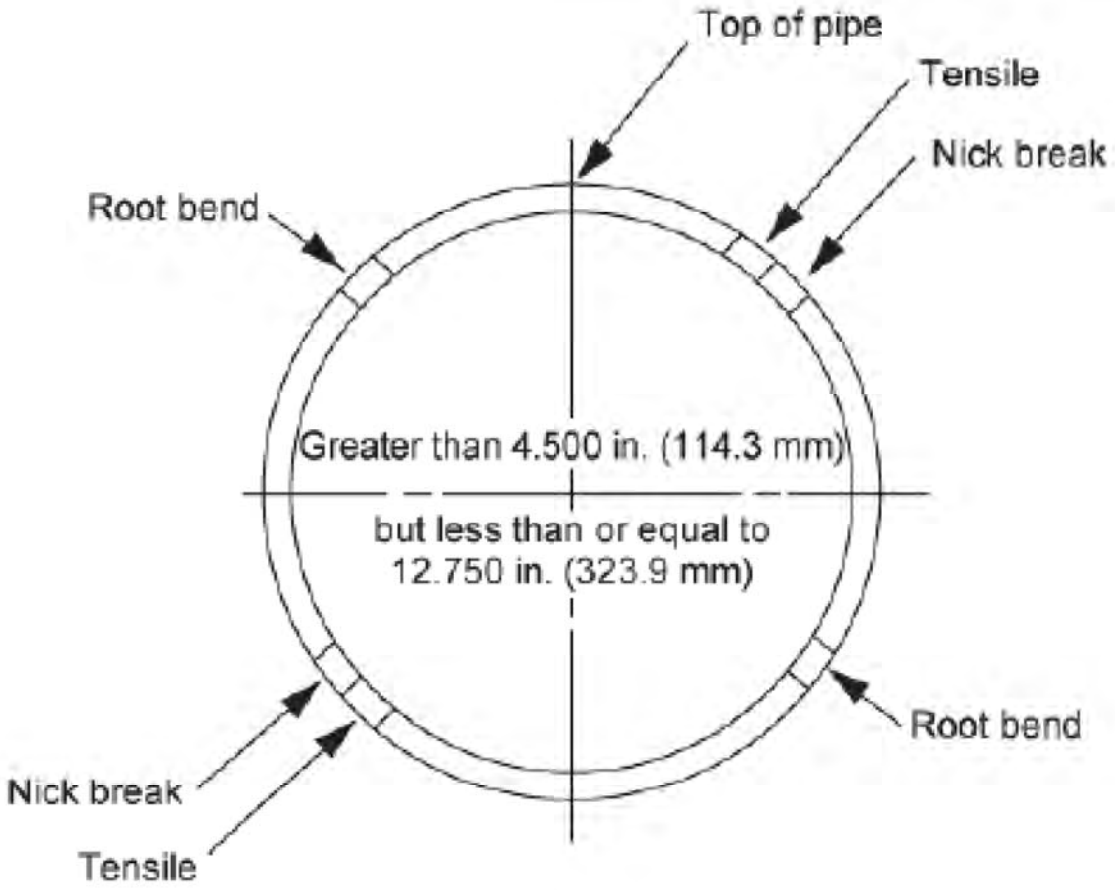

Figure 17. Location of SMAW Welder Qualification Butt Weld Test Specimens

Radiographic inspection shall performed by qualified personnel in accordance with API 1104. Radiographic inspection shall not be used to inspect butt welds to locate sound areas for destructive testing.

The branch groove weld test specimens include four nick-break test specimens and shall be removed from the weld and tested in accordance with Section 10.5.

Finally, there will also be a written exam given which tests basic welding knowledge.

After successful completion of the A welder qualification tests, the welder will be qualified to deposit construction welds following any SMAW welding procedure in accordance with **Table 8** and Section 11.2.

Table 8. A Welder Qualification Ranges for Construction Welding

Weld Direction	Filler Metal Group	Outside Diameter Range	Wall Thickness Range	Positions	Joints	Max. MAOP
Downhill	Group 1 or 2	All	All	All	All	None

11.3.2. SMAW B Welder Qualification Requirements

The welder shall complete the qualification welds in accordance with Section 11.3.1 with the exception that the pipe outside diameter shall be 8.625 inch. After successful completion of the B welder qualification tests, the welder will be qualified to deposit construction welds in accordance with any SMAW welding procedure in accordance with **Table 9** and Section 11.2.

Table 9. B Welder Qualification Ranges for Construction Welding

Weld Direction	Filler Metal Group	Outside Diameter Range	Wall Thickness Range	Positions	Joints	Max. MAOP
Downhill	Group 1 or 2	≤ 8.625 inch	All	All	All	400 psig

11.3.3. SMAW C Welder Qualification Requirements

The welder shall complete the qualification welds in accordance with Section 11.3.1 with the exception that the pipe outside diameter shall be 6.625 inch. After successful completion of the C welder qualification tests, the welder will be qualified to deposit construction welds with any SMAW welding procedure in accordance with **Table 10** and Section 11.2.

Table 10. C Welder Qualification Ranges for Construction Welding

Weld Direction	Filler Metal Group	Outside Diameter Range	Wall Thickness Range	Positions	Joints	Max. MAOP
Downhill	Group 1 or 2	≤ 6.625 inch	All	All	All	125 psig

11.3.4. Oxy-acetylene Construction Welder Qualification Requirements (O Welder)

11.3.4.1. The welder shall complete one butt weld in 2.375 inch outside diameter, 0.154 inch thick API 5L X42 or X52 grade pipe, one butt weld in 2.375 inch outside diameter, 0.218 inch thick API 5L X42 or X52 grade pipe and two butt welds in 1.66 inch outside diameter, 0.113 inch thick API 5L X42 or X 52 grade pipe. All welds shall be welded in the 5G position following WPS 10.

11.3.4.2. At a minimum the joint configuration, including the joint bevel and root opening, travel speed and corresponding flame characteristics shall be monitored to ensure compliance with the corresponding welding procedure.

11.3.4.3. The completed qualification welds shall be inspected in accordance with Section 10.5. After the inspection is completed, the qualification welds shall be destructively tested in accordance with Section 10.4 with the following exceptions.

- The type and number of destructive butt weld test specimens are provided in **Table 11**.
- The destructive test specimens shall be removed from the weld in accordance with **Figure 18**.

Table 11. Type and Number of Oxy-acetylene Welder Qualification Butt Weld Test Specimens

Outside Diamter of Pipe	Number of Specimens					
in	Tensile Strength	Nick Break	Root Bend	Face Bend	Side Bend	Total
< or = 2.375	0	2	2	0	0	4

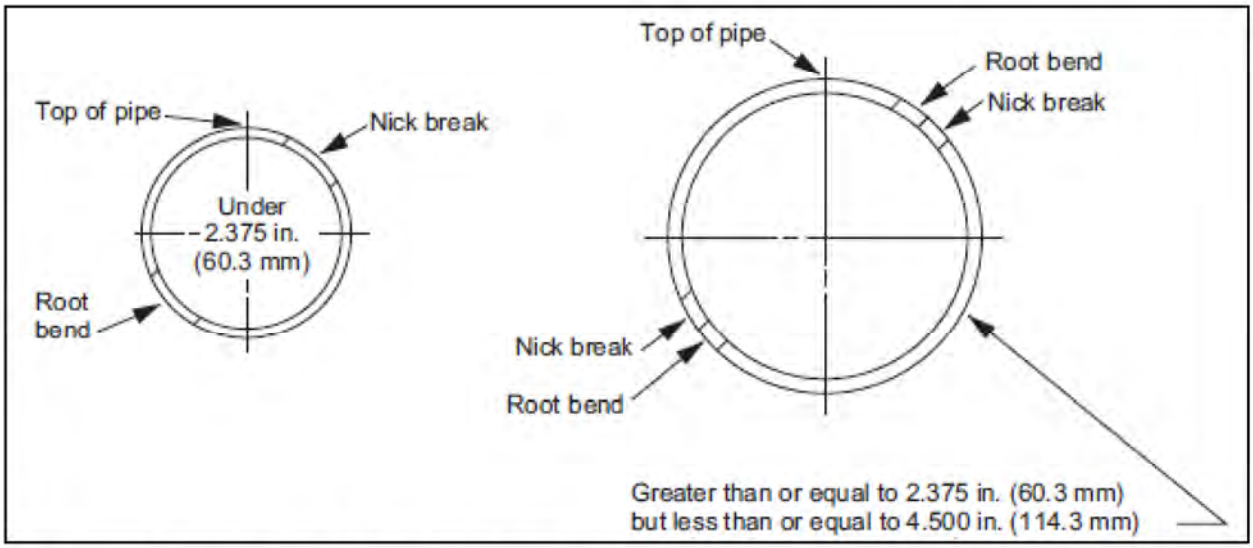

Figure 18. Location of Oxy-Acetylene Welder Qualification Butt Weld Test Specimens

11.3.4.4. After successful completion of the qualification tests, the welder will be qualified to deposit the construction welds following any oxy-acetylene welding procedure in accordance with **Table 10** and Section 11.2. Welders qualified for construction oxy-acetylene welding shall be considered to have the same welder endorsement as the welder's current SMAW construction welder endorsement. If the welder does not have a current SMAW construction welder endorsement then the welder shall be considered a C Welder.

Table 12. Oxy-Acetylene Welder Qualification Ranges for Construction Welding

Weld Direction	Filler Metal Group	Outside Diameter Range	Wall Thickness Range	Positions	Joints
Uphill	Group 6	≤ 2.375 inch	< 0.188 inch	All	Butt and Lap Fillet Welds
Uphill	Group 6	2.375 inch	0.188 – 0.218 inch	All	Butt and Lap Fillet Welds

11.3.5. GMAW (MIG) Construction Welder Qualification Requirements (M Welder)

11.3.5.1. The welder shall complete the qualification tests in accordance with Section I of Appendix C of CFR Title 49 Part 192, "Qualification of Welders for Low Stress Level Pipe" (See the Appendix of this standard for the test instructions from 192).

11.3.5.2. The qualification work for the MIG welds will be done using a 4.5" diameter steel pipe. This allows the MIG welder to weld on any pipe diameter equal to or less than the 6.625" diameter pipe. The pipe will be 0.188" wall thickness. The pipe will be welded in a fixed horizontal position. The weld must conform to the specifications of the procedure under which the welder is being qualified.

11.3.5.3. The (4) coupons extracted from the butt weld will be subjected to only a root bend test. A welder who successfully passes a butt-weld qualification test under this section shall be qualified to weld on all pipe diameters less than or equal to 12 inches.

11.4. Repair Welder Qualification Requirements (R Welder) (API 1104 21st Ed. Only)

11.4.1. This section was written to conform to Section 10 of the 21st edition of API 1104, though currently neither Section 10 of any edition or the 21st Edition of API 1104 are yet incorporated by reference into CFR 192/195.

11.4.2. The welder shall complete a full-thickness, weld-centerline repair and a fusion-line, cover-pass weld repair for the weld joint type (butt weld or branch groove or fillet weld) to be considered a qualified repair welder. The welder shall follow the repair welding procedure that was qualified in accordance with Section 10.6 for the weld joint type that will require the repair weld. The excavation for all repairs shall be orientated on the bottom of the pipe prior to welding.

11.4.3. At a minimum the joint configuration, including the joint bevel and root opening, travel speed, and corresponding welding parameters shall be monitored to ensure compliance with the corresponding welding procedure.

11.4.4. The completed repair qualification welds shall be inspected and tested in accordance with Section 11.3.1.1, as applicable, with the following exceptions.

- When qualifying the butt weld repairs by destructive testing the total number and type of full thickness butt repair weld test specimens shall be in accordance with **Table 13**.
- There shall only be two nick-break test specimens to qualify the full thickness branch groove repair weld.
- There shall only be one face bend test specimen to qualify the cover-pass, branch groove repair weld in accordance with Section 10.7.

Table 13. Type and Number of Repair Welder Qualification Butt Weld Test Specimens

Repair Type	Tensile Strength	Nick Break [b]	Root Bend	Face Bend	Side Bend	Total (Minimum)
Full thickness	0	2	1	1	0	4
Cover pass	0	2	0	1	0	3

[b] One nick break specimen is taken at the transition between the repair weld end and original weld bead and the second nick break specimen located at the midpoint of the repair weld deposit.

11.4.5. After successful completion of the R welder qualification tests the welder will be qualified to deposit repair welds, following any repair welding procedure for the weld joints and welding process used during the qualification, in accordance with **Table 14** and Section 11.2. Repair depths greater than the depths listed in **Table 14** may be performed with approval from Gas Engineering.

Table 14. R Welder Qualification Ranges for Repair Welding

Qualified Welding Process	Welding process specified in the Repair Welding Procedure
Qualified Welding Direction	Welding direction specified in the Repair Welding Procedure
Qualified Filler Metal Group	Welding direction specified in the Repair Welding Procedure
Qualified Diameter Range	All
Qualified Wall Thickness Range	All
Qualified Positions	All
Qualified Joints	Weld joint specified in the Repair Welding Procedure
Qualified Repair Types	Weld Centerline Repairs (Full and Partial Thickness) Weld Toe Cover Pass Repairs
Qualified Repair Depth	Weld Centerline Repairs with a depth of 0.75 inch Weld Toe Cover Pass Repair with a depth of 0.200 inch

11.5. Live Line (In-Service) Welder Qualification Requirements (IN-A and IN-B Welder)

11.5.1. IN-A Welder Qualification Requirements

11.5.1.1. The welder shall have a current A Welder qualification in accordance with Section 11.3.1. The welder shall complete a sleeve fillet weld and a sleeve long seam weld on a 12.75 inch outside diameter, minimum .250 inch thick API 5L pipe of any grade but shall have a maximum CEPCM of 0.25 or CEIIW of 0.43, as appropriate (See API 5L 9.2 for each formula). The pipe shall be filled with water and the water shall be allowed to flow during welding by welding caps on the pipe. The