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ABSTRACT

Using the standards of the American Welding Society and the American Society of Mechanical Engineers, this welding instructional guidelines manual presents a course of study in accordance with the current practices in industry. Intended for use in welding programs now practiced within the Federal Prison System, the phases of the program are designed for beginning and advanced students or metal workers interested in welding as a supplement to their trade. The guidelines are based on accepted practices of welding instruction, and encourage manipulative skills in using shielded arc electrodes. The guidelines also outline the process of oxyacetylene welding and cutting, gas tungsten-arc, and gas metal-arc welding. The lesson plans include suggested time allotment, an introduction to and illustration of the type of joint and welding position covered in the lesson, equipment and materials needed, and step-by-step procedures for accomplishing the lesson. (SB)

FOREWORD

The social and economic value of training offenders in career occupations is well known among teachers and other personnel in correctional institutions. Of equal value is the development of instructional materials which are pertinent to the real world of work. Both of these criteria are met in this welding guideline because its content relates to the actual technical skills required for working in the welding industry and allied fields.

This guideline is representative of what can be achieved by school staffs who are interested in maintaining up-to-date instructional techniques in their professional areas of work. What is more important, however, is the fact that the offender will be able to seek and hold employment because he was taught the right kind of skills to match the skill requirements of the job. Productive work skills are important for upward mobility in the job market place and the opportunity to share in this process is essential to the success of the offender when he is released to the community.

This publication is a timely contribution to the field of vocational education in the correctional setting and should serve as a reference for teaching staffs who are engaged in the development of instructional activities.

Norman A. Carlson, Director
Bureau of Prisons
U.S. Department of Justice



AMERICAN WELDING SOCIETY

2501 NORTHWEST 7th STREET ■ MIAMI, FLORIDA 33125 ■ (305) 642-7090

The American Welding Society is pleased to endorse this manual which represents a significant factor in the efforts of the United States Bureau of Prisons to establish a uniform approach to the training of welders.

The rapid strides being made in all types of welded fabrication require greater skills and competence of the craftsmen. Good, qualified welders are-and for the immediate future still will be-in short supply. The program of the United States Bureau of Prisons, which concerns the standardization of the training and qualification of welders to recognized welding codes, including the AWS Structural Welding Code, appears to be a sound and worthwhile approach.

The American Welding Society wishes to extend its best wishes to the United States Bureau of Prisons for a most successful program of welder training.

Sincerely yours.

R.D. Stout
R.D. Stout
President, AWS

E.A. Fenton
E.A. Fenton
Executive Director, AWS

PREFACE

Using the standards of the American Welding Society and the American Society of Mechanical Engineers, this welding instructional guidelines manual presents a course of study in accordance with the current practices in industry.

It has been planned for use in welding programs now practiced within the Federal Prison System. Years of use with these procedures has shown to increase a man's advantages in acquiring code certification as a welder.

The phases are designed for beginning and advanced students or metal workers interested in welding as a supplement to their trade.

The guidelines are based on accepted practices of welding instruction, and encourage manipulative skills to students interested in becoming certified welders using shielded arc electrodes. The guidelines also outline the process of oxyacetylene welding and cutting, gas tungsten-arc welding (TIG), and gas metal-arc welding (MIG). The type of joint and welding positions are described in the lesson plan and includes an illustration of the text.

The author has prepared this manual and arranged the lessons so that the student is introduced to new experiences while reviewing the lessons he has previously learned.

The procedures listed account for the author's tried and tested methods, and he does not imply that individual preferences should not be used when desired.

While this manual deals only with the skills of welding, other factors of the trade are equally important. It should not be overlooked that safety and good work habits are taught parallel to every project, and that pride in workmanship is basic to craftsmanship.

INTRODUCTION

In April of 1971 the Institutional Visitation of Welding Instructors met at Lompoc, CA and Englewood, CO under the co-ordinated management of Shelvy Johnson, Supervisor of Vocational Training.

The purpose of these meetings resulted in determining standards and guidelines for use in vocational welding programs that are operational within the federal prison service. If the welding programs were to use the same recognized standards, it would be possible to establish uniform, measurable objectives for all programs. It would also be possible to determine the number of training hours required for a student to reach each phase of a uniform standard. Thus, it would be adaptable to all programs regardless of their course length or geographical area.

Using Section IX - Welding Qualification of the American Society of Mechanical Engineers Boiler & Pressure Code as the recognized standard, and the testing to be performed in a reputable testing laboratory, a survey was developed and mailed to each welding instructor. The results of the survey are shown in the table below.

Procedures, material specifications, and method of testing were extracted from Section IX of the American Society of Mechanical Engineers Boiler & Pressure Code

<u>Name & Position of Test</u>	<u>Procedure & Material Specifications</u>	<u>Method of Testing</u>	<u>*No. of Training Hrs</u>
Flat Fillet 1F	Fig. Q-9-A	Q-9-A	58
Horizontal Fillet 2F	Fig. Q-9-A	Q-9-A	78
Vertical Fillet 3F	Fig. Q-9-A	Q-9-A	122
Overhead Fillet 4F	Fig. Q-9-A	Q-9-A	177
Glat Groove 1G	Fig. (Q-23)(QN-23A)	F19(Q-7-2)(Q-8)	356
Horizontal Groove 2G	Fig. (Q-23)(QN-23A)	F19(Q-7-2)(Q-8)	389
Vertical Groove 3G	Fig. (Q-23)(QN-23A)	F19(Q-7-2)(Q-8)	453
Overhead Groove 4G	Fig. (Q-23)(QN-23A)	F19(Q-7-2)(Q-8)	573

*Recommended by field survey of welding instructors in Bureau of Prisons

ACKNOWLEDGEMENTS

This writer is grateful to Mr. Shelvy E. Johnson, Supervisor of Vocational Training, United States Bureau of Prisons, for inspiration, co-operation, and guidance without whose farsightedness these welding guidelines would not have been possible.

Gratitude is also due to F.F. Kenton, Warden and D.R. Scott, Supervisor of Education for providing the resources and encouragement to produce this work.

Credit is also due to all the welding instructors in the Federal Bureau of Prisons for their support and contributions of data and instructional material.

The author has drawn freely from the code books of the American Welding Society and the American Society of Mechanical Engineers, and is especially indebted to both organizations.

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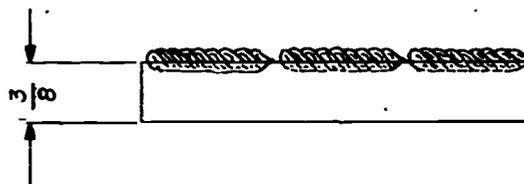
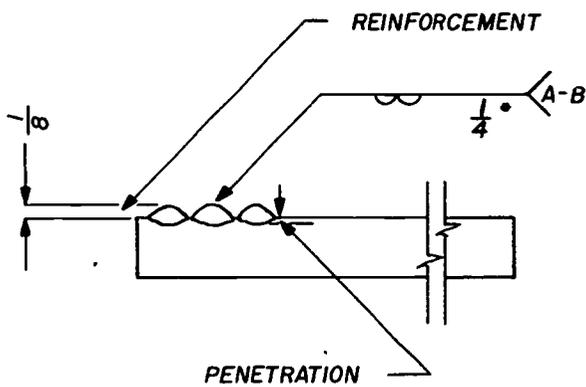
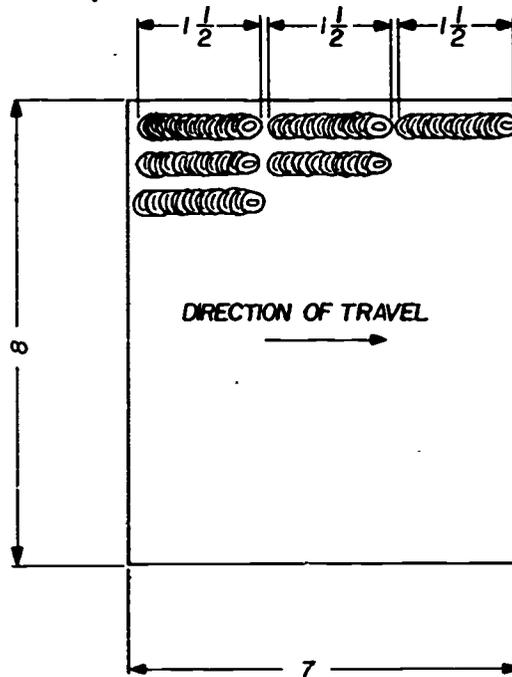
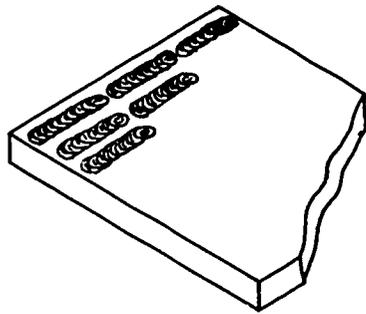
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COURSE: VOCATIONAL TRADE WELDING
BASIC SHIELDED METAL-ARC WELDING
PHASE I OBJECTIVE

Those trainees participating in the 125 hour course will develop the skills of arc welding, flame cutting, and arc-air gouging. Practice in shielded metal-arc welding will be limited to fillet welds made in all positions. Use of the cutting torch will be limited to cutting simple shapes from steel plate one inch or less in thickness. The arc-air tool will be used to gouge out welds.

The trainee in this course can expect to develop a level of skill that will enable him to obtain employment as a limited welder on steel structures. He also may find use for this skill in other mechanical trades.



A. WELD ON BOTH SIDES OF PLATE.

B. FLAT POSITION.

* REFERS TO BEAD WIDTH

NAME SURFACING WELD		MILESTONE A STARTING AN ARC		MODULE NO. I
				FIGURE NO. 1
ELECTRODE SIZE	$\frac{1}{8}$ DIA. DC/RP	TYPE	AWS - E - 6010	
MATERIAL		SPEC.	AMT	SIZE
	STEEL	MILD	1	$\frac{3}{8} \times 8 \times 7$

BASIC SHIELDED METAL-ARC WELDING

Module I. Surfacing Weld

Milestone A, Starting the Arc

Project 1; Time: 3 hours.

INTRODUCTION

The student will establish an arc between the electrode and the work surface using a scratching motion. After the arc is started he will deposit short beads, 1-1/2 inches long, five times in succession without sticking the electrode.

EQUIPMENT REQUIRED

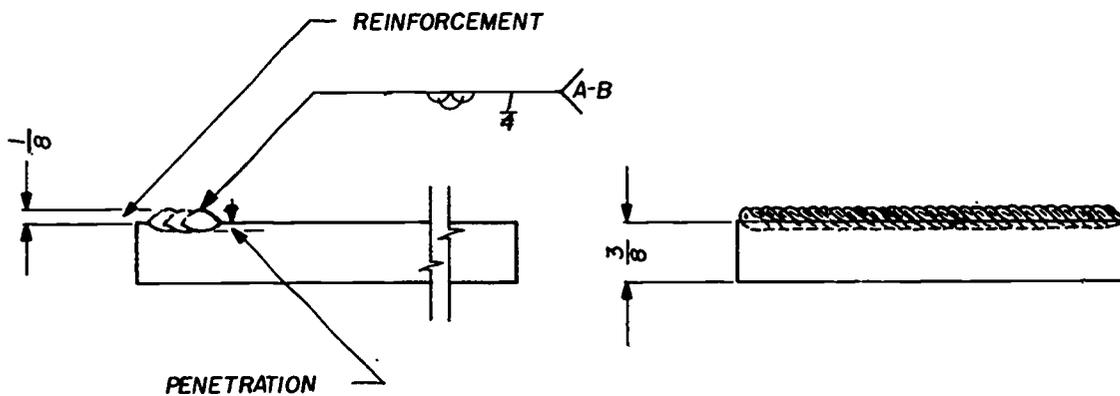
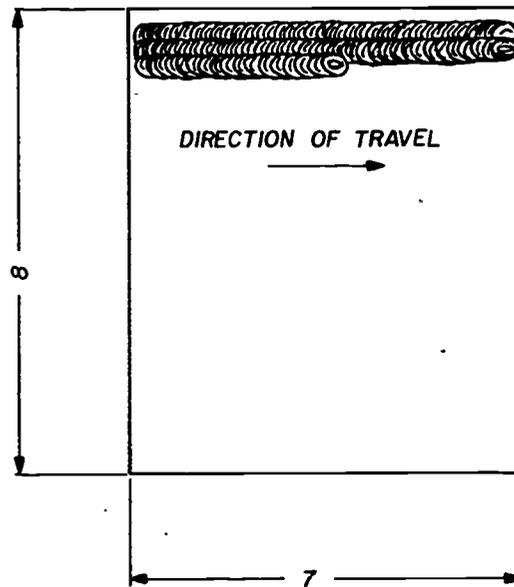
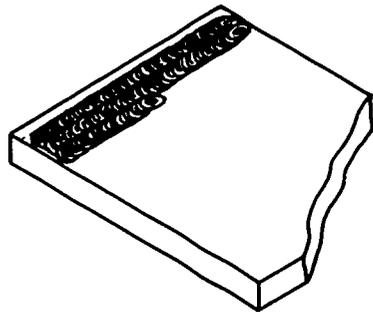
Direct current welding machine, slag hammer, wire brush, tongs, face shield and gloves.

MATERIAL NEEDED

Scrapped steel plate or used butts, surface weld plates, 1/8 inch E6010 electrodes.

PROCEDURE

1. Clean plate surface with wire brush, place in the flat position for welding.
2. Set amperage and polarity as directed.
3. Start welding machine.
4. Put on jacket, face shield and gloves.
5. Put electrode in holder.
6. Drop face shield, contact plate with electrode, raise slightly, in a continuing motion.
7. Lower electrode to the proper arc length, as directed.
8. Deposit a short weld bead, as demonstrated.
9. Use all electrodes down to a stub end 1-1/2 inches long.
10. Raise flip front, place holder in its rest.
11. Clean all slag from the weld bead using the chipping hammer and wire brush.
12. Repeat this procedure until arc starting can be done without trouble.
13. Secure equipment as directed.



- A. WELD ON BOTH SIDES OF PLATE
- B. FLAT POSITION

NAME SURFACING WELD	MILESTONE B RUNNING FULL WIDTH BEADS		MODULE NO. I
			FIGURE NO. 2
ELECTRODE SIZE $\frac{1}{8}$ DIA DC/RP	TYPE STEEL AWS-E-6010		
MATERIAL.	SPEC.	AMT.	SIZE
STEEL	MILD	1	$\frac{3}{8}$ X 8 X 7

BASIC SHIELDED METAL-ARC WELDING

Module I. Surfacing Weld

Milestone B, Full Width Beads

Project 2; Time: 6 hours

INTRODUCTION

The student will demonstrate, to the satisfaction of the instructor, his ability to make full width beads. Each weld bead will overlap the previous bead by 50% of its width. This will be done with straight line travel. Each bead should have uniform height, width, and ripple.

EQUIPMENT REQUIRED

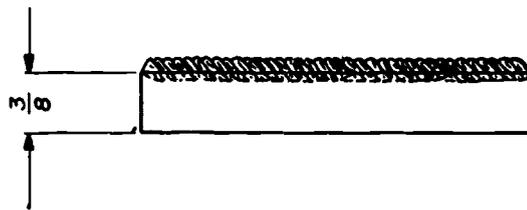
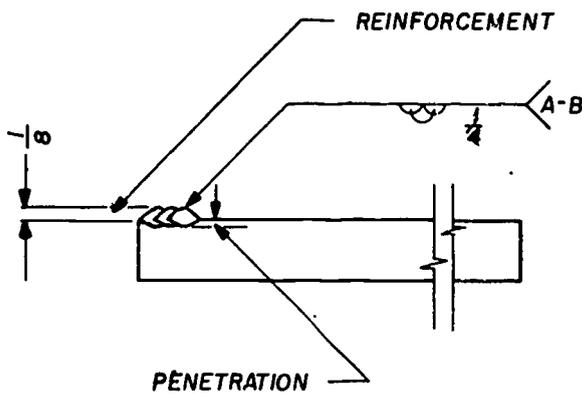
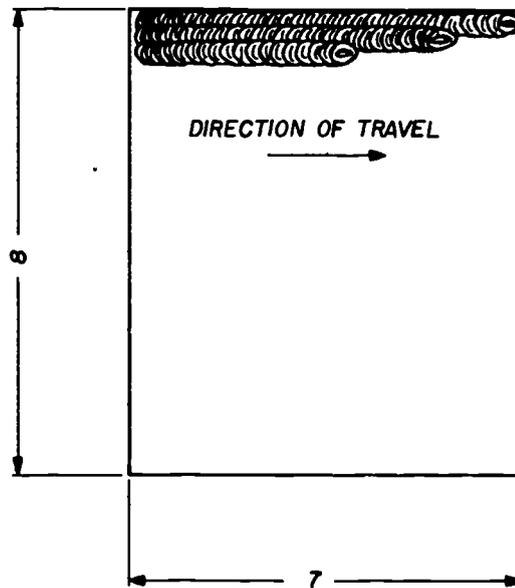
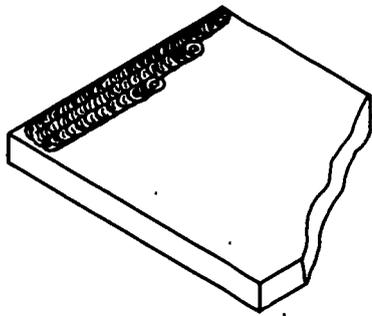
Direct current welding machine, slag hammer, wire brush, tongs, face shield, jacket, and gloves.

MATERIAL NEEDED

Scrapped steel plate or used butts and surface weld project plates, 1/8 inch E6010 electrodes.

PROCEDURE

1. Clean plate with wire brush, place for welding in the flat position.
2. Set amperage and polarity as directed.
3. Start welding machine.
4. Put on jacket, face shield, and gloves.
5. Put electrode in holder.
6. Drop face shield, establish an arc, raise electrode slightly, move to the starting point.
7. Lower electrode to proper arc length.
8. Hold the electrode at 90° to the plate, this is the work angle. Hold an angle of 20° in direction of travel, this is the lead angle.
9. Feed electrode into puddle at a controlled rate, maintaining a constant arc length.
10. Establish rate of travel by maintaining a uniform puddle and bead width.
11. Deposit weld bead from left to right, if right handed, as demonstrated.
12. Use all electrodes down to a stub end 1-1/2 inches long.
13. Lift flip from on face shield, place holder in its hanger.
14. Chip and wire brush the bead to remove all slag.
15. Inspect weld bead, discuss its quality with your instructor.
16. Repeat this procedure until satisfactory welds are produced.
17. Secure equipment.



- A. WELD ON BOTH SIDES OF PLATE.
- B. FLAT POSITION.

NAME SURFACING WELD	MILESTONE C MULTIPLE PASS PAD / FIRST LAYER		MODULE NO. I
			FIGURE NO. 3
ELECTRODE SIZE $\frac{1}{8}$ DIA. DC/RF		TYPE STEEL AWS-E-6010	
MATERIAL	SPEC.	AMT.	SIZE
STEEL	MILD	1	$\frac{3}{8}$ X 8 X 7

BASIC SHIELDED METAL-ARC WELDING

Module I. Surfacing Weld

Milestone C, Multiple Pass Pads/First Layer

Project 3; Time: 5 hours

INTRODUCTION

The student will make a surfacing weld on one side of a steel plate using 1/8 inch E6010 electrodes. The weld beads should be straight, of uniform height and width, with an overlap of 50% of each bead.

EQUIPMENT REQUIRED

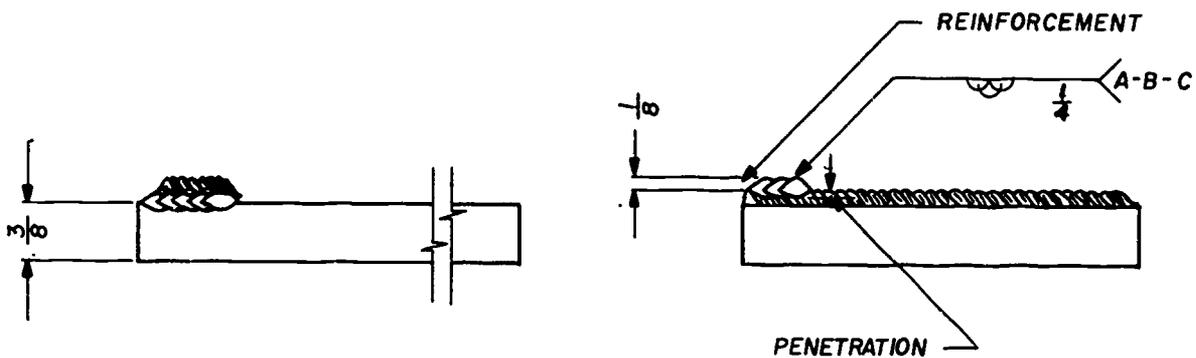
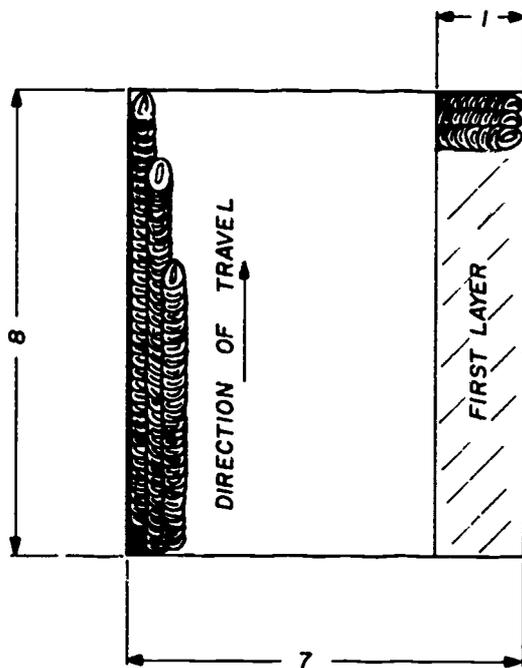
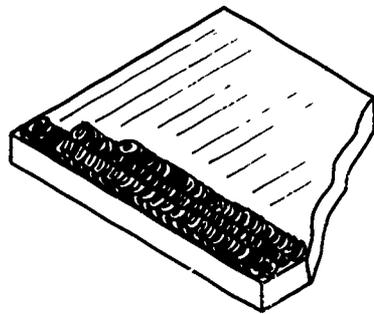
Direct current welding machine, slag hammer, wire brush, tongs, face shield, gloves, and jacket.

MATERIAL NEEDED

1 piece 3/8 x 7 x 8 inch steel plate, 1/8 inch E6010 electrodes.

PROCEDURE

1. Clean plate with wire brush, place for welding in the flat position.
2. Set amperage and polarity as directed.
3. Start welding machine.
4. Put on jacket, face shield, and gloves.
5. Put electrode in holder.
6. Drop face shield, establish an arc, raise electrode slightly, move to the starting point.
7. Lower electrode to the proper arc length.
8. Hold the electrode with a leading angle of about 75°.
9. Feed electrode into puddle at a controlled rate, holding a constant arc length as demonstrated.
10. Establish rate of travel by maintaining a uniform puddle and bead width.
11. Deposit weld bead in a straight line from left to right, if right handed, as demonstrated.
12. Use all electrodes down to a stub end 1-1/2 inches long.
13. Raise flip front, put holder in its rest.
14. Clean off all slag with hammer and brush.
15. Inspect bead, discuss its quality with your instructor.
16. Repeat this procedure until the weld beads are consistent.
17. Secure equipment.



- A. WELD ON BOTH SIDES OF PLATE
- B. FLAT POSITION
- C. LEAVE 1" OF FIRST BEAD SHOWING

NAME SURFACING WELD		MILESTONE D MULTIPLE PASS PAD / SECOND LAYER - WHIP BEAD		MODULE NO. I FIGURE NO. 4	
ELECTRODE SIZE $\frac{1}{8}$ DC/RP		TYPE STEEL AWS-E-6010			
MATERIAL	SPEC.	AMT.	SIZE		
STEEL	MILD	1	$\frac{3}{8}$ X 8 X 7		

BASIC SHIELDED METAL-ARC WELDING

Module I. Surfacing Weld

Milestone D, Multiple Pass Pad/Second Layer - Whip Bead

Project 4; Time: 3 hours

INTRODUCTION

Using the reverse side of the plate from Project 3, the student will make a surfacing weld with electrode manipulation (Whip Bead). This is a forward and back motion in increments of about $\frac{3}{8}$ and $\frac{1}{4}$ inch. The arc length must be held constant. Overlap the weld beads by 50% of their width. The completed surface must be uniform in depth and appearance.

EQUIPMENT REQUIRED

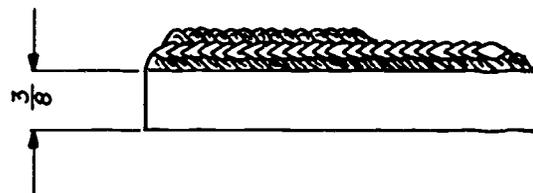
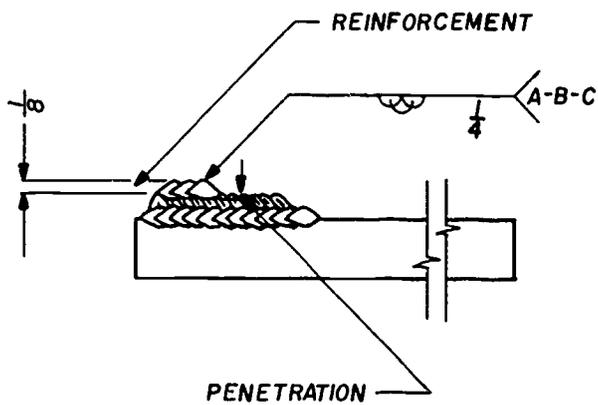
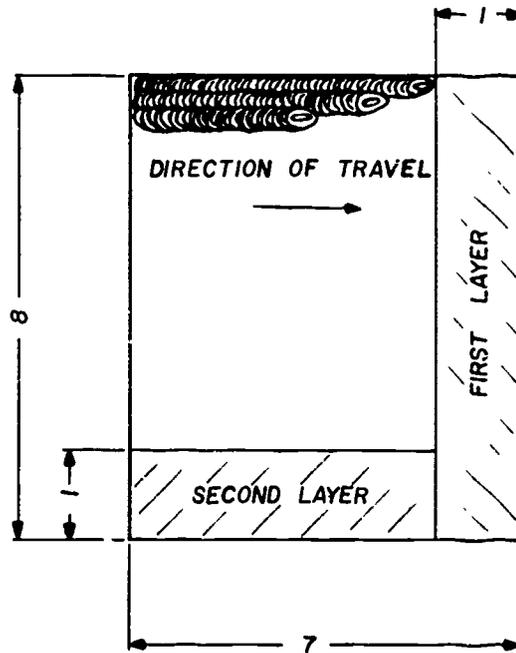
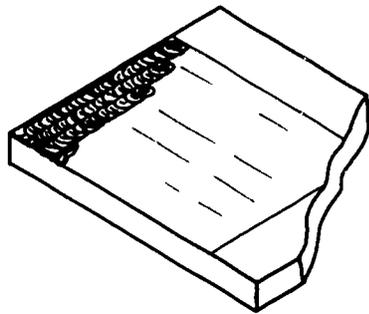
Direct current welding machine, slag hammer, wire brush, tongs, face shield, gloves and jacket.

MATERIAL NEEDED

Use the plate with a surface weld from Project 3, $\frac{1}{8}$ inch electrodes type E6010.

PROCEDURE

1. Clean plate with wire brush, place for welding in the flat position.
2. Set amperage and polarity as directed.
3. Start welding machine.
4. Put on jacket, face shield and gloves.
5. Put electrode in holder.
6. Drop face shield, establish an arc, raise the electrode slightly, move to the starting point.
7. Lower electrode to the proper arc length.
8. Practice the forward and back manipulation described and demonstrated. Observe how this is an aid to deposit beads of the desired shape and size.
9. Use all electrodes down to a stub end $1\frac{1}{2}$ inches long.
10. Open flip front, place holder in its rest.
11. Clean off all slag with hammer and brush.
12. Discuss your results with instructor.
13. Save plate for further work.
14. Secure equipment.



- A. WELD ON BOTH SIDES OF PLATE
- B. FLAT POSITION
- C. LEAVE 1" OF SECOND BEAD SHOWING

NAME		MILESTONE E		MODULE NO. I	
SURFACING WELD		MULTIPLE PASS PAD / THIRD LAYER		FIGURE NO. 5	
ELECTRODE SIZE $\frac{1}{8}$ DIA DC/SP		TYPE		STEEL AWS-E-6013	
MATERIAL		SPEC.	AMT	SIZE	
STEEL		MILD	1	$\frac{3}{8} \times 8 \times 7$	

BASIC SHIELDED METAL-ARC WELDING

Module I. Surfacing Weld

Milestone E, Multiple Pass Pad/Third Layer

Project 5; Time: 3 hours

INTRODUCTION

The student will change the current from reversed to straight polarity, explaining to the instructor why this is done. The student will make a surfacing weld with 1/8 inch E6013 electrodes over the surfacing weld of Project 4. Each weld bead must be overlapped 50% of the preceding bead. Even spacing, uniform height, ripple, and width are the objectives.

EQUIPMENT REQUIRED

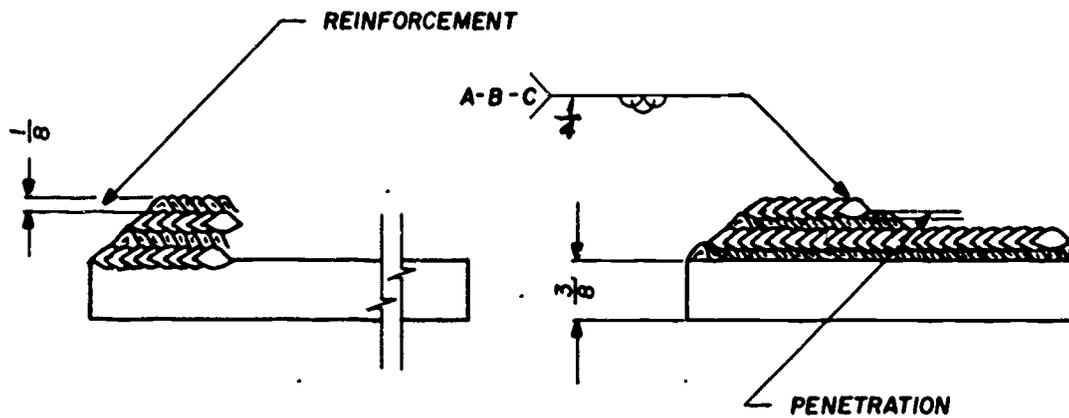
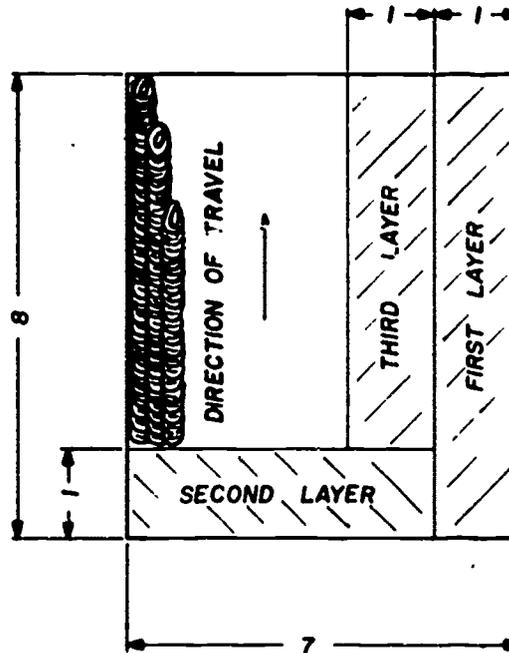
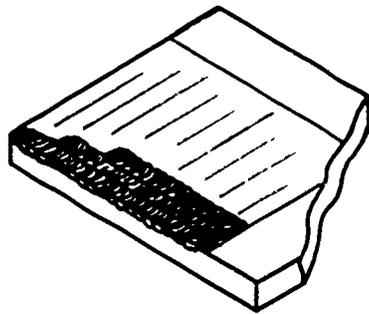
Direct current welding machine, slag hammer, wire brush, tongs, face shield, gloves and jacket.

MATERIAL NEEDED

Surfacing weld plate from Project 3 and 4, 1/8 inch E6013 electrodes.

PROCEDURE

1. Clean plate with wire brush, place for welding in the flat position.
2. Set amperage and polarity as directed.
3. Start welding machine.
4. Put on jacket, face shield and gloves.
5. Put electrode in holder.
6. Drop face shield, establish an arc, raise electrode slightly, move to the starting point.
7. Lower electrode to proper arc length.
8. Hold the electrode with a leading angle of about 80°, feed into puddle at a controlled rate, holding a constant arc length.
9. Establish rate of travel by maintaining a consistent puddle and bead width.
10. Move from left to right, if right handed.
11. Weld beads must be parallel and overlapping by 50%, as demonstrated.
12. Use all electrodes down to a stub end of 1-1/2 inch.
13. Lift flip front, place holder in its rest, chip off all slag, use wire brush as directed.
14. Inspect work, discuss the results with your instructor.
15. When a satisfactory weld is completed, save plate for the following project.



- A. WELD ON BOTH SIDES OF PLATE
- B. FLAT POSITION
- C. LEAVE 1" OF THIRD BEAD SHOWING

NAME SURFACING WELD	MILESTONE F MULTIPLE PASS PAD / FOURTH LAYER		MODULE NO. I	
			FIGURE NO. 6	
ELECTRODE SIZE $\frac{1}{8}$ DIA DC/RP	TYPE AWS - E - 7018			
MATERIAL	SPEC.	AMT.	SIZE	
STEEL	MILD	1	$\frac{3}{8}$ X 8 X 7	

BASIC SHIELDED METAL-ARC WELDING

Module I. Surfacing Weld

Milestone F, Multiple Pass Pad/Fourth Layer

Project 6; Time: 3 hours

INTRODUCTION

For this project the student will use reverse polarity, electrode positive. He will make a surfacing weld on the plate used in Project 5. The beads must be uniform in height, width, with uniform ripple. Use 1/8 inch E7018 electrodes.

EQUIPMENT REQUIRED

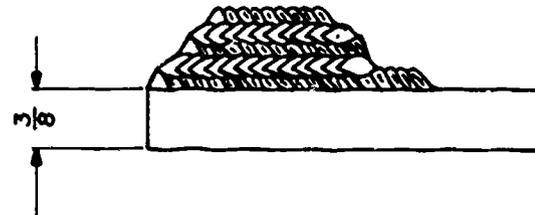
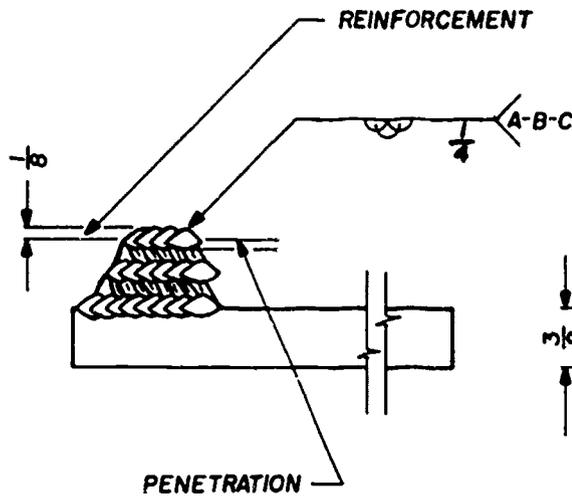
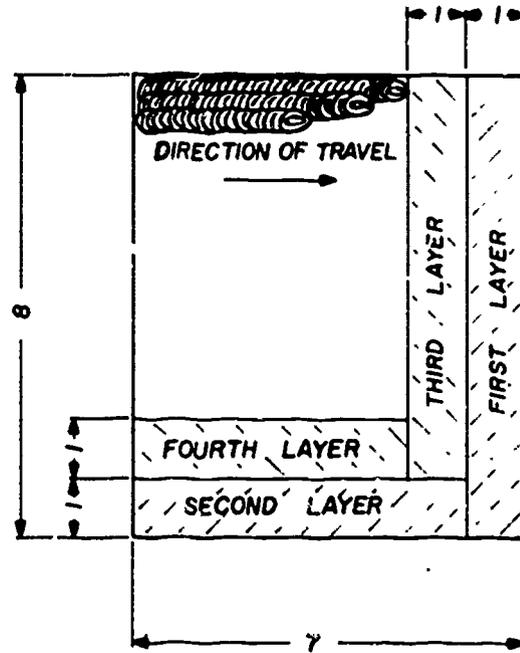
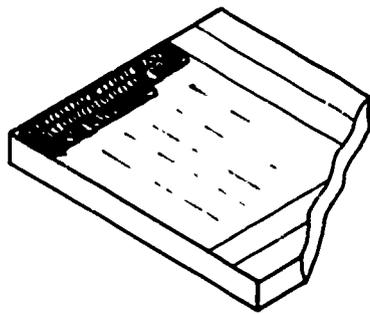
Direct current welding machine, slag hammer, wire brush, tongs, face shield, gloves, and jacket.

MATERIAL NEEDED

Plate from Project 5, 1/8 inch E7018 electrodes.

PROCEDURE

1. Clean the plate with wire brush, place for welding in the flat position.
2. Set amperage and polarity as directed.
3. Start welding machine.
4. Put on jacket, gloves and face shield.
5. Put electrode in holder.
6. Drop face shield, establish an arc, raise the electrode slightly, move to the starting point.
7. Lower electrode to the proper arc length.
8. Hold the electrode with a leading angle of about 80°.
9. Feed electrode into puddle at a controlled rate while holding a constant arc length.
10. Establish rate of travel by maintaining a consistent puddle and bead width.
11. Deposit a straight bead from left to right, if right handed.
12. Beads must be parallel and have a 50% overlap.
13. Use all electrodes down to a stub end 1-1/2 inches long.
14. Lift flip front, place holder in its rest, clean off slag with hammer and wire brush.
15. Inspect weld beads, discuss the results with your instructor.
16. When a satisfactory surfacing weld is produced, save it for the next project.



- A. WELD ON BOTH SIDES OF PLATE
- B. FLAT POSITION
- C. LEAVE 1" OF FOURTH BEAD SHOWING

NAME SURFACING WELD	MILESTONE G MULTIPLE PASS PAD / FIFTH LAYER		MODULE NO. I	
			FIGURE NO. 7	
ELECTRODE SIZE $\frac{1}{8}$ DIA DC/RP	TYPE AWS - E - 7024			
MATERIAL	SPEC.	AMT	SIZE	
STEEL	MILD	1	$\frac{3}{8}$ X 8 X 7	

BASIC SHIELDED METAL-ARC WELDING

Module I. Surfacing Weld

Milestone G, Multiple Pass Pad/Fifth Layer

Project 7; Time: 3 hours

INTRODUCTION

The student will cover the surfacing weld of Project 6 with an additional layer of weld metal using 1/8 inch E7024 electrodes. The beads must be overlapped 50%. They will have a uniform surface and ripple, with an even buildup.

EQUIPMENT REQUIRED

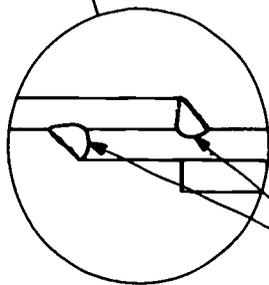
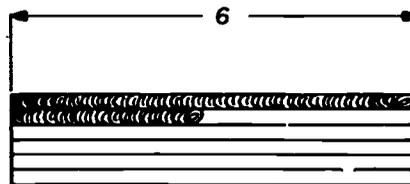
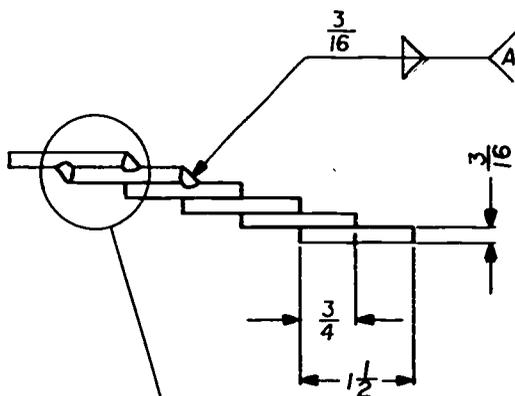
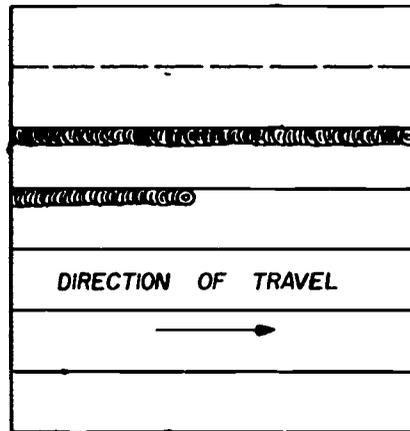
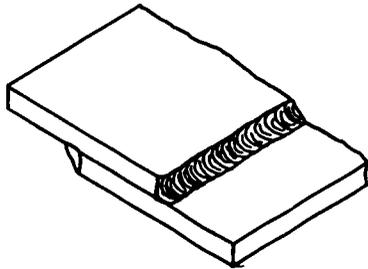
Direct current welding machine, slag hammer, wire brush, tongs, and safety equipment.

MATERIAL NEEDED

Use the surfacing weld plate from Project 6, 1/8 inch E7024 electrodes.

PROCEDURE

1. Clean plate with wire brush, place for welding in the flat position.
2. Set amperage and polarity as directed.
3. Start welding machine.
4. Put on face shield and gloves.
5. Put electrode in holder.
6. Drop face shield, establish an arc, raise electrode slightly, move to starting point.
7. Lower electrode to the proper arc length.
8. Hold the electrode with a leading angle of about 80°.
9. Feed electrode into the puddle at a controlled rate, maintaining a constant arc length, as demonstrated.
10. Establish the rate of travel by controlling the width of puddle and bead.
11. Deposit straight beads from left to right, if right handed.
12. Beads should have a 50% overlap.
13. Use all electrodes down to a stub end 1-1/2 inches long.
14. Raise flip front, put holder in its rest, chip and wire brush weld to remove all slag.
15. Inspect beads, discuss results with your instructor.
16. Save those properly made surface weld plates for projects following.



PENETRATION

A. WELD ON BOTH SIDES

NAME LAP WELD SETS		MILESTONE A LAP WELDS		MODULE NO. II	
				FIGURE NO. 8	
ELECTRODE SIZE $\frac{1}{8}$ DIA. DC/RP		TYPE AWS-E-6010			
MATERIAL	SPEC.	AMT.	SIZE		
STEEL	MILD	6	$\frac{3}{16} \times \frac{1}{2} \times 6$		

BASIC SHIELDED METAL-ARC WELDING

Module II. Lap Weld Sets

Milestone A, Lap Welds

Project 8; Time: 6 hours

INTRODUCTION

The student will make a lap set to contain 10 welds. These will be finished on alternate sides until the set is complete. Each weld should have a leg length equal to plate thickness, with a flat face and uniform ripple. There should be no excess reinforcement on top plate or undercut. Use 1/8 inch E6010 electrodes with a forward and back (Hot Whip) motion.

EQUIPMENT REQUIRED

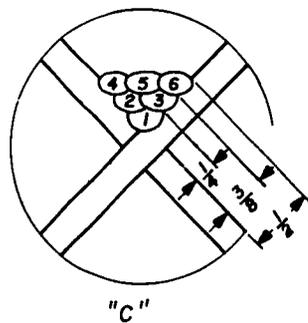
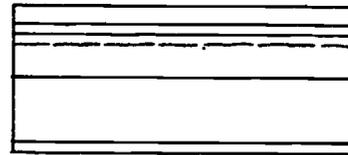
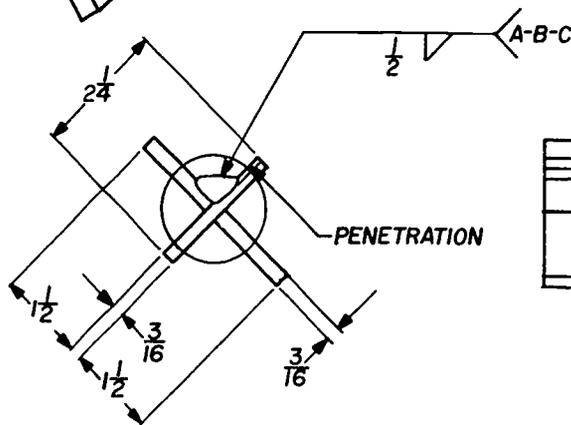
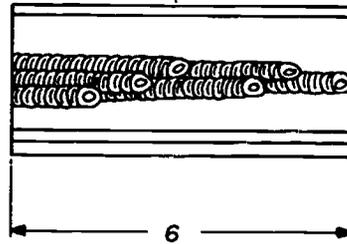
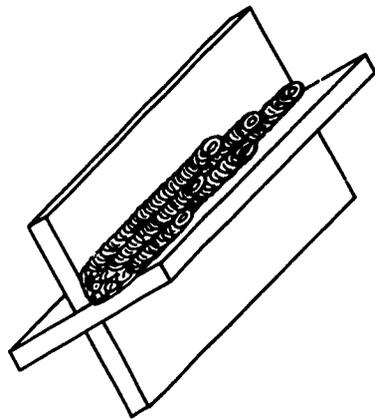
Direct current welding machine, slag hammer, wire brush, tongs, and safety equipment.

MATERIAL NEEDED

6 pieces 3/16 x 1-1/2 x 6 inch steel plate, 1/8 inch E6010 electrodes.

PROCEDURE

1. Clean plate with wire brush.
2. Set amperage and polarity as directed.
3. Start welding machine.
4. Put on safety equipment.
5. Put electrode in holder.
6. Overlap plates 3/4 inch and tack weld at each end of the joints. Place for welding in the horizontal position.
7. Drop face shield, establish an arc, raise electrode slightly, move to the starting point.
8. Lower electrode to the proper arc length.
9. Hold electrode about 45° to the work inclined 60° in the leading direction.
10. Deposit weld with a forward and back manipulation in small increments, as demonstrated. Hold a constant arc length.
11. Use all electrodes down to a stub end of 1-1/2 inch.
12. Raise flip front, place holder in its rest, clean off slag with ahmmer and wire brush.
13. Inspect bead, discuss results with your instructor.
14. Repeat this procedure until the desired weld is produced.



A. WELD ALL FOUR CORNERS

B. FLAT POSITION

C. WELD SEQUENCE

NAME FILLET WELD SETS		MILESTONE A FILLET WELDS IN THE FLAT POSITION			MODULE NO. III
					FIGURE NO. 9
ELECTRODE SIZE $\frac{1}{8}$ DIA. DC/RP		TYPE AWS - E - 6010			
MATERIAL	STEEL	SPEC. MILD	AMT 2	SIZE $\frac{3}{16} \times \frac{1}{2} \times 6$	
	STEEL	MILD	1	$\frac{3}{16} \times 2\frac{1}{4} \times 6$	

BASIC SHIELDED METAL-ARC WELDING

Module III. Fillet Weld Sets

Milestone A, Fillet Welds in the Flat Position

Project 9; Time: 6 hours

INTRODUCTION

The student will make a fillet weld set to contain four, 6 pass welds. The beads will be deposited to make fillets of 1/4, 3/8, and 1/2 inch leg lengths progressively. Each finished weld should have equal leg lengths, a flat face, with uniform ripple. Use E6010 electrodes with reverse polarity, electrode positive.

EQUIPMENT REQUIRED

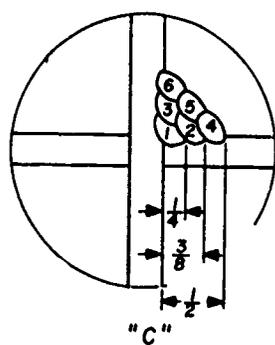
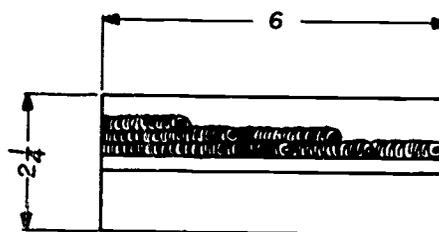
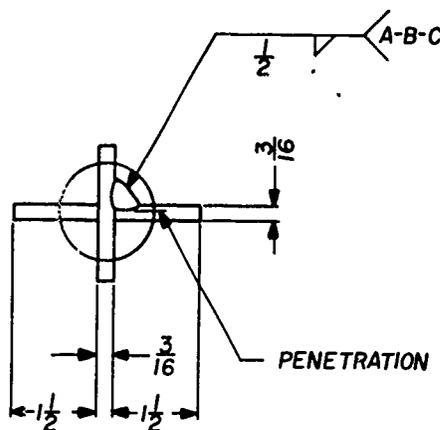
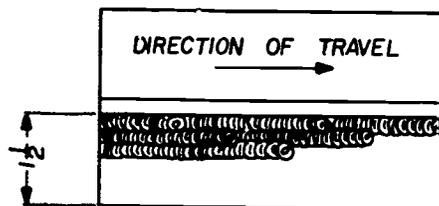
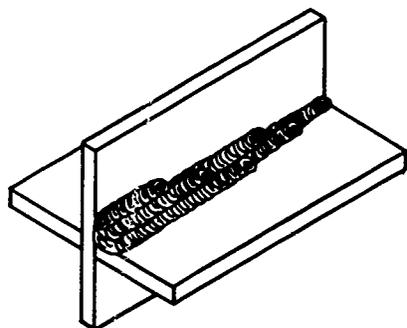
Direct current welding machine, slag hammer, wire brush, tongs, and safety equipment.

MATERIAL NEEDED

1 piece 3/16 x 2-1/4 x 6 inch, 2 pieces 3/16 x 1-1/2 x 6 inch steel plate, 1/8 inch E6010 electrodes.

PROCEDURE

1. Clean plate with wire brush.
2. Set amperage and polarity as directed.
3. Start welding machine.
4. Put on face shield and gloves.
5. Put electrode in holder.
6. Tack weld plates at 90° to form a cross; place for welding in the flat position.
7. Drop face shield, establish an arc, raise electrode slightly, move to the starting point.
8. Lower electrode to the proper arc length.
9. Deposit weld, holding electrode at various angles, depending on position of the bead.
10. After each bead is complete, clean off slag with hammer and wire brush.
11. Follow instructor's demonstrated procedure.
12. Repeat this procedure until the desired weld is produced.
13. Check fillet size with gage.
14. Save material for square butt weld.
15. Secure equipment.



- A. WELD ALL FOUR CORNERS
- B. HORIZONTAL POSITION
- C. WELD SEQUENCE

NAME FILLET WELD SETS		MILESTONE B FILLET WELDS IN THE HORIZONTAL POSITION		MODULE NO. III	
				FIGURE NO. 10	
ELECTRODE SIZE $\frac{1}{8}$ DIA. DC/RP		TYPE AWS-E-6010			
MATERIAL	STEEL	SPEC. MILD	AMT 2	SIZE $\frac{3}{16} \times \frac{1}{2} \times 6$	
	STEEL	MILD	1	$\frac{3}{16} \times 2\frac{1}{4} \times 6$	

BASIC SHIELDED METAL-ARC WELDING

Module III. Fillet Weld Sets

Milestone B, Fillet Weld in the Horizontal Position

Project 10; Time: 12 hours

INTRODUCTION

The student will make a fillet weld set to contain four, six pass welds. The beads will be deposited to make fillets of $1/4$, $3/8$, and $1/2$ inch leg length progressively. Each finished weld should have equal leg lengths, a flat face, with uniform ripple. Use E6010 electrodes, weld in the horizontal position.

EQUIPMENT REQUIRED

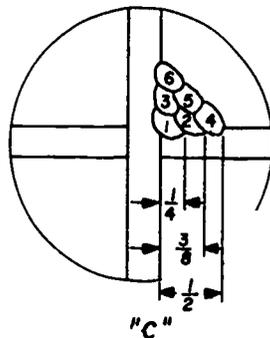
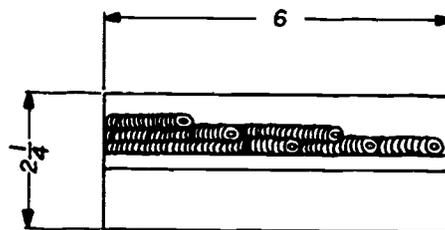
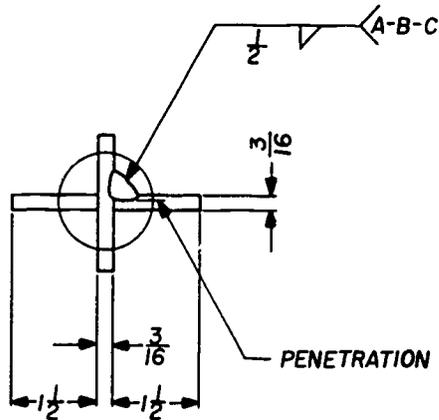
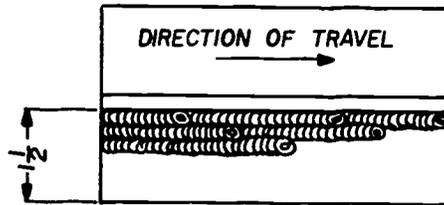
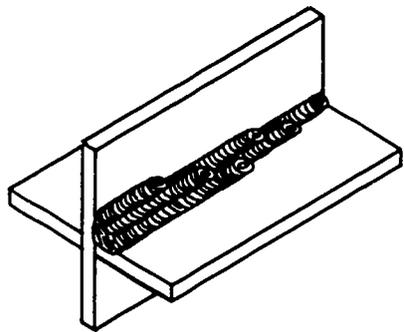
Direct current welding machine, slag hammer, wire brush, tongs, and safety equipment.

MATERIAL NEEDED

1 piece $3/16$ x $2-1/4$ x 6 inch, 2 pieces $3/16$ x $1-1/2$ x 6 inch steel plate, $1/8$ inch E6010 electrodes.

PROCEDURE

1. Clean plate with wire brush.
2. Set amperage and polarity as directed.
3. Start welding machine.
4. Put on face shield and gloves.
5. Put electrode in holder.
6. Tack weld plates at 90° to form a cross, place for welding in the horizontal position.
7. Drop face shield, establish an arc, raise electrode slightly, move to the starting point.
8. Lower electrode to the proper arc length.
9. Deposit weld, holding electrode at various angles, depending on position of the beads.
10. After each bead is complete, clean off slag with hammer and wire brush.
11. Follow instructor's demonstrated procedures.
12. Repeat this procedure until the desired weld is produced.
13. Check fillet size with gage.
14. Save material for square butt weld.
15. Secure equipment.



A. WELD ALL FOUR CORNERS

B. HORIZONTAL POSITION

C. WELD SEQUENCE

NAME FILLET WELD SETS		MILESTONE C FILLET WELDS IN THE HORIZONTAL POSITION			MODULE NO. III
					FIGURE NO. 11
ELECTRODE SIZE $\frac{1}{8}$ DIA. DC/SP		TYPE AWS-E-6013			
MATERIAL	STEEL	SPEC. MILD	AMT 2	SIZE $\frac{3}{16} \times \frac{1}{2} \times 6$	
	STEEL	MILD	1	$\frac{3}{16} \times \frac{1}{4} \times 6$	

BASIC SHIELDED METAL-ARC WELDING

Module III. Fillet Weld Sets

Milestone C, Fillet Weld in the Horizontal Position Using E6013 Electrodes

Project 11; Time: 6 hours

INTRODUCTION

The student will make a fillet weld set to contain four, 6 pass welds. The beads will be deposited to make fillets of 1/4, 3/8, and 1/2 inch leg lengths progressively. Each finished weld should have equal leg lengths, a flat face, with uniform ripple. Use E6013 electrodes with straight polarity, electrode negative.

EQUIPMENT REQUIRED

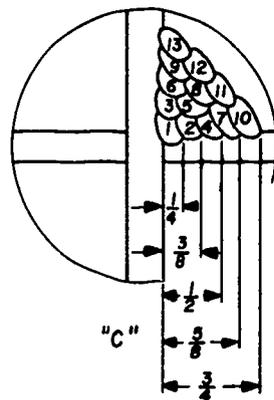
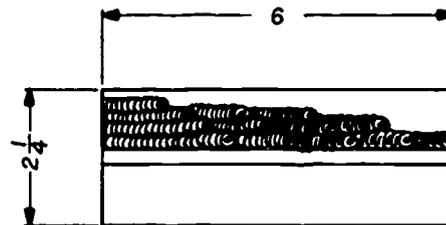
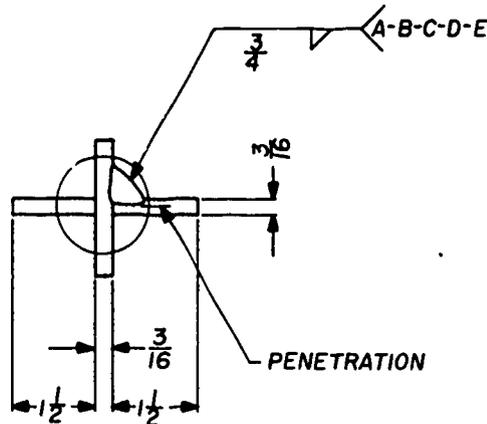
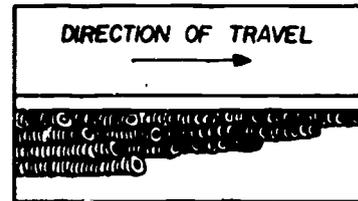
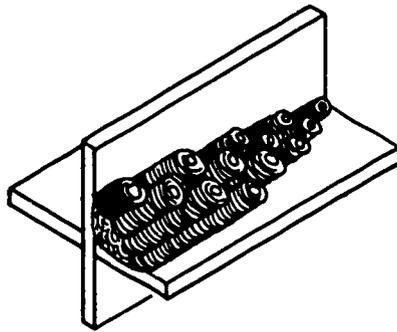
Direct current welding machine, slag hammer, wire brush, tongs, and safety equipment.

MATERIAL NEEDED

1 piece 3/16 x 2-1/4 x 6 inch, 2 pieces 3/16 x 1-1/2 x 6 inch steel plate, 1/8 inch E6013 electrodes.

PROCEDURE

1. Clean plate with wire brush.
2. Set amperage and polarity as directed.
3. Start welding machine.
4. Put on face shield and gloves.
5. Put electrode in holder.
6. Tack weld plates at 90° to form a cross, place for welding in the horizontal position.
7. Drop face shield, establish an arc, raise electrode slightly, move to the starting point.
8. Lower electrode to the proper arc length.
9. Deposit weld, holding electrode at various angles, depending on position of the beads.
10. After each bead is complete, clean off slag with hammer and wire brush.
11. Follow instructor's demonstrated procedures.
12. Repeat this procedure until the desired weld is produced.
13. Check fillet size with gage.
14. Save material for square butt weld.
15. Secure equipment.



- A. WELD ALL FOUR CORNERS.
- B. HORIZONTAL POSITION
- C. WELD SEQUENCE
- D. FIRST SIX BEADS - 6013
- E. LAST SEVEN BEAD - 7024

NAME FILLET WELD SETS		MILESTONE <u>D</u> FILLET WELDS IN THE HORIZONTAL POSITION		MODULE NO. III
				FIGURE NO. 12
ELECTRODE SIZE $\frac{1}{8}$ DIA. DC/RP		TYPE AWS - E - 7024 - 6013		
MATERIAL	STEEL	SPEC. MILD	AMT. 2	SIZE $\frac{3}{16} \times 1\frac{1}{2} \times 6$
	STEEL	MILD	1	$\frac{3}{16} \times 2\frac{1}{4} \times 6$

BASIC SHIELDED METAL-ARC WELDING

Module III. Fillet Weld Sets

Milestone D, Fillet Welds in the Horizontal Position Using E7024 Electrodes.

Project 12; Time: 3 hours

INTRODUCTION

The student will use a completed weld set from Project 11, to add seven passes with 1/8 inch E7024 electrodes. These will be deposited as follows: first, 3 beads; second, 4 beads. This will increase the fillets from 1/2 inch to 3/4 inch size. The finished weld will have a flat face, equal leg lengths, and a uniform ripple.

EQUIPMENT REQUIRED

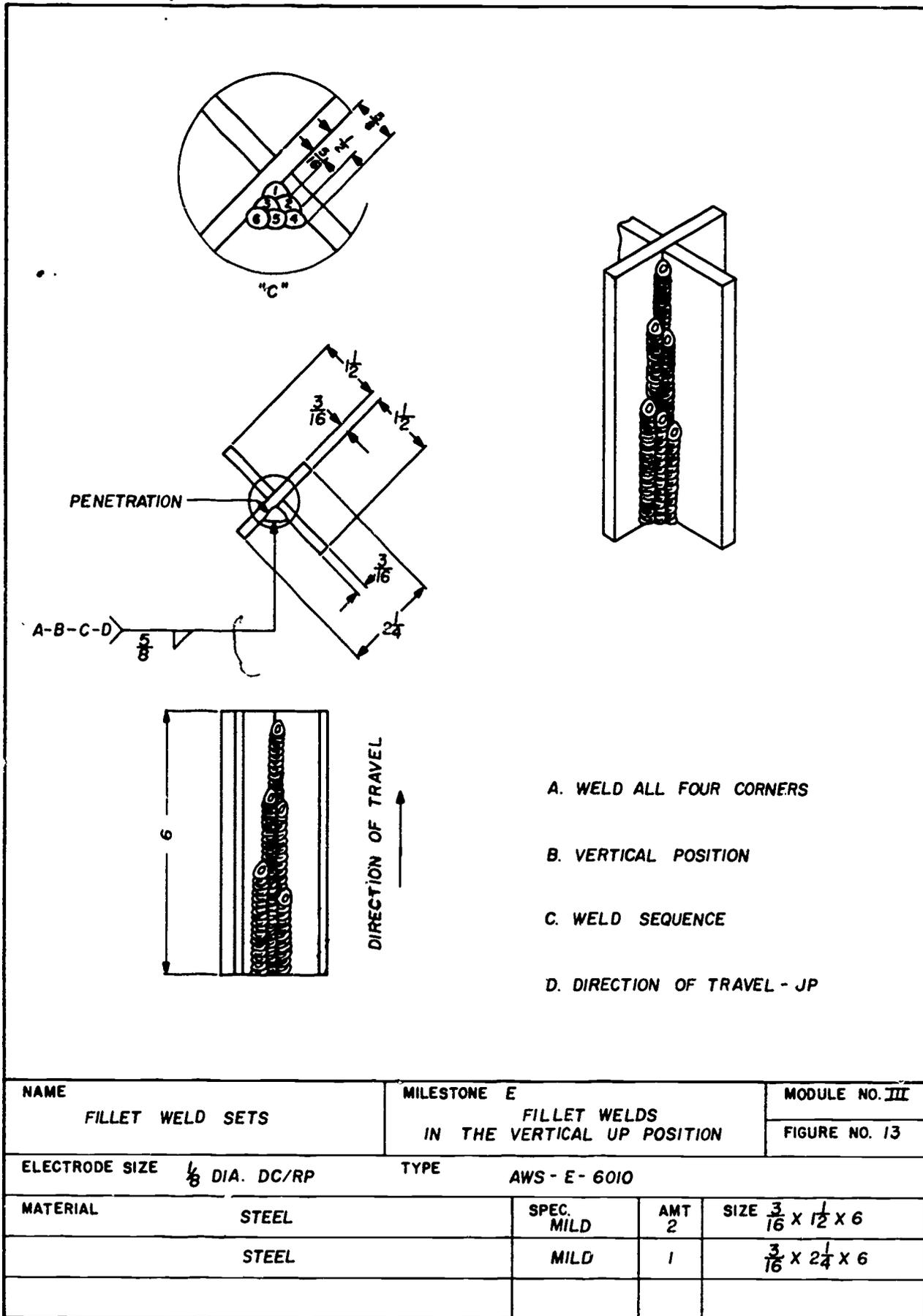
Direct current welding machine, slag hammer, wire brush, tongs, and safety equipment.

MATERIAL NEEDED

Completed sets from Project 11, 1/8 inch E7024 electrodes.

PROCEDURE

1. Clean welds with wire brush, place for welding in the horizontal position.
2. Set amperage and polarity as directed.
3. Start welding machine.
4. Put on face shield and gloves.
5. Put electrode in holder.
6. Drop face shield, establish an arc, raise electrode slightly, move to the starting point.
7. Lower electrode to the proper arc length.
8. Electrode angle will change with each bead, depending on its position.
9. Clean off all slag after completing each pass.
10. Practice as demonstrated.
11. Repeat this procedure until the desired weld is produced.
12. Check work with fillet gage, as directed.



BASIC SHIELDED METAL-ARC WELDING

Module III. Fillet Weld Sets

Milestone E, Fillet Welds in the Vertical-Up Position

Project 13; Time: 15 hours

INTRODUCTION

The student will make a fillet set to contain four, 6 pass welds. These will be deposited to make fillets of 5/16, 1/2, and 5/8 inch leg lengths progressively. These welds will have a flat face, equal leg lengths and a uniform ripple.

EQUIPMENT REQUIRED

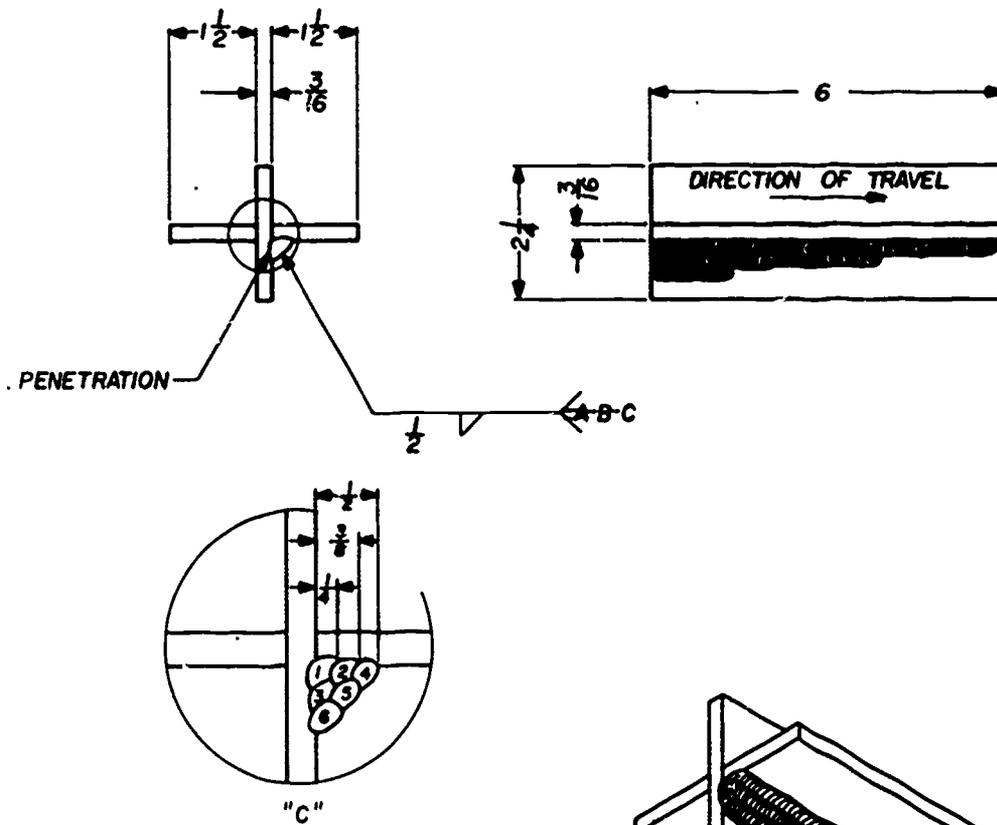
Direct current welding machine, slag hammer, wire brush, tongs, positioner, and safety equipment.

MATERIAL NEEDED

1 piece 3/16 x 2-1/4 x 6 inch, 2 pieces 3/16 x 1-1/2 x 6 inch steel plate, 1/8 inch E6010 electrodes.

PROCEDURE

1. Clean plate with wire brush.
2. Set amperage and polarity as directed.
3. Start welding machine.
4. Put on face shield and gloves.
5. Put electrode in holder.
6. Tack weld plate at 90° to form a cross, place in positioner for vertical welding.
7. Drop face shield, establish an arc, raise electrode slightly, move to the starting point.
8. Lower electrode to the proper arc length.
9. Deposit bead moving upward with an up and down manipulation. Follow demonstration procedures.
10. The increments of motion are about 3/8 inch up and 1/4 inch down, holding a constant arc length.
11. Clean off all slag from each completed bead.
12. Repeat this procedure until the desired weld is produced.
13. Check fillet dimension with gage.



- A. WELD ALL FOUR CORNERS
- B. OVERHEAD POSITION
- C. WELD SEQUENCE

NAME FILLET WELD SETS		MILESTONE F FILLET WELDS IN THE OVERHEAD POSITION		MODULE NO. III
				FIGURE NO. 14
ELECTRODE SIZE $\frac{1}{8}$ DIA DC/RP		TYPE AWS-E-6010		
MATERIAL	STEEL	SPEC. MILD	AMT. 2	SIZE $\frac{3}{16} \times 1\frac{1}{2} \times 6$
	STEEL	MILD	1	$\frac{3}{16} \times 2\frac{1}{4} \times 6$

BASIC SHIELDED METAL-ARC WELDING

Module III. Fillet Weld Sets

Milestone F, Fillet Welds in the Overhead Position

Project 14; Time: 9 hours

INTRODUCTION

The student will make a fillet set to contain four, six pass welds. These will be made in the overhead position, using E6010 electrodes. The beads will be deposited to make fillets of 1/4, 3/8, and 1/2 inch leg size progressively. The finished welds will have a flat face, with uniform ripple.

EQUIPMENT REQUIRED

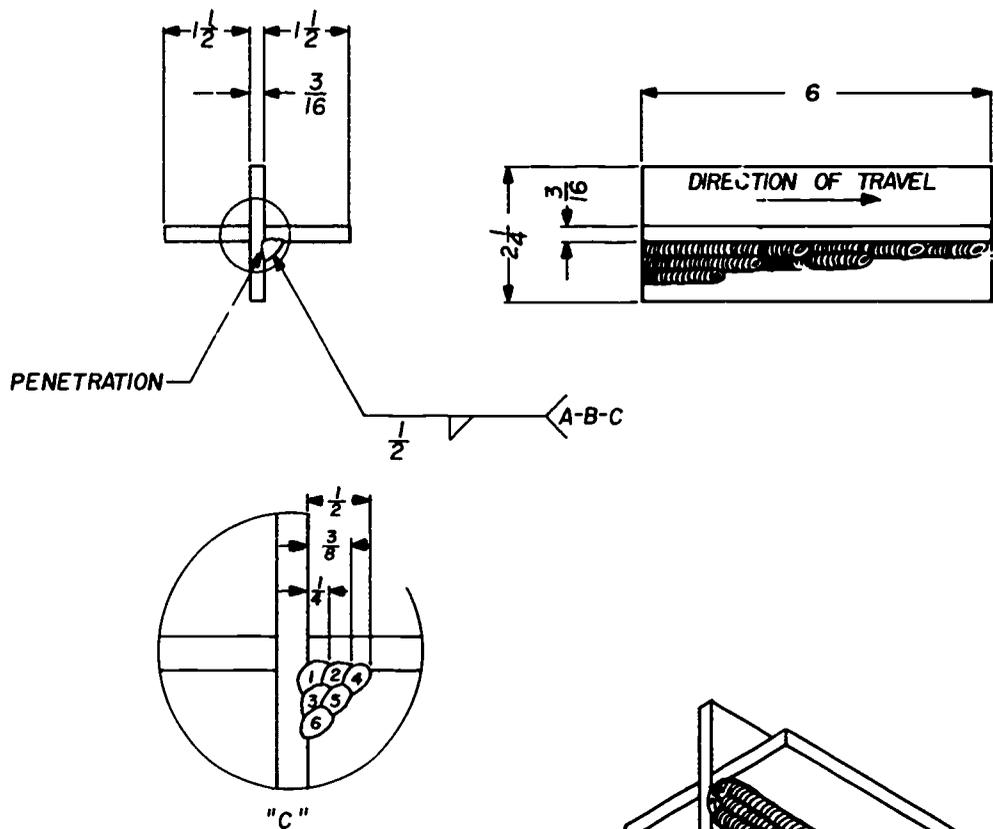
Direct current welding machine, slag hammer, wire brush, tongs, positioner, and safety equipment.

MATERIAL NEEDED

1 piece 3/16 x 2-1/4 x 6 inch, 2 pieces 3/16 x 1-1/2 x 6 inch steel plate, 1/8 inch E6010 electrodes.

PROCEDURE

1. Clean plate with wire brush.
2. Set amperage and polarity as directed.
3. Start welding machine.
4. Put on face shield and gloves.
5. Put electrode in holder.
6. Tack weld plates at 90° to form a cross, place in positioner for overhead welding.
7. Drop face shield, establish an arc, lower electrode slightly, move to the starting point.
8. Raise electrode to the proper arc length.
9. Practice as demonstrated, use a slight "C" motion for better puddle control and penetration. Hold a constant arc length.
10. Clean off slag after completing each pass.
11. Repeat this procedure until the desired weld is produced.
12. Check fillet size with gage.



PENETRATION

A-B-C

"C"

A. WELD ALL FOUR CORNERS

B. OVERHEAD POSITION

C. WELD SEQUENCE

NAME FILLET WELD SETS		MILESTONE G FILLET WELDS IN THE OVERHEAD POSITION			MODULE NO. III
					FIGURE NO. 15
ELECTRODE SIZE $\frac{1}{8}$ DIA. DC/SP		TYPE AWS-E-6013			
MATERIAL	STEEL	SPEC. MILD	AMT. 2	SIZE $\frac{3}{16} \times \frac{1}{2} \times 6$	
	STEEL	MILD	1	$\frac{3}{16} \times 2\frac{1}{4} \times 6$	

BASIC SHIELDED METAL-ARC WELDING

Module III. Fillet Weld Sets

Milestone G, Fillet Welds made in the Overhead Position.

Project 15; Time: 6 hours

INTRODUCTION

The student will make a fillet set to contain four, six pass welds. These will be made in the overhead position using E6013 electrodes. The beads will be deposited to make fillets of 1/4, 3/8, and 1/2 inch leg size progressively. The finished welds will have a flat face, with uniform ripple.

EQUIPMENT REQUIRED

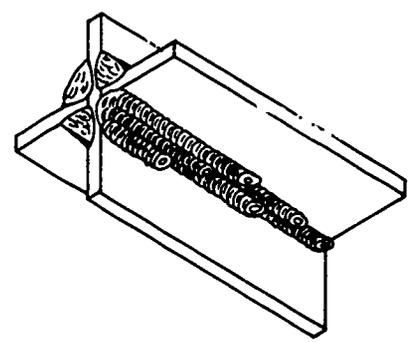
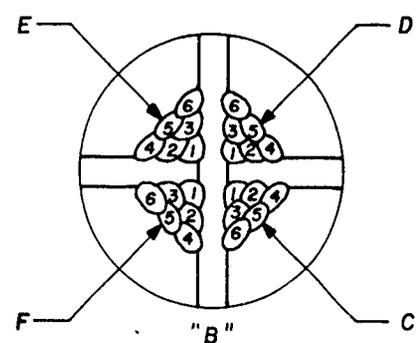
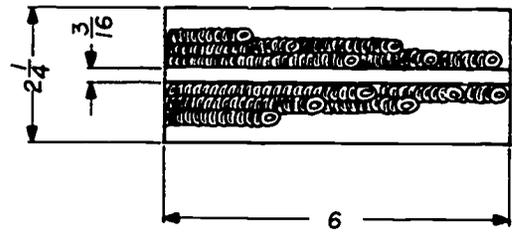
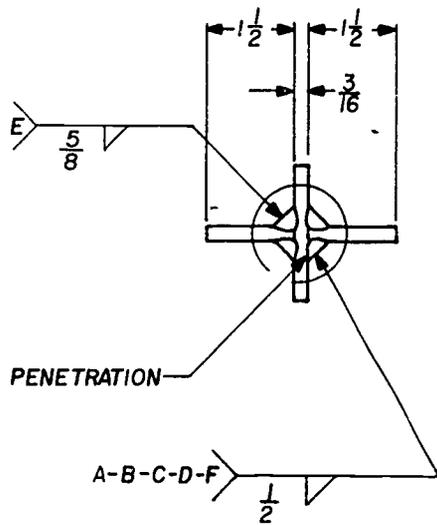
Direct current welding machine, slag hammer, wire brush, tongs, positioner, and safety equipment.

MATERIAL NEEDED

1 piece 3/16 x 2-1/4 x 6 inch, 2 pieces 3/16 x 1-1/2 x 6 inch steel plate, 1/8 inch E6013 electrodes.

PROCEDURE

1. Clean plate with wire brush.
2. Set amperage and polarity as directed.
3. Start welding machine.
4. Put on face shield and gloves.
5. Put electrode in holder.
6. Tack weld plates at 90° to form a cross, place in positioner for overhead welding.
7. Drop face shield, establish an arc, lower electrode slightly, move to the starting point.
8. Raise electrode to the proper arc length.
9. Practice as demonstrated, use a slight "C" motion for better puddle control and penetration.
10. Clean off slag after completing each pass.
11. Repeat this procedure until the desired weld is produced.
12. Check fillet size with gage.



- A. WELD ALL FOUR CORNERS
- B. WELD SEQUENCE
- C. FLAT POSITION
- D. HORIZONTAL POSITION
- E. VERTICAL POSITION
- F. OVERHEAD POSITION

NAME FILLET WELD SETS	MILESTONE H FILLET WELDS-TEST IN THE FOUR POSITIONS			MODULE NO. III
				FIGURE NO 16
ELECTRODE SIZE $\frac{1}{8}$ DIA	DC/RP	TYPE	AWS - E - 6010	
MATERIAL	STEEL	SPEC	AMT	SIZE $\frac{3}{16} \times 1\frac{1}{2} \times 6$
	STEEL	MILD	1	$\frac{3}{16} \times 2\frac{1}{4} \times 6$

BASIC SHIELDED METAL-ARC WELDING

Module III. Fillet Weld Sets

Milestone H, Fillet Weld Test in 4 Positions

Project 16; Time: 80 minutes

INTRODUCTION

The student will make a fillet weld set to contain four, six pass welds. These will be made in the flat, horizontal, vertical-up, and overhead positions using 1/8 inch E6010 electrodes. The finished welds will be to specified size with flat face, equal leg lengths with a uniform appearance. Original plates issued will be returned to instructor in 80 minutes for grading.

EQUIPMENT REQUIRED

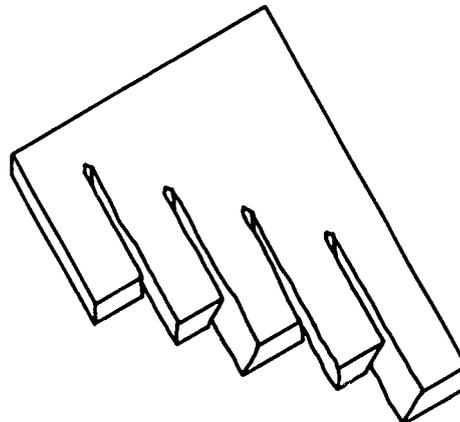
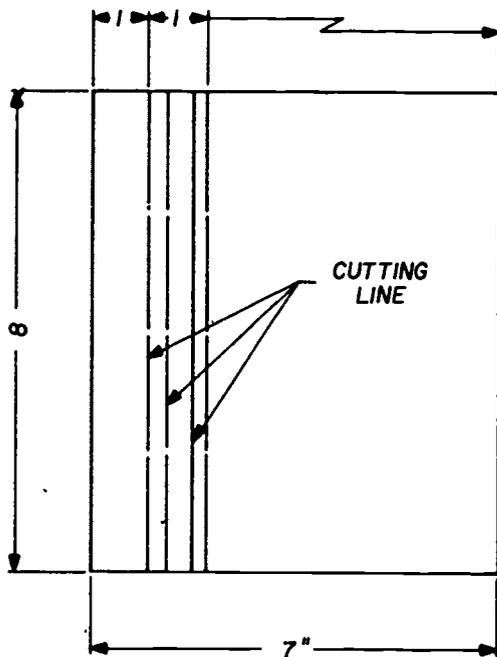
Direct current welding machine, slag hammer, wire brush, tongs, positioner, and safety equipment.

MATERIAL NEEDED

1 piece 3/16 x 2-1/4 x 6 inch, 2 pieces 3/16 x 1-1/2 x 6 inch steel plate, 1/8 inch E6010 electrodes.

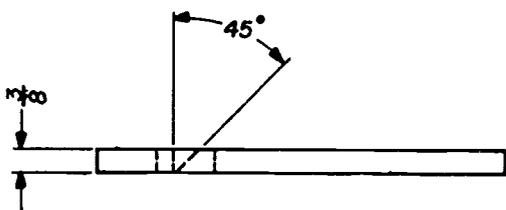
PROCEDURE

1. Clean plate with wire brush.
2. Set amperage and polarity as directed.
3. Start welding machine.
4. Put on face shield and gloves.
5. Put electrode in holder.
6. Tack weld plates at 90° to form a cross.
7. Place for welding in the flat position, deposit a 6 pass 1/2 inch fillet weld.
8. Place for welding in the horizontal position, deposit a 6 pass 1/2 inch fillet weld.
9. Place for welding in a vertical position, deposit a 6 pass 5/8 inch weld.
10. Place for welding in an overhead position, deposit a 6 pass 1/2 inch weld.
11. Cool and clean welds.
12. Present your work to the instructor for inspection and grading.



NOTE:

1. FLAME CUT INTO 1" STRIPS
2. ALTERNATE EDGE CUTS AT 90° & 45°



NAME OXYACETYLENE CUTTING		MILESTONE A USE OF THE OXYACETYLENE CUTTING TORCH		MODULE NO. <u>IV</u>
				FIGURE NO. 17
ELECTRODE SIZE		TYPE		
MATERIAL	STEEL	SPEC. MILD	AMT 1	SIZE $\frac{3}{8}$ X 8 X 7

BASIC SHIELDED METAL-ARC WELDING

Module IV. Oxyacetylene Cutting

Milestone A, Use of the Oxyacetylene Cutting Torch

Project 17; Time: 6 hours

INTRODUCTION

The student will demonstrate his ability to assemble the oxyacetylene cutting torch, select the proper tip size for the metal thickness being cut, and test for gas leaks in the system. He will use this equipment to cut one inch strips from used butt weld plates. A successful cut is made to dimension, with a clean kerf. Separation must be complete.

EQUIPMENT REQUIRED

Oxyacetylene pressure regulators, cutting torch, tips, wrench, hose, flint lighter, goggles, gloves, square, tongs.

MATERIAL NEEDED

Used butt weld plates.

PROCEDURE

1. See that the hose and fittings are in good servicable condition.
2. Hold torch with valve wheels upward, attach hose, use wrench on union nuts.
3. Select proper sized tip, attach to torch; use wrench on union nut.
4. Close torch valves.
5. Turn regulator adjusting screws counterclockwise until tension is released.
6. Open line or cylinder valves.
7. Turn regulator adjusting screws clockwise, adjust for the required pressures.
8. Close line or cylinder valves, watch for any pressure drop which indicates leakage. Correct for any leaks.
9. Reopen line or cylinder valves.
10. Put on cleaned goggles.
11. Open oxygen and acetylene torch valves about 1/4 turn, ignite with flint lighter.
12. Adjust to a neutral condition with the proper flame length.
13. Hold torch in left hand, guide and work oxygen valve with right hand.
14. Hold flame at edge of plate on guide line with the flame tips touching plate.
15. When plate becomes red, slowly depress oxygen cutting valve to full open; raise torch slightly.
16. Immediately move along guide line at a constant rate, maintain good clearance between flame and plate.
17. Rate of travel is governed by cutting effect. Too slow results in oxide buildup; too fast will stop burning action; proper rate makes a clean cut with parallel sides.
18. Repeat this procedure until good cuts are produced.
19. Secure equipment.

BASIC SHIELDED METAL-ARC WELDING

Module V. Arc-Air Gouging

Milestone A, Understanding and Using the Process

Project 18; Time: 3 hours

INTRODUCTION

The student will assemble the arc-air equipment, and use it for removing the weld deposit from fillet and butt weld sets. After gouging the weld from the joints, the pieces should separate and have edges that can be rewelded without further work.

EQUIPMENT REQUIRED

Direct current welding machine, compressed air outlet, arc-air equipment, slag hammer, wire brush, tongs, and safety equipment.

MATERIAL NEEDED

Fillet and butt weld sets from previous projects, carbon electrodes.

PROCEDURE

1. Clean welds with wire brush.
2. Adjust the amperage and polarity as directed.
3. Attach power cable and air hose to the arc-air fittings, open the air valve at source.
4. Start welding machine.
5. Put on face shield and gloves.
6. Put carbon electrode in holder so that about 3 inches extends from the grooved button to the pointed end. This will leave 9 inches above the button.
7. The air discharge holes must be below the carbon so that air passes to plate at point of arcing.
8. Open air valve on holder.
9. Drop face shield.
10. Make contact to establish the arc, move immediately along the weld at a rapid rate. Hold the electrode at an angle of 10 degrees from the plate.
11. Remove metal in small amounts of about 1/4 inch deep for each pass.
12. Repeat gouging until the desired depth is reached. Move the electrode down in the holder as it is burned away.
13. Chip away all slag from the edges of the gouge.
14. Secure equipment.

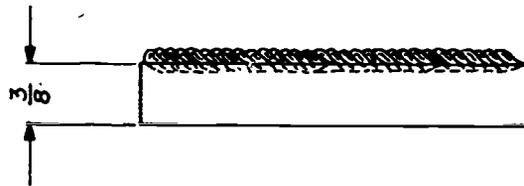
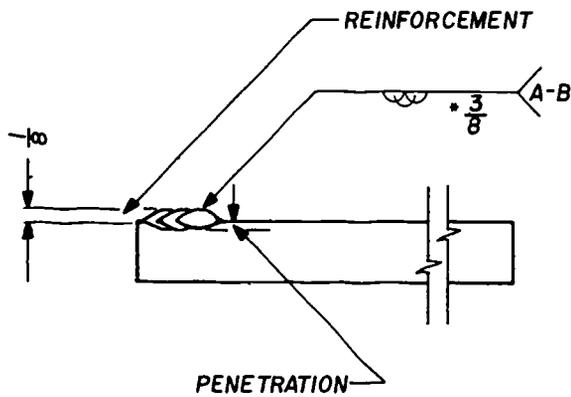
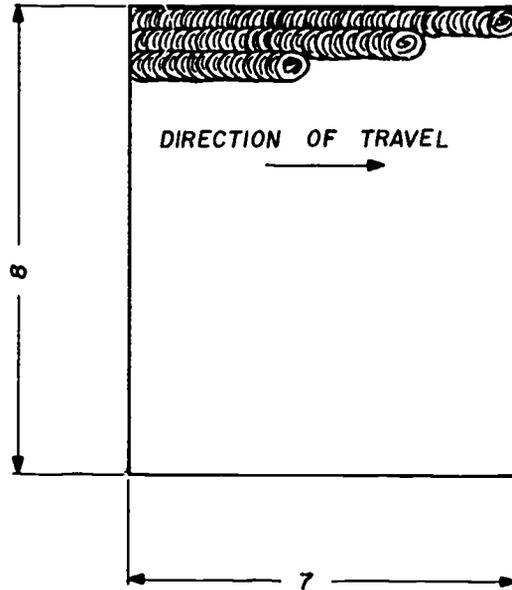
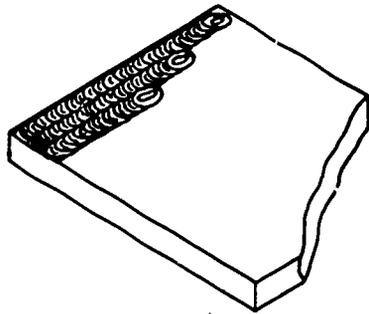
COURSE: VOCATIONAL TRADE WELDING
ADVANCED SHIELDED METAL-ARC WELDING

PHASE II OBJECTIVE

After the successful completion of the basic shielded metal-arc welding course the student has the option to continue to practice in the Advanced Course.

Of those electing to participate in Phase II of the program, 80% of the students will have taken and passed the fillet weld tests, and are familiar with the groove weld plate test similar to the A.W.S. D1-0-72, Welding in Building Construction or Section IX of the American Society of Mechanical Engineers Boiler & Pressure Vessel code test.

This standard is equal to, or surpasses, the requirements commonly used by industry for evaluating shielded metal-arc weldors. Eighty-percent of the students completing the course will possess a marketable skill.



A WELD BOTH SIDES.

B. FLAT POSITION.

NOTE: * REFERS TO BEAD WIDTH

NAME SURFACING WELD		MILESTONE A SURFACING WELDS WHIP BEAD		MODULE NO. I	
				FIGURE NO. 1	
ELECTRODE SIZE 5/32 DIA. DC/RP		TYPE AWS-E-6010			
MATERIAL		SPEC.	AMT	SIZE	
STEEL		MILD	1	3/8 X 8 X 7	

ADVANCED SHIELDED METAL-ARC WELDING

Module I. Surfacing Weld

Milestone A, Surfacing Welds in the Flat Position with Electrode Manipulation (Whip Beads)

Project 1; Time: 6 hours

INTRODUCTION

The student will deposit stringer beads with a 50% overlap. To cover the surface of a steel plate, use 5/32 inch E6010 electrodes with a forward and back motion. This manipulation is made in small increments while holding the arc to a constant length. The completed deposit should be uniform in thickness and appearance.

EQUIPMENT REQUIRED

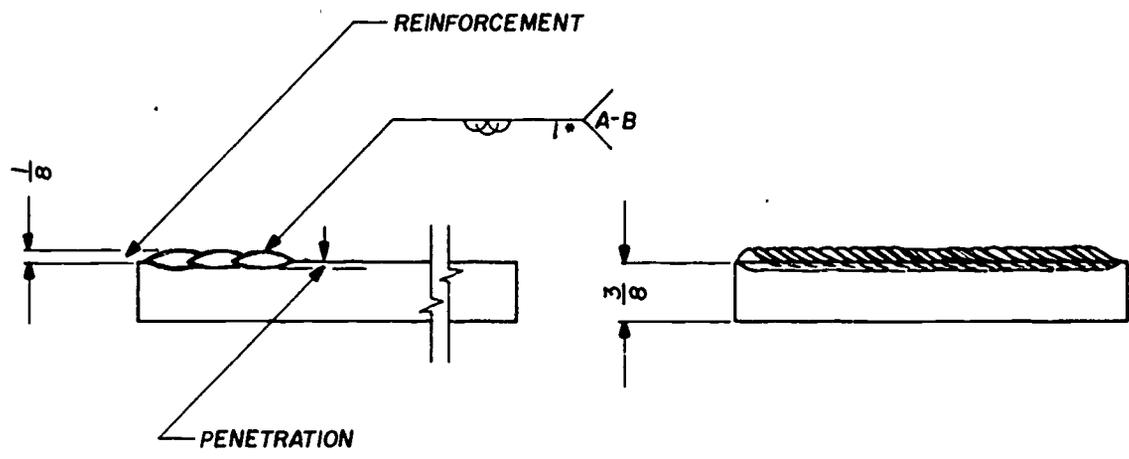
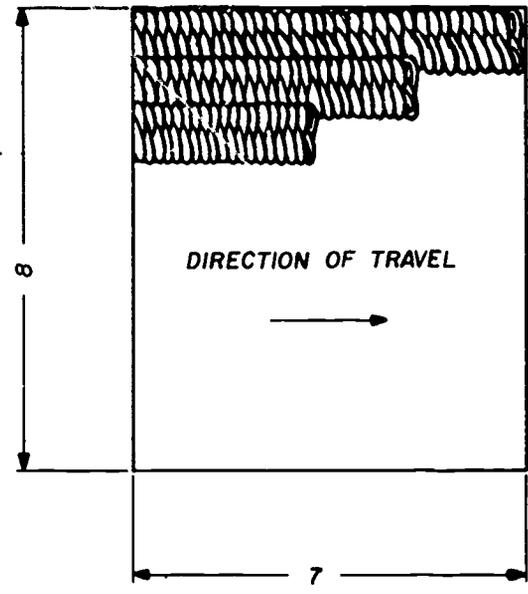
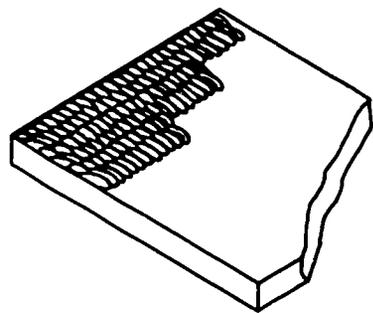
Direct current welding machine, slag hammer, wire brush, tongs, face shield, and gloves.

MATERIAL NEEDED

1 piece 3/8 x 7 x 8 inch steel plate.

PROCEDURE

1. Clean plate with wire brush, place for welding in the flat position.
2. Set amperage and polarity as directed.
3. Start welding machine.
4. Put on face shield and gloves.
5. Put electrode in holder.
6. Drop face shield.
7. Establish the arc, raise electrode slightly, move to the starting point.
8. Lower electrode to proper arc length.
9. Make beads with forward and back motion in the direction of travel while holding a constant arc length.
10. Use electrodes down to 1-1/2 inch stub.
11. Chip and wire brush the deposit until it is completely cleaned.
12. Arc should be directed at the edge of each previously deposited bead for the 50% overlap.
13. Save this specimen for the following project.



A. WELD BOTH SIDES

B. FLAT POSITION

NOTE: *REFERS TO BEAD WIDTH

NAME SURFACING WELD		MILESTONE B SURFACING WELDS WEAVE BEAD		MODULE NO. 1	
				FIGURE NO. 2	
ELECTRODE SIZE 5/32 DIA. DC/RP		TYPE AWS-E-6010			
MATERIAL		SPEC.	AMT	SIZE	
STEEL		MILD	1	3/8 X 8 X 7	

ADVANCED SHIELDED METAL-ARC WELDING

Module I. Surfacing Weld

Milestone B, Surfacing Welds with a Weaving Manipulation in the Flat Position

Project 2; Time: 3 hours

INTRODUCTION

Use the plate from Project 1 to make a second surfacing weld deposit. This will also be done in the flat position using 5/32 inch E6010 electrodes. Make a deposit of from 2 to 3 times the width of a stringer bead by weaving the electrode from side to side. A short dwell time at each side with rapid motion across the deposit will make a flat weld with even ripple. Advance each time by 50% of the width of the deposit.

EQUIPMENT REQUIRED

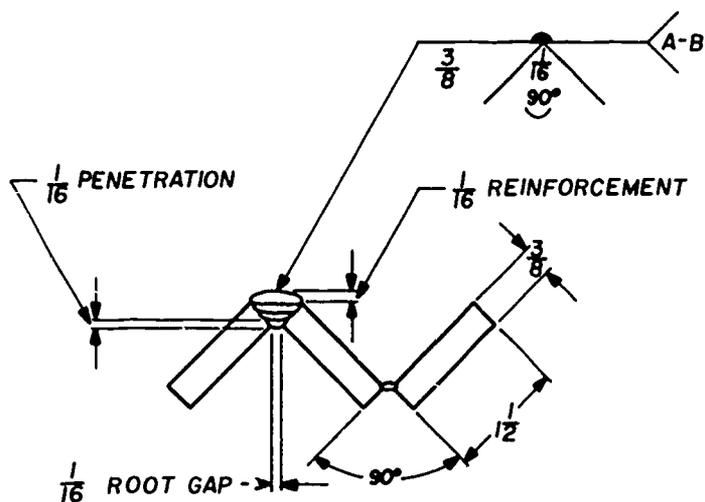
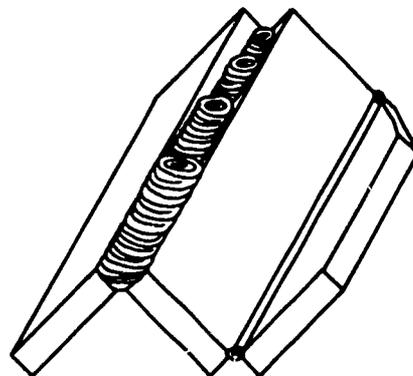
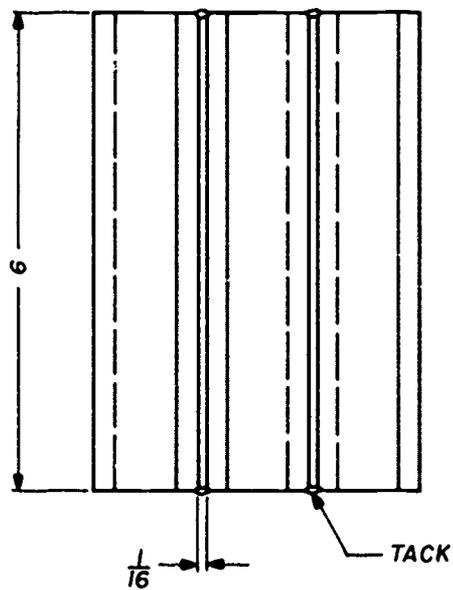
Direct current welding machine, slag hammer, wire brush, tongs, face shield, and gloves.

MATERIAL NEEDED

Use the plate from Project 1.

PROCEDURE

1. Clean plate with wire brush.
2. Position for welding in the flat position.
3. Set amperage and polarity as directed.
4. Start welding machine.
5. Put on face shield and gloves.
6. Put electrode in holder.
7. Drop face shield.
8. Establish the arc, raise electrode slightly, move to the starting point.
9. Lower electrode to the proper arc length.
10. Practice the use of a side-to-side motion in straight lines across the direction of travel. Keep the puddle narrow while it overlaps the preceding deposit.
11. This manipulation should make a weld about 3/4 to 1 inch wide.
12. Use electrodes down to a stub 1-1/2 inches long.
13. After completing each pass, open flip front of face shield and chip and wire brush the weld.
14. Repeat this procedure until the desired weld is obtained.
15. Save this plate for use in other surfacing weld practice.



A. WELD ON ONE SIDE ONLY.

B. FLAT POSITION.

NOTE: SAVE FOR NEXT PROJECT.

NAME GROOVE WELD		MILESTONE A. CORNER WELDS IN THE FLAT POSITION		MODULE NO. III	
				FIGURE NO. 3	
ELECTRODE SIZE $\frac{5}{32}$ DIA. DC/RP		TYPE AWS-E-6010			
MATERIAL		SPEC.	AMT	SIZE	
STEEL		MILD	3	$\frac{3}{8} \times \frac{1}{2} \times 6$	

ADVANCED SHIELDED METAL-ARC WELDING

Module III. Groove Weld

Milestone A, Corner Weld in the Flat Position

Project 3; Time: 3 hours

INTRODUCTION

The student will make a corner weld in the flat position. The deposit sequence will be: first, a single 100% penetration bead; second, two filler beads; third, a weave bead cover pass. The surface should be slightly convex with a uniform ripple with no excessive reinforcement on either side of joint.

EQUIPMENT REQUIRED

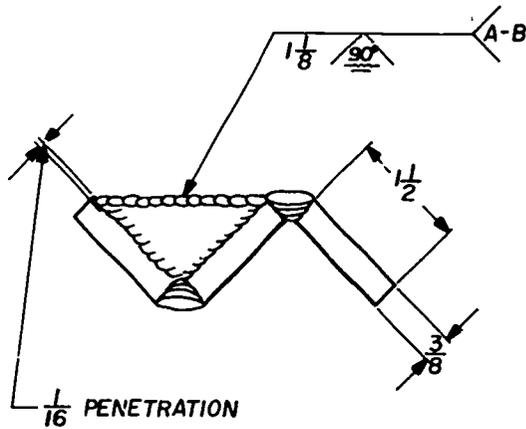
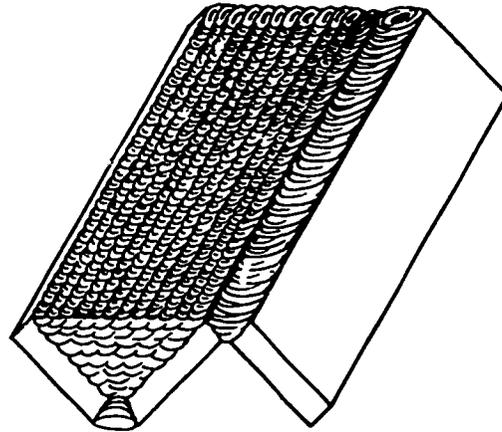
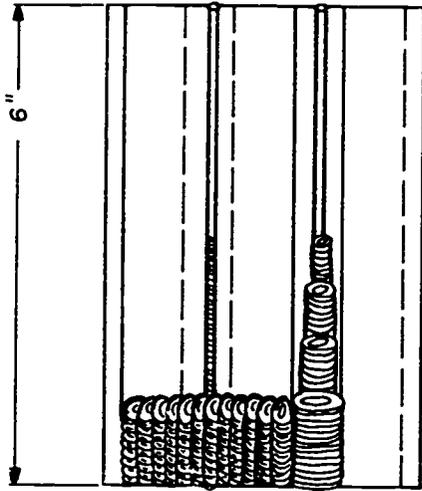
Direct current welding machine, slag hammer, wire brush, tongs, face shield, and gloves.

MATERIAL NEEDED

3 pieces $3/8 \times 1-1/2 \times 6$ inch steel plate, $5/32$ inch E6010 electrodes.

PROCEDURE

1. Clean the plate with the wire brush.
2. Set amperage and polarity as directed.
3. Start welding machine.
4. Put on face shield and gloves.
5. Put electrode in holder.
6. Stand the plates on end at 90°, making an outside corner. Drop face shield and tack weld.
7. Place this assembly for welding in the flat position.
8. Establish the arc, raise electrode slightly, move to the starting point.
9. Lower electrode to the proper arc length.
10. Deposit penetration bead with forward and back motion; hold constant arc length.
11. Chip and wire brush after each pass.
12. Make the succeeding passes with two filler beads and the weave bead cover.
13. Repeat this procedure until a satisfactory weld is produced.
14. Save this weldment for use in the next project.



A. WELD ON ONE SIDE ONLY

B. FLAT POSITION

NAME GROOVE WELD		MILESTONE B "V" GROOVE WELD IN THE FLAT POSITION		MODULE NO. III	
				FIGURE NO. 4	
ELECTRODE SIZE	$\frac{1}{8}$ DIA. DC/RP	TYPE	AWS - E - 7024		
MATERIAL	STEEL	SPEC.	AMT.	SIZE	
		MILD	3	$\frac{3}{8} \times \frac{1}{2} \times 6$	

ADVANCED SHIELDED METAL-ARC WELDING

Module III. Groove Weld

Milestone B, 'V' Groove Weld in the Flat Position

Project 4; Time: 3 hours

INTRODUCTION

The student will make a flat groove weld by using a corner weldment salvaged from Project 3. He will invert this assembly to weld on the root side. Use 1/8 inch E7024 electrodes for multiple passes until this back side is filled. The deposit must be free from slag inclusions, undercut, and pinholes. The deposit should fill out to plate ends.

EQUIPMENT REQUIRED

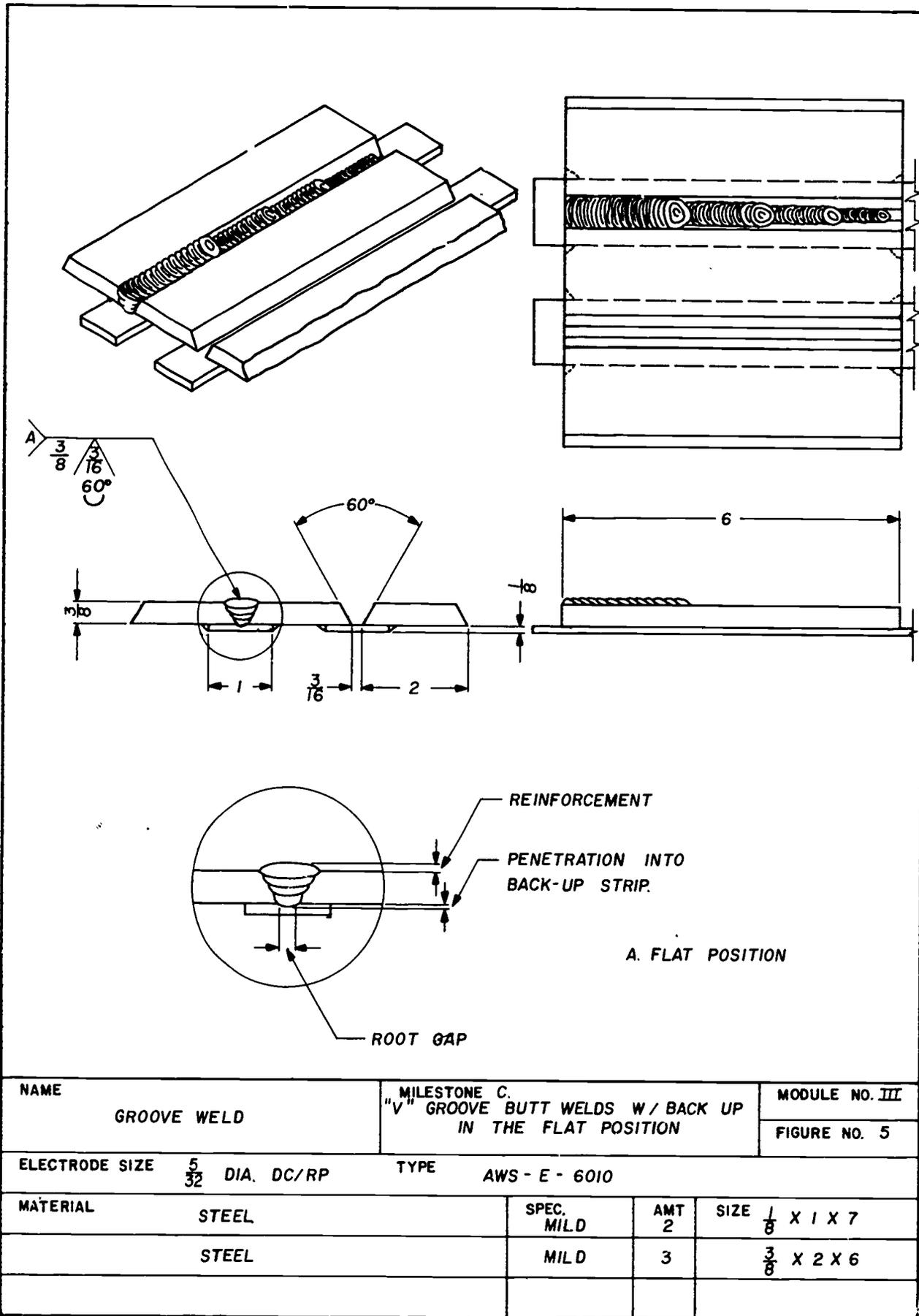
Direct current welding machine, slag hammer, wire brush, tongs, face shield, and gloves.

MATERIAL NEEDED

Salvaged weldment from Project number 3, 1/8 inch E7024 electrodes.

PROCEDURE

1. Clean the plate with the wire brush.
2. Support the weldment for welding in the flat position.
3. Set amperage and polarity as directed.
4. Start welding machine.
5. Put on face shield and gloves.
6. Put electrode in holder.
7. Drop face shield.
8. Establish the arc, raise electrode slightly, move to starting point.
9. Lower electrode to the proper arc length.
10. Make all the beads in a straight forward motion; hold a leading angle on the electrode of about 20°.
11. Clean off the slag after each pass; continue depositing beads until groove is filled.
12. Repeat this procedure until the desired weld is produced.
13. Secure the equipment.



NAME GROOVE WELD		MILESTONE C. "V" GROOVE BUTT WELDS W/ BACK UP IN THE FLAT POSITION		MODULE NO. III	
				FIGURE NO. 5	
ELECTRODE SIZE	$\frac{5}{32}$ DIA. DC/RP	TYPE	AWS - E - 6010		
MATERIAL	STEEL	SPEC. MILD	AMT 2	SIZE $\frac{1}{8}$ X 1 X 7	
	STEEL	MILD	3	$\frac{3}{8}$ X 2 X 6	

ADVANCED SHIELDED METAL-ARC WELDING

Module III. Groove Weld

Milestone C, 'V' Groove Butt Welds with Backing Strip in the Flat Position

Project 5; Time: 3 hours

INTRODUCTION

The student will make a groove weld with backing strip in the flat position. The beads will be placed as follows: Root bead fuses the three pieces together, the beveled edges to the backing strip; second, a weave bead; third, a weave bead; fourth, a weave bead cover pass that is slightly convex with a uniform pattern and tight ripple.

EQUIPMENT REQUIRED

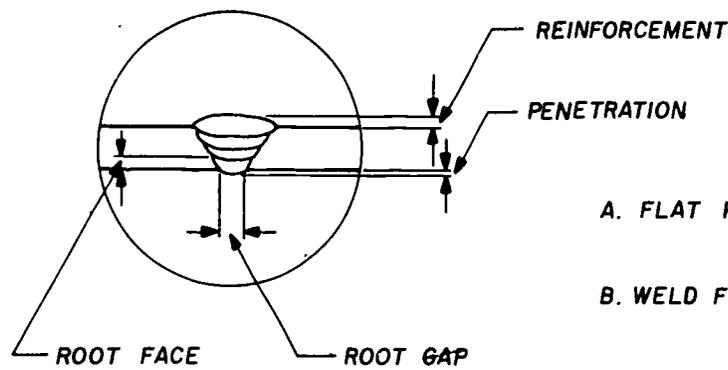
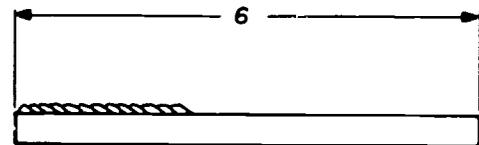
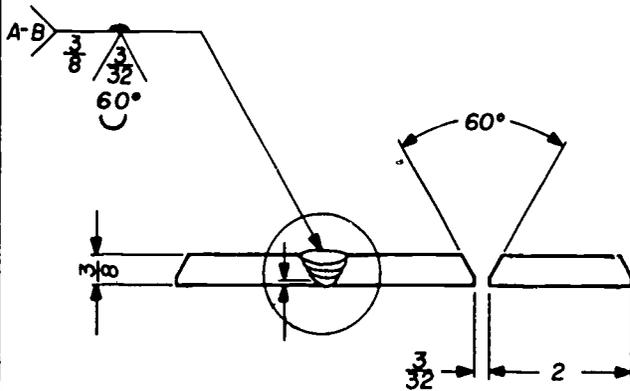
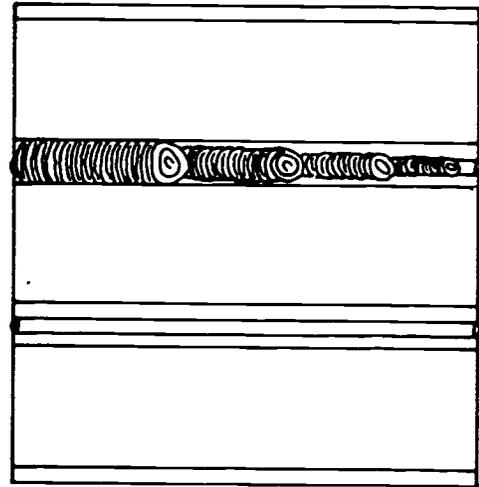
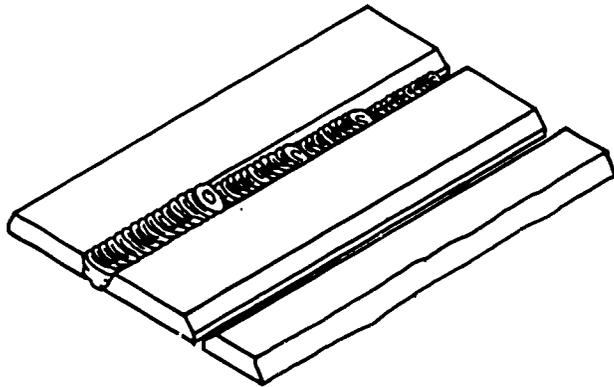
DC welding machine, slag hammer, wire brush, tongs, and safety equipment.

MATERIAL NEEDED

3 pieces $3/8$ x 2 x 6 inch, and 2 pieces $1/8$ x 1 x 7 inch steel plate, $5/32$ inch E6010 electrodes.

PROCEDURE

1. Clean the plate with the wire brush.
2. Set amperage and polarity as directed.
3. Start welding machine.
4. Put on face shield and gloves.
5. Put electrode in holder.
6. Assemble plates face down, the beveled edges gapped $3/16$ inch, cover with the backing strip and tack weld at each side.
7. Turn this assembly face up for welding in the flat position.
8. Make the first bead fusing both beveled edges and the backing strip.
9. Clean away slag completely after each pass.
10. Weave additional beads, pass across quickly and dwell at each side for good fusion.
11. The completed reinforcement should not be higher than $1/8$ inch above plate thickness or wider than $1/16$ inch at each side of the groove.
12. Repeat the procedure until a satisfactory weld is produced.
13. Show work to your instructor; discuss the results.
14. Save this material for practice beads.



A. FLAT POSITION.

B. WELD FROM ONE SIDE ONLY.

NAME GROOVE WELD		MILESTONE D "V" GROOVE BUTT WELDS IN THE FLAT POSITION		MODULE NO. III FIGURE NO. 6	
ELECTRODE SIZE 5/32 DIA. DC/RP		TYPE AWS - E - 6010			
MATERIAL STEEL		SPEC. MILD	AMT 3	SIZE 3/8 X 1/2 X 6	

ADVANCED SHIELDED METAL-ARC WELDING

Module III. Groove Weld

Milestone D, 'V' Groove Butt Welds in the Flat Position
(When available, substitute pipe for plate)

Project 6; Time: 6 hours

INTRODUCTION

The student will make a groove weld without a backing strip. This is done in the flat position. The first stringer bead must penetrate the root completely. Two filler beads are deposited over this root pass. The cover is a weave bead, slightly convex, without undercut.

EQUIPMENT REQUIRED

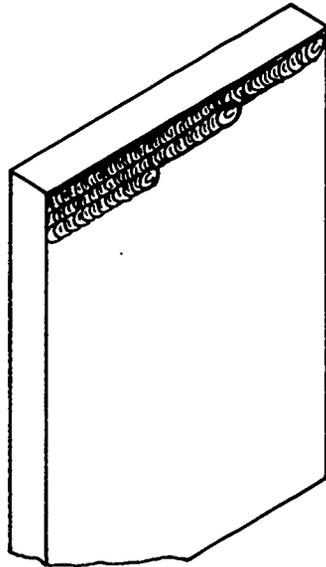
DC welding machine; slag hammer, wire brush, tongs and safety equipment.

MATERIAL NEEDED

3 pieces 3/8 x 1-1/2 x 6 inch steel plate beveled on one side to 30°, 5/32 inch E6010 electrodes.

PROCEDURE

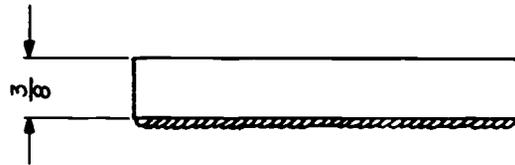
1. Clean plates with wire brush.
2. Set amperage and polarity as directed.
3. Start welding machine.
4. Put on face shield and gloves.
5. Put electrode in holder.
6. Put the plate face down with the beveled edges aligned and gapped to 3/16 inch. Tack weld.
7. Turn this assembly face up for welding in the flat position.
8. Establish an arc, raise electrode slightly, move to the starting point.
9. Lower electrode to the proper arc length.
10. Deposit the first bead with full penetration. Use a forward and back motion; concentrate arc at the root gap.
11. Clean each pass completely with chipping hammer and wire brush.
12. Place the two filler beads, then the weave bead cover.
13. The reinforcement must not be more than 1/8 inch above plate thickness, or wider than 1/16 inch at each side of the groove.
14. Repeat this procedure until the desired weld is produced.
15. Show work to your instructor; discuss the results.
16. Save the material for practice welding.



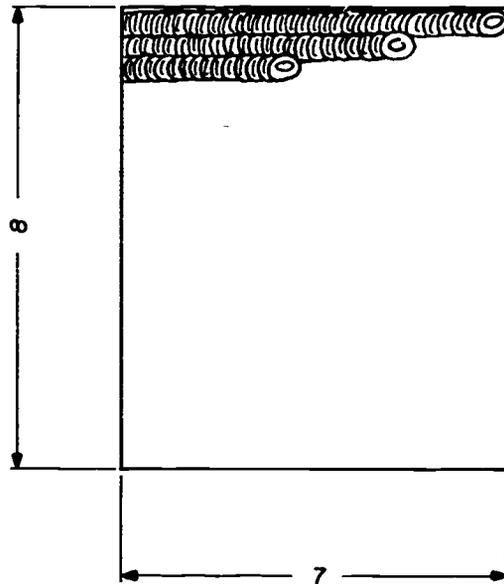
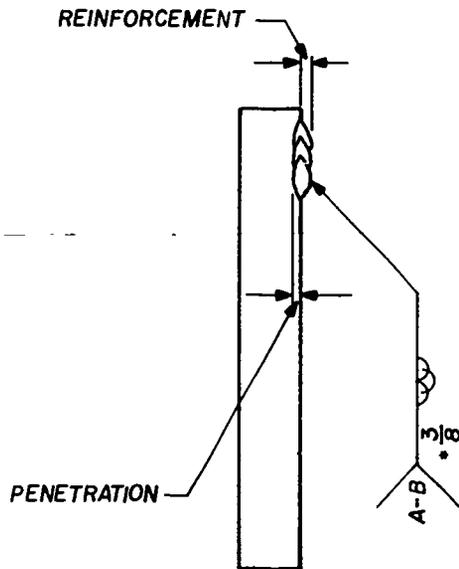
A. WELD BOTH SIDES

B. HORIZONTAL POSITION

NOTE: *REFERS TO BEAD WIDTH



REINFORCEMENT



NAME		MILESTONE C		MODULE NO. I
SURFACING WELD		SURFACING WELDS IN THE HORIZONTAL POSITION		FIGURE NO. 7
ELECTRODE SIZE $5/32$ DIA. DC/RP		TYPE AWS-E-6010		
MATERIAL	SPEC.	AMT.	SIZE	
STEEL	MILD	1	$3/8$ X 8 X 7	

ADVANCED SHIELDED METAL-ARC WELDING

Module I. Surfacing Weld

Milestone C, Surfacing Welds in the Horizontal Position

Project 7; Time: 6 hours

INTRODUCTION

The student will make surface weld beading on steel plate in the horizontal position using 5/32 inch E6010 electrodes. A forward and back (whip) motion will be used to deposit these beads. Make a 50% overlap. Cover both sides of the plate to a uniform depth.

EQUIPMENT REQUIRED

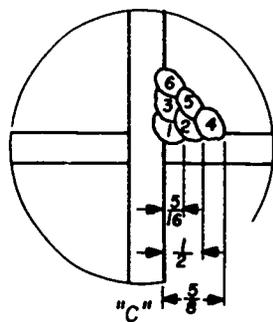
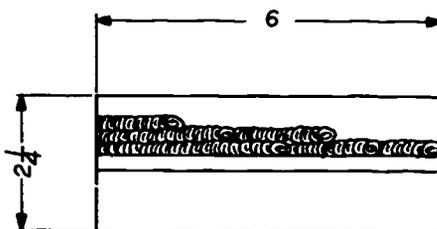
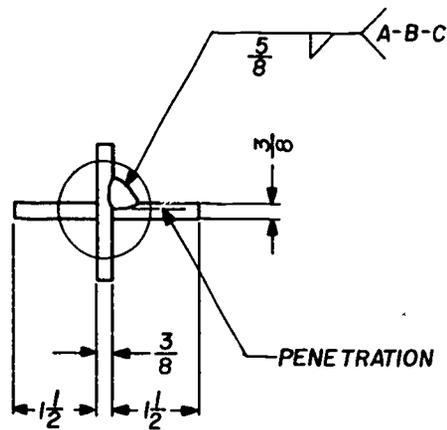
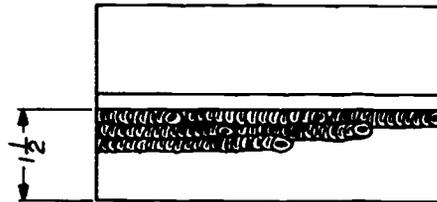
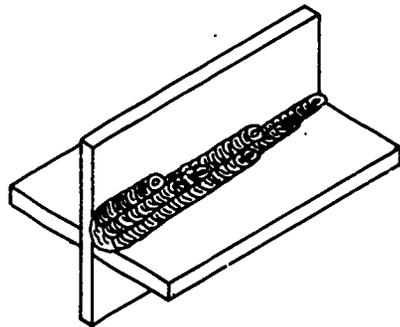
DC welding machine, slag hammer, wire brush, tongs, positioner and safety equipment.

MATERIAL NEEDED

1 piece 3/8 x 7 x 8 inch steel plate, 5/32 inch E6010 electrodes.

PROCEDURE

1. Clean the plate with wire brush, place in position for horizontal welding.
2. Set amperage and polarity as directed.
3. Start welding machine.
4. Put on face shield and gloves.
5. Put electrode in holder.
6. Establish an arc, raise electrode slightly, move to the starting point.
7. Lower the electrode to the proper arc length.
8. Hold electrode at about 5° slope upward while welding.
9. Make a small forward and back motion, move along the length of the bead with a constant arc length.
10. Use all electrodes down to a stub end 1-1/2 inches long.
11. Clean slag away completely after each pass.
12. Continue this procedure until the entire plate has been covered with weld metal.
13. Save material for surface weld in the vertical position.



A. WELD ALL FOUR CORNERS

B. HORIZONTAL POSITION

C. WELD SEQUENCE

NAME FILLET WELD		MILESTONE A FILLET WELDS IN THE HORIZONTAL POSITION		MODULE NO. II
				FIGURE NO. 8
ELECTRODE SIZE	$\frac{5}{32}$ DIA. DC/RP	TYPE	AWS-E-6010	
MATERIAL	STEEL	SPEC. MILD	AMT. 1	SIZE $\frac{3}{8} \times 2\frac{1}{4} \times 6$
	STEEL	MILD	2	$\frac{3}{16} \times 1\frac{1}{2} \times 6$

ADVANCED SHIELDED METAL-ARC WELDING

Module II. Fillet Weld

Milestone A, Fillet Welds in the Horizontal Position

Project 8; Time: 6 hours

INTRODUCTION

The student will make a fillet weld set for welding in the horizontal position. This set will contain four welds with six beads in each. The first bead will make a $5/16$ inch, the second and third beads will make a $1/2$ inch and beads fourth, fifth and sixth will complete the fillets to $5/8$ inch. These should have a flat face, equal leg length and uniform ripple.

EQUIPMENT REQUIRED

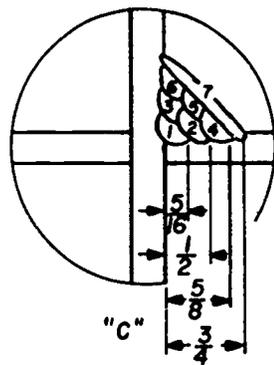
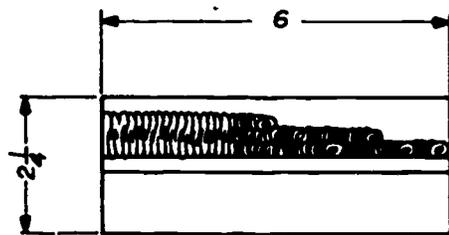
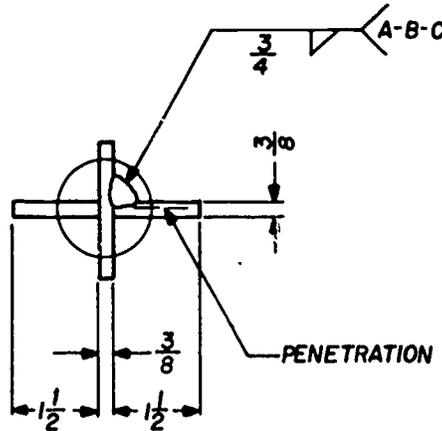
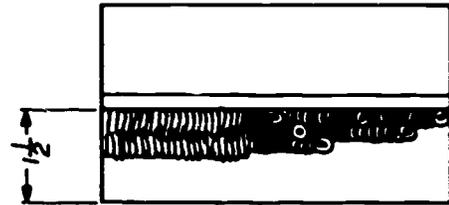
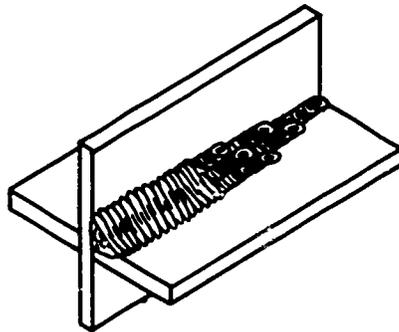
DC welding machine, slag hammer, wire brush, tongs, positioner and safety equipment.

MATERIAL NEEDED

1 piece $3/8$ x $2-1/4$ x 6 inch, 2 pieces $3/16$ x $1-1/2$ x 6 inch steel plate, $5/32$ inch E6010 electrodes.

PROCEDURE

1. Clean the plate with the wire brush.
2. Set amperage and polarity as directed.
3. Start welding machine.
4. Put on face shield and gloves
5. Assemble and tack weld pieces to form a cross; place in the positioner for horizontal welding.
6. Drop face shield.
7. Establish an arc, raise electrode slightly, move to the starting point.
8. Lower electrode to the proper arc length.
9. Make the weld as demonstrated, use a small forward and back motion, holding a constant arc length.
10. Clean away slag completely after each pass.
11. Continue depositing and overlapping beads until the fillets are of the proper size.
12. Repeat this procedure until the desired weld is produced.
13. Check dimension of the fillet with gage.
14. Save this material for the next project.



- A. WELD ALL FOUR CORNERS
- B. HORIZONTAL POSITION
- C. WELD SEQUENCE

NAME FILLET WELD	MILESTONE B FILLET WELDS IN THE HORIZONTAL POSITION WITH LACING BEADS			MODULE NO. II
				FIGURE NO. 9
ELECTRODE SIZE 5/32 DIA. DC/RP	TYPE AWS-E-6010			
MATERIAL STEEL	SPEC MILD	AMT. 1	SIZE 3/8 X 2 1/4 X 6	
STEEL	MILD	2	3/16 X 1 1/2 X 6	

ADVANCED SHIELDED METAL-ARC WELDING

Module II. Fillet Weld

Milestone B, Fillet Welds in the Horizontal Position with Lacing Bead

Project 9; Time: 9 hours

INTRODUCTION

The student will use the stringer bead fillet welds of Project 8 to practice this lacing bead in the horizontal position. This cover pass is deposited on the down stroke, only. The upstroke is made quickly, no metal is deposited, and the electrode is advanced to the position for the next down stroke. Overlap about 50% each time down. The completed weld will have a 3/4 inch leg dimension with a flat face, and a smooth surface.

EQUIPMENT REQUIRED

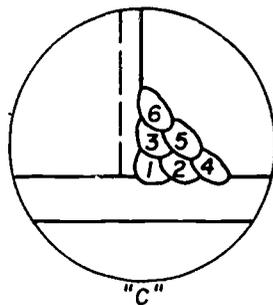
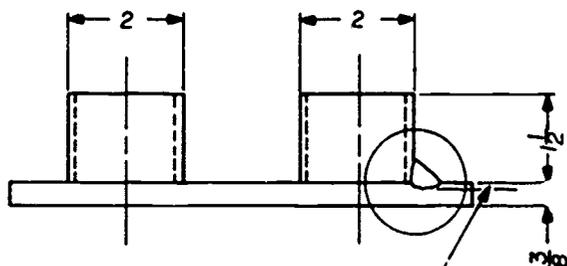
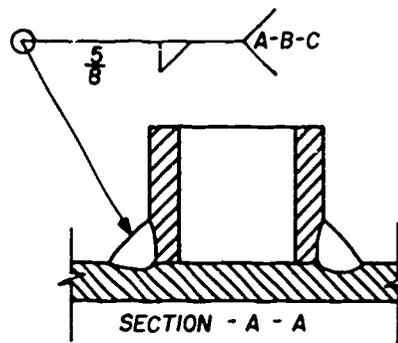
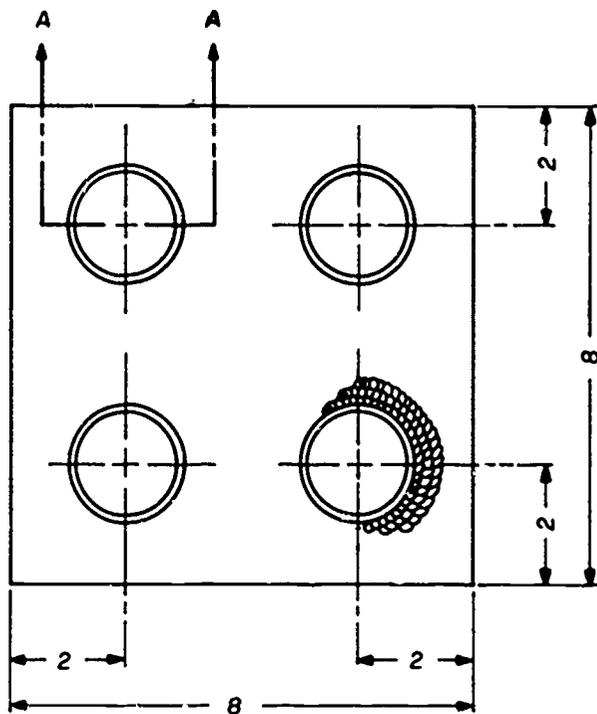
DC welding machine, slag hammer, wire brush, tongs, and safety equipment.

MATERIAL NEEDED

Cruciform from Project 8, 5/32 inch E6010 electrodes.

PROCEDURE

1. Clean the Project 8 welds with hammer and wire brush, completely.
2. Set amperage and polarity as directed.
3. Start welding machine.
4. Put on face shield and gloves.
5. Put electrode in holder.
6. Establish an arc, raise electrode slightly, move to the starting point.
7. Lower electrode to the proper arc length.
8. Make welds as demonstrated by your instructor. Keep the ripples close together.
9. Repeat this procedure until the desired weld is produced.
10. Use gage to measure depth of deposit.
11. Save material for square groove butt joint.



A. HORIZONTAL POSITION

B. WELD ALL FOUR PIPES

C. WELD SEQUENCE

NAME FILLET WELD	MILESTONE C PIPE TO PLATE FILLET WELDS IN THE HORIZONTAL POSITION		MODULE NO. II
			FIGURE NO. 10
ELECTRODE SIZE $\frac{5}{32}$ DIA. DC/RP	TYPE	AWS - E - 6010	
MATERIAL	STEEL	SPEC. MILD	AMT 1
			SIZE $\frac{3}{8} \times 8 \times 8$
	STEEL PIPE	MILD	4
			SIZE $20 \times 1\frac{1}{2}$

ADVANCED SHIELDED METAL-ARC WELDING

Module II. Fillet Weld

Milestone C, Pipe to Plate Fillet Welds in the Horizontal Position

Project 10; Time: 6 hours

INTRODUCTION

The student will make a pipe to plate fillet weld set by joining four pipe nipples to each side of a steel plate. Welding will be done with the pipe nipples in the vertical position. Six beads will be required to make a fillet with a 5/8 inch leg. The fillets should have a flat face, equal leg length and no undercut.

EQUIPMENT REQUIRED

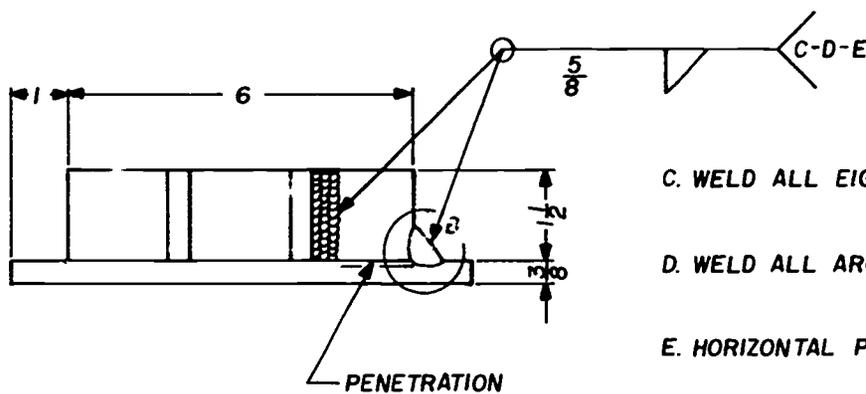
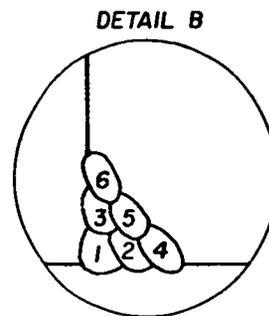
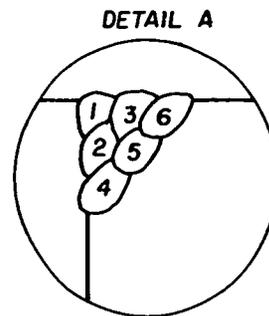
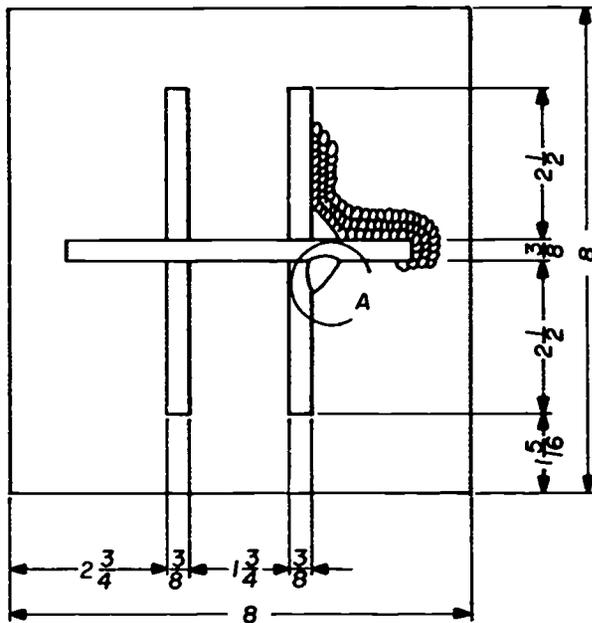
DC welding machine, slag hammer, wire brush, tongs, and safety equipment.

MATERIAL NEEDED

1 piece 3/8 x 8 x 8 inch steel plate, 4 pipe nipples 2 x 1-1/2 inches long, 5/32 inch E6010 electrodes.

PROCEDURE

1. Clean material with wire brush.
2. Set amperage and polarity as directed.
3. Start welding machine.
4. Put on face shield and gloves.
5. Put electrode in holder.
6. Tack weld four pieces of 2 inch pipe to the plate 2 inches in from the plate edges. See drawing No. 10.
7. Place assembly for welding in the horizontal position.
8. Establish an arc, raise the electrode slightly, move to the starting point.
9. Lower the electrode to the proper arc length.
10. Weld half way around pipe in one pass, clean off slag, weld second half to complete root bead.
11. Complete these root beads on each nipple before completing any single fillet.
12. Clean off slag, continue welds until six beads have been deposited on each weld.
13. Practice as demonstrated; use a small forward and back motion.
14. Repeat this procedure until the desired weld is produced.
15. Use gage to check weld size.
16. Show work to your instructor, discuss the results.



- C. WELD ALL EIGHT CORNERS
- D. WELD ALL AROUND
- E. HORIZONTAL POSITION

NAME FILLET WELD		MILESTONE D MULTIPLE CORNER FILLET WELDS IN THE HORIZONTAL POSITION			MODULE NO. II
					FIGURE NO. 11
ELECTRODE SIZE $\frac{5}{32}$ DC/RP		TYPE AWS-E-6010			
MATERIAL	STEEL	SPEC. MILD	AMT. 1	SIZE $\frac{3}{8} \times 8 \times 8$	
	STEEL	MILD	1	$\frac{3}{8} \times 1\frac{1}{2} \times 6$	
	STEEL	MILD	4	$\frac{3}{8} \times 1\frac{1}{2} \times 2\frac{1}{2}$	

ADVANCED SHIELDED METAL-ARC WELDING

Module II. Fillet Weld

Milestone D, Multiple Corner Fillet Welds in the Horizontal Position

Project 11; Time: 6 hours

INTRODUCTION

The student will make a multiple corner set to contain six outside corner welds, four unobstructed corner, and four obstructed corner welds. Each will require six passes to make fillets with 5/8 inch legs, a flat face, uniform ripples, and no undercut.

EQUIPMENT REQUIRED

DC welding machine, slag hammer, wire brush, tongs, fillet weld gage, positioner and safety equipment.

MATERIAL NEEDED

1 piece 3/8 x 8 x 8 inch, 1 piece 3/8 x 1-1/2 x 6 inch, 4 pieces 3/8 x 1-1/2 x 2-1/2 inch steel plate, 5/32 inch E6010 electrodes.

PROCEDURE

1. Clean plate with wire brush.
2. Set amperage and polarity as directed.
3. Start welding machine.
4. Put on face shield and gloves.
5. Put electrode in holder.
6. Tack weld 3/8 x 1-1/2 inch bars to the 3/8 x 8 x 8 inch plate as shown in the drawing. A model is kept on display board.
7. Position this assembly for horizontal welding.
8. Establish an arc, raise electrode slightly, move to the starting point.
9. Lower electrode to the proper arc length.
10. Deposit root bead in all corners on both sides of the plate before completing any single weld.
11. After completing each fillet, clean off all slag.
12. Weld as demonstrated, use a forward and back motion with a constant arc length.
13. Repeat this procedure until the desired weld is produced.
14. Show the work to your instructor; discuss the results.

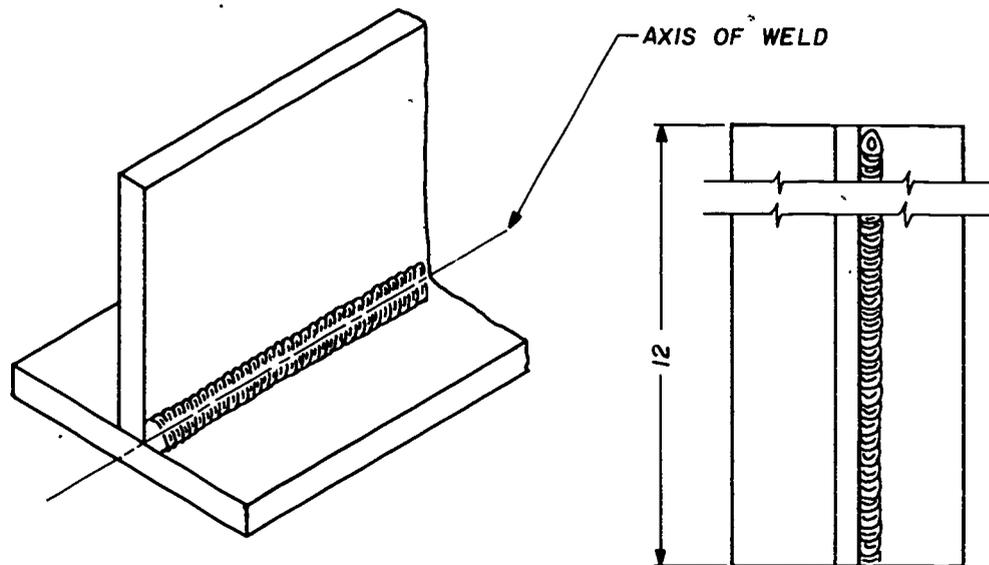
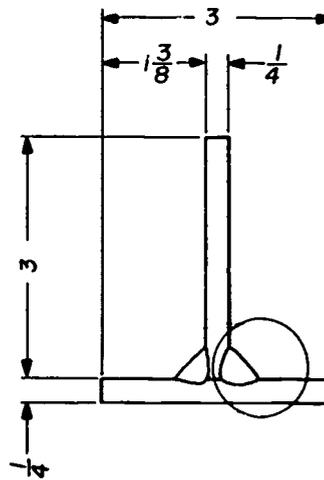
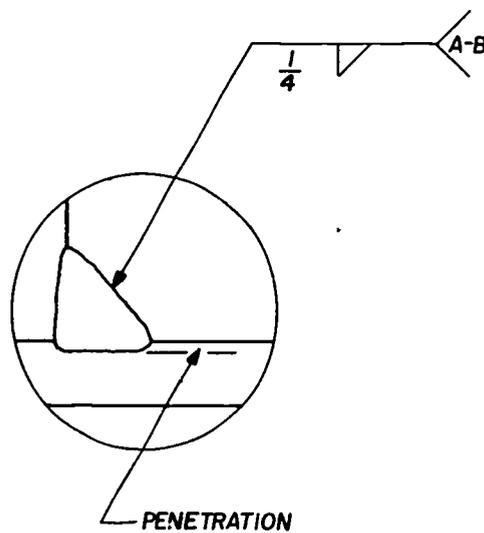


PLATE IS IN HORIZONTAL POSITION FOR TEST.



A. TEST, FILLET WELD

B. HORIZONTAL POSITION

NAME FILLET WELD	MILESTONE E FILLET WELD TEST AWS - ASME		MODULE NO. II	
			FIGURE NO. II-A	
ELECTRODE SIZE $\frac{5}{32}$ DIA. DC/RP	TYPE AWS - E - 6010			
MATERIAL	SPEC.	AMT	SIZE	
STEEL	MILD	2	$\frac{1}{4}$ X 12 X 3	

ADVANCED SHIELDED METAL-ARC WELDING

Module II. Fillet Weld

Milestone E, Fillet Welds Performed According to ASME-AWS Specification.

Project 11-A

INTRODUCTION

The student will demonstrate his ability to pass the fillet weld test as described in the ASME Fired and Unfired Pressure Vessel Code, Section IX. The test illustrated in Figures Q-4 (6). The AWS also illustrates this test in D1.0-72, Figure A-3, 2F (b).

EQUIPMENT REQUIRED

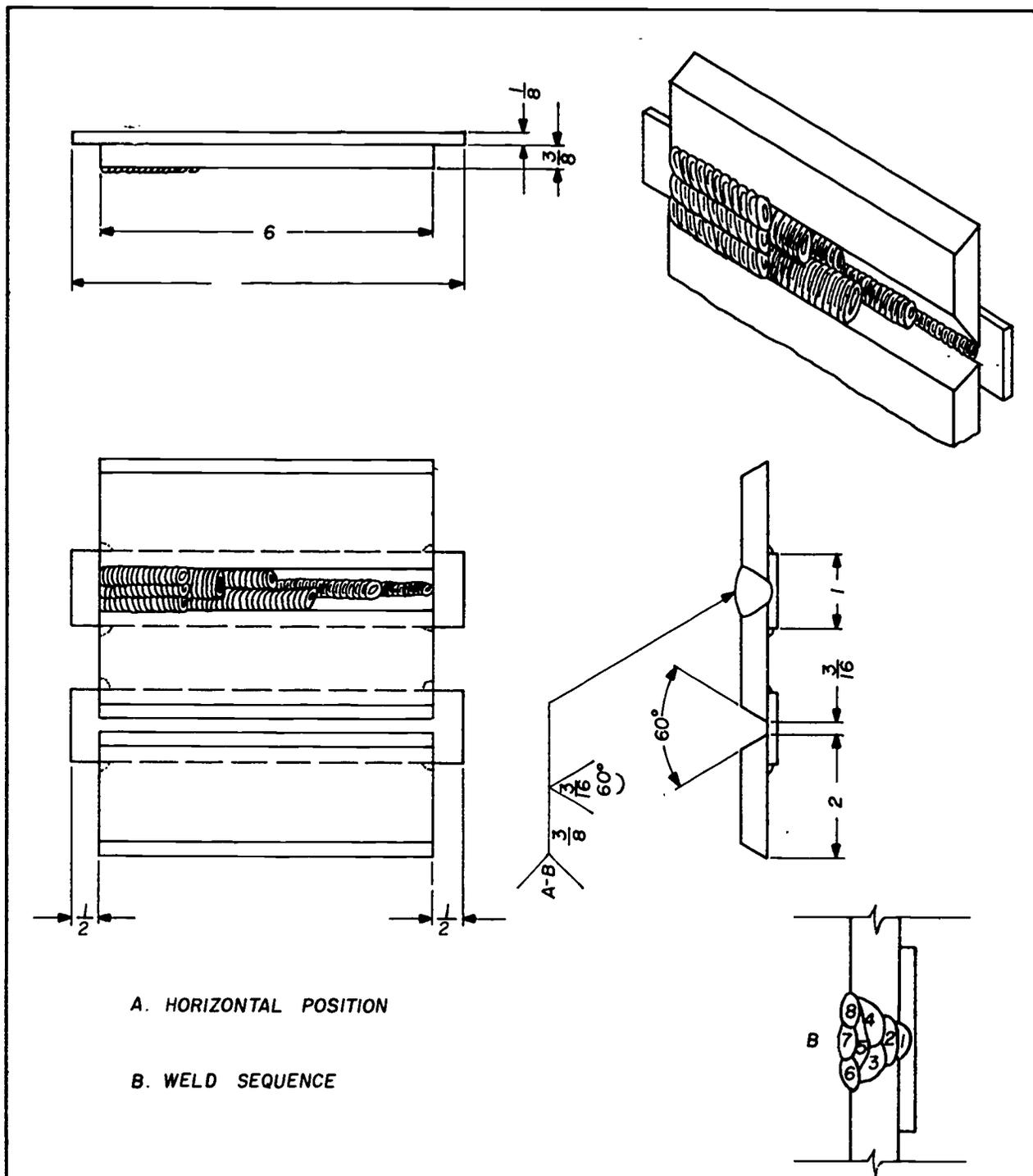
DC welding machine, slag hammer, wire brush, tongs, fillet weld gage, and safety equipment.

MATERIAL NEEDED

2 pieces 1/4 x 3 x 12 inch ASTM A-36 steel plate, 5/32 inch electrodes.

PROCEDURE

1. Clean plate with wire brush.
2. Set amperage and polarity as directed.
3. Start welding machine.
4. Put on face shield and gloves.
5. Put electrode in holder.
6. Tack weld plates to form a 'T' joint, position for horizontal welding.
7. Establish an arc, raise electrode slightly, move to the starting point.
8. Lower electrode to the proper arc length.
9. Deposit a 1/4 inch fillet weld. Each weld must be stopped and restarted at the midpoint of the bead.
10. There is no wrap around or return around corner deposit.
11. Test weld according to the ASME procedure.



A. HORIZONTAL POSITION
 B. WELD SEQUENCE

NAME GROOVE WELD		MILESTONE E "V" GROOVE BUTT WELDS W/ BACK UP IN THE HORIZONTAL POSITION		MODULE NO. III	
				FIGURE NO. 12	
ELECTRODE SIZE $\frac{5}{32}$ DIA. DC/RP		TYPE AWS-E-6010			
MATERIAL STEEL		SPEC. MILD	AMT. 2	SIZE $\frac{1}{8}$ X 7 X 1	
STEEL		MILD	3	$\frac{3}{8}$ X 6 X 2	

ADVANCED SHIELDED METAL-ARC WELDING

Module III. Groove Weld

Milestone E, 'V' Groove Butt Welds with Backing Strip in the Horizontal Position

Project 12; Time: 12 hours

INTRODUCTION

The student will make a groove weld with backing strip. Use 5/32 inch E6010 electrodes and stringer beads. These will be deposited in this order; first, root bead fusing the three pieces; second, pass a single filler bead; third, pass three overlapping beads; fourth, a three bead cover. The cover pass will be free of undercut, and have a flat or slightly convex face.

EQUIPMENT REQUIRED

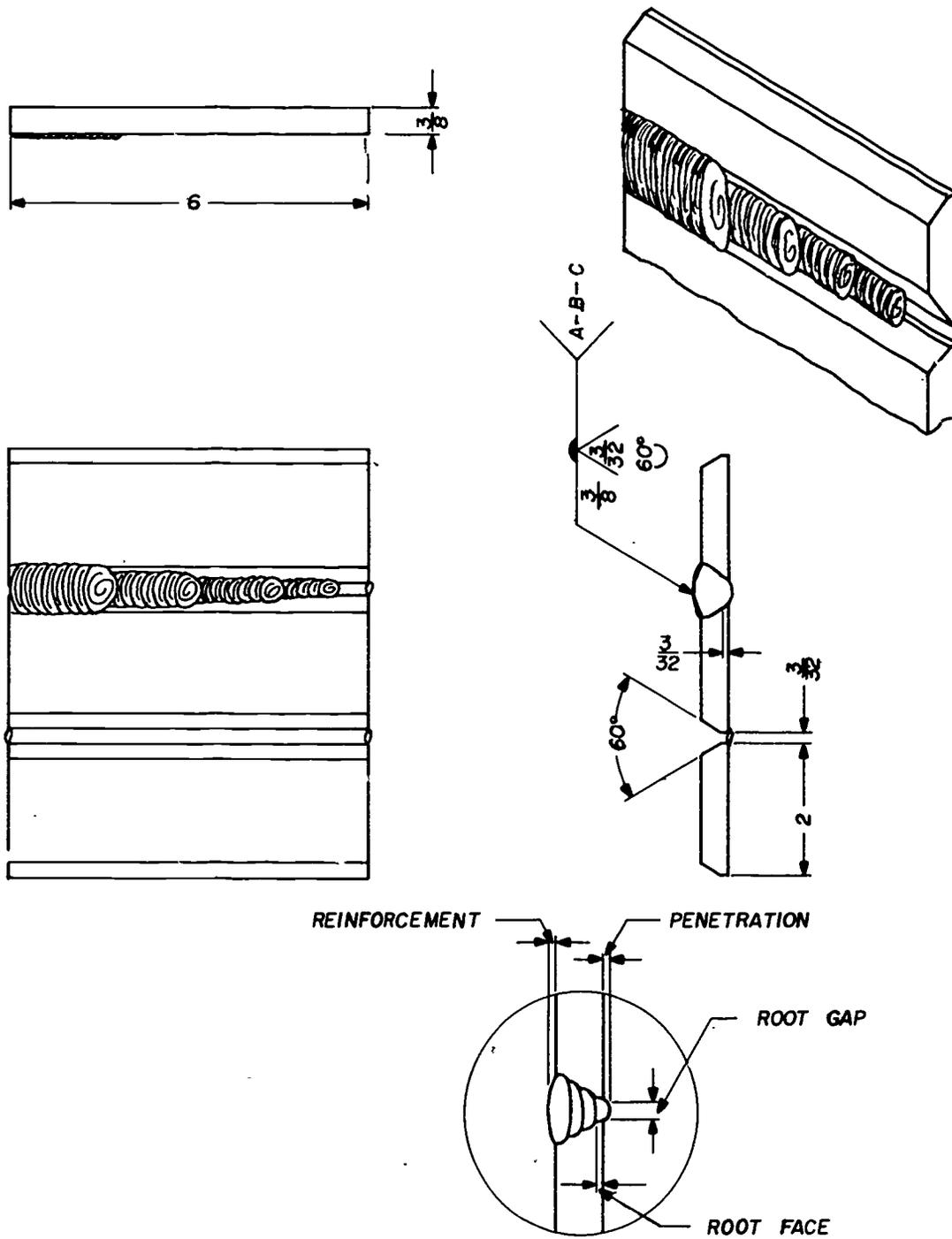
Direct current welding machine, slag hammer, wire brush, tongs, positioner, and safety equipment.

MATERIAL NEEDED

3 pieces 3/8 x 2 x 6 inch steel plate beveled to 30° on one side, 2 pieces 1/8 x 1 x 7 inch steel for backing, 5/32 inch E6010 electrodes.

PROCEDURE

1. Clean plate with wire brush.
2. Set amperage and polarity as directed.
3. Start welding machine.
4. Put on face shield and gloves.
5. Assemble plate for a groove butt joint with a 3/16 inch root opening against the backing strip. Place this assembly face down so that tack welding can be done on back side.
6. Position for welding in the horizontal position.
7. Drop face shield, establish an arc, raise the electrode slightly, move to the starting point.
8. Lower the electrode to the proper arc length, make the root bead.
9. Move along the joint to fuse the beveled edges and the backing strip together.
10. Clean away slag by chipping and brushing.
11. Deposit the additional beads as directed by your instructor.
12. The three bead cover pass should not be more than 1/8 inch above the plate thickness, or wider than 1/16 inch beyond each side of the groove.
13. Repeat this procedure until the desired weld is produced.
14. Show your work to your instructor, discuss the results.
15. Save material for beading practice.



NAME GROOVE WELD		MILESTONE F "V" GROOVE BUTT WELDS IN THE HORIZONTAL POSITION		MODULE NO. III	
				FIGURE NO. 13	
ELECTRODE SIZE $\frac{5}{32}$ DIA. DC/RP		TYPE AWS-E-6010			
MATERIAL	SPEC.	AMT	SIZE		
STEEL	MILD	3	$\frac{3}{8}$ X 2 X 6		

ADVANCED SHIELDED METAL-ARC WELDING

Module III. Groove Weld

Milestone F, 'V' Groove Butt Welds in the Horizontal Position

Project 13; Time: 12 hours

INTRODUCTION

The student will make a groove weld, without backing strip, in the horizontal position. This will require 4 beads to complete. The first bead should have consistent root penetration; the 2 filler beads should fill the plate almost flush. The lacing bead cover pass will have no undercut and no sag at the bottom of the bead.

EQUIPMENT REQUIRED

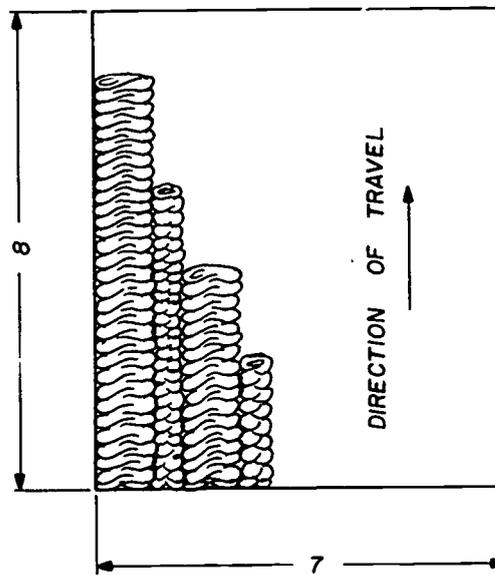
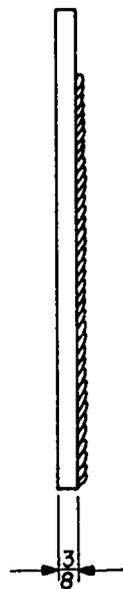
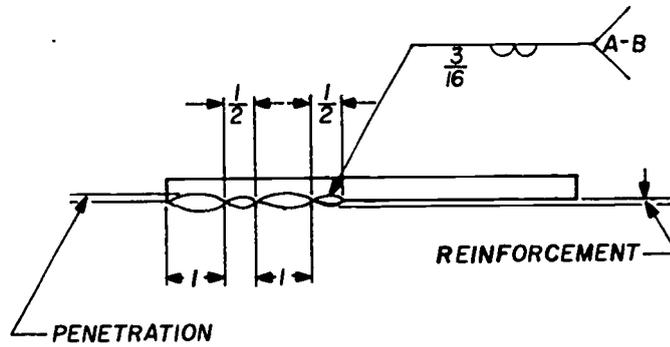
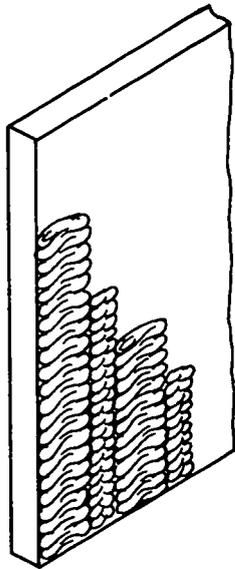
DC welding machine, slag hammer, wire brush, tongs, positioner, and safety equipment.

MATERIAL NEEDED

3 pieces 3/8 x 2 x 6 inch steel plate with 30° bevel on one side, 5/32 inch E6010 electrodes.

PROCEDURE

1. Clean plate with wire brush.
2. Set amperage and polarity as directed.
3. Start welding machine.
4. Put on face shield and gloves.
5. Put electrode in holder.
6. Put the plates face down with the beveled edges parallel and gapped to 3/32 inch. Tack weld on the back side.
7. Place this assembly in the positioner for horizontal welding.
8. Drop face shield, establish an arc, raise electrode slightly, move to the starting point.
9. Lower the electrode to the proper arc length.
10. Deposit the root bead with a forward and back motion, concentrate the arc at the gap. Hold a constant arc length.
11. Clean away slag after each bead is completed.
12. Use lacing manipulation for completing the weld.
13. The reinforcement should not be more than 1/8 inch above plate thickness, or wider than 1/16 inch at each side of the groove.
14. Repeat this procedure until an acceptable weld is produced.
15. Show work to your instructor for a discussion of results.
16. Save material for beading practice.



A. WELD BOTH SIDES

B. VERTICAL POSITION

NAME SURFACING WELD	MILESTONE D SURFACING WELDS IN THE VERTICAL POSITION - WEAVE BEADS		MODULE NO. I
			FIGURE NO. 14
ELECTRODE SIZE $\frac{5}{32}$ DIA. DC/RP	TYPE AWS-E-6010		
MATERIAL	SPEC.	AMT	SIZE
STEEL	MILD	1	$\frac{3}{8}$ X 8 X 7

ADVANCED SHIELDED METAL-ARC WELDING

Module I. Surfacing Weld

Milestone D, Surfacing Welds with Weave Beads in the Vertical Position

Project 14; Time: 6 hours

INTRODUCTION

The student will make weave beads, vertically, on steel plate. These beads will alternate in width, one of 1/2 inch wide followed by a 1 inch bead until the plate is covered. Beads will be straight with a tight uniform ripple and pattern.

EQUIPMENT REQUIRED

DC welding machine, slag hammer, wire brush, tongs, positioner, and safety equipment.

MATERIAL NEEDED

1 piece 3/8 x 7 x 8 inch steel plate, 5/32 inch E6010 electrodes.

PROCEDURE

1. Clean plate with wire brush and place in the positioner for vertical welding.
2. Set amperage and polarity as directed.
3. Start welding machine.
4. Put on face shield and gloves.
5. Put electrode in holder.
6. Drop face shield, establish an arc, raise electrode slightly, move to the starting point.
7. Raise electrode to the proper arc length.
8. Deposit the weave bead moving upward.
9. Make the beads 1/2 inch and 1 inch wide, the rippling must be uniform, each weave should overlap the preceding pass.
10. Use all electrodes down to a stub end 1-1/2 inch long.
11. Clean off slag after completing each bead.
12. Show work to your instructor for a discussion to the results.

ADVANCED SHIELDED METAL-ARC WELDING

Module II. Fillet Weld

Milestone F, Multiple Pass Fillet Welds in the Vertical Position

Project 15; Time: 9 hours

INTRODUCTION

The student will make a fillet weld set to contain four welds. These will be made with weave beads 5/16, 1/2, 5/8 & 7/8 inch leg dimensions. Welding will be in the vertical position, travel up. All welds will have equal leg lengths, flat face, and no undercut.

EQUIPMENT REQUIRED

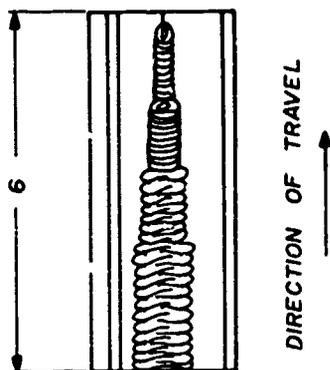
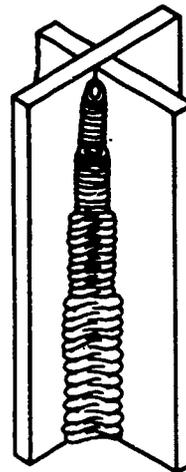
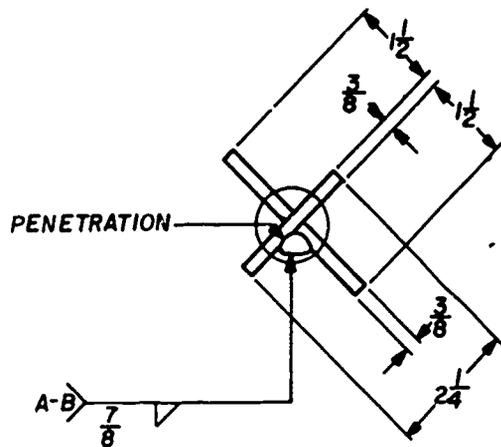
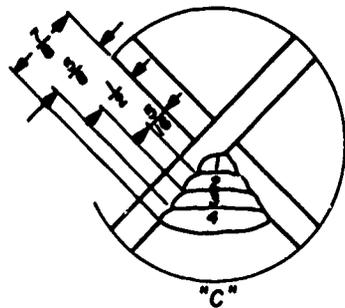
DC welding machine, slag hammer, wire brush, tongs, positioner, and safety equipment.

MATERIAL NEEDED

1 piece 3/8 x 2-1/4 x 6 inch, 2 pieces 3/8 x 1-1/2 x 6 inch steel plate, 5/32 inch E6010 electrodes.

PROCEDURE

1. Clean plates with wire brush.
2. Set amperage and polarity to specification.
3. Start welding machine.
4. Put on face shield and gloves.
5. Put electrode in holder.
6. Tack weld plates at 90° to form a cross, place in the positioner for vertical-up welding.
7. Drop face shield, establish an arc, raise electrode slightly, move to the starting point.
8. Lower electrode to the proper arc length.
9. Deposit the first bead with an up and down motion in small increments.
10. Clean away all slag after completing each pass.
11. Use weave motion, crossing in the upward direction, to complete the weld.
12. Repeat this procedure until a weld of specified size and shape is produced.
13. Check the results with fillet weld gage.
14. Secure the equipment.



A. WELD ALL FOUR CORNERS

B. VERTICAL POSITION

C. WELD SEQUENCE

NAME FILLET WELD		MILESTONE G FILLET WELDS IN THE VERTICAL POSITION - WEAVE BEADS		MODULE NO. II
				FIGURE NO. 16
ELECTRODE SIZE	1/8 DIA. DC/ RP	TYPE	AWS - E - 7018	
MATERIAL	STEEL	SPEC.	MILD	AMT. 1
				SIZE 3/8 X 2 1/4 X 6
	STEEL		MILD	2
				3/16 X 1 1/2 X 6

ADVANCED SHIELDED METAL-ARC WELDING

Module II. Fillet Weld

Milestone G, Multiple Pass Fillet Welds in the Vertical Position

Project 16; Time: 6 hours

INTRODUCTION

The student will make a fillet weld set to contain four welds. These will each be made with 4 weave beads in the vertical position. Use 1/8 inch E7018 electrodes. The welds will measure 5/16-1/2-5/8-7/8 respectively. All welds will have a flat face, uniform ripples, no undercut, and equal leg lengths.

EQUIPMENT REQUIRED

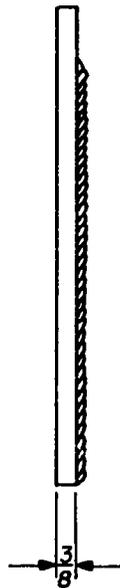
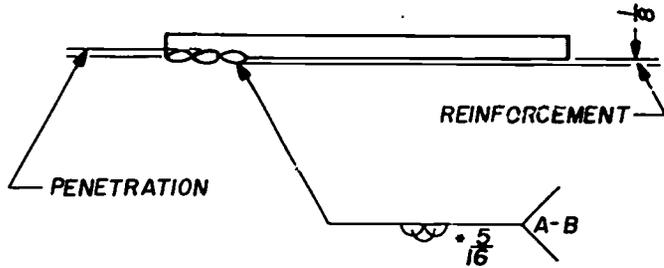
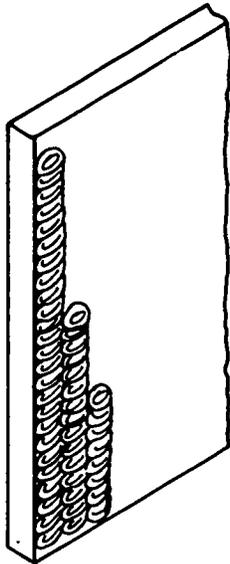
DC welding machine, slag hammer, wire brush, tongs, positioner and safety equipment.

MATERIAL NEEDED

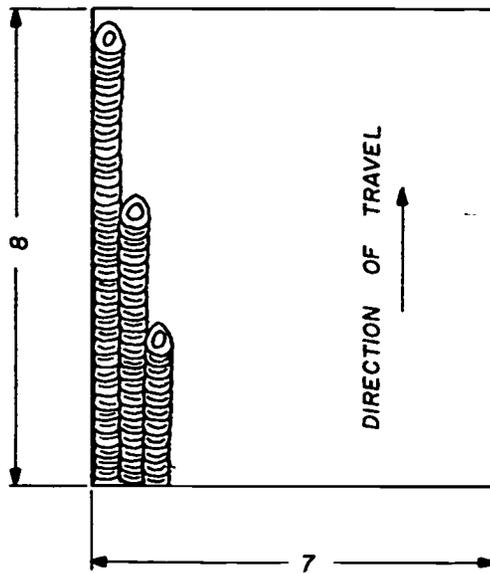
1 piece 3/8 x 2-1/4 x 6 inch and 2 pieces 3/16 x 1-1/2 x 6 inch steel plate, 1/8 inch E7018 electrodes.

PROCEDURE

1. Clean plate with wire brush.
2. Set amperage and polarity as directed.
3. Start welding machine.
4. Put on face shield and gloves.
5. Put electrode in holder.
6. Tack weld the plates at 90° to form a cross, place in positioner for vertical-up welding.
7. Drop face shield, establish an arc, raise slightly, move to the starting point.
8. Lower electrode to proper arc length.
9. Use weave motion to deposit bead upward.
10. Clean slag from weld after each pass.
11. Continue welding until the fillet is of the specified size and shape.
12. Repeat this procedure until a proper weld is produced.
13. Check weld with the fillet gage.
14. Secure the equipment.



4



A. WELD BOTH SIDES

B. VERTICAL POSITION

NOTE: * REFERS TO BEAD WIDTH

NAME SURFACING WELD	MILESTONE E SURFACING WELDS IN THE VERTICAL POSITION- WHIP BEADS		MODULE NO. I
			FIGURE NO. 17
ELECTRODE SIZE $\frac{5}{32}$ DIA. DC/RP	TYPE AWS-E-6010		
MATERIAL	SPEC.	AMT.	SIZE
STEEL	MILD	1	$\frac{3}{8}$ X 8 X 7

ADVANCED SHIELDED METAL-ARC WELDING

Module I. Surfacing Weld

Milestone E, Surfacing Welds in the Vertical Position

Project 17; Time: 3 hours

INTRODUCTION

The student will make a surfacing weld with stringer beads in the vertical position. Use an 8 inch square steel plate, cover both sides with beads with overlapping of 50%. Make a uniform thickness of deposit with even ripple.

EQUIPMENT REQUIRED

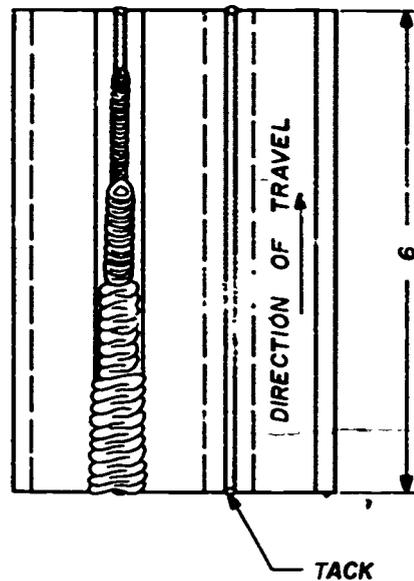
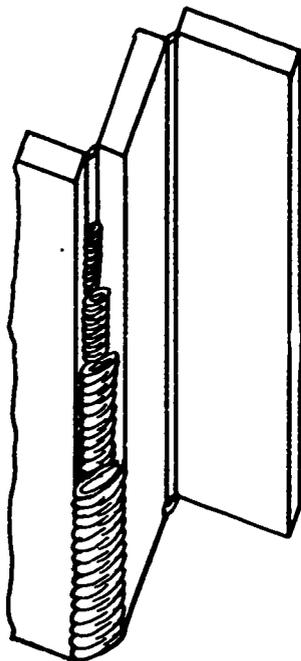
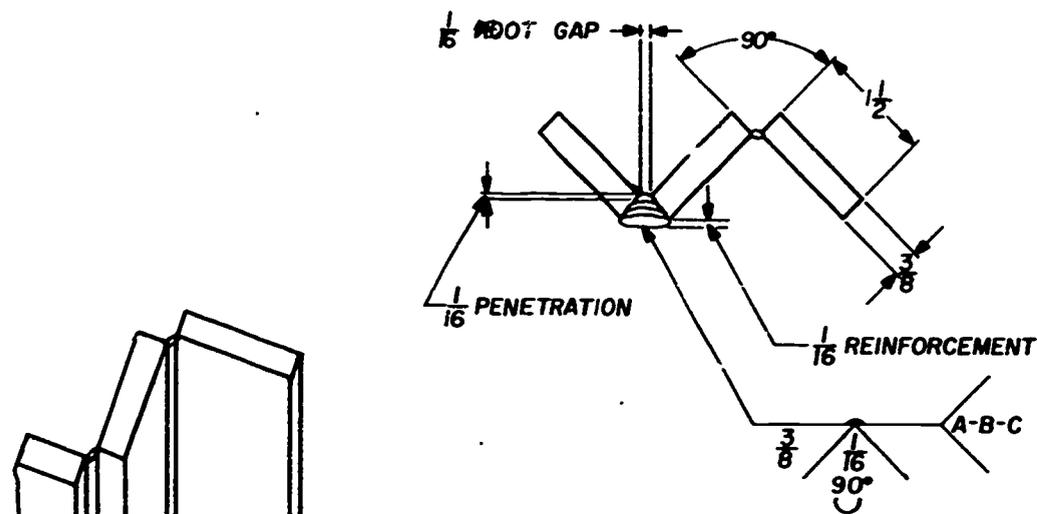
DC welding machine, slag hammer, wire brush, tongs, positioner, and safety equipment.

MATERIAL NEEDED

1 piece 3/8 x 7 x 8 inch steel plate, 5/32 inch E6010 electrodes.

PROCEDURE

1. Clean plate with wire brush, put in positioner for vertical-up welding.
2. Set amperage and polarity as directed.
3. Put on face shield and gloves.
4. Start welding machine.
5. Put electrode in holder.
6. Drop face shield, establish an arc, raise electrode slightly, move to the starting point.
7. Lower electrode to the proper arc length.
8. Practice vertical welding manipulation. This is a short up and down whip motion while holding a constant arc length.
9. Deposit the beads with a 50% overlap so that the new welded surface is uniform in appearance and depth.
10. Clean away slag after finishing each bead.
11. Repeat this procedure until the desired weld is produced.
12. Show work to your instructor, discuss the results.
13. Save this plate for Project 20.



- A. WELD ONE SIDE ONLY
- B. VERTICAL - UP POSITION
- C. SAVE FOR NEXT PROJECT

NAME GROOVE WELD		MILESTONE G CORNER WELDS IN THE VERTICAL POSITION		MODULE NO. III
				FIGURE NO. 18
ELECTRODE SIZE $\frac{5}{32}$ DIA. DC/RP		TYPE AWS-E-6010		
MATERIAL	SPEC.	AMT.	SIZE	
STEEL	MILD	3	$\frac{3}{8} \times \frac{1}{2} \times 6$	

ADVANCED SHIELDED METAL-ARC WELDING

Module III. Groove Weld

Milestone G, Corner Welds in the Vertical Position

Project 18; Time: 3 hours

INTRODUCTION

The student will make a corner weld with four beads. The first, root bead; second and third, 2 filler beads; fourth, a weave bead cover. This weld will be made in the vertical position; it should have a slightly convex face with a uniform appearance, and no excessive reinforcement on either side of the joint.

EQUIPMENT REQUIRED

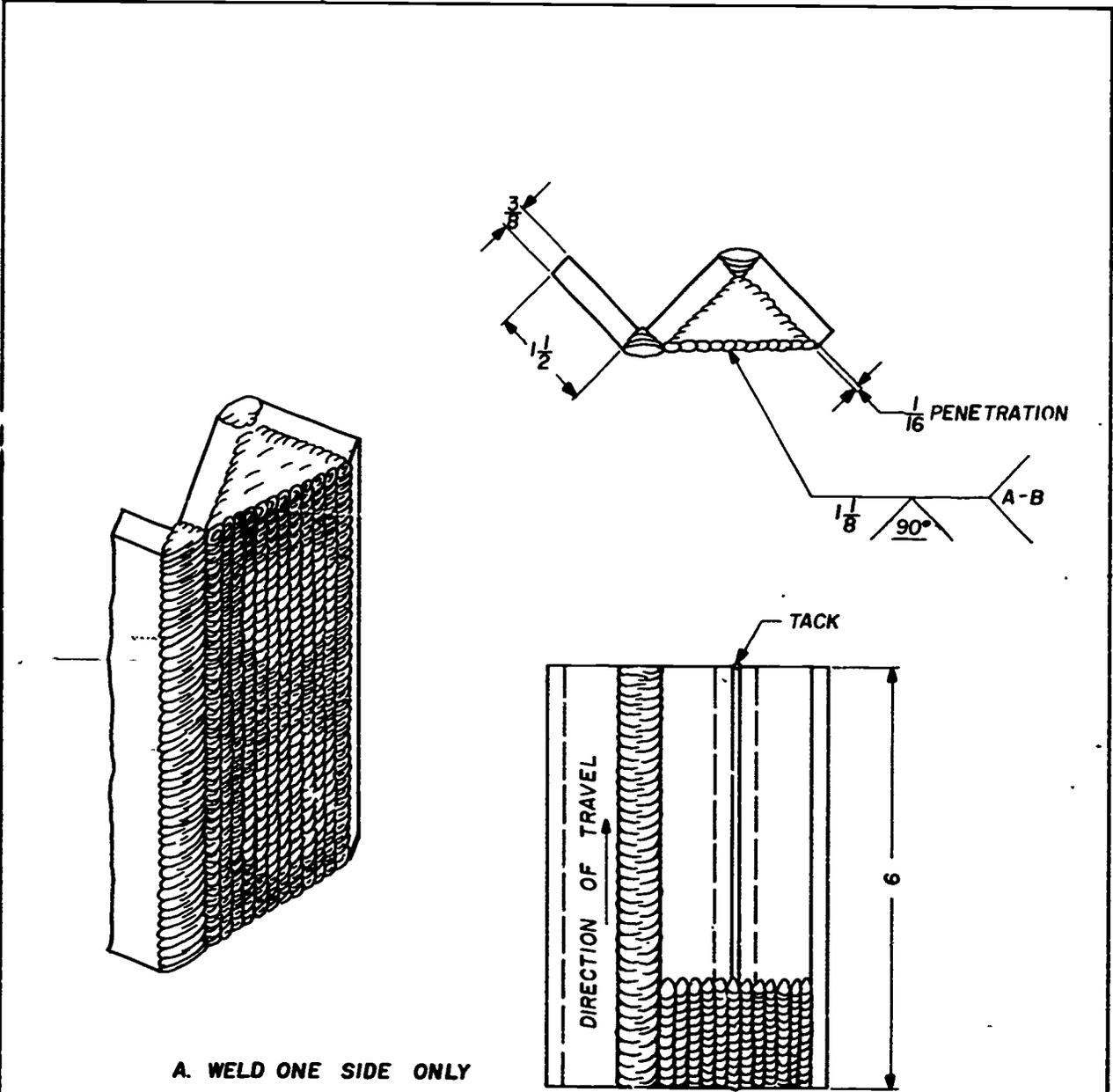
DC welding machine, slag hammer, wire brush, tongs, positioner, and safety equipment.

MATERIAL NEEDED

3 pieces 3/8 x 1-1/2 x 6 inch steel plate, 5/32 inch E6010 electrodes.

PROCEDURE

1. Clean plate with wire brush.
2. Set amperage and polarity as directed.
3. Start welding machine.
4. Put on face shield and gloves.
5. Put electrode in holder.
6. Tack weld plates for a 90° corner weld, place in positioner for vertical-up welding.
7. Drop face shield, establish an arc, raise electrode slightly, move to the starting point.
8. Lower electrode to the proper arc length.
9. Make first bead using an up and down motion in small increments. Hold a constant arc length.
10. This bead should fully penetrate the joint.
11. Clean away all slag after each pass.
12. Place the two overlapping beads over the root pass. Finish with a weave bead.
13. Repeat this procedure until a proper weld is produced.
14. Secure the equipment.



A. WELD ONE SIDE ONLY
 B. VERTICAL-UP POSITION

NAME GROOVE WELD		MILESTONE H "V" GROOVE WELDS IN THE VERTICAL POSITION		MODULE NO. III
				FIGURE NO. 19
ELECTRODE SIZE 5/32 DIA. DC/RP		TYPE AWS - E - 6010		
MATERIAL	SPEC.	AMT.	SIZE	
STEEL	MILD	3	3/8 X 1/2 X 6	

ADVANCED SHIELDED METAL-ARC WELDING

Module III. Groove Weld

Milestone H, 'V' Groove Welds in the Vertical Position

Project 19; Time: 6 hours

INTRODUCTION

The student will make a multiple bead 'V' groove weld on the reverse side of the corner weld project, number 18. This will require a minimum of 20 beads. There should be no evidence of slag inclusions, pinholes, or porosity. The ends of the joints must be full and straight. Use 5/32 inch E6010 electrodes. Weld in the vertical position.

EQUIPMENT REQUIRED

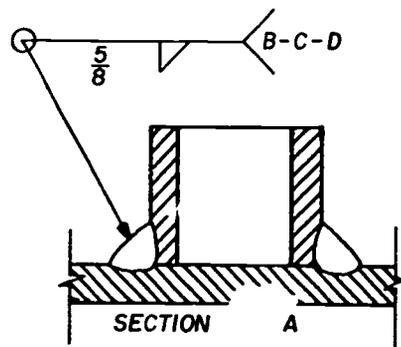
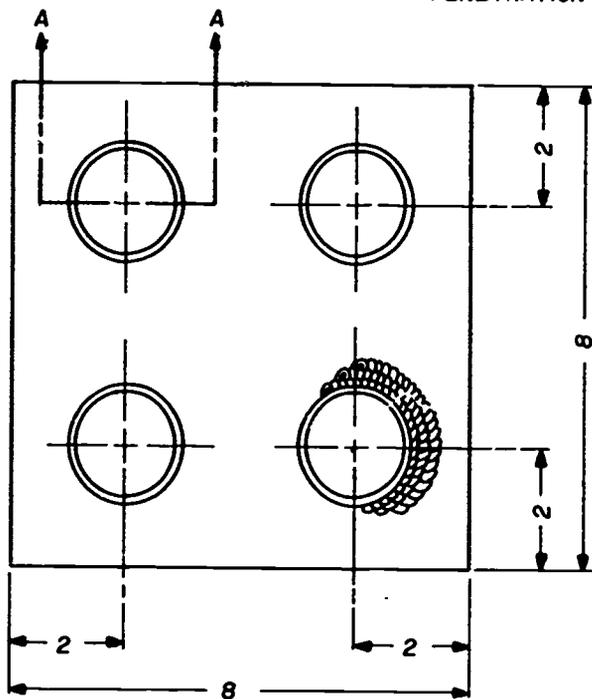
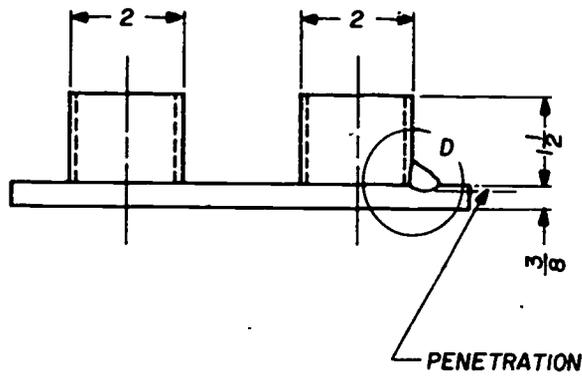
DC welding machine, slag hammer, wire brush, tongs, positioner, and safety equipment.

MATERIAL NEEDED

Use reverse of Project 18 weldment, 5/32 inch E6010 electrodes.

PROCEDURE

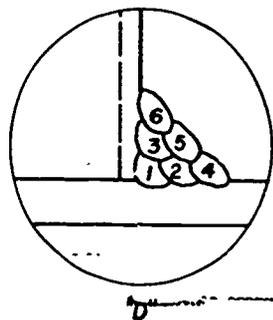
1. Wire brush the plate, place in positioner for vertical welding.
2. Set amperage and polarity as directed.
3. Start welding machine.
4. Put on face shield and gloves.
5. Put electrode in holder.
6. Drop face shield, establish an arc, raise electrode slightly, move to starting point.
7. Lower electrode to proper arc length.
8. Place the root bead; use an up and down motion in the direction of travel.
9. Up 3/8 and down 1/4 inch are the approximate increments of movement. Hold a close arc.
10. Clean off slag after depositing each bead.
11. Repeat this procedure until the desired weld is produced.
12. Have the instructor see your work, discuss the results with him.



B. FIXED POSITION

C. WELD ALL FOUR PIPES

D. WELD SEQUENCE



NAME FILLET WELD		MILESTONE H FILLET WELDS IN THE FIXED POSITION - PIPE TO PLATE			MODULE NO. II
					FIGURE NO. 20
ELECTRODE SIZE	$\frac{5}{32}$ DIA. DC/RP	TYPE	AWS - E - 6010		
MATERIAL	STEEL	SPEC. MILD	AMT. 1	SIZE $\frac{3}{8} \times 8 \times C$	
	STEEL PIPE	MILD	4	$2^0 \times 1\frac{1}{2}$	

ADVANCED SHIELDED METAL-ARC WELDING

Module II. Fillet Weld

Milestone H, Fillet Welds in the Fixed Position - Pipe to Plate

Project 20; Time: 6 hours

INTRODUCTION

The student will make a pipe to plate set. He will tack weld four pipe nipples to each side of a steel plate. With this plate held in vertical plane, the fillet welds formed will be welded with 6 passes, each. The weld will measure 5/8 inch, have a flat face, and equal leg lengths.

EQUIPMENT REQUIRED

DC welding machine, slag hammer, wire brush, tongs, positioner, fillet gage, and safety equipment.

MATERIAL NEEDED

1 piece 3/8 x 8 x 8 inch steel plate, 4 pieces 1-1/2 x 2 inch steel pipe, 5/32 inch E6010 electrodes.

PROCEDURE

1. Clean the material with wire brush.
2. Set amperage and polarity as directed.
3. Start welding machine.
4. Put on face shield and gloves.
5. Put electrode in holder.
6. Tack weld the 4 pieces of pipe on one side of the plate 1 inch in from the edge, and on 4 inch centers. Place in positioner for vertical welding.
7. Drop face shield, establish an arc, raise electrode slightly, move to the starting point.
8. Lower electrode to the proper arc length.
9. Start each bead at position 7 o'clock, move vertically upward to position 12 o'clock in a clockwise direction.
10. Clean off slag.
11. Start second half of this bead at the beginning of the first half, at position 7 o'clock. Move counterclockwise under and up to position 12 o'clock.
12. Repeat this procedure until consistent results are obtained.
13. Check work with fillet gage for the proper weld contour and size.
14. Show work to your instructor for a discussion of the results.

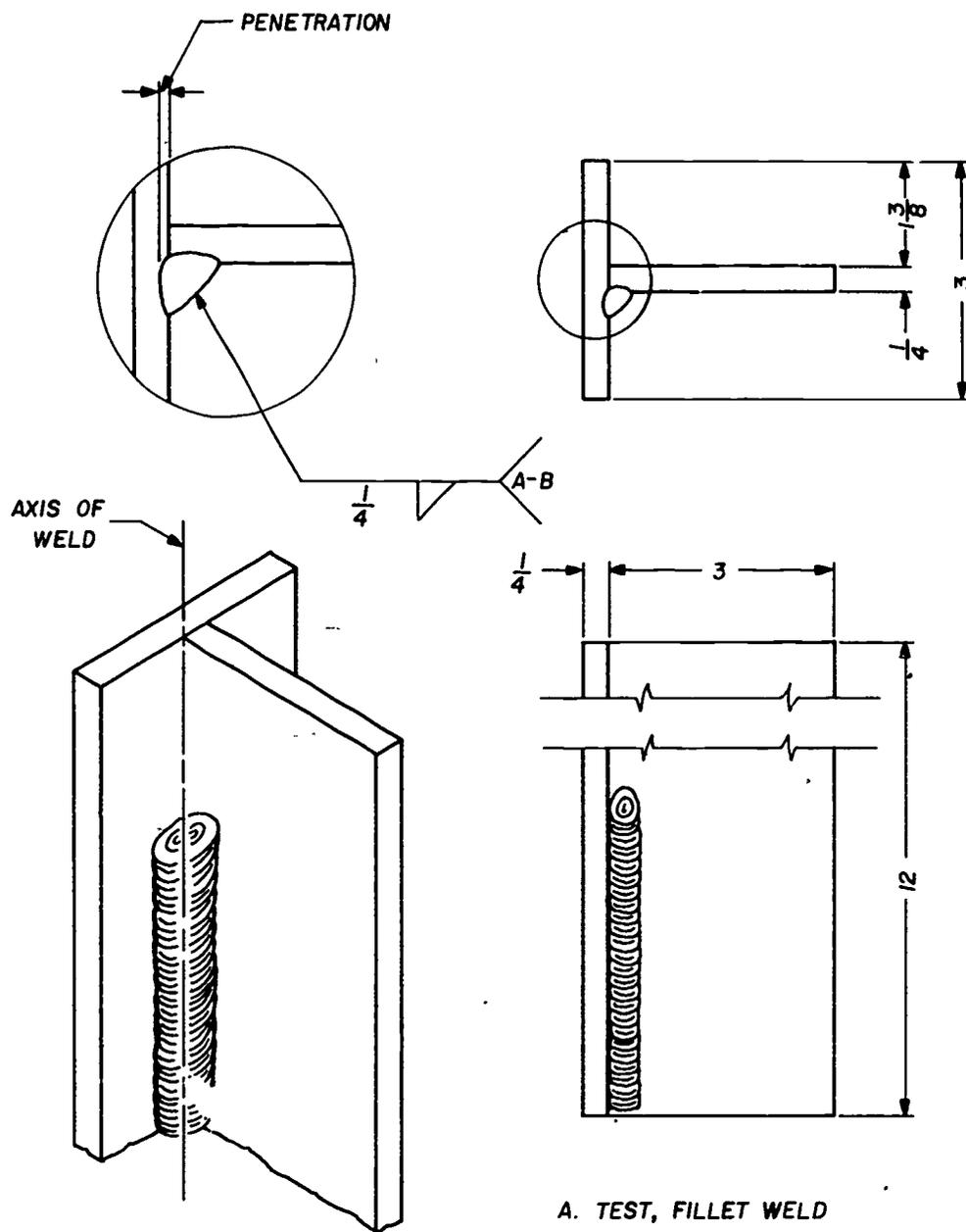


PLATE IS IN VERTICAL POSITION FOR TEST.

A. TEST, FILLET WELD

B. VERTICAL POSITION

NAME FILLET WELD		MILESTONE I FILLET WELD TEST AWS - ASME		MODULE NO. II FIGURE NO. 20-A	
ELECTRODE SIZE $\frac{5}{32}$ DIA. DC/RP		TYPE AWS-E-6010			
MATERIAL	SPEC.	AMT	SIZE		
STEEL	MILD	2	$\frac{1}{4}$ X 12 X 3		

ADVANCED SHIELDED METAL-ARC WELDING

Module II. Fillet Weld

Milestone I, Fillet Weld Test in the Vertical Position

Project; 20-A

INTRODUCTION

The student will demonstrate his welding ability by performing the ASME fillet weld test shown in Fig. Q-4 (C) in the ASME Fired and Unfired Pressure Vessel Code, Section IX. This is also shown in AWS code D1.0-72, Fig. A-3, 3F (C).

EQUIPMENT REQUIRED

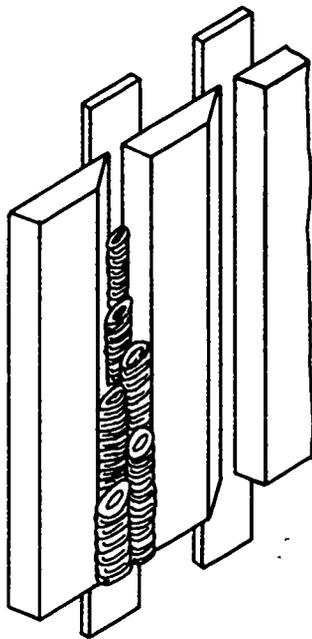
DC welding machine, slag hammer, wire brush, tongs, positioner, fillet weld gage, and safety equipment.

MATERIAL NEEDED

2 pieces 1/4 x 3 x 12 inch ASTM A36 steel plate, 5/32 inch E6010 electrodes.

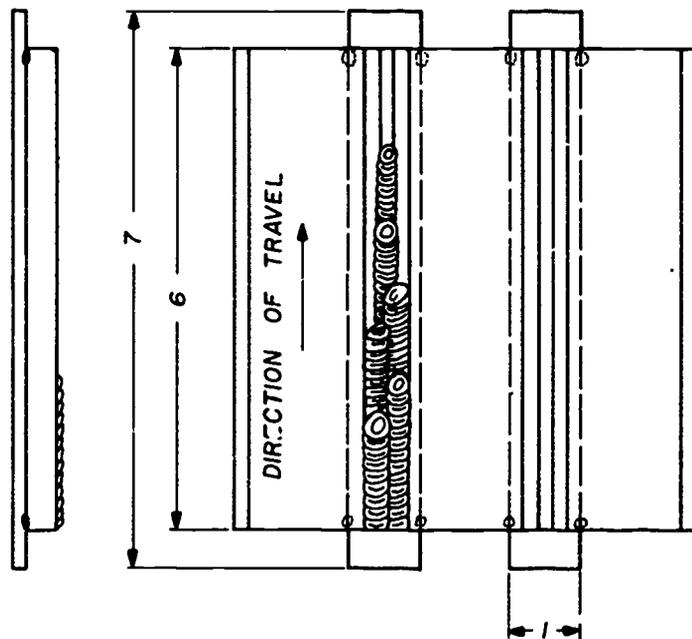
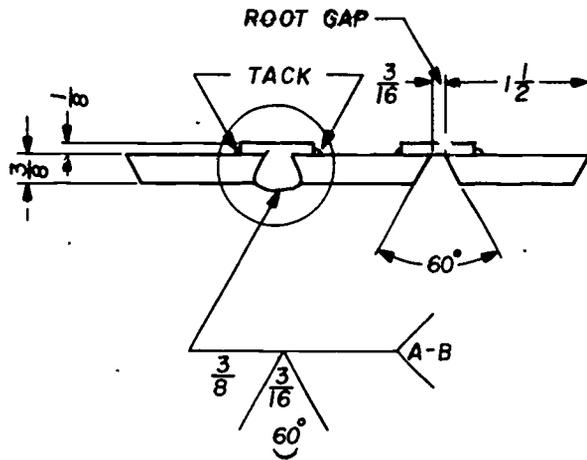
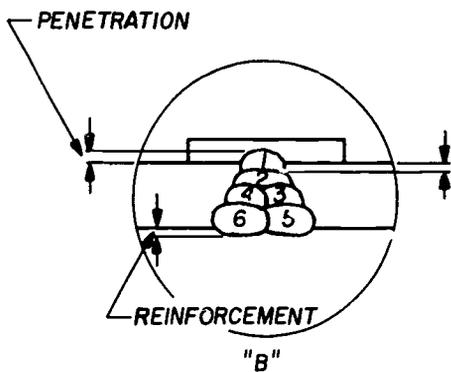
PROCEDURE

1. Clean plate with wire brush.
2. Set amperage and polarity as directed.
3. Start welding machine.
4. Put on face shield and gloves.
5. Put electrode in holder.
6. Tack weld plates in a 'T' joint for fillet welding.
7. Place in positioner for vertical-up welding.
8. Drop face shield, establish an arc, raise electrode slightly, move to the starting point.
9. Raise electrode to the proper arc length.
10. Weld from the bottom up; use the technique practiced in Project 18.
11. Each pass must be stopped and restarted at the midpoint.
12. Clean away slag before restarting the weld.
13. There is no weld around the plate ends.
14. See the ASME testing procedure; make this test on the weld.



A. VERTICAL POSITION

B. WELD SEQUENCE



NAME GROOVE WELD		MILESTONE "V" GROOVE BUTT WELDS W/ BACK UP IN THE VERTICAL POSITION			MODULE NO. III FIGURE NO. 21
ELECTRODE SIZE $\frac{5}{32}$ DIA. DC/RP		TYPE AWS - E - 6010			
MATERIAL STEEL		SPEC. MILD	AMT. 2	SIZE $\frac{1}{8} \times 1 \times 7$	
STEEL		MILD	3	$\frac{3}{8} \times 1\frac{1}{2} \times 6$	

ADVANCED SHIELDED METAL-ARC WELDING

Module III. Groove Weld

Milestone I, 'V' Groove Butt Welds with Backing Strip, in the Vertical Position

Project 21; Time: 18 hours

INTRODUCTION

The student will make a 'V' groove weld with a backing strip in the vertical position. Use 5/32 inch E6010 electrodes to make this 6 pass weld. First, pass in root to fuse backing and beveled edges; second, a single bead; third, two filler beads complete with a two bead cover pass. The cover pass will have a uniform ripple and no evidence of undercut.

EQUIPMENT REQUIRED

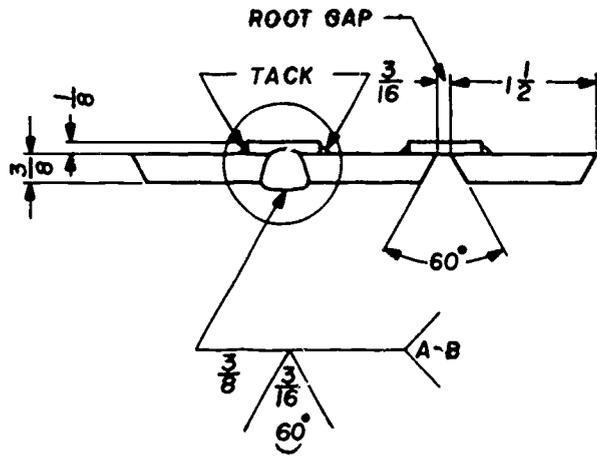
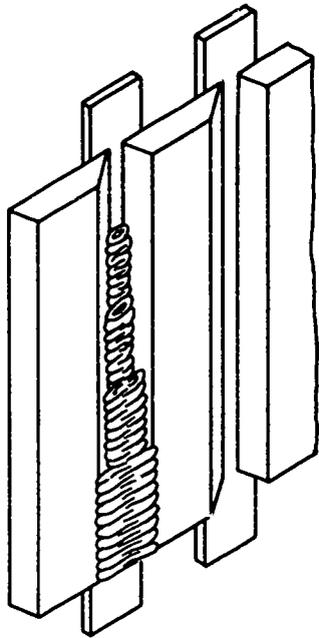
DC welding machine, slag hammer, wire brush, tongs, positioner, and safety equipment.

MATERIAL NEEDED

3 pieces 3/8 x 1-1/2 x 6 inch steel plate, beveled to 30° on one side, 2 pieces 1/8 x 1 x 7 inch plate, 5/32 inch E6010 electrodes.

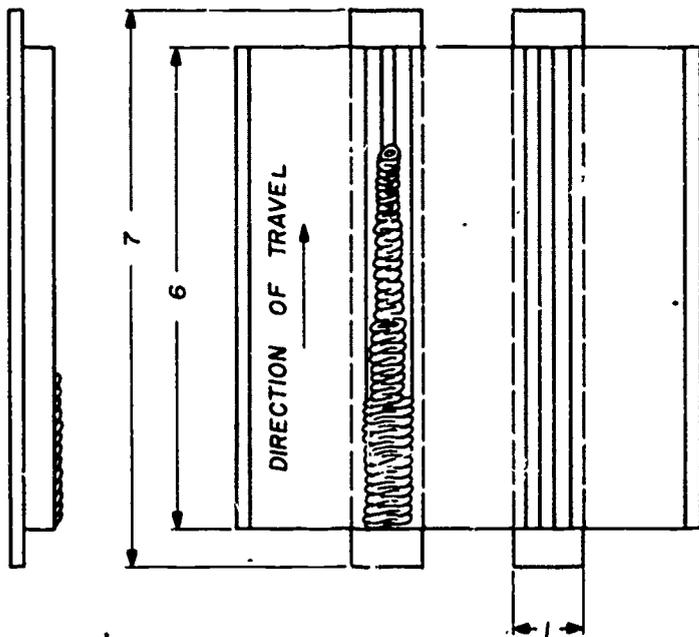
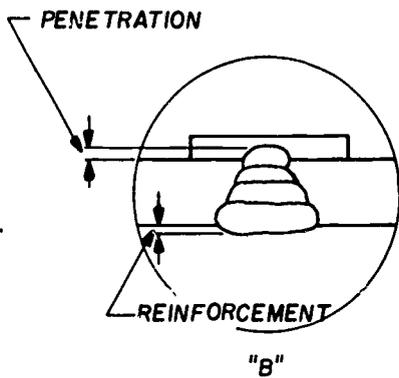
PROCEDURE

1. Clean plate with wire brush.
2. Set amperage and polarity as directed.
3. Start welding machine.
4. Put on face shield and gloves.
5. Place beveled plates face down with parallel alignment and a root opening of 3/16 inch. Put backing strip over this joint. Tack weld.
6. Place in positioner for welding in the vertical-up position.
7. Establish an arc, raise the electrode slightly, move to the starting point.
8. Lower the electrode to the proper arc length.
9. Make the root bead, fusing the beveled edges and the backing strip.
10. Chip and wire brush to completely remove slag after finishing each pass.
11. Place additional beads as directed.
12. The finished reinforcement should not be more than 1/8 inch above base metal thickness, or wider than 1/16 inch at each side of the groove.
13. Repeat this procedure until an acceptable weld is produced.
14. Show work to your instructor, discuss the results.
15. Save material for beading practice.



A. VERTICAL POSITION

B. WELD SEQUENCE



NAME GROOVE WELD		MILESTONE J "V" GROOVE BUTT WELDS W/BACK UP IN THE VERTICAL POSITION		MODULE NO. III	
				FIGURE NO. 22	
ELECTRODE SIZE $\frac{5}{32}$ DIA. DC/RP		TYPE AWS-E-6010			
MATERIAL	STEEL	SPEC. MILD	AMT 2	SIZE $\frac{1}{8} \times 1 \times 7$	
	STEEL	MILD	3	$\frac{3}{8} \times \frac{1}{2} \times 6$	

ADVANCED SHIELDED METAL-ARC WELDING

Module III. Groove Weld

Milestone J, 'V' Groove Butt Welds with Backing Strip in the Vertical Position

Project 22: Time: 6 hours

INTRODUCTION

The student will make a groove weld with backing strip in the vertical position. Place the beads as follows: First, root bead fusing, the beveled edges to the backing strip; second, two filler beads; third, a weave bead cover. The cover pass will have a uniform pattern with a flat light ripple and no undercut.

EQUIPMENT REQUIRED

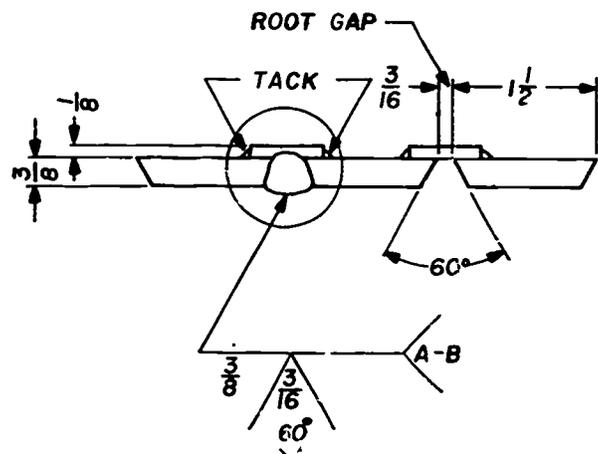
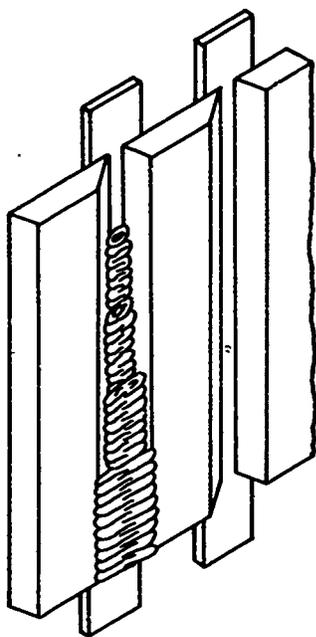
DC welding machine, slag hammer, wire brush, tongs, positioner, and safety equipment.

MATERIAL NEEDED

3 pieces $3/8 \times 1-1/2 \times 6$ inch steel plate beveled on one side to 30° , 2 pieces $1/8 \times 1 \times 7$ inch steel strip, $5/32$ inch E6010 electrodes.

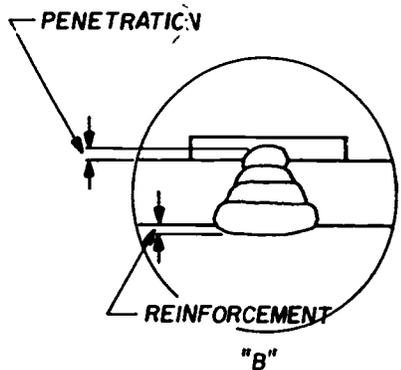
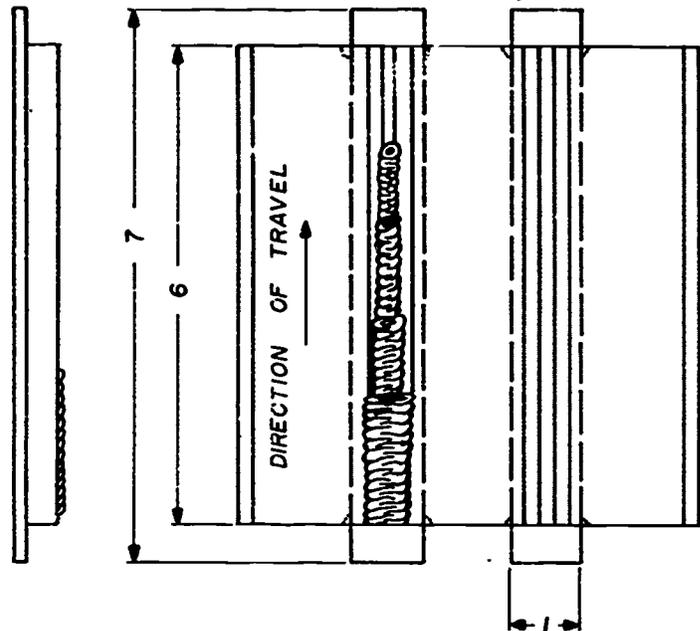
PROCEDURE

1. Clean plate with wire brush.
2. Set amperage and polarity as directed.
3. Put on face shield and gloves.
4. Put electrode in holder.
5. Assemble plate by placing the beveled pieces face down, the edges parallel with a $3/16$ inch gap. Place backing strip over this gap, tack weld to each side.
6. Position for vertical-up welding.
7. Drop face shield, establish an arc, raise electrode slightly, move to the starting point.
8. Lower electrode to the proper arc length.
9. Make root pass using an up and down motion, hold a constant arc length.
10. Clean away slag after each bead is completed.
11. Place additional stringer beads, the cover bead is a weave pass.
12. The reinforcement should not be more than $1/8$ inch above plate thickness, or wider than $1/16$ inch at each side of the groove.
13. Repeat this procedure until an acceptable weld is produced.
14. Save material for beading practice.



A. VERTICAL POSITION

B. WELD SEQUENCE



"B"

NAME GROOVE WELD	MILESTONE K "V" GROOVE BUTT WELDS W/BACK UP IN THE VERTICAL POSITION		MODULE NO. III
			FIGURE NO. 23
ELECTRODE SIZE $\frac{1}{8}$ DIA. DC/RP	TYPE AWS - E - 7018		
MATERIAL STEEL	SPEC. MILD	AMT. 2	SIZE $\frac{1}{8} \times 1 \times 7$
STEEL	MILD	3	$\frac{3}{8} \times \frac{1}{2} \times 6$

ADVANCED SHIELDED METAL-ARC WELDING

Module III. Groove Weld

Milestone K, 'V' Groove Butt Welds with Backing Strip in the Vertical Position

Project 23; Time: 6 hours

INTRODUCTION

The student will make a groove weld with backing strip in the vertical position. Use 1/8 inch E7018 electrodes to deposit beads as follows: first, a root pass fusing the 3 plates together; second and third, 2 filler beads; fourth, a weave bead cover pass. The cover pass will have a uniform pattern with tight flat ripples and no evidence of undercut.

EQUIPMENT REQUIRED

DC welding machine, slag hammer, wire brush, tongs, positioner and safety equipment.

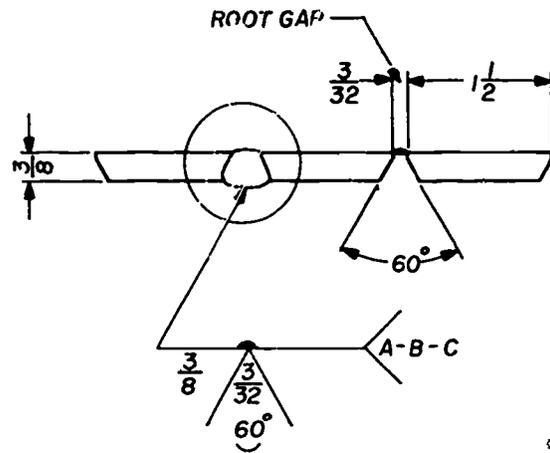
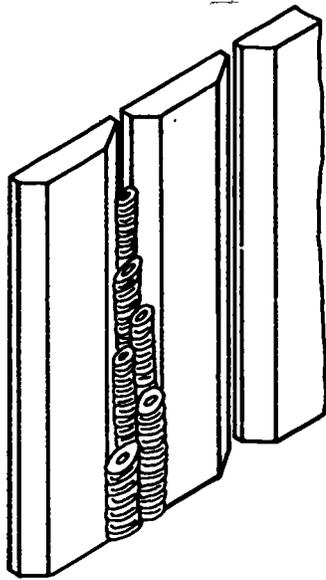
MATERIAL NEEDED

3 pieces 3/8 x 1-1/2 x 6 inch steel plate beveled to 30° on one side, 2 pieces 1/8 x 1 x 7 inch steel for backing strip, AWS 1/8 E7018 electrodes.

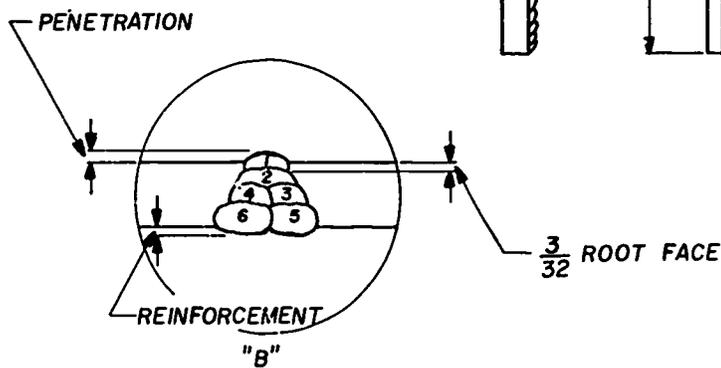
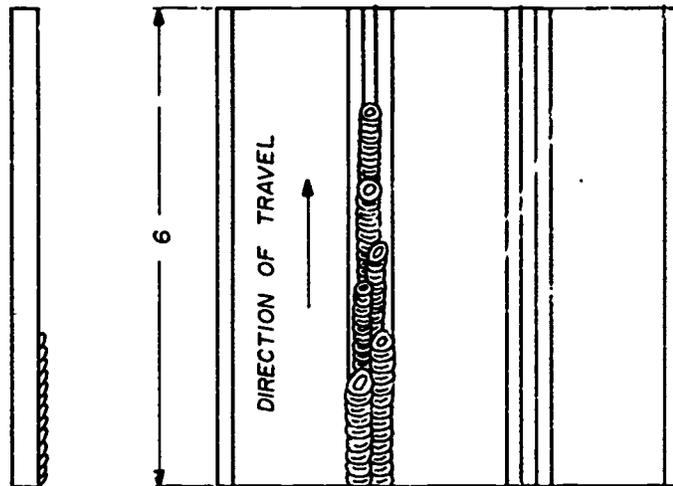
PROCEDURE

1. Clean plate with wire brush.
2. Set amperage and polarity as directed.
3. Start welding machine.
4. Put on face shield and gloves.
5. Put electrode in holder.
6. Tack weld 3/8 inch beveled plates to backing strip in parallel alignment leaving a root opening of 3/16 inch. Place in positioner for vertical-up welding.
7. Establish an arc, raise electrode slightly, move to the starting point.
8. Lower electrode to the proper arc length.
9. Make the root pass with a small weave motion. Concentrate arc to fuse the three plates together.
10. Remove slag after each pass is completed.
11. Weave additional beads as directed.
12. Make the cover pass. It should not be more than 1/8 inch above plate thickness, or wider than 1/16 inch at each side of the groove.
13. Repeat this procedure until an acceptable weld is produced.
14. Show work to your instructor, discuss the results.
15. Save material for beading practice.

Note: The root opening may vary according to local practice or design. This may require a greater number of beads for completion of the joint.



- A. VERTICAL POSITION
- B. WELD SEQUENCE
- C. SUBSTITUTE 6" PIPE IF AVAILABLE



NAME GROOVE WELD		MILESTONE L "V" GROOVE BUTT WELDS IN THE VERTICAL POSITION		MODULE NO. III	
				FIGURE NO. 24	
ELECTRODE SIZE $\frac{5}{32}$ DIA. DC/RP		TYPE AWS - E - 6010			
MATERIAL	SPEC.	AMT	SIZE		
STEEL	MILD	3	$\frac{3}{8} \times \frac{1}{2} \times 6$		

ADVANCED SHIELDED METAL-ARC WELDING

Module III. Groove Weld

Milestone L, 'V' Groove Butt Welds in the Vertical Position
(When available, substitute 6 inch pipe)

Project 24; Time: 6 hours

INTRODUCTION

The student will make a 'V' groove weld without a backup in the vertical position. Use 5/32 inch E6010 electrodes. Place the beads as follows: first, a root pass with full penetration; second pass, single bead; third, two overlapping beads; fourth, two bead cover. The cover will have tight uniform ripples and no evidence of undercut.

EQUIPMENT REQUIRED

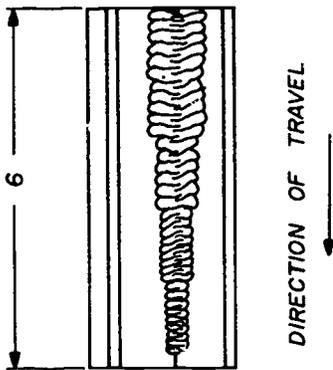
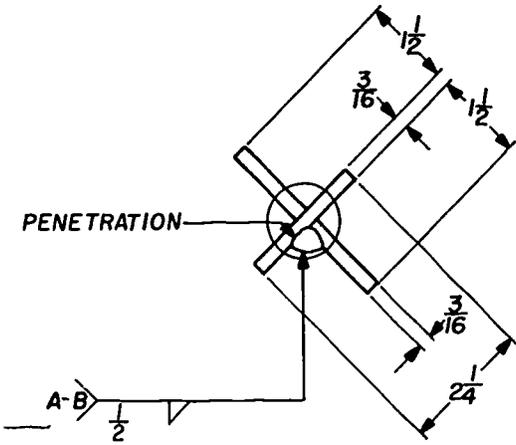
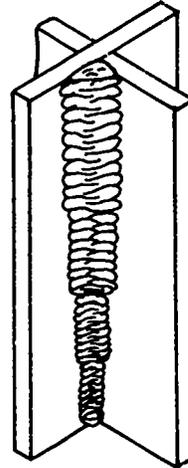
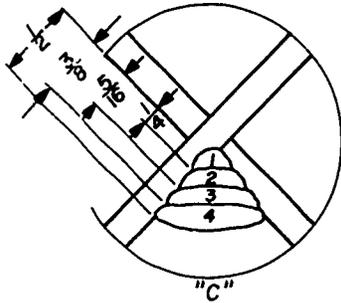
DC welding machine, slag hammer, wire brush, tongs, positioner and safety equipment.

MATERIAL NEEDED

3 pieces 3/8 x 1-1/2 x 6 inch steel plate beveled on one side to 30°, 5/32 inch E6010 electrodes.

PROCEDURE

1. Clean the plate with wire brush.
2. Set amperage and polarity as directed.
3. Start welding machine.
4. Put on face shield and gloves.
5. Put electrode in holder.
6. Tack weld the beveled plates with a root opening of 3/32 inch, place in positioner for vertical-up welding.
7. Drop face shield, establish an arc, raise electrode slightly, move to the starting point.
8. Lower electrode to the proper arc length.
9. Deposit root bead, use an up and down motion with a short arc.
10. Clean off slag completely after each pass.
11. Whip the remaining passes as demonstrated.
12. The cover bead must not exceed the plate thickness by more than 1/8 inch or be wider than 1/16 inch at each side of the groove.
13. Repeat this procedure until the required weld is produced.
14. Secure the equipment.



A. WELD ALL FOUR CORNERS

B. VERTICAL POSITION

C. WELD SEQUENCE

NAME FILLET WELD		MILESTONE J FILLET WELDS IN THE VERTICAL DOWN POSITION		MODULE NO. II FIGURE NO. 25	
ELECTRODE SIZE $\frac{5}{32}$ DIA. DC/RP		TYPE AWS-E-6010			
MATERIAL	STEEL	SPEC. MILD	AMT 1	SIZE $\frac{3}{8} \times 2\frac{1}{4} \times 6$	
	STEEL	MILD	2	$\frac{3}{16} \times 1\frac{1}{2} \times 6$	

ADVANCED SHIELDED METAL-ARC WELDING

Module II. Fillet Weld

Milestone J, Fillet Welds in the Vertical Down Position

Project 25; Time: 3 hours

INTRODUCTION

The student will make a fillet weld set to contain four, four pass welds. These will be deposited as weave beads in the vertical down position. Use 5/32 inch E6010 electrodes. The beads will have a fine, smooth texture, flat face, and no evidence of pinholes or porosity.

EQUIPMENT REQUIRED

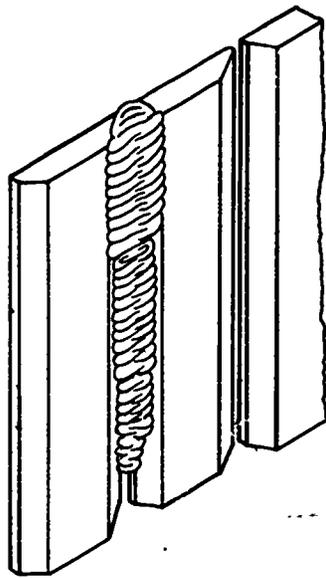
DC welding machine, slag hammer, wire brush, tongs, positioner and safety equipment.

MATERIAL NEEDED

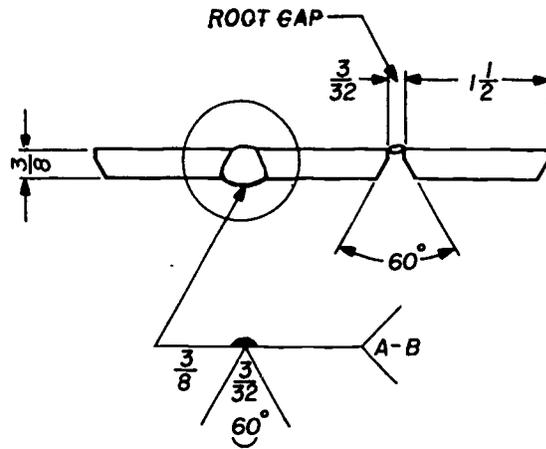
1 piece 3/8 x 2-1/4 x 6 inch, 2 pieces 3/16 x 1-1/2 x 6 inch steel plate, 5/32 inch E6010 electrodes.

PROCEDURE

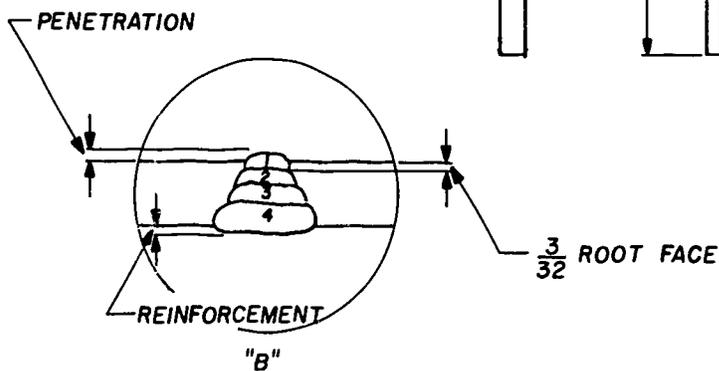
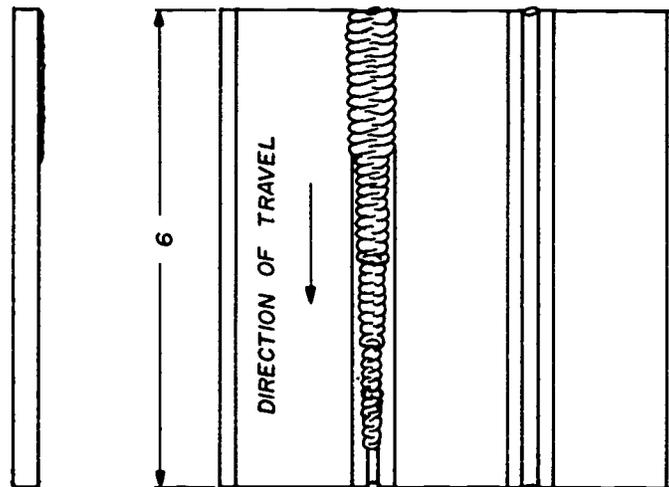
1. Clean plate with wire brush.
2. Set amperage and polarity as directed.
3. Start welding machine.
4. Put on face shield and gloves.
5. Put electrode in holder.
6. Tack weld plate to form a cross, place in the positioner for vertical welding.
7. Establish an arc, raise electrode slightly, move to the starting point.
8. Lower electrode to the proper arc length.
9. Hold electrode to a 60° angle downward from the joint, make a rapid weave motion while moving down.
10. Clean away all slag after each pass is completed.
11. Continue weaving beads for 3 more passes to fill the joint to the required dimension.
12. Repeat this procedure until the desired weld is produced.
13. Show work to your instructor, discuss results.



A. VERTICAL POSITION



B. WELD SEQUENCE



NAME GROOVE WELD	MILESTONE M "V" GROOVE BUTT WELDS IN THE VERTICAL DOWN POSITION		MODULE NO. III
			FIGURE NO. 26
ELECTRODE SIZE $\frac{5}{32}$ DIA. DC/RP	TYPE AWS - E - 6010		
MATERIAL	SPEC	AMT	SIZE
STEEL	MILD	3	$\frac{3}{8} \times \frac{1}{2} \times 6$

ADVANCED SHIELDED METAL-ARC WELDING

Module III. Groove Weld

Milestone M, 'V' Groove Butt Welds in the Vertical Down Position

Project 26; Time: 3 hours

INTRODUCTION

The student will make a groove butt weld in the vertical down position. This four pass weld consists of two stringer beads, finished with two weave beads. Use 5/32 inch E6010 electrodes. The cover pass will have a fine smooth ripple and no evidence of pinholes, porosity, or undercut.

EQUIPMENT REQUIRED

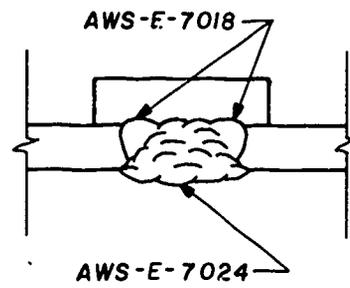
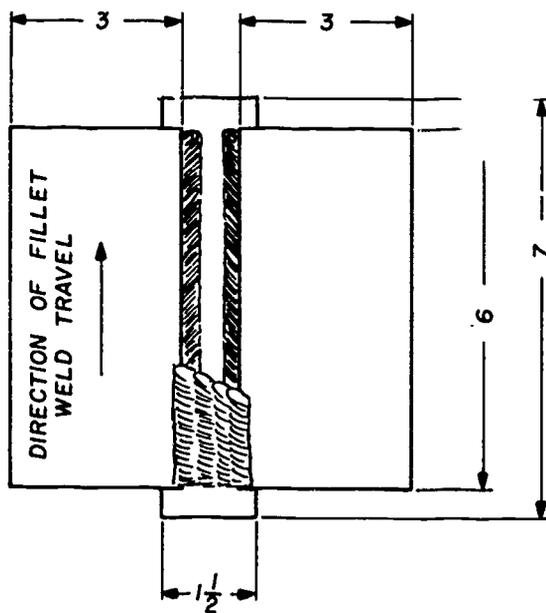
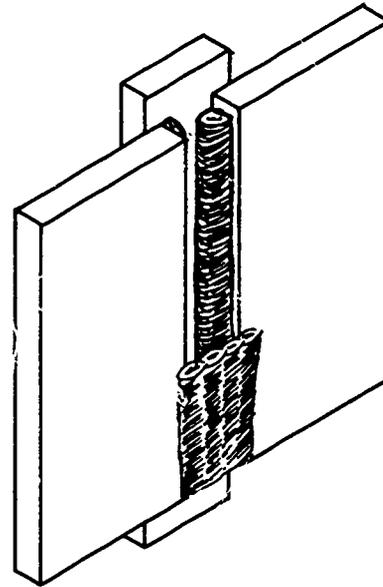
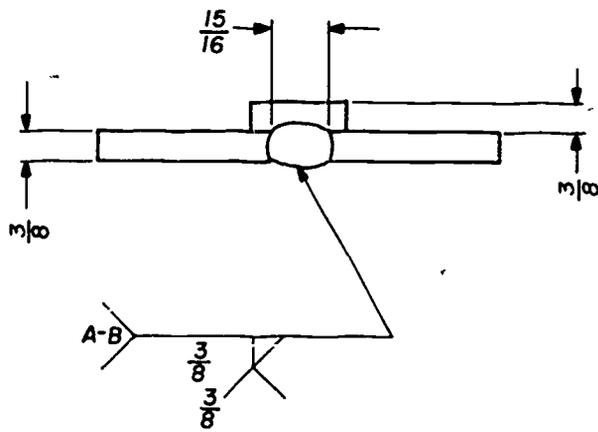
DC welding machine, slag hammer, wire brush, tongs, positioner and safety equipment.

MATERIAL NEEDED

3 pieces 3/8 x 1-1/2 x 6 inch steel plate beveled to 30° on one side, 5/32 inch E6010 electrodes.

PROCEDURE

1. Clean plate with wire brush.
2. Set amperage and polarity as directed.
3. Start welding machine.
4. Put on face shield and gloves.
5. Put electrode in holder.
6. Tack weld plates with 3/32 inch gap between the beveled edges, place in the positioner for vertical welding.
7. Establish an arc, raise electrode slightly, move to the starting point at the top of the joint.
8. Lower the electrode to the proper arc length.
9. Hold electrode at a 60° angle downward from joint, move down with a fast weave bead.
10. Clean away slag completely after each pass.
11. Make a weave bead for each succeeding pass until groove is filled.
12. Repeat this procedure until the desired weld is produced.
13. Show work to your instructor, discuss the results.



- A. AWS-E-7018 FILLET WELD VERTICAL POSITION.
- B. AWS-E-7024 GROOVE WELD OPTIONAL POSITION.

NAME GROOVE WELD		MILESTONE N WELD SOUNDNESS IN THE VERTICAL POSITION		MODULE NO. III FIGURE NO. 27	
ELECTRODE SIZE $\frac{1}{8}$ DIA. DC/RP		TYPE AWS-E-7018 / AWS-E-7024			
MATERIAL STEEL		SPEC. MILD	AMT 1	SIZE $\frac{3}{8} \times \frac{1}{2} \times 7$	
STEEL		MILD	2	$\frac{3}{8} \times 3 \times 6$	

ADVANCED SHIELDED METAL-ARC WELDING

Module III. Groove Weld

Milestone N, Weld Soundness, Vertical Position

Project 27; Time: 9 hours

INTRODUCTION

The student will make a weld on square cut plates tack welded to a backing strip so that there will be two fillet welds at each side of the groove. These will be made in the vertical position, using E7018 electrodes. The remaining weld beads are deposited in the flat position using E7024 electrodes until the fillets are covered and the groove is filled.

EQUIPMENT REQUIRED

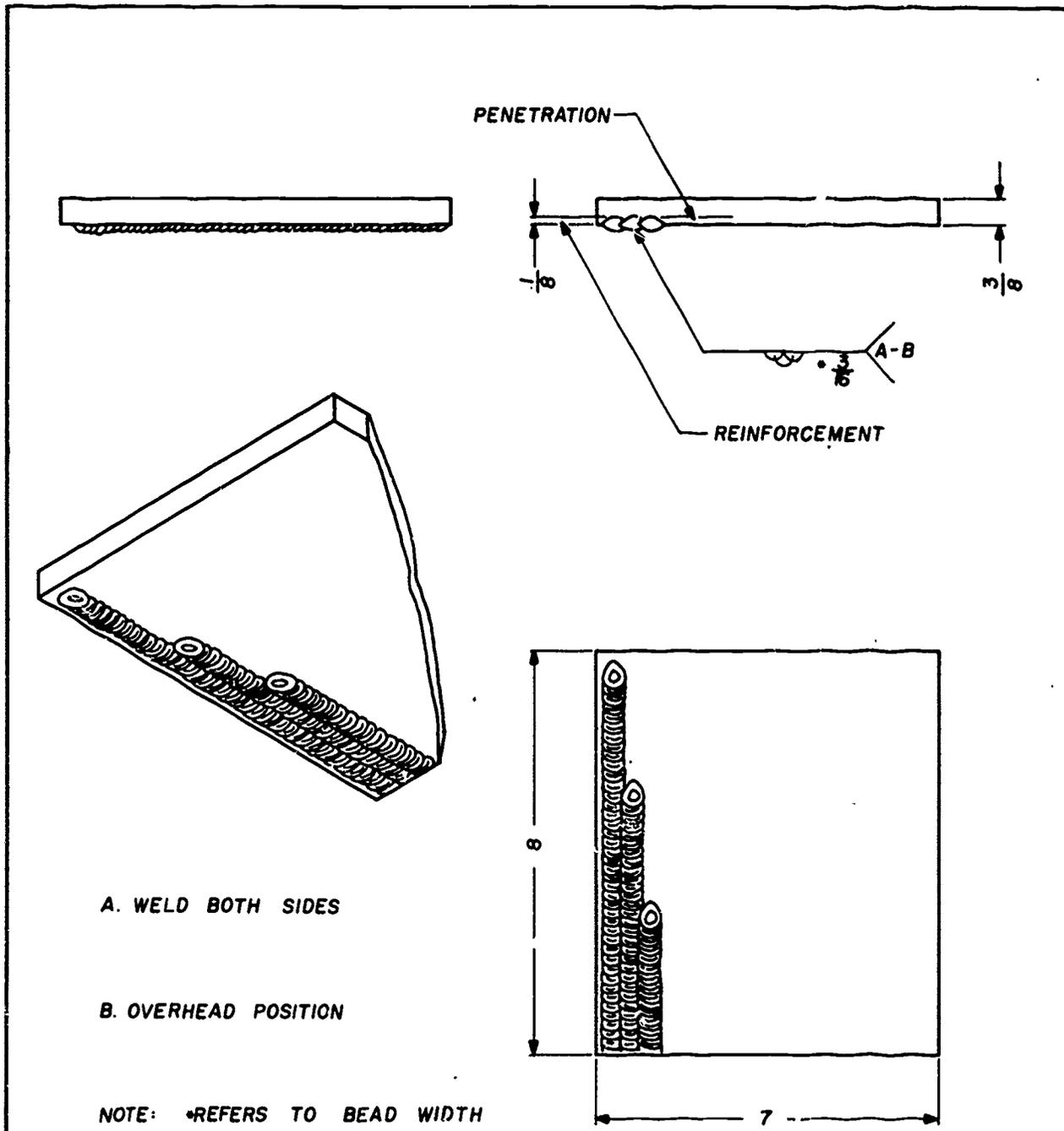
DC welding machine, slag hammer, wire brush, tongs, positioner and safety equipment.

MATERIAL NEEDED

2 pieces 3/8 x 3 x 6 inch, 1 piece 3/8 x 1-1/2 x 7 inch steel plate, 1/8 inch E7018 and E7024 electrodes.

PROCEDURE

1. Clean plates with wire brush.
2. Set amperage and polarity as directed.
3. Start welding machine.
4. Put on face shield and gloves.
5. Put electrode in holder.
6. Assemble plates for a double lap joint with a 15/16 inch opening between the plates. Tack weld these to the backing strip on the back side.
7. Place in the positioner for vertical welding.
8. Use 1/8 inch E7018 electrodes to make two fillets at each side of the groove.
9. Place in the flat position, remove slag completely.
10. Use 1/8 inch E7024 electrodes to fill the groove with overlapping beads. There should be no evidence of slag inclusions, pinholes, or porosity. The ends of the joints must be full and straight.
11. Repeat this procedure until the desired weld is produced.
12. Save the material for practice welding.



NAME SURFACING WELD		MILESTONE F SURFACING WELDS IN THE OVERHEAD POSITION		MODULE NO. I	
				FIGURE NO. 28	
ELECTRODE SIZE $\frac{5}{32}$ DIA. DC/RP		TYPE AWS - E - 6010			
MATERIAL	SPEC.	AMT	SIZE		
STEEL	MILD	1	$\frac{3}{8}$ X 7 X 8		

ADVANCED SHIELDED METAL-ARC WELDING

Module I. Surfacing Weld

Milestone F, Surfacing Welds in the Overhead Position

Project 28: Time: 6 hours

INTRODUCTION

The student will deposit surfacing welds on both sides of a steel plate. This will be done in the overhead position, using 5/32 inch E6010 electrodes, overlap each bead by 50%. The surface should be uniform in buildup and appearance.

EQUIPMENT REQUIRED

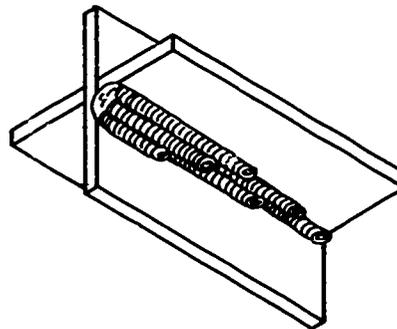
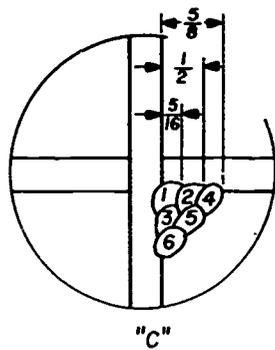
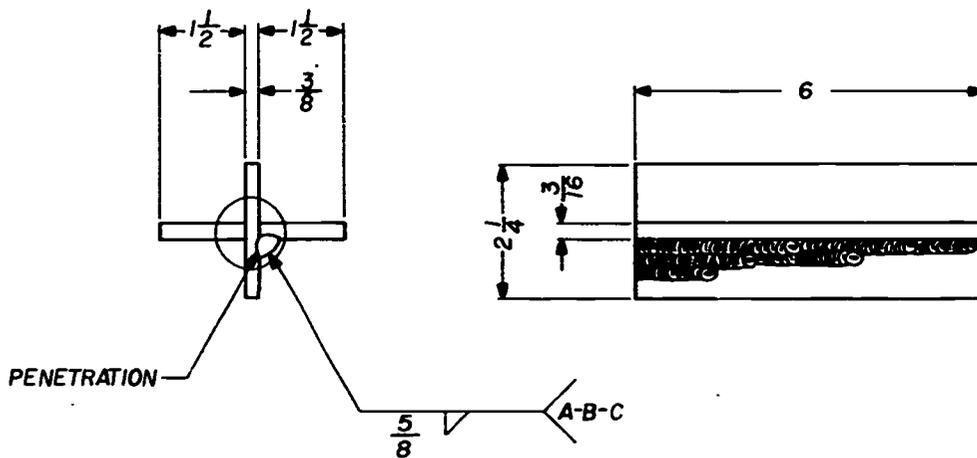
DC welding machine, slag hammer, wire brush, tongs, positioner and safety equipment.

MATERIAL NEEDED.

1 piece 3/8 x 7 x 8 inch steel plate, 5/32 inch E6010 electrodes.

PROCEDURE

1. Clean plate with wire brush, place in positioner for overhead welding.
2. Set amperage and polarity as directed.
3. Start welding machine.
4. Put on face shield and gloves.
5. Put electrode in holder.
6. Establish an arc, lower the electrode slightly, move to the starting point.
7. Raise electrode to proper arc length.
8. Hold electrode 90° to the plate, the work angle, and with a leading angle of 45°.
9. Use a forward and back motion in small increments, arc length should not change.
10. Use all electrodes down to a stub 1-1/2 inches long.
11. Clean off all slag after each pass is completed.
12. Repeat until plate is covered with a uniform surface.
13. Show work to your instructor for a discussion of the results.
14. Save material for further projects.



- A. WELD ALL FOUR CORNERS
- B. OVERHEAD POSITION
- C. WELD SEQUENCE

NAME FILLET WELD		MILESTONE K FILLET WELDS IN THE OVERHEAD POSITION		MODULE NO. II FIGURE NO. 29
ELECTRODE SIZE $\frac{5}{32}$ DIA. DC/RP		TYPE AWS-E-6010		
MATERIAL	STEEL	SPEC. MILD	AMT. 2	SIZE $\frac{3}{16} \times \frac{1}{2} \times 6$
	STEEL	MILD	1	$\frac{3}{16} \times 2\frac{1}{4} \times 6$

ADVANCED SHIELDED METAL-ARC WELDING

Module II. Fillet Weld

Milestone K, Multiple Pass Fillet Welds in the Overhead Position

Project 29; Time: 6 hours

INTRODUCTION

The student will make a fillet weld set for welding in the overhead position. This set will contain 4 welds with six beads each. The first bead will make a $5/16$ inch weld. The second and third beads will make a $1/2$ inch weld. The fourth, fifth, and sixth beads will complete the fillets to $5/8$ inch. These should have a flat face, equal leg length, and uniform ripple.

EQUIPMENT REQUIRED

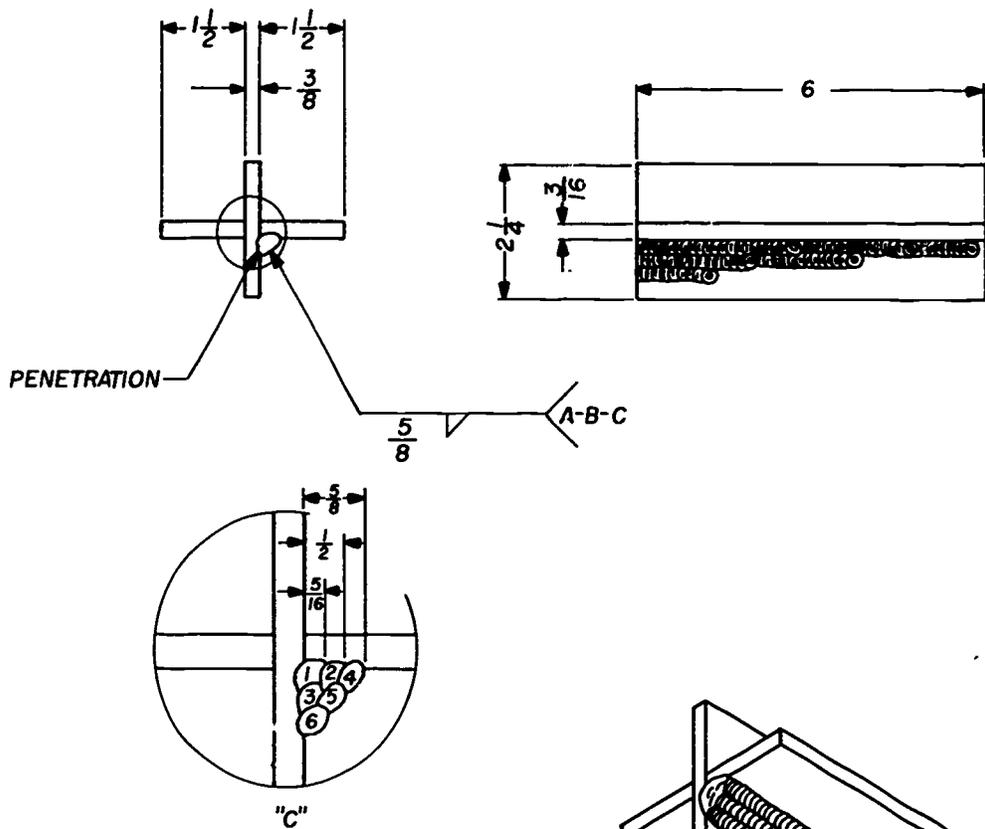
DC welding machine, slag hammer, wire brush, tongs, positioner and safety equipment.

MATERIAL NEEDED

2 pieces $3/16$ x $1-1/2$ x 6 inch, 1 piece $3/16$ x $2-1/4$ x 6 inch steel plate, $5/32$ inch E6010 electrodes.

PROCEDURE

1. Clean plate with wire brush.
2. Set amperage and polarity as directed.
3. Start welding machine.
4. Put on face shield and gloves.
5. Put electrode in holder.
6. Tack weld plates to form a cross, place in positioner for overhead welding.
7. Establish an arc, lower electrode slightly, move to the starting point.
8. Raise electrode to the proper arc length.
9. Deposit beads with a forward and back motion in small increments, hold a constant arc length.
10. After each bead is completed remove all slag.
11. Continue welding, overlapping each bead, until the $5/8$ inch leg length is reached.
12. Repeat this procedure until a proper weld is produced.
13. Check the weld dimension with gage.



A. WELD ALL FOUR CORNERS

B. OVERHEAD POSITION

C. WELD SEQUENCE

NAME FILLET WELD		MILESTONE L FILLET WELDS IN THE OVERHEAD POSITION		MODULE NO. II FIGURE NO. 30
ELECTRODE SIZE $\frac{1}{8}$ DIA. DC/RP		TYPE AWS-E-7018		
MATERIAL	STEEL	SPEC. MILD	AMT. 2	SIZE $\frac{3}{16} \times \frac{1}{2} \times 6$
	STEEL	MILD	1	$\frac{3}{16} \times 2\frac{1}{4} \times 6$

ADVANCED SHIELDED METAL-ARC WELDING

Module II. Fillet Weld

Milestone L, Multiple Pass Fillet Welds in the Overhead Position

Project 30; Time: 6 hours

INTRODUCTION

The student will make a fillet weld set for welding in the overhead position. This set will contain 4 welds with six beads each. The first bead will make a 5/16 inch weld. The second and third beads will make a 1/2 inch weld. The fourth, fifth, and sixth beads will complete the fillets to 5/8 inch. These should have a flat face, equal leg length, and uniform ripple.

EQUIPMENT REQUIRED

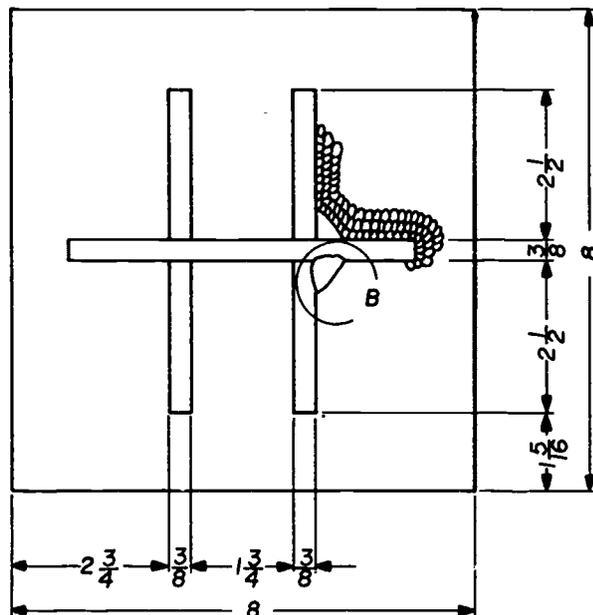
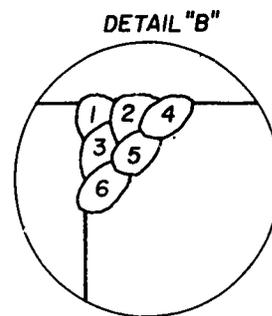
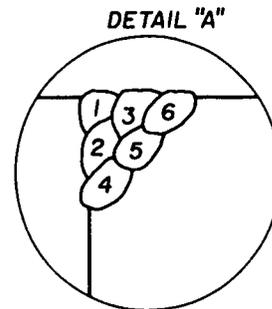
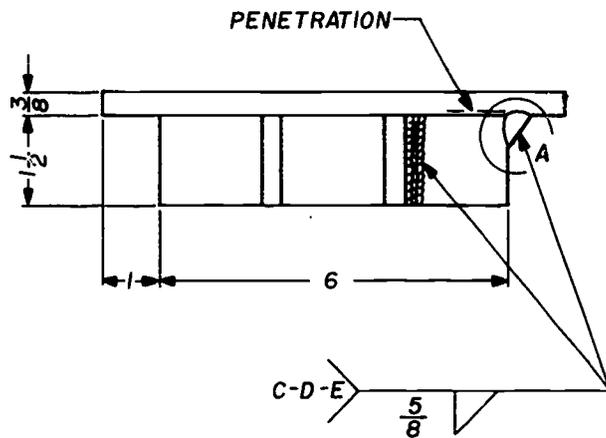
DC welding machine, slag hammer, wire brush, tongs, positioner and safety equipment.

MATERIAL NEEDED

2 pieces 3/16 x 1-1/2 x 6 inch, 1 piece 3/16 x 2-1/4 x 6 inch steel plate, 1/8 inch E7018 electrodes.

PROCEDURE

1. Clean plate with wire brush.
2. Set amperage and polarity as directed.
3. Start welding machine.
4. Put on face shield and gloves.
5. Put electrode in holder.
6. Assemble and tack weld pieces at 90° to form a cross, plate in the positioner for overhead welding.
7. Establish an arc, lower electrode slightly, move to the starting point.
8. Raise electrode to the proper arc length.
9. Practice as demonstrated by the instructor using a "C" motion for better puddle control and penetration.
10. After each bead is completed, remove slag completely.
11. Continue welding, overlapping each bead until the 5/8 inch leg dimension is reached.
12. Repeat this procedure until a proper weld is produced.
13. Check fillet dimension with gage.



C. WELD ALL EIGHT CORNERS

D. WELD ALL AROUND

E. VERTICAL FIXED POSITION

NAME FILLET WELD		MILESTONE M CORNER WELDS IN THE VERTICAL FIXED POSITION		MODULE NO. II FIGURE NO. 31
ELECTRODE SIZE $\frac{5}{32}$ DIA. DC/RP		TYPE AWS-E-6010		
MATERIAL	STEEL	SPEC. MILD	AMT 1	SIZE $\frac{3}{8} \times 8 \times 8$
	STEEL	MILD	1	$\frac{3}{8} \times 1\frac{1}{2} \times 6$
	STEEL	MILD	4	$\frac{3}{8} \times 1\frac{1}{2} \times 2\frac{1}{2}$

ADVANCED SHIELDED METAL-ARC WELDING

Module II. Fillet Weld

Milestone M, Corner Welds in the Vertical Fixed Position

Project 31; Time: 12 hours

INTRODUCTION

The student will make a multiple corner fillet weld set. This will have six outside corner welds, four unobstructed corner welds, and four obstructed corner welds. Use six passes for each weld with 5/32 inch E6010 electrodes. All welds will have equal leg lengths of 5/8 inch with a flat face and no undercut.

EQUIPMENT REQUIRED

DC welding machine, slag hammer, wire brush, tongs, positioner and safety equipment.

MATERIAL NEEDED

1 piece 3/8 x 8 x 8 inch, 1 piece 3/8 x 1-1/2 x 6 inch, 4 pieces 1/8 x 1-1/2 x 2-1/2 inch steel plate, 5/32 inch E6010 electrodes.

PROCEDURE

1. Clean plate with wire brush.
2. Set amperage and polarity as directed.
3. Start welding machine.
4. Put on face shield and gloves.
5. Put electrode in holder.
6. Tack weld the pieces together as shown in the drawing. A sample is on the display board.
7. Place this assembly in the positioner for vertical welding.
8. Establish an arc, raise the electrode slightly, move to the starting point.
9. Lower the electrode to the proper arc length.
10. Deposit the root beads in all of the joints on both sides of the plate before completing any one weld.
11. Chip and wire brush the welds to completely remove slag.
12. Practice welding as demonstrated by your instructor, use an up and down motion in small increments.
13. Repeat this procedure until consistent welds are produced.
14. Show work to your instructor for a discussion of the results.

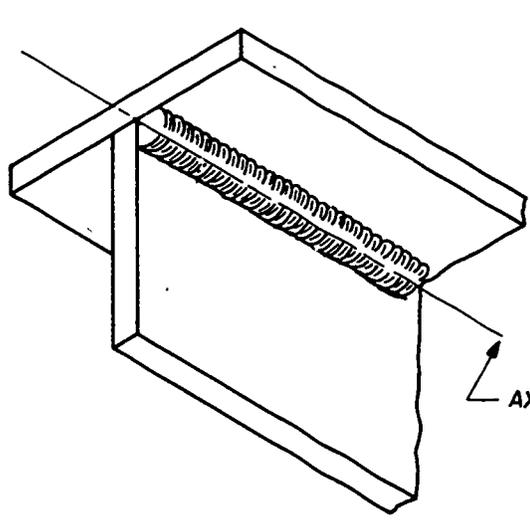
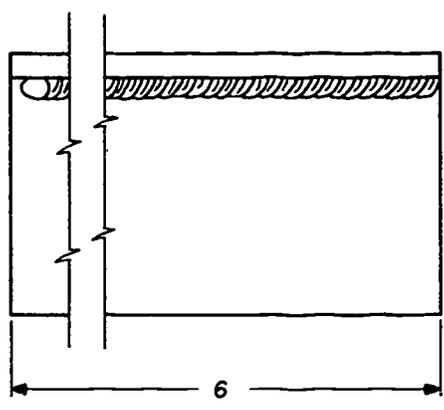
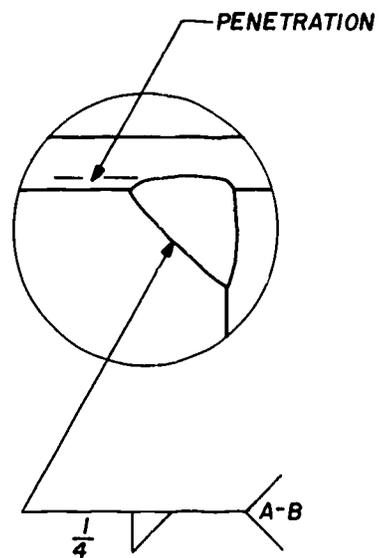
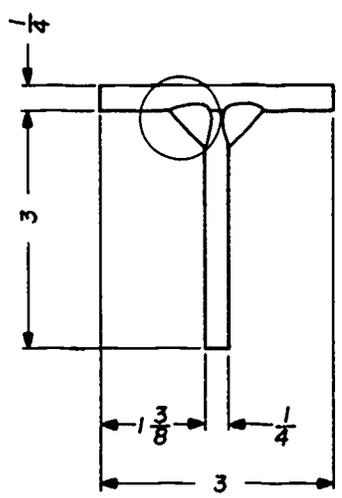


PLATE IS IN OVERHEAD POSITION FOR TEST.



A. TEST, FILLET WELD.



B. OVERHEAD POSITION.

NAME FILLET WELD		MILESTONE N FILLET WELD TEST AWS - ASME		MODULE NO. II	
				FIGURE NO. 31-A	
ELECTRODE SIZE $\frac{5}{32}$ DIA. DC/RP		TYPE AWS - E - 6010			
MATERIAL		SPEC.	AMT	SIZE	
STEEL		MILD	2	$\frac{1}{4}$ X 12 X 3	

ADVANCED SHIELDED METAL-ARC WELDING

Module II. Fillet Weld

Milestone N, Fillet Weld Test, Overhead Position

Project 31-A

INTRODUCTION

The student will demonstrate his ability to pass the ASME fillet weld test as it is described in the ASME Fired and Unfired Pressure Vessel Code, Section IX, Fig.Q4(d), or the AWS fillet weld test described in the D1.0-72, Fig.A-3, 4F(d).

EQUIPMENT REQUIRED

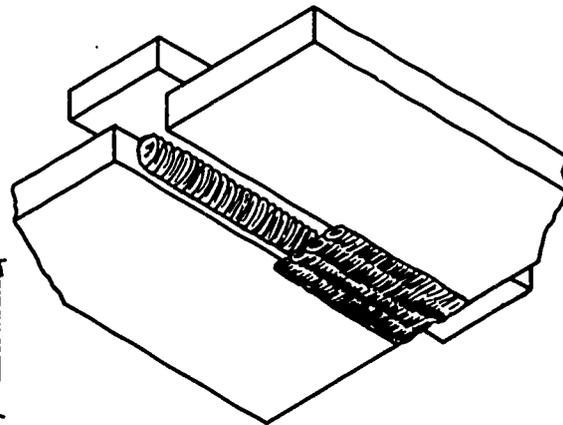
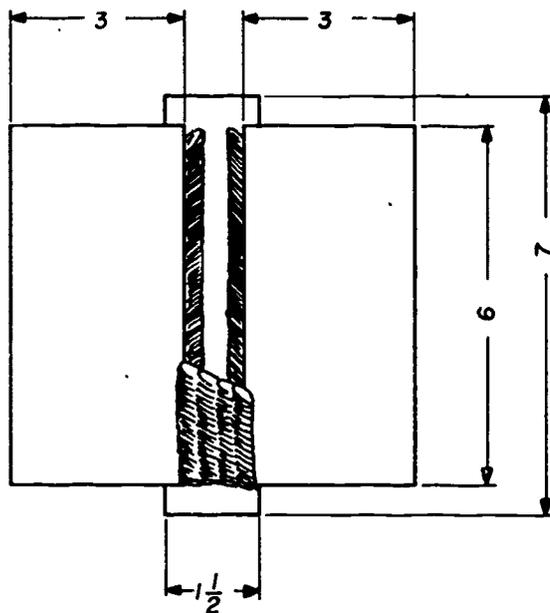
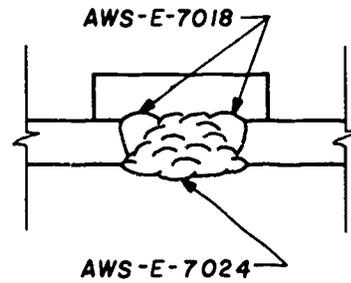
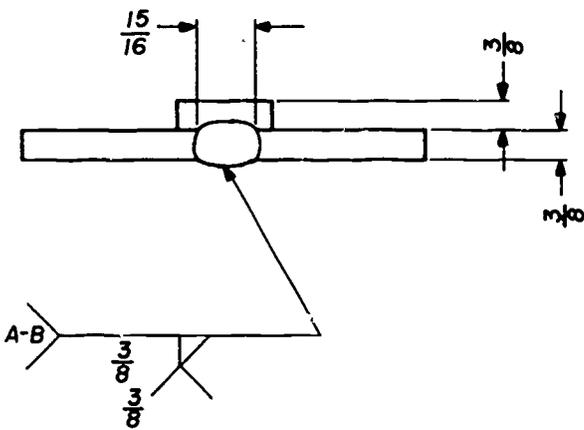
DC welding machine, slag hammer, wire brush, tongs, positioner and safety equipment.

MATERIAL NEEDED

2 pieces 1/4 x 3 x 12 inch ASTM A36 steel plate, 5/32 inch E6010 electrodes.

PROCEDURE

1. Clean plate with wire brush.
2. Set amperage and polarity as directed.
3. Start welding machine.
4. Put on face shield and gloves.
5. Put electrode in holder.
6. Tack weld plate to form a 'T' joint, place in positioner for overhead welding.
7. Establish an arc, lower electrode slightly, move to the starting point.
8. Raise electrode to the proper arc length.
9. Weld from left to right, using a forward and back motion, with a constant arc length. Each bead must be stopped and restarted at the midpoint of the bead.
10. The completed weld should have equal leg length of 1/4 inch.
11. There is no wrap around weld or return at the corners.
12. Test this weld as shown in the ASME procedure.



A. AWS-E-7018 FILLET WELD OVERHEAD POSITION

B. AWS-E-7024 GROOVE WELD OPTIONAL POSITION

NAME GROOVE WELD	MILESTONE 0		MODULE NO. III
	WELD SOUNDNESS IN THE OVERHEAD POSITION		FIGURE NO. 32
ELECTRODE SIZE $\frac{1}{8}$ DIA. DC/RP	TYPE AWS-E-7018 / AWS-E-7024		
MATERIAL STEEL	SPEC. MILD	AMT 1	SIZE $\frac{3}{8} \times \frac{1}{2} \times 7$
STEEL	MILD	2	$\frac{3}{8} \times 3 \times 6$

ADVANCED SHIELDED METAL-ARC WELDING

Module III. Groove Weld

Milestone 0, Weld Soundness, Overhead Position

Project 32; Time: 3 hours

INTRODUCTION

The student will make a weld on square cut plates which are tack welded to a backing strip. This forms a groove for two fillet welds at each side. These will be made in the overhead position using E7018 electrodes. The remaining weld beads will be deposited in the flat position using E7024 electrodes to complete filling the groove.

EQUIPMENT REQUIRED

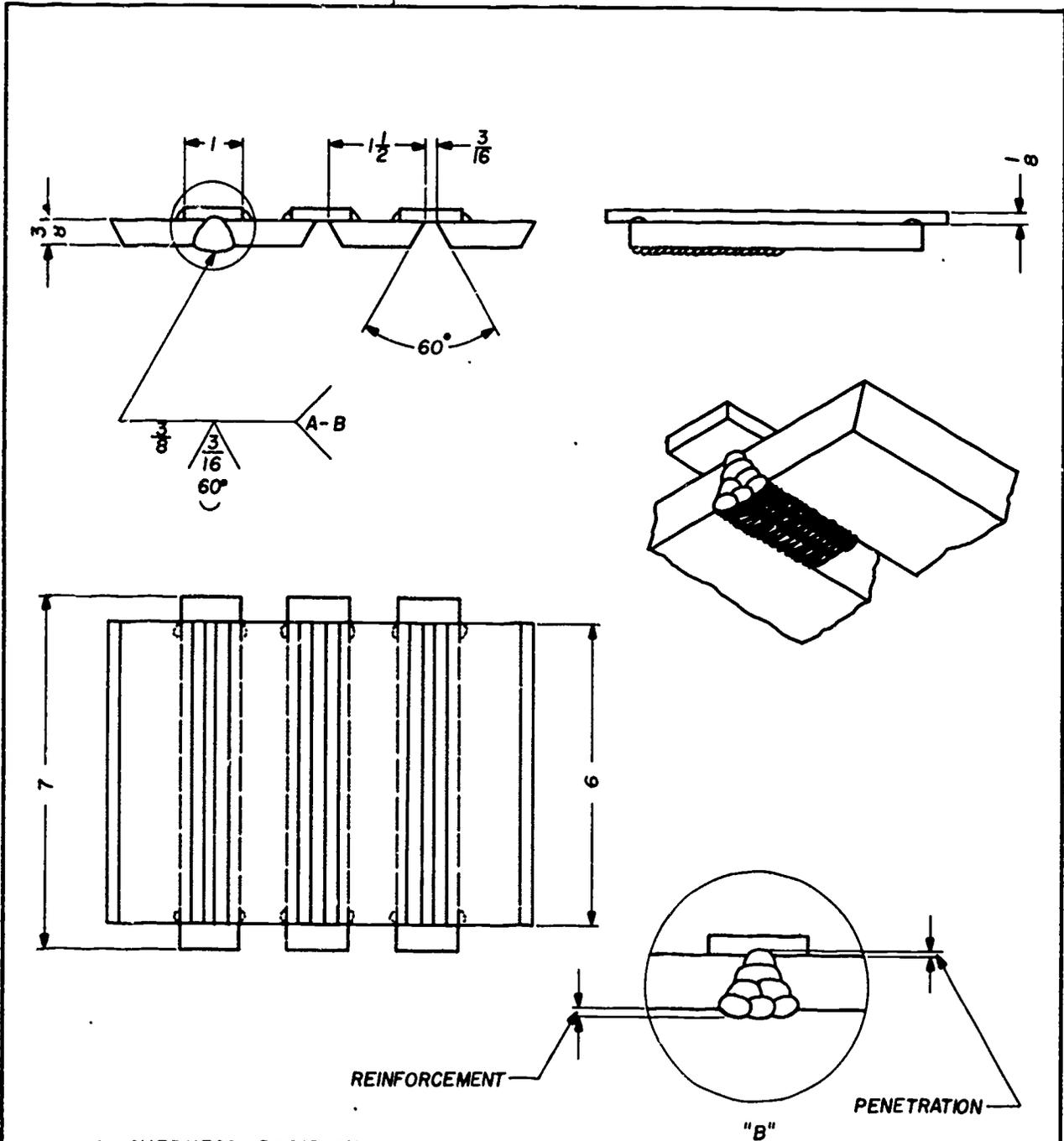
DC welding machine, slag hammer, wire brush, tongs, positioner and safety equipment.

MATERIAL NEEDED

1 piece $3/8 \times 1-1/2 \times 7$ inch, 2 pieces $3/8 \times 3 \times 6$ inch square cut steel plate, $1/8$ inch E7018 and E7024 electrodes.

PROCEDURE

1. Clean plate with wire brush.
2. Set amperage and polarity as directed.
3. Start welding machine.
4. Put on face shield and gloves.
5. Put electrode in holder.
6. Tack weld the plates to form a double lap joint with the backing strip. Leave an opening of $15/16$ inch between the square cut pieces.
7. Place in the positioner for overhead welding.
8. Weld the two fillets using E7018 electrodes. Direct the arc to the corners for good penetration.
9. Place in the flat position, clean away all slag, complete the weld by filling the groove with overlapping beads. Use E7024 electrodes for this.
10. Repeat this procedure until the desired weld is produced.
11. Save material for weld practice.



A. OVERHEAD POSITION

B. WELD SEQUENCE

NAME GROOVE WELD		MILESTONE P "V" GROOVE BUTT WELDS W/BACK UP IN THE OVERHEAD POSITION			MODULE NO. <u>II</u>	
					FIGURE NO. 33	
ELECTRODE SIZE	$\frac{5}{32}$ DIA.	DC/RP	TYPE	AWS - E - 6010		
MATERIAL	STEEL		SPEC. MILD	AMT 4	SIZE $\frac{3}{8} \times \frac{1}{2} \times 6$	
	STEEL		MILD	3	$\frac{1}{8} \times 1 \times 7$	

ADVANCED SHIELDED METAL-ARC WELDING

Module III. Groove Weld

Milestone P, 'V' Groove Butt Welds with Backing Strip, in the Overhead Position

Project 33; Time: 9 hours

INTRODUCTION

The student will make a 'V' groove with backing strip in the overhead position. Use 5/32 inch E6010 electrodes. Place beads in the following order: first, root bead; second, single bead; third, two overlapping beads; fourth, three bead cover. The cover pass will have a uniform appearance and no undercut.

EQUIPMENT REQUIRED

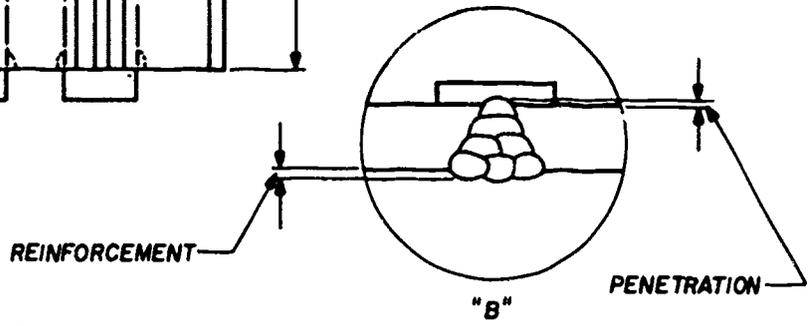
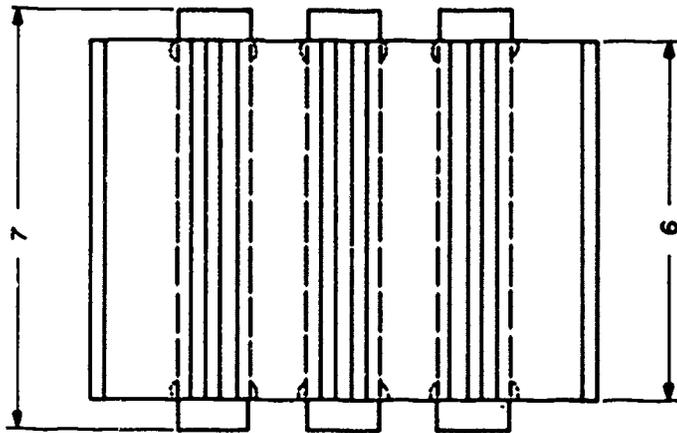
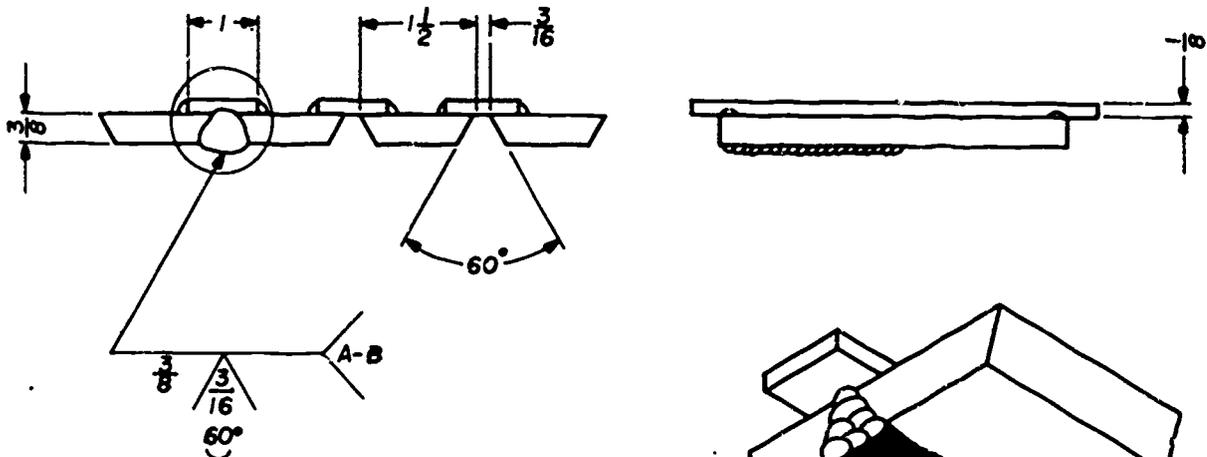
DC welding machine, slag hammer, wire brush, tongs, positioner, and safety equipment.

MATERIAL NEEDED

4 pieces 3/8 x 1-1/2 x 6 inch steel plate beveled to 30° on one side, 3 pieces 1/8 x 1 x 7 inch steel strip, 5/32 inch E6010 electrodes.

PROCEDURE

1. Clean plate with wire brush.
2. Set amperage and polarity as directed.
3. Start welding machine.
4. Put on face shield and gloves.
5. Put electrode in holder.
6. Assemble the plates for a 'V' groove butt joint with a 3/16 inch root opening. Tack weld these to the backing strip. Place in the positioner for overhead welding.
7. Establish an arc, lower electrode slightly, move to the starting point.
8. Raise electrode to the proper arc length.
9. Make the first bead, fusing the two beveled edges to the backing strip. Use a forward and back motion with a constant arc length.
10. Clean away slag completely when each pass is finished.
11. Continue depositing stringer beads for the succeeding passes and the cover.
12. The reinforcement should be slightly convex, uniform in appearance. It should not be more than 1/8 inch thicker than the plate or more than 1/16 inch wider at each side of the groove.
13. Repeat this procedure until the desired weld is produced.
14. Show work to your instructor, discuss the results.
15. Save material for weld practice.



A. OVERHEAD POSITION
 B. WELD SEQUENCE

NAME GROOVE WELD		MILESTONE Q "V" GROOVE BUTT WELDS W/ BACK UP IN THE OVERHEAD POSITION			MODULE NO. III
					FIGURE NO. 34
ELECTRODE SIZE	1/8 DIA. DC/RP	TYPE	AWS - E - 7018		
MATERIAL	STEEL	SPEC. MILD	AMT. 4	SIZE 3/8 X 1 1/2 X 6	
	STEEL	MILD	3	1/8 X 1 X 7	

ADVANCED SHIELDED METAL-ARC WELDING

Module III: Groove Weld

Milestone Q, 'V' Groove Butt Welds with Backing Strip, in the Overhead Position

Project 34; Time: 9 hours

INTRODUCTION

The student will make a 'V' groove butt joint with backing strip weld in the overhead position. Use 1/8 inch E7018 electrodes in the following sequence: first, root bead; second, single bead; third, two overlapping beads; fourth, three bead cover. The cover will have a uniform appearance and no undercut.

EQUIPMENT REQUIRED

DC welding machine, slag hammer, wire brush, tongs, positioner and safety equipment.

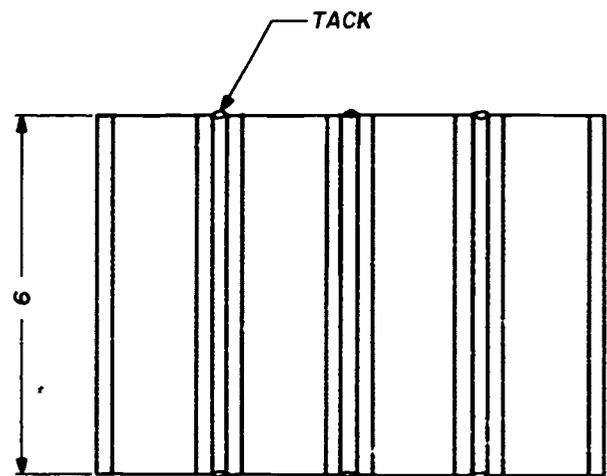
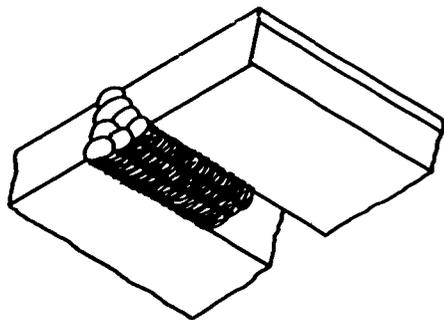
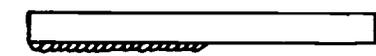
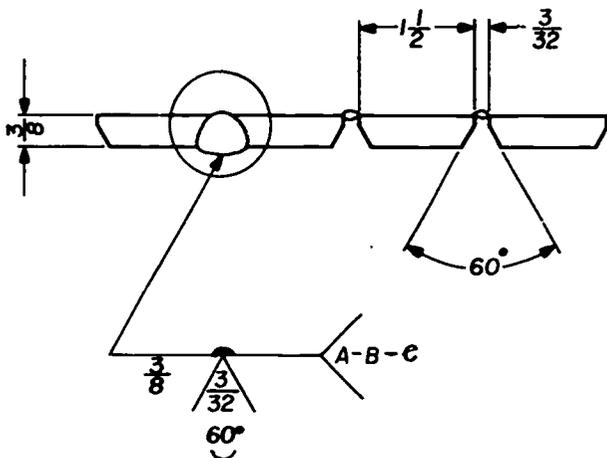
MATERIAL NEEDED

4 pieces 3/8 x 1-1/2 x 6 inch steel plate beveled to 30° on one side. 3 pieces 1/8 x 1 x 7 inch steel for the backing strip, 1/8 inch E7018 electrodes.

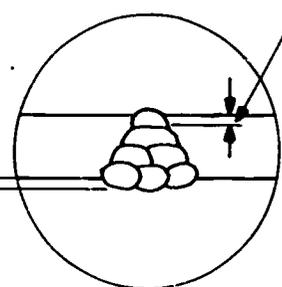
PROCEDURE

1. Clean plate with wire brush.
2. Set amperage and polarity as directed.
3. Start welding machine.
4. Put on face shield and gloves.
5. Put electrode in holder.
6. Assemble plate for a groove joint with 3/16 inch root opening, tack weld to backing strip. Place in the positioner for overhead welding.
7. Establish an arc, lower electrode slightly, move to the starting point.
8. Raise electrode to the proper arc length.
9. Make root bead, fusing the beveled edges together and to the backing strip. Use a small weaving motion with a constant arc length.
10. After completing each bead, clean all slag from metal.
11. Place additional beads as directed until the groove is filled.
12. The reinforcement should not be more than 1/8 inch thicker than the plate, or wider than 1/16 inch at each side of the groove.
13. Repeat this procedure until an acceptable weld is produced.
14. Show work to your instructor for a discussion of results.
15. Save material for welding practice.

Note: The root opening may vary according to local practice or design. This may require a greater number of beads for completion of the joint.



$\frac{3}{32}$ ROOT FACE



"B"

- A. OVERHEAD POSITION
- B. WELD SEQUENCE
- C. SUBSTITUTE 6 IN. PIPE IF AVAILABLE

REINFORCEMENT

NAME GROOVE WELD		MILESTONE R "V" GROOVE BUTT WELDS IN THE OVERHEAD POSITION		MODULE NO. III	
				FIGURE NO. 35	
ELECTRODE SIZE	$\frac{5}{32}$ DIA. DC/RP	TYPE	AWS - E - 6010		
MATERIAL	STEEL	SPEC. MILD	AMT 4	SIZE $\frac{3}{8} \times \frac{1}{2} \times 6$	

ADVANCED SHIELDED METAL-ARC WELDING

Module III. Groove Weld

Milestone R, 'V' Groove Butt Welds in the Overhead Position
(When available, substitute 6 inch pipe)

Project 35; Time: 6 hours

INTRODUCTION

The student will make a groove butt weld without backup strip in the overhead position. Use 5/32 inch E6010 electrodes. Beads will be placed: root bead with full penetration; second, single bead; third, two overlapping beads; fourth, three bead cover. Inspect the sample weld on the display board for guidance.

EQUIPMENT REQUIRED

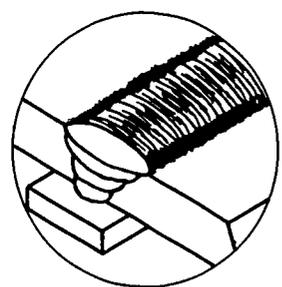
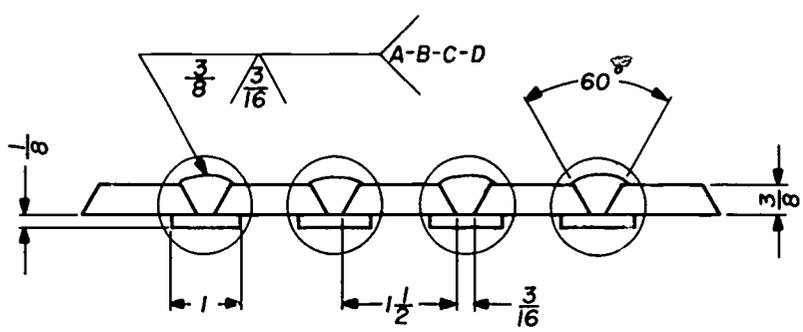
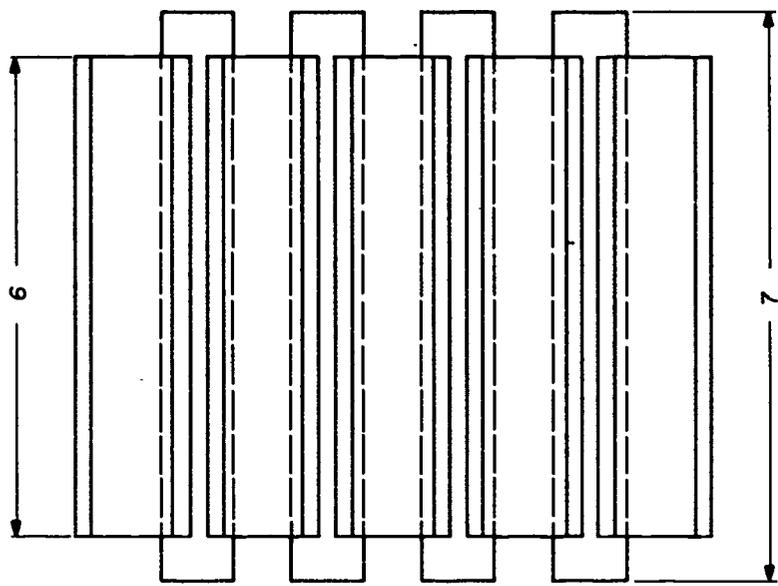
DC welding machine, slag hammer, wire brush, tongs, positioner and safety equipment.

MATERIAL NEEDED

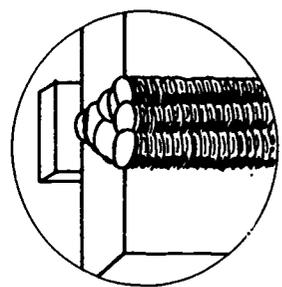
4 pieces 3/8 x 1-1/2 x 6 inch steel plate beveled to 30° on one side, 5/32 inch E6010 electrodes.

PROCEDURE

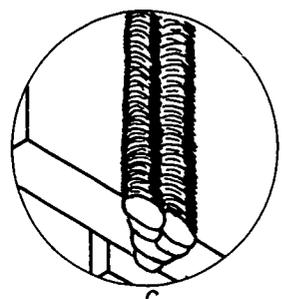
1. Clean plate with wire brush.
2. Set amperage and polarity as directed.
3. Start welding machine.
4. Put on face shield and gloves.
5. Put electrode in holder.
6. Assemble the plates and tack weld together with a root opening of 3/32 inches. Place in the positioner for overhead welding.
7. Establish an arc, lower electrode slightly, move to the starting point.
8. Raise electrode to the proper arc length.
9. Deposit a root bead with full penetration, drag electrode on plate edges.
10. After each pass is completed remove all slag.
11. Deposit succeeding beads as directed. The reinforcement should not be more than 1/8 inch above plate thickness, or wider than 1/16 inch at each side of the groove.
12. Repeat this procedure until the desired weld is produced.
13. Show work to your instructor, discuss the results.
14. Save material for practice welds.



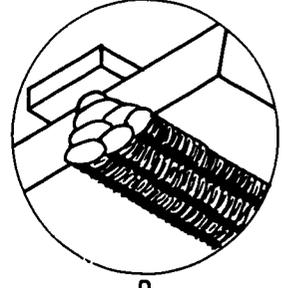
A



B



C



D

- A. FLAT POSITION
- B. HORIZONTAL POSITION
- C. VERTICAL POSITION
- D. OVERHEAD POSITION

NAME GROOVE WELD		MILESTONE S "V" GROOVE BUTT WELDS - TEST IN FOUR POSITIONS		MODULE NO. III
				FIGURE NO. 36
ELECTRODE SIZE	$\frac{5}{32}$ DIA. DC/RP	TYPE	AWS-E-6010	
MATERIAL	STEEL	SPEC.	AMT	SIZE $\frac{3}{8} \times 1\frac{1}{2} \times 6$
	STEEL	MILD	5	
		MILD	4	$\frac{1}{8} \times 1 \times 7$

ADVANCED SHIELDED METAL-ARC WELDING

Module III. Groove Weld

Milestone S, 'V' Groove Butt Weld Test in Four Positions

Project 36; Time: 3 hours

INTRODUCTION

The student will prepare beveled plates for welding four groove welds with backing strips. These are described in Section IX of the ASME Code, Fig. Q23, 1G(a), 2G(b), and 4G(c). After completing the welds, they will be machined to plate dimension; 1-1/2 inch coupons will be taken for bend testing. One face and one root bend will be made for each welding position. The student will prepare and bend these specimens. This project is only for training and not for certification.

EQUIPMENT REQUIRED

DC welding machine, slag hammer, wire brush, tongs, and safety equipment. The use of a shaper and bending press will also be required.

MATERIAL NEEDED

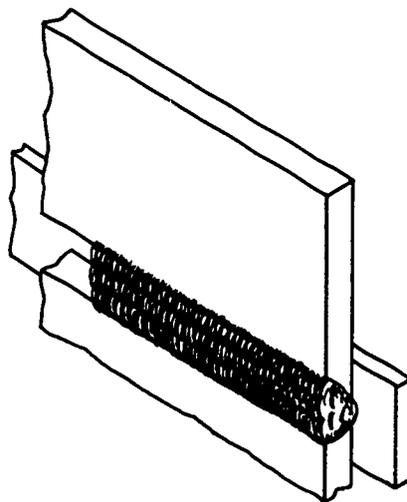
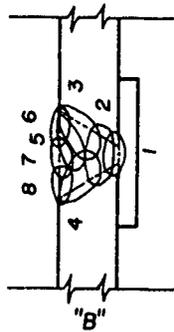
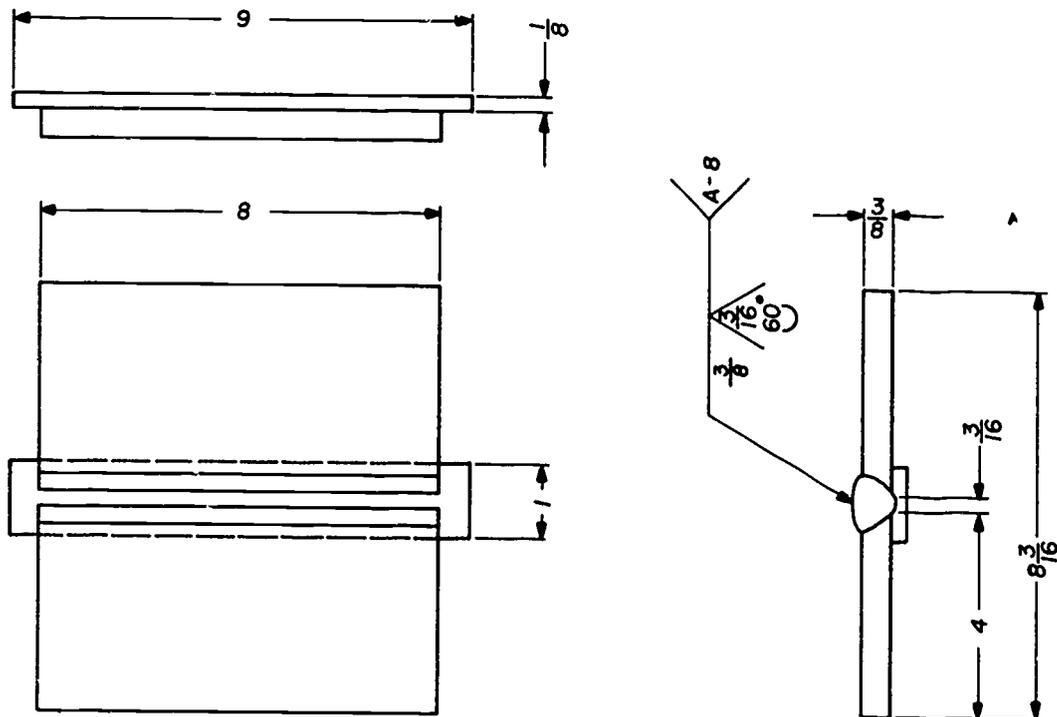
4 pieces 1/8 x 1 x 7 inch, 5 pieces 3/8 x 1-1/2 x 6 inch steel plate with a 30° bevel on each side, 5/32 inch E6010 electrodes.

PROCEDURE

1. Clean plate with wire brush.
2. Set amperage and polarity to specifications.
3. Start welding machine.
4. Put on face shield and gloves.
5. Put electrode in holder.
6. Tack weld the plates to form 4 'V' groove butt weld joints with 3/16 inch root opening. Place consecutively in the positioner for flat, horizontal, vertical and overhead welding.
7. Weld each joint with stringer beads at the root; clean and complete following the specifications shown on the drawing. Full fusion of the beveled and backing strips is required. Guard against slag inclusions, and pinholing.

SHIELDED METAL-ARC WELDING
CERTIFICATION
PHASE III PART A OBJECTIVE

Following the completion of both the basic and advanced arc welding programs, the trainee is given the opportunity to participate in arc certification practice for 180 hours (Part A). Eighty-percent of those students who take part in this work will have the ability to pass the American Society for Mechanical Engineers groove weld with backing strip test. The procedure is described in section IX Figure Q-23 (A) and Figure Q-3 position 2G, 3G, and 4G of the ASME boiler and pressure vessel code. The American Welding Society also describes the test in the AWS Manual D1.0-72, Code for Welding in Building Construction, Figure A-14, and positioned according to Figure A-2, 2G(b), 3G(c), 4G(d).



A. HORIZONTAL POSITION

B. WELD SEQUENCE

NAME ASME-AWS GROOVE WELD TESTS		MILESTONE A "V" GROOVE W/BACK UP IN THE HORIZONTAL POSITION		MODULE NO. I	
				FIGURE NO. 1	
ELECTRODE SIZE $\frac{5}{32}$ DIA. DC/RP		TYPE AWS-E-6010			
MATERIAL STEEL		SPEC. MILD	AMT. 2	SIZE $\frac{3}{8}$ X 4 X 8	
STEEL		MILD	1	$\frac{1}{8}$ X 1 X 9	

SHIELDED METAL-ARC WELDING CERTIFICATION TEST

Module I. ASME or AWS Groove Weld Tests

Milestone A, 'V' Groove with Backing Strip in the Horizontal Position

Project 1; Time: 12 hours

INTRODUCTION

The student will make a 'V' groove weld with backing strip in the horizontal position, using 5/32 inch E6010 electrodes. The beads to be deposited as follows: first pass, penetration; second pass, single bead; third pass, three beads; fourth pass, three bead cover. The finished weld must be of test quality to be used for qualifying the weldor's skill.

EQUIPMENT REQUIRED

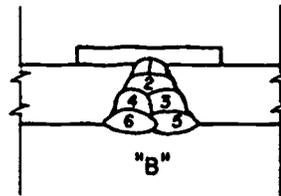
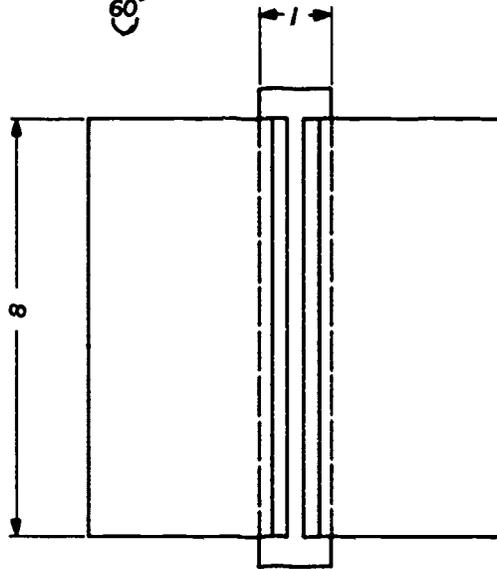
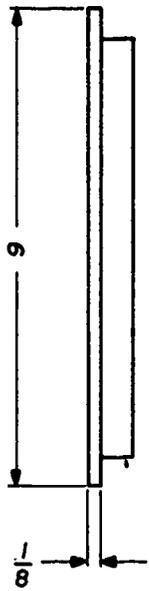
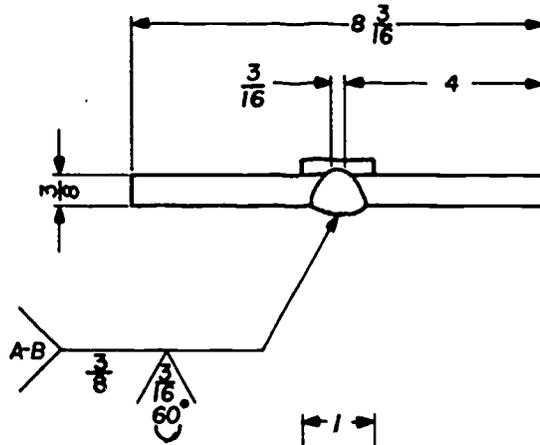
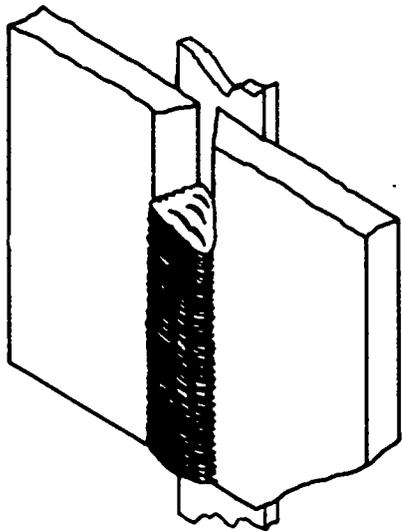
DC welding machine, slag hammer, wire brush, tongs, safety equipment, and shaper.

MATERIAL NEEDED

2 pieces 3/8 x 4 x 8 inch steel plate, beveled on one side to 30°, 1 piece 1/8 x 1 x 9 inch for the backing strip, 5/32 inch E6010 electrodes.

PROCEDURE

1. Clean the plates with wire brush.
2. Set the amperage and polarity to specification.
3. Start welding machine.
4. Put on face shield and gloves.
5. Place electrode in holder.
6. Drop face shield.
7. Tack weld the back side of the plates to the backing strip with a root opening of 3/16 inches.
8. Place this assembly in the positioner for welding in the horizontal position.
9. Establish an arc, raise electrode slightly, move to the starting point.
10. Power electrode to proper arc length.
11. Place the first pass using a forward and back motion in small increments.
12. After each pass is completed, chip and wire brush the weld so that it is completely clean of slag.
13. Place the succeeding beads as directed by your instructor.
14. Concentrate the arc on the edges of the previous bead.
15. Place the cover beads so that the total reinforcement will not exceed the plate thickness by more than 1/8 inch, nor be wider than 1/16 inch at each side of the groove.
16. Show work to your instructor for a discussion of the results.
17. Prepare for testing; remove all metal at the face and root of the weld down to plate thickness. Cut out 1-1/2 inch coupons for the bend test.



A. VERTICAL POSITION

B. WELD SEQUENCE

NAME ASME-AWS GROOVE WELD TESTS		MILESTONE B "V" GROOVE W/BACK UP IN THE VERTICAL POSITION		MODULE NO. I	
				FIGURE NO. 2	
ELECTRODE SIZE	$\frac{5}{32}$ DIA. DC/RP	TYPE	AWS - E - 6010		
MATERIAL	STEEL	SPEC.	MILD	AMT.	2
	STEEL		MILD		1
				SIZE	$\frac{3}{8}$ X 4 X 8
					$\frac{1}{8}$ X 1 X 9

SHIELDED METAL-ARC WELDING CERTIFICATION TEST

Module I. ASME or AWS Groove Weld Tests

Milestone B, 'V' Groove with Backing Strip in the Vertical Position

Project 2; Time: 18 hours

INTRODUCTION

The student will make a 'V' groove weld with backing strip in the vertical position, using 5/32 inch E6010 electrodes. The beads will be deposited as follows: first pass, penetration; second pass, single bead; third pass, two beads; fourth pass, two bead cover. The finished weld must be of test quality to be used for qualifying the welder's skill.

EQUIPMENT REQUIRED

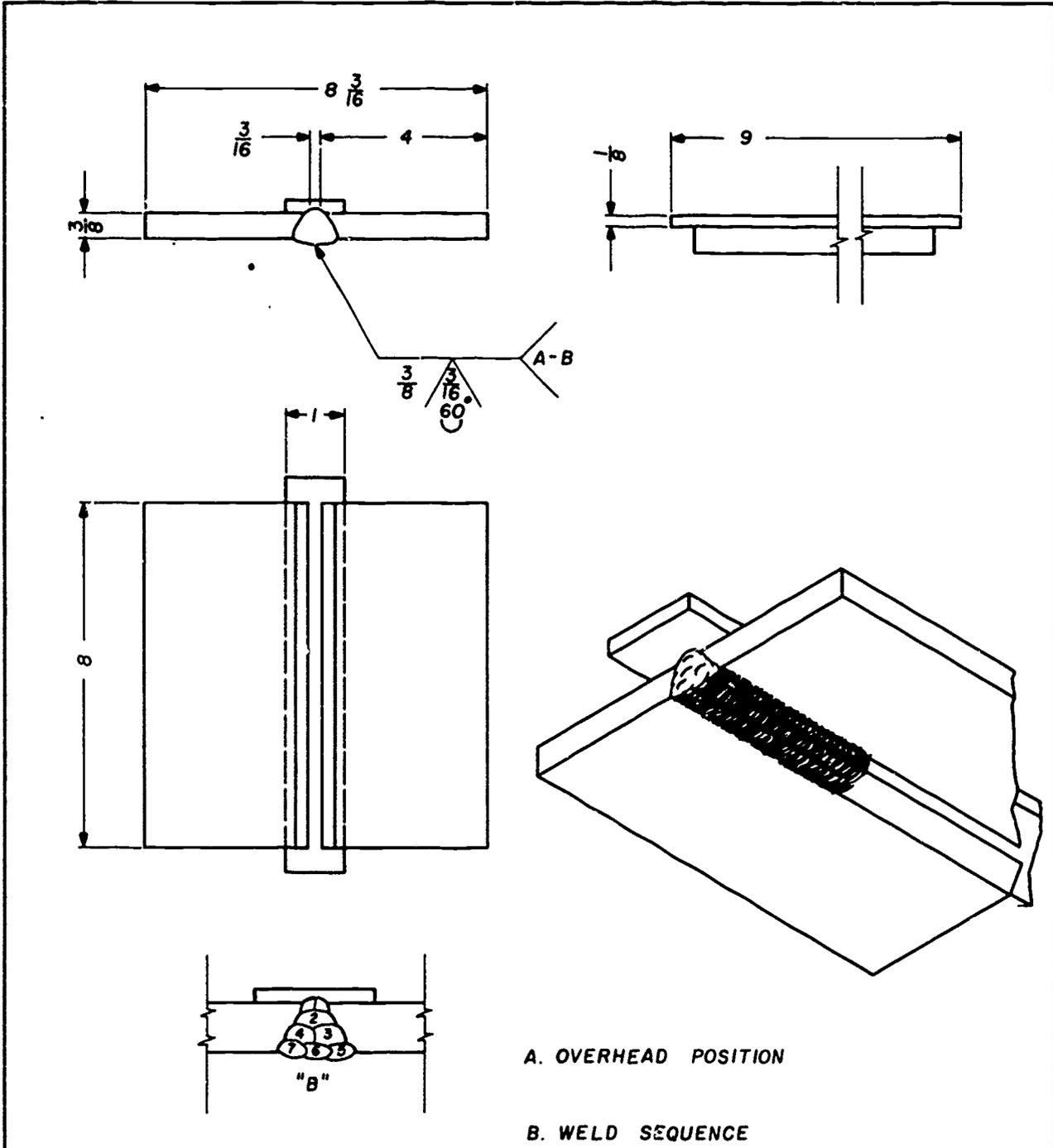
DC welding machine, slag hammer, wire brush, tongs, safety equipment, and shaper.

MATERIAL NEEDED

2 pieces 3/8 x 4 x 8 inch steel plate, beveled on one side to 30°, 1 piece 1/8 x 1 x 9 inch for backing strip, 5/32 E6010 electrodes.

PROCEDURE

- 1 thru 6. Repeat equipment & safety procedures.
7. Tack weld the back side of the plates to the backing strip with a root opening of 3/16 inches.
8. Place this assembly in position for vertical welding.
9. Establish an arc, raise electrode slightly, move to the starting point.
10. Close the arc gap to the proper dimension.
11. Place the first pass using an up and down motion in small increments.
12. After each pass is completed, chip and wire brush the weld so that the bead is completely clean of slag.
13. Place the succeeding beads as directed by your instructor. Concentrate the arc on the edges of the previous bead.
14. Place the cover beads so that the total reinforcement does not exceed the plate thickness by more than 1/8 inch above the plate thickness, nor wider than 1/16 inch at each side of the groove.
15. Repeat this procedure until a weld is produced to the specification.
16. Show work to your instructor for a discussion of results.
17. Prepare for testing; remove all metal at the face and root of the weld down to plate thickness. Cut out 1-1/2 inch coupons for the bend test.



A. OVERHEAD POSITION

B. WELD SEQUENCE

NAME ASME-AWS GROOVE WELD TESTS		MILESTONE C "V" GROOVE WELD W/BACK UP IN THE OVERHEAD POSITION		MODULE NO. I FIGURE NO. 3	
ELECTRODE SIZE $\frac{5}{32}$ DIA. DC/RP		TYPE AWS-E-6010			
MATERIAL STEEL		SPEC. MILD	AMT 2	SIZE $\frac{3}{8}$ X 4 X 8	
STEEL		MILD	1	$\frac{1}{8}$ X 1 X 9	

SHIELDED METAL-ARC WELDING CERTIFICATION TEST

Module I. ASME or AWS Groove Weld Tests

Milestone C, 'V' Groove with Backing Strip in the Overhead Position

Project 3; Time: 9 hours

INTRODUCTION

The student will make a 'V' groove weld with backing strip in the overhead position, using 5/32 inch E6010 electrodes. The beads will be deposited as follows: first pass, penetration; second pass, single bead; third pass, two beads; fourth pass, three bead cover. The finished weld must be of test quality to be used for qualifying the welder's skill.

EQUIPMENT REQUIRED

DC welding machine, slag hammer, wire brush, tongs, safety equipment, positioner, and shaper.

MATERIAL NEEDED

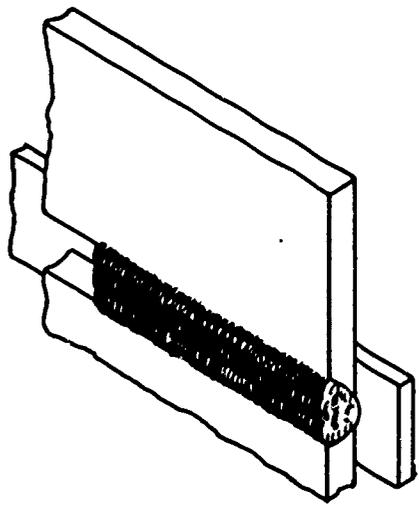
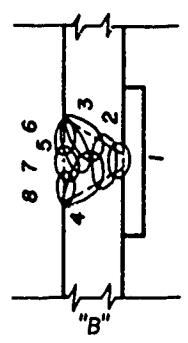
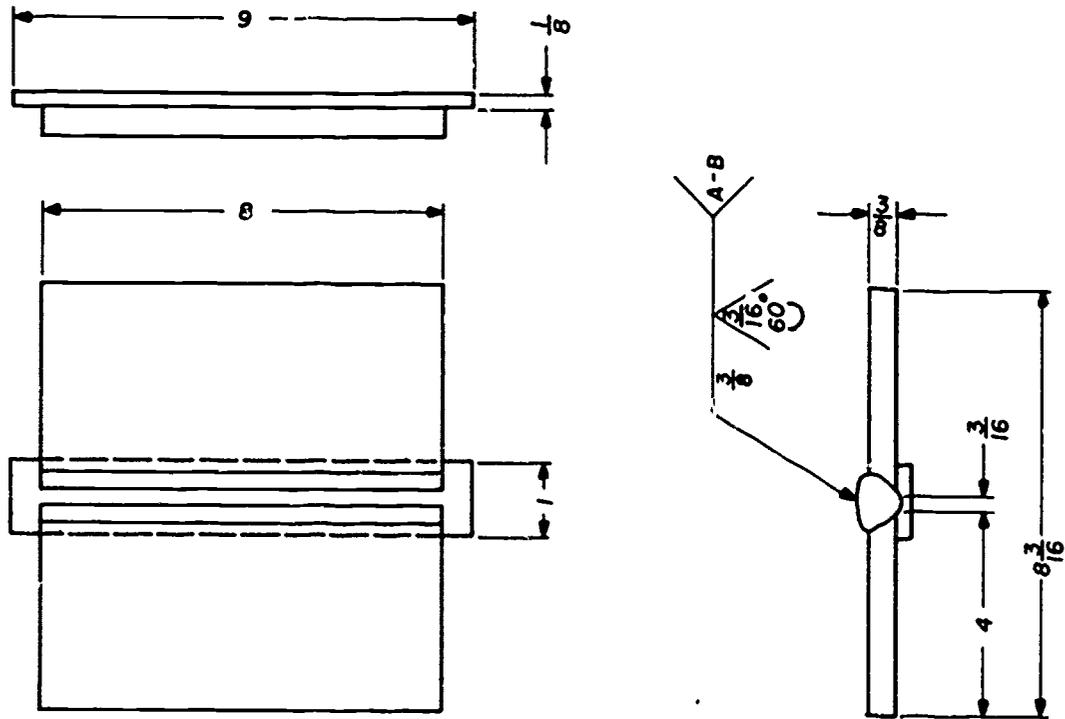
2 pieces 3/8 x 4 x 8 inch steel plate, beveled on one side to 30°, 1 piece 1/8 x 1 x 9 inch for the backing strip, 5/32 inch E6010 electrodes.

PROCEDURE

- 1 thru 6. Repeat equipment & safety procedures.
7. Tack weld the back side of the plates to the backing strip with a root opening of 3/16 inches.
8. Place this assembly in the positioner for overhead welding.
9. Establish an arc, raise electrode slightly, move to the starting point.
10. Close the arc gap to the proper dimension.
11. Place first pass using a forward and back motion in small increments.
12. After each pass is completed, chip and wire brush the weld so that it is completely clean of slag.
13. Place the succeeding beads as directed by your instructor.
14. Concentrate the arc on the edges of the previous weld.
15. Place cover beads so that the total reinforcement will not exceed the plate thickness by more than 1/8 inch, nor be wider than 1/16 inch at each side of the groove.
16. Repeat this procedure until a weld is produced to the specification.
17. Show work to your instructor for a discussion of results.
18. Prepare for testing; remove all metal at the face and root of the weld down to plate thickness. Cut out 1-1/2 inch coupons for the bend test.

SHIELDED METAL-ARC WELDING
CERTIFICATION
PHASE III PART B OBJECTIVE

Following the completion of shielded metal-arc welding certification in Part A of this program, the trainee is given the opportunity to participate in Part B. This module uses the construction code tests of city or state inspection agencies where the student will have residence.



A. HORIZONTAL POSITION

B. WELD SEQUENCE

NAME CITY OF LOS ANGELES SHOP AND FIELD CERTIFICATION		MILESTONE A "V" GROOVE W/BACK UP IN THE HORIZONTAL POSITION			MODULE NO. I
					FIGURE NO. 4
ELECTRODE SIZE	5 32	DIA.	DC/ RP	TYPE	AWS-E-6010
MATERIAL	STEEL	SPEC.	MILD	AMT.	2
		SIZE	3/8 X 4 X 8		
	STEEL		MILD	1	1/8 X 1 X 9

SHIELDED METAL-ARC WELDING CERTIFICATION TEST

Module II. City of Los Angeles Shop and Field Certification
Milestone A, 'V' Groove with Backing Strip in the Horizontal
Position

Project 4; Time: 12 hours

INTRODUCTION

The student will make a 'V' groove weld with backing strip in the horizontal position, using E6010 electrodes. The beads to be deposited in the following manner: first pass, penetration; second pass, single bead; third pass, three beads; fourth pass, three bead cover. The finished weld must be of test quality to be used for qualifying the welder's skill.

EQUIPMENT REQUIRE

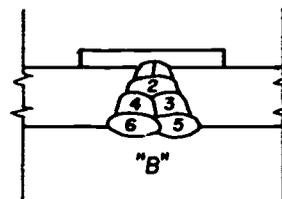
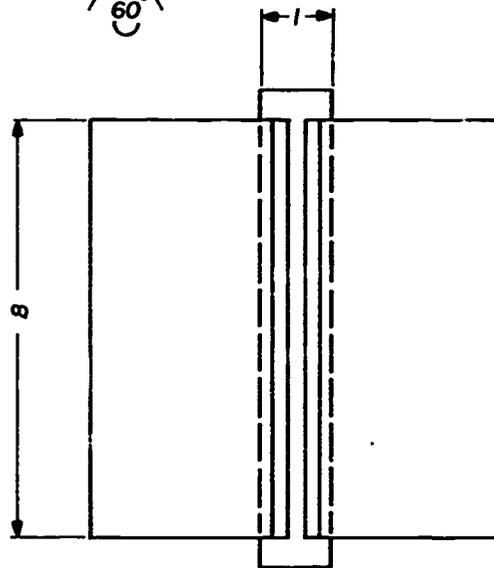
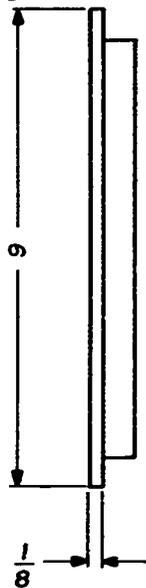
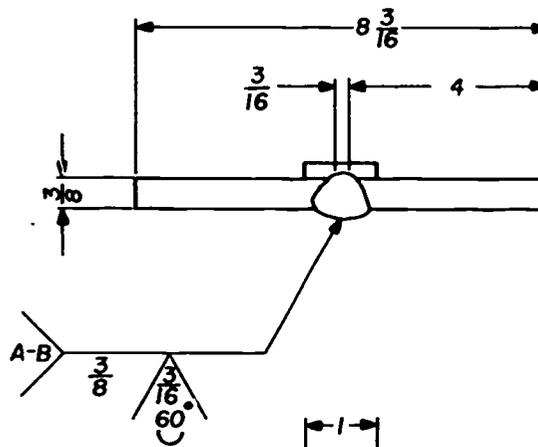
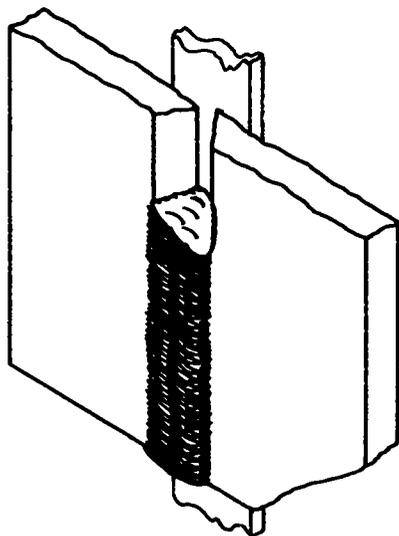
DC welding machine, slag hammer, wire brush, tongs, safety equipment, and shaper. Also the use of a positioner.

MATERIAL NEEDED

2 pieces 3/8 x 4 x 8 inch steel plate, beveled on one side to 30°, 1 piece 1/8 x 1 x 9 inch steel for backing strip, 5/32 inch E6010 electrodes.

PROCEDURE

- 1 thru 6. Repeat equipment & safety procedures.
7. Tack weld the back side of the plates to the backing strip to form a butt weld with a root opening of 3/16 inches.
8. Place this assembly in the positioner for welding in the horizontal position.
9. Establish the arc, raise the electrode slightly, move to the starting point.
10. Lower electrode to proper arc length.
11. Place the first pass using a forward and back motion in small increments.
12. After each pass is completed, chip and wire brush the weld so that it is completely clean of slag.
13. Place succeeding beads as directed by your instructor.
14. Concentrate the arc on the edges of the previous bead.
15. Place cover beads so that the total reinforcement will not exceed the plate thickness by more than 1/8 inch above the plate thickness.



A. VERTICAL POSITION

B. WELD SEQUENCE

NAME CITY OF LOS ANGELES SHOP AND FIELD CERTIFICATION		MILESTONE B "V" GROOVE W/BACK UP IN THE VERTICAL POSITION		MODULE NO. II FIGURE NO. 5	
ELECTRODE SIZE $\frac{5}{32}$ DIA. DC/RP		TYPE AWS - E - 6010			
MATERIAL	STEEL	SPEC. MILD	AMT. 2	SIZE $\frac{3}{8}$ X 4 X 8	
	STEEL	MILD	1	$\frac{1}{8}$ X 1 X 9	

SHIELDED METAL-ARC WELDING CERTIFICATION TEST

Module II. City of Los Angeles Shop and Field Certification
Milestone B, 'V' Groove with Backing Strip in the Vertical
Position

Project 5; Time: 18 hours

INTRODUCTION

The student will make a 'V' groove weld with backing strip in the vertical position, using E6010 electrodes. The beads to be deposited in the following manner: First pass, penetration; second pass, single bead; third pass, two beads; fourth pass, two bead cover. The finished weld must be of test quality to be used for qualifying the welder's skill.

EQUIPMENT REQUIRED

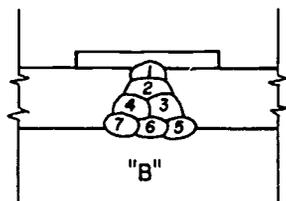
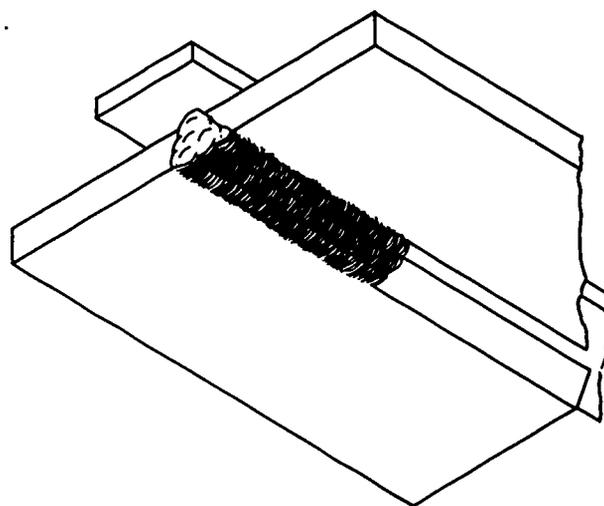
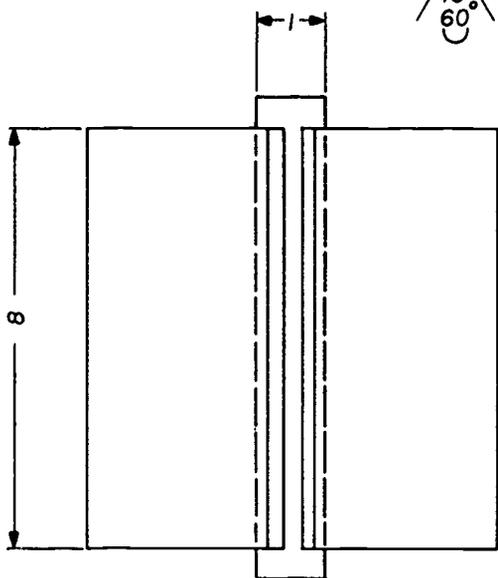
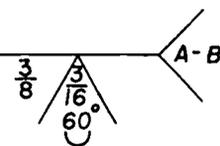
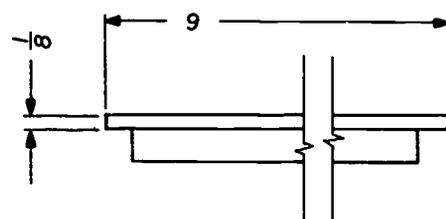
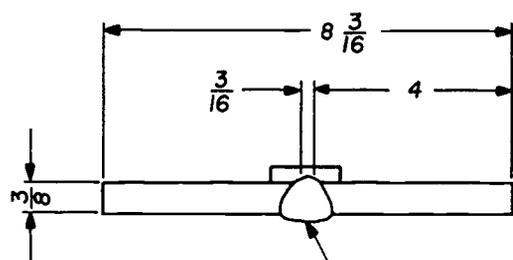
DC welding machine, slag hammer, wire brush, tongs, safety equipment, and shaper.

MATERIAL NEEDED

2 pieces 3/8 x 4 x 8 inch steel plate, beveled on one side to 30°, 1 piece 1/8 x 1 x 9 inch steel for backing strip, 5/32 inch E6010 electrodes.

PROCEDURE

- 1 thru 6. Repeat equipment & safety procedures.
7. Tack weld the back side of the plates to the backing strip to form a butt weld with a root opening of 3/16 inches.
8. Place this assembly in position for vertical welding.
9. Establish the arc, raise the electrode slightly, move to the starting point.
10. Lower electrode to proper arc length.
11. Place the first pass using an up and down motion in small increments.
12. After each pass is completed, chip and wire brush the weld so that it is completely clean of slag.
13. Place succeeding beads as directed by your instructor.
14. Concentrate the arc on the edges of the previous bead.
15. Place cover beads so that the total reinforcement will not exceed the plate thickness by more than 1/8 inch, nor more than 1/8 wider than the groove.
16. Repeat this procedure until a weld is produced to the specification.
17. Show work to your instructor for a discussion of results.
18. Prepare for testing; remove all metal at the face and root of the weld down to plate thickness. Cut out 1-1/2 inch coupons for the bend test.



A. OVERHEAD POSITION

B. WELD SEQUENCE

NAME CITY OF LOS ANGELES SHOP AND FIELD CERTIFICATION		MILESTONE C "V" GROOVE W/BACK UP IN THE OVERHEAD POSITION		MODULE NO. II	
				FIGURE NO. 6	
ELECTRODE SIZE $\frac{5}{32}$ DIA. DC/RP		TYPE AWS-E-6010			
MATERIAL STEEL		SPEC. MILD	AMT 2	SIZE $\frac{3}{8}$ X 4 X 8	
STEEL		MILD	1	$\frac{1}{8}$ X 1 X 9	

SHIELDED METAL-ARC WELDING CERTIFICATION TEST

Module II. City of Los Angeles Shop and Field Certification
Milestone C, 'V' Groove with Backing Strip in the Overhead
Position

Project 6; Time: 9 hours

INTRODUCTION

The student will make a 'V' groove weld with backing strip in the overhead position, using E6010 electrodes. The beads to be deposited in the following manner: first pass, penetration; second pass, single bead; third pass, two beads; fourth pass, three bead cover. The finished weld must be of test quality to be used for qualifying the welder's skill.

EQUIPMENT REQUIRED

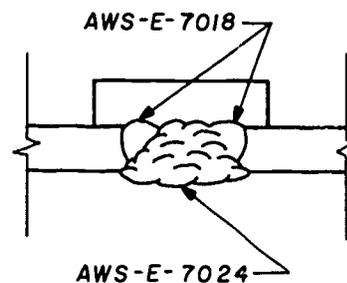
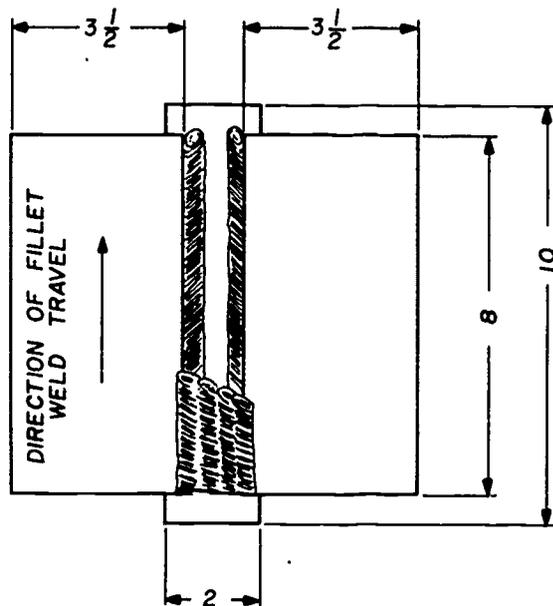
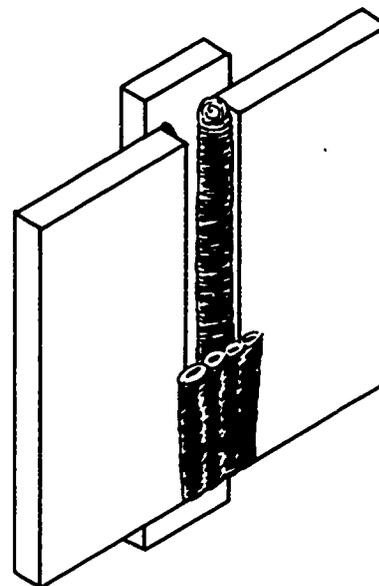
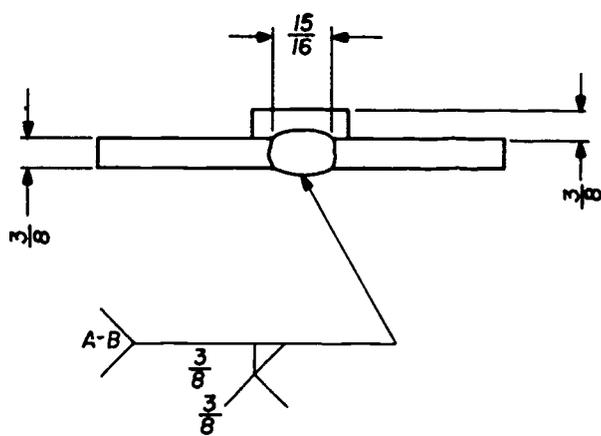
DC welding machine, slag hammer, wire brush, tongs, safety equipment, positioner, and shaper.

MATERIAL NEEDED

2 pieces 3/8 x 4 x 8 inch steel plate, beveled on one side to 30°, 1 piece 1/8 x 1 x 9 inch steel for backing strip, 5/32 inch E6010 electrodes.

PROCEDURE

- 1 thru 6. Repeat equipment & safety procedures.
7. Tack weld the plates to the backing strip on the back side to form a butt weld with a root opening of 3/16 inches.
8. Place this assembly in the positioner for overhead welding.
9. Establish the arc, drop the electrode slightly, move to starting point.
10. Raise electrode to the proper arc length.
11. Place the first pass using a forward and back motion in small increments.
12. After each pass is completed, chip and wire brush the weld so that it is completely clean of slag.
13. Place succeeding beads as directed by your instructor.
14. Concentrate the arc on the edges of the previous bead.
15. Place the cover beads so that the total reinforcement will not exceed the plate thickness by more than 1/8 inch, nor more than 1/16 inch at each side of the groove.
16. Repeat this procedure until a weld is produced to the specification.
17. Show work to your instructor for a discussion of results.
18. Prepare for testing; remove all metal at the face and root of the weld down to plate thickness. Cut out 1-1/2 inch coupons for the bend test.



A. AWS-E-7018 FILLET WELD VERTICAL POSITION.

B. AWS-E-7024 GROOVE WELD OPTIONAL POSITION.

NAME CITY OF LOS ANGELES SHOP AND FIELD CERTIFICATION		MILESTONE D WELD SOUNDNESS TEST IN THE VERTICAL POSITION		MODULE NO. II	
				FIGURE NO. 7	
ELECTRODE SIZE $\frac{1}{8}$ DIA. DC/RP		TYPE AWS-E-7018 / AWS-E-7024			
MATERIAL STEEL		SPEC. MILD	AMT 1	SIZE $\frac{3}{8} \times 2 \times 10$	
STEEL		MILD	2	$\frac{3}{8} \times 3\frac{1}{2} \times 8$	

SHIELDED METAL-ARC WELDING CERTIFICATION TEST

Module II. City of Los Angeles Shop and Field Certification
Milestone D, Weld Soundness Test in the Vertical Position

Project 7; Time: 9 hours

INTRODUCTION

The student will make a weld soundness test in the vertical position. This will be made with a backing strip, using both E7018 and E7024 electrodes. The square cut plates are tack welded to the backing strip so that the first beads are fillet welds in the vertical position with the E7018 electrodes. The assembly is then placed for welding in a flat position; the remaining groove is filled using the E7024 electrodes. The finished weld must be of test quality to be used for qualifying the welder's skill.

EQUIPMENT REQUIRED

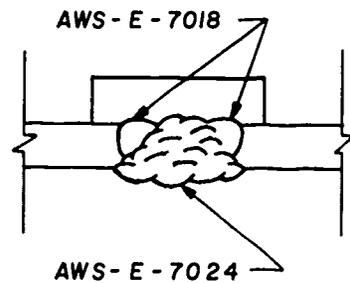
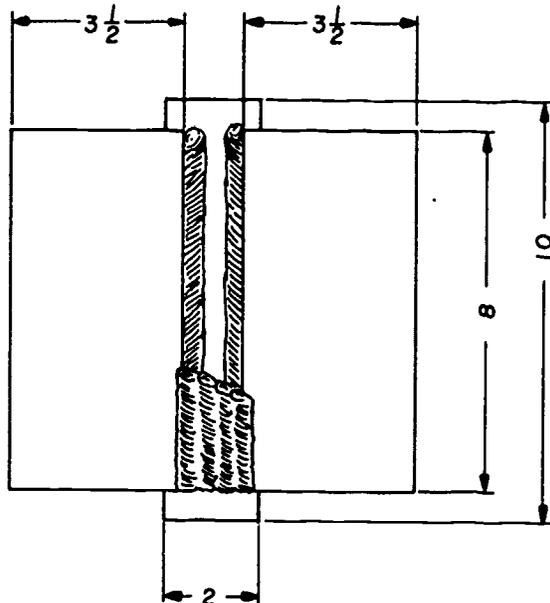
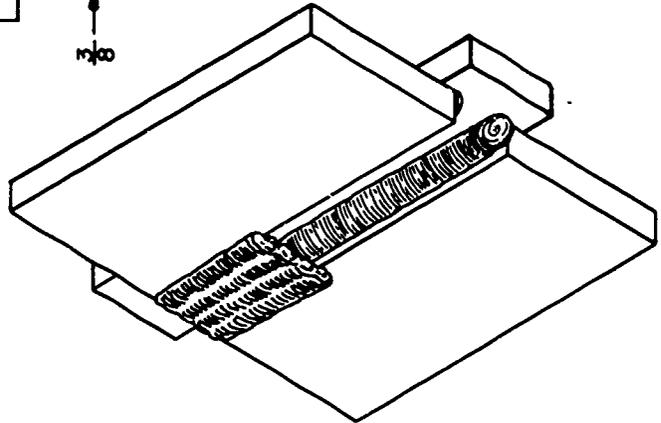
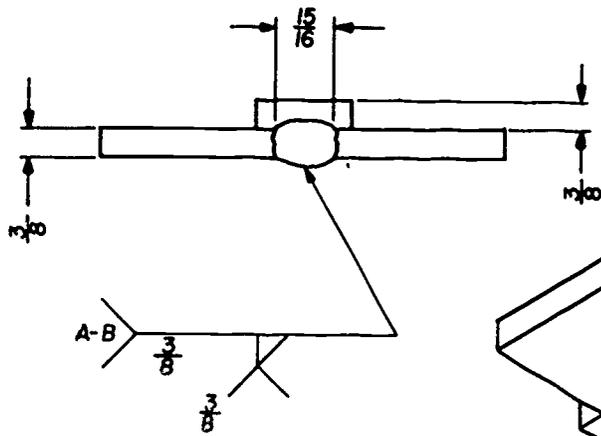
DC welding machine, slag hammer, wire brush, tongs, safety equipment, positioner, and shaper.

MATERIAL NEEDED

2 pieces 3/8 x 3-1/2 x 8 inch steel plate, squart cut, 1 piece 3/8 x 2 x 10 inch steel for the backing strip, 1/8 inch E7018 and 1/8 inch E7024 electrodes.

PROCEDURE

- 1 thru 6. Repeat equipment & safety procedures.
7. Tack weld the back side of the plates to the backing strip to form a butt weld with an opening of 15/16 inches.
8. Place this assembly in the positioner for vertical welding.
9. Establish the arc, raise the electrode slightly, move to the starting point, using the E7018 electrodes for these fillets.
10. Lower the electrode to proper arc length.
11. Place the fillets using a small weave motion. Concentrate the arc in the corners for good penetration.
12. Chip and wire brush the beads after each pass.
13. Place the weldment in the flat position and continue to fill the groove with the E7024 electrodes. Make overlapping stringer beads without manipulation.
14. Repeat these procedures until a consistent, sound weld is produced.
15. Prepare for testing; remove the backing strip and face reinforcement to the plate thickness. Cut out 1-1/2 inch coupons for the bend test.



A. AWS-E-7018 FILLET WELD
OVERHEAD POSITION

B. AWS-E-7024 GROOVE WELD
OPTIONAL POSITION

NAME CITY OF LOS ANGELES SHOP AND FIELD CERTIFICATION		MILESTONE E WELD SOUNDNESS TEST IN THE OVERHEAD POSITION		MODULE NO. II
				FIGURE NO. 8
ELECTRODE SIZE $\frac{5}{32}$ DIA. DC/RP		TYPE AWS-E-7018 / AWS-E-7024		
MATERIAL	STEEL	SPEC. MILD	AMT. 2	SIZE $\frac{3}{8} \times 4 \times 8$
	STEEL	MILD	1	$\frac{1}{8} \times 1 \times 9$

SHIELDED METAL-ARC WELDING CERTIFICATION TEST

Module II. City of Los Angeles Shop and Field Certification

Milestone E, Weld Soundness Test in the Overhead Position

Project 8; Time: 3 hours

INTRODUCTION

The student will make a weld soundness test in the overhead position. This will be made with a backing strip, using both E7018 and E7024 electrodes. The square cut plates are tack welded to the backing strip so that the first beads are fillet welds made in the overhead position using the E7018 electrodes. The assembly is then placed for welding in a flat position; the remaining groove is filled using the E7024 electrodes. The finished weld must be of test quality to be used for qualifying the welder's skill.

EQUIPMENT REQUIRED

DC welding machine, slag hammer, wire brush, tongs, safety equipment, positioner, and shaper.

MATERIAL NEEDED

2 pieces 3/8 x 4 x 8 inch steel plate, square cut, 1 piece 1/8 x 1 x 9 inch steel for the backing strip, 1/8 inch E7018 and E7025 electrodes.

PROCEDURE

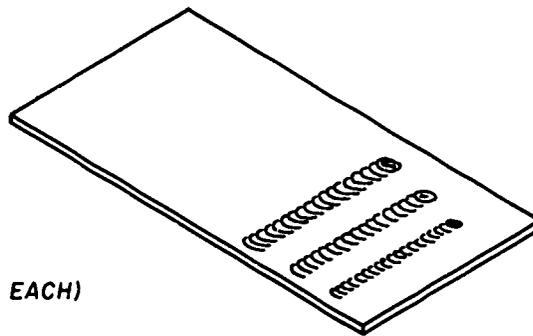
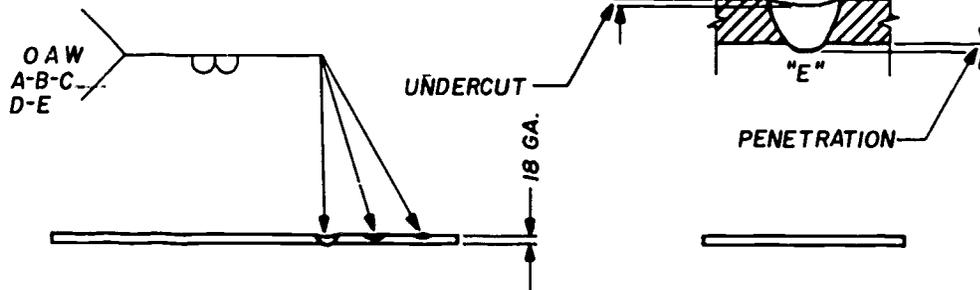
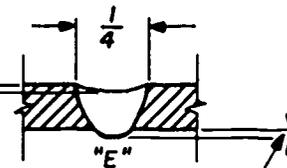
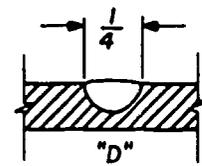
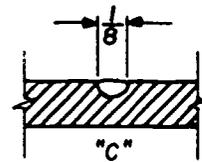
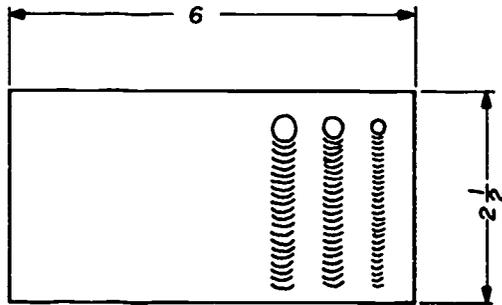
- 1 thru 6. Repeat equipment & safety procedures.
7. Tack weld the back side of the plates to the backing strip to form a butt weld with an opening of 15/16 inches.
8. Place this assembly in the positioner for overhead welding.
9. Establish the arc, lower the electrode slightly, move to the starting point, using the 1/8 inch E7018 electrodes for these fillets.
10. Raise the electrode to the proper arc length.
11. Place the fillets using a small "C" motion. Concentrate the arc in the corners for good penetration.
12. Chip and wire brush the beads after each pass.
13. Place the weldment in the flat position and continue to fill the groove with the 1/8 inch E7024 electrodes. Make overlapping stringer beads without manipulation.
14. Repeat these procedures until a consistent, sound weld is produced.
15. Prepare for testing; remove the backing strip and face reinforcement to the plate thickness. Cut out 1-1/2 inch coupons for the bend test.

OXYACETYLENE WELDING AND CUTTING PHASE IV OBJECTIVE

By taking part in the practice of oxyacetylene welding and cutting the student will learn how to assemble and use this equipment, while familiarizing himself with the processes.

A second objective in learning oxyacetylene welding is to prepare the student for use of the gas tungsten-arc torch. Each system uses a hand held torch while filler metal is hand fed.

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- A. FLAT POSITION
- B. FLAME NEUTRAL
- C. DO NOT PENETRATE (THREE EACH)
- D. DO NOT PENETRATE (THREE EACH)
- E. PENETRATE (THREE EACH)

NAME PROCESS FAMILIARIZATION AND EQUIPMENT USE		MILESTONE A RUNNING STRINGER BEADS WITHOUT FILLER RODS			MODULE NO. I
					FIGURE NO. 1
ELECTRODE SIZE	N/A	TYPE	N/A		
MATERIAL	STEEL	SPEC. MILD	AMT 1	SIZE	18 GA. X 2 1/2 X 6

OXYACETYLENE WELDING

Module I. Process Familiarization and Equipment Use

Milestone A, Running Stringer Beads Without Filler Rod

Project 1; Time: 3 hours

INTRODUCTION

The student will make weld beads across a piece of 18 gage steel. The purpose for this exercise is to learn torch control, flame adjustment, and rate of travel. There will be three sets of three beads, the first bead should be straight and narrow with a fine ripple. The second should be twice the width of the first, with the same appearance. The third bead should be the same size as the second, but will have uniform penetration on the back side.

EQUIPMENT REQUIRED

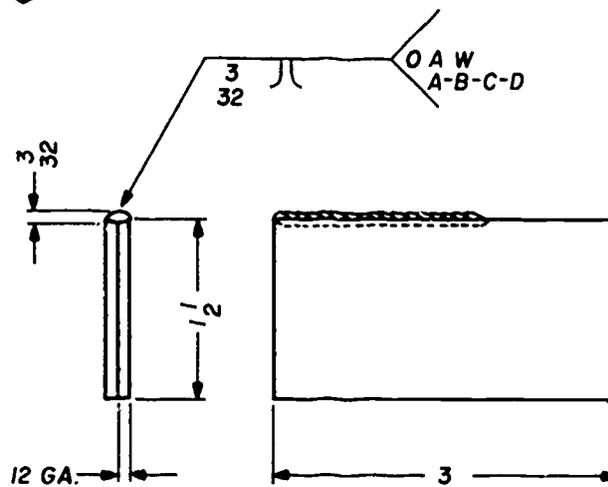
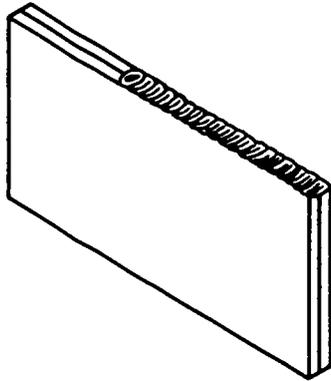
Oxyacetylene torch, tips, regulators, flint lighter, wrench, tongs, goggles, vise grip-pliers.

MATERIAL NEEDED

1 piece of 18 gage steel 2-1/2 x 6 inches.

PROCEDURE

1. Inspect hose and fittings to see that they are servicable.
2. Attach hose to torch, use wrench for a leak tight union.
3. Select proper tip size for the metal thickness being welded; attach to torch barrel, finger tight.
4. Close torch valves.
5. Turn regulator adjustment screws counterclockwise until tension is released.
6. Open oxygen and acetylene source valves.
7. Turn regulator adjustment screws clockwise until the specified pressure is raised.
8. Close oxygen and acetylene source valves; watch for any pressure drop at regulators. Correct for any leaks.
9. Clean work and put on goggles.
10. Open torch valves about one quarter turn; light with flint lighter.
11. Adjust flame to a neutral condition with a cone length as directed.
12. Hold torch as a pencil, the flame pointed with a 45° leading angle, the tip of cone 1/8 inch from metal surface.
13. Hold at metal edge until melting starts, then move this puddle slowly across.
14. For beads 2 and 3 use some torch side motion to increase puddle, and bead width.
15. Practice this procedure until the desired results are produced.
16. Secure equipment.



- A. FLAT POSITION
- B. FLAME NEUTRAL
- C. WELD ALL FOUR EDGES
- D UNIFORM RIPPLE

NAME PROCESS FAMILIARIZATION AND EQUIPMENT USE		MILESTONE B EDGE WELD WITHOUT FILLER ROD		MODULE NO. I FIGURE NO. 2	
ELECTRODE SIZE	N/A	TYPE	N/A		
MATERIAL	STEEL	SPEC.	AMT	SIZE	
		MILD	2	12 GA. X 1/2 X 3	

OXYACETYLENE WELDING

Module I. Process Familiarization and Equipment Use

Milestone B, Edge Welds Without Filler Rod

Project 2; Time: 3 hours

INTRODUCTION

The student will clamp together two pieces of 12 gage steel to form an edge joint. This assembly will be positioned for flat position welding. The edges will be fused without the use of filler rod. The weld should have a fine and uniform ripple and a convex face.

EQUIPMENT REQUIRED

Oxyacetylene torch, tips, regulators, flint lighter, wrench, tongs, goggles, vise grip-pliers.

MATERIAL NEEDED

2 pieces 12 gage steel 1-1/2 x 3 inches.

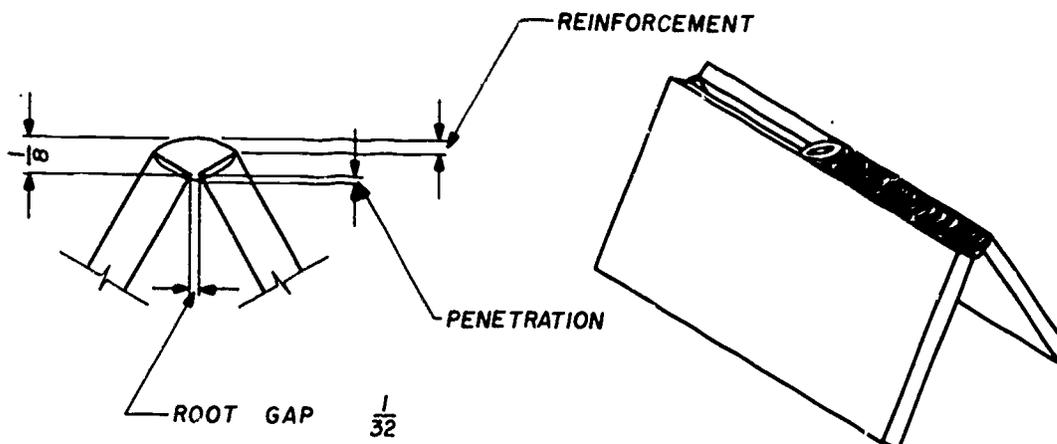
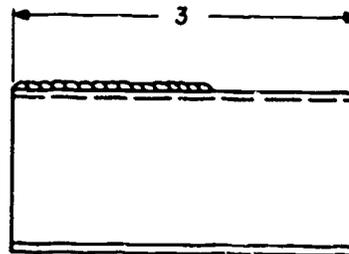
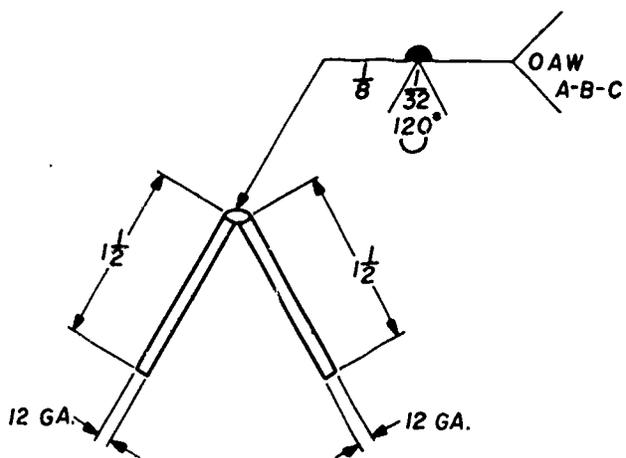
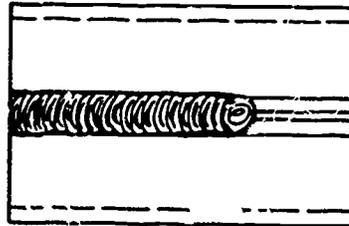
PROCEDURE

- 1 - 8. Repeat equipment & safety procedures.
9. Clamp the metal pieces together with vise grip-pliers, the edges aligned. Position for flat welding.
10. Open torch valves about one quarter turn; light with flint lighter.
11. Adjust flame to a neutral condition with a cone length as directed.
12. Hold torch as a pencil, the flame pointed with a 45° leading angle, the tip of cone 1/8 inch from metal surface.
13. Hold flame steady at edge of joint until fusion starts; move from right to left with a steady motion, melting down the edges consistently. Join all four edges.
14. Repeat this procedure until the desired results are produced.
15. Secure equipment.

A. FLAT POSITION

B. FLAME NEUTRAL

C. PENETRATE



NAME GROOVE WELD	MILESTONE A		MODULE NO. II
	CORNER WELD IN THE FLAT POSITION		FIGURE NO. 3
ELECTRODE SIZE $\frac{1}{16}$ DIA.	TYPE COPPER COATED AWS-ASTM CLASS I TYPE C		
MATERIAL STEEL	SPEC. MILD	AMT. 2	SIZE 12 GA. $\frac{1}{2}$ X 3

OXYACETYLENE WELDING

Module II. Groove Weld

Milestone A, Corner Weld in the Flat Position

Project 3; Time: 6 hours

INTRODUCTION

A corner weld will be made by joining two pieces of steel at 60°. This joint will be welded in the flat position with full penetration. Use filler rod and one pass. The weld face will have uniform ripple and convex face.

EQUIPMENT REQUIRED

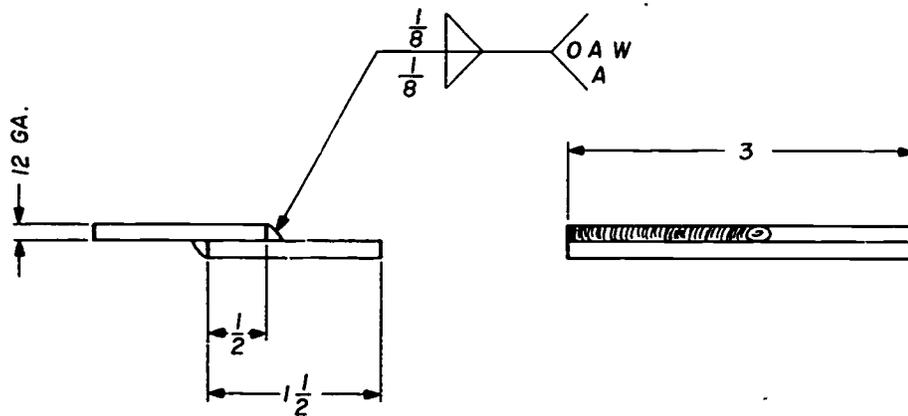
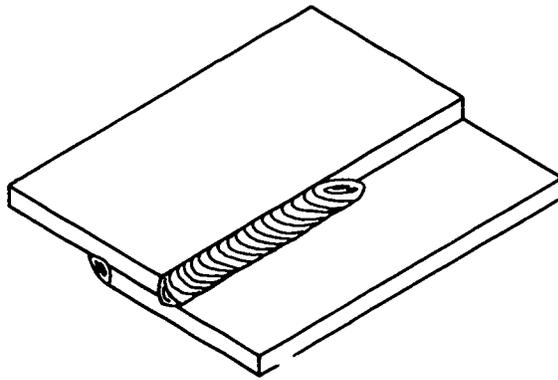
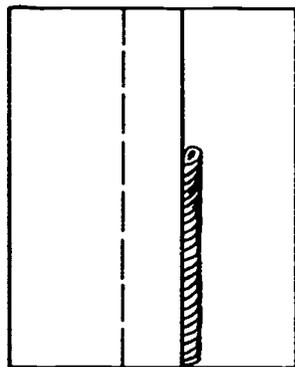
Oxyacetylene torch, tips, regulators, flint lighter, wrench, tongs, goggles, vise grip-pliers.

MATERIAL NEEDED

2 pieces 12 gage steel, 1-1/2 x 3 inches, 1/16 inch steel filler rod.

PROCEDURE

- 1 - 8. Repeat equipment & safety procedures.
9. Clamp two pieces of steel together to form a corner joint of 60° with a root opening of 1/32 inch. Position for flat welding.
10. Open torch valves about one quarter turn; light with flint lighter.
11. Adjust flame to a neutral condition with a cone length as directed.
12. Hold torch as a pencil, the flame pointed with a 45° leading angle, the tip of cone 1/8 inch from metal surface.
13. Hold on metal edge until melting starts, then move this puddle slowly across.
14. Add filler metal in center of puddle to fill out bead size.
15. Travel from right to left at a rate resulting in a uniform bead in height and width.
16. Secure equipment.



A. FLAME NEUTRAL

NAME	MILESTONE A		MODULE NO. III
FILLET WELD	LAP WELD		FIGURE NO. 4
ELECTRODE SIZE	$\frac{1}{16}$ DIA.	TYPE	COPPER COATED AWS-ASTM CLASS I TYPE C
MATERIAL	STEEL	SPEC. MILD	AMT 2
			SIZE 12 GA. $\frac{1}{2}$ X 3

OXYACETYLENE WELDING

Module III. Fillet Weld

Milestone A, Lap Weld

Project 4; Time: 6 hours

INTRODUCTION

The student will overlap two pieces of steel to form fillet weld joints. These two joints will be welded, using filler wire. They should have a flat face, no undercut and without excessive deposit above the upper piece of steel.

EQUIPMENT REQUIRED

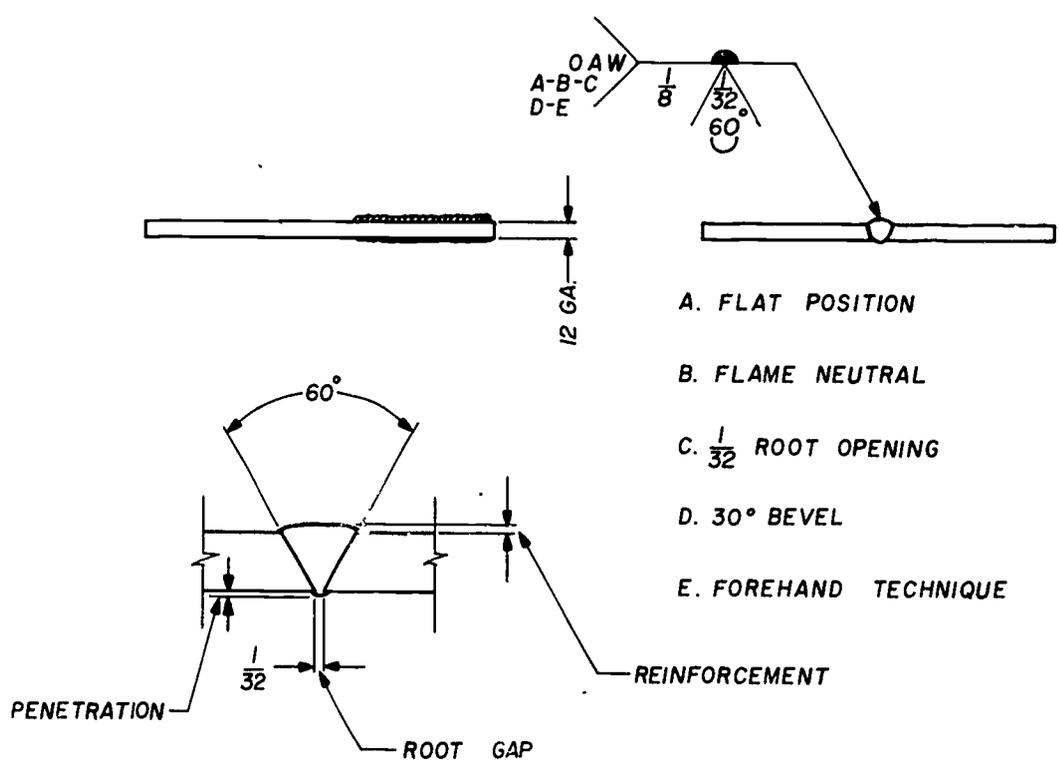
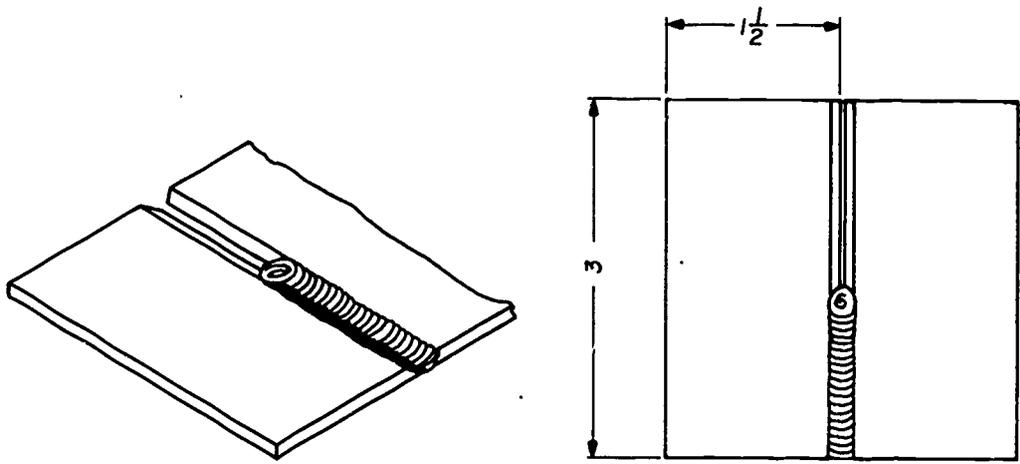
Oxyacetylene torch, tips, regulators, flint lighter, wrench, tongs, goggles, vise grip-pliers.

MATERIAL NEEDED

2 pieces 12 gage steel, 1-1/2 x 3 inches, 1/16 inch steel filler.

PROCEDURE

- 1 - 8. Repeat equipment & safety procedures.
9. Overlap two pieces of steel 1/2 inch and clamp with the vise grip-pliers. Place for welding in the flat position.
10. Open torch valves about one quarter turn; light with flint lighter.
11. Adjust flame to a neutral condition with a cone length as directed.
12. Hold torch as a pencil, the flame pointed with a 45° leading angle, the tip of cone 1/8 inch from metal surface.
13. Hold flame in joint so that top and bottom pieces are fused; add filler metal as required to form a uniform fillet.
14. Move along joint at a uniform rate to form a fillet with a flat face and even ripple.
15. Repeat this procedure until the desired results are produced.
16. Secure equipment.



NAME GROOVE WELD	MILESTONE B "V" GROOVE WELD IN THE FLAT POSITION		MODULE NO. II
			FIGURE NO. 5
ELECTRODE SIZE $\frac{1}{16}$ DIA.	TYPE COPPER COATED AWS-ASTM CLASS I TYPE C		
MATERIAL STEEL	SPEC. MILD	AMT 2	SIZE 12 GA. X $\frac{1}{2}$ X 3

OXYACETYLENE WELDING

Module II. Groove Weld

Milestone B, 'V' Groove Weld in the Flat Position

Project 5; Time: 6 hours

INTRODUCTION

The student will make a single pass forehand butt weld with a 1/32 inch root opening for full penetration. The bead should have a uniform build-up and ripple.

EQUIPMENT REQUIRED

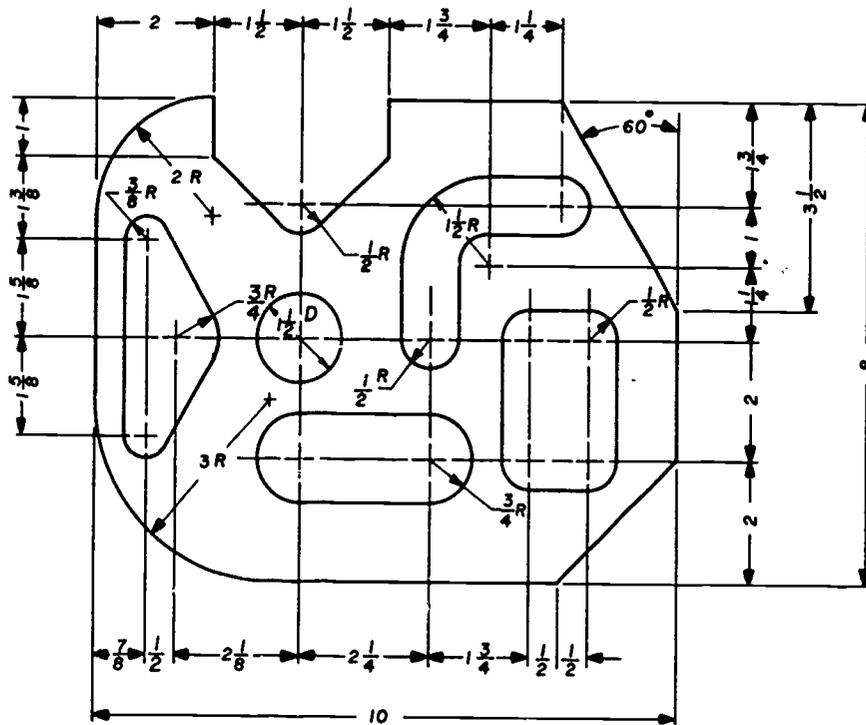
Oxyacetylene torch, tips, regulators, flint lighter, wrench, tongs, goggles, vise grip-pliers.

MATERIAL NEEDED

2 pieces 12 gage steel 1-1/2 x 3 inches, 1/16 inch steel filler wire.

PROCEDURE

- 1 - 8. Repeat equipment & safety procedures.
9. Lay pieces of steel flat with parallel edges and a gap of 1/32 inch; tack weld at each end.
10. Hold flame at beginning of weld with filler wire close. When fusion starts this must be quickly added.
11. Move along the joint, watching for melt through at root, then adding filler to the amount that gives the proper build-up.
12. Continue this procedure until the required weld is produced.
13. Secure equipment.



NAME OXYACETYLENE CUTTING		MILESTONE A HAND CUTTING / OXYACETYLENE TORCH		MODULE NO. IV FIGURE NO. 6	
ELECTRODE SIZE	N/A	TYPE	N/A		
MATERIAL	STEEL	SPEC.	MILD	AMT.	1
				SIZE	3/8 X 8 X 10

OXYACETYLENE WELDING

Module IV. Oxyacetylene Cutting

Milestone A, Learning to Use the Hand Cutting Oxyacetylene Torch

Project 6; Time: 3 hours

INTRODUCTION

The student will demonstrate his ability to assemble and use the manual oxyacetylene cutting torch. He will layout simple patterns on steel plate, then cut to these lines. The cuts should be square edged, have a smooth surface with a minimum amount of slag.

EQUIPMENT REQUIRED

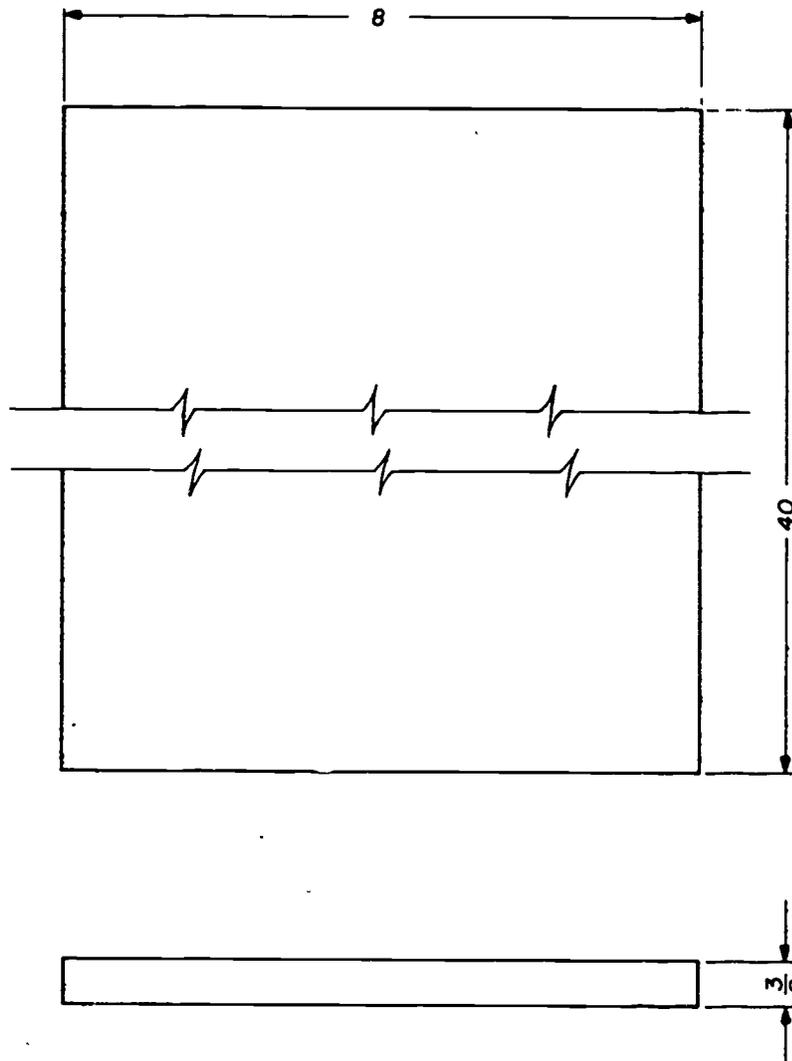
Cutting torch and hose, tips, flint lighter, wrench, tongs, goggles, gloves, scale, dividers, center punch, scribe.

MATERIAL NEEDED

Steel plate with a surface suitable for layout work. Refer to drawing #6.

PROCEDURE

- 1 - 8. Repeat equipment & safety procedures.
9. Clean plate with wire brush; layout shapes according to the drawing; place on the burning table.
10. Open torch valves about one quarter turn; light with flint lighter.
11. Adjust flame to a neutral condition with preheat flame of the proper length, as directed.
12. Hold flame at edge of plate on the guide line; when color changes to red slowly open cutting oxygen valve, depress fully.
13. Immediately move along the guide line. Move at a constant rate determined by the condition of the cut. Too fast will lose the cut, and too slow will fill the kerf with slag.
14. Repeat this procedure until the desired cuts can be made.
15. Secure equipment.



NOTE:

A. CUT INTO 8" SQ

NAME OXYACETYLENE CUTTING		MILESTONE B MACHINE CUTTING/ AUTOMATIC CUTTING MACHINE		MODULE NO. IV FIGURE NO. 7	
ELECTRODE SIZE	N/A	TYPE	N/A		
MATERIAL	STEEL	SPEC. MILD	AMT. 1	SIZE $\frac{3}{8}$ X 8 X 40	

OXYACETYLENE WELDING

Module IV. Oxyacetylene Cutting

Milestone B, Learning to Use the Automatic Cutting Machine

Project 7; Time: 3 hours

INTRODUCTION

The student will demonstrate his ability to assemble and use the automatic cutting torch. He will cut several square pieces from steel plate.

EQUIPMENT REQUIRED

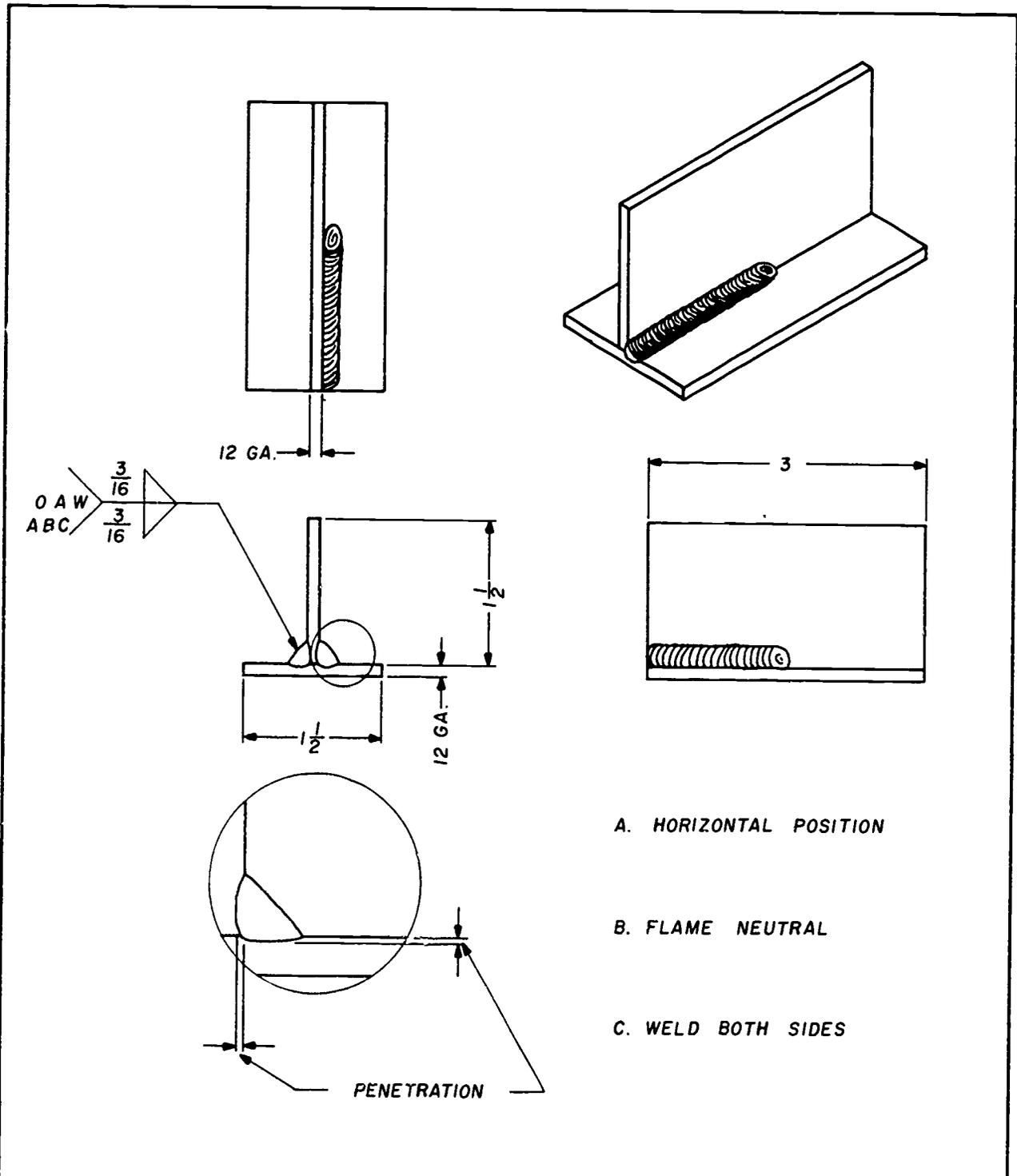
Cutting torch for automatic use, tractor, track, tips, flint lighter, wrench, electric cable, pressure regulators, hose, wire brush, scale, straight edge, square, tongs, goggles, and gloves.

MATERIAL NEEDED

Steel plate. Refer to drawing #7.

PROCEDURE

1. Place steel plate on the cutting table, clean with wire brush, put track on the plate 12 inches in from and parallel to its edge.
2. Place tractor on track, engage clutch to lock in place, put motor switch to off, then plug in cable to current outlet.
- 3 - 8. Repeat equipment & safety procedures. Select, attach appropriate sized cutting tip.
9. Move tractor to one end of the cut and adjust torch to 8-1/16 inches in from the plate edge.
10. Lift the torch about one inch above the plate and trace out the cut.
11. Return to the starting edge of the cut, lower torch to 1/4 inch above plate, put on goggles.
12. Open oxygen and acetylene torch valves one quarter turn; light torch with flint lighter; adjust to a neutral condition, with preheat flames of the proper length as directed.
13. Heat the plate edge to a red spot, slowly open cutting oxygen valve to full, and immediately close the tractor switch to on.
14. Watch the condition of the cut; hold one hand on the speed regulator; change faster or slower when indicated.
15. Watch for any change in the flame clearance and make adjustment to maintain at about 1/8 inch above plate.
16. Repeat this procedure to produce five steel squares of 8 inches each.
17. Secure equipment.



- A. HORIZONTAL POSITION
- B. FLAME NEUTRAL
- C. WELD BOTH SIDES

NAME FILLET WELD		MILESTONE B FILLET WELDS IN THE HORIZONTAL POSITION		MODULE NO. III
				FIGURE NO. 8
ELECTRODE SIZE $\frac{1}{16}$ DIA.		TYPE COPPER COATED AWS - ASTM CLASS 1 TYPE C		
MATERIAL	STEEL	SPEC. MILD	AMT 2	SIZE 12 GA. X $\frac{1}{2}$ X 3

OXYACETYLENE WELDING

Module III. Fillet Weld

Milestone B, Fillet Welds in the Horizontal Position

Project 8; Time: 12 hours

INTRODUCTION

The student will make a fillet weld by joining two pieces of steel in a "T" joint. This will be welded on each side in one pass. There will be full penetration, flat face, equal leg length, and no undercut.

EQUIPMENT REQUIRED

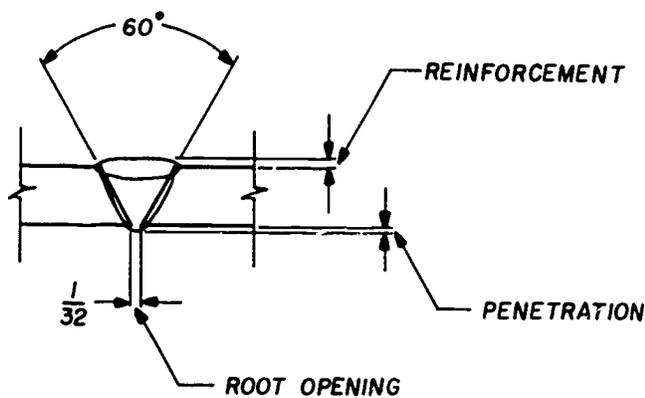
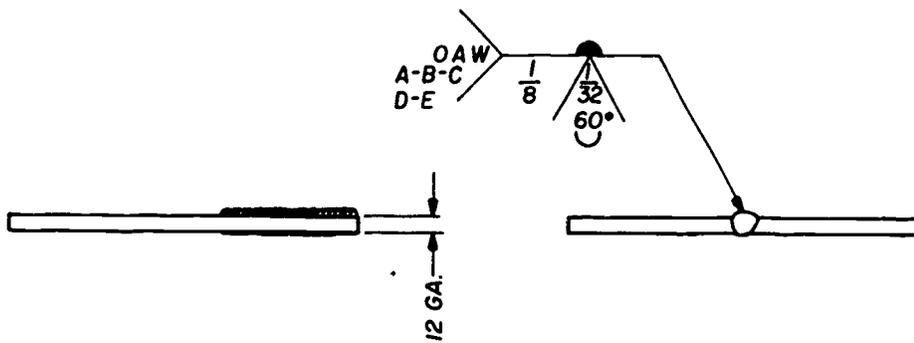
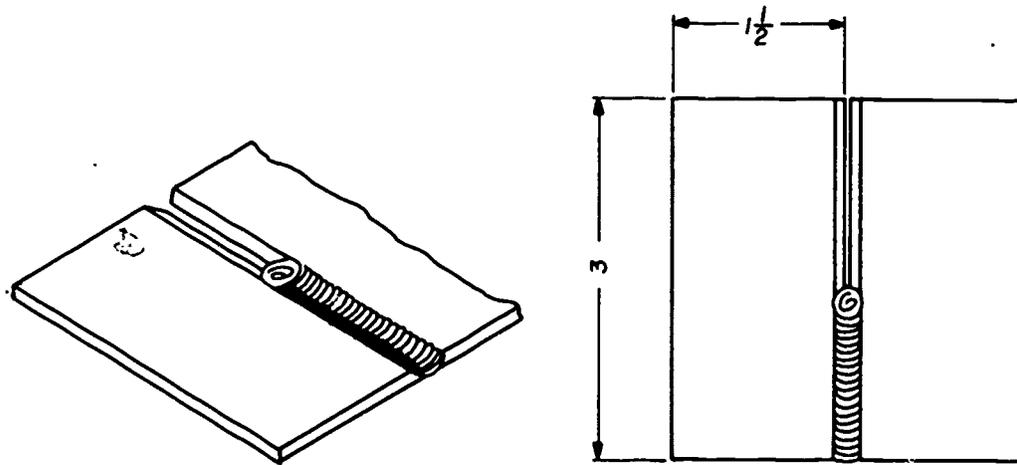
Oxyacetylene torch, tips, regulators, flint lighter, wrench, tongs, goggles, vise grip-pliers.

MATERIAL NEEDED

2 pieces 12 gage steel 1-1/2 x 3 inches, 1/16 steel welding rod.

PROCEDURE

- 1 - 8. Repeat equipment & safety procedures.
9. Hold steel pieces with tongs and tack weld at 90° in a "T" form; place for horizontal welding.
10. Direct flame into root of joint so that full penetration is obtained.
11. Move across weld slowly with a slight forward and back motion; add filler on back motion.
12. Completed fillet must have a flat face and equal leg length.
13. Repeat this procedure until the desired weld is produced.
14. Secure equipment.



- A. FLAT POSITION
- B. FLAME NEUTRAL
- C. $\frac{1}{32}$ ROOT OPENING
- D. 30° BEVEL
- E. BACKHAND SCALE TECHNIQUE

NAME GROOVE WELD	MILESTONE C "V" GROOVE WELD IN THE FLAT POSITION		MODULE NO. 37
			FIGURE NO. 9
ELECTRODE SIZE $\frac{1}{16}$ DIA.	TYPE COPPER COATED AWS-ASTM CLASS 1 TYPE C		
MATERIAL STEEL	SPEC. MILD	AMT. 2	SIZE 12 GA. X $\frac{1}{2}$ X 3

OXYACETYLENE WELDING

Module II. Groove Weld

Milestone C, 'V' Groove Welds in the Flat Position

Project 9; Time: 6 hours

INTRODUCTION

The student will make a two pass backhand butt weld with full penetration on 12 gage steel plate. The bead surface must be convex and uniform in appearance.

EQUIPMENT REQUIRED

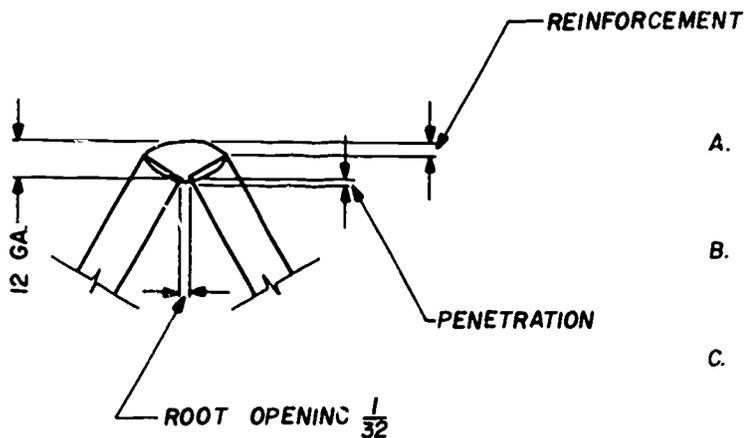
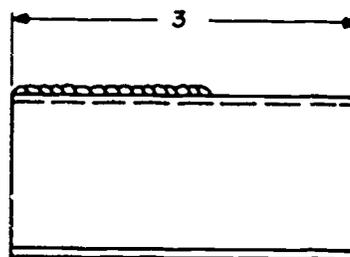
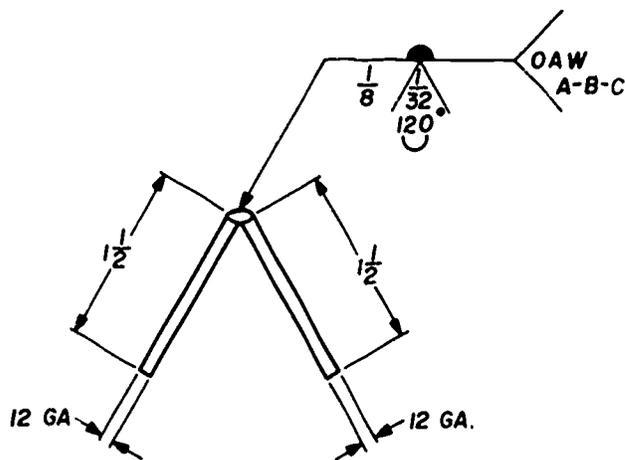
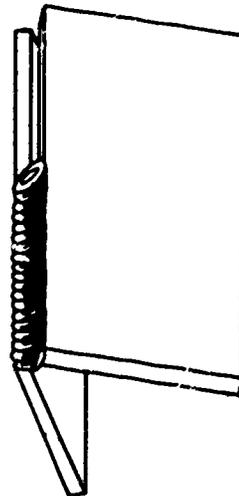
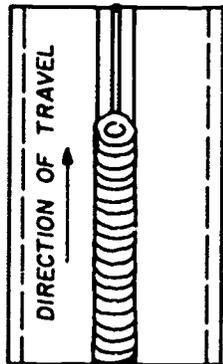
Oxyacetylene torch, tips, regulators, flint lighter, wrench, tongs, goggles, vise grip-pliers.

MATERIAL NEEDED

2 pieces 12 gage steel 1-1/2 x 3 inches, 1/16 steel welding rod.

PROCEDURE

- 1 - 8. Repeat equipment & safety procedures.
9. Tack weld pieces in a butt joint without gapping; place for flat position welding.
10. Open torch valves about one quarter turn; light with flint lighter.
11. Adjust flame to a neutral condition with a cone length as directed.
12. Hold torch with a dragging angle of about 45° at the left end of joint; hold tip of cone clear of steel by 1/8 inch.
13. Move to the right cone of flame directed backward into puddle.
14. Add filler material to make a full bead.
15. Follow technique as demonstrated.
16. Repeat this procedure until the desired weld is produced.
17. Secure equipment.



A. VERTICAL POSITION

B. FLAME NEUTRAL

C. PENETRATE

NAME GROOVE WELD		MILESTONE D CORNER WELD IN THE VERTICAL POSITION		MODULE NO. IX
				FIGURE NO. D
ELECTRODE SIZE $\frac{1}{16}$ DIA.		TYPE COPPER COATED AWS-ASTM CLASS I TYPE C		
MATERIAL STEEL	SPEC. MILD	AMT. 2	SIZE 12 GA. $\frac{1}{2}$ X 3	

OXYACETYLENE WELDING

Module II. Groove Weld

Milestone D, Corner Weld in the Vertical Position

Project 10; Time: 3 hours

INTRODUCTION

The student will make a vertical-up corner weld joint by joining two pieces of 12 gage steel at 60°. This is a one pass weld with full penetration. Bead surface should be convex and uniform in appearance.

EQUIPMENT REQUIRED

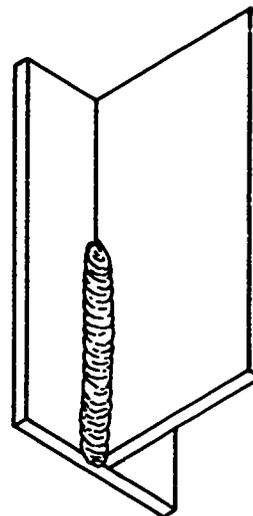
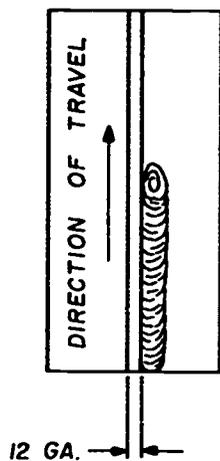
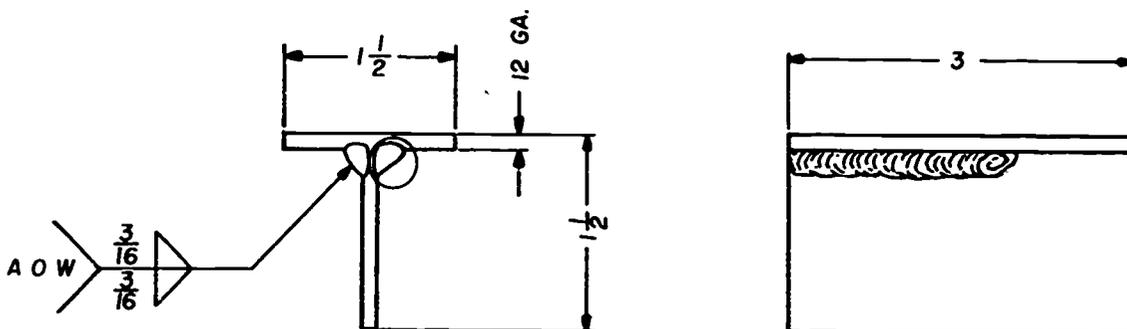
Oxyacetylene torch, tips, regulators, flint lighter, wrench, tongs, goggles, vise grip-pliers.

MATERIAL NEEDED

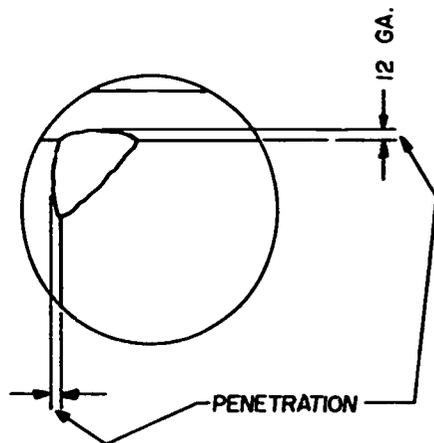
2 pieces 12 gage steel 1-1/2 x 3 inches, 1/16 steel welding rod.

PROCEDURE

- 1 - 8. Repeat equipment & safety procedures.
9. Clamp steel pieces together at 60° to form a corner joint; with a 1/32 inch root gap. Position for vertical welding.
10. Open torch valves about one quarter turn; light with flint lighter.
11. Adjust flame to a neutral condition with a cone length as directed.
12. Hold torch as a pencil, the flame pointed with a 45° leading angle, the tip of cone 1/8 inch from metal surface, puddle slowly across.
13. Hold torch steady at base of the joint until fusion starts.
14. Add filler in puddle as torch is moved upward.
15. Repeat this procedure until desired result is obtained.
16. Secure equipment.



A. VERTICAL POSITION



B. FLAME NEUTRAL

C. WELD BOTH SIDES

NAME FILLET WELD	MILESTONE C		MODULE NO. III
	FILLET WELDS IN THE VERTICAL POSITION		FIGURE NO. 11
ELECTRODE SIZE	$\frac{1}{16}$ DIA.	TYPE	COPPER COATED AWS-ASTM CLASS 1 TYPE C
MATERIAL	STEEL	SPEC.	MILD
		AMT.	2
		SIZE	12 GA. X $\frac{1}{2}$ X 3

OXYACETYLENE WELDING

Module III. Fillet Weld

Milestone C, Fillet Welds in the Vertical Position

Project 11; Time: 6 hours

INTRODUCTION

The student will make a 'T' joint to be welded in the vertical position. This is a one pass fillet; there should not be any voids at the root. It will have a flat face and equal leg length.

EQUIPMENT REQUIRED

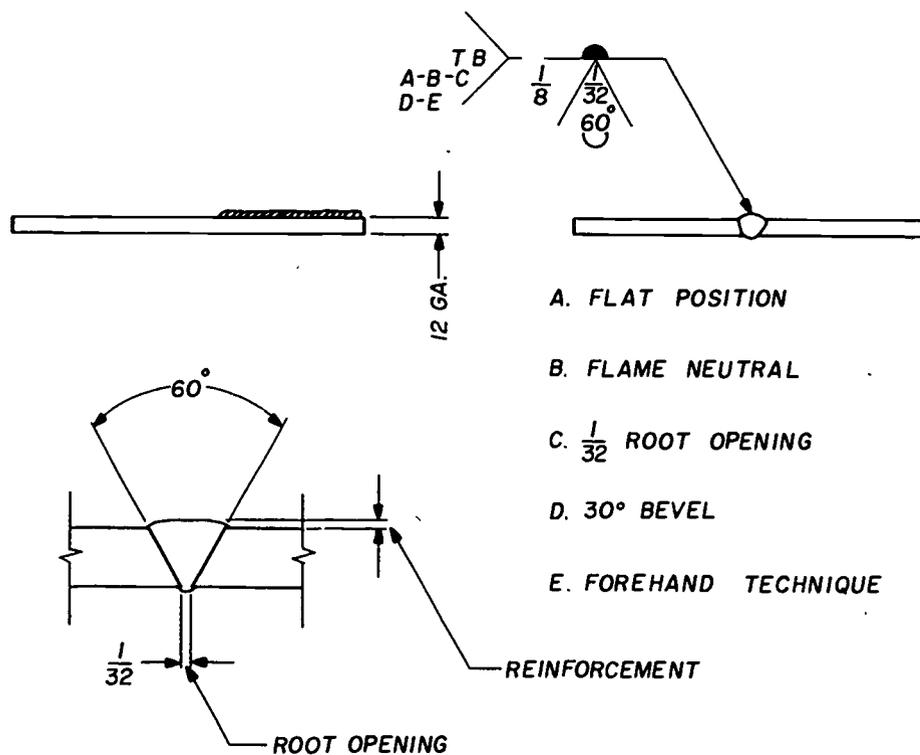
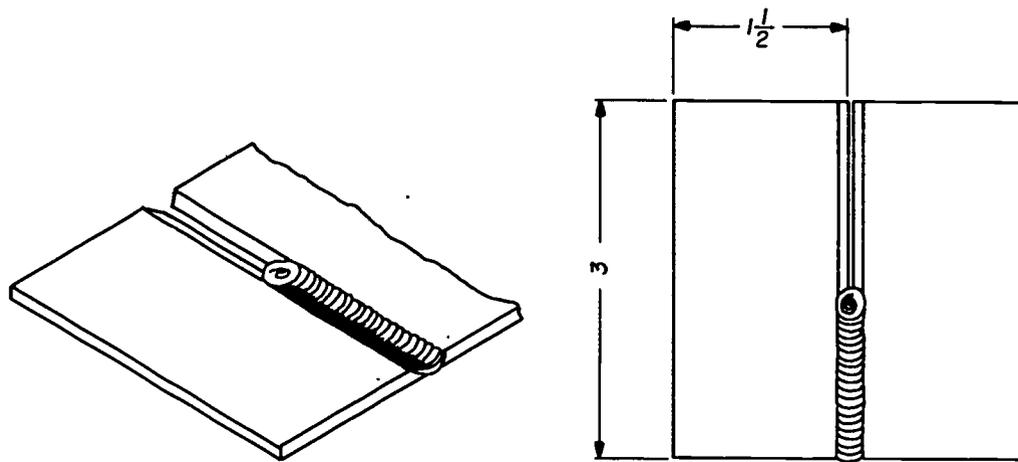
Oxyacetylene torch, tips, regulators, flint lighter, wrench, tongs, goggles, vise grip-pliers.

MATERIAL NEEDED

2 pieces 12 gage steel 1-1/2 x 3 inches, 1/16 steel welding rod.

PROCEDURE

- 1 - 8. Repeat equipment & safety procedures.
9. Hold steel pieces with tongs and tack weld at 90° in a 'T' form; place for vertical-up welding.
10. Open torch valves about one quarter turn; light with flight lighter.
11. Adjust flame to a neutral condition with a cone length as directed.
12. Hold torch as a pencil, the flame pointed with a 45° leading angle, the tip of cone 1/8 inch from metal surface.
13. Hold torch steady at base of the joint until fusion starts.
14. Add filler in puddle as torch is moved upward.
15. Repeat this procedure until desired result is obtained.
16. Secure equipment.



NAME BRAZE WELD		MILESTONE A "V" GROOVE WELD IN THE FLAT POSITION		MODULE NO. V
				FIGURE NO. 12
ELECTRODE SIZE $\frac{1}{8}$ DIA.		TYPE GAS BRAZING ROD		
MATERIAL STEEL	SPEC. MILD	AMT. 2	SIZE 12 GA. X $\frac{1}{2}$ X 3	

OXYACETYLENE WELDING

Module V. Braze Welds

Milestone A, 'V' Groove Weld in the Flat Position

Project 12; Time: 3 hours

INTRODUCTION

The student will form a groove butt joint with 2 pieces of 12 gage steel having a root gap of 1/32 inch. These pieces will be jointed by braze welding, using brass filler with flux. There should be full penetration with uniform reinforcement at face and root.

EQUIPMENT REQUIRED

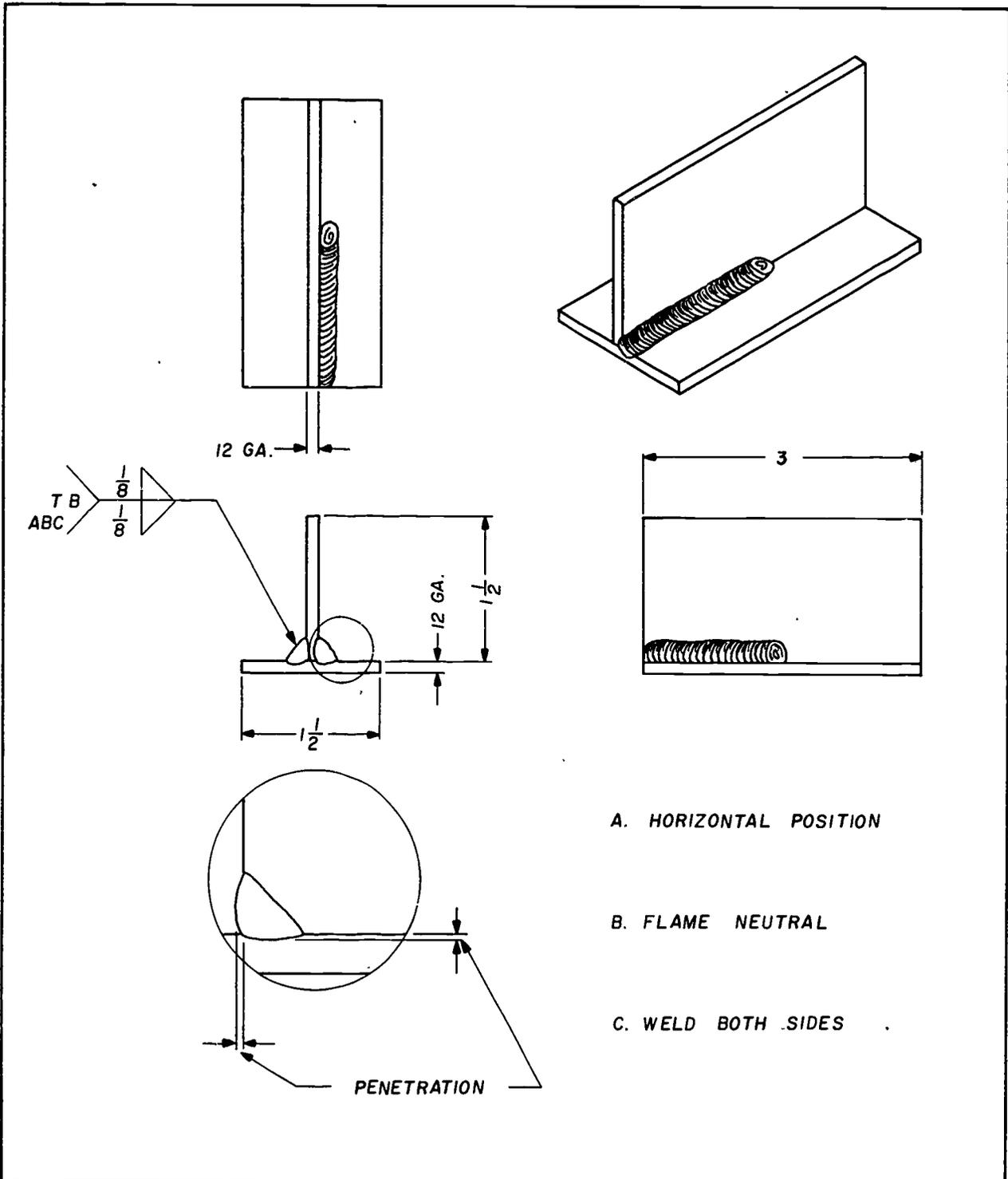
Oxyacetylene torch, tips, regulators, flint lighter, wrench, tongs, goggles, vise grip-pliers.

MATERIAL NEEDED

2 pieces 12 gage steel 1-1/2 x 3 inch, 1/8 inch brazing rod, brazing flux.

PROCEDURE

- 1 - 8. Repeat equipment & safety procedures.
9. Tack weld pieces to form a butt joint with a 1/32 inch root gap.
10. Open torch valves about one quarter turn; light with flint lighter.
11. Adjust flame to a neutral condition with a cone length as directed.
12. Hold torch as a pencil, the flame pointed with a 45° leading angle, the tip of cone 1/8 inch from metal surface.
13. Heat the brass rod, dip into flux for a 2 to 3 inch coating.
14. Heat joint end to the melting point of the brass, 1651°F. There will be little color change of the steel, and no melting of the steel.
15. Move along joint with torch motion back and forth or circular, deposit brass on back motion. Do not allow bead to flow away from the joint over the steel surface.
16. Repeat this procedure until the desired weld is produced.
17. Secure equipment.



NAME BRAZE WELD		MILESTONE B FILLET WELDS IN THE HORIZONTAL POSITION		MODULE NO. IV
				FIGURE NO. 13
ELECTRODE SIZE $\frac{1}{8}$ DIA.		TYPE GAS BRAZING ROD		
MATERIAL	STEEL	SPEC. MILD	AMT. 2	SIZE 12 GA. X $\frac{1}{2}$ X 3

OXYACETYLENE WELDING

Module V. Braze Welds

Milestone B, Fillet Welds in the Horizontal Position

Project 13; Time: 3 hours

INTRODUCTION

The student will make a 'T' joint to be braze welded in the horizontal position. This is a single pass weld with a flat face and equal leg length.

EQUIPMENT REQUIRED

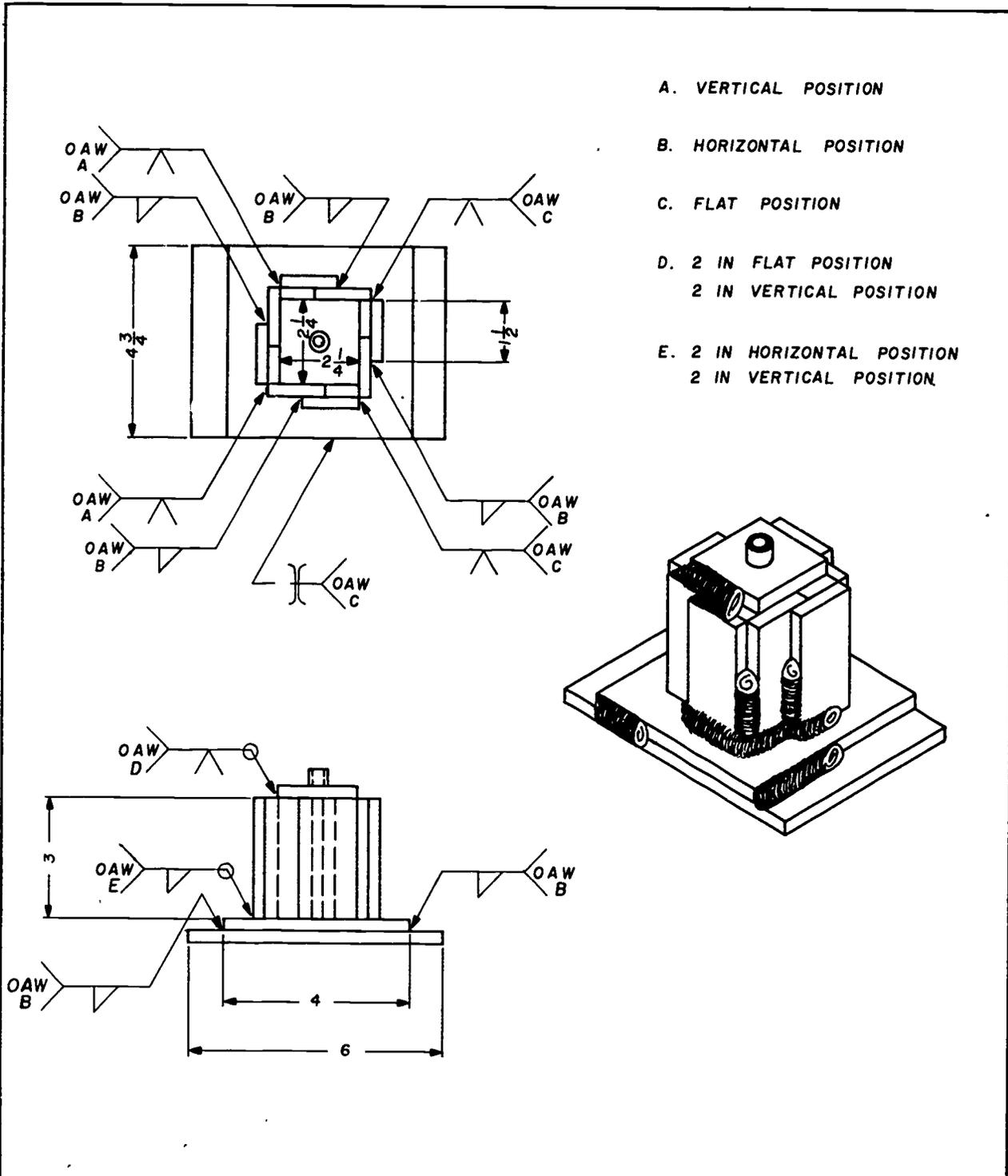
Oxyacetylene torch, tips, regulators, flint lighter, wrench, tongs, goggles, vise grip pliers.

MATERIAL NEEDED

2 pieces 12 gage steel 1-1/2 x 3 inch, 1/8 inch brazing rod, brazing flux.

PROCEDURE

- 1 - 8. Repeat equipment & safety procedures.
9. Tack weld steel plate pieces to form a 'T' fillet joint.
10. Open torch valves about one quarter turn; light with flint lighter.
11. Adjust flame to a neutral condition with a cone length as directed.
12. Hold torch as a pencil, the flame pointed with a 45° leading angle, the tip of cone 1/8 inch from metal surface.
13. Heat the brass rod, dip into flux for a 2 to 3 inch coating.
14. Heat joint end to the melting point of the brass, 1651°F. There will be little color change of the steel, and no melting.
15. Move along joint with torch motion back and forth or circular, deposit brass on back motion. Do not allow bead to flow away from the joint over the steel surface.
16. Repeat this procedure until the desired weld is produced.
17. Secure equipment.



NAME PRESSURE VESSEL		MILESTONE A OXYACETYLENE WELDING FINAL TEST		MODULE NO. VI
				FIGURE NO. 14
ELECTRODE SIZE $\frac{1}{16}$ DIA.		TYPE COPPER COATED ASW - ASTM CLASS 1 TYPE C		
MATERIAL	STEEL	SPEC. MILD	AMT. 8	SIZE 12 GA. $1\frac{1}{2}$ X 3
	STEEL	MILD	1	12 GA. 4 X 6
	STEEL	MILD	1	12 GA. 4 X 4
	STEEL	MILD	1	12 GA. $2\frac{1}{4}$ X $2\frac{1}{4}$

OXYACETYLENE WELDING

Module VI. Pressure Vessel

Milestone A, Final Test - Oxyacetylene Welding

Project 14; Time: 12 hours

INTRODUCTION

The student will make a pressure vessel from lap welded projects. These pieces will be joined by corner welds to form a cube on a base. This can be given a pressure test.

EQUIPMENT REQUIRED

Oxyacetylene torch, tips, regulators, flint lighter, wrench, tongs, goggles, vise grip-pliers.

MATERIAL NEEDED

8 pieces 12 gage steel 1-1/2 x 3 inch, 1 piece 4 x 4 inch, 1 piece 4 x 6 inch, 1 piece 2-1/4 x 2-1/4 inch.

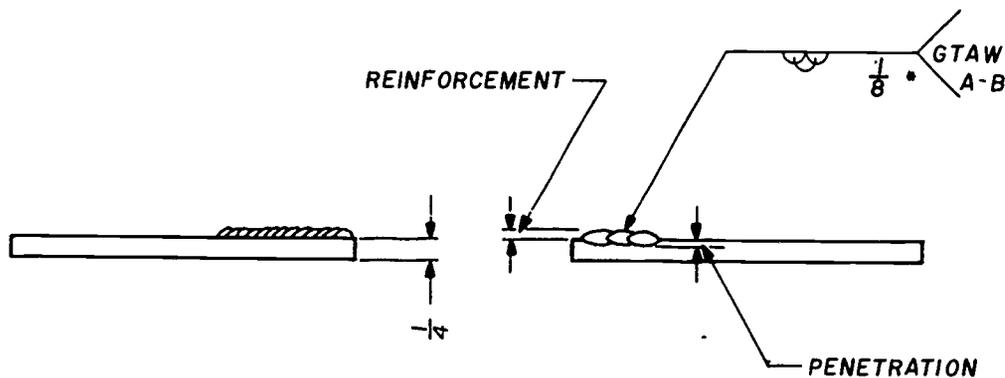
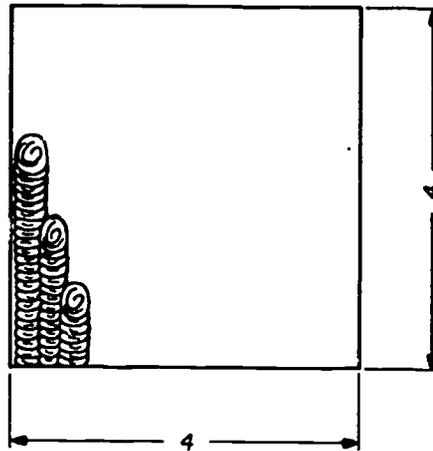
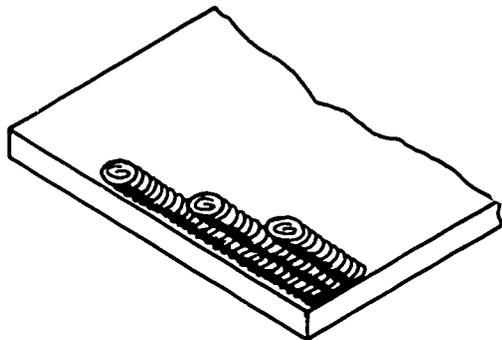
PROCEDURE

- 1 - 8. Repeat equipment & safety procedures.
9. Make 4 lap welds to join 8 pieces of 1-1/2 inch steel. Overlap 1/2 inch, weld in the horizontal position.
10. Join these pieces to form a square; make 2 corner welds in flat and 2 in the vertical position.
11. Make a base plate by centering the 4 x 4 inch piece on the 4 x 6 inch piece. Join with 2 edge welds and 2 fillets.
12. Center the square box on this base and join with 2 fillet welds in the horizontal and 2 in the vertical position.
13. Close the box by welding the 2-1/4 x 2-1/4 inch piece at the top. Make 2 corner welds in the horizontal and 2 in the vertical position.
14. Repeat these operations until all welds are properly made. It may be an advantage to tack weld the entire structure together before making any one weld. This will reduce distortion and loss of dimension.
15. This vessel may be pressure tested by melting an opening in the top to receive a small pipe nipple. Connect this to a water supply source, not air, inspect for leaks.

GAS TUNGSTEN-ARC WELDING (TIG) PHASE V, PART A OBJECTIVE

In this course the student will learn the characteristics of the gas tungsten-arc welding system and how to use it. He will become familiar with air cooled and water cooled torches. He will weld thin gage ferrous and non-ferrous metals.

The skill developed through this experience will make the student employable as a welder using gas tungsten-arc welding equipment except for that work covered by codes or demanding advanced experience.



A. FLAT POSITION

B. WELD BOTH SIDES

NOTE: * REFERS TO BEAD WIDTH

NAME FAMILIARIZATION WITH THE PROCESS		MILESTONE A STRINGER BEADS IN THE FLAT POSITION		MODULE NO. I FIGURE NO. A-1	
ELECTRODE SIZE $\frac{1}{8}$ DIA. AC/HF		TYPE ALUM. 1100-0			
MATERIAL	SPEC.	AMT	SIZE		
ALUM. PLATE	1100-0	1	$\frac{1}{4}$ X 4 X 4		

GAS TUNGSTEN-ARC WELDING (TIG)

Module I. Familiarization with the Process

Milestone A, Stringer Beads

Project 1; Time: 6 hours

INTRODUCTION

With TIG equipment and aluminum plate the student will assemble the torch, set proper argon gas pressure and flow rate. Using filler wire he will hand feed this to weld beads on both sides of the aluminum plate. These beads must be consistent in width, be straight and have uniform width and rippling.

REQUIRED EQUIPMENT

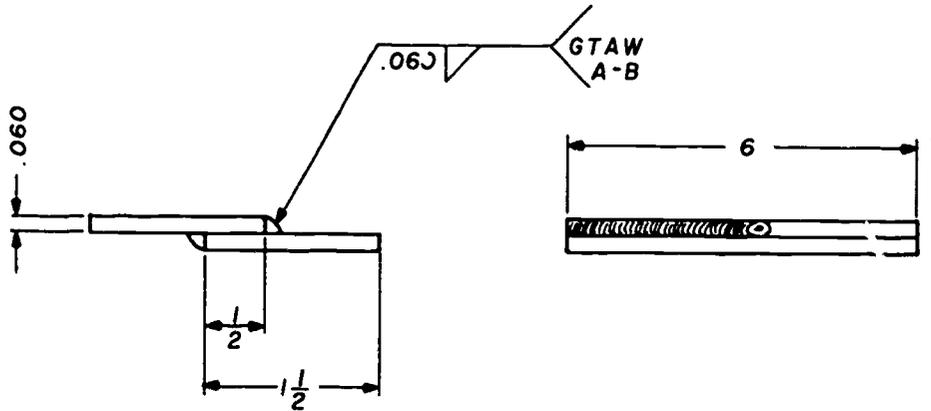
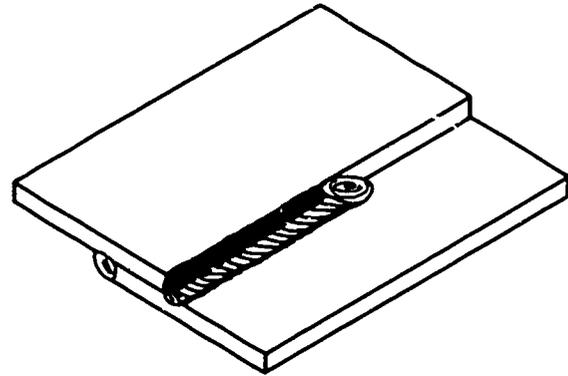
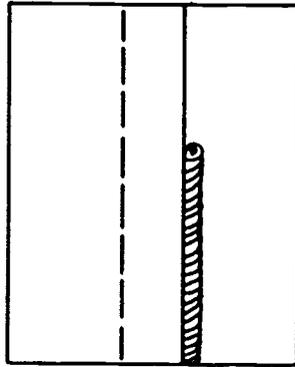
Alternate-direct current welding machine with high frequency current, foot control, pressure regulator, flow meter, TIG torch complete, tongs, and safety equipment.

MATERIAL NEEDED

Aluminum plate 1/4 x 4 x 4 inches, type 1100-0 filler wire.

PROCEDURE

1. Clean plate surface with steel wool, pull the filler wire through the steel wool to remove oxide.
2. Set current controls: amperage, high frequency intensity, polarity and remote control as required.
3. Open argon gas valve, set pressure and flow rate as required.
4. Open cooling water valve.
5. Assemble torch with the proper sized tungsten, collet and collet body, cup. The electrode may require grinding to a tapered end.
6. Start welding machine.
7. Put on face shield and gloves.
8. Hold torch as though it is a pencil, drop face shield.
9. Depress foot switch to start arcing on copper backing.
10. Move arc to the plate, hold until melting starts.
11. Start across plate, adding filler material, establish rate of travel by maintaining uniform puddle width.
12. Move from right to left, with a forward and back motion in small increments, add filler back movement.
13. Stop arc by pressing on foot control with heel, do not lift torch until arc is extinguished.
14. Repeat this procedure until uniform beads are produced.
15. Inspect beads, discuss their quality with your instructor.
16. Secure equipment.



A. HORIZONTAL POSITION

B. WELD BOTH SIDES

NAME FILLET WELD	MILESTONE A LAP WELDS IN THE HORIZONTAL POSITION		MODULE NO. II	
			FIGURE NO. A-2	
ELECTRODE SIZE $\frac{1}{8}$ DIA.	TYPE ALUM. 1100-0			
MATERIAL	SPEC.	AMT.	SIZE	
ALUM. SHEET	1100-0	2	.060 X 6 X $1\frac{1}{2}$	

GAS TUNGSTEN-ARC WELDING (TIG)

Module II. Fillet Weld

Milestone A, Lap Welds in the Horizontal Position

Project 2; Time: 12 hours

INTRODUCTION

The student will make a lap weld set by overlapping two pieces of sheet aluminum 1/2 inch. He will make a fillet weld on each side of this assembly. These welds must have equal leg length and a flat face.

EQUIPMENT REQUIRED

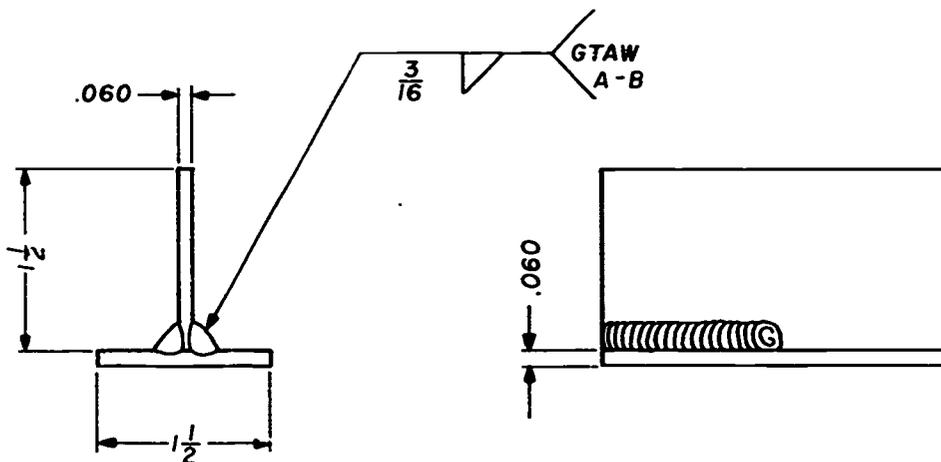
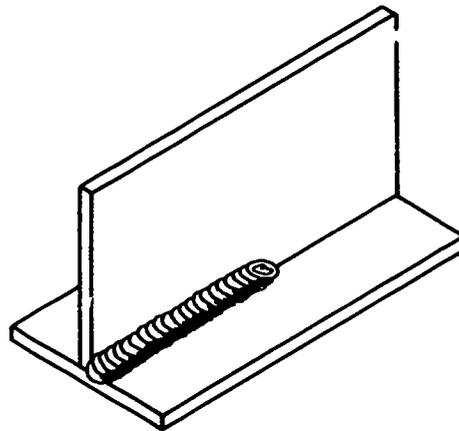
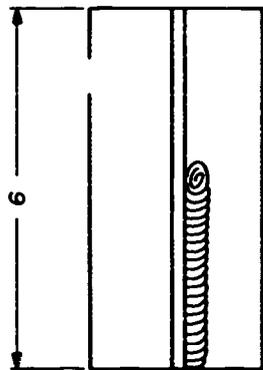
AC-DC welding machine with high frequency current, foot control, pressure regulator, flow meter, TIG torch complete, tongs, vise grip pliers, welding jig and safety equipment.

MATERIAL NEEDED

2 pieces .060 x 1-1/2 x 6 inch sheet aluminum, type 1100-0
1/8 inch diameter filler wire.

PROCEDURE

- 1 - 6. Repeat equipment & safety procedures.
7. Put on face shield and gloves.
8. Clamp the aluminum pieces in the vise grip with a 1/2 inch overlap. Drop face shield.
9. Hold torch as though it is a pencil, depress foot control to start the arc on the aluminum, hold until melting starts.
10. Arc should be directed against the bottom piece, in the corner of the fillet. Move forward and back with constant arc length. Control heat with foot.
11. Dip filler wire in puddle on back stroke of torch.
12. Avoid melting the top edge too deeply.
13. Rate of travel will control size of the weld.
14. Repeat these procedures until the specified weld is produced.
15. Secure equipment



A. HORIZONTAL POSITION

B. WELD BOTH SIDES

NAME FILLET WELD		MILESTONE B FILLET WELDS IN THE HORIZONTAL POSITION		MODULE NO. 11
				FIGURE NO. A-3
ELECTRODE SIZE $\frac{1}{8}$ DIA. AC/HF		TYPE ALUMINUM 1100-0		
MATERIAL	SPEC.	AMT.	SIZE	
ALUMINUM SHEET	1100-0	2	.060 x $\frac{1}{2}$ x 6	

GAS TUNGSTEN-ARC WELDING (TIG)

Module II. Fillet Weld

Milestone B, Fillet Welds in the Horizontal Position

Project 3; Time: 12 hours

INTRODUCTION

The student will make a fillet weld set with two pieces of aluminum, tack welding them in a 'T' form. The two welds will be made in the flat position and must have equal leg lengths and flat faces. This type of joint does not allow for penetration through the vertical member.

EQUIPMENT REQUIRED

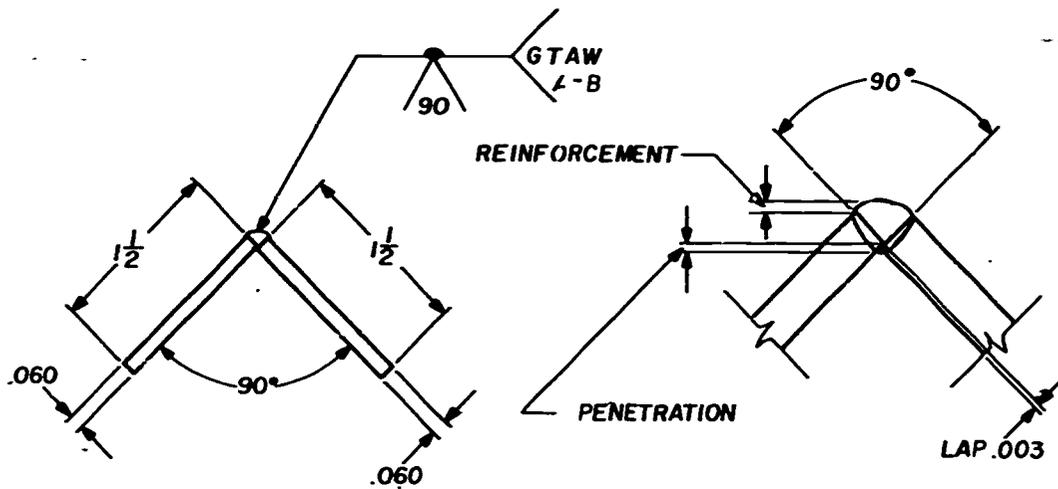
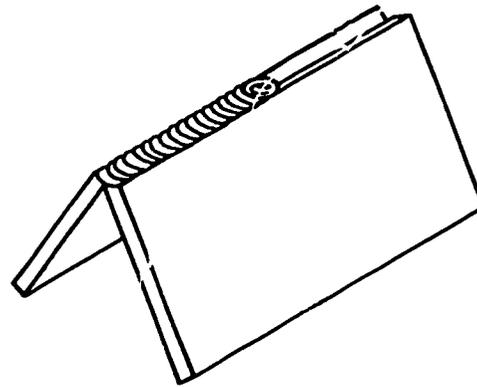
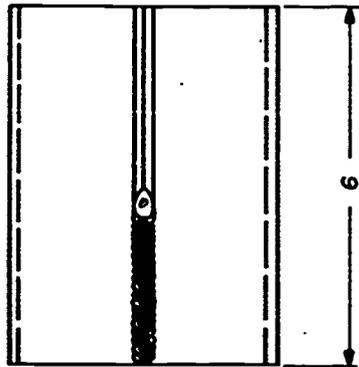
AC welding machine with high frequency current, foot control, pressure regulator, flow meter, TIG torch complete, tongs, welding jig and safety equipment, vise grip pliers.

MATERIAL NEEDED

2 pieces .060 x 1-1/2 x 6 inch sheet aluminum, 1/8 inc type 1100-0 aluminum filler wire.

PROCEDURE

- 1 - 6. Repeat equipment & safety procedures.
7. Put on face shield and gloves.
8. Form a 'T' joint by supporting the vertical piece with the vise grip pliers at the center of the base piece. Drop face shield.
9. Depress foot control to initiate the arc to the copper grounding plate.
10. Move arc to the joint and tack weld each end.
11. Make the fillet welds; direct the arc in the corner with the greatest amount of heat against the base plate. Move forward and back in small increments, deposit filler on back stroke.
12. Welds must be equal in leg dimension, have flat face without undercut.
13. Repeat this procedure until welds are to specification.
14. Secure equipment.



A. FLAT POSITION

B. JIG WITH BACK UP

NAME GROOVE WELD		MILESTONE A CORNER WELD		MODULE NO. 311
				FIGURE NO. A-4
ELECTRODE SIZE $\frac{1}{8}$ DIA. AC/HF		TYPE ALUM. 1100-0		
MATERIAL	SPEC.	AMT.	SIZE	
ALUMINUM SHEET	1100-0	2	.060 X $1\frac{1}{2}$ X 6	

GAS TUNGSTEN-ARC WELDING (TIG)

Module III. Groove Weld

Milestone A, Corner Weld in the Flat Position

Project 4; Time: 6 hours

INTRODUCTION

The student will tack weld two pieces of sheet aluminum to form a corner weld. Welding will be done in the flat position in one pass. The weld should fully penetrate the joint, have a slight convex surface with even ripple.

EQUIPMENT REQUIRED

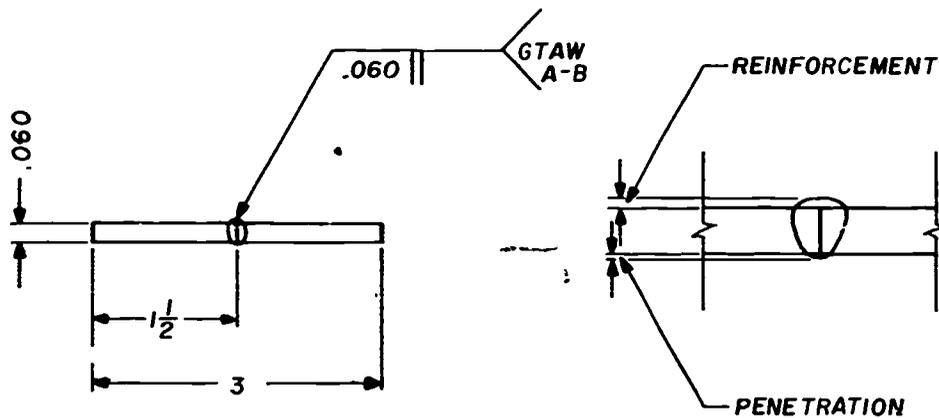
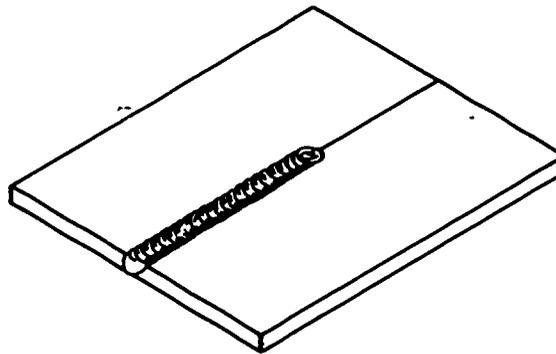
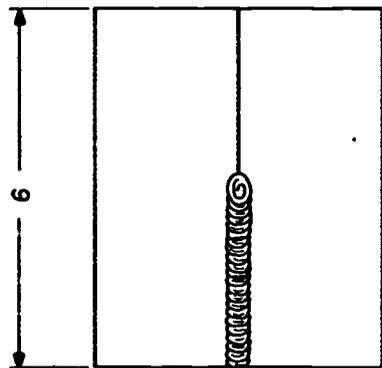
AC-DC welding machine with high frequency current, foot control, pressure regulator, flow meter, TIG torch complete, tongs, welding jig and safety equipment.

MATERIAL NEEDED

2 pieces .060 x 1-1/2 x 6 inch aluminum sheet, 1/8 filler wire type 1100-0.

PROCEDURE

- 1 - 6. Repeat equipment & safety procedures.
7. Place pieces in the welding jig to form a corner joint.
8. Put on face shield and gloves.
9. Hold torch as though it is a pencil, drop face shield.
10. Depress the foot control to initiate the arc to the jig backing.
11. Move the arc to the joint, make the weld with a forward and back motion in small increments; add filler wire on the back stroke.
12. Repeat this procedure until the desired weld is produced.
13. Secure equipment.



A. FLAT POSITION

B. JIG WITH GAS BACK UP

NAME GROOVE WELD		MILESTONE B SQUARE BUTT WELDS IN THE FLAT POSITION		MODULE NO. III
				FIGURE NO. A-5
ELECTRODE SIZE	$\frac{1}{8}$ DIA. AC/HF	TYPE	ALUM. 1100-0	
MATERIAL	ALUMINUM SHEET	SPEC.	AMT.	SIZE
		1100-0	2	.060 X $1\frac{1}{2}$ X 6

GAS TUNGSTEN-ARC WELDING (TIG)

Module III. Groove Weld

Milestone B, Square Butt Weld in the Flat Position

Project 5; Time: 6 hours

INTRODUCTION

The student will make a single pass butt weld with full penetration. The weld will have a convex face with even ripple. There should be no undercut.

EQUIPMENT REQUIRED

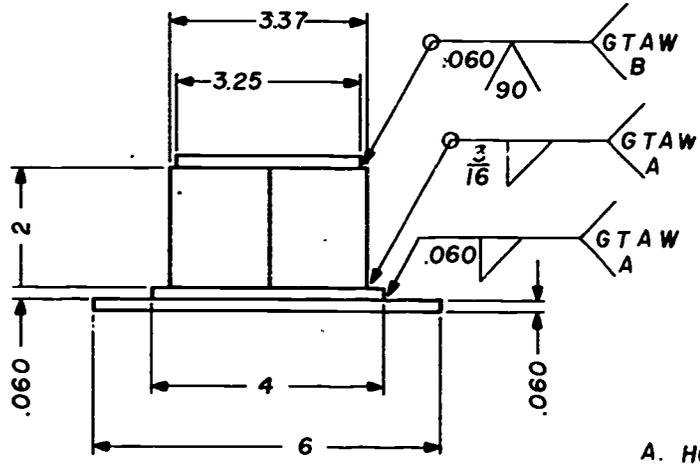
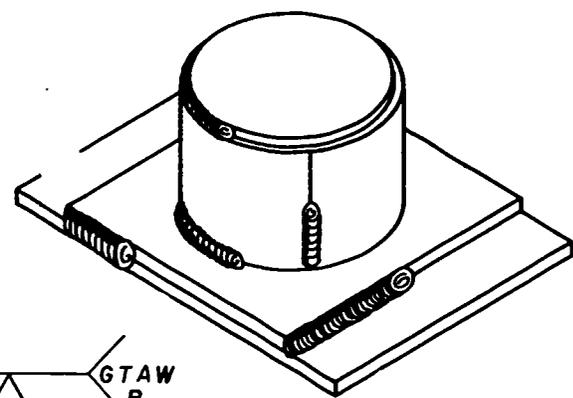
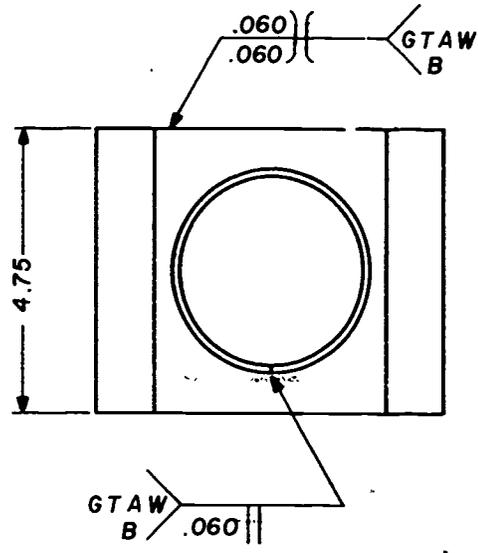
AC-DC welding machine with high frequency current, foot control, pressure regulator, flow meter, TIG torch complete, tongs, welding jig, and safety equipment.

MATERIAL NEEDED

2 pieces .060 x 1-1/2 x 6 inch aluminum sheet, 1/8 inch filler wire type 1100.0.

PROCEDURE

- 1 - 6. Repeat equipment & safety procedures.
7. Place pieces in the welding jig to form a tight butt joint.
8. Put on face shield and gloves.
9. Hold torch as though it is a pencil, drop face shield.
10. Depress foot control to initiate the arc to the jig backing.
11. Move the arc to the joint, make the weld with a forward and back motion in small increments; add filler wire on the back stroke
12. Repeat this procedure until the desired weld is produced.
13. Secure equipment.



A. HORIZONTAL POSITION

B. FLAT POSITION

NAME PRESSURE VESSEL		MILESTONE A ALUMINUM PRESSURE VESSEL		MODULE NO. IX	
				FIGURE NO. A-6	
ELECTRODE SIZE $\frac{1}{8}$ DIA. AC/HF		TYPE ALUM. 1100-0			
MATERIAL	ALUMINUM SHEET	SPEC. 1100-0	AMT. 1	SIZE .060 X 4.75 X 4	
	ALUMINUM SHEET	1100-0	1	.060 X 4.75 X 6	
	ALUMINUM SHEET	1100-0	1	.060 X 3.25 D.	
	ALUMINUM SHEET	1100-0	1	.060 X 10.25 X 2	

GAS TUNGSTEN-ARC WELDING (TIG)

Module IV. Pressure Vessel

Milestone A, Aluminum Pressure Vessel

Project 6; Time: 3 hours.

INTRODUCTION

Follow the instructions in the drawing to construct a vessel using the prepared materials. This structure will be joined by 1 butt, 1 corner, 2 lap, 2 edge, and 1 fillet weld. This is the final project of this module; the vessel may be pressure tested.

EQUIPMENT REQUIRED

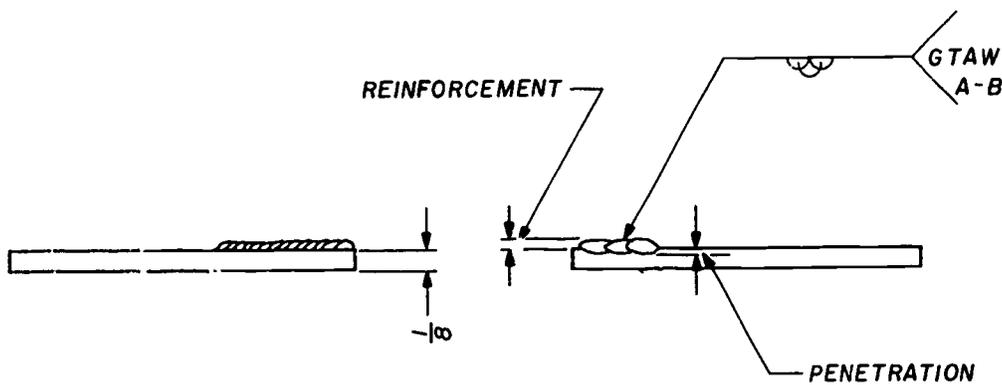
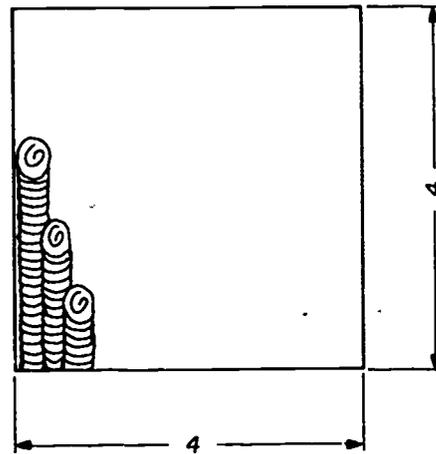
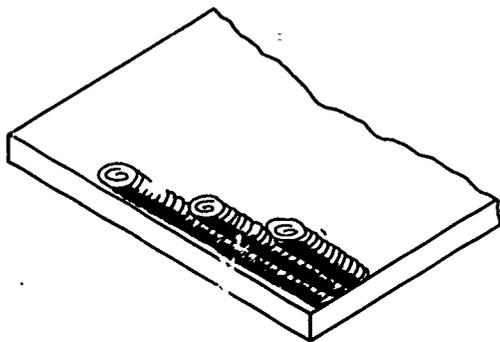
AC-DC welding machine, with high frequency current, foot control, pressure regulator, flow meter, TIG torch complete, tongs, welding jig, and safety equipment.

MATERIAL NEEDED

Pre-cut aluminum pieces listed and shown on drawing A-6.

PROCEDURE

Use the drawing to determine the assembly and welding routine. Duplicate all operations shown.



A. FLAT POSITION

B. WELD BOTH SIDES

NOTE: REFERS TO BEAD WIDTH

NAME FAMILIARIZATION WITH THE PROCESS	MILESTONE B STRINGER BEADS IN THE FLAT POSITION			MODUL
				FIGURE NO. A-7
ELECTRODE SIZE $\frac{1}{16}$ DIA. DC/SP	TYPE S.S. 308			
MATERIAL	SPEC.	AMT.	SIZE	
STAINLESS STEEL PLATE	308	1	$\frac{1}{8}$ X 4 X 4	

GAS TUNGSTEN-ARC WELDING (TIG)

Module I. Familiarization of Process

Milestone B, Stringer Beads in the Flat Position

Project 7; Time: 6 hours

INTRODUCTION

The student will make stringer beads to form a pad covering both sides of a stainless steel plate. The beads, made with 1/16 inch filler wire, must be uniform in width, straight, and have a 25% overlap on each bead.

EQUIPMENT REQUIRED

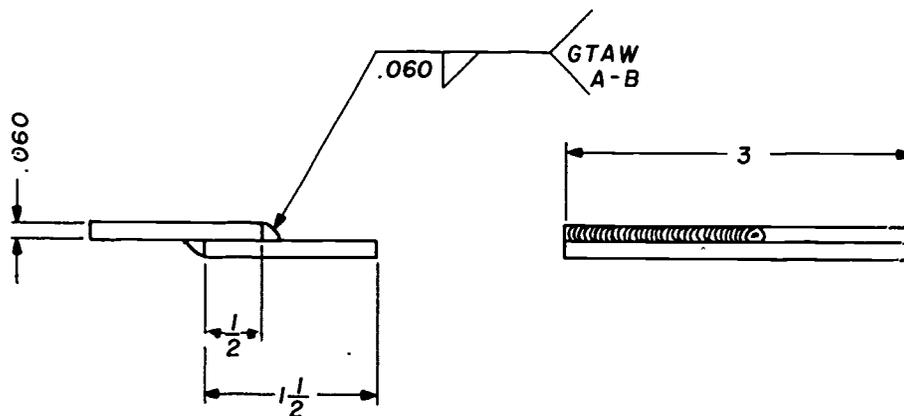
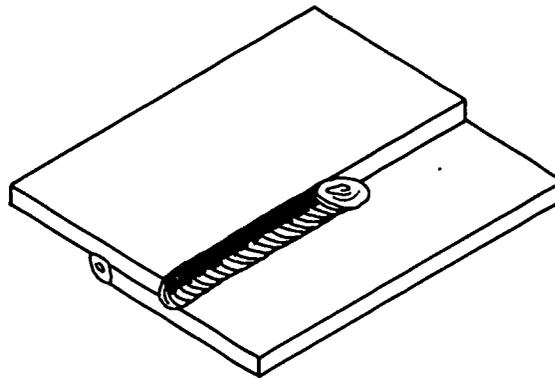
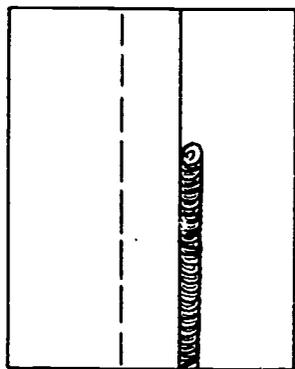
AC-DC welding machine with high frequency current, foot control, pressure regulator, flow meter, torch assembly, tongs, and safety equipment.

MATERIAL NEEDED

1 piece 1/8 x 4 x 4 inch stainless steel plate, 1/16 inch filler wire of a type that will match the base metal.

PROCEDURE

- 1 - 6. Repeat equipment & safety procedures.
7. Hold the torch as though it were a pencil, drop face shield.
8. Depress foot control to initiate the arc to the copper backing, move the arc to the plate and hold until melting starts.
9. Move at a constant rate with forward and back motion in small increments.
10. Add filler metal on the back motion of the torch.
11. Control rate of travel by keeping a constant bead width.
12. When a bead is completed, raise face shield to evaluate results.
13. Repeat this procedure until an acceptable bead is produced.
14. Secure equipment.



A. HORIZONTAL POSITION

B. WELD BOTH SIDES

NAME FILLET WELD		MILESTONE C LAP WELDS IN THE HORIZONTAL POSITION		MODULE NO. II FIGURE NO. A-8
ELECTRODE SIZE $\frac{1}{16}$ DIA. DC/SP		TYPE STAINLESS STEEL 308		
MATERIAL	SPEC.	AMT	SIZE	
STAINLESS STEEL	308	2	$.060 \times \frac{1}{2} \times 3$	

GAS TUNGSTEN-ARC WELDING (TIG)

Module II. Fillet Weld

Milestone C, Lap Welds in the Horizontal Position

Project 8; Time: 12 hours

INTRODUCTION

The student will overlap two pieces of stainless steel by 1/2 inch. He will weld both sides of this lap joint with two single pass fillet welds. These must have a flat face and legs of equal dimension.

EQUIPMENT REQUIRED

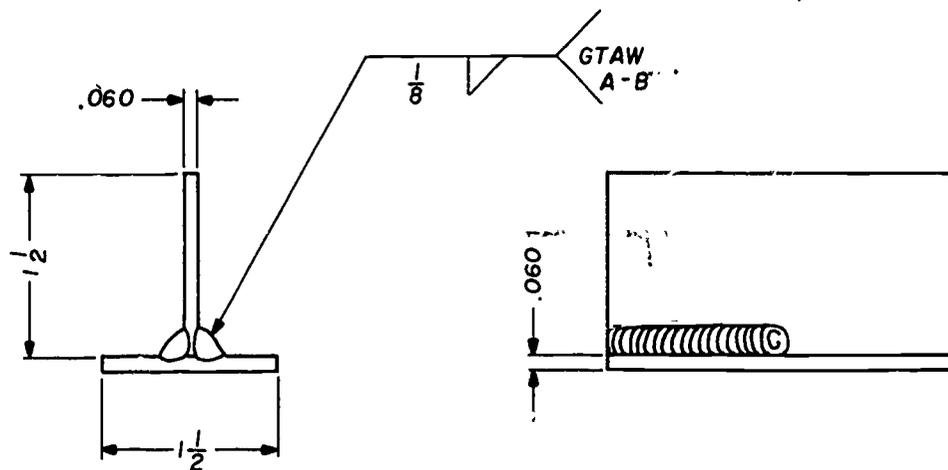
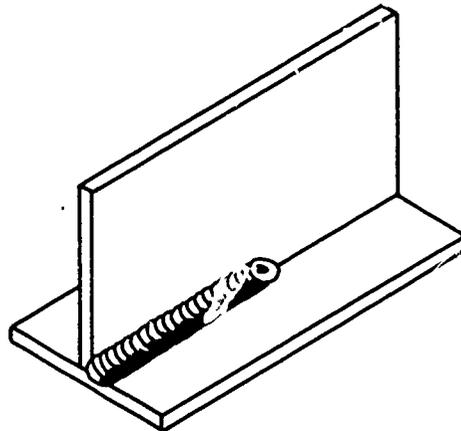
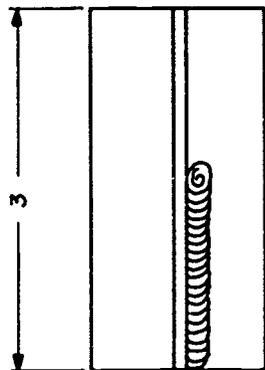
AC-DC welding machine with high frequency current, foot control, pressure regulator, flow meter, torch assembly, vise grip pliers, tongs, and safety equipment.

MATERIAL NEEDED

2 pieces .060 x 1-1/2 x 3 inch stainless steel, 1/16 inch filler wire of a type matching the base metal.

PROCEDURE

- 1 - 6. Repeat equipment & safety procedures.
7. Set amperage, high frequency start only, and remote control as directed.
8. Hold the torch as though it is a pencil, drop face shield.
9. Depress foot control to initiate the arc to the copper backing, move arc to the joint and hold until melting starts. Direct the arc into the corner of the joint with the major heat against the bottom plate.
10. Move at a constant rate with forward and back motion in small increments.
11. Add filler metal on the back motion of the torch.
12. Control the rate of travel by keeping a constant bead width.
13. Repeat this procedure until the desired weld is produced.
14. Secure equipment.



A. HORIZONTAL POSITION

B. WELD BOTH SIDES

NAME FILLET WELD		MILESTONE D FILLET WELDS IN THE HORIZONTAL POSITION		MODULE NO. II FIGURE NO. 4-9	
ELECTRODE SIZE $\frac{1}{16}$ DIA. DC/SP		TYPE STAINLESS STEEL 308			
MATERIAL	SPEC.	AMT	SIZE		
STAINLESS STEEL SHEET	308	2	$.060 \times 1\frac{1}{2} \times 3$		

GAS TUNGSTEN-ARC WELDING (TIG)

Module II. Fillet Weld

Milestone D, Fillet Welds in the Horizontal Position

Project 9; Time: 12 hours

INTRODUCTION

The student will make a 'T' joint and weld the fillets in the flat/horizontal position. These will be made in one pass, must have a flat face and equal leg length. They must not have undercut, or penetration through the vertical plate.

REQUIRED EQUIPMENT

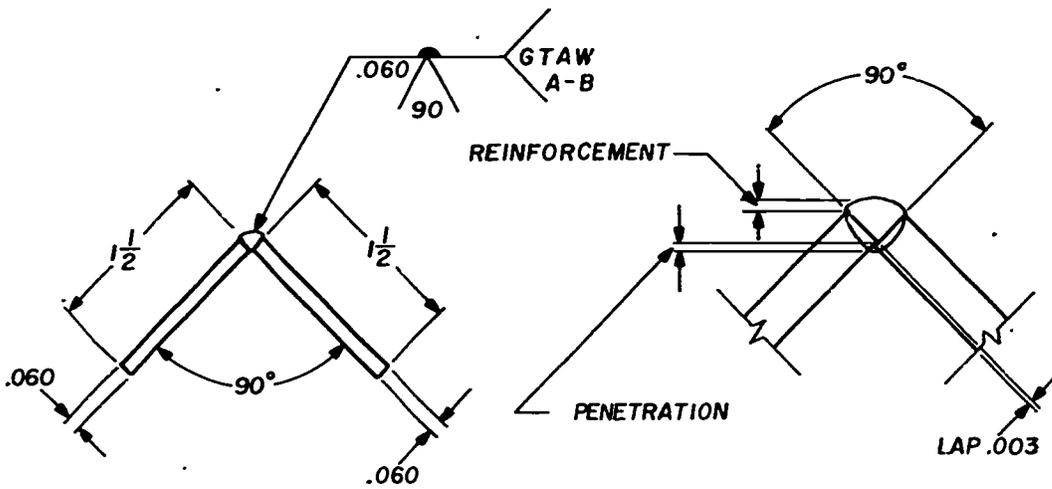
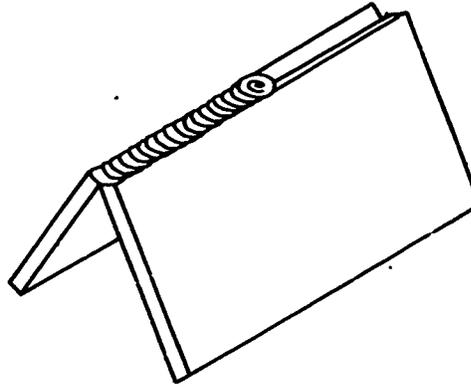
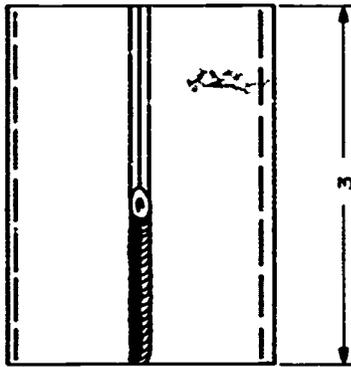
AC-DC welding machine with high frequency current, pressure regulator, flow meter, torch assembly, vise grip pliers, tongs, and safety equipment.

MATERIAL NEEDED

2 pieces .060 x 1-1/2 x 3 inch stainless steel, 1/16 inch filler wire of a type to match the base metal.

PROCEDURE

- 1 - 6. Repeat equipment & safety procedures.
7. Put on face shield and gloves.
8. Form a 'T' joint by supporting vertical piece with vise grip pliers at the center of the base plate.
9. Drop face shield.
10. Depress foot control to initiate the arc to the copper grounding plate.
11. Move arc to the joint and tack weld each end.
12. Make the fillet welds; direct the arc in the corner with the greatest amount of heat against the base plate. Move forward and back in small increments, deposit filler on back stroke.
13. Welds must be equal in leg length, dimension, have a flat face without undercut.
14. Repeat this procedure until welds are to specifications.
15. Secure equipment.



A. FLAT POSITION

B. JIG WITH BACK UP

NAME GROOVE WELD	MILESTONE C		MODULE NO. III
	CORNER WELDS IN THE FLAT POSITION		FIGURE NO. A-10
ELECTRODE SIZE $\frac{1}{16}$ DIA. DC/SP	TYPE STAINLESS STEEL 308		
MATERIAL	SPEC.	AMT.	SIZE
STAINLESS STEEL SHEET	308	2	.060 X $\frac{1}{2}$ X 3

GAS TUNGSTEN-ARC WELDING (TIG)

Module III. Groove Weld

Milestone C, Corner Weld in the Flat Position

Project 10; Time: 6 hours

INTRODUCTION

The student will make a corner weld set by tack welding two pieces of stainless steel at an angle of 90°. This joint will be welded in the flat position. Make a full penetration bead in one pass. Weld face should be slightly convex and have even ripple.

EQUIPMENT REQUIRED

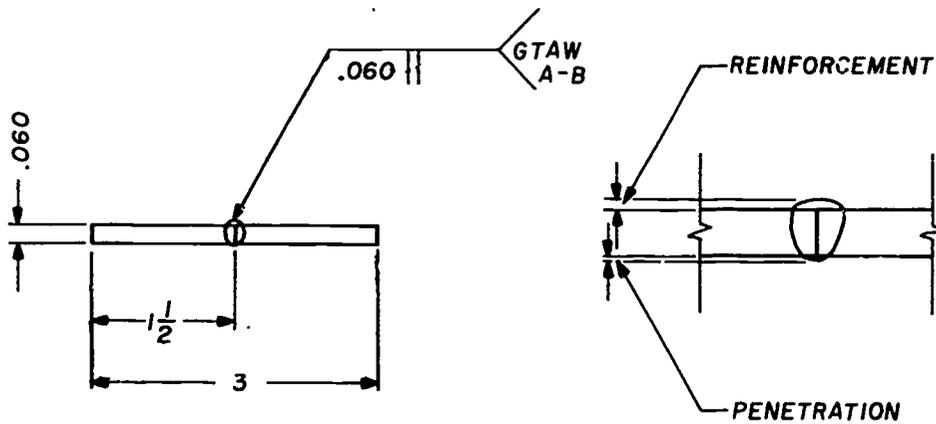
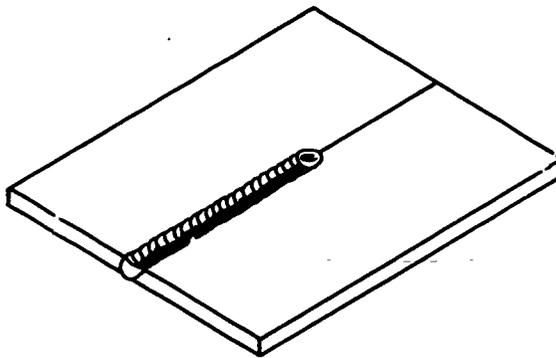
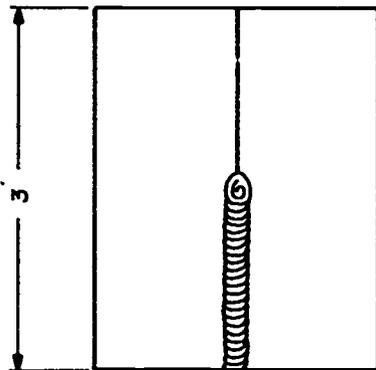
AC-DC welding machine with high frequency current, pressure regulator, flow meter, torch assembly, tongs, and safety equipment, welding jig.

MATERIAL NEEDED

2 pieces .060 x 1-1/2 x 3 inch stainless steel, 1/16 inch filler of a type to match the base metal.

PROCEDURE

- 1 - 6. Repeat equipment & safety procedures.
7. Place pieces in jig to form a corner joint.
8. Put on face shield and gloves.
9. Hold torch as though it is a pencil, drop face shield.
10. Depress foot control to start arcing to the jig, move to the joint.
11. Direct arc so that edges of metal fuse. Add filler when torch is moved back in the forward and back procedure.
12. Repeat this procedure until a satisfactory weld is produced.
13. Secure equipment.



A. FLAT POSITION

B. JIG WITH GAS BACK UP

NAME GROOVE WELD		MILESTONE D SQUARE BUTT WELDS IN THE FLAT POSITION		MODULE NO. III
				FIGURE NO. A-11
ELECTRODE SIZE $\frac{1}{16}$ DIA. DC/SP		TYPE S.S. 308		
MATERIAL	SPEC.	AMT.	SIZE	
STAINLESS STEEL SHEET	308	2	$.060 \times \frac{1}{2} \times 3$	

GAS TUNGSTEN-ARC WELDING (TIG)

Module III. Groove Weld

Milestone D, Square Butt Weld in the Flat Position

Project 11; Time: 6 hours

INTRODUCTION

The student will make a single pass butt weld with full penetration. The finished weld should be convex, of uniform width and shape. There should be no undercut.

EQUIPMENT REQUIRED

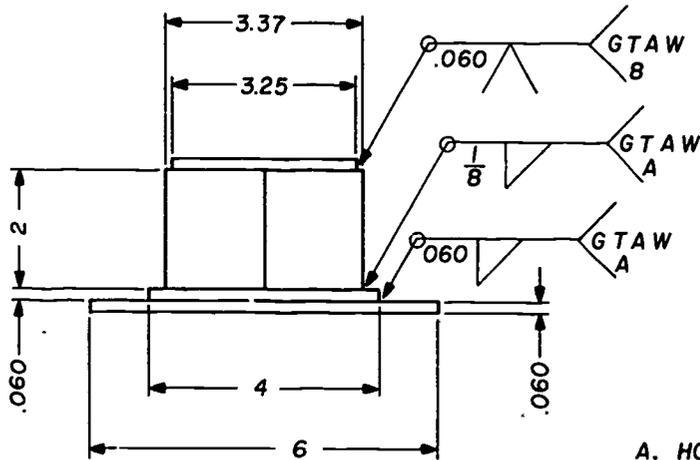
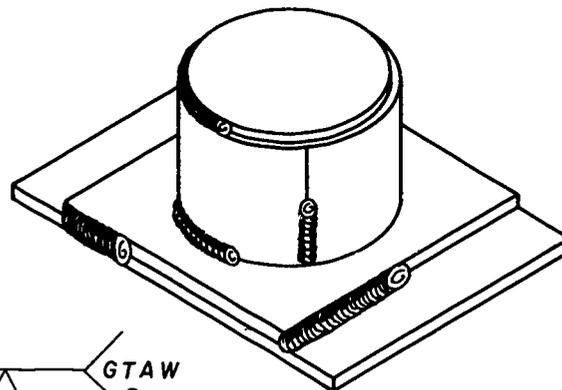
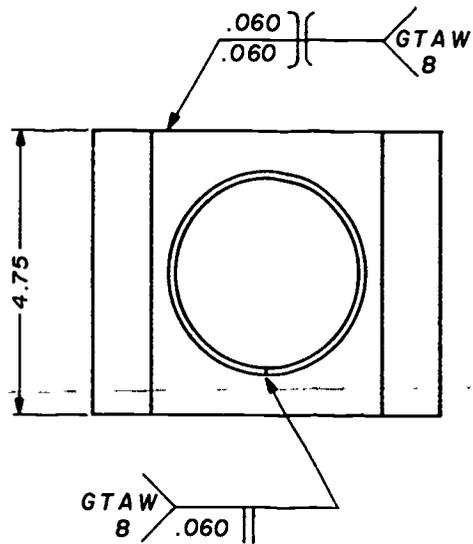
AC-DC welding machine with high frequency current, pressure regulator, flow meter, torch assembly, tongs, welding jig, and safety equipment.

MATERIAL NEEDED

2 pieces .060 x 1-1/2 x 3 inch stainless steel, 1/16 inch filler wire of a type matching the base metal.

PROCEDURE

- 1 - 6. Repeat equipment & safety procedures.
7. Place the pieces in a jig so that edges are flush and touching.
8. Put on face shield and gloves.
9. Hold torch as though it is a pencil, drop face shield.
10. Depress foot control to start arcing to the jig, move to the start of the joint.
11. Hold torch so that both edges fuse. Add filler metal when torch is moved back, in the forward and back procedure.
12. Repeat this procedure until a satisfactory weld is produced.
13. Secure equipment.



A. HORIZONTAL POSITION

B. FLAT POSITION

NAME PRESSURE VESSEL		MILESTONE B PRESSURE VESSEL IN A MULTIPLE POSITION		MODULE NO. IV FIGURE NO. A-12	
ELECTRODE SIZE $\frac{1}{16}$ DIA. DC/SP		TYPE S. S. 308			
MATERIAL	STAINLESS STEEL SHEET	SPEC. 308	AMT. 1	SIZE .060 X 4.75 X 4	
	STAINLESS STEEL SHEET	308	1	.060 X 4.75 X 6	
	STAINLESS STEEL SHEET	308	1	.060 X 3.25 D.	
	STAINLESS STEEL SHEET	308	1	.060 X 10.25 X 2	

GAS TUNGSTEN-ARC WELDING (TIG)

Module IV. Pressure Vessel

Milestone B, Pressure Vessel in a Multiple Position

Project 12; Time: 3 hours

INTRODUCTION

The student will construct a vessel to the specifications shown in the drawing. Use the precut and rolled material provided. This assembly will contain 1 butt, 1 corner, 2 lap, 2 edge, and 1 fillet weld. This vessel is the final project of this module, it may be pressure tested.

EQUIPMENT REQUIRED

AC-DC welding machine with high frequency current, foot control, pressure regulator, flow meter, tongs, welding jig, and TIG torch, safety equipment.

MATERIAL NEEDED

Prepared stainless steel pieces shown in the drawing, 1/16 inch filler metal of a type matching the base metal.

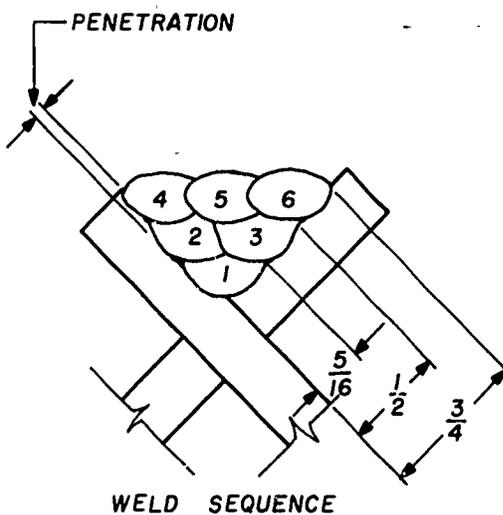
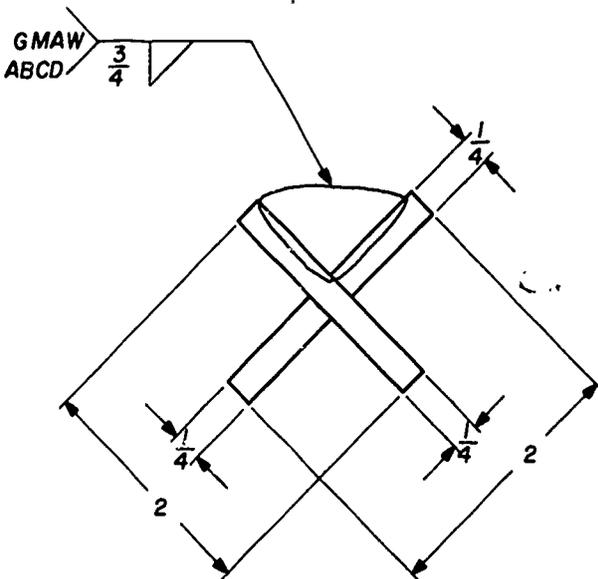
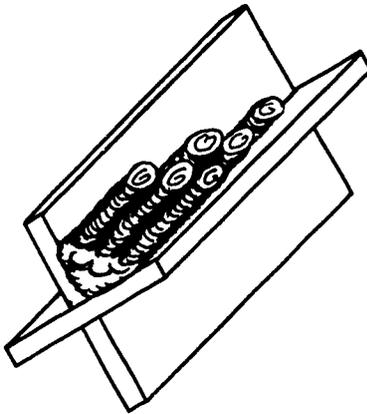
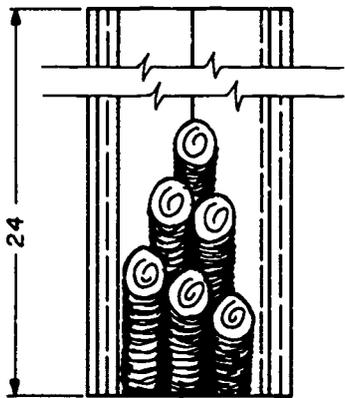
PROCEDURE

Use the drawing to determine the assembly and welding routine. Duplicate all operations shown.

GAS METAL-ARC WELDING (MIG)
PHASE V, PART B OBJECTIVE

In this section of phase V the student will learn to use the semi-automatic equipment of the gas metal-arc process. He will become familiar with the different methods of metal transfer, as in spray, short circuiting, and flux cored electrode welding.

The skill developed through this experience will make the student employable as a welder using gas metal-arc welding equipment except for that work covered by codes or demanding advanced experience.



A. FLAT POSITION

C. SPRAY ARC

B. M.I.G. PROCESS

D. WELD ALL SIDES

NAME FILLET WELD		MILESTONE A FILLET WELDS IN THE FLAT POSITION		MODULE NO. I FIGURE NO. B-1	
ELECTRODE SIZE: .035 DIA. DC/CP		TYPE WIRE SPOOL MO-1313 STEEL			
MATERIAL STEEL		SPEC. MILD	AMT. 1	SIZE 1/4 X 2 X 24	
STEEL		MILD	2	1/4 X 1 X 24	

GAS METAL-ARC WELDING (MIG)

Module I. Fillet Weld

Milestone A, Fillet Welds in the Flat Position

Project 1; Time: 2 hours

INTRODUCTION

The student will make a fillet weld set of steel plate that will contain four 3/4 inch fillet welds 24 inches long. He will use the spray method of metal transfer, depositing the number of passes that will make a fillet of the desired depth. Weld will be made in the flat position.

EQUIPMENT REQUIRED

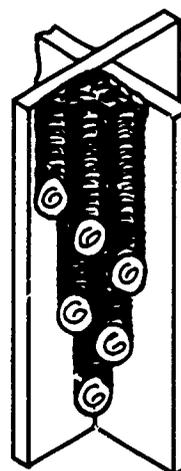
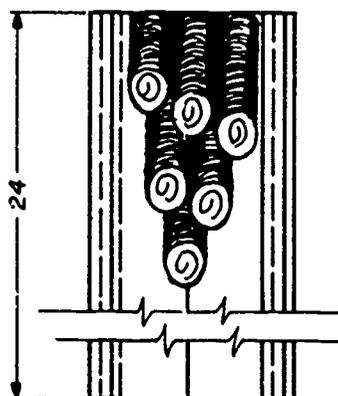
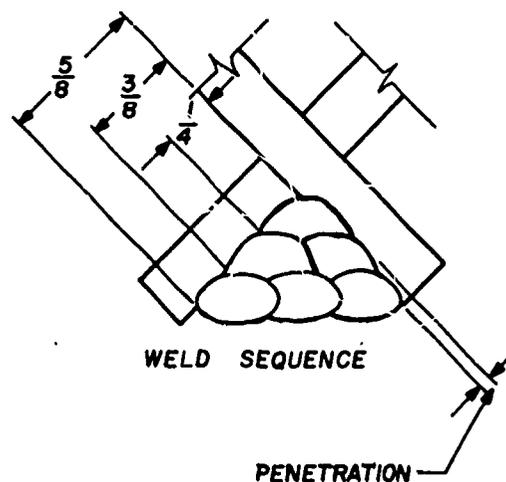
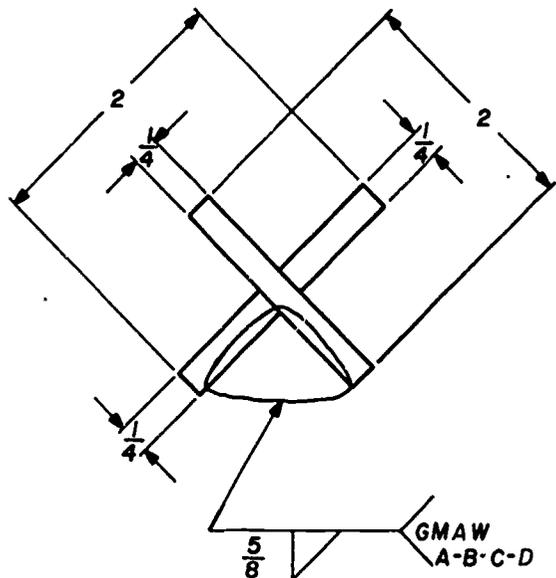
DC constant potential welding machine, wire feeder with gun, gas mixing manifold, tongs, wire brush and safety equipment.

MATERIAL NEEDED

1 piece 1/4 x 2 x 24 and 2 pieces 1/4 x 1 x 24 inch steel plate.

PROCEDURE

1. Clean the plate as required.
2. Select the proper size and type of fillet wire, wire guides drive rolls, contact tube, and gas cup.
3. Thread wire through the system with 1 inch of stick out below the contact tube.
4. Select the proper shielding gas mixture and set pressures and flow rates.
5. Set proper amperage, voltage, slope, and wire feed rate.
6. Start welding machine.
7. Open cooling water valve.
8. Put on face shield and gloves.
9. Hold gun, drop face shield, and tack weld the pieces to form a cross.
10. Direct the gun so that the wire points to the corner of the joint.
11. Close contactor switch, move gun along the joint.
12. Use a leading angle and a small weave motion.
13. On thin gage material do not use weaving, and hold gun with a drag angle.
14. Make the required width of bead by controlling the rate of travel.
15. Repeat this procedure until a uniform weld is produced.
16. Secure equipment.



- A. VERTICAL DOWN POSITION
- B. M.I.G. PROCESS
- C. SHORT ARC
- D. WELD ALL SIDES

NAME FILLET WELD		MILESTONE B FILLET WELDS IN THE VERTICAL DOWN POSITION		MODULE NO. 3
				FIGURE NO. B-2
ELECTRODE SIZE .035 DIA. DC/CP WIRESPOOL TYPE MO -1313 STEEL				
MATERIAL	STEEL	SPEC. MILD	AMT. 1	SIZE 1/4 X 2 X 24
	STEEL	MILD	2	1/4 X 1 X 24

GAS METAL-ARC WELDING (MIG)

Module I. Fillet Weld

Milestone B, Fillet Welds in the Vertical Down Position

Project 2; Time: 2 hours

INTRODUCTION

The student will make a fillet weld set with steel plate to hold four 5/8 x 24 inch fillet welds. He will use the short circuiting arc method of metal transfer, making the number of passes that will produce the desired depth of weld. This is made in the vertical down position.

EQUIPMENT REQUIRED

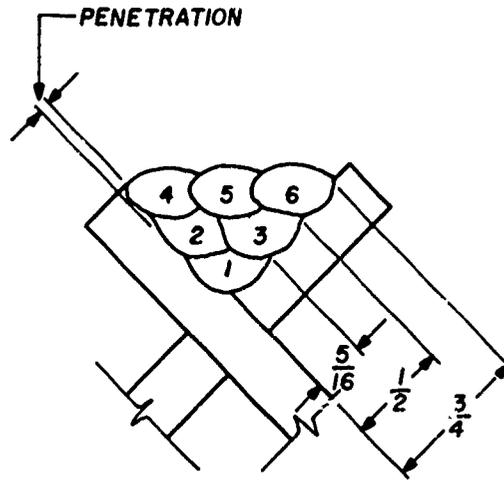
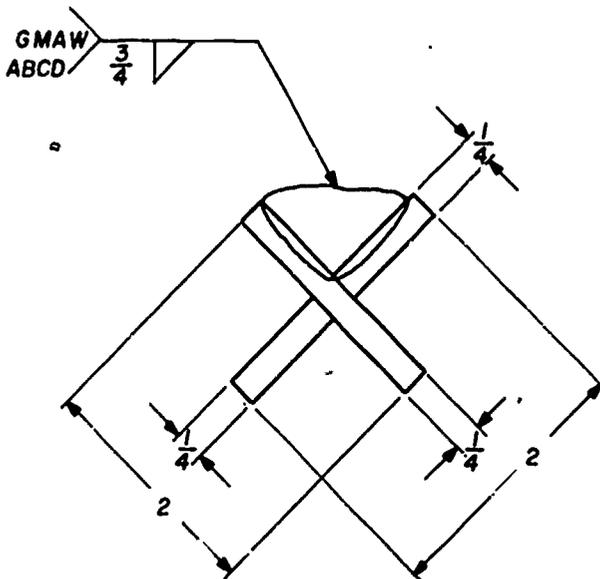
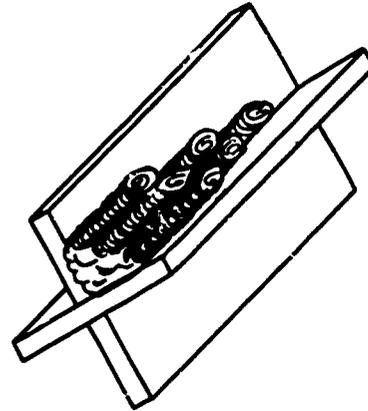
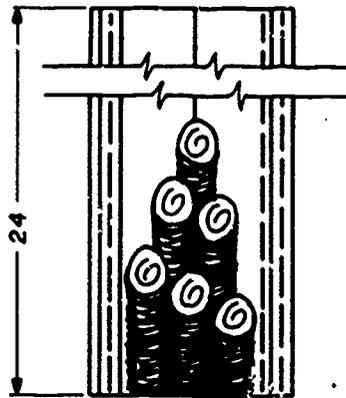
DC welding machine with constant potential, wire feeder with gun assembly, gas mixing manifold, tongs, wire brush, and safety equipment.

MATERIAL NEEDED

1 piece 1/4 x 2 x 24 and 2 pieces 1/4 x 1 x 24 inches steel plate.

PROCEDURE

- 1 - 8. Repeat equipment & safety procedures.
9. Hold pieces with tongs, drop face shield, tack weld plate to form a cross for the four fillet welds.
10. Place this assembly in the positioner for vertical welding.
11. Drop face shield, point gun so that wire is at top center of the joint.
12. Close contactor switch, pull or drag gun down with a slight weave pattern. Move at a uniform rate to form the bead of the desired width.
13. Repeat this procedure until a uniform weld is produced.
14. Secure equipment.



A. FLAT POSITION

C. SPRAY ARC

B. M.I.G. PROCESS

D. WELD ALL SIDES

NAME FILLET WELD		MILESTONE C FILLET WELDS IN THE FLAT POSITION		MODULE NO. I FIGURE NO. B-3	
ELECTRODE SIZE $\frac{1}{16}$ DIA. DC/CP WIREPOOL TYPE 4043 ALUM.					
MATERIAL	ALUMINUM PLATE	SPEC. 4043	AMT. 1	SIZE $\frac{1}{4} \times 2 \times 24$	
	ALUMINUM PLATE	4043	2	$\frac{1}{4} \times 1 \times 24$	

GAS METAL-ARC WELDING (MIG)

Module I. Fillet Weld

Milestone C, Fillet Welds in the Flat Position

Project 3; Time: 2 hours

INTRODUCTION

The student will make a fillet on aluminum by making a set to contain four 3/4 x 24 inch welds. The spray metal transfer method will be used to deposit the needed filler metal to make the required depth of deposit. This will be done in the flat position.

EQUIPMENT REQUIRED

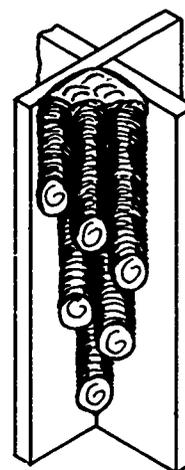
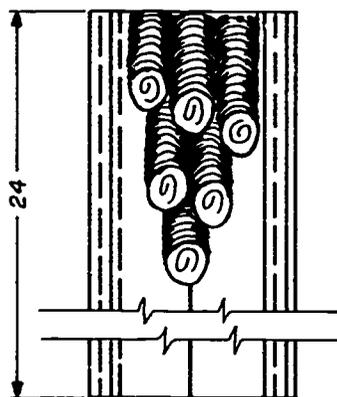
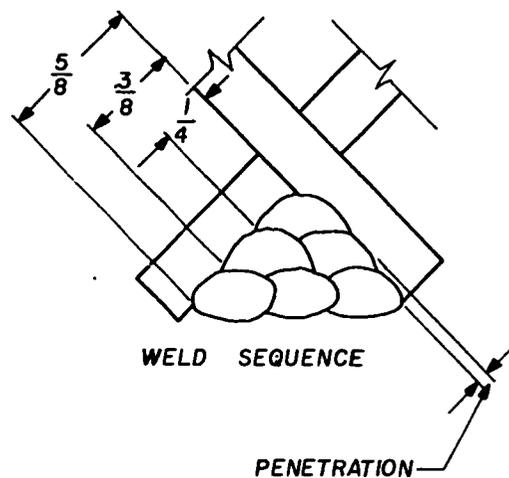
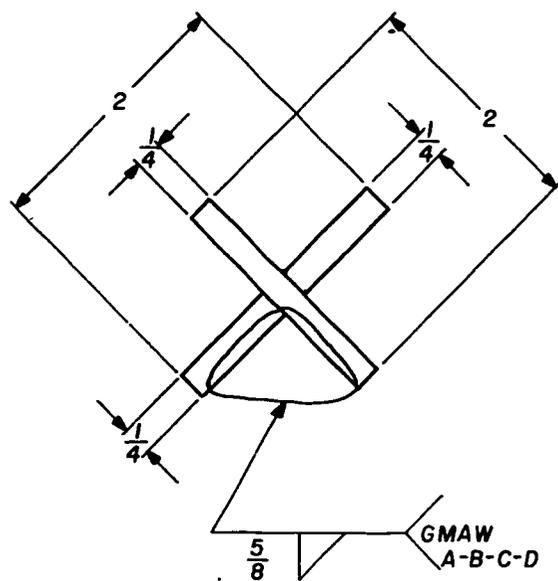
DC welding machine with constant potential, wire feeder with gun assembly, pressure regulator and flow meter, tongs, and safety equipment.

MATERIAL NEEDED

1 piece 1/4 x 2 x 24, 2 pieces 1/4 x 1 x 24 inch aluminum plate.

PROCEDURE

- 1 - 9. Repeat equipment & safety procedures.
10. Hold pieces with tongs, drop face shield, tack weld plates to form a cross for the four fillet welds.
11. Point the gun so that wire is directed to the corner and starting point of the fillet.
12. Close contactor switch, push gun along with a slight lead angle, use a small weave motion.
13. Move at a uniform speed that will deposit the desired amount of filler metal.
14. Repeat this procedure until a uniform weld is produced.
15. Secure equipment



- A. VERTICAL DOWN POSITION
- B. M.I.G. PROCESS
- C. SHORT ARC
- D. WELD ALL SIDES

NAME FILLET WELD	MILESTONE D FILLET WELDS IN THE VERTICAL DOWN POSITION W/ SHORTCIRCUITING METAL TRANSFER			MODULE NO. I
				FIGURE NO. B-4
ELECTRODE SIZE $\frac{1}{16}$ DIA. DC/CP WIREPOOL TYPE 4043 ALUM.				
MATERIAL	ALUMINUM PLATE	SPEC. 4043	AMT. 1	SIZE $\frac{1}{4}$ X 2 X 24
	ALUMINUM PLATE	4043	2	$\frac{1}{4}$ X 1 X 24

GAS METAL-ARC WELDING (MIG)

Module I. Fillet Weld

Milestone D, Vertical Down Welding with Short Circuiting Metal Transfer

Project 4; Time: 2 hours

INTRODUCTION

The student will make a fillet weld set of aluminum to contain four 5/8 inch welds. The short circuiting metal transfer method will be used, welding in the vertical down position. Deposit the number of beads needed to complete the weld to dimension. Equal leg length and a flat face should be produced.

EQUIPMENT REQUIRED

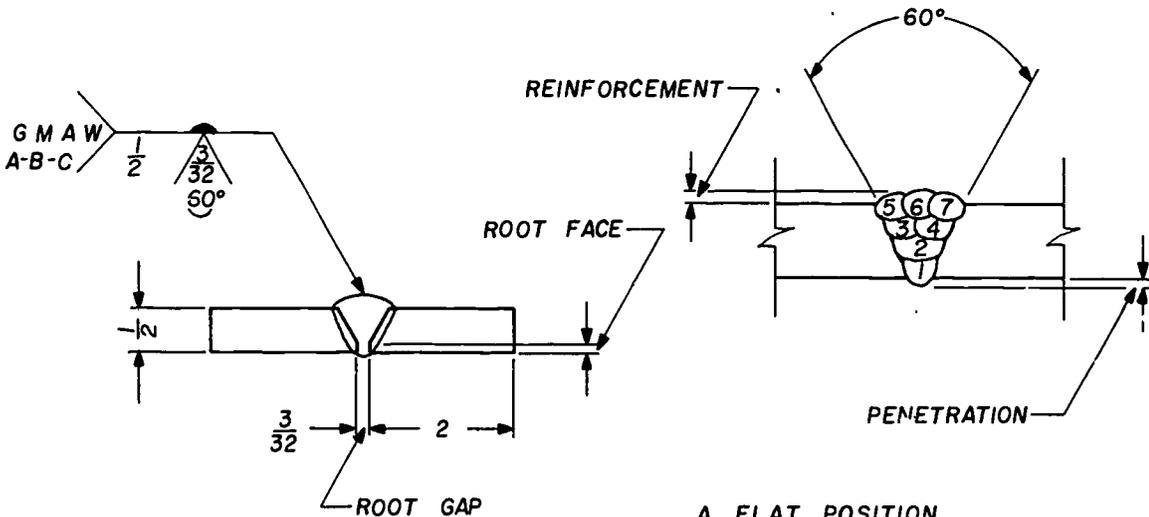
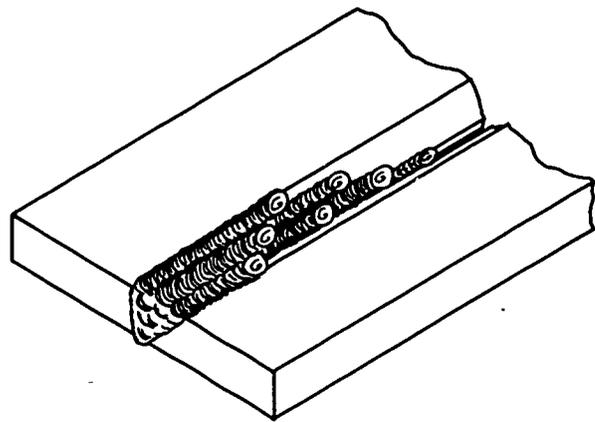
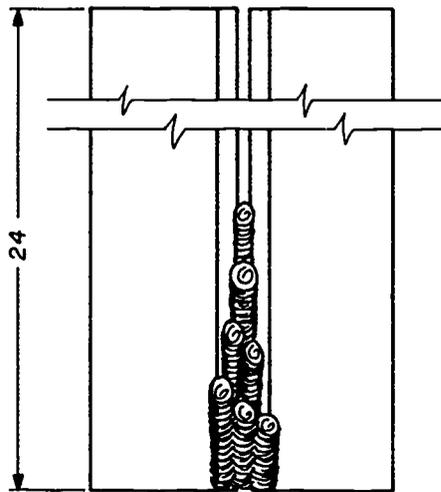
DC constant potential welding machine, wire feeder, with gun complete, pressure regulator, flow meter, tongs, and safety equipment.

MATERIAL NEEDED

1 piece 1/4 x 2 x 24 inch, 2 pieces 1/4 x 1 x 24 inch aluminum plate, filler wire type 4043.

PROCEDURE

- 1 - 8. Repeat equipment & safety procedures.
9. Hold gun, drop face shield and tack weld plate in the form of a cross for fillet welds.
10. Place this assembly in the positioner for vertical welding.
11. Point the gun at the top of the joint with a slight drag angle.
12. Use a small weave motion, move down at a rate to form the proper sized bead.
13. Continue welding until the 5/8 inch dimension is reached; overlap and fuse each bead added.
14. Repeat this procedure until the desired weld can be produced.
15. Secure equipment.



A. FLAT POSITION

B. M.I.G PROCESS

C. SUBSTITUTE STEEL PIPE
IF AVAILABLE

NAME GROOVE WELD		MILESTONE A "V" GROOVE BUTT WELDS IN THE FLAT POSITION		MODULE NO. II	
				FIGURE NO. B-5	
ELECTRODE SIZE .035 DIA. DC/CP WIREPOOL TYPE MO-1313 STEEL					
MATERIAL		SPEC.	AMT.	SIZE	
STEEL		MILD	2	$\frac{1}{2}$ X 2 X 24	

GAS METAL-ARC WELDING (MIG)

Module II. Groove Weld

Milestone A, 'V' Groove Butt Weld in the Flat Position
(when available, substitute pipe)

Project 5; Time: 2 hours

INTRODUCTION

The student will make a butt weld on steel plate in the flat position. This weld can be made with either four weave passes or seven stringer beads. The reinforcement should be slightly convex, uniform in width, but without undercut or pinholes. Penetration should be complete.

EQUIPMENT REQUIRED

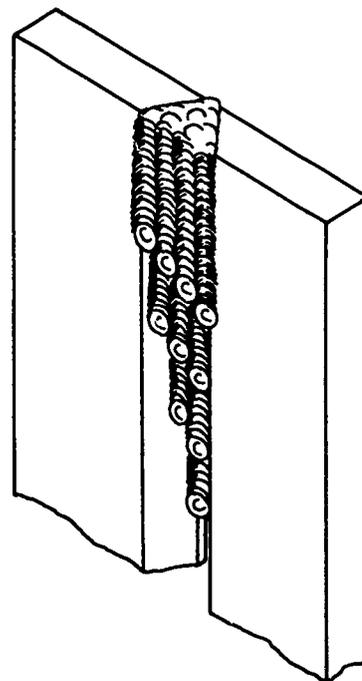
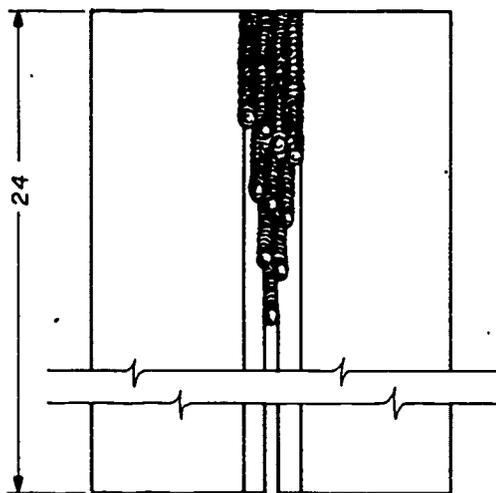
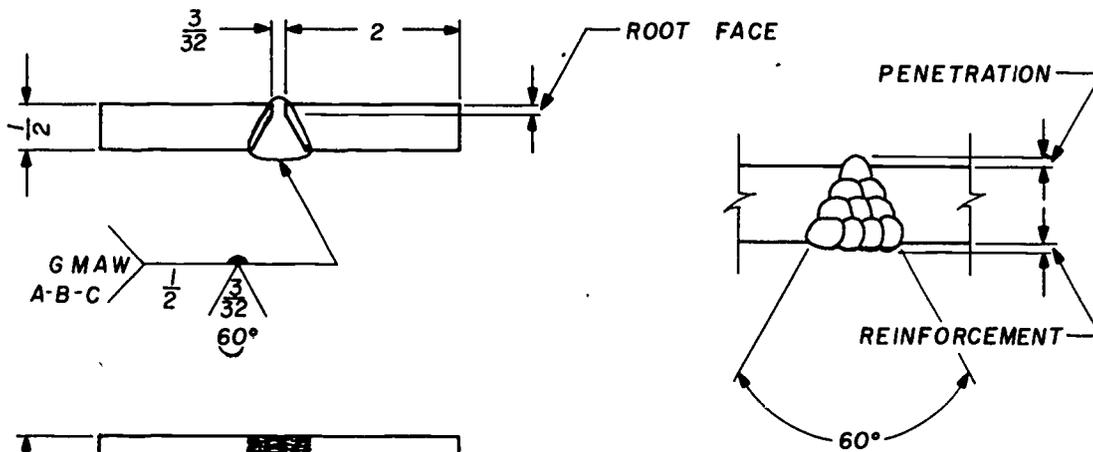
DC constant potential welding machine, wire feeder with gun complete, gas mixer manifold, tongs, and safety equipment.

MATERIAL NEEDED

2 pieces 1/2 x 2 x 24 inch steel plate beveled to 30°.

PROCEDURE

- 1 - 7. Repeat equipment & safety procedures.
8. Place the plate in the jig for butt weld with a root opening of about 1/8 inch.
9. Point the gun at the centerline of the joint, drop face shield.
10. Close trigger switch, push gun along the joint at about 15° from vertical in the direction of travel.
11. Use either the weave or stringer procedure.
12. Move at a uniform rate and repeat until the groove is filled.
13. Reinforcement should not exceed plate thickness by more than 1/8 inch; it should be uniform in appearance.
14. Repeat the procedure until an acceptable weld is produced.
15. Secure equipment.



- A. VERTICAL DOWN POSITION
- B. M.I.G. PROCESS
- C. SUBSTITUTE STEEL PIPE IF AVAILABLE

NAME GROOVE WELD		MILESTONE B "V" GROOVE BUTT WELDS IN THE VERTICAL DOWN POSITION		MODULE NO. II
				FIGURE NO. B-6
ELECTRODE SIZE .035 DIA. DC/CP WIREPOOL TYPE MO-1313 STEEL				
MATERIAL	SPEC.	AMT.	SIZE	
STEEL	MILD	2	1/2 X 2 X 24	

GAS METAL-ARC WELDING (MIG)

Module II. Groove Weld

Milestone B, 'V' Groove Butt Weld in the Vertical Down Position (when available, substitute pipe)

Project 6; Time: 2 hours

INTRODUCTION

The student will make a butt weld on steel plate in the vertical down position. This weld can be made using short circuiting arc method of metal transfer, making the number of passes that will produce the desired weld size. The reinforcement should be slightly convex, uniform in width, but without undercut or pinholes. Penetration should be complete.

EQUIPMENT REQUIRED

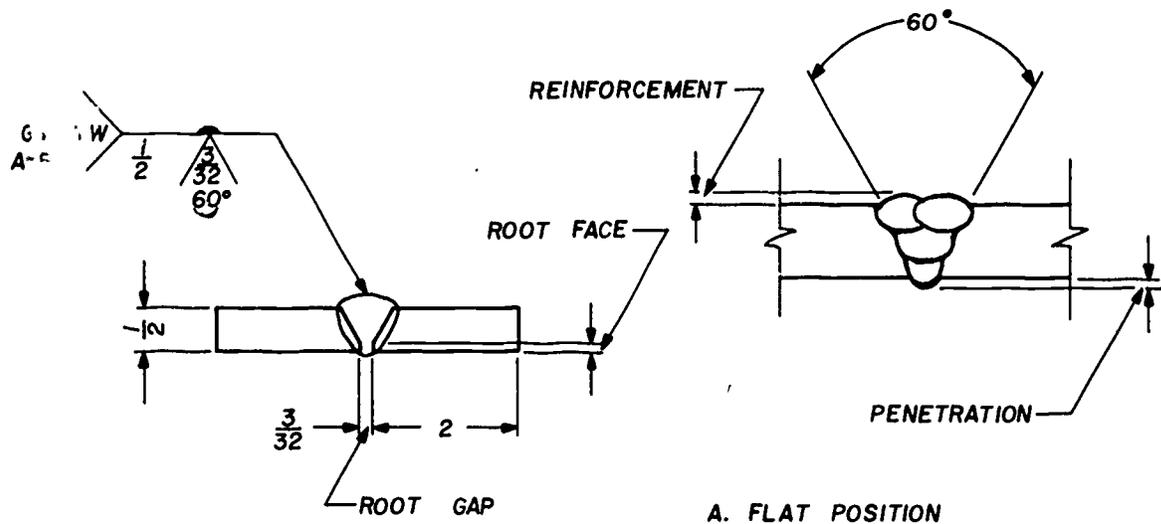
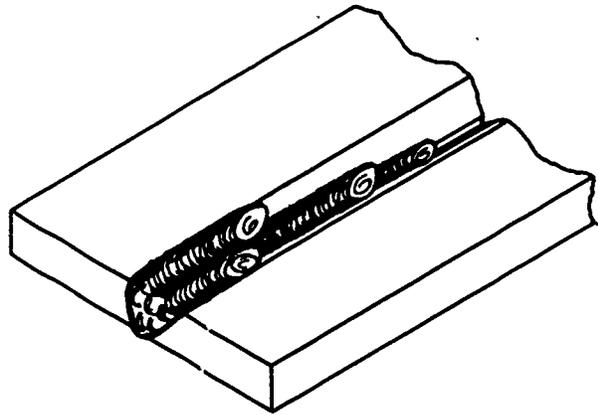
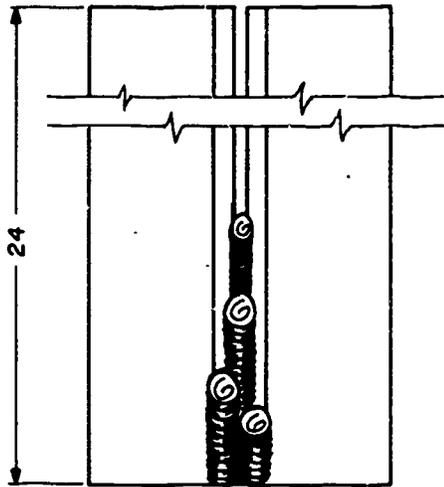
DC constant potential welding machine, wire feeder with gun complete, gas mixer manifold, tongs, and safety equipment.

MATERIAL NEEDED

2 pieces 1/2 x 2 x 24 inch steel plate beveled on one side to 30°.

PROCEDURE

- 1 - 7. Repeat equipment & safety procedures.
8. Place the plate in the jig for a butt weld with a root opening of about 1/8 inch.
9. Position this assembly for vertical welding.
10. Point the gun at the center line of the joint, hold a slight dragging angle down. Drop the face shield.
11. Close trigger switch, move downward with a small weave motion, or hold steady to make stringer beads.
12. Move at a uniform rate and repeat until the groove is filled.
13. The reinforcement should not exceed plate thickness by more than 1/8 inch; it should be uniform in appearance.
14. Repeat this procedure until an acceptable weld is produced.
15. Secure equipment.



- A. FLAT POSITION
- B. M.I.G. PROCESS
- C. SPRAY ARC
- D. SUBSTITUTE STEEL PIPE
IF AVAILABLE

NAME GROOVE WELD	MILESTONE G "V" GROOVE BUTT WELD IN THE FLAT POSITION		MODULE NO. II
			FIGURE NO. B-7
ELECTRODE SIZE $\frac{1}{16}$ DIA. DC/CP WIRESPOOL TYPE 4043 ALUM.			
MATERIAL	SPEC.	AMT.	SIZE
ALUMINUM PLATE	4043	2	$\frac{1}{2}$ X 2 X 24

GAS METAL-ARC WELDING (MIG)

Module II. Groove Weld

Milestone C, 'V' Groove Butt Weld in the Flat Position
(when available, substitute pipe)

Project 7; Time: 2 hours

INTRODUCTION

The student will make a butt weld on aluminum plate in the flat position. This weld can be made using spray method of metal transfer, making the number of passes that will produce the desired weld size. The reinforcement should be slightly convex, uniform in width, but without undercut. Penetration should be complete.

EQUIPMENT REQUIRED

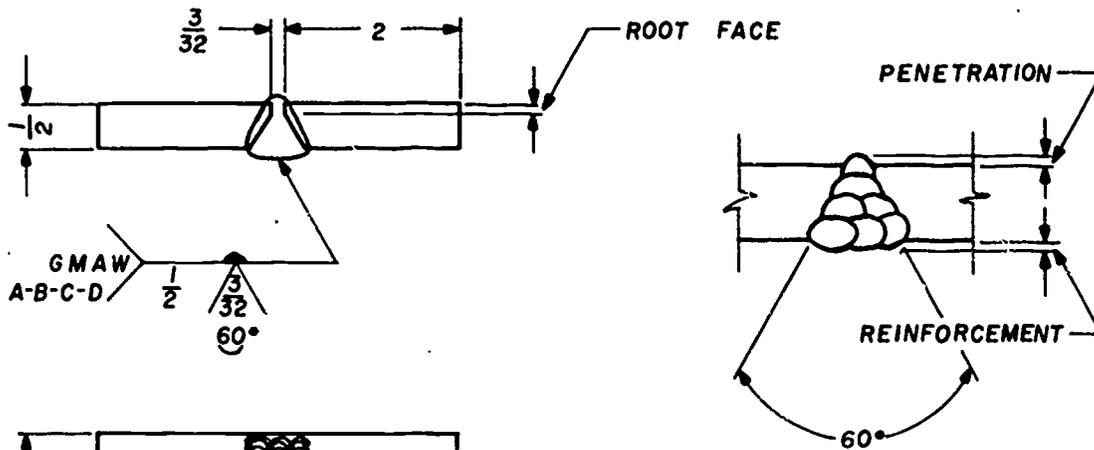
DC constant potential welding machine, wire feeder with gun complete pressure regulator, flow meter, tongs, and safety equipment.

MATERIAL NEEDED

2 pieces 1/2 x 2 x 24 inch aluminum plate beveled on one side to 30°; spool of type 4043 filler wire.

PROCEDURE

- 1 - 7. Repeat equipment & safety procedures.
8. Place the plate in the jig for butt joint with a root opening of about 1/8 inch. Place for flat position welding.
9. Put on face shield and gloves.
10. Point the gun at the centerline of the joint, drop face shield.
11. Close the trigger switch, push gun along the joint at about 15° from the vertical in the direction of travel.
12. Use either weaving or stringer procedure.
13. Move at a uniform rate and repeat until groove is filled.
14. Reinforcement should not exceed plate thickness by more than 1/8 inch; it should be uniform in appearance.
15. Repeat this procedure until an acceptable weld is produced.
16. Secure equipment.



- A. VERTICAL DOWN POSITION
- B. M.I.G. PROCESS
- C. SHORT ARC
- D. SUBSTITUTE STEEL PIPE IF AVAILABLE

NAME GROOVE WELD		MILESTONE D "V" GROOVE BUTT WELDS IN THE VERTICAL DOWN POSITION		MODULE NO. II
				FIGURE NO. B-8
ELECTRODE SIZE $\frac{1}{16}$ DIA. DC/CP WIREPOOL TYPE 4043 ALUM.				
MATERIAL	SPEC.	AMT.	SIZE	
ALUMINUM PLATE	4043	2	$\frac{1}{2}$ X 2 X 24	

GAS METAL-ARC WELDING (MIG)

Module II. Groove Weld

Milestone D, 'V' Groove Butt Weld in the Vertical Down Position (when available, substitute pipe)

Project 8; Time: 2 hours

INTRODUCTION

The student will make a butt weld on aluminum plate in the vertical down position. This weld can be made using short circuiting arc method of metal transfer making the number of passes that will produce the desired weld size. The reinforcement should be slightly convex, uniform in width, but without undercut or pinholes. Penetration should be complete.

EQUIPMENT REQUIRED

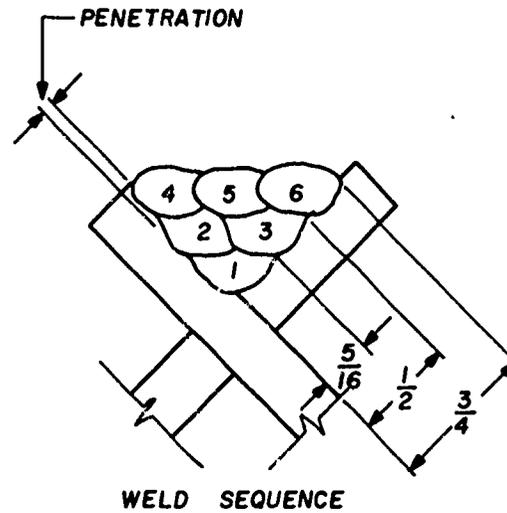
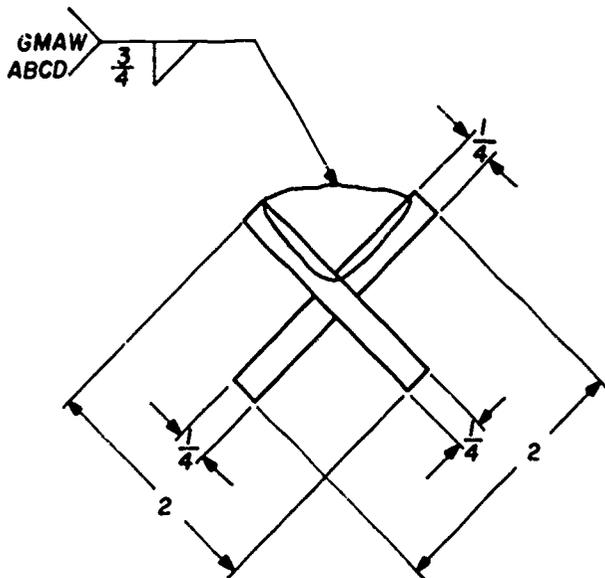
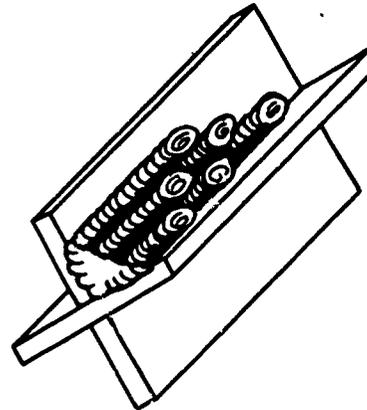
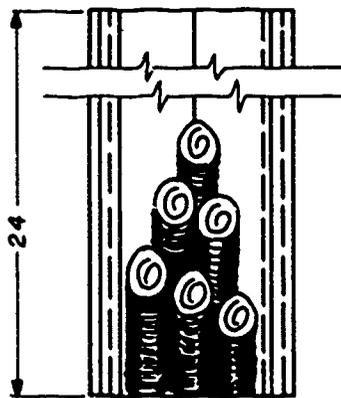
DC constant potential welding machine, wire feeder with gun complete, pressure regulator, flow meter, tongs, and safety equipment.

MATERIAL NEEDED

2 pieces 1/2 x 2 x 24 inch aluminum plate, beveled on one side to 30°; type 4043 filler wire.

PROCEDURE

- 1 - 7. Repeat equipment & safety procedures.
8. Place the plate in the jig for a butt joint with a root opening of about 1/8 inch. Position for vertical welding.
9. Put on face shield and gloves.
10. Point gun at the centerline of the joint, drop face shield.
11. Close trigger switch, move downward with a slight drag angle.
12. Use either weaving or stringer welding procedure.
13. Move at uniform rate and repeat until the groove is filled.
14. Reinforcement should not exceed plate thickness by more than 1/8 inch; it should be uniform in appearance.
15. Repeat this procedure until an acceptable weld is produced.
16. Secure equipment.



A. FLAT POSITION

C. FLUX CORE

B. M.I.G. PROCESS

D. WELD ALL SIDES

NAME FLUX CORED ELECTRODE WELDING		MILESTONE A FILLET WELDS IN THE FLAT POSITION		MODULE NO. III
				FIGURE NO. B-9
ELECTRODE SIZE .045 DIA. DC/CP WIREPOOL TYPE AWS - A5 20 - 69				
MATERIAL	STEEL	SPEC. MILD	AMT. 1	SIZE 1/4 X 2 X 24
	STEEL	MILD	2	1/4 X 1 X 24

GAS METAL-ARC WELDING (MIG)

Module III. Flux Cored Electrode Welding

Milestone A, Fillet Welds in the Flat Position

Project 9; Time: 2 hours

INTRODUCTION

The student will make a fillet weld set of steel plate for welding in the flat position. Four fillet welds will be made with 3/4 inch leg dimension. Flux cored electrode equipment will be used to deposit the metal needed to fill the fillets to the required depth. These should have a flat face and equal leg length.

EQUIPMENT REQUIRED

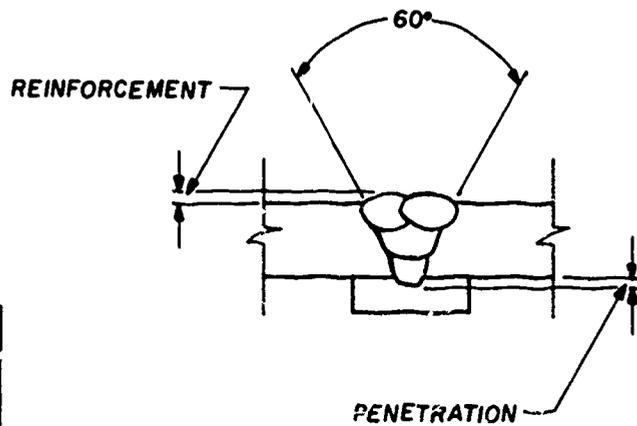
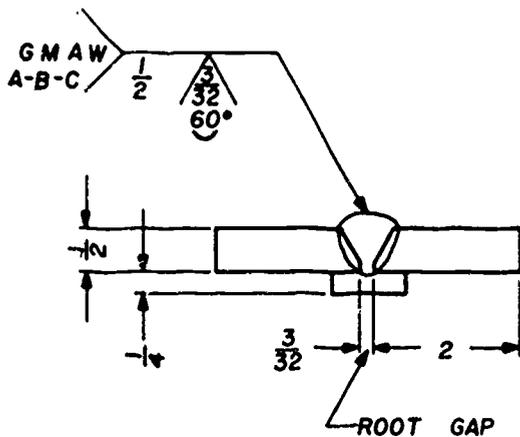
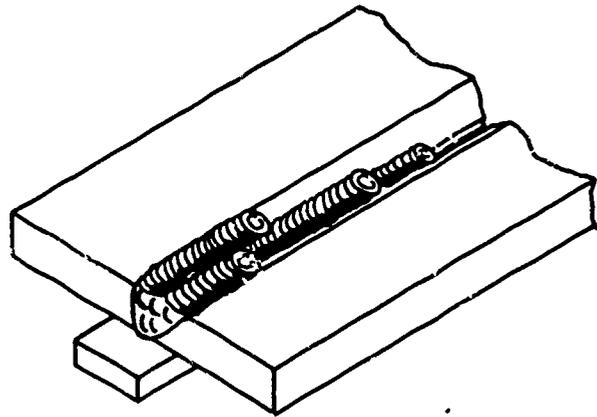
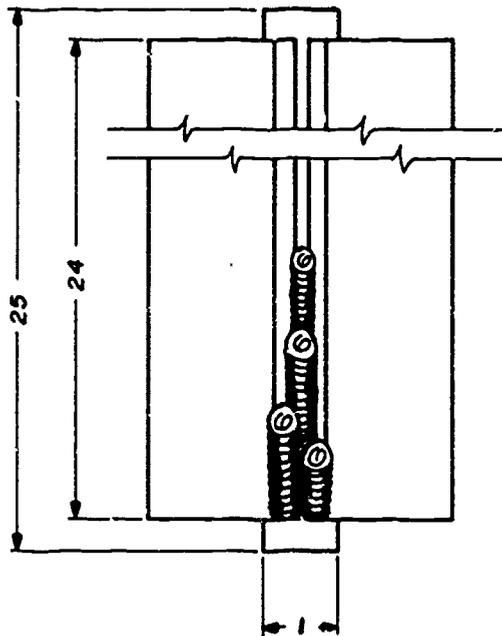
DC constant potential welding machine, wire feeder with gun complete, gas mixing manifold, tongs, and safety equipment.

MATERIAL NEEDED

1 piece 1/4 x 2 x 24 inch and 2 pieces 1/4 x 1 x 24 inch steel plate.

PROCEDURE

- 1 - 8. Repeat equipment & safety procedures.
9. Hold gun, drop face shield and tack weld the pieces to form a cross.
10. Direct the gun so that the wire points to the corner of the joint.
11. Close contactor switch, move gun along the joint.
12. Use a leading angle and a small weaving motion.
13. Make the required width of bead by controlling the rate of travel.
14. Repeat this procedure until a uniform bead is produced.
15. Secure equipment.



- A. FLAT POSITION
- B. M.I.G. PROCESS
- C. FLUX CORE
- D. SUBSTITUTE STEEL PIPE IF AVAILABLE

NAME FLUX CORED ELECTRODE WELDING		MILESTONE B "V" GROOVE BUTT WELD W/BACK UP IN THE FLAT POSITION		MODULE NO. 3E
				FIGURE NO. B-10
ELECTRODE SIZE .045 DIA. DC/CP WIREPOOL TYPE AWS A-5 20-69				
MATERIAL	STEEL	SPEC. MILD	AMT. 2	SIZE 1/2 X 2 X 24
	STEEL	MILD	1	1/4 X 1 X 25

GAS METAL-ARC WELDING (MIG)

Module III. Flux Core Electrode Welding

Milestone B, 'V' Groove Butt Weld in the Flat Position with Backing Plate

Project 10; Time: 2 hours

INTRODUCTION

The student will make a butt weld with backing strip on steel plate with a beveled edge. Two or three passes will be needed to complete this weld, depending on the size of the wire used. The reinforcement should be slightly convex, with uniform ripple. Fusion with the backing strip should be complete. There should not be any undercut or pinholes.

EQUIPMENT REQUIRED

DC constant potential welding machine, wire feeder with gun complete, gas mixing manifold, tongs, and safety equipment.

MATERIAL NEEDED

2 pieces 1/2 x 2 x 24 inch steel plate with one side beveled to an angle of 30°; 1 piece of 1/4 x 1 x 25 inch steel bar.

PROCEDURE

- 1 - 7. Repeat equipment & safety procedures.
8. Place the plates in welding jig to form a butt weld with the backing strip. The root opening should be about 3/16 inches.
9. Put on face shield and gloves.
10. Hold gun with wire pointed at the root of the joint.
11. Drop face shield, close contactor switch, move along the root of the joint. Use a small weave motion so that all three members of the joint are fused.
12. Clean each pass as it is completed, continue depositing beads until the groove is filled.
13. The reinforcement should be uniform, have a slightly convex surface without undercut or pinholes.
14. Repeat this procedure until the desired weld is produced.
15. Secure equipment.