An Analysis of the Welding Occupation

The general purpose of the occupational analysis is to provide workable, basic information dealing with the many and varied duties performed in the welding occupation. It includes the basic manipulative skills and technical information in the following four areas: oxy/acetlene, electric arc, tungsten inert-gas arc, and metallic inert-arc welding. The document opens with a brief introduction followed by a job description. The bulk of the document is presented in table form. The four areas are broken down into a number of tasks and for each task a two-page table is presented, showing on the first page: tools, equipment, materials, objects acted upon; performance knowledge (related also to decisions, cues and errors); safety—hazard; and on the second page: science; math—number systems; and communications (performance modes, examples, and skills and concepts). Also included in the document are a brief note on abbreviation of welding terms, and 2 sections on safety (eye protection and general safety practices).
Occupational Analysis

WELDING

Instructional Materials Laboratory
Trade and Industrial Education
The Ohio State University
AN ANALYSIS OF THE WELDING OCCUPATION

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Occupational Analysis
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Director: Tom L. Hindes
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The Instructional Materials Laboratory
Trade and Industrial Education
The Ohio State University
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The occupational analysis project was conducted by The Instructional Materials Laboratory, Trade and Industrial Education, The Ohio State University in conjunction with the State Department of Education, Division of Vocational Education pursuant to a grant from the U.S. Office of Education.

The Occupational Analysis project was proposed and conducted to train vocational educators in the techniques of making a comprehensive occupational analysis. Instructors were selected from Agriculture, Business, Distributive, Home Economics and Trade and Industrial Education to gain experience in developing analysis documents for sixty-one different occupations. Representatives from Business, Industry, Medicine, and Education were involved with the vocational instructors in conducting the analysis process.

The project was conducted in three phases. Phase one involved the planning and development of the project strategies. The analysis process was based on sound principles of learning and behavior. Phase two was the identification, selection and orientation of all participants. The training and workshop sessions constituted the third phase. Two-week workshops were held during which teams of vocational instructors conducted an analysis of the occupations in which they had employment experience. The instructors were assisted by both occupational consultants and subject matter specialists.

The project resulted in producing one hundred two trained vocational instructors capable of conducting and assisting in a comprehensive analysis of various occupations. Occupational analysis data were generated for sixty-one occupations. The analysis included a statement of the various tasks performed in each occupation. For each task the following items were identified: tools and equipment; procedural knowledge; safety knowledge; concepts and skills and mathematics, science and communication needed for successful performance in the occupation. The analysis data provided a basis for generating instructional materials, course outlines, student performance objectives, criterion measures, as well as identifying specific supporting skills and knowledge in the academic subject areas.
The information compiled in this document is an analysis of the required skills used in the performance of duties and tasks by the average welder. It includes the basic manipulative skills and technical information in the following four areas: oxy/acetylene, electric arc, tungsten inert-gas arc, and metallic inert-gas arc welding.
ACKNOWLEDGMENT

We wish to acknowledge the valuable assistance rendered by the following subject matter specialists. They provided input to the vocational instructors in identifying related skills and concepts of each respective subject matter area and served as training assistants in the analysis process during the two-week workshops.

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Colchester, Connecticut

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Lillian Yontz, Biology
The Ohio State University
Caldwell, Ohio
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Mindy Fausnaugh  
Rita Hastings  
Carol Hicks  
Sue Holsinger  
Barbara Hughes  
Carol Marvin  
Kathy Roediger

Research Associate  
Administrative Assistant  
Editorial Consultant  
Typist  
Typist  
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Typist
JOB DESCRIPTION

A welder selects equipment, plans layout and welding procedure while applying knowledge of basic measurement skills and concepts, and the welding characteristics and physical properties of metals; sets up equipment and welds parts using arc or gas welding equipment; repairs products by dismantling, straightening, reshaping, and re-assembling them using cutting torch, straightening equipment and proper hand tools.

A welder also secures parts in position for welding by clamping, tack welding, or bolting; fits and welds components which have been fabricated, cast, or forged to assemble structural forms according to blueprints; performs welding operations in the flat, horizontal, vertical and overhead positions, utilizing all types of joint design.
DUTY I. OXY/ACETYLENE WELDING

A. Set up and test equipment
B. Oxy/acetyl weld mild steel
C. Oxy/acetyl weld pipe
D. Oxy/acetyl weld cast-iron
E. Braze mild steel
F. Braze cast-iron
G. Silver Braze stainless steel
H. Silver braze copper alloys
I. Cut using oxy/acylene
J. Form and bend
K. Hardface
L. Soft solder
# TASK STATEMENT

**I-A SET UP AND TEST OXY-ACETYLENE WELDING EQUIPMENT**

<table>
<thead>
<tr>
<th>TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON</th>
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</thead>
<tbody>
<tr>
<td>Oxygen and Acetylene Supply</td>
</tr>
<tr>
<td>Oxygen Regulator</td>
</tr>
<tr>
<td>Acetylene Regulator</td>
</tr>
<tr>
<td>Oxygen hose with fittings</td>
</tr>
<tr>
<td>Acetylene hose with fittings</td>
</tr>
<tr>
<td>Oxyacetylene Torch</td>
</tr>
<tr>
<td>Oxyacetylene Torch Tips</td>
</tr>
<tr>
<td>Leak testing fluids</td>
</tr>
<tr>
<td>S. T. as required</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>PERFORMANCE KNOWLEDGE</th>
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</thead>
<tbody>
<tr>
<td>Attach Oxygen Regulator to Oxygen supply</td>
</tr>
<tr>
<td>Attach Acetylene Regulator to Acetylene supply</td>
</tr>
<tr>
<td>Attach Oxygen and Acetylene hoses to respective supply</td>
</tr>
<tr>
<td>Attach torch</td>
</tr>
<tr>
<td>Test according to safety procedure</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SAFETY – HAZARD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Refer to Index under Safe Practice:</td>
</tr>
<tr>
<td>X—Safety Precautions for Hand Tools—[Items 1 thru 10]</td>
</tr>
<tr>
<td>XIX—Oxy-Acetylene Welding—[Items 1 thru 35]</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>DECISIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attach Oxygen Regulator to Oxygen supply</td>
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<tr>
<td>Attach Acetylene Regulator to Acetylene supply</td>
</tr>
<tr>
<td>Attach hoses to respective supplies</td>
</tr>
<tr>
<td>Attach torch to respective supplies</td>
</tr>
<tr>
<td>Appraise results by visual inspection</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CUES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of gas-pressure required</td>
</tr>
<tr>
<td>Standard colors and fittings</td>
</tr>
<tr>
<td>Job requirement</td>
</tr>
<tr>
<td>Condition of fittings</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ERRORS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explosive possibilities</td>
</tr>
<tr>
<td>Explosive possibilities</td>
</tr>
<tr>
<td>Explosive possibilities</td>
</tr>
<tr>
<td>Explosive possibilities</td>
</tr>
<tr>
<td>Damaged fittings-leaks</td>
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</table>
### SCIENCE

- Fluids under pressure
  - Instability of gases under pressure
  - Exceed maximum pressures of equipment
- Relationship of forces to distortion in an elastic body
  - Distort or break brn, fittings

### MATH - NUMBER SYSTEMS

- Set of Real Numbers—[Positive rationals]
- Basic Measurement Skills and Concepts—[Instruments]
  - [Read gage-pounds per square inch, cubic feet per hour]

### COMMUNICATIONS

#### PERFORMANCE MODES

- Speaking
- Reading
- Writing
- Listening
- Viewing
- Touching

#### EXAMPLES

- Make oral requisitions for materials
- Read and interpret pressures on both guages
- Read and follow written instruction for set-up
- Make written requisitions for materials needed
- Follow oral instructions
- Perform operation; appraise finished work

#### SKILLS/CONCEPTS

- Terminology
- Logic, Gesturing, Usage
- Comprehension, Detail, Proposals, Description, Terminology, Instruction
- Sketch, Description, Logic, Terminology, Usage
- Discriminate facts, Logic, Concentration, Note taking
- Visual analysis, Logic, Discrimination, Detail
- Recognition of symbols, Codes, etc.
- Size, Shape, Temperature
**TASK STATEMENT**  I-B OXY/ACETYL WELD MILD STEEL

<table>
<thead>
<tr>
<th>TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON</th>
<th>PERFORMANCE KNOWLEDGE</th>
<th>SAFETY – HAZARD</th>
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<tbody>
<tr>
<td>Oxy/Acet Welding Equipment</td>
<td>Determine type weld</td>
<td>Refer to Index under Safe Practice</td>
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<tr>
<td>Materials:</td>
<td>Select filler rod size</td>
<td>X—Safety Precautions for Hand Tools—[Items 1 thru 10]</td>
</tr>
<tr>
<td>M.S. Material</td>
<td>Select tip size</td>
<td>XIX—Oxy-Acetylene Welding—[Items 1 thru 35]</td>
</tr>
<tr>
<td>M.S. Filler Rod</td>
<td>Determine weld position</td>
<td></td>
</tr>
<tr>
<td>S.T. as required</td>
<td>Weld in accordance to proper procedure</td>
<td></td>
</tr>
</tbody>
</table>

**DECISIONS**
- Determine type weld
- Select filler rod
- Select tip size
- Determine position
- Appraise condition of finished weld by visual inspection

**CUES**
- Specs, Job Requirement, Joint design
- Thickness of metal, bead size
- Thickness of metal, bead size
- Ease of application
- General appearance, uniformity, penetration, etc.

**ERRORS**
- Will not meet job specifications
- Poor weld quality
- Poor weld quality
- Poor weld quality
- Poor weld quality
<table>
<thead>
<tr>
<th>SCIENCE</th>
<th>MATH — NUMBER SYSTEMS</th>
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</table>

| COMMUNICATIONS |

<table>
<thead>
<tr>
<th>PERFORMANCE MODES</th>
<th>EXAMPLES</th>
<th>SKILLS/CONCEPTS</th>
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</thead>
<tbody>
<tr>
<td>Reading</td>
<td>Make written requisitions for materials needed.</td>
<td>Comprehension, Detail, Proposals, Description, Terminology, Instruction.</td>
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<tr>
<td>Writing</td>
<td>Follow oral instructions.</td>
<td>Sketch, Description, Terminology, Logic, Usage.</td>
</tr>
<tr>
<td>Listening</td>
<td>Appraise finished product.</td>
<td>Discriminate facts, Logic, Concentration, Note taking.</td>
</tr>
<tr>
<td>Viewing</td>
<td></td>
<td>Visual analysis, Logic, Discrimination, Detail, Recognition of symbols, Codes, etc.</td>
</tr>
<tr>
<td>Touching</td>
<td></td>
<td>Size, Shape, Temperature.</td>
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</table>
**TASK STATEMENT**  I-C OXY/ACETYL WELD PIPE

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<td>Oxy/Acetylene Equipment</td>
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<tr>
<td>Materials:</td>
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<tr>
<td>Steel Pipe</td>
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<tr>
<td>M. S. filler rod</td>
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<tr>
<td>Aligning fixture</td>
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<td>S. T. as required</td>
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<table>
<thead>
<tr>
<th>PERFORMANCE KNOWLEDGE</th>
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</thead>
<tbody>
<tr>
<td>Determine joint design</td>
</tr>
<tr>
<td>Select filler rod</td>
</tr>
<tr>
<td>Select tip size</td>
</tr>
<tr>
<td>Determine weld position</td>
</tr>
<tr>
<td>Align work</td>
</tr>
<tr>
<td>Perform welding in accordance to proper procedure</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>SAFETY – HAZARD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Refer to Index under Safe Practice.</td>
</tr>
<tr>
<td>X — Safety Precautions for Hand Tools — [Items 1 thru 10]</td>
</tr>
<tr>
<td>XIX — Oxy-Acetylene Welding — [Items 1 thru 35]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DECISIONS</th>
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</thead>
<tbody>
<tr>
<td>Determine joint design</td>
</tr>
<tr>
<td>Select filler</td>
</tr>
<tr>
<td>Select tip size</td>
</tr>
<tr>
<td>Determine weld position</td>
</tr>
<tr>
<td>Appraise finish work by visual inspection</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CUES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specifications, job requirements</td>
</tr>
<tr>
<td>Metal thickness</td>
</tr>
<tr>
<td>Amount heat required</td>
</tr>
<tr>
<td>Ease of application</td>
</tr>
<tr>
<td>Appearance, penetration, uniformity, etc.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ERRORS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Will not meet job specifications</td>
</tr>
<tr>
<td>Poor weld quality</td>
</tr>
<tr>
<td>Poor weld quality</td>
</tr>
<tr>
<td>Poor weld quality</td>
</tr>
</tbody>
</table>
### SCIENCE

- Simple machines used to gain mechanical advantage.
- Effect of heating and cooling on expansion of materials.
- Transfer of heat from one body to another.
- Arrangement of molecules, atoms and ions and the effect on structure and strength of materials.

[Types and Physical properties of Steel Pipe]

### MATH – NUMBER SYSTEMS

- Set of Real Numbers – Positive Rationals
  - Fractions
- Fundamental Operations (Calculation)
  - Addition algorithm
  - Subtraction algorithm
  - Multiplication algorithm
  - Division algorithm
- Order of operations, i.e., Use of parentheses in simplifying arithmetic expressions
- Basic Measurement Skills and Concepts
  - Instruments. [Basic measurements]
  - Measurement, Geometric
    - Linear
    - Angle
- Measurement, Non-geometric
  - Temperature
- Reading and interpreting tables, charts, and graphs
- Scale drawings, floor plans/blueprints
- Basic Geometry Skills and Concepts
  - Knowledge of geometric relationships
    - Parallel
    - Perpendicular
- Determination of area and circumference of circles
- Determination of area and perimeter of an ellipse
- Determination of facts involving lines tangent to circles.

### COMMUNICATIONS

<table>
<thead>
<tr>
<th>PERFORMANCE Modes</th>
<th>EXAMPLES</th>
<th>SKILLS/CONCEPTS</th>
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<tbody>
<tr>
<td>Speaking</td>
<td>Make oral requisitions for materials</td>
<td>Terminology, Logic, Gestures, Usage</td>
</tr>
<tr>
<td></td>
<td>Interpret blueprint and written specifications</td>
<td>Comprehension, Detail, Proposals, Description, Terminology, Instruction</td>
</tr>
<tr>
<td>Reading</td>
<td>Measure and layout pipe according to blueprint or sketch</td>
<td>Sketch, Description, Terminology, Logic, Usage</td>
</tr>
<tr>
<td>Answering</td>
<td>Make written requisition for materials needed</td>
<td>Discriminate Facts, Logic, Concentration, Note taking</td>
</tr>
<tr>
<td>Listening</td>
<td>Follow oral instructions if given</td>
<td>Visual analysis, Logic, Discrimination, Detail, Recognition of symbols, Codes, etc.</td>
</tr>
<tr>
<td>Viewing</td>
<td>Interpret blueprint and written specifications</td>
<td>Size, Shape, Temperature</td>
</tr>
<tr>
<td>Touching</td>
<td>Examine finished product</td>
<td></td>
</tr>
</tbody>
</table>
**TASK STATEMENT**  
I-D OXY/ACETYLEN WELD CAST IRON

### TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON

- Oxy-Acetylene Welding Equipment
- S. T. as needed
- Cast Iron Filler Rod
- Cast Iron Material
- Flux

### PERFORMANCE KNOWLEDGE

- Determine type joint preparation
- Determine filler rod size
- Determine tip size
- Determine necessity of preheat/postheat
- Select flux
- Complete weld according to proper procedure

### SAFETY - HAZARD

Refer to Index under Safe Practice

- X Safety Precautions for Hand Tools - [Items I thru 10]
- XIX - OXY-Acetylene Welding - [Items I thru 35]

### DECESSIONS

- Determine joint preparation
- Determine filler rod size
- Determine tip size
- Determine necessity of preheat/postheat
- Determine flux
- Complete weld according to correct procedure.

### CUES

- Job requirement, condition of metal
- Determine by parent metal thickness
- Weight and design of casting
- Visual and specification

### ERRORS

- Porosity, poor quality weld
- Poor quality, hard spots in weld
- Poor fusion, porosity, lack of penetration
- Uneven expansion and contraction, possible cracking condition
- Poor fusion, porosity, hard spots in weld
<table>
<thead>
<tr>
<th>SCIENCE</th>
<th>MATH – NUMBER SYSTEMS</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>COMMUNICATIONS</th>
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<tbody>
<tr>
<td><strong>PERFORMANCE MODES</strong></td>
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<tr>
<td>Speaking</td>
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<tr>
<td>Reading</td>
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<tr>
<td>Writing</td>
</tr>
<tr>
<td>Making written requisitions for materials needed.</td>
</tr>
<tr>
<td>Listening</td>
</tr>
<tr>
<td>Viewing</td>
</tr>
<tr>
<td>Touching</td>
</tr>
</tbody>
</table>

**COMMUNICATIONS PERFORMANCE MODES**

- Speaking
- Reading
- Writing
- Listening
- Viewing
- Touching

**EXAMPLES**

- Make oral requisition for materials
- Read preheat and postheat temperatures as noted in written or oral instructions.
- Interpret blueprint and written specifications.
- Make written requisitions for materials needed.
- Follow oral instructions.
- Examine finished weld.

**SKILLS/CONCEPTS**

- Terminology, Logic, Gesture, Usage
- Comprehension, Detail, Proposals, Description, Terminology, Instruction
- Sketch, Description, Logic, Terminology, Usage
- Discriminate facts, Logic, Concentration, Notetaking
- Visual analysis, Logic, Discrimination, Detail, Recognition of symbols, Codes, etc
- Size, Shape, Temperature
### TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON
- Oxy/Acetylene Equipment
- M. S. Material
- Bronze Filler Rod
- Proper Flux
- S. T. as required

### PERFORMANCE KNOWLEDGE
- Analyze job requirements
- Select filler rod size
- Select tip size
- Clean and prepare joint
- Determine weld position
- Apply proper flux and complete brazing operation in accordance to proper procedure

### SAFETY – HAZARD
- Refer to Index under Safe Practice
  - X. Safety Precautions for Hand Tools—[Items 1 thru 10]
  - XIX. OXY-Acetylene Welding—[Items 1 thru 35]

### DECISIONS
- Analyze job requirement
- Select rod size
- Select tip size
- Determine position
- Appraise finished joint by visual inspection

### CUES
- Job requirements
- Metal thickness/joint design
- Metal thickness/joint design
- Ease of application
- General appearance, uniformity of bead

### ERRORS
- Will not meet job requirement
  - Porosity, Poor bond
- Porosity, Poor bond
  - Porosity, poor bond—appearance
<table>
<thead>
<tr>
<th>SCIENCE</th>
<th>MATH – NUMBER SYSTEMS</th>
</tr>
</thead>
</table>
| Simple machines used to gain mechanical advantage.  
Effect of heating and cooling on expansion of materials  
Transfer of energy from one form to another  
{gases and fluxes}  
Arrangement of molecules, atoms and ions and the effect on structure and strength of materials  
Metallurgical reasons for bond | Set of Real Numbers. Positive Rational.  
Fundamental Operations (Calculation)  
Addition algorithm  
Subtraction algorithm  
Multiplication algorithm  
Division algorithm  
Order of operations, i.e., Use of parentheses in simplifying arithmetic expressions.  
Basic Measurement Skills and Concepts  
Instruments - [Basic Measurement]  
Measurement: Geometric  
Linear  
Reading and interpreting tables, charts, and graphs  
Scale drawings, floor plans, blueprints  
Basic Arithmetic Skills and Concepts  
Ratio and proportion  
[bond proportionate to parent metal] |

<table>
<thead>
<tr>
<th>COMMUNICATIONS</th>
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<tr>
<td>PERFORMANCE MODES</td>
</tr>
<tr>
<td>Speaking</td>
</tr>
<tr>
<td>Reading</td>
</tr>
<tr>
<td>Writing</td>
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<td>Listening</td>
</tr>
<tr>
<td>Viewing</td>
</tr>
<tr>
<td>Touching</td>
</tr>
</tbody>
</table>
## TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON

| Oxy-Acet. Equipment | S. T, as required | Cast iron material | Bronze filler rod | Flux |

## PERFORMANCE KNOWLEDGE

- Determine preparation needed
- Select filler rod size
- Select tip size
- Determine position
- Determine preheat/postheattr
- Apply proper flux-complete brazing operation following proper procedures.

## SAFETY – HAZARD

Refer to Index under Safe Practice:
- X - Safety Precautions for Hand Tools - [Items 1 thru 10]
- XIX - OXY-Acetylene Welding - [Items 1 thru 35]

## DECISIONS

- Determine preparation needed
- Select filler rod size
- Select tip size
- Determine position
- Determine preheat/postheat
- Appraise finished work

## CUES

- Job requirement, joint design, condition of metal
- Job requirement, metal thickness, bead size
- Metal thickness
- Job requirement
- Job requirement
- Appearance, uniformity

## ERRORS

- Porosity, poor adhesion
- Porosity, poor adhesion
- Poor adhesion, appearance
- Poor appearance
- Uneven expansion and contraction
<table>
<thead>
<tr>
<th>SCIENCE</th>
<th>MATH – NUMBER SYSTEMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simple machines used to gain mechanical advantage—[use of S.T.]</td>
<td>Set of Real Numbers—Positive Rationals</td>
</tr>
<tr>
<td>Effect of heating and cooling on expansion of materials—[cracks]</td>
<td>Fundamental Operations (Calculation)</td>
</tr>
<tr>
<td>Fluids under pressure—[gas]</td>
<td>Addition algorithm</td>
</tr>
<tr>
<td>Transfer of heat from one body to another—[metals]</td>
<td>Subtraction algorithm</td>
</tr>
<tr>
<td>Arrangement of molecules, atoms and ions and the effect on structure and strength of materials—[weld and material]</td>
<td>Multiplication algorithm</td>
</tr>
<tr>
<td>Resistance of materials to change in shape—[cast iron cannot be bent or shaped at any temperature]</td>
<td>Division algorithm</td>
</tr>
<tr>
<td>Metallurgical reasons for bond</td>
<td>Order of operations, i.e., Use of parentheses in simplifying arithmetic expressions.</td>
</tr>
</tbody>
</table>

**COMMUNICATIONS**

<table>
<thead>
<tr>
<th>PERFORMANCE MODES</th>
<th>EXAMPLES</th>
<th>SKILLS/CONCEPTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speaking</td>
<td>Make oral requisition for materials</td>
<td>Terminology, Logic, Gesture, Usage</td>
</tr>
<tr>
<td>Reading</td>
<td>Read preheat and postheat temperatures as noted in written or oral instructions</td>
<td>Comprehension, Detail, Proposal, Description, Terminology, Instruction</td>
</tr>
<tr>
<td>Writing</td>
<td>Interpret blueprint and written specifications</td>
<td>Sketch, Description, Logic, Terminology, Usage</td>
</tr>
<tr>
<td>Listening</td>
<td>Make written requisition for materials needed</td>
<td>Discriminate facts, Logic, Concentration, Note-taking</td>
</tr>
<tr>
<td>Viewing</td>
<td>Follow oral instructions</td>
<td>Visual analysis, Logic, Discrimination, Detail, Recognition of symbols, Codes, etc.</td>
</tr>
<tr>
<td>Touching</td>
<td>Appraise finished work</td>
<td>Size, Shape, Temperature</td>
</tr>
</tbody>
</table>
### Tools, Equipment, Materials, Objects Acted Upon

- Oxy/Acetylene Welding Equipment
  - Material: Stainless Steel
  - Silver Alloy filler wire
  - Silver brazing flux
  - S. T. as required

### Performance Knowledge

- Determine joint design
- Select type and size of filler wire
- Select tip size
- Clean and prepare joint
- Determine position
- Apply proper flux; complete work in accordance to proper procedure

### Decisions

- Determine joint design
- Select type and size of filler wire
- Select tip size
- Determine position
- Appraise finished work by visual inspection

### Cues

- Job requirements
- Physical, chemical properties
- Amount of heat requirement
- Ease of application
- General appearance, porosity, uniformity

### Errors

- Will not meet job specifications
- Poor bonding
- Excessive heat, breaks down physical properties of base metal

### Safety - Hazard

- Refer to Index under Safe Practice
  - X - Safety Precautions for Hand Tools—[Items 1 thru 10]
  - XIX - OXY-Acetylene Welding—[Items 1 thru 35]
<table>
<thead>
<tr>
<th>SCIENCE</th>
<th>MATH - NUMBER SYSTEMS</th>
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<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Speaking</td>
<td>Make oral requisitions for materials</td>
<td>Terminology, Logic, Gesture, Usage</td>
</tr>
<tr>
<td>Reading</td>
<td>Interpret blueprint and written specifications</td>
<td>Comprehension, Detail, Proposals, Description, Terminology, Instruction</td>
</tr>
<tr>
<td>Writing</td>
<td>Make written requisitions for materials needed</td>
<td>Sketch, Description, Logic, Terminology, Usage</td>
</tr>
<tr>
<td>Listening</td>
<td>Follow oral instructions</td>
<td>Discriminate facts, Logic, Concentration, Note taking</td>
</tr>
<tr>
<td>Viewing</td>
<td>Perform operation, appraise finished work</td>
<td>Visual analysis, Logic, Discrimination, Detail, Recognition of symbols, Codes, etc.</td>
</tr>
<tr>
<td>Touching</td>
<td></td>
<td>Sure, Shape, Temperature</td>
</tr>
</tbody>
</table>
### Tools, Equipment, Materials, Objects Acted Upon
- Oxy-Acet. Equipment
  - S. T. as required
- Copper alloy material
- Silver alloy filler wire
- Silver brazing flux

### Performance Knowledge
- Determine joint design
- Determine preparation needed
- Select tip size
- Determine position
- Complete brazing operation following proper procedure

### Safety - Hazard
- Refer to index under Safe Practice
  - X - Safety Precautions for Hand Tools—[Items 1 thru 10]
  - XIX - OXY-Acetylene Welding—[Items I thru 35]

### Decisions
- Determine joint design
- Determine preparation needed
- Select tip size
- Select filler wire size
- Determine position
- Appraise finished work

### Cues
- Job requirement
- Job requirement
- Thickness of base metal
- Thickness of base metal
- Ease of application
- Appearance, specification

### Errors
- Weakness in weldment
- Porosity, poor adhesion
- Porosity, poor adhesion
- Material waste
- Poor quality and appearance
<table>
<thead>
<tr>
<th>SCIENCE</th>
<th>MATH – NUMBER SYSTEMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simple machines used to gain mechanical advantage—use of standard tools</td>
<td>Set of real numbers—positive rationals</td>
</tr>
<tr>
<td>Effect of heating and cooling on expansion of materials—size, shape</td>
<td>Fundamental operations (calculation)</td>
</tr>
<tr>
<td>Fluids under pressure—gas</td>
<td>Addition algorithm</td>
</tr>
<tr>
<td>Transfer of heat from one body to another—rapid transmission</td>
<td>Subtraction algorithm</td>
</tr>
<tr>
<td>Arrangement of molecules, atoms and ions and the effect on structure and strength of materials—weld and material</td>
<td>Multiplication algorithm</td>
</tr>
<tr>
<td>[Different silver brazing materials available]</td>
<td>Division algorithm</td>
</tr>
<tr>
<td></td>
<td>Order of operations, i.e., use of parentheses in simplifying arithmetic expressions.</td>
</tr>
<tr>
<td></td>
<td>Basic measurement skills and concepts</td>
</tr>
<tr>
<td></td>
<td>Instruments—basic measurement</td>
</tr>
<tr>
<td></td>
<td>Measurement: geometric</td>
</tr>
<tr>
<td></td>
<td>Linear</td>
</tr>
<tr>
<td></td>
<td>Reading and interpreting tables, charts, and graphs</td>
</tr>
<tr>
<td></td>
<td>Scale drawings, floor plans, blueprints</td>
</tr>
</tbody>
</table>

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</tr>
<tr>
<td>Touching</td>
</tr>
<tr>
<td>EXAMPLES</td>
</tr>
<tr>
<td>Make oral requisitions for materials</td>
</tr>
<tr>
<td>Interpret blueprint and written specifications</td>
</tr>
<tr>
<td>Make written requisitions for materials needed</td>
</tr>
<tr>
<td>Follow oral instructions</td>
</tr>
<tr>
<td>Appraise job</td>
</tr>
<tr>
<td>SKILLS/CONCEPTS</td>
</tr>
<tr>
<td>Terminology, logic, gesture, usage</td>
</tr>
<tr>
<td>Comprehension, detail, proposals, description, terminology, instruction</td>
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<tr>
<td>Sketch, description, logic, terminology, usage</td>
</tr>
<tr>
<td>Discriminate facts, logic, concentration, note taking</td>
</tr>
<tr>
<td>Visual analysis, logic, discrimination, detail, recognition of symbols, codes, etc.</td>
</tr>
<tr>
<td>Size, shape, temperature</td>
</tr>
</tbody>
</table>
### Task Statement

**I-I-Cut Using Oxy/Acetylene**

#### Tools, Equipment, Materials, Objects Acted Upon

- Oxy/Acetylene Equipment
- Cutting Torch Assembly
- M. S. Material
- S. T. as required

#### Performance Knowledge

- Determine job requirements
- Layout material using center punch or scribe
- Select tip size
- Select proper gas pressures
- Preheat to start cut
- Open oxygen torch cutting valve and proceed to complete cut following layout

#### Safety - Hazard

Refer to Index under Safe Practice
- X— Safety Precautions for Hand Tools—[Items I thru 10]√
- XIX—Oxy-Acetylene Welding—[Items I thru 35]

### Decisions

- Job requirements
- Select tip size
- Select gas pressures
- Evaluate finished cut visually

### Cues

- Job requirements
- Thickness of metal to be cut
- Thickness of metal to be cut
- Cut should have uniform kerf, square edge;

### Errors

- Improper cut
- Improper cut
- Improper cut
- Excessive slag, rough edge, kerf too wide
<table>
<thead>
<tr>
<th>SCIENCE</th>
<th>MATH – NUMBER SYSTEMS</th>
</tr>
</thead>
</table>

<table>
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<th>EXAMPLES</th>
<th>SKILLS/CONCEPTS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Speaking</td>
<td>Make oral requisition for materials Interpret blueprint and written specifications Make written requisition for materials needed Lay-out job according to blueprint, sketch, or instruction Set pressures according to manufacturers-chart.</td>
<td>Terminology, Logic, Gesture, Usage Comprehension, Detail, Proposals, Description, Terminology, Instruction Sketch, Description, Logic, Terminology, Usage Discriminate facts, Logic, Concentration, Note taking Visual analysis, Logic, Discrimination, Detail, Recognition of symbols, Codes, etc. Size, Shape, Temperature</td>
</tr>
<tr>
<td>TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON</td>
<td>PERFORMANCE KNOWLEDGE</td>
<td>SAFETY – HAZARD</td>
<td></td>
</tr>
<tr>
<td>-----------------------------------------------</td>
<td>------------------------</td>
<td>------------------</td>
<td></td>
</tr>
<tr>
<td>Oxy/Acetylene Equipment</td>
<td>Determine job requirements</td>
<td>Refer to Index under Safe Practice</td>
<td></td>
</tr>
<tr>
<td>Material to be formed or shaped</td>
<td>Set-up Jig and/or fixture required</td>
<td>X— Safety Precautions for Hand Tools— [Items 1 thru 10]</td>
<td></td>
</tr>
<tr>
<td>Jigs and/or Fixtures required</td>
<td>Select heating torch and tip size</td>
<td>XIX— OXY-Acetylene Welding— [Items 1 thru 35]</td>
<td></td>
</tr>
<tr>
<td>S. T. as required</td>
<td>Heat material until plastic enough to be formed</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>to desired shape</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Complete operation to job requirements</td>
<td></td>
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</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DECISIONS</th>
<th>CUES</th>
<th>ERRORS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Determine job requirements</td>
<td>Job requirements</td>
<td>Will not meet job specifications</td>
</tr>
<tr>
<td>Set-up Jig and/or fixture</td>
<td>Ease of performance</td>
<td>Will not meet job specifications</td>
</tr>
<tr>
<td>Evaluate finished product by visual inspection</td>
<td>Job requirements</td>
<td>Undesired physical properties</td>
</tr>
<tr>
<td>SCIENCE</td>
<td>MATH – NUMBER SYSTEMS</td>
<td></td>
</tr>
<tr>
<td>---------</td>
<td>----------------------</td>
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</tr>
<tr>
<td>Simple machines used to gain mechanical advantage — [S.T. as needed]</td>
<td>Set of Real Numbers—Positive Rationals</td>
<td></td>
</tr>
<tr>
<td>Effect of heating and cooling on expansion of materials — [change in dimension]</td>
<td>Fundamental Operations (Calculation)</td>
<td></td>
</tr>
<tr>
<td>Effect of heating and cooling on state of matter — [material is made plastic]</td>
<td>Addition algorithm</td>
<td></td>
</tr>
<tr>
<td>Arrangement of molecules, atoms and ions and the effect on structure and strength of materials — [change physical properties]</td>
<td>Subtraction algorithm</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Multiplication algorithm</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Division algorithm</td>
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<tr>
<td></td>
<td>Order of operations, i.e., use of parentheses in simplifying arithmetic expressions</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Basic Measurement Skills and Concepts</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Instruments — [Basic Measurement]</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Measurement: Geometric</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Linear</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Reading and interpreting tables, charts, and graphs</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Scale drawings: floor plans/blueprints</td>
<td></td>
</tr>
</tbody>
</table>

### COMMUNICATIONS

#### PERFORMANCE MODES

- Speaking
- Reading
- Writing
- Listening
- Viewing
- Touching

#### EXAMPLES

- Make oral requisition for materials
- Layout job according to blueprint, sketch, or oral instruction
- Interpret blueprint and written specifications
- Make written requisition for materials needed
- Follow oral instructions
- Perform operation, appraisal finished work

#### SKILLS/CONCEPTS

- Terminology, Logic, Gesture, Usage
- Comprehension, Detail, Proposals, Description, Terminology, Instruction
- Sketch, Description, Logic, Terminology, Usage
- Discriminate facts, Logic, Concentration, Note taking
- Visual analysis, Logic, Discrimination, Detail, Recognition of symbols, Codes, etc
- Size, Shape, Temperature
### Task Statement

#### I-K Hardface

<table>
<thead>
<tr>
<th>TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON</th>
<th>PERFORMANCE KNOWLEDGE</th>
<th>SAFETY – HAZARD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxy/Acet. equipment</td>
<td>Determine joint design</td>
<td>Refer to Index under Safe Practice</td>
</tr>
<tr>
<td>S T. as required</td>
<td>Determine preparation needed</td>
<td>X Safety Precautions for Hand Tools – [Items 1 thru 10]</td>
</tr>
<tr>
<td>Grinder</td>
<td>Select tip size</td>
<td>XIX OXY-Acetylene Welding – [Items 1 thru 35]</td>
</tr>
<tr>
<td>Steel or Steel Alloy material</td>
<td>Select filler rod size and type</td>
<td></td>
</tr>
<tr>
<td>Hardfacing filler rod</td>
<td>Determine position</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Complete hardfacing operation — following proper procedure</td>
<td></td>
</tr>
</tbody>
</table>

### Decisions

- Determine joint design
- Determine preparation needed
- Select tip size
- Select filler rod size and type
- Determine position
- Appraise finished work

### Cues

- Job requirements
- Condition of metal, job requirement
- Thickness of base metal
- Results desired
- Ease of application
- Appearance and specifications

### Errors

- Material waste
- Poor adhesion, porosity
- Poor adhesion, dilution of bead
- Wrong physical properties
- Poor appearance—too soft
### Science

- Simple machines used to gain mechanical advantage—[use of standard tools]
- Effect of heating and cooling on expansion of materials—[cracks]
- Fluids under pressure—[instability of gases]
- Transfer of heat from one body to another—[effect of adjacent areas]
- Arrangement of molecules, atoms and ions and the effect on structure and strength of materials
- Resistance of materials to change in shape—[rigid and hard material]
  - [the metallurgy of hardfacing materials]

### Math – Number Systems

- Set of Real Numbers—Positive Rationals
- Fundamental Operations (Calculation)
  - Addition algorithm
  - Subtraction algorithm
  - Multiplication algorithm
  - Division algorithm
  - Order of operations, i.e., Use of parentheses in simplifying arithmetic expressions
- Basic Measurement Skills and Concepts
  - Instruments—[Basic Measurement]
  - Measurement: Geometric
  - Linear
  - Reading and interpreting tables, charts, and graphs
  - Scale drawings; floor plans/blueprints
- Basic Arithmetic Skills and Concepts—Ratio and proportion
  - [ratio of hardness of application to hardness of parent metal]

### Communications

#### Performance Modes
- Speaking
- Reading
- Writing
- Listening
- Viewing
- Touching

#### Examples
- Make oral requisition for materials
- Interpret blueprint and written specifications
- Make written requisition for materials needed
- Follow oral instructions
- Appraise work

#### Skills/Concepts
- Terminology, Logic, Gesture, Usage
- Comprehension, Detail, Proposals, Description, Terminology, Instruction
- Sketch, Description, Logic, Terminology, Usage
- Discriminate facts, Logic, Concentration, Note taking
- Visual analysis, Logic, Discrimination, Detail, Recognition of symbols, Codes, etc.
- Size, Shape, Temperature
### TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON

<table>
<thead>
<tr>
<th>Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxy Acetylene Equipment</td>
</tr>
<tr>
<td>Material to be Soft Soldered</td>
</tr>
<tr>
<td>Fixtures, chill block etc. as required</td>
</tr>
<tr>
<td>Solder material as required</td>
</tr>
<tr>
<td>Proper flux</td>
</tr>
<tr>
<td>S. T. as required</td>
</tr>
</tbody>
</table>

### PERFORMANCE KNOWLEDGE

<table>
<thead>
<tr>
<th>Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>Determine job requirements</td>
</tr>
<tr>
<td>Determine procedure</td>
</tr>
<tr>
<td>Select proper solder material</td>
</tr>
<tr>
<td>Select proper flux</td>
</tr>
<tr>
<td>Select tip size</td>
</tr>
<tr>
<td>Position work to protect components from heat</td>
</tr>
<tr>
<td>Complete operation following proper procedure</td>
</tr>
</tbody>
</table>

### SAFETY – HAZARD

Refer to Index under Safe Practice
- X. Safety Precautions for Hand Tools [Items 1 thru 10]
- XIX OXY-Acetylene Welding [Items 1 thru 35]

### DECISIONS

<table>
<thead>
<tr>
<th>Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>Determine job requirement</td>
</tr>
<tr>
<td>Determine procedure</td>
</tr>
<tr>
<td>Select soldering material</td>
</tr>
<tr>
<td>Select flux</td>
</tr>
<tr>
<td>Evaluate finished operation by visual inspection</td>
</tr>
</tbody>
</table>

### CUES

<table>
<thead>
<tr>
<th>Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>Job requirements</td>
</tr>
<tr>
<td>Ease of application</td>
</tr>
<tr>
<td>Type of metal being soldered</td>
</tr>
<tr>
<td>Type of metal being soldered</td>
</tr>
<tr>
<td>Amount of heat required</td>
</tr>
<tr>
<td>General appearance, complete bond, neat and clean</td>
</tr>
</tbody>
</table>

### ERRORS

<table>
<thead>
<tr>
<th>Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>Will not meet job requirements</td>
</tr>
<tr>
<td>Poor bond</td>
</tr>
</tbody>
</table>
### SCIENCE

- Simple machines used to gain mechanical advantage—[use of Standard tools]
- Effect of heating and cooling on expansion of materials—[finished product]
- Transfer of energy from one form to another—[chemical reaction fluxes]
- Transfer of heat from one body to another—[effect adjacent material]
- Arrangement of molecules, atoms and ions and the effect on structure and strength of materials—[finished bond]

[Physical & chemical properties of soldering alloys and fluxes]

### MATH — NUMBER SYSTEMS

- Set of Real Numbers—Positive Rationals
- Fundamental Operations (Calculation)
  - Addition algorithm
  - Subtraction algorithm
  - Multiplication algorithm
  - Division algorithm
- Order of operations, i.e., Use of parentheses in simplifying arithmetic expressions.
  - Basic Measurement Skills and Concepts
    - Instruments—[Basic Measurement]
    - Measurement: Geometric Linear
    - Reading and interpreting tables, charts, and graphs
    - Scale drawings/floor plans/blueprints

  - Basic Arithmetic Skills and Concepts—Ratio and proportion
    - Basic Geometry Skills and Concepts—Congruence

### COMMUNICATIONS

#### PERFORMANCE MODES
- Speaking
- Reading
- Writing
- Listening
- Viewing
- Touching

#### EXAMPLES
- Make oral requisition for materials
- Interpret blueprint and written specifications
- Make written requisition for materials needed
- Follow oral instructions
- Appraise work

#### SKILLS/CONCEPTS
- Terminology, Logic, Gesture, Usage
- Comprehension, Detail, Proposals, Description, Terminology, Instruction
- Sketch, Description, Logic, Terminology, Usage
- Discriminate facts, Logic, Concentration, Note taking
- Visual analysis, Logic, Discrimination, Detail, Recognition of symbols, Codes, etc.
- Size, Shape, Temperature
DUTY II. ELECTRIC ARC WELDING

A. Set up equipment for electric arc welding
B. Arc weld mild steel
C. Arc weld pipe
D. Arc weld stainless steel
E. Arc weld cast iron
F. Hardface
G. Cut metals
**TASK STATEMENT**

**ARC WELDING**

**TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON**

- AC-DC Arc Welding equipment, Cables and fittings
- S. T. as required

**PERFORMANCE KNOWLEDGE**

- Determine operation requirements
- Connect correct power lead connection
- Connect correct electrode and ground cable connections
- Inspect current and polarity controls
- Inspect performance of welding machine

**SAFETY – HAZARD**

*Refer to Index under Safe Practice: XVIII – Electric Arc Welding—[Items 1 thru 28]*

**DECISIONS**

- Determine amount of set-up necessary
- Determine correct power source and leads
- Determine correct electrode and ground cable connections
- Determine correct current and polarity settings
- Evaluate completed set-up

**CUES**

- Operation requirement
- Operation requirement
- Operation requirement
- Electrode to be used
- Results

**ERRORS**

- Incomplete set-up
- Machine will not function properly
- Poor performance
- Poor performance
### SCIENCE

- Simple machines used to gain mechanical advantage—[use of standard tools]
- Transfer of energy from one form to another—[electrical energy to heat]
- Resistance of materials to flow of electrical current—[correct cable size]

### MATH - NUMBER SYSTEMS

- Set of Real Numbers—Positive Rationals
- Fundamental Operations (Calculation)
  - Addition algorithm
  - Subtraction algorithm
  - Multiplication algorithm
  - Division algorithm
- Order of operations, i.e., Use of parentheses in simplifying arithmetic expressions.
- Basic Measurement Skills and Concepts
  - Instruments—[Basic Measurement]
  - Measurement: Geometric
  - Linear
- Reading and interpreting tables, charts, and graphs
  - Scale drawings/floor plans/blueprints

### COMMUNICATIONS

#### PERFORMANCE MODES

- Speaking
- Reading
- Writing
- Listening
- Viewing
- Touching

#### EXAMPLES

- Make oral requisition for materials
- Read and follow written instructions for set-up
- Make written requisitions for materials needed
- Follow oral instructions
- Appraise work

#### SKILLS/CONCEPTS

- Terminology, Logic, Gesture, Usage
- Comprehension, Detail, Proposals, Description, Terminology, Instruction
- Sketch, Description, Logic, Terminology, Usage
- Discriminate facts, Logic, Concentration, Note taking
- Visual analysis, Logic, Discrimination, Detail, Recognition of symbols, Codes, etc.
- Size, Shape, Temperature
### II-B ARC WELD MILD STEEL

**TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON**

- AC DC Arc Welding equipment
- M. S. Material
- Welding Electrodes
- S. T. as required

**PERFORMANCE KNOWLEDGE**

- Determine joint design
- Select electrode type, size
- Determine weld position
- Select polarity
- Adjust current
- Strike Arc and complete weld in accordance to proper procedure

**SAFETY – HAZARD**

Refer to Index under Safe Practice.

**DECISIONS**

- Determine joint design
- Select electrode size
- Determine weld position
- Select polarity
- Adjust amperage
- Evaluate finished weld by visual inspection

**CUES**

- Job requirements
- Physical & chemistry, current requirements
- Ease of application
- Electrode requirement
- For penetration
- Good appearance, penetration informity

**ERRORS**

- Will not meet job specifications
- Poor weld quality
- Difficult to perform
- Poor weld quality
- Poor weld quality
- Impurities, poor penetration, etc.
### SCIENCE

- Simple machines used to gain mechanical advantage—[use of standard tools]
- Effect of heating and cooling on expansion of materials—[control distortion]
- Arrangement of molecules, atoms and ions and the effect on structure and strength of materials—[weld]

### MATH — NUMBER SYSTEMS

- Set of Real Numbers—Positive Rationals
- Fundamental Operations (Calculation)
  - Addition algorithm
  - Subtraction algorithm
  - Multiplication algorithm
  - Division algorithm
- Order of operations, i.e., Use of parentheses in simplifying arithmetic expressions.
- Basic Measurement Skills and Concepts
  - Instruments—[Basic Measurement]
  - Measurement: Geometric
    - Linear
    - Reading and interpreting tables, charts, and graphs
    - Scale drawings/floor plans/blueprints
- Basic Arithmetic Skills and Concepts—Ratio and proportion
  - [weld proportionate to parent metal]

### COMMUNICATIONS

#### PERFORMANCE MODES

- Speaking
- Reading
- Writing
- Listening
- Viewing
- Touching

#### EXAMPLES

- Make oral requisition for materials
- Interpret blueprint and written specifications. Seek information.
- Make written requisitions for materials needed
- Follow oral instructions
- Appraise work

#### SKILLS/CONCEPTS

- Terminology, Logic, Gesture, Usage
- Comprehension, Detail, Proposals, Description, Terminology, Instruction
- Sketch, Description, Logic, Terminology, Usage
- Discriminate facts, Logic, Concentration, Note taking
- Visual analysis, Logic, Discrimination, Detail, Recognition of symbols, Codes, etc.
- Size, Shape, Temperature
<table>
<thead>
<tr>
<th>TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON</th>
<th>PERFORMANCE KNOWLEDGE</th>
<th>SAFETY - HAZARD</th>
</tr>
</thead>
<tbody>
<tr>
<td>• AC DC Arc Welding equipment</td>
<td>Determine joint design</td>
<td>Refer to Index under Safe Practice: XVIII Electric Arc Welding [Items 1 thru 28]</td>
</tr>
<tr>
<td>S. T. as required</td>
<td>Determine alignment procedure</td>
<td></td>
</tr>
<tr>
<td>Alignment fixture</td>
<td>Determine electrode size and type</td>
<td></td>
</tr>
<tr>
<td>Steel Pipe</td>
<td>Determine position</td>
<td></td>
</tr>
<tr>
<td>Electrodes</td>
<td>Determine polarity setting</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Adjust current</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Complete weld according to proper procedure</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DECISIONS</th>
<th>CUES</th>
<th>ERRORS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Determine joint design</td>
<td>Job requirements, specifications</td>
<td>Lack of fusion and penetration</td>
</tr>
<tr>
<td>Determine alignment procedure</td>
<td>Job requirements, specifications</td>
<td>Misalignment of weldment</td>
</tr>
<tr>
<td>Determine electrode size and type</td>
<td>Job requirements, specifications</td>
<td>Poor quality of weld</td>
</tr>
<tr>
<td>Determine position</td>
<td>Ease of application</td>
<td>Poor quality of weld, appearance</td>
</tr>
<tr>
<td>Determine polarity setting</td>
<td>According to electrode type</td>
<td>Poor quality of weld, appearance</td>
</tr>
<tr>
<td>Adjust current</td>
<td>Job requirement</td>
<td>Poor quality of weld, appearance</td>
</tr>
<tr>
<td>Appraise finished work</td>
<td>Visual appearance, specifications</td>
<td></td>
</tr>
</tbody>
</table>
### SCIENCE

- Simple machines used to gain mechanical advantage—[use of standard tools]
- Effect of heating and cooling on expansion of materials—[change in material size]
- Magnetic fields of force—[electrical characteristics]
- Transfer of energy from one form to another—[electrical energy to heat]
- Transfer of heat from one body to another—[adjacent areas]
- Resistance of materials to flow of electrical current—[cable size, electrode size]
- Arrangement of molecules, atoms and ions and the effect on structure and strength of materials

### MATH — NUMBER SYSTEMS

- Set of Real Numbers—Positive Rationals
- Fundamental Operations (Calculation)
  - Addition algorithm
  - Subtraction algorithm
  - Multiplication algorithm
  - Division algorithm
- Order of Operations, i.e., Use of parentheses in simplifying arithmetic expressions.
- Basic Measurements Skills and Concepts
  - Instruments—[Basic Measurement]
  - Measurement: Geometric
    - Angle
  - Measurement: Non-geometric
    - Temperature
- Reading and interpreting tables, charts, and graphs
- Basic Geometry Skills and Concepts
  - Knowledge of geometric relationships
    - Parallel
    - Perpendicular
  - Determination of facts involving lines tangent to circles.

### COMMUNICATIONS

**PERFORMANCE MODES**

- Speaking
- Reading
- Writing
- Listening
- Viewing
- Touching

**EXAMPLES**

- Make oral requisitions for materials
- Interpret blueprint and written specifications
- Measure and lay-out pipe according to blueprint
- Make written requisitions for materials needed
- Follow oral instructions
- Appraise work

**SKILLS/CONCEPTS**

- Terminology, Logic, Gesture, Usage
- Comprehension, Detail, Proposals, Description, Terminology, Instruction
- Sketch, Description, Logic, Terminology, Usage
- Discriminate facts, Logic, Concentration, Note taking
- Visual analysis, Logic, Discrimination, Detail, Recognition of symbols, Codes, etc
- Size, Shape, Temperature
## Task Statement

**II-D ARC WELD STAINLESS STEEL**

### Tools, Equipment, Materials, Objects Acted Upon

- AC/DC Arc Welding equipment
- Stainless Steel material
- Stainless Steel electrodes
- S. T. as required

### Performance Knowledge

- Determine joint design
- Select electrode type/size
- Determine welding position
- Select polarity
- Adjust current
- Set up work, proceed with weld,
  Technique used consistent with proper procedure

### Safety - Hazard

Refer to Index under Safe Practice:

- XVIII - Electric Arc Welding -- [Items 1 thru 18]

### Decisions

- Determine joint design
- Select electrode type/size
- Determine weld position
- Select polarity
- Adjust current
- Set up work
- Appraise finished weld by visual inspection

### Cues

- Job requirement
- Physical & chemical property
- Ease of application
- Electrode requirement
- For proper penetration etc.
- Ease of operation
- Appearance, uniformity penetration

### Errors

- Does not meet requirement
- Does not meet requirement
- Job difficult to perform
- Poor weld quality
- Poor weld quality
- Job difficult to perform
- Impurities in weld, poor penetration, etc.
### Science

- Simple machines used to gain mechanical advantage—[standard tools]
- Effect of heating and cooling on expansion of materials—[control distortion]
- Arrangement of molecules, atoms and ions and the effect on structure and strength of materials
- [physical and chemical characteristics of electrodes, electrode coatings and their function]

### Math - Number Systems

- Set of Real Numbers—Positive Rationals
- Fundamental Operations (Calculation)
  - Addition algorithm
  - Subtraction algorithm
  - Multiplication algorithm
  - Division algorithm
- Order of operations, i.e., Use of parentheses in simplifying arithmetic expressions
- Basic Measurement Skills and Concepts
  - Instruments—[Basic Measurement]
  - Measurement: Geometric
  - Linear
  - Reading and interpreting tables, charts, and graphs
  - Scale drawings/floor plans/blueprints

### Communications

#### Performance Modes

- Speaking
- Reading
- Writing
- Listening
- Viewing
- Touching

#### Examples

- Make oral requisition for materials
- Perform operation—appraise finished work

#### Skills/Concepts

- Terminology, Logic, Gesture, Usage
- Comprehension, Detail; Proposals, Description, Terminology, Instruction
- Sketch, Description, Logic, Terminology, Usage
- Discriminate facts, Logic, Concentration, Note taking
- Visual analysis, Logic, Discrimination, Detail, Recognition of symbols, Codes, etc.
- Size, Shape, Temperature
**TASK STATEMENT**  
II-E ARC WELD CAST IRON

<table>
<thead>
<tr>
<th>OBJECTS ACTED UPON</th>
<th>PERFORMANCE KNOWLEDGE</th>
<th>SAFETY – HAZARD</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC DC Arc Welding equipment</td>
<td>Determine joint design</td>
<td></td>
</tr>
<tr>
<td>S T as required</td>
<td>Determine preparation needed</td>
<td></td>
</tr>
<tr>
<td>Grinder</td>
<td>Select electrode—size and type</td>
<td></td>
</tr>
<tr>
<td>Cast Iron material</td>
<td>Determine position</td>
<td></td>
</tr>
<tr>
<td>Electrodes</td>
<td>Determine polarity setting</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Adjust current</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Determine preheat/postheat needed</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Complete weld, using proper procedure</td>
<td></td>
</tr>
</tbody>
</table>

Refer to Index under Safe Practice
XVIII  Electric Arc Welding  [Items 1 thru 28]

---

**DECISIONS**
- Determine joint design
- Determine preparation needed
- Select electrode—size and type
- Determine position
- Determine polarity setting
- Adjust current
- Determine preheat/postheat needed
- Appraise finished work

**CUES**
- Job requirement
- Condition of metal—dirt, rust, etc.
- Job requirement
- Job requirement
- Electrode requirement
- Job requirement
- Job requirement
- Visual appearance and specifications

**ERRORS**
- Material waste
- Porosity—poor quality
- Wrong physical properties
- Poor bead shape
- Poor quality of weld metal
- Poor quality of weld metal
- Possible cracking
### SCIENCE

- Simple machines used to gain mechanical advantage—[standard tools]
- Effect of heating and cooling on expansion of materials—[cracks]
- Magnetic fields of force—[behavior of electric arc affected]
- Transfer of energy from one form to another—[electric energy to heat]
- Transfer of heat from one body to another—[adjacent areas]
- Resistance of materials to flow of electrical current—[cable size, electrode size]
- Arrangement of molecules, atoms and ions and the effect on structure and strength of materials—[weld]
- Resistance of materials to change in shape—[cast iron cannot be bent or shaped]

### MATH – NUMBER SYSTEMS

- Set of Real Numbers—Positive Rationals
- Fundamental Operations (Calculation)
  - Addition algorithm
  - Subtraction algorithm
  - Multiplication algorithm
  - Division algorithm
- Order of operations, i.e., Use of parentheses in simplifying arithmetic expressions

### COMMUNICATIONS

#### PERFORMANCE MODES

- Speaking
- Reading
- Writing
- Listening
- Viewing
- Touching

#### EXAMPLES

- Make oral requisitions for materials
- Read preheat and postheat temperatures as noted in written or oral instructions
- Interpret blueprint and written specifications
- Make written requisitions for materials needed
- Follow oral instructions
- Appraise work

#### SKILLS/CONCEPTS

- Terminology, Logic, Gesture, Usage
- Comprehension, Detail, Proposals, Description, Terminology, Instruction
- Sketch, Description, Logic, Terminology, Usage
- Discriminate facts, Logic, Concentration, Note taking
- Visual analysis, Logic, Discrimination, Detail, Recognition of symbols, Codes, etc.
- Size, Shape, Temperature
**TASK STATEMENT**  
**II-F HARDFACE**

<table>
<thead>
<tr>
<th>TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON</th>
<th>PERFORMANCE KNOWLEDGE</th>
<th>SAFETY – HAZARD</th>
</tr>
</thead>
</table>
| AC DC Arc Welding equipment | Determine joint design  
S T as required  
Grinder  
Steel or steel alloy material  
Hardfacing electrodes | Determine joint design  
Determine preparation needed  
Select electrode—size and type  
Determine position  
Determine polarity setting  
Adjust current  
Complete hardfacing operation according to procedure | Refer to Index under Safe Practice  
XVIII Electric Arc Welding [Items 1 thru 28] |

**DECISIONS**  
Determine joint design  
Determine preparation needed  
Select electrode—size and type  
Determine position  
Determine polarity setting  
Adjust current  
Appraise finished work  

**CUES**  
Job requirement  
Job requirement  
Electrode used according to specifications  
Ease of application  
Determined by electrode type  
Job requirement  
Visual appearance and specification  

**ERRORS**  
Material waste  
Poor quality—poor adhesion  
Material waste—poor quality  
Poor shape of bead  
Poor quality  
Poor adhesion affects physical properties  
Poor appearance—too soft
### SCIENCE

<table>
<thead>
<tr>
<th>Task Statement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simple machines used to gain mechanical advantage—[use of standard tools]</td>
</tr>
<tr>
<td>Effect of heating and cooling on expansion of materials—[cracks]</td>
</tr>
<tr>
<td>Transfer of heat from one body to another—[adjacent areas]</td>
</tr>
<tr>
<td>Arrangement of molecules, atoms and ions and the effect on structure and strength of materials—[weld]</td>
</tr>
<tr>
<td>Resistance of materials to change in shape—[rigid and hard]</td>
</tr>
</tbody>
</table>

### MATH – NUMBER SYSTEMS

<table>
<thead>
<tr>
<th>Mathematical Concepts</th>
</tr>
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<tbody>
<tr>
<td>Set of Real Numbers—Positive Rationals</td>
</tr>
<tr>
<td>Fundamental Operations (Calculation)</td>
</tr>
<tr>
<td>Addition algorithm</td>
</tr>
<tr>
<td>Subtraction algorithm</td>
</tr>
<tr>
<td>Multiplication algorithm</td>
</tr>
<tr>
<td>Division algorithm</td>
</tr>
<tr>
<td>Order of operations, i.e., Use of parentheses in simplifying arithmetic expressions</td>
</tr>
<tr>
<td>Basic Measurement Skills and Concepts</td>
</tr>
<tr>
<td>Instruments—[Basic Measurement]</td>
</tr>
<tr>
<td>Measurement: Geometric</td>
</tr>
<tr>
<td>Linear</td>
</tr>
<tr>
<td>Reading and interpreting tables, charts, and graphs</td>
</tr>
<tr>
<td>Scale drawings/floor plans/blueprints</td>
</tr>
<tr>
<td>Basic Arithmetic Skills and Concepts—Ratio and proportion</td>
</tr>
<tr>
<td>[Comparison of cost of hardfacing to cost of new part]</td>
</tr>
</tbody>
</table>

### COMMUNICATIONS

#### PERFORMANCE MODES

<table>
<thead>
<tr>
<th>Mode</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speaking</td>
<td>Make oral requisitions for materials</td>
</tr>
<tr>
<td>Reading</td>
<td>Interpret blueprint and written specifications</td>
</tr>
<tr>
<td>Writing</td>
<td>Make written requisitions for materials needed</td>
</tr>
<tr>
<td>Listening</td>
<td>Follow oral instructions</td>
</tr>
<tr>
<td>Viewing</td>
<td>Appraise work</td>
</tr>
<tr>
<td>Touching</td>
<td></td>
</tr>
</tbody>
</table>

#### SKILLS/CONCEPTS

<table>
<thead>
<tr>
<th>Concept</th>
</tr>
</thead>
<tbody>
<tr>
<td>Terminology, Logic, Gesture, Usage</td>
</tr>
<tr>
<td>Comprehension, Detail, Proposals, Description, Terminology, Instruction</td>
</tr>
<tr>
<td>Sketch, Description, Logic, Terminology, Usage</td>
</tr>
<tr>
<td>Discriminate facts, Logic, Concentration, Note taking</td>
</tr>
<tr>
<td>Visual analysis, Logic, Discrimination, Detail, Recognition of symbols, Codes, etc</td>
</tr>
<tr>
<td>Size, Shape, Temperature</td>
</tr>
</tbody>
</table>

**39**
**II-G CUT METALS**

### TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON

- AC/DC Arc Welding equipment
- Metal to be cut
- Cutting Electrodes
- Standard tools as required

### PERFORMANCE KNOWLEDGE

- Determine job requirements
- Select electrode type, size
- Layout metal using proper marking tool
- Adjust current
- Strike arc, complete cutting operation according to proper procedure

### SAFETY – HAZARD

- Refer to Index under Safe Practice XVIII Electric Arc Welding [Items 1 thru 28]

### DECISIONS

- Determine job requirements
- Select electrode type, size
- Adjust current
- Evaluate finished cut by visual inspection

### CUES

- Job requirements
- Type and thickness metal to be cut
- Uniformity, proper dimension, neat, etc.

### ERRORS

- Will not meet job requirements
- Poor, erratic, incomplete cut
- Poor, erratic, incomplete cut
- Poor, erratic, incomplete cut
<table>
<thead>
<tr>
<th>SCIENCE</th>
<th>MATH – NUMBER SYSTEMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simple machines used to gain mechanical advantage—[use standard tools] Effects of heating and cooling on expansion of materials—[Distortion] Transfer to energy from one form to another—[electrical energy converted to heat] Arrangement of molecules, atoms and ions and the effect on structure and strength of materials—[heat effected zone] [Physical and chemical characteristics of electrodes, electrode coatings and their function]</td>
<td>Set of Real Numbers—Positive Rationals Fundamental Operations (Calculation) Addition algorithm Subtraction algorithm Multiplication algorithm Division algorithm Order of operations, i.e., Use of parentheses in simplifying arithmetic expressions Basic Measurement Skills and Concepts Instruments—[Basic Measurement] Measurement: Geometric Linear Reading and interpreting tables, charts, and graphs Scale drawings/floor plans/blueprints</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>COMMUNICATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>PERFORMANCE MODES</td>
</tr>
<tr>
<td>Speaking</td>
</tr>
<tr>
<td>Reading</td>
</tr>
</tbody>
</table>
DUTY III. TUNGSTEN INERT-GAS ARC WELDING

A. Set up Tungsten Inert-Gas welding equipment
B. TIG weld mild steel
C. TIG weld pipe
D. TIG weld stainless steel
E. TIG weld aluminum
F. TIG weld cast iron
G. Hardface
### III-A Set Up Tungsten-Inert-Gas Welding Equipment

<table>
<thead>
<tr>
<th>Tools, Equipment, Materials, Objects Acted Upon</th>
<th>Performance Knowledge</th>
<th>Safety - Hazard</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC/DC Arc Welding Equipment with Hi-frequency unit. Cables and fittings TIG Torch assembly Tungsten electrodes Inert gas supply S. T. as required</td>
<td>Determine operation requirement Determine power lead connection Determine electrode and ground cable connection Determine water supply connections Determine flow meter connections Determine torch assembly connections Inspect all controls Evaluate completed set-up.</td>
<td>Refer to Index under Safe Practice: XVIII - Electric Arc Welding - [Items 1 thru 28]</td>
</tr>
</tbody>
</table>

### Decisions
- Determine amount of set-up necessary
- Correct placement of power lead
- Correct electrode and ground cable connections
- Correct water supply connection
- Correct flow meter connections
- Correct torch assembly connection
- Correct setting and function of controls
- Evaluate completed set-up

### Cues
- Job requirements
- Connect according to directions
- Connect according to directions
- Ample supply
- Set-up requirement
- Set-up requirement
- Set-up requirement
- All phases working

### Errors
- Wrong rotation
- Wrong polarity possible
- Overheating
- Leaks weld contamination
- Leaks weld contamination
- Leaks weld contamination
### SCIENCE

- Indestructibility of energy and matter—[non-consumable electrode]
- Simple machines used to gain mechanical advantage—[use of Standard Tools]
- Effect of heating and cooling on state of matter—[changes possible physical metallurgy]
- Transfer of heat from one body to another—[Heat treating]
- Resistance of materials to flow of electrical current—[cable size, Electrode size]
- Relationship of force to distortion in an elastic body—[Forging and Shaping]
- Arrangement of molecules, atoms and ions and the effect on structure and strength of materials—[Welds and Metals]
- Fluids under pressure—[inert gases and their function]
- Physical characteristics of inert gases and their function

### MATH – NUMBER SYSTEMS

- Set of Real Numbers—Positive Rationals
- Basic Measurement Skills and Concepts—Instruments
  - [read gauge pounds per square inch, cubic feet per hour]

### COMMUNICATIONS

#### PERFORMANCE MODES

- Speaking
- Reading
- Writing
- Listening
- Viewing
- Touching

#### EXAMPLES

- Make oral requisitions for materials
- Read and follow written instructions for set-up
- Make written requisitions for materials needed
- Follow oral instructions
- Appraise work

#### SKILLS/CONCEPTS

- Terminology, Logic, Gesture, Usage
- Comprehension, Detail, Proposals, Description, Terminology, Instruction
- Sketch, Description, Logic, Terminology, Usage
- Discriminate facts, Logic, Concentration, Note taking
- Visual analysis, Logic, Discrimination, Detail, Recognition of symbols, Codes, etc.
- Size, Shape, Temperature
### TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON

- AC/DC Arc Welding Equipment
- Hi-frequency capability
- Flow Meter Regulator
- TIG Welding Torch
- Tungsten Electrodes
- Inert Gas Supply
- M. S. Material
- M. S. Filler Rod
- S. T. as required

### PERFORMANCE KNOWLEDGE

- Determine joint design
- Select electrode size
- Determine weld position
- Select polarity
- Adjust current
- Adjust arc-gas flow
- Set and adjust hi-frequency
- Set up work, complete weld according to proper procedure

### DECISIONS

- Determine joint design
- Select electrode size
- Determine position
- Adjust current
- Adjust gas flow
- Set and adjust hi-frequency
- Appraise finished work by visual inspection

### CUES

- Job requirement or specs
- Current requirements
- Ease of application
- Proper penetration
- Proper shielding
- Spark intensity, mode, etc.
- Appearance, Penetration, Uniformity, etc.

### ERRORS

- Does not meet requirement
- Improper Arc characteristics
- Poor weld quality
- Poor weld quality
- Poor weld quality
- Electrode contamination
- Porosity, penetration cracks, etc.

### SAFETY – HAZARD

Refer to Index under Safe Practice:

- XVIII - Electric Arc Welding [Items 1 thru 28]
**Science**

1. Simple machines used to gain mechanical advantage—(use of standard tools)
2. Effect of heating and cooling on expansion of materials—(Control distortion)
3. Transfer of heat from one body to another—(water cooled torch)
4. Arrangement of molecules, atoms and ions and the effect on structure and strength of materials—(strength of weld)
5. Physical characteristics of inert gases and their function
6. Different types of Tungsten Electrodes and their use Hi-frequency and its function

**Math—Number Systems**

- Set of Real Numbers—Positive Rationals
- Fundamental Operations (Calculation)
  - Addition algorithm
  - Subtraction algorithm
  - Multiplication algorithm
  - Div. on algorithm
- Order of operations, e.g., Use of parentheses in simplifying arithmetic expressions
- Basic Measurement Skills and Concepts—Basic Measurement
  - Measurement: Geometric
    - Linear
    - Reading and interpreting tables, charts, and graphs
    - Scale drawings/floor plans/blueprints
- Basic Arithmetic Skills and Concepts—Ratio and proportion
  - Weldment proportional to parent metal

**Communications**

**Performance Modes**

- Speaking
- Reading
- Writing
- Listening
- Viewing
- Touching

**Examples**

- Make oral requisitions for materials
- Interpret blueprint or written specifications
- Make written requisitions for materials needed
- Follow oral instructions
- Appraise work

**Skills/Concepts**

- Terminology, Logic, Gesture, Usage
- Comprehension, Detail, Proposals, Description, Terminology, Instruction
- Sketch, Description, Logic, Terminology, Usage
- Discriminate facts, Logic, Concentration, Note taking
- Visual analysis, Logic, Discrimination, Detail, Recognition of symbols, Codes, etc.
- Size, Shape, Temperature
**TASK STATEMENT**

III-C TIG WELD PIPE

<table>
<thead>
<tr>
<th>TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON</th>
<th>PERFORMANCE KNOWLEDGE</th>
<th>SAFETY – HAZARD</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC/DC Arc Welding equipment with High-frequency unit.</td>
<td>Determine joint design</td>
<td>Refer to Index under Safe Practice: XVIII Electric Arc Welding [Items I thru 28]</td>
</tr>
<tr>
<td>TIG Torch Assembly</td>
<td>Determine alignment procedure</td>
<td></td>
</tr>
<tr>
<td>Tungsten Electrode</td>
<td>Determine electrode size and type</td>
<td></td>
</tr>
<tr>
<td>Inert gas supply</td>
<td>Determine filler rod size and type</td>
<td></td>
</tr>
<tr>
<td>Aligning fixture</td>
<td>Determine position</td>
<td></td>
</tr>
<tr>
<td>Pipe</td>
<td>Determine current setting</td>
<td></td>
</tr>
<tr>
<td>Filler rod</td>
<td>Determine polarity setting</td>
<td></td>
</tr>
<tr>
<td>St. T. as required</td>
<td>Determine gas flow</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Complete weld according to proper procedure</td>
<td></td>
</tr>
</tbody>
</table>

**DECISIONS**

- Determine joint design
- Determine alignment procedure
- Select electrode size and type
- Select filler rod size and type
- Determine position
- Select current setting
- Select polarity setting
- Set gas flow
- Appraise finished work

**CUES**

- Job requirement or specification
- Job requirement or specification
- According to parent metal
- According to parent metal
- More efficient ease of application
- Job requirement specification
- Job requirement specification
- Job requirement specification
- Visual appearance and specifications

**ERRORS**

- Lack of fusion and penetration
- Misalignment of weldment
- Poor quality of weld
- Poor quality of weld
- Poor quality of weld
- Poor quality of weld
- Poor quality of weld
- Weld contamination
### Science

- Simple machines used to gain mechanical advantage—[use of standard tools]
- Effect of heating and cooling on expansion of materials—[change in material size]
- Transfer of energy form one form to another—[electrical energy to heat]
- Transfer of heat from one body to another—[effect on adjacent areas]
- Resistance of materials to flow of electrical current—[cable size, electrode size]
- Arrangement of molecules, atoms and ions and the effect on structure and strength of materials—[strength of weld]
- Physical characteristics of inert gases and their function
- Tungsten electrodes—types High-frequency and its functions

### Math – Number Systems

- Set of Real Numbers—Positive Rationals
- Fundamental Operations (Calculation)
  - Addition algorithm
  - Subtraction algorithm
  - Multiplication algorithm
  - Division algorithm
- Order of Operations, i.e., Use of parentheses in simplifying arithmetic expressions
- Basic Measurements Skills and Concepts
- Instruments—[Basic Measurement]
- Measurement: Geometric
  - Angle
- Measurement: Non-geometric
  - Temperature
- Reading and interpreting tables, charts, and graphs
- Basic Geometry Skills and Concepts
  - Knowledge of geometric relationships
    - Parallel
    - Perpendicular
  - Determination of area and circumference of circles.
  - Determination of area and perimeter of an ellipse.
  - Determination of facts involving lines tangent to circles.

### Communications

<table>
<thead>
<tr>
<th>Performance Modes</th>
<th>Examples</th>
<th>Skills/Concepts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speaking</td>
<td>Make oral requisitions for materials</td>
<td>Terminology, Logic, Gesture, Usage</td>
</tr>
<tr>
<td>Reading</td>
<td>Interpret blueprint and written specifications</td>
<td>Comprehension, Detail, Proposals, Description, Terminology, Instruction</td>
</tr>
<tr>
<td>Writing</td>
<td>Measure and lay-out pipe according to blueprint or sketch</td>
<td>Sketch, Description, Logic, Terminology, Usage</td>
</tr>
<tr>
<td>Listening</td>
<td>Make written requisitions for materials needed</td>
<td>Discriminate facts, Logic, Concentration, Note taking</td>
</tr>
<tr>
<td>Viewing</td>
<td>Follow oral instructions</td>
<td>Visual analysis, Logic, Discrimination, Detail, Recognition of symbols, Codes, etc.</td>
</tr>
<tr>
<td>Touching</td>
<td>Appraise work</td>
<td>Size, Shape, Temperature</td>
</tr>
</tbody>
</table>

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### TASK STATEMENT
**TIG WELD STAINLESS STEEL**

### TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON
- AC/DC Arc Welding Equipment
- Hi-frequency capability
- Flow Meter Regulator
- TIG Welding Torch
- Tungsten Electrodes
- Inert Gas Supply
- Stainless Steel Material
- Stainless Steel Filler Rod
- S.T. as required

### PERFORMANCE KNOWLEDGE
- Determine joint design
- Select electrode size
- Determine welding position
- Select polarity
- Adjust current
- Adjust inert gas flow
- Set and adjust hi-frequency
- Set up work, complete weld according to proper procedure

### DECISIONS
- Determine joint design
- Select electrode size
- Determine weld position
- Adjust current
- Adjust gas flow
- Set and adjust hi-frequency
- Appraise finished work by visual inspection

### CUES
- Job requirements or specs
- Current required
- Ease of application
- Proper penetration
- Proper shielding
- Spark intensity, mode, etc.
- Appearance, penetration, etc.

### SAFETY – HAZARD
Refer to Index under Safe Practice:
- XVIII  Electric Arc Welding  [Items 1 thru 28]

### ERRORS
- Does not meet requirements
- Improper arc characteristics
- Poor weld quality
- Poor weld quality
- Poor weld quality
- Electrode contamination
- Porosity, poor penetration, cracks, etc.

---

**Note:** The content above is a table outlining the task statement, tools, equipment, materials, objects acted upon, performance knowledge, decisions, cues, and errors related to TIG welding stainless steel.
### SCIENCE

- Simple machines used to gain mechanical advantage—[use of standard tools]
- Effect of heating and cooling on expansion of materials—[controlling distortion]
- Transfer of heat from one body to another—[water cooled torch]
- Arrangement of molecules, atoms and ions and the effect on structure and strength of materials
  - [Physical characteristic of inert gases and their function]
  - [Different types Tungsten Electrodes and their use Hi-frequency and its function]
- Weldable and non-weldable stainless steels

### MATH — NUMBER SYSTEMS

- Set of Real Numbers—Positive Rationals
- Fundamental Operations (Calculation)
  - Addition algorithm
  - Subtraction algorithm
  - Multiplication algorithm
  - Division algorithm
- Order of operations, i.e., use of parentheses in simplifying arithmetic expressions
- Basic Measurement Skills and Concepts
  - Instruments—[Basic Measurement]
  - Measurement: Geometric
    - Linear
    - Reading and interpreting tables, charts, and graphs
    - Scale drawings/floor plans/blueprints
- Basic Arithmetic Skills and Concepts
  - Ratio and proportion
  - [Weldment proportional to parent metal]

### COMMUNICATIONS

#### PERFORMANCE MODES

- Speaking
- Reading
- Writing
- Listening
- Viewing
- Touching

#### EXAMPLES

- Make oral requisitions for materials
- Interpret blueprint and written specifications
- Make written requisitions for materials needed
- Follow oral instructions
- Appraise work

#### SKILLS/CONCEPTS

- Terminology, Logic, Gesture, Usage
  - Comprehension, Detail, Proposals, Description, Terminology, Instruction
  - Sketch, Description, Logic, Terminology, Usage
- Discriminate facts, Logic, Concentration, Note taking
  - Visual analysis, Logic, Discrimination, Detail, Recognition of symbols, Codes, etc
- Size, Shape, Temperature
### TASK STATEMENT

**III-E TIG WELD ALUMINUM**

<table>
<thead>
<tr>
<th>TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON</th>
<th>PERFORMANCE KNOWLEDGE</th>
<th>SAFETY – HAZARD</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC, DC Arc Welding Equipment</td>
<td>Determine joint design</td>
<td>Refer to Index under Safe Practice:</td>
</tr>
<tr>
<td>Hi-frequency capability</td>
<td>Select electrode size</td>
<td>XVIII Electric Arc Welding [Items 1 thru 28]</td>
</tr>
<tr>
<td>Flow-meter Regulator</td>
<td>Select filler type/size</td>
<td></td>
</tr>
<tr>
<td>TIG Welding Torch</td>
<td>Determine welding position</td>
<td></td>
</tr>
<tr>
<td>Tungsten Electrodes</td>
<td>Adjust current</td>
<td></td>
</tr>
<tr>
<td>Inert Gas Supply</td>
<td>Adjust inert-gas flow</td>
<td></td>
</tr>
<tr>
<td>Aluminum Material</td>
<td>Set and adjust hi-frequency</td>
<td></td>
</tr>
<tr>
<td>Aluminum filler Rod</td>
<td>Set up work complete weld according to proper procedure</td>
<td></td>
</tr>
<tr>
<td>Standard tools as required</td>
<td>Determine preheat needed</td>
<td></td>
</tr>
</tbody>
</table>

### DECISIONS

- Determine joint design
- Select electrode size
- Select filler type/size
- Determine weld position
- Preheat to required temperature
- Adjust current
- Adjust inert-gas flow
- Set/Adjust hi-frequency
- Appraise finished weld by visual inspection

### CUES

- Job requirement or specs
- Current required
- Job Requirements
- Ease of application
- Job requirements
- Proper penetration
- Proper shielding
- Mode, Spark intensity
- Appearance, penetration, uniformity, etc.

### ERRORS

- Will not meet job specifications
- Improper arc characteristics
- Poor weld quality
- Poor weld quality
- Poor fusion—appearance
- Poor weld quality
- Poor weld quality
- Electrode contamination
- Porosity, poor penetration, cracks, etc.
### SCIENCE

- Simple machines used to gain mechanical advantage—[use of standard tools]
- Effect of heating and cooling on expansion of materials—[controlling distortion]
- Transfer of heat from one body to another—[water cooled torch]
- Arrangement of molecules, atoms and ions and the effect on structure and strength of materials
- [Physical characteristics of inert gases and their function]
- [Different types Tungsten Electrodes and their use.]
- [Hi-frequency and its function]
- Weldable and non-weldable aluminum alloys

### MATH — NUMBER SYSTEMS

- Set of Real Numbers—Positive Rationals
- Fundamental Operations (Calculation)
  - Addition algorithm
  - Subtraction algorithm
  - Multiplication algorithm
  - Division algorithm
- Order of operations, i.e., Use of parentheses in simplifying arithmetic expressions.
- Basic Measurement Skills and Concepts
- Instruments—[Basic Measurement]
- Measurement: Geometric
- Linear
- Reading and interpreting tables, charts, and graphs
- Scale drawings/ floor plans/blueprints
- Basic Arithmetic Skills and Concepts—Ratio and proportion
  - [Weld proportionate to parent metal]

### COMMUNICATIONS

#### PERFORMANCE MODES

- Speaking
- Reading
- Writing
- Listening
- Viewing
- Touching

#### EXAMPLES

- Make oral requisitions for materials
- Interpret blueprint and written specifications
- Make written requisition for materials needed
- Follow oral instructions
- Appraise work

#### SKILLS/CONCEPTS

- Terminology, Logic, Gesture, Usage
- Comprehension, Detail, Proposals, Description
- Terminology, Instruction
- Sketch, Description, Logic, Terminology, Usage
- Discriminate facts, Logic, Concentration, Note taking
- Visual analysis, Logic, Discrimination, Detail, Recognition of symbols, Codes, etc.
- Size, Shape, Temperature
### Tools, Equipment, Materials, Objects Acted Upon

- AC/DC Arc Welding equipment with High-frequency unit
- TIG Torch Assembly
- Tungsten Electrode
- Inert gas supply
- Filler rod
- Grinder
- Cast iron material
- S. T. as required

### Performance Knowledge

- Determine joint design
- Determine preparation needed
- Determine electrode size and type
- Determine filler rod size and type
- Determine necessity of preheat or postheat
- Determine position
- Determine polarity
- Determine current setting
- Determine gas flow
- Complete weld according to proper procedure

### Safety - Hazard

Refer to Index under Safe Practice: XVIII - Electric Arc Welding - [Items 1 thru 28]

### Decisions

- Determine joint design
- Determine preparation needed
- Select electrode size and type
- Select filler rod size and type
- Select preheat and/or postheat
- Select position
- Set polarity
- Make current setting
- Set gas flow
- Appraise finished work

### Cues

- Job requirement
- Condition of metal, dirty, rusty etc.
- Procedure requirement
- Procedure requirement
- Weight and shape of casting
- Better and more efficient results
- Job requirement
- Job requirement
- Visual and specification

### Errors

- Lack of fusion and penetration
- Porosity, poor quality of weld
- Drop in quality of weld
- Porosity, poor quality of weld
- Possible cracks in casting
- Poor shape of weld bead
- May not be feasible
- Porosity, lack of fusions had bead shape
- Contamination of weld and electrode
- Poor quality of finished job
<table>
<thead>
<tr>
<th>SCIENCE</th>
<th>MATH – NUMBER SYSTEMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simple machines used to gain mechanical advantage — [use of standard tools]</td>
<td>Set of Real Numbers — Positive Rationals</td>
</tr>
<tr>
<td>Effect of heating and cooling on expansion of materials — [fast cooling may cause uneven contraction, cracks]</td>
<td>Fundamental Operations (Calculation)</td>
</tr>
<tr>
<td>Transfer of energy from one form to another — [electric energy to heat]</td>
<td>Addition algorithm</td>
</tr>
<tr>
<td>Transfer of heat from one body to another — [effect of adjacent areas]</td>
<td>Subtraction algorithm</td>
</tr>
<tr>
<td>Resistance of materials to flow of electrical current — [cable size, electrode size]</td>
<td>Multiplication algorithm</td>
</tr>
<tr>
<td>Arrangement of molecules, atoms and ions and the effect on structure and strength of materials — [weld]</td>
<td>Division algorithm</td>
</tr>
<tr>
<td>Resistance of materials to change in shape — [cast iron cannot be bent or shaped]</td>
<td>Order of operations, i.e., Use of parentheses in simplifying arithmetic expressions</td>
</tr>
<tr>
<td>[Characteristics of inert gases and function]</td>
<td>Basic Measurement Skills and Concepts</td>
</tr>
<tr>
<td>[Types of tungsten electrodes]</td>
<td>Instruments — [Basic Measurement]</td>
</tr>
<tr>
<td>[Function of high-frequency]</td>
<td>Measurement: Geometric Linear</td>
</tr>
<tr>
<td>[Filler rods used — cast iron and nickel]</td>
<td>Reading and interpreting ta., charts, and graphs</td>
</tr>
<tr>
<td></td>
<td>Scale drawings/floor plans/blueprints</td>
</tr>
<tr>
<td></td>
<td>Basic Measurement Skills and Concepts — Measurement: Non-geometric</td>
</tr>
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<td></td>
<td>Temperature [Checking and Controlling]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>COMMUNICATIONS</th>
</tr>
</thead>
<tbody>
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<td>PERFORMANCE MODES</td>
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<td>Speaking</td>
</tr>
<tr>
<td>Reading</td>
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<tr>
<td>Writing</td>
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<td>Listening</td>
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<tr>
<td>Viewing</td>
</tr>
<tr>
<td>Touching</td>
</tr>
<tr>
<td>TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON</td>
</tr>
<tr>
<td>-----------------------------------------------</td>
</tr>
</tbody>
</table>
| AC, DC Arc Welding equipment with High-frequency unit.  
  Tungsten electrode  
  Inert gas supply  
  Steel or Steel alloy  
  Filler rod  
  Grinder | Det. ...the joint design  
  Determine preparation needed  
  Determine electrode size and type  
  Determine filler rod size and type  
  Determine position  
  Determine current setting  
  Determine polarity setting  
  Determine gas flow  
  Complete weld according to proper procedure | Refer to Index under Safe Practice:  
  XVIII  Electric Arc Welding  
  [Items 1 thru 28] |

<table>
<thead>
<tr>
<th>DECISIONS</th>
<th>CUES</th>
<th>ERRORS</th>
</tr>
</thead>
</table>
| Determine joint design  
  Determine preparation needed  
  Select electrode size and type  
  Select filler rod size and type  
  Determine position  
  Select current setting  
  Select polarity  
  Set gas flow  
  Appraise finished job | Job requirement  
  Job requirements and condition of metal  
  Metal thickness  
  Job requirement  
  Ease of application  
  Job requirement  
  Job requirement  
  Job requirement  
  Visual appearance and specification | Material waste  
  Poor quality, poor adhesion  
  Poor quality, appearance  
  Poor quality, undesired physical properties  
  Poor shape of bead  
  Poor quality, dilution of bead  
  Poor quality, or not feasible  
  Weld contaminations and oxidation |
### SCIENCE

- Simple machines used to gain mechanical advantage — [use of standard tools]
- Effect of heating and cooling on expansion of materials — [material size, distortion]
- Transfer of energy from one form to another — [electrical energy to heat]
- Transfer of heat from one body to another — [adjacent areas]
- Resistance of materials to flow of electrical current — [cable size, electrode size]
- Arrangement of molecules, atoms and ions and the effect on structure and strength of materials — [weld and material]
- Resistance of materials to change in shape — [rigid and hard materials]
- [The metallurgy of hardfacing materials]
- [The characteristics of inert gases-function]

### MATH — NUMBER SYSTEMS

- Set of Real Numbers — Positive Rationals
- Fundamental Operations (Calculation)
  - Addition algorithm
  - Subtraction algorithm
  - Multiplication algorithm
  - Division algorithm
- Order of operations, i.e., Use of parentheses in simplifying arithmetic expressions.
- Basic Measurement Skills and Concepts
  - Instruments — [Basic Measurement]
  - Measurement, Geometric
    - Linear
    - Reading and interpreting tables, charts, and graphs
    - Scale drawings, floor plans/blueprints

### COMMUNICATIONS

#### PERFORMANCE MODES

- Speaking
- Reading
- Writing
- Listening
- Viewing
- Touching

#### EXAMPLES

- Make oral requisition for materials
- Interpret blueprint and written specifications
- Make written requisitions for materials needed
- Follow oral instructions
- Appraise work

#### SKILLS/CONCEPTS

- Terminology, Logic, Gesture, Usage
- Comprehension, Detail, Proposals, Description, Terminology, Instruction
- Sketch, Description, Logic, Terminology, Usage
- Discriminate facts, Logic, Concentration, Note taking
- Visual analysis, Logic, Discrimination, Detail, Recognition of symbols, Codes, etc.
- Size, Shape, Temperature
DUTY IV. METALLIC INERT-GAS ARC WELDING

A. Set up equipment for Metallic Inert-Gas welding
B. MIG weld carbon steels
C. MIG weld pipe
D. MIG weld aluminum
### TASK STATEMENT

**IV-A SET UP EQUIPMENT FOR METALLIC INERT-GAS**

<table>
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<tr>
<th>TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON</th>
</tr>
</thead>
<tbody>
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<td>Constant Voltage, Direct Current</td>
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<tr>
<td>Welding Machine</td>
</tr>
<tr>
<td>Power Input supply</td>
</tr>
<tr>
<td>Inert Gas supply</td>
</tr>
<tr>
<td>Wire-feed assembly and controls</td>
</tr>
<tr>
<td>Water supply</td>
</tr>
<tr>
<td>Flow meter regulator</td>
</tr>
<tr>
<td>Ground and Electrode cables</td>
</tr>
<tr>
<td>MIG Torch Assembly</td>
</tr>
<tr>
<td>Filler wire on reel</td>
</tr>
<tr>
<td>Standard Tools as required</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PERFORMANCE KNOWLEDGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connect machine to power supply</td>
</tr>
<tr>
<td>Attach water supply to machine</td>
</tr>
<tr>
<td>Attach cables to ground and torch</td>
</tr>
<tr>
<td>Attach flow meter to inert-gas supply</td>
</tr>
<tr>
<td>Attach filler wire reel to feed assembly</td>
</tr>
<tr>
<td>Adjust wire feed and current control</td>
</tr>
<tr>
<td>Adjust voltage</td>
</tr>
<tr>
<td>Inspect for operation procedure</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SAFETY – HAZARD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Refer to Index under Safe Practice XVIII</td>
</tr>
<tr>
<td>Electric Arc Welding -- I Items I dim 28)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DECISIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connect machine to power supply</td>
</tr>
<tr>
<td>Attach water supply</td>
</tr>
<tr>
<td>Attach cables to ground and torch</td>
</tr>
<tr>
<td>Attach flow meter</td>
</tr>
<tr>
<td>Adjust wire feed current</td>
</tr>
<tr>
<td>Adjust voltage</td>
</tr>
<tr>
<td>Appraise operation by actual test use</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CUES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current requirements of machine</td>
</tr>
<tr>
<td>Needed to keep torch cool</td>
</tr>
<tr>
<td>Make positive and secure</td>
</tr>
<tr>
<td>To control shielding gas</td>
</tr>
<tr>
<td>Amount needed for operation</td>
</tr>
<tr>
<td>For smooth Arc</td>
</tr>
<tr>
<td>Proper wire feed, good Arc characteristic, good deposit</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ERRORS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Damage to machine</td>
</tr>
<tr>
<td>Damage torch through overheating</td>
</tr>
<tr>
<td>Poor connections, Damage equipment</td>
</tr>
<tr>
<td>Poor weld quality</td>
</tr>
<tr>
<td>Improper weld deposit</td>
</tr>
<tr>
<td>Improper weld deposit</td>
</tr>
<tr>
<td>Improper weld deposit, poor Arc characteristics</td>
</tr>
</tbody>
</table>
### IV-A Set Up Equipment for Metallic Inert-Gas

**Science**
- Simple machines used to gain mechanical advantage (use of standard tools)
- Work input, work output, friction and efficiency in simple machines
- [Wire fed assembly operation]
- Transfer of heat from one body to another - [Water cooled torch]
- [Physical characteristic of inert gases and their function]
- [Different types filler wire]
- [Short-arc and Spray Arc]
- [Methods of application]

**Math - Number Systems**
- Set of Real Numbers
  - Positive Rationals
- Fundamental Operations (Calculation)
  - Addition algorithm
  - Subtraction algorithm
  - Multiplication algorithm
  - Division algorithm
- Order of operations, i.e., use of parentheses in simplifying arithmetic expressions

**Communications**

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<tr>
<th>Performance Modes</th>
<th>Examples</th>
<th>Skills/Concepts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speaking</td>
<td>Make oral requisition for materials</td>
<td>Terminology, Logic, Gesture, Usage</td>
</tr>
<tr>
<td>Reading</td>
<td>Read and follow written instructions for set-up</td>
<td>Comprehension, Detail, Proposals, Description, Terminology, Instruction</td>
</tr>
<tr>
<td>Writing</td>
<td>Make written requisitions for materials needed</td>
<td>Sketch, Description, Logic, Terminology, Usage</td>
</tr>
<tr>
<td>Listening</td>
<td>Follow oral instructions</td>
<td>Discriminate facts, Logic, Concentration, Note taking</td>
</tr>
<tr>
<td>Viewing</td>
<td>Appraise work</td>
<td>Visual analysis, Logic, Discrimination, Detail, Recognition of symbols, Codes, etc</td>
</tr>
<tr>
<td>Touching</td>
<td></td>
<td>Size, Shape, Temperature</td>
</tr>
</tbody>
</table>
### IV-B MIG WELD CARBON STEELS

**TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON**

- MIG Welding Equipment
- Inert-Gas Supply
- Flow meter Regulator
- MIG Torch Assembly
- Filler Wire Supply
- Standard tools as required

**PERFORMANCE KNOWLEDGE**

- Determine joint design
- Select wire size
- Determine weld position
- Adjust inert gas flow
- Adjust wire feed and current control
- Adjust Voltage
- Set-up work, complete weld according to proper procedure

**SAFETY – HAZARD**

Refer to Index under Safe Practice.

**DECISIONS**

- Determine joint design
- Select wire size
- Determine welding position
- Adjust gas flow
- Wire feed and current control
- Adjust voltage
- Appraise finished weld by visual inspection

**CUES**

- Job requirements, specifications
- Current requirements
- Ease of application
- Proper shielding
- Amount needed for operation
- Smooth Arc
- Appearance, uniformity bend, penetration

**ERRORS**

- Will not meet job specifications
- Poor Arc characteristics
- Poor weld quality
- Poor weld quality
- Poor weld quality
- Poor Arc characteristics
- Porosity, penetration too great or too little
### IV-B MIG WELD CARBON STEELS

#### SCIENCE

- Simple machines used to gain mechanical advantage—[use of standard tools]
- Work input, work output, friction and efficiency in simple machines
- Effect of heating and cooling on expansion of materials—[control distortion]
- Transfer of heat from one body to another—[water cooled torch]
- Arrangement of molecules, atoms and ions and the effect on structure and strength of materials
- [Physical characteristics of inert gases and their functions]

#### MATH – NUMBER SYSTEMS

- Set of Real Numbers
- Positive Rationals
- Fundamental Operations (Calculation)
- Addition algorithm
- Subtraction algorithm
- Multiplication algorithm
- Division algorithm
- Order of operations, i.e., use of parentheses in simplifying arithmetic expressions

#### COMMUNICATIONS

### PERFORMANCE MODES

- Speaking
- Reading
- Writing
- Listening
- Viewing
- Touching

### EXAMPLES

- Make oral requisitions for materials
- Interpret blueprint and written specifications
- Make written requisitions for materials needed
- Follow oral instructions
- Appraise work

### SKILLS/CONCEPTS

- Terminology, Logic, Gesture, Usage
- Comprehension, Detail, Proposals, Description, Terminology, Instruction
- Sketch, Description, Logic, Terminology, Usage
- Discriminate facts, Logic, Concentration, Note taking
- Visual analysis, Logic, Discrimination, Detail, Recognition of symbols, Codes, etc
- Size, Shape, Temperature
### IV-C MIG WELD PIPE

#### TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON
- MIG Welding equipment:
  - Inert gas supply
  - Filler wire
  - Aligning fixture
  - S. T as required
  - Pipe

#### PERFORMANCE KNOWLEDGE
- Determine joint design
- Determine alignment procedure
- Select wire size and type
- Determine position
- Adjust voltage setting
- Set wire feed speed
- Select gas flow
- Complete weld according to proper procedure and specifications

#### SAFETY – HAZARD
Refer to Index under Safe Practice: XVIII Electric Arc Welding – [Items 1 thru 28]

#### DECISIONS
- Determine joint design
- Determine alignment procedure
- Select wire size and type
- Determine position
- Adjust voltage setting
- Set wire feed speed
- Set gas flow
- Appraise finished work

#### CUES
- Job requirement — specification
- Job requirement and procedure
- Job requirement — base metal
- More efficient — ease of application
- Job requirement
- Current requirement — bead size
- Job requirement — specification
- Visual evaluation — specifications

#### ERRORS
- Lack of fusion and penetration
- Misalignment of weldment
- Poor quality
- Poor quality
- Lack of fusion, poor appearance
- Appearance: contamination
### Science
- Simple machines used to gain mechanical advantage - [use of standard tools]
- Effect of heating and cooling on expansion of materials
  - [change in material size]
- Magnetic fields of force - [effects electric Arc characteristics]
- Transfer of energy from one form to another - [electrical energy to heat]
- Transfer of heat from one body to another - [effect on adjacent areas]
- Resistance of materials to flow of electrical current - [cable size, wire size]
- Arrangement of molecules, atoms and ions and the effect on structure and strength of materials - [weld]

### Math - Number Systems
- Set of Real Numbers - Positive Rational
- Fundamental Operations (Calculation)
  - Addition algorithm
  - Subtraction algorithm
  - Multiplication algorithm
  - Division algorithm
- Order of Operations, i.e., use of parentheses in simplifying arithmetic expressions.
- Basic Measurements Skills and Concepts
  - Instruments - [Basic Measurement]
  - Measurement: Geometric
    - Angle
    - Measurement, Non-geometrical
    - Temperature
  - Reading and interpreting tables, charts, and graphs
- Basic Geometry Skills and Concepts
  - Knowledge of geometric relationships
    - Parallel
    - Perpendicular
  - Determination of area and circumference of circles
  - Determination of area and perimeter of an ellipse
  - Determination of facts involving lines tangent to circles

### Communications
#### Performance Modes
- Speaking
- Reading
- Writing
- Listening
- Viewing
- Touching

#### Examples
- Make oral requisitions for material
- Measure and lay-out pipe according to blueprint or sketch
- Interpret blueprint and written specifications
- Make written requisitions for materials needed
- Follow oral instructions
- Appraise work

#### Skills/Concepts
- Terminology, Logic, Gesture, Usage
- Comprehension, Detail, Proposals, Description, Terminology, Instruction
- Sketch, Description, Logic, Terminology, Usage
- Discriminate facts, Logic, Concentration, Note taking
- Visual analysis, Logic, Discrimination, Detail, Recognition of symbols, Codes, etc.
- Size, Shape, Temperature
### TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON
- MIG Welding equipment
- Inert gas supply
- Filler wire
- S. T. as required
- Aluminum material
- Flow Meter Regulator

### PERFORMANCE KNOWLEDGE
- Determine joint design
- Determine preparations needed
- Determine weld position
- Adjust gas flow
- Adjust wire feed and current control
- Adjust voltage
- Select wire size and type
- Complete weld according to proper procedure
- Determine preheat needed

### SAFETY – HAZARD
Refer to Index under Safe Practice.

### DECISIONS
- Determine joint design
- Necessary cleaning
- Position necessary
- Set as flow
- Set wire feed and current
- Set voltage
- Select wire size and type
- Appraise finished work
- Preheat to specified temperature

### CUES
- Job requirements, Specification
- Condition of Metal
- Ease of application
- Job requirement
- Job requirement
- Job requirement
- Thickness and type of base metal
- Appraise weld visual and specifications
- Job requirement, specifications

### ERRORS
- Not same as specifications
- Porosity in weld
- Poor appearance
- Porosity, poor quality
- Poor fusion, appearance
- Poor Arc characteristics
- Wrong physical characteristics
- Poor fusion, appearance
### SCIENCE

- Simple machines used to gain mechanical advantage—[use of standard tools]
- Work input, work output, friction and efficiency in simple machines
- Magnetic fields of force—[effects electric arc characteristics]
- Transfer of energy from one form to another—[Electrical energy to heat]
- Arrangement of molecules, atoms and ions and the effect on structure and strength of materials—[strength of weld and material]
- Weldable and non-weldable aluminum alloys, tempers

### MATH – NUMBER SYSTEMS

- Set of Real Numbers
- Positive Rationals
- Fundamental Operations (Calculation)
- Addition algorithm
- Subtraction algorithm
- Multiplication algorithm
- Division algorithm
- Order of operations, i.e., Use of parentheses in simplifying arithmetic expressions.

### COMMUNICATIONS

#### PERFORMANCE MODES

- Speaking
- Reading
- Writing
- Listening
- Viewing
- Touching

#### EXAMPLES

- Make oral requisition for materials
- Interpret blueprint and written specifications
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#### SKILLS/CONCEPTS

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- Visual analysis, Logic, Discrimination, Detail, Recognition of symbols, Codes, etc.
- Size, Shape, Temperature
ABBREVIATIONS

Acetyl—Acetylene
M.S.---Mild steel
Oxy—Oxygen
S.T.---Standard tools:

center punch                hammer-ballpeen
clamps                      marking crayon
cold chisel                 pliers-combination
combination square          pliers-vise grips
compass                     protracters
dividers                    screwdriver
files                       scribe
hacksaw                     steel rules
hammer-chipping             tape measure
Some type of eye protection should be worn for all operations where open flame and/or arc welding is being performed, both by the operator and those who may be required to be close by. The oxy-acetylene, flame and molten puddle, has a high temperature and concentration, emits a large quantity of ultra-violet and infra-red rays which are injurious to the eyes and skin. Special lenses in goggles and face shields of a green or amber shade filter out most of these harmful rays while allowing the green, orange and yellow rays to pass through. These lenses come in shades numbered from one to twelve. Two factors must be considered when determining the numbered lens shade to be used for best visibility of puddle detail with the least amount of eye strain and skin burn or injury. First, the intensity of the flame or arc; second, the size of the pool of molten metal. The following is a list of recommended lens shades to be used for different operations:

<table>
<thead>
<tr>
<th>OPERATIONS</th>
<th>LENS SHADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soft soldering and light brazing</td>
<td>No. 1-3</td>
</tr>
<tr>
<td>For heavy silver-brazing, bronze welding and brazing; and welding of light gauge metal with open flame (oxy-acet)</td>
<td>No. 4</td>
</tr>
<tr>
<td>For medium welding, heavy brazing with oxy-acet</td>
<td>No. 5</td>
</tr>
<tr>
<td>For heavy welding and burning with oxy-acet</td>
<td>No. 6</td>
</tr>
<tr>
<td>For very light Tig welding (up to 10 Amp) and for short periods of time (one to five min.)</td>
<td>No. 8</td>
</tr>
<tr>
<td>For medium Tig welding (10-100 Amp) and light arc welding (stick electrode)</td>
<td>No. 9</td>
</tr>
<tr>
<td>For heavy Tig welding and medium arc welding (up to 200 amps)</td>
<td>No. 10</td>
</tr>
<tr>
<td>For amp exceeding 200</td>
<td>No. 11-12</td>
</tr>
</tbody>
</table>

These are, of course, all recommended uses. A good rule to follow is to use as dark a lens as possible with maximum visibility and a minimum of discomfort for the operator.
INDEX
SAFE PRACTICES
IN WELDING

I. Introduction:
Safety is a major objective in every welding shop. It is the most important attitude a operator must learn in becoming a proficient tradesman. Therefore the goal of these safety policies is to provide a strong safety program for the benefit of all involved.

II. General Safety Precautions:
1. Walk—do not run in shop areas.
2. Remember horseplay has no place in the shop.
3. Work with tools, machines and equipment only after having received proper instruction.
4. Get help for lifting heavy or awkward objects.
5. Wear approved eye protection at all times.
6. Report any and all injuries immediately.
7. Never throw objects in shop area, distraction and injury can result.
8. Be careful of long hair around moving parts of machinery.
9. Be considerate for safety of others.

III. Safety Precautions for Metal Saws.
1. When turning on power, stand to one side of saw frame, and adjust speed to suit work.
2. Mount work only when saw is stopped.
3. Support protruding end of work or material being cut so end will not fall and cause possible injury to anyone.
4. Be sure that the blade is in good condition before using.
5. If blade breaks in work, shut off power and do not attempt to disengage blade from work until the machine has come to a stop.

IV. Safety Precautions for Drill Press
1. Use drills that are properly sharpened and that run true.
2. Chuck wrenches must be removed from drill chucks before starting the machine.
3. Never attempt to hold work under the drill by hand. Always clamp work to table.
4. Change belt for speeds only when power is “Off.”
5. Run drills at proper speed. Forcing or feeding too fast may result in broken or splintered drills and serious injuries.
6. Keep your head back and well away from any moving part of the drill press.

V. Safety Precautions on Grinders—Pedestal Type:
1. Stand to one side out of line of wheel when starting it up, especially if wheel is new.
2. The face of the wheel must be flat and free from grooves.
3. Make sure the tool rest is only one-eighth inch from the face of the wheel. Check this distance, too much clearance may cause the job to jam the wheel and break it.
4. Do not set tool rest while machine is in motion.
5. Work should be fed slowly and gradually. Using too much pressure or striking wheel suddenly, may cause it to break.
6. Hold job against wheel firmly so that it will not slip out of the hand and cause hands and fingers to come in contact with wheel.
7. Use clamp or other suitable holding devices for grinding short pieces.
8. Stop wheel if it chatters or vibrates excessively. This may be a danger signal that the wheel is not properly balanced or not attached securely to spindle.
9. Always use face shield or goggles even if grinder is provided with protective glass shields.

VI. Safety Precaution on Sheet Metal Brake
1. Keep fingers clear of the mouth of the machine when closing down on the metal.
2. Use care when inserting or removing sharp edged sheets.
3. Make sure counterweight bars do not strike others while working.
4. Get assistance when bending large thick material to avoid backstrain.
5. Keep fingers out of pinch area as the metal is bent, especially on maximum capacity bends.

VIII. Safety Precautions on Shears and Punch
1. Fingers must be kept out of the cutting or punching area.
2. Keep your attention on the job; avoid distractions while working.
3. Always use properly installed guards.
4. The shear and punch will be operated normally by one person only.

IX. Safety Precautions on Squaring Shear
1. Keep fingers clear of the blade and never under the hold down bar.
2. Never reach behind the shear to support metal. This places you in an awkward position, subject to a fall and puts fingers in a blind area.
3. To avoid crushing toes, keep feet clear of the pedal.
4. Use care in handling sheared razor sharp metal.
5. Never cut excessively small pieces on a shear; use hand snips.
6. The shear is a one man machine; use accordingly.
7. In leaning forward as blade is depressed, people tend to keep balance by grasping the top of the large outer-casting. After the blade has descended, it is possible to insert a finger inadvertently into the slide, as the blade returns, a very serious crush can result.

X. Safety Precautions for Hand Tools

Hand Tools, General:
1. Clamp work securely in vises, but do not hammer on vise handles.
2. Remove filings and chips from benches with a brush, not the hands.
3. Do not allow work to project from vise or bench and cause obstructions.
4. Use the correct size wrench for the job.
5. When using cutting tools, direct the cutting action away from you.
6. Mushroom heads on chisels, punches, etc., should be eliminated continuously.
7. Avoid carrying tools in pockets. Screwdrivers, etc. can injure you if you fall.
8. Inspect hand tools before using.
9. When using tin snips or other similar tools, avoid letting flesh come between the
   handles. Pinches and blisters generally result.
10. When using a chipping hammer, chip toward wall or shield to protect others from
   flying chips.

XI. **Screw Drivers**
   1. Select screw drivers to fit screw head being used.
   2. Keep screw driver handle smooth.
   3. Do not use a hammer on a screwdriver handle.
   4. Avoid holding work in the hand when using a screwdriver on it, as it may slip and
      cause stab wounds.
   5. Never grind a screwdriver to a chisel edge.

XII. **Wrenches**
   1. Discard wrenches that are spread.
   2. Select open-end wrenches to fit the job.
   3. When possible, avoid using an adjustable or monkey wrench.
   4. If a wrench has been burred, grind off the rough spots to avoid cutting the hands.
   5. It is generally safer to pull wrench toward yourself than to push it away from you.
   6. Be sure that your knuckles will clear obstructions when the wrench turns.

XIII. **Hammers:**
   1. Hammers that are chipped should be discarded.
   2. Never use a hammer that has a loose or split handle.

XIV. **Chisels:**
   1. In using a chisel and hammer, keep the chisel head free from burring by grinding it if
      necessary.
   2. Where chips may fly, use a shield to protect others.
   3. Hold the chisel and hammer firmly.
   4. Do not use a chisel with a mushroomed head.

XV. **Files:**
   1. Always use a file with a handle.
   2. Never use a file as a pry bar.
   3. Keep firm grip on file at all times.
   4. Do not blow filings so that they can go into anyone's eyes.
   5. Make sure the work to be filed is securely mounted.

XVI. **Pliers:**
   1. When using pliers, keep hands clear of the pinch area. This may be at the rear of the
      bolt as well as ahead.
   2. Place hands over short wire pieces, cotter pins or other small items being cut. Such
      items tend to fly and may cause eye injury.
   3. Remove any burrs caused by pliers which can cause injury.

XVII. **Hacksaws:**
   1. Use the correct blade for the job.
2. See that blade is securely fixed in the frame.
3. When the saw breaks through work, ease up on the pressure so that the hand will not strike the work or vise.

XVIII. **Electric Arc Welding**
1. Avoid looking at the arc or flash unless equipped with appropriate dark glasses.
2. Helmets and welding goggles must be free of cracks or holes permitting penetration of intense light.
3. Wear protective clothing to help protect the skin from intense rays.
4. Always wear gloves. Leather gauntlet type that can be thrown off are recommended.
5. Where necessary, wear leather aprons, arm coverings or other protection to protect from molten metal or hot sparks.
6. Where a helper is used, he must be protected the same as the welder.
7. Wear high type shoes rather than undercut shoes.
8. Always wear eye protection when chipping. Never chip if there is a possibility someone nearby without glasses will be struck by flying chips.
9. Keep sleeves and pants cuffs rolled down and collar buttoned up.
10. Never touch a piece of metal in the welding area if uncertain about the temperature.
11. Mark hot metal to read “HOT.”
12. Do not handle excessively hot metal with gloves unless cool area beyond hot spot permits safe handling.
13. Exercise good judgement in selecting welding jobs. Automotive work is especially hazardous due to fuel tank, fuel line, hydraulic lines, flammable upholstery, etc.
14. Special metals require the use of respirators to protect welders from harmful fumes. Adequate ventilation is always desirable, especially when welding galvanized materials.
15. Toxic gas, phosgene, is formed when the ultra-violet rays of an electric arc come in contact with chlorinated degreasing solvents. Metal cleaned with carbon tetrachloride and trichlorethylene should not be welded until thoroughly dried.
16. Never strike an arc on compressed air cylinders.
17. Work in dry area.
18. Do not get wound up in your work! Keep cables free from your body so you can move freely, especially should your clothing ignite or some other such accident occur.
19. Ground work before turning on welder.
20. Do not change polarity or connections while a welder is being used.
21. Keep floor free of electrodes once you begin to weld. They could cause a slip or fall.
22. Place stubs in metal container.
23. Never tack weld without a helmet.
24. Keep clamps and other tools off the floor and put away. They can cause a fall.
25. Keep clamps and other tools off the floor and put away. They can cause a fall.
26. Replace the cables by coiling them to eliminate tripping hazards.

XIX. **Oxy-Acetylene Welding**
1. Before attaching a regulator to a cylinder valve, “crack” the valve to blow out dust and dirt.
2. Do not use oil on the torch, blow pipe, valves, regulators, or any other portion of the equipment.
3. Check for leaks whenever you change tanks or suspect a leak.
4. Leaks around equipment should be checked with soapy water, never a flame.
5. Should you suspect a leak in any equipment, stop until repairs are made.
6. Avoid the use of pliers on apparatus. Use torch wrench and turn right for oxygen connections and left for gas or acetylene connections.
8. Open cylinder valves gradually.
9. Open the oxygen valves wide to prevent leakage.
10. Open acetylene cylinder valve one-eighth to one-quarter turn.
11. Keep wrench on acetylene cylinder valve while in use so it can be shut off quickly if necessary.
12. Under no circumstances will acetylene pressure exceed 15 pounds. If used in excess of this amount, an explosion may result.
13. Make sure connections are tight when you change tips or other apparatus. Do not overtighten.
14. Do not use oxygen to blow dirt off your clothes.
15. Use correct type eye protection for all operations.
16. Keep your welding equipment in good, clean, dry condition.
17. Use ventilating system or means of ventilation provided.
18. Keep welding area neat, clean, and dry.
19. Make certain the fire extinguisher is in place and that you know how to use it.
20. Do not permit autos or equipment to run over the hoses. Protect them from sharp objects, kinks, etc.
21. Keep the hose out of the way so it does not become a tripping hazard.
22. Make sure you do not drag the hose over hot metal scrap when cutting.
23. Use flint spark lighters, never matches or cigarette lighters.
24. Purge oxygen and acetylene line before lighting torch.
25. Use special care when cutting so hot pieces do not fall or tumble onto feet. Do not stand with feet so close to the cutting that they are subject to intense heat, sparks, and molten metal.
26. Never lay down or hand up a lighted torch or blowpipe and leave welding station.
27. Hot metal should be marked “HOT” with chalk or soap stone.
28. Adjusting screws on regulators should always be released when not in use. Turn the screw out counter clockwise.
29. Never allow a cylinder to fall. They are under high pressure internally and can explode if ruptured by a sudden shock. Always secure cylinder to a stationary object.
30. Never use oxygen or acetylene directly from tanks without the use of regulators.
31. Cylinders should not come in contact with electric wires.
32. Never tamper with the fusible safety plugs.
33. Acetylene piping, hoses and fittings should be color coded “Red.”
34. Never “crack” a cylinder in the vicinity of an open flame or fire source.
35. Keep protective cylinder valve covers secured on cylinders when not in use.