WLD 152
Wire Welding Certification Practice

This project was supported, in part, by the *National Science Foundation* Opinions expressed are those of the authors And not necessarily those of the Foundation

PCC/ CCOG / WLD

Course Number:
WLD 152

Course Title:
Flux Cored Arc Welding (Gas Shielded) Certification Practice

Credit Hours:
4

Lecture Hours:
0

Lecture/Lab Hours:
80

Lab Hours:
0

Special Fee:
$24.00

Course Description

Covers safety, welding technique, and qualification procedures in compliance with AWS D1.1 structural test. Prerequisites: Department permission required. Audit available.

Addendum to Course Description

This is an outcome based course utilizing a lecture/lab format. This course includes classroom discussions, videotapes, and lab demonstrations of technical skills. Course outcomes will include: theoretical concepts, lay out, fabrication, welding, oxy-fuel cutting and safety.

Intended Outcomes for the course

Upon completion of the course students should be able to:

- Function safely in the PCC Welding Lab.
- Operate oxy-fuel portable and track cutting systems in accordance with industry standards.
- Understand and apply code requirements for FCAW E71T-1.
- Interpret blueprints to accurately lay out, prepare, and assemble weld joints.
- Weld single V-groove welds with E71T-1 to AWS D1.1 Structural Steel Welding Code.
- Operate an CAC-A (Carbon Arc Cutting - Air) system in accordance with industry standards.
- Apply visual and destructive examination principles and practices in accordance with AWS D1.1.

Course Activities and Design

Welding lec/lab courses are Open Entry and Open Exit (OE/OE) and are offered concurrently. Courses are designed to meet the needs of the students with flexible scheduling options. Students may attend full time or part time. This is an OE/OE course which does not align with the normal academic calendar.

Outcome Assessment Strategies

The course syllabus will identify the methods used to assess student progress and the criteria for assigning a course grade. The student will be assessed on his/her ability to demonstrate the development of course outcome. The methods of assessment may include one or more of the following: oral or written examinations, quizzes, written assignments, welding tests, safe work habits and task performance.

Course Content (Themes, Concepts, Issues and Skills)

Function safely in the PCC Welding Shop.

- Understand and practice personal safety by using proper protective gear
- Understand and practice power tool safety
- Understand and practice equipment safety for welding and oxy-fuel cutting systems
- Understand and maintain a safe work area
    - Recognize and report dangerous electrical and air/gas hose connections
    - Understand and practice fire prevention

Operate oxy-fuel portable and track cutting systems in accordance with industry standards.

- Demonstrate correct setup and shutdown procedures for the hand cutting and track cutting systems.
- Perform oxy-fuel cutting with guided practice.

Understand and apply code requirements for FCAW E71T-1.

- Demonstrate proper stick out and Travel speed
- Demonstrate correct starting, stopping and restarting techniques
- Demonstrate proper bead placement for single V-groove welds

Interpret blueprints to accurately lay out, prepare, and assemble weld joints.

- Interpret lines, symbols, views and notes
- Lay out material per specifications
- Use the oxy-fuel cutting process to cut material to specified dimensions
- Assemble project per welding procedure specifications (WPS)

Weld single V-groove welds with E71T-1 to AWS D1.1 Structural Steel Welding Code in the following joint configurations and positions:

Demonstrate correct welding techniques in the following joints:

- Vertical Position:
    - Single V-groove
- Overhead Position:
    - Single V-groove

Operate an CAC-A (Carbon Arc Cutting - Air) system in accordance with industry standards.

- Demonstrate the effects of the following variables in position: electrode angle, amperage setting, air pressure, and travel speed.
- Demonstrate correct CAC-A gouging techniques on single V-groove welds.

Apply visual and destructive examination principles and practices in accordance with AWS D1.1.

- Explain visual inspection criteria
- Evaluate welds using appropriate welding inspection tools
- Assess weld discontinuities causes and corrections

Course Assignments

Reading

Welding Principles and Applications: by Larry Jeffus.
AWS/ANSI D1.1 Structural Steel Welding Code, Performance Qualification

Writing Work Sheets

Inspection and Testing
Performance Qualification

Cutting Projects

Complete Bill of Materials

Welding Projects

FCAW- Dual Shield
6" Vertical Groove (3G)
6" Overhead Groove (4G)
Bend Test Procedures

Final Exam

Closed Book Exam

Reference List

Standard Welding Terms and Definitions: ANSI/AWS A3.0-94
AWS D1.1 Structural Steel Welding Code
The Procedure Handbook of Arc Welding: By The Lincoln Electric Company

Timeline

Open-entry, open-exit instructional format allows the students to work their own pace. It is the student's responsibility for completing all assignments in a timely manner. See your instructor for assistance.

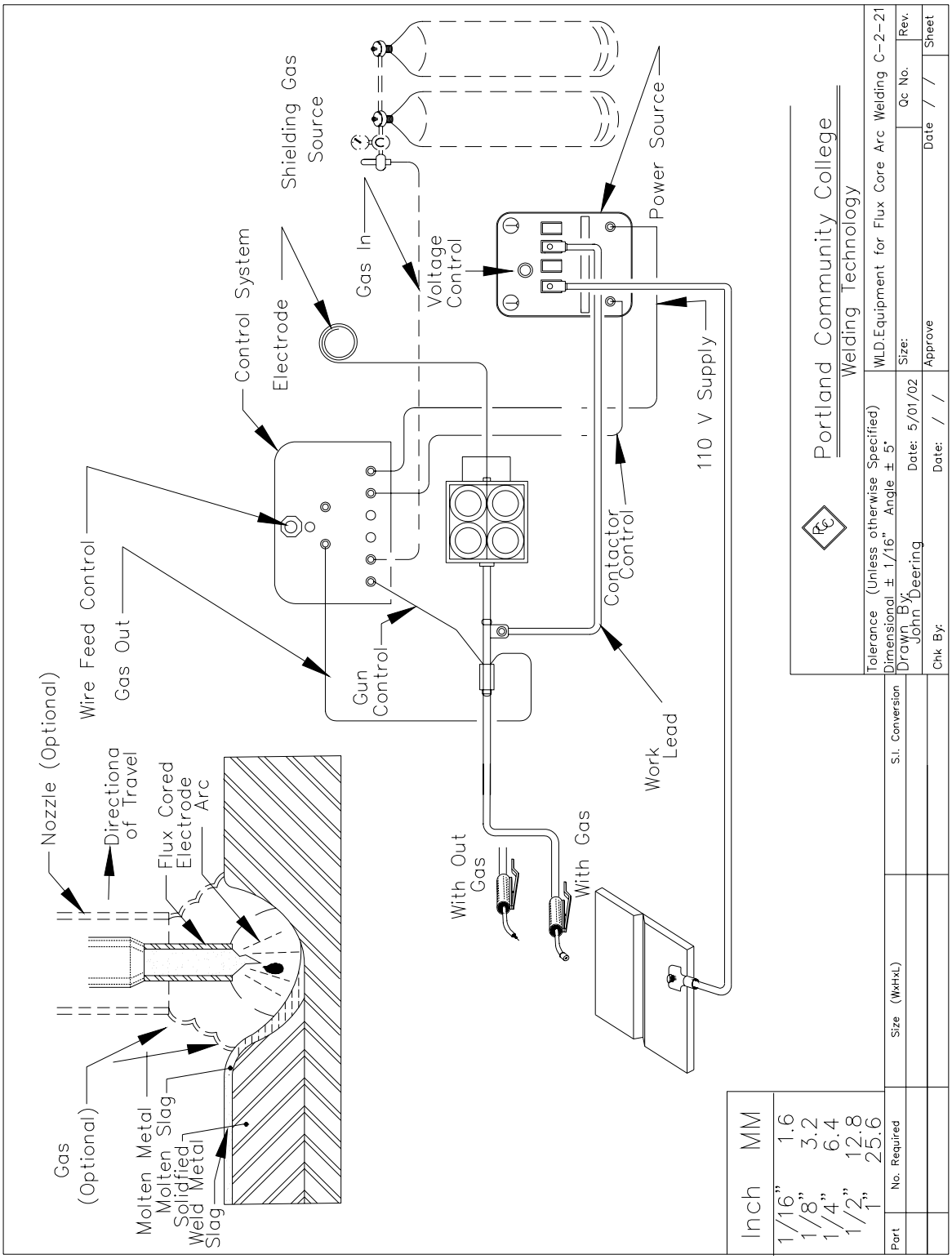
Outcome Assessment Policy

The student will be assessed on his/her ability to demonstrate the development 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.

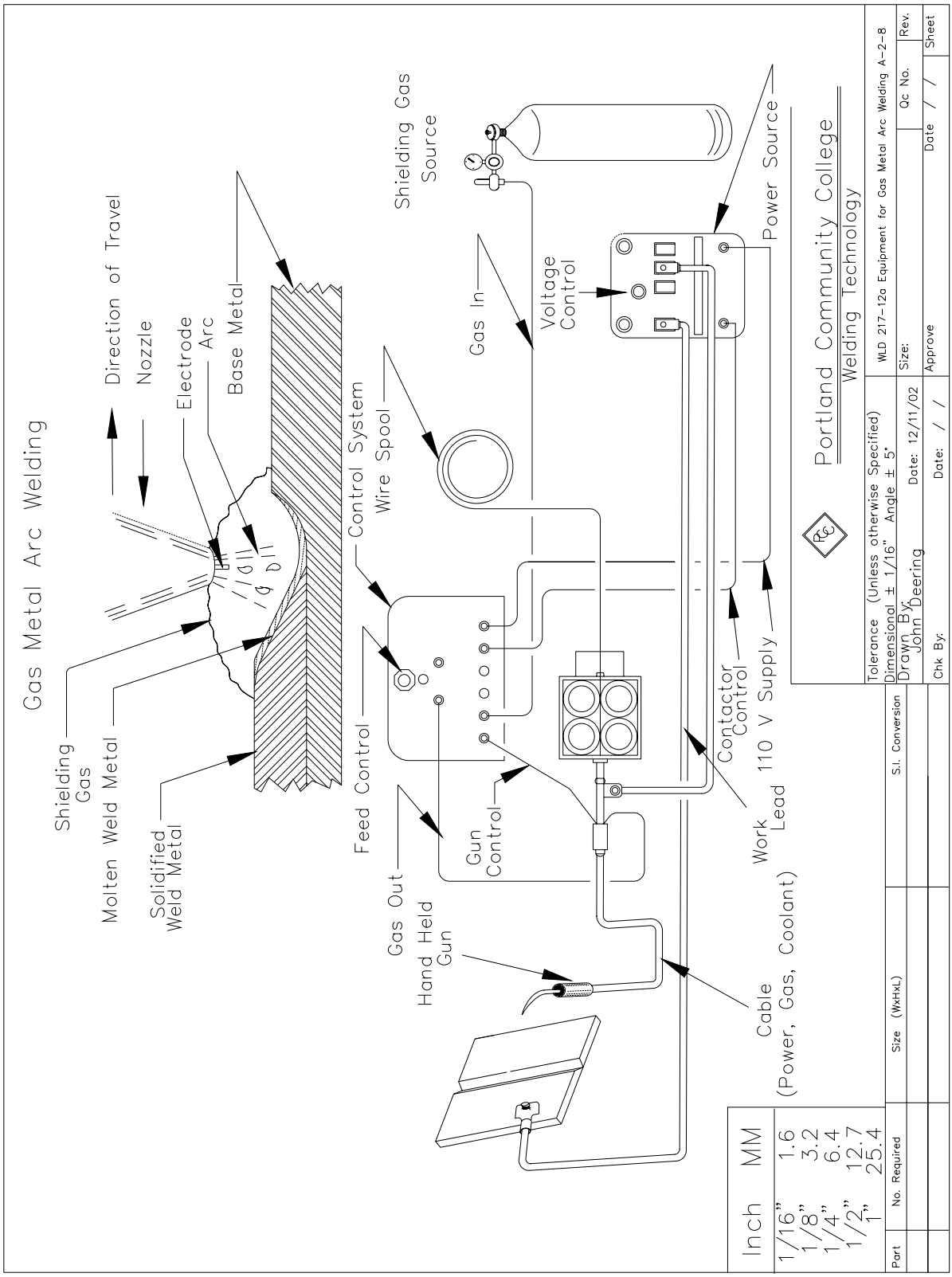
Grading criteria

The student's assessment will be based on the following criteria:
20% of grade is based on Safe work habits and shop practices
20% of grade is based on Completion of written and reading assignments
20% of grade is based on demonstrating professional work ethics
40% of grade is based on completion of welding exercises

Flux Cored Arc Welding (FCAW) Equipment



Gas Metal Arc Welding (GMAW) Equipment



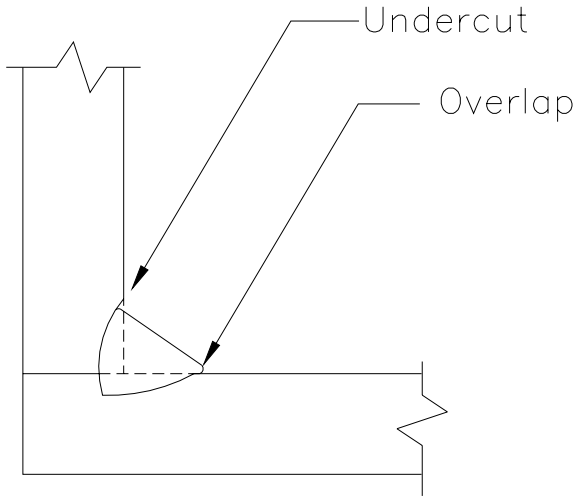
Undercut

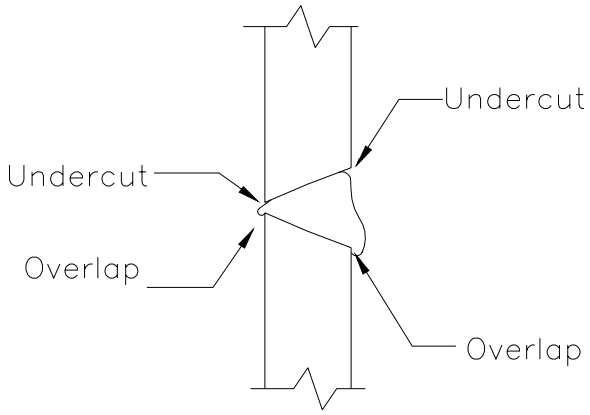
Is a condition where the base metal has been melted away during the welding operation and there is insufficient filler metal deposited to adequately fill the resulting depression. These grooves vary in depth and length. Undercut can be present at a weld-to-weld junction or a weld to base metal junction (toe of weld). Undercut causes a stress concentration point (stress riser) that is a potential starting point for weld cracking.

Causes:

Improper welding technique
Arc length too long
Oscillation too abrupt, not spending enough time on the sides of the puddle.
Amperage too high
Base material too hot
Travel speed too fast

Maximum undercut allowed is 1/32" in depth for welder qualification tests.



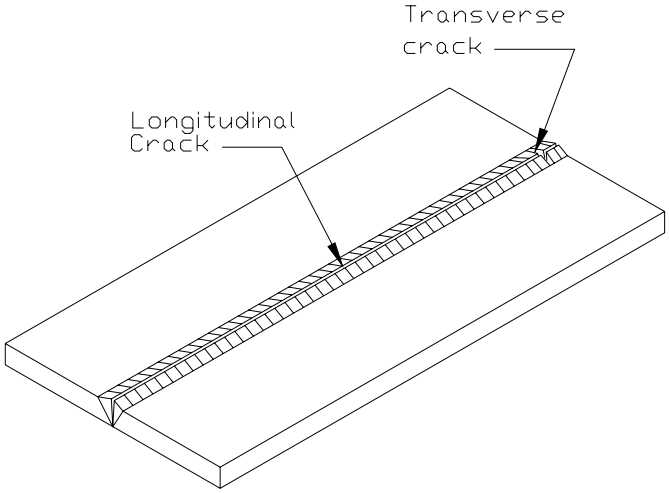


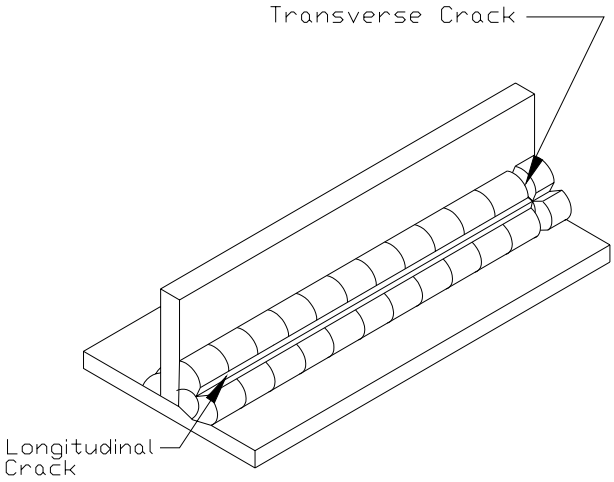
Cracks

Cracks are caused by stresses in the immediate area that exceed the strength of weld metal or base metal (tensile strength).

Cracks are a major concern because of their ends, which are generally sharp and jagged. With increased stress, the crack can then propagate (travel) in the weld or base metal causing catastrophic (total) failure.

Maximum Cracks Allowed: None





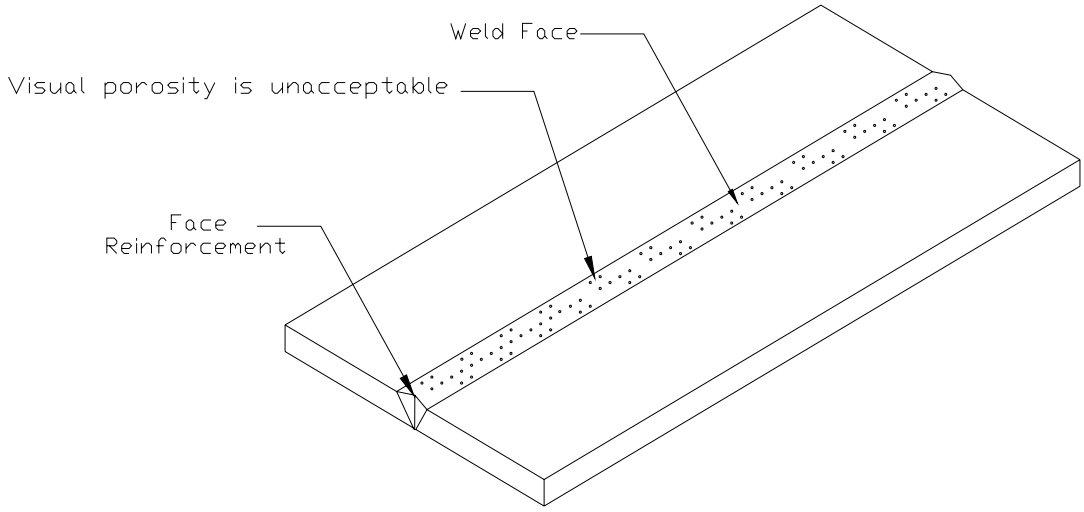
Porosity

Cavity type discontinuities caused by gas trapped during weld solidification. Due to its spherical shape, porosity is considered the least detrimental discontinuity.

Causes:

Loss of shielding gas
Base metal contamination (oils, grease, water)
Too long of an arc.

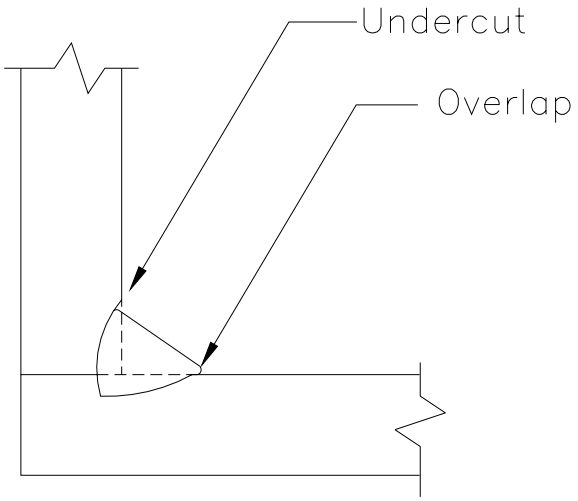
Visual porosity is unacceptable for a Welder qualification test

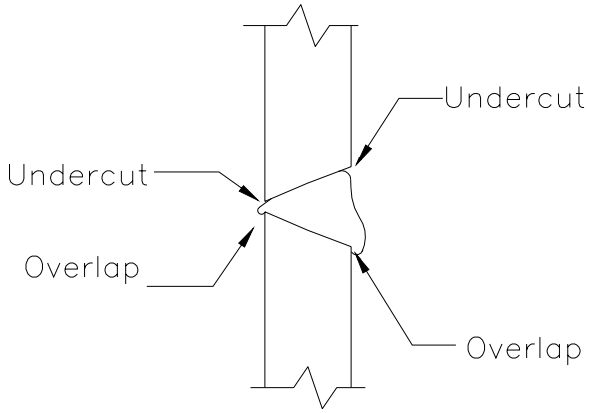


Overlap (Also known as: Cold Lap, Roll Over or Cold Roll)

Is the protrusion of weld metal beyond the weld toe or root. Due to its linearity and relatively sharp end condition, over lap represents a significant weld discontinuity.

None Allowed



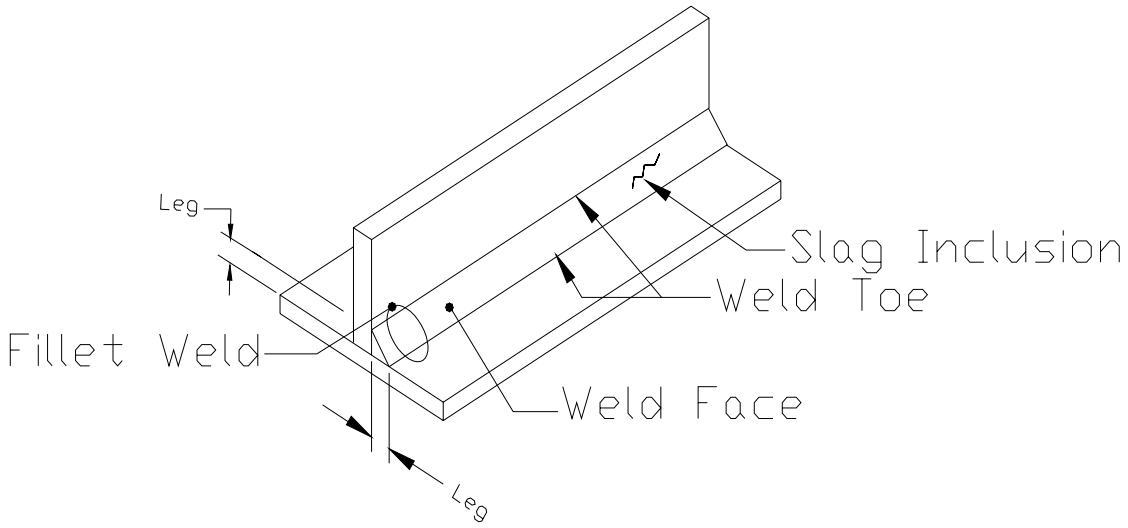


Slag Inclusions

Slag is a nonmetallic by product of the welding process. If slag is not cleaned out thoroughly prior to depositing the next pass it can be trapped. Or, if the previous weld(s) have poor weld profile slag can become trapped in the crevices when welded over.

Slag inclusions are most often caused by improper cleaning, improper electrode manipulation or poor bead placement.

Slag Inclusion



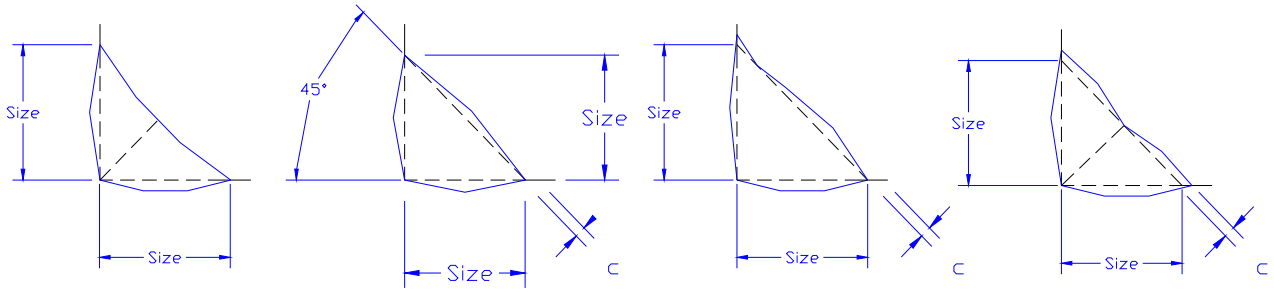
Weld Profile

Reinforcement

Minimum: Flush with base metal
Maximum: 1/8” high

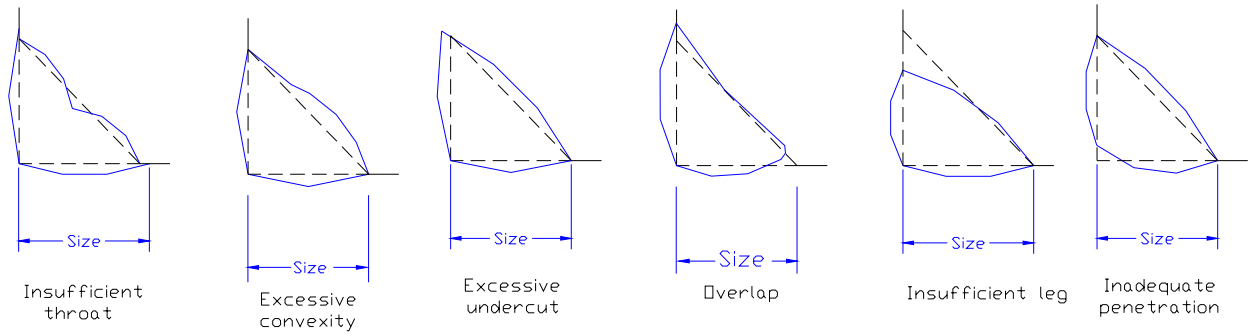
Bead Contour

Smooth transition from bead to bead and weld metal to base metal.



(A) Desirable Fillet weld profiles. (B) Acceptable fillet weld profiles.

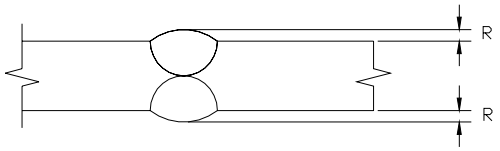
Width of weld face or individual surface Bead,W	max. convexity, c
W≤ 5/16″ (8MM)	1/16″ (1.6 MM)
W> 3/8″to W<1″ (25MM)	1/8″ (3MM)
W≥ 1″	3/16″ (5MM)



Unacceptable fillet weld profiles

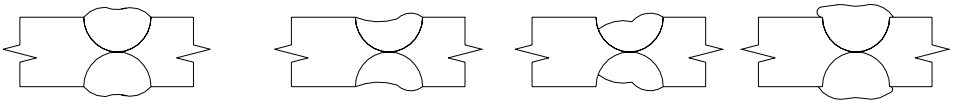
Reference AWS D1.1

Groove Weld Information Sheet



Acceptable butt weld profile.

NOTE: Reinforcement (R) shall not exceed 1/8".



Excessive Reinforcement | Insufficient Weld Size | Excessive Undercut | Overlap

WLD Infor. Sheet 2

Contents of this Packet

- *Importance of Code Qualification*
- *Why Mechanical Properties Testing?*
- *AWS D1.1 Structural Welding Code – Steel*
- *Significance of Bend Testing*
- *Bend Testing of Welds deposited with E7018 and other Low Hydrogen Electrodes*
- *Guided Bend vs. Free Bend Testing*
- *Tensile Testing and Charpy V-Notch Impact Testing*

Importance of Code Qualification

In all industries, there are applicable codes and standards to assure the quality, reproducibility, and adequacy of welded joints. Depending upon the application, a welded joint may need certain mechanical properties; for example, welds on bridges must pass tests for strength, tensile ductility, bend ductility, and Charpy impact toughness. These codes are based on many years of experience. Changes to codes are ongoing to reflect the dynamic changes that taking place in the industry. There are many welding codes to ensure quality welding. For example, the following is a list of only a few typical industries and governing codes for welding quality.

Pressure Vessels	ASME Boiler and Pressure Vessel Code (Vol. IX – Welding Qualifications)
Pipe and Pipelines	API Standard 1104; Standard for Welded Pipelines and Related Facilities
Pressure Piping	ASME Code for Pressure Piping B31
All Steel Structures	AWS D1.1 Structural Welding Code – Steel
Buildings	AISC Specification for Structural steel Buildings
Bridges	AASHTO/AWS D1.5; Bridge Welding Code
Ships	ABS Rules for Building and Classing Steel Vessels
Sheet Metal	AWS D9.1; Sheet Metal Welding Code
Automotive Frames	ANSI/AWS D8.8; Specification for Automotive Frame Weld Quality
Aircraft	MIL-STD-1595A; Qualification of Aircraft, Missile and Aerospace Fusion Welders

Why Mechanical Properties Testing?

In all codes for welded structures and pipe, various degrees of mechanical testing are performed to assure the quality and integrity of the structure. This includes both procedure qualification and welder qualification. For example, the procedure qualification for steel structures in accordance with the AWS D1.5 Bridge Welding Code–Steel requires that certain welds undergo all-weld-metal tensile testing, transverse-to-weld tensile testing, side bend testing, Charpy v-notch (CVN) impact testing as well as non-destructive testing. Mechanical testing is very important because it ensures that the welding procedure, welder qualification, consumables, and the resulting metallurgy of the weld and heat-affected zone were all acceptable.

AWS D1.1 Structural Welding Code – Steel

When a structure is going to be built, the owner and contractor agree on the appropriate welding code, which will be needed to govern the acceptability or rejection of structural welds being fabricated. AWS D1.1 Structural Welding Code – Steel is devised to provide welded joints with acceptable strength, ductility, and CVN impact toughness for the intended application, such as a building, general construction, motorized vehicle, etc. Procedure qualification requirements welder qualification and certification are required. The qualification and certification tests for welders are specially designed to determine the welder's ability to produce sound welds. To achieve these quality standards, the welder qualification and certification provide the means to ensure acceptable welds.

Significance of Bend Testing

Of all the tests prescribed by different welding codes, the bend test provides the best and most reliable measure of ductility of the entire weld joint, including the weld metal, heat-affected zone, and unaffected base metal. Bend tests are one way to determine qualification results. This is because the bend test is extremely sensitive to all types of metallurgical problems associated with welding. For example, weld joints which have inadequate ductility and fail the bend test may be have been affected by: (a) hydrogen assisted cracking, (b) micro fissuring due internal solidification cracking, (c) excessive slag inclusions, (d) excessive porosity, (e) wrong filler metal, causing embrittlement, (e) wrong welding parameters, causing embrittlement, and (f) other metallurgical factors affecting the ductility of the weld joint.

There are three types of bend tests, (1) side bend, (2) face bend, and (3) root bend. Side bend tests are required for welds that are greater than 3/8-inch thick for AWS D1.1 and over ½-inch thick for API-1104. For example, a 2-inch thick butt joint deposited by single-pass electroslag welding could not be tested by face or root bend testing, because the thickness is too great for practical testing. However, a 2-inch thick butt joint can be machined to several 3/8-inch thick side bend specimens and tested easily.

Face and root bending are used to test the ductility of butt joints that are 3/8" and thinner. Whether face bends, root bends, or both face and root bends specimens are required depends upon the code used. In AWS D1.1 Structural Welding Code, both face and root bends are required in most cases. The root bend test determines the adequacy of the root penetration and soundness of the root portion of the weld joint. This is particularly important in open root welding applications. Similarly, the face bend test determines the adequacy of the weld metal deposited on the face of the

joint. These specimens must be able to withstand bending strains that are produced when a plunger forces a 3/8-inch thick welded specimen into a guided bend fixture. The plunger, having a specified bend radius, forces the welded bend specimen into a die in order to endure a specified amount of bending (or plastic deformation), that is required by the code for structural applications. From Table 1, the plunger radius and plunger thickness increase with increasing yield strength of the base metal being tested. Bending becomes more difficult with increasing yield strength, because ductility decreases as the strength of the steel increases. Thus, AWS D1.1 permits the bend radius required for welder qualification to increase with increasing yield strength, as shown in Table 1.

Table 1 Specified Bending Parameters for Guided Bend Test for Steel Welds in accordance with AWS D1.1 Structural Welding Code - Steel

Yield Strength Of Base Metal	Plunger Thickness	Plunger Radius	Interior Die Opening	Die Radius
50,000psi and less	1 ½"	¾"	2 3/8"	1 3/16"
Over 50,000psi to 90,000psi	2"	1"	2 7/8"	1 7/16"
90,000psi and greater	2 ½"	1 ¼"	3 3/8"	1 11/16"

Bend Testing of Welds deposited by FCAW using E71T-1, T-8 and T-11 Electrodes

The bend test for steel welds is very sensitive to not only the presence of diffusible hydrogen in the weld, but also high levels of non-metallic inclusions. Typically, these welds will fail in the weld metal. E71T-1 gas shielded welds and E71T-8 self-shielded welds are generally minimally contaminated with non-metallic inclusions and will pass the bend tests prescribed by applicable codes like D1.1 Structural Welding Code. However, the self-shielded E71T-11 electrode contains substantial inclusion content and may be susceptible to reductions in ductility to possibly fail the bend test. In all cases, poor workmanship is the most probable of a bend failure. This may include slag inclusions, lack of fusion, excessive porosity, etc. If workmanship is adequate, then the weld metal deposited with electrodes, which must meet high Charpy impact requirements, will ultimately be the most successful in the bend test.

Guided Bend vs. Free Bend Testing

The most widely used bend test, which is required by most welding codes, is the guided bend test. The benefit of the guided bend test, like that required by the AWS/AASHTO D1.5 Bridge Welding Code and AWS D1.1 Structural Welding Code is that the weld metal, heat affected zone and the unaffected base metal are subject to bending equally. This test requires expensive fixturing and a hydraulic ram to perform the guided bend test.

There is another test called the free bend test. The free bend testing apparatus is less expensive to build and is hand-operated. The disadvantage of this test is that all of the zones of the weld joint (weld metal, heat affected zone and unaffected zone) are not bent equally. In free bend testing, the zone(s) having the lowest tensile strength will bend the most, while the zone(s) having the highest strength will bend the least. This effect may hide potential problems in the weld joint. This is why most codes insist on the guided bend test and not the free bend test.

Tensile Testing and Charpy V-Notch Impact Testing

For welder qualification and certification in accordance with AWS D1.1, tensile testing and Charpy v-notch (CVN) testing of the test weld are not required. However, in other codes, these tests are also used for welder qualification (in addition to bend testing).

Helpful Hints for Wire Welding

Wire Stick out

When welding with the FCAW process it is essential to keep the required stick out. This stick out provides electrical resistance heating to the electrode. This is important because the flux inside of the wire is preheated so it will react more efficiently in the puddle that will provide for more aggressive scavenging by the flux.

First and Second Layers of Groove Welds

When completing the first and second layers of a groove weld it is important to have a well-set machine. The parameters (volts & amps) may need to be changed because of the need for a "crisp" arc to reach the bottom of the groove. One of two things need to change to achieve this:

1. Increase the wire feed speed to accommodate for the increased stick out.
2. Use a shorter gas nozzle and set so contact tip is extending from it by 1/8" to 1/4". This will allow for the gun to reach the bottom of the groove with the normal stick out length. Either technique win provide for a suitable outcome. Just remember to make the correction back to normal operating procedures when room in the groove allows.

Common Causes for Porosity

Gas Diffuser is clogged
Insulator has unscrewed and is covering gas ports
Dirty Cup
Contact tip is not recessed 1/4".
Leaks in flow meter, hose and or connections (venturi effect)
Too little or too much gas flow
Too long of a stick out
Gun angle too steep (venturi effect)
Too short of a stick out
Dragging or bumping the cup
Gas supply depleted

Cover Pass Technique

Maximum bead width recommended 1/2"
Reduce WFS and leave the voltage the same
Reduce stick out to 1/2"
Do not fill the groove flush. Leave 1/16" shoulder so there is room for the finish beads.
Allow sufficient time between passes for the plate to cool.

SUMMARY OF VISUAL INSPECTION CRITERIA

A. The test must be complete. The full length (6”) of the test plate will be visually inspected. Use your run off tabs throughout the test to insure quality results at the start and finish at both ends of the plates. All craters shall be filled to the full cross section of the weld.

B. Reinforcement layer (**cover pass**) height shall be **Flush** to **1/8” (3 mm)** above the plate.

C. A reinforcement layer higher that **1/8” (3 mm)** will not be accepted.

D. Weld width cannot exceed ¼” wider than original groove opening.

E. Weld shall merge smoothly with the base metal.

F. Weld must be free of porosity, slag inclusions, and/or cold lap.

G. Undercut shall not exceed **1/32 in. (1 mm).**

H. Arc strikes outside of the weld area are **NOT** acceptable.

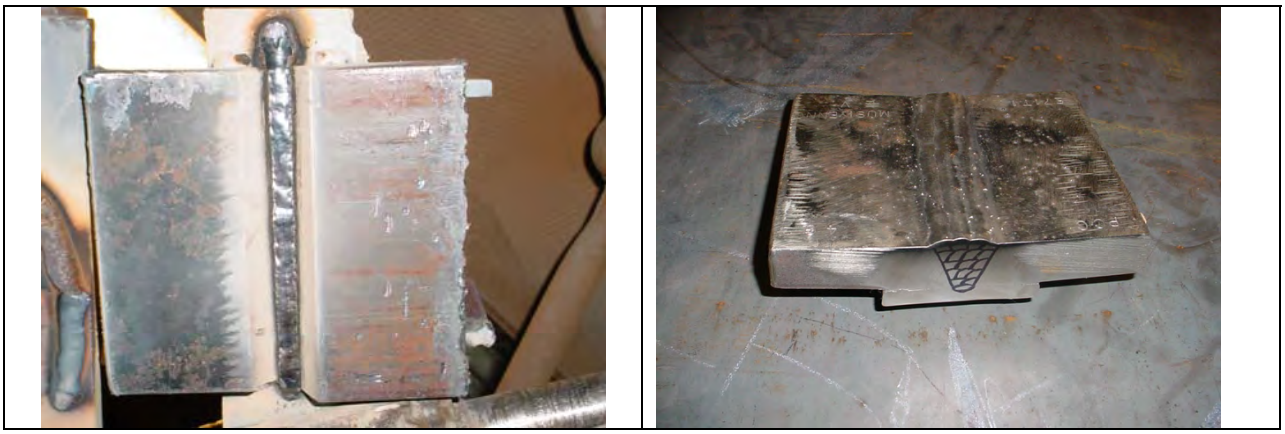
Craftsmanship Expectations for Welding Projects

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 project assemblies of metal at a time this will save a great amount of time.
3. Assemble the welding projects per drawing specifications.
4. Review the 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:

Metal Preparation	**Project Layout**	**Post Weld Clean-up**
Oxyacetylene Cut quality	Accurate (+/- 1/16”)	Remove Slag/Spatter
Grind all cut surfaces clean	Limit waste	Remove sharp edges



Example of a High Quality Weld

Weld Quality per AWS D1.1

VT Criteria	Cover Pass
Reinforcement (groove welds)	Flush to 1/8”
Fillet Weld Size	See specification on drawing
Undercut	1/32” deep
Weld Contour	Smooth Transition
Penetration	N/A
Cracks	None Allowed
Arc Strikes	None Allowed
Fusion	Complete Fusion Required
Porosity	None Allowed
Overlap	None Allowed

Complete Joint Penetration Information Sheet

All the pieces to assemble a Single V Groove Weld with Strong Backs.

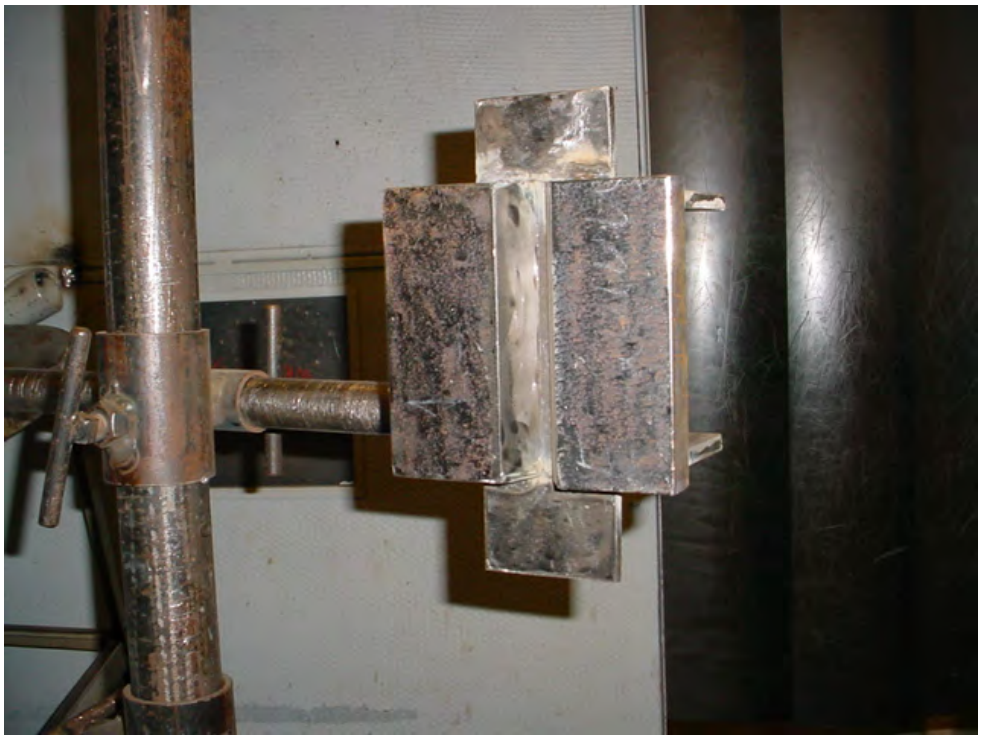
E71T-1 Plate Fit Up
"Outer Shield or Dual Shield"

Note the special fit up requirements for the E71T-1 Dual Shield Electrodes.

E71T-1 Butt Joint- Single V Groove Weld (3G) Project #1,2,3

Welding Sequence

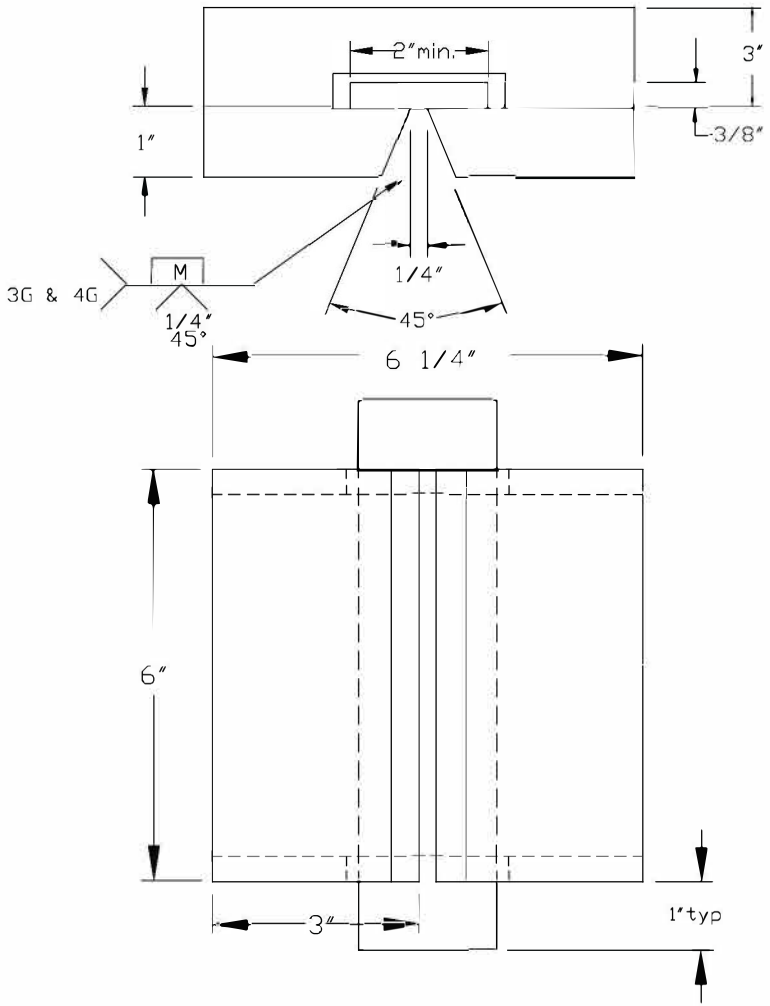
E71T-1-- Root Pass	Single pass technique with slight weave to ensure the weld metal is fusing into all three pieces of metal.
E71T-1—Fill	Use the multi-pass bead technique with stringer beads ensuring even fill.
E71T-1 Finish Beads	Use stringer bead technique keeping the electrode in the puddle at all times.



Successful completion of this project will require the student to complete ***THREE weldments*** that meet both visual testing requirements and bend test requirements set forth in AWS D1.1 Structural Steel Welding Code.

VT Criteria	Project #1	Project #2	Project #3
Reinforcement	Root-	Root-	Root-
Undercut			
Bead Contour			
Cracks	Cover -	Cover-	Cover-
Arc Strikes			
Fusion			
Porosity	Bend-	Bend-	Bend-
Bend Test			
	Grade Date	Grade Date	Grade Date

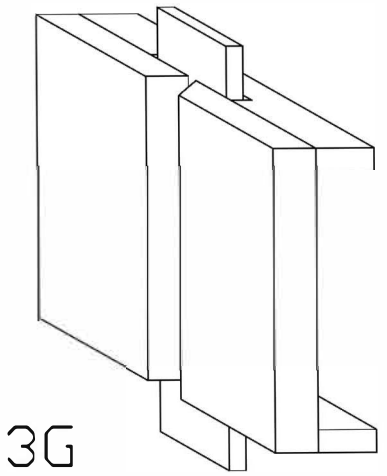
WLD 152
Single "V" Groove 3G



Welding Procedure for
Single "V" Groove 3G

1. Electrode
2. Diameter
3. Polarity
4. Amperage
5. Arc Length
6. Welding Position — Vertical and Overhead
7. Travel Angle
8. Work Angle
9. Technique

* Bend Test required Per AWS D1.1 for both 3G and 4G plates.



3G

3/8" (Typ.)

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 (TxWxL)	S.I. Conversion

Portland Community College
Welding Technology

Tolerance (Unless otherwise Specified) Dimensional ± 1/16" Angle ± 5°		WLD 151 Final	
Drawn By: John Deering		Size:	Qc No. 30 Rev.
Chk By:	Date: 7/23/05	Approve	Date Sheet

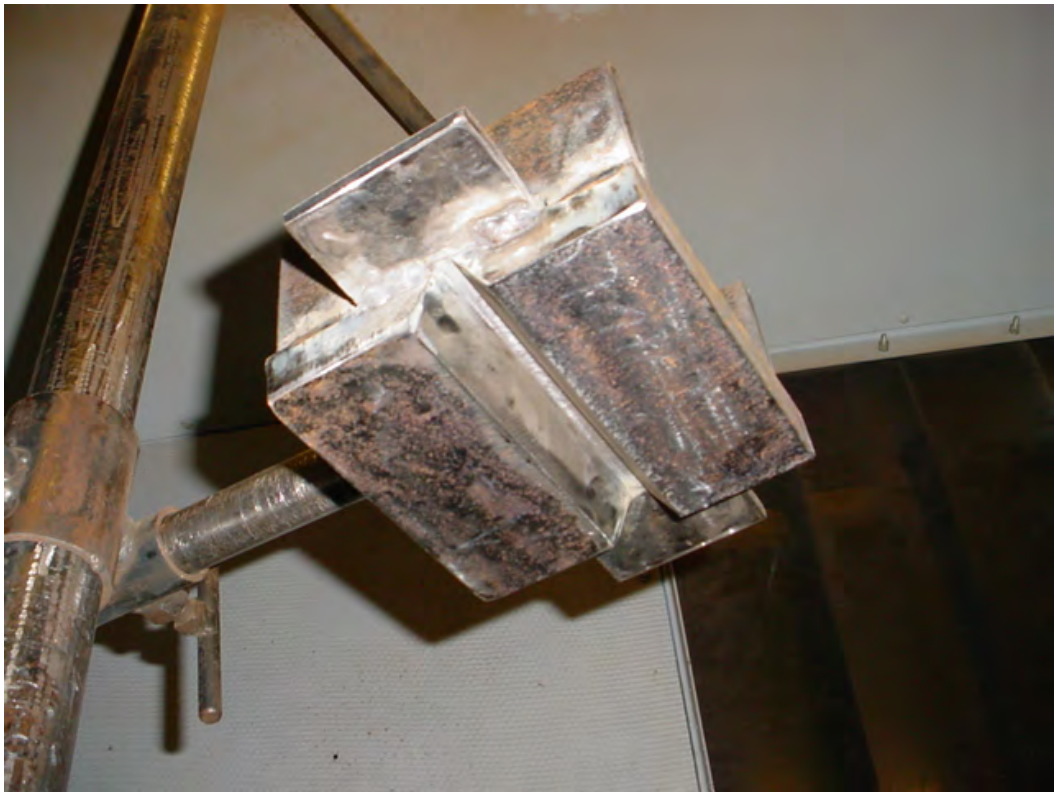
E71T-1 Butt Joint- Single V Groove Weld (4G) Project #4,5,6

Welding Sequence

E71T-1-- Root Pass Single pass technique with slight weave to ensure the weld metal is fusing into all three pieces of metal.

E71T-1—Fill Use the multi-pass technique with stringer beads ensuring even fill.

E71T-1—Finish Beads Use stringer bead technique keeping the electrode in the puddle at all times.



Successful completion of this project will require the student to complete ***THREE weldments*** that meet both visual testing requirements and bend test requirements set forth in AWS D1.1 Structural Steel Welding Code.

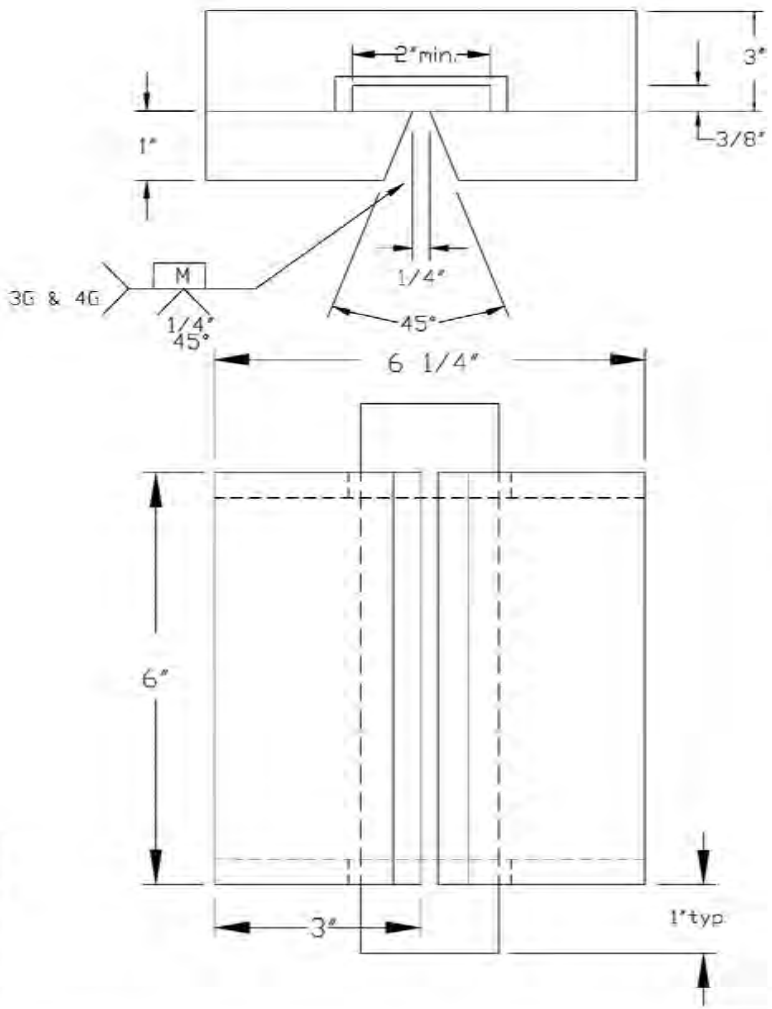
VT Criteria	Project #4	Project #5	Project #6
Reinforcement	Root-	Root-	Root-
Undercut			
Bead Contour			
Cracks	Cover-	Cover-	Cover-
Arc Strikes			
Fusion			
Porosity	Bend-	Bend-	Bend-
Bend Test			
	Grade Date	Grade Date	Grade Date

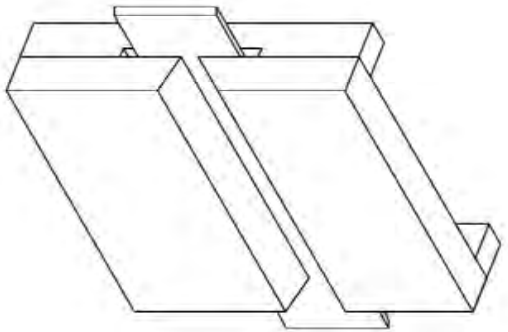
WLD 152

Welding Procedure for Single "V" Groove 4G

1. Electrode
2. Diameter
3. Polarity
4. Amperage
5. Arc Length
6. Welding Position — Vertical and Overhead
7. Travel Angle
8. Work Angle
9. Technique

* Bend Test required Per AWS D1.1 for both 3G and 4G plates.





4G

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 (TxWxL)	S.I. Conversion

Portland Community College
Welding Technology

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

WLD 151 Final

Drawn By: John Deering

Size | Qc No. | Rev.

Chk By: | Date 7/23/05 | 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 provided. Once completed, return the exam to your instructor for grading.

Part Two
This portion of the exam is a practical test where you will weld out a vertical and an overhead one-inch certification test plate in accordance with AWS D1.1 requirements using **"Dual Shield"**.
The evaluation of this portion of the exam will be based on AWS D1.1 Structural Steel Welding Code.

152 Final Exam
TESTING PROCEDURE
For 1" Plates

STEP 1: Read entire procedure before you start your testing.
You have three class periods to complete testing.

STEP 2: Notify your instructor that you are going to begin your test.

STEP 3: Obtain a 300 degrees temp stick from the tool room.

STEP 4: Using a torch preheat the test plates to 70 degrees shall be sufficient to prevent cracking.

STEP 5: **INSPECTION:** ***(See your instructor***): **Test Plate Position**
Position the test plates at your welding station. The plate stamped **3G** is Positioned vertical. The plate stamped **4G** is positioned overhead.

Have your instructor inspect the proper positioning of the test plates. **Test plates must remain in position throughout the test. DO NOT MOVE THE TESTS Plates. Tests Plates must be cleaned and inspected in position. No grinding is allowed on the test.**

Inspection by instructor:	**Instructors signature:** _____
Date: _____	**Student signature:** _____

STEP 6: Complete the root passes in both positions.

STEP 7: ***INSPECTION:*** **Root Pass Inspection *(See your instructor):* Have your instructor inspect the root pass.**

Inspection by instructor:	**Instructors signature:** _____
Date: _____	**Student signature:** _____

STEP 8: Complete welding the V groove until the weld is within **1/16 to 1/8"** below the base material.

Practical Final Exam Bend Procedure For 1" Test Plate

Bend tests are used to determine the ductility and soundness of a weld joint. The test will determine if fusion was obtained in the weld joint. Use the following procedure in preparing and bending your coupons.

1. Reference the AWS D1.1 Structural Welding Code to determine the dimensional layout of the bend coupons (use this diagram for all positions).

2. Flush back up strip off of the plate. **Note: flushing of the backing strip maybe removed by flushing provided that at least 1/8 inch of its thickness is left to be removed by grinding.**

3. Layout four 3/8" thick coupons and cut using the track burner**. Do Not Bend coupons greater than 3/8" thick. This will damage the machine.**

4. Allow coupon to air cool. **Do Not Quench!**

5. Grind coupon's smooth, ensuring grinding marks are going with the length of the coupon's and all edges are rounded.

6. Request permission from your instructor to use the bend test machine.

7. **CAUTION**: ***Keep hands and fingers clear when operating equipment.***

8. Ensure guard is in the correct position. The coupons sometimes eject out the end of the machine rapidly.

9. ***Place coupon in the machine taking care to not position your hands/fingers in the way. Locate weld in the center of the die. Position coupons for side bends only.***

10. Actuate the machine by the lever on top of the machine and stand clear of end where the coupon will exit.

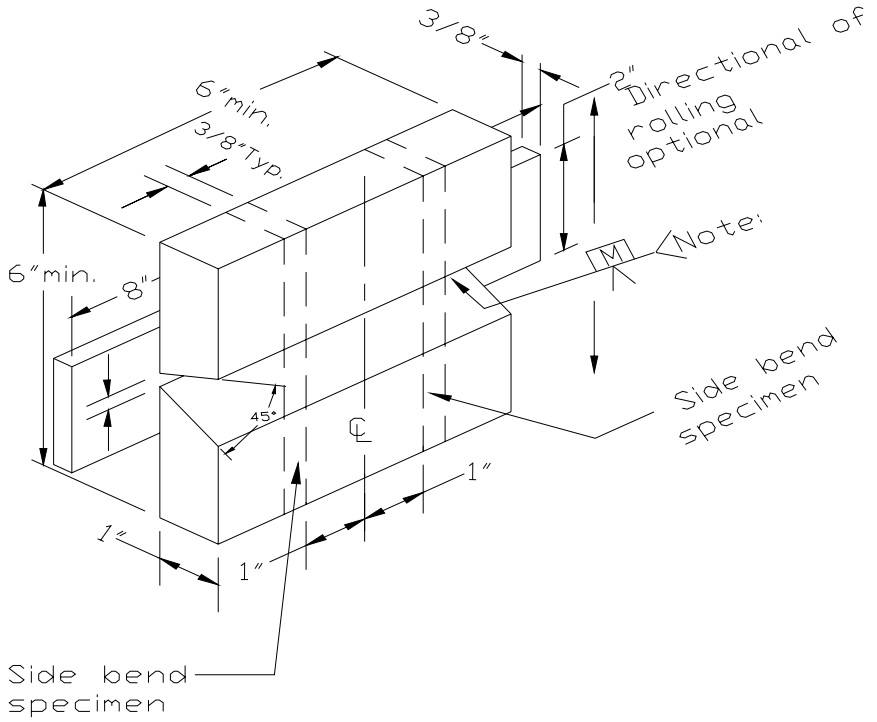
11. Inspect the coupon for fusion type defects. **Reference AWS D1.1 Structural Welding Code, for acceptance criteria**.

Inspection by instructor:	**Instructors signature:** _____
Date: _____	**Student signature:** _____

Final Exam Bend Test Preperation

SHOP TEST

1" Bend Test



Note:

1. When radiography is used for testing, no tack welds shall be in test area.
2. The backing thickness shall be 1/4" min to 3/8" max; backing width shall be 3" min when not removed for radiography, otherwise 1" min.

Note: Back Strap Dimensions
T x W x L
3/8"x 2 x 8

Inch	MM
1/4"	6
3/8"	10
1"	25
5"	125
6"	150

Part	No. Required	Size(TxLxL)	S.I. Conversion

Portland Community College
Welding Technology

Tolerance (Unless otherwise Specified) Dimensional ± 1/16" Angle± 5°	WLD Fillet Weld 1 inch Bend Test		
Drawn By: John Deering	Size:	Qc No.	Rev.
Chk By: Date: 01/12/02	Approve	Date	Sheet

Bend Test Procedure

For 1" Test Plate

Bend tests are used to determine the ductility and soundness of a weld joint. The test will allow the welder to determine if he/she has obtained fusion in the weld joint. Use the following procedure in preparing and bending your coupons.

1. Flush back up strip off of the plate at the flushing station.

2. Layout four 3/8" coupons and cut using the track burner**.** **Do Not Bend** coupons greater than 3/8 " thick it will damage the dies in the bending machine!
3. Allow coupon to air cool. Do Not Quench!
4. Grind coupon's smooth, ensuring grinding marks are going with the length of the coupon's and all edges are broken.
5. Request permission from your instructor to use the bend test machine.
6. CAUTION: Keep hands and fingers clear when operating equipment.

Helpful Hints

1. Be prepared to feel confident during your test. You need to have demonstrated consistency during your practice tests. Repeat the practice tests as many times as necessary to ensure confidence and consistent performance.

2. **Be comfortable!!!** Plan your test on a day that you know you will be at your best, well rested and able to concentrate. Check your clothing, to be certain you are protected from any stray sparks. Nothing breaks your concentration faster than getting burned or catching on fire!

3. Check the condition of your cover lenses**; make sure that you can see clearly.**

4. Bring a flashlight so you may thoroughly inspect your inter-pass cleaning. Clean the weld thoroughly. Make sure your slag hammer and wire brush are in good condition.

5. Plan the weld carefully to avoid having to patch up low spots. Decide before you strike the arc the size and location of the bead you are about to run. **If the weld fill becomes uneven, fix it immediately by filling in the low areas, don't wait until the flush layer or cover layer.**

6. Notify your fellow students in your area that you are testing; ask their cooperation in avoiding any banging or movement of the booth area while you are welding.

7. **Above all don't panic!** Relax and take your time. Don't hold your breath! If at any time you become uncomfortable stop and reposition.

8. If you cannot see **STOP**. If you feel you have lost or are loosing control of the puddle **STOP**.

9. Do not over heat the plates. Allow the plates **to air cool to 200 degrees** before you attempt to weld the cover passes.

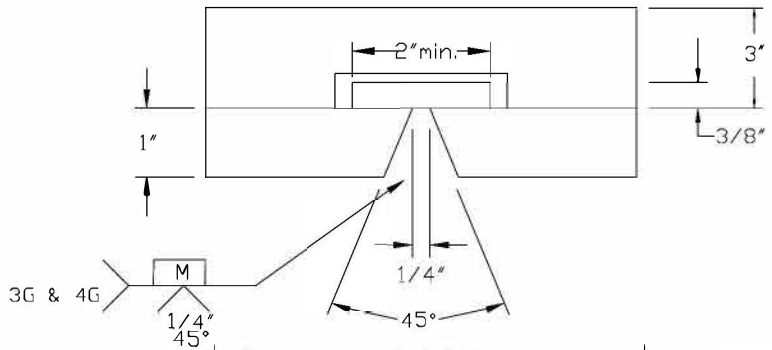
10. See **your instructor** at anytime if you have a concern. Take a break as needed.

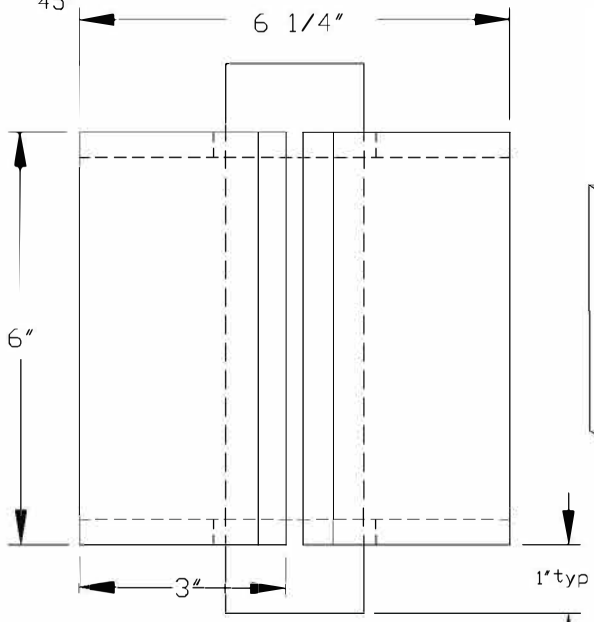
WLD 152
Final Exam

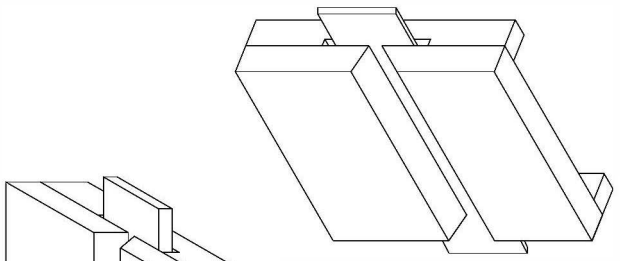
Welding Procedure for Single "V" Groove 3G and 4G

1. Electrode
2. Diameter
3. Polarity
4. Amperage
5. Arc Length
6. Welding Position — Vertical and Overhead
7. Travel Angle
8. Work Angle
9. Technique

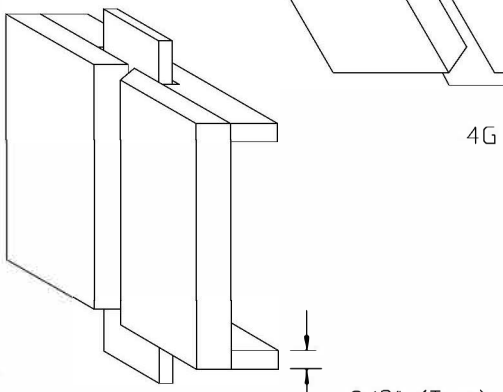
* Bend Test required Per AWS D1.1 for both 3G and 4G plates.







4G



3G

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 (TxWxL)	S.I. Conversion

Portland Community College
Welding Technology

Tolerance (Unless otherwise Specified) Dimensional ± 1/16" Angle ± 5°	WLD 151 Final		
Drawn By: John Deering	Size:	Qc No.	Rev.
Chk By: Date: 7/23/05	Approve Date		Sheet

Inspection and Testing

Name:_____ Date:_____

Directions
Review chapters 19, 20 and 21 in Welding Principles and Applications and utilize that information to complete the questions on this work sheet. Answer the questions using *complete sentences*, and do not hesitate to reference other sections in the text to find an answer.

1. Why should weld inspection be looked upon as a productive phase in cost planning?

2. What tools are used for visual inspection (VT)?

3. What items should be inspected prior to welding a weldment?

4. What is the difference between nondestructive testing and destructive?

5. List the five steps needed for PT.

6. Explain the theory of liquid penetrant testing (PT). What are its advantages and its limitations?

7. Explain the theory of magnetic particle testing (MT). What are its advantages and its limitations?

8. Explain the theory of radiographic testing and its safety concerns.

9. Explain the theory of ultrasonic testing (UT). What are its advantages and its limitations?

10. What is spot-checking and why is it important?

11. Why are hardness tests used?

12. List two common types of hardness tests.

13. What would be the flow rate for a 1/16-in. FCAW electrode?

14. What does the flux-to-metal ratio have to do with FCA welding deposition efficiency?

15. Which shielding gas or gas mixture provides GMAW with the highest average efficiency?

16. Why must electrodes and fluxes be kept dry?

17. How can crater cracking be reduced?

Performance Qualification

Name:_____ Date:_____

Directions

Read AWS/ANSI D1.1 Structural Steel Welding Code, Performance Qualification Section and utilize that information to complete the questions on this work sheet. List the section(s) where the answer was found in the code. Answer the questions using *complete sentences,* and do not hesitate to reference other sections in the code to find an answer.

1. Why is a qualification test not used as a guide for welding or tack welding during actual construction?

2. If a welder satisfactorily completes a vertical groove weld test on one-inch thick plate is s/he qualified to make a horizontal fillet weld on a 30-inch diameter pipe? Why or Why not?

3. Does a welder who welded the original WPS, which passed, need to take a welding qualification test?

4. If a welder qualifies with an E71T-1 electrode, is s/he qualified with E71T-11 Electrode? Why or why not?

5. What does PJP mean?

6. What are the acceptance criteria for visual inspection of a test plate?

7. What are the acceptance criteria for radiographic testing? What section of the code is it found in?

8. If a welder fails a test what are the stipulations for retesting?

9. If upon radiographic testing a 3/16" long flaw was found in the weld on a 1" plate test, would this plate be deemed acceptable? Why or why not?

10. A worm track porosity pore (elongated porosity) was found at the surface on a one-inch plate, would this plate be deemed acceptable? Why or why not?

11. What are the allowable limits for the following defects?

A. Undercut

B. Cracks

C. Overlap

D. Fusion & Porosity

12. What are the contour requirements for the following terms?

    A. Height (maximum & minimum)

    B. Bead to Bead Contour

13. Why must a test plate be kept in the same position, without taking it down, during a test?

Final Grading Rubric for practical exam
Class Name: WLD 152

Name: _____ Date: _____

Hold Points are mandatory points in the fabrication process, which require the inspector to check your work. You are required to follow the hold points.

Points Possible	***Hold Points***	***Instructor's Evaluation***
5 points	**Blueprint Interpretation and Material Cut List** 5 points = 0 errors, all parts labeled and sized correctly 3 points = 1 error in part sizing and/or identification 2 points = 2 errors 1 point = 3 errors 0 points = 4 or more errors	
10 points	**Material Layout and Cutting (Tolerances +/- 1/16")** 10 points Layout and cutting to +/-1/16" Smoothness of cut edge to 1/32" 7 points Layout and cutting to +/- 1/8" Smoothness of cut edge to 1/16 **REWORK REQUIRED IF OUT OF TOLERANCE BY MORE THAN 1/8 INCH**	
10 points	**Fit-up and Tack weld (Tolerances +/- 1/16")** 10 points Tolerances +/- 1/16" Straight and square to +/-1/16" 7 Points Tolerances +/- 1/8" Straight and square to +/-1/8" **REWORK REQUIRED IF OUT OF TOLERANCE BY MORE THAN 1/8 INCH**	
15 points	**Weld Quality** Subtract 1 point for each weld discontinuity, incorrect weld size and incorrect spacing sequence.	
28 points	***Minimum points acceptable. This equates to the minimum AWS D1.1 Code requirements.***	
	Total Points	**/40**

WLD 152 FCAW E71T-1: Project Assessment Form
Student Name:_____ Date_____

Vertical V-Groove	Assessment	Instructor Signature/Date
Root		
Cover Pass		
Side Bends		

Vertical V-Groove	Assessment	Instructor Signature/Date
Root		
Cover Pass		
Side Bends		

Vertical V-groove	Assessment	Instructor Signature/Date
Root		
Cover Pass		
Side Bends		

Overhead V-Groove	Assessment	Instructor Signature/Date
Root		
Cover Pass		
Side Bends		

Overhead V-Groove	Assessment	Instructor Signature/Date
Root		
Cover Pass		
Side Bends		

Overhead V-Groove	Assessment	Instructor Signature/Date
Root		
Cover Pass		
Side Bends		