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This project was supported, in part, by the **National Science Foundation**

Opinions expressed are those of the authors
Not necessarily those of the Foundation
Course Assignments

Reading
WLD 259 Information Sheets

Welding Projects
6G Butt - Single Vee Grove Weld - Open Root - Pipe Weld
5G Butt - Single Vee Grove Weld - Open Root - Pipe Weld
6” Inverted T (Fabricated and Weld Out)

Video Training
See Library collection located at pcc.edu/library
Tipsandtricks.com
YouTube

Final Exam
Part One (Closed Book Exam)
Part Two (Practical Exam)

Outcome Assessment Policy:
The student will be assessed on his/her ability to demonstrate the achievement of course outcomes. The methods of assessment may include one or more of the following: oral or written examinations, quizzes, written assignments, visual inspection techniques, welding tests, safe work habits, task performance and work relations.
Watts Pipe Cutter Information Sheet

- The Watts pipe beveler uses oxygen and acetylene to flame cut pipe bevels. All safety procedures that apply to the track burners and hand torches apply with this pipe beveler.

- Place pipe in jaws and snug jaws down with T-bar wrench.

- Swivel cutting head over pipe ensuring there is approximately ¾” clearance between the cutting tip and pipe.

- Slowly hand rotate the pipe, referencing the cutting tip to pipe wall distance. For a quality cut this variation should not exceed 1/16”. Adjust as necessary.

- Tighten jaws after alignment is completed.
Watts Pipe Cutter Information Sheet Continued

- Turn on manifold and adjust cutting pressures. A good starting point is 5 psi for acetylene and 40 psi for oxygen.

- Turn the Ignite toggle switch ON and open the acetylene needle valve on the back side of the unit. Light the torch and adjust the acetylene flame so the heavy soot disappears.

- Add oxygen, and adjust to a neutral flame.
**Watts Pipe Cutter Information Sheet Continued**

- Turn the *Cut and Roll toggle switch* ON and adjust to a neutral flame. When adding the cutting oxygen, the fuel gas to oxygen ratio changes thus requiring the need to readjust to a neutral flame.

- Once flame is adjusted, the manual needle valves do not need to be turn off each time. Use the *Ignite toggle switch* to turn the torch ON and OFF.

- Light torch and align head over the pipe. Use the *Fast Roll toggle switch* and preheat the pipe by having it rotate 360 degrees. Once pipe is preheated let the torch set idle over one area to heat the kindling temperature (cherry red).

  *Helpful Hint:* Clamp vice grips at the cutting start point. This is a good visual reference for when the pipe cut will be completed, as well as a tool to catch the pipe coupon.

- Once pipe is cherry red, turn the *Cut and Roll toggle switch* on and the cut will begin.

  *Helpful Hint:* Once flame pierces through the pipe, adjust the torch back slightly to remove the starting flaw.
Watt’s Pipe Grinding Station Information Sheet

- Ensure pipe is cool enough to handle before handling it.
- Mount pipe in the rotating fixture ensuring that it is mounted concentrically.
- Tighten the thumbscrew ensuring that the pie is secure.

Thumb Screws
- Hand start the pipe fixture rotation and then begin grinding the groove face.
- Ensure grinder has enough clearance, so it does not hit or catch on the rotating fixture.
• Do not let the fixture rotate too fast. Slow it down frequently, so that the pipe is not thrown from the fixture.

• Ensure the grinder is placed in such a way that the sparks are shooting downward.

• Ensure screens are in place so no bystanders are showered with sparks.

• Grind the groove face clean, and then grind the root face (land). For the downhill root pass technique, use a “dime land” (the land is ground to a thickness of a nickel which is approximately 1/16”).

Watt’s Pipe Grinding Station Information Sheet Continued
Once grinding is completed, remove pipe coupon, replace with next coupon and complete the grinding process.
Fitting Up the Pipe

1. “Dry” fits pipe together and rotate top pipe to determine best fit-up to eliminate high-low condition and excessive root opening. Once the best fit-up is determined, draw a soap stone line to indicate placement of pipe coupons to assist alignment after the spacer is put into place.

High Low
A high-low condition refers to the pipe material being offset at the fit up area. This is because each pipe coupon is not a perfect circle. The API 1104 Standard only allows 1/16” for high low.

2. Place a spacer wire between the pipes for the proper root opening. Rotate the top pipe to minimize a high low fit-up.
3. Make the first tack weld ½” long between the open ends of the spacer wire. The first tack should only be ½” long to help control distortion. The remaining three tacks should be ¾” long.

4. Remove the spacer wire and reposition it as shown, and weld the second tack opposite the first tack (this is referred to as diametrically opposed to the first tack).
5. Tack weld the two remaining sides starting with the wider of the two sides. At this point the pipe should have one tack weld at 12, 3, 6 and 9 o’clock positions.

6. Use a hand grinder with a 1/8” thick notching wheel to feather (ramp) the tacks. The keyhole side of the tack will not need as much grinding. Too much grinding on this end of the tack will potentially cause burn through when welding the root pass.

Minimal grinding at the key hole end
Pipe Welding Power Tools

At a minimum a pipe welder should have:

- Two 9 inch grinders for pipe that is 6 inches and larger (one with a notching wheel and one with a wire wheel).
- Two 4½ inch grinders for 4 inch pipe and smaller (one with a notching wheel and one with a wire wheel).
- File with “teeth ground in it” used for slag removal  (*Do Not Use a Chipping hammer on Pipe*).
- Flash light for inspection purposes.
6G Downhill Welding Techniques

1. Secure the pipe in the fixture in the 6G position to be welded.

6G Position
Pipe axis is inclined 45 degrees from the horizontal plane

1. Strike the arc and extend the arc length (“long arc”) over the tack weld and allow electrode to “warm up.” "Pop" the electrode into open root and pause slightly, and begin welding. Note that the Arc is “burning” through the root opening getting complete penetration. This is seen by the keyhole that the arc creates.
2. Use the drag technique for the root pass, pushing the electrode no more than half way into the root area. Ensure that the “fire” stays on the back side of the pipe. This will create the distinctive sound when obtaining 100% penetration.

**Drag Technique**

*Keep the arc tight and step no more than 1 electrode diameter in distance.*

---

**Root Pass Arc Length**

*Keep a tight arc when touching down into the puddle. Try not to push electrode more than ½ way into the root face area.*

<table>
<thead>
<tr>
<th>Root Pass Notes:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) 90% of the “fire” should be inside the pipe. This should create a “bee hive” sound.</td>
</tr>
<tr>
<td>2) The bead should be centered in the root opening.</td>
</tr>
<tr>
<td>3) Over filling is a common problem on the root. Travel almost too fast... The exterior side of the bead should not be allowed to get too big.</td>
</tr>
</tbody>
</table>
While welding the root pass, keep the bead centered in the root opening and moving downward. There is nothing but the puddle to catch itself on the backside of an open root weld so a slow travel speed will lead to excessive root reinforcement and/or burn through.

Use the two handed technique to strike the arc. This will help eliminate arc strikes on the pipe wall that will render the pipe useless.

This technique is sometimes referred to as “shooting pool.”
Note that the root pass is ground out and ready for the hot pass.

Five variables to control when applying the root pass:
- Root face
- Root opening
- Amperage
- Arc length
- Travel speed

Root Bead Suggestions:
- Center root pass (stringer) in the root opening when welding, this will help prevent internal undercut or inadequate penetration (IP).
- Keep the bead moving
- Avoid letting the key hole get too large
- Vary technique for joint fit up.

Adjust Technique for Root Fit Up to ensure 100% penetration
Narrow gap techniques:
• Push electrode into opening to “burn through”
• Increase amperage
• Grind root area to reduce root land

Wide gap technique:
• Weld wide section last. Hopefully welding the other three quadrants will shrink wide area.
• Reduce current
• Allow the pipe to cool.

Internal Undercut:
• Electrode too deep into groove
• Amperage too high
• Root opening too large
• Root land too thin

Stopping techniques
Use a quick step out of the root bead to decrease keyhole size when terminating the weld. Leaving a large keyhole can cause excessive root reinforcement on the inside upon restarting.
Root Pass inspection

A quality root pass

- Remove the slag from the internal root pass side. Inspect the root for complete penetration, undercut and excessive penetration. See Craftsmanship Expectations for inspection criteria.

Applying the Hot Pass
Grind out face of root bead to prepare for the hot pass

- Increase amperage 10 to 20 amps above root bead setting.
- The whip and pause technique should be used with whipping distance 1 to 2 electrode diameters with a medium arc length. Use a circling technique “Paint The Walls” to remove wagon tracks.

The purpose of the hot pass:
- Burn out slag (wagon tracks)
- Re-contour stringer
- Anneal (stress relieve)
- Drive out hydrogen in heat affected zone (HAZ)
Fill and Cover Pass Technique

A tight arc is essential when welding with E6010 fill and cover passes. The puddle relies on the vaporization of the flux and the molten slag for shielding. Keep the electrode in the puddle always, weave the electrode to evenly distribute the weld metal.

First Fill layer with the E6010

- Use the slant loop technique to cover the whole hot pass. Pause at the side walls and not the middle of the puddle.
- Remove all slag prior to applying next layer
Second fill layer (if needed) with the E6010:

- Use the slant loop multiple pass stringer bead technique for the second layer of fill beads.
- Ensure to leave enough area for the second pass on this layer. If the first bead is too large there will not be enough room for the second bead to go in without trapping slag.
- Remove all slag prior to applying next layer.
Cover Passes (Finish Beads) for the 6G

- Use the Slant Loop Stringer Bead Technique

**Slant Loop Technique**

- For the 6G weld, a weave bead can be used. Care must be taken not to roll the bottom side. It is common to step up to a 5/32” electrode size to help eliminate the need to oscillate.
- Remove all slag with a wire wheel. Note that a hand file can be used to smooth out undercut at the weld and the pipe wall interface (toe). Excessive filing will not be permitted because it reduces the pipe wall thickness.
**5G Downhill Welding Techniques**

1. Tack weld pipe coupons together and secure the pipe in the fixture in the 5G position to be welded.

   ![5G Position](image)

   **5G Position**
   
   *Pipe axis is parallel to the horizontal plane and the pipe is not rotated*

2. When applying the root pass, strike the arc and extend the arc length ("long arc") over the tack weld and allow electrode to "warm up." "Pop" the electrode into open root and pause slightly, and begin welding. Note that the Arc is "burning" through the root opening getting complete penetration. This is seen by the *keyhole* that the arc creates while welding.

   ![Strike the arc on the tack weld](image)
   ![The “fire” is inside of the pipe which creates a distinctive beehive sound](image)
3. Use the drag technique for the root pass pushing the electrode no more than half way into the root area. Ensure that the "fire" stays on the back side of the pipe. This will create the distinctive sound when obtaining 100% penetration.

Drag Technique – Root Pass

Arc Length
Keep a tight arc when touching down into the puddle. Try not to push electrode more than ½ way into the root face area.

Use the two-handed technique to strike the arc. This will help eliminate arc strikes on the pipe wall that will render the pipe useless.

This technique is sometimes referred to as "shooting pool."
Keep the root pass centered in the root opening and moving forward. There is nothing but the puddle to catch itself on the backside of an open root weld. Traveling too slow will lead to excessive root reinforcement. Listen for the distinctive beehive sound the arc makes when achieving full penetration.

Note that the lumpy areas are not detrimental since the root pass will be ground before applying the hot pass.
Five variables to control when running the root pass:
- Root land
- Root opening
- Amperage
- Arc length
- Travel speed

The soundness of the root pass will be greatly affected by these five variables. The welder will need to learn to control these variables to produce a quality root bead.

Root Bead Suggestions:
- Center root pass (stringer) when welding, this will help prevent internal undercut or inadequate penetration (IP).
- Keep the bead moving
- Avoid letting the key hole get too large
- Vary technique for joint fit up.

Adjust Technique for Root Fit Up to ensure 100% penetration

Narrow gap techniques:
- Push electrode into opening to “burn through”
- Increase amperage
- Grind root area to reduce root land

Wide gap technique:
- Weld wide section last. Hopefully welding the other three quadrants will shrink wide area.
- Reduce current
- Allow pipe to cool.

Internal Undercut:
- Electrode too deep into groove
- Amperage too high
- Root opening too large
- Root land too thin
Stopping techniques
Use a quick step out of the root bead to decrease keyhole size when terminating the weld. Leaving a large keyhole can cause excessive root reinforcement on the inside.

Root Pass inspection

A quality root pass

- Remove the slag from the internal root pass side. Inspect the root for complete penetration, undercut and excessive penetration. See Craftsmanship Expectations for inspection criteria.
Hot Pass (Whip and Pause)

Grind out face of root bead to prepare for the hot pass

Applying the Hot Pass

- Increase amperage 10 to 20 amps above root bead setting.
- The whip and pause technique should be used with whipping distance 1 to 2 electrode diameters with a medium arc length. Use a circling whip and pause technique to “Paint the Walls” to remove wagon tracks.
The purpose of the hot pass is to:
• Burn out slag (wagon tracks)
• Re-contour stringer
• Anneal (stress relieve)
• Drive out hydrogen in heat affected zone (HAZ)

Fill and Cover Pass Technique

A tight arc is essential when welding with E6010. The puddle relies on the vaporization of the flux and the molten slag for shielding. Keep the electrode in the puddle always while weaving the electrode to evenly deposit the weld metal.

Failure to follow these techniques may result in porosity, undercut, slag inclusions, or lower impact strength.

First layer of the E6010 fill pass
• Use the side-to-side weave technique to cover the whole hot pass. Emphasize the side walls when welding not the middle of the puddle.
• Remove all slag prior to applying next layer

Second layer of the E6010 fill pass:
• Use the side-to-side weave bead technique for the second layer fill bead.
• Ensure to leave enough area for the cover pass.
• Remove all slag prior to applying next layer.

Example of the side-to-side technique for the fill passes.
Cover Passes for the 5G

- Note--- with pipe welding applications it is common place to use a weave bead technique.
- Use the Side-to-Side Weave Bead Technique
- For the 5G weld, the maximum bead width should not be more than 1/8 larger than the groove opening. Excessively wide beads will lead to a sloppy appearance and a waste of time and filler material.
- Remove all slag with a wire wheel. Note that a hand file can be used to smooth out undercut at the weld and pipe wall interface (toe). Excessive filing will not be permitted.
Common Pipe Vocabulary #1

Name: _______________________________  Date: __________

Use any resource available to define the following terms.

1.  Pipe

2.  Tube

3.  Standard wall pipe

4.  Extra Strong Pipe

5.  Pipe Fittings

6.  Center line construction

7.  Take off

8.  90-degree fitting
9. 45-degree fitting

10. Welded pipe

11. Screw Pipe

12. Two holing a flange

13. Weld outlets

14. Header

15. Branch

16. Tripod Pipe Jack stand

17. Stripper Bead

18. Socket Weld
Common Pipe Welding Defects #2

Name: __________________________    Date: ____________

Use any resource available to define the following terms.

1. Arc Strikes

2. Undercut (Internal and External)

3. Overlap (Cold Lap)

4. Incomplete Fusion (IF)

5. Inadequate Penetration (IP)

6. Internal Concavity (Suck Back)

7. Under fill

8. Wagon Tracks
9. Burn Through

10. Porosity
Craftsmanship Expectations for Welding Projects

The student should complete the following tasks prior to welding.

1. Thoroughly read each drawing.
2. Make a cutting list for each project. Cut at least two projects’ worth of metal at a time, this will save a great amount of time.
3. Assemble the welding projects per drawing specifications.
4. Review Welding Procedure portion of the prints to review welding parameter information.
5. See the instructor for the evaluation.

Factors for grading welding projects are based on the following criteria:

<table>
<thead>
<tr>
<th>Metal Preparation</th>
<th>Project Layout</th>
<th>Post Weld Clean-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxyfuel cut quality</td>
<td>Accurate (+/- 1/16”)</td>
<td>Remove Slag/Spatter</td>
</tr>
<tr>
<td>Grind all cut surfaces clean</td>
<td>Limit waste</td>
<td>Remove sharp edges</td>
</tr>
</tbody>
</table>

Weld Quality per API 1104

<table>
<thead>
<tr>
<th>VT Criteria</th>
<th>Root Pass</th>
<th>Cover Pass</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reinforcement</td>
<td>Flush to 1/16”</td>
<td>Flush to 1/8”</td>
</tr>
<tr>
<td>Undercut</td>
<td>1/32 “deep”</td>
<td>1/32” deep</td>
</tr>
<tr>
<td>Bead Contour</td>
<td>Smooth Transition</td>
<td>Smooth Transition</td>
</tr>
<tr>
<td>Penetration</td>
<td>Complete Joint Penetration</td>
<td>N/A</td>
</tr>
<tr>
<td>Cracks</td>
<td>None Allowed</td>
<td>None Allowed</td>
</tr>
<tr>
<td>Arc Strikes</td>
<td>None Allowed</td>
<td>None Allowed</td>
</tr>
<tr>
<td>Fusion</td>
<td>Complete Fusion Required</td>
<td>Complete Fusion Required</td>
</tr>
<tr>
<td>Porosity</td>
<td>None Allowed</td>
<td>None Allowed</td>
</tr>
</tbody>
</table>
E6010 Butt Joint- Single V (6G)                  Project #1
Welding Sequence
E6010-- Root Pass  80- 90 Amps. Utilize the "key hole" dragging technique. Keep the key hole small.
E6010-- Hot Pass  100-110 Amps. Grind the root surface clean and increase amperage 10 to 20 amps above root bead setting to apply the hot pass. Use the whip and pause technique to “Paint the walls” to burn out wagon tracks.
E6010-- Fill and Cap  90-100 Amps. Keep a tight arc length when welding downhill. Use the side-to-side or inverted U weave technique with 1/8” electrode. Use 110- 135 Amps with 5/32” diameter rod for the cover pass with a stepping technique to reduce the weaving width.

<table>
<thead>
<tr>
<th>VT Criteria</th>
<th>Project #1</th>
<th>Project #2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reinforcement</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Undercut</td>
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<td></td>
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<tr>
<td>Bead Contour</td>
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<tr>
<td>Penetration</td>
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<tr>
<td>Cracks</td>
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<tr>
<td>Arc Strikes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fusion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Porosity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grade and Date</td>
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</tbody>
</table>
Wld 259
 Butt Joint-Single Vee
(6G)

Welding Procedure
1. Electrode ________ E6010
2. Electrode Diameter ________ 1/8" & 5/32"
3. Polarity ________ DCCP
4. Amperage ________ 80 to 140
5. Root Face ________ 1/16"
6. Arc Length ________ Touching - 1/16"
7. Welding Position ________ (6G)
8. Material Size ________ Available
9. Work Angle ________ 20° to 70°

NOTE:
Use 6" sch 40 pipe

NOTE:
Start with 6" long coupons and cut out the welds with the Watts beveler to limit waste.

<table>
<thead>
<tr>
<th>Inch</th>
<th>MM</th>
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<tbody>
<tr>
<td>1/16&quot;</td>
<td>1.6</td>
</tr>
<tr>
<td>1/8&quot;</td>
<td>3.2</td>
</tr>
<tr>
<td>1/4&quot;</td>
<td>6.4</td>
</tr>
<tr>
<td>1/2&quot;</td>
<td>12.7</td>
</tr>
<tr>
<td>1&quot;</td>
<td>25.4</td>
</tr>
</tbody>
</table>

Portland Community College
Welding Technology

Tolerance (Unless otherwise specified)
Dimensional ± 1/16" Angle ± 5°

WLD 259-01

Drawn By: John Deering

CHK By: Date: 12/12/15

Approve Date Sheet
E6010 Butt Joint- Single V (5G)                  Project #2
Welding Sequence
E6010-- Root Pass  80- 90 Amps. Utilize the "key hole" dragging technique. Keep the
key hole small.
E6010-- Hot Pass  100-110 Amps. Grind the root surface clean and increase amperage
10 to 20 amps above root bead setting to apply the hot pass. Use
the whip and pause technique to “Paint the walls” to burn out
wagon tracks.
E6010-- Fill and Cap  90-100 Amps. Keep a tight arc length when welding downhill.
Use the side-to-side or inverted U weave technique with 1/8”
electrode. Use 110- 135 Amps with 5/32” diameter rod for the
cover pass with a stepping technique to reduce the weaving width.

<table>
<thead>
<tr>
<th>VT Criteria</th>
<th>Project #1</th>
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<tbody>
<tr>
<td>Reinforcement</td>
<td></td>
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<td>Bead Contour</td>
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<tr>
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<tr>
<td>Cracks</td>
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<tr>
<td>Arc Strikes</td>
<td></td>
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<tr>
<td>Fusion</td>
<td></td>
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<tr>
<td>Porosity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grade and Date</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Weld 259
Butt Joint
(5C)

Welding Procedure
1. Electrode ___ 6010
2. Electrode Diameter ___ 1/8" & 5/32"
3. Polarity ___ DC R/P
4. Amperage ___ 80 to 140
5. Root Face ___ 1/16"
6. Arc Length ___ Touching
7. Welding Position ___ Vertical Up (5C)
8. Material Size ___ Available
9. Work Angle ___ 20 to 70
10. Technique ___ Stringer/weave Bead

NOTE:
Start with 6" long coupons and cut out the welds with the Watts beveler to limit waste.

NOTE:
Use 6" sch 40 pipe

---

Portland Community College
Welding Technology

Tolerance (Unless otherwise Specified)
Dimensional ± 1/16"  Angle ± 5°

WLD 259-02

---

Inch  | MM
--- | ---
1/16"  | 1.6
1/8"   | 3.2
1/4"   | 6.4
1/2"   | 12.7
1      | 25.4

Part No. Required | Size | SI. Conversion
--- | --- | ---

Size:  | Qc No. | Rev.
--- | --- | ---

Chk By:  | Date: 12/15/15  | Approve Date  | Sheet
Final Exam

Part One
This portion of the final exam is a closed book test. Consult with your instructor to
determine items that you may need to review. Once you determine that you are ready for
the exam, request it from your instructor. Complete the exam and write all answers on
the answer sheet. Once completed, return the exam and the answer sheet to your
instructor.

Study Guide

Safety
• Oxyacetylene safety
• SMAW safety
• Hand Tool Safety

SMAW and OAC Processes
• Power source specifics
  o Polarity
  o Current output
• AWS electrode classification
• OAC
  o Theory of cutting
  o Flame types

Welding Symbols and Blueprints
• Orthographic views
• Isometric views
• Welding symbol
  o Weld symbols
  o Reference line
  o Tail

Math and Math conversions
  ▪ Adding and subtracting fractions
  ▪ Reading a tape measure
  ▪ Metric conversions

API 1104 Weld Quality Requirements
Practical Exam

Part Two
This portion of the exam is a practical test where you will fabricate and weld a 6” Schedule 40 pipe test. The evaluation of this portion of the exam will be based on quality requirements set forth in API 1104.

Use the following diagram to lay out destructive tests.

See the API 1104 Standard for more information if needed.

See the API 1104 Code for destructive test sample sizes.
### API-1104 Qualified Ranges

| Diameter: 2.375 OD through 12.75 OD | Filler Metal Group: API Group 3 |
| Thickness: .188” thru 7.50” | Joint Type: Sleeve/fillet/butt full penetration |
| Material: Yield less than 42 ksi | Progression: Downhill |
| Positions: Fixed |

### Weld Joint

| Type: Sleeve/fillet/butt – 30 degrees (+7.5 degrees) | Class: Full and Partial Penetration |
| Joint Description: Single V Groove Weld |
| Sketch Number: See drawing |

### Filler Metal

| API Group No: 3 | AWS Classification: E6010 |
| SFA Classification: 5.1/5.5 | F number: 3 |
| Size: 1/8” and 5/32” | Number of Beads: 4 passes |

### Base Metal

| Specification: A53B | Thickness Welded: .154” to .750” |
| Pipe Diameter: 6 inch | Qualification Range: 2.375” to 12.75” |
| P number: 1 | Group: 1 |
| Time between passes: 5 minutes between root and hot pass |

### Position

| Position: 6G | Progression: Downhill |
| Preheat: 70 F | PWHT: None |

### Electrical Characteristics

| Current: Direct Current | Polarity: Electrode Positive | Amps 90-125 |
| Transfer Mode: N/A | WFS/IPM: N/A | Volts 17-22 |
| Electrode size and type: E6010, 1/8” to 5/32” | Travel IPM: 5-13 IPM |

### Welding Technique

| Technique and number of passes: Stringer/Weave beads with multiple passes |
| Cleaning: Grind and wire brush as necessary |
Joint Sketch and Bead Number and Sequence

Note: Weld layers are representative only – actual number of passes and layer sequence may vary due to variation in the joint design, thickness and fit-up.

### Typical Welding Parameters

<table>
<thead>
<tr>
<th>Pass #</th>
<th>Filler/Electrode</th>
<th>Diameter</th>
<th>Amps</th>
<th>Volts</th>
<th>Travel Speed</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>E6010</td>
<td>1/8&quot;</td>
<td>70-115</td>
<td>20-25</td>
<td>5-10</td>
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</tr>
<tr>
<td>2</td>
<td>E6010</td>
<td>1/8&quot;</td>
<td>90-135</td>
<td>20-25</td>
<td>6-12</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>E6010</td>
<td>1/8&quot;</td>
<td>85-120</td>
<td>20-25</td>
<td>6-12</td>
<td></td>
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<tr>
<td>4</td>
<td>E6010</td>
<td>5/32&quot;</td>
<td>110-140</td>
<td>24-30</td>
<td>6-12</td>
<td></td>
</tr>
</tbody>
</table>

WPS Welded By: Tanner J Scott          Date: 09/01/2016

Prepared by: Matthew J Scott          Date: 09/21/2016

We certify that the statements herein are correct and that the tests were conducted in accordance with API 1104.

Authorized by: Scott Judy          Date: 9/21/2016
Wld. 259
Butt Joint—Single V-groove
Final Exam (6G)

Notes:
1. 6" Schedule 40 carbon steel pipe.
2. Final project shall consist of two pipe sections,
   each a minimum of 6 inch long.
3. For joint detail refer to detail "A", applicable performance
   qualification requirements.
4. All welding to be done in position according to applicable
   performance qualification requirements.
5. All parts shall be mechanically cut by OFC.
6. UT and RT examination in accordance AFI 1104

Welding Procedure
1. Electrode: E6010
2. Electrode Diameter: 1/8" and 5/32"
3. Polarity: DCRP
4. Amperage: 80 to 140
5. Root Pass: 1/16"
6. Arc Length: Touching - 1/16"
7. Welding Position: (6G)
8. Material Size: 6" sch 40
9. Technique: See below

Portland Community College
Welding Technology

<table>
<thead>
<tr>
<th>Inch</th>
<th>MM</th>
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<tbody>
<tr>
<td>1/16&quot;</td>
<td>1.6</td>
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<tr>
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<tr>
<td>1/4&quot;</td>
<td>6.4</td>
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<td>12.7</td>
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<tr>
<td>1&quot;</td>
<td>25.4</td>
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</tbody>
</table>

Part No. Required | Size (WxHxD) | SI. Conversion

Pc

Chk By: John Deering
Date: 12/15/15
Rev.:

Size: Qc No.