TYPICAL WELDING SKILL TRAINING CURRICULUM & TYPICAL TECHNICAL TRAINING

1.0 TRAINING OBJECTIVE

To instruct welding techniques and manipulative skills required for each major welding process. Welding technique is stressed above welding theory or technology, thereby allowing a significant majority of the student's time to be devoted to supervised welding practice.

Section A: Typical Welding Skill Training Curriculum

Section B: Typical Technical Training Curriculum

2.0 COURSE AVAILABILITY

The following courses were available at this writing. Additional courses may be developed as warranted or requested.

A. Oxy-Fuel Welding and Cutting (OFW/C)
B. Gas Tungsten Arc Welding – Basic (GTAW)
C. Gas Tungsten Arc Welding: Pipe (GTAW-P)
D. Gas Tungsten Arc Welding – Aluminum (GTAW-AL)
E. Gas Tungsten Arc Welding: Stainless Steel (GTAW-SS)
F. Gas Tungsten Arc Welding for Nuclear Applications (GTAW-N)
G. Plasma Arc Welding and Cutting (PAW/C)
H. Gas Metal Arc Welding: Basic (GMAW-B)
I. Gas Metal Arc Welding – Short Circuiting Method (GMAW-SC)
J. Gas Metal Arc Welding – Spray Method (GMAW-SP)
K. Gas Metal Arc Welding – Pipe & Tube (GMAW-P)
L. Gas Metal Arc Welding -- Aluminum (GMAW-AL)
M. Flux Core Arc Welding – (FCAW)
N. Shielded Metal Arc Welding -- Basic (SMAW)
O. Shielded Metal Arc Welding -- Pipe Uphill (SMAW-UP)
P. Shielded Metal Arc Welding – Pipe Downhill (SMAW-DN)
Q. Torch Brazing (TB)

SECTION A: TYPICAL WELDING SKILL TRAINING CURRICULUM

3.0 COURSE OUTLINES

3.1 Oxy-Fuel Welding and Cutting (OFW/C) (2 Weeks: 48 Hours)

A. **Skills Description:** Upon completion, the student should be able to perform the industrial requirements of oxyacetylene welding and flame cutting associated with maintenance welding and cutting of sheet steel and small diameter pipe.

B. **Prerequisite:** None

C. **Course Objective:** To enable the student to produce quality fillet and groove welds on carbon steel plate, and produce quality cuts on carbon steels by hand or machine.

D. **Course Content:** Provides the student with a thorough technical understanding of oxyacetylene welding and cutting, as well as safety practices. Provides training to develop the manual skill necessary to produce quality mild steel fillet and square groove welds, in all positions. Skill is developed in the areas of flame cutting of mild steel plate. Related information is included on weld quality and applications of alternate fuel gases not used in this course.

E. **Testing:** Proficiency Tests include written quizzes on course content and modified AWS guided bend tests in three positions: Flat (1G), Vertical (3G), and Overhead (4G) – (Fillet welds in these positions may also demonstrated) as well as a flame cutting proficiency test.

3.2 Gas Tungsten Arc Welding Basic (GTAW-B) (64 Hours)

A. **Skills Description:** Upon completion of this course, the student is expected to be able to perform production and maintenance welding on mild steel, using the GTAW process.

B. **Prerequisite:** The student must have successfully completed the Oxy-Fuel Welding and Cutting (OFW/C) course, or if the student has not completed the above course, skill must be demonstrated by successfully passing a visual and guided bend test of a groove weld on 3/16 in. carbon steel plate in the Flat position, using the OFW process.

C. **Course Objective:** To enable the student to produce quality fillet and groove welds on carbon steel plate in the Flat (1G), Vertical (3G), and Overhead (4G), using the GTAW process. (Fillet welds in these positions may also be required to be demonstrated). The quality of welds is inspected in accordance with the ASME Section IX requirements. This course also prepares the student for welding in accordance AWS requirements.

D. **Course Content:** This course provides the student with a thorough technical understanding of gas tungsten arc welding, arc characteristics and welding safety. It provides training to develop the skill necessary to make quality gas tungsten arc welds on 16 and 11 gauge mild steel, and to introduce the students to the oscillating cup technique, using direct current. In addition, material is presented on the weld characteristics of carbon steel. Information on pulsed current is included to prepare the student for more detailed applications of pulsed current used in gas tungsten arc welding of pipe.

E. **Testing:** Tests include two written quizzes on welding and one ASME Section IX guided bend test in the Flat (1G), Vertical (3G), and Overhead (4G), positions on mild steel.

3.3 Gas Tungsten Arc Welding – Pipe and Tube (GTAW-P) (64 Hours)

A. **Skills Description:** Upon completion of the course, the student should have developed skills for process and pressure piping work as well as for the welding of cryogenic vessels.

B. **Prerequisites:** The student must have successfully completed the Gas Tungsten Arc Welding (GTAW) course, or in lieu thereof must be demonstrate skill by successfully passing a visual and guided bend test of a groove weld on 3/16 in. carbon steel plate in the vertical (3G) position, using the GTAW process.

C. **Course Objective:** To be able to produce quality single vee groove welds on 2 in. (50 mm) diameter Schedule 40 or larger in steel pipe in all positions. Quality is determined through visual inspection and mechanical testing according to ASME Section IX requirements.

D. **Course Content:** This course provides the student with a thorough technical understanding of gas tungsten arc welding (GTAW), preparation for welding pipe and develops the skills necessary to produce quality groove welds on 2 in. OD and over, Schedule 40 carbon steel pipe in the Horizontal (2G) and Vertical/Overhead (5G), or Inclined (6G) positions. It also provides training to weld Schedule 10 carbon steel pipe in all positions, as time permits.

E. **Testing:** Tests include one written quiz on welding, plus a visual and ASME Section IX guided bend test in the Horizontal (2G) and Vertical/Overhead (5G), or Inclined (6G) positions.

3.4 Gas Tungsten Arc Welding, Nuclear Applications: (GTAW-N) (96 Hours)

A. **Skills Description:** Upon completion of the course, the student will have developed uphill pipe welding techniques and skills for pressure and nuclear pipe welding applications. This process is also used for all utility work and nuclear vessels.

B. **Prerequisites:** The student must have successfully passed the Gas Tungsten Arc Welding course and Shielded Metal Arc Welding Pipe (uphill) course, or in lieu thereof must be demonstrate skill by successfully passing a visual and guided bend test of groove welds on 2 in. OD and over, Schedule 40 carbon steel pipe in the Horizontal (2G) and Vertical/Overhead (5G), or Inclined (6G) positions. using the GTAW process, and pass a visual inspection on a Schedule 60 carbon steel pipe welded in the Horizontal (2G) and Vertical/Overhead (5G) position, with backing rings, using the SMAW process with EXX18 low hydrogen electrodes.

C. **Course Objective:** To enable the student to produce quality single vee groove welds on carbon steel pipe in all welding positions using a combination GTAW and SMAW process. Quality is determined through visual inspection and mechanical testing in accordance with ASME Section IX requirements.

D. **Course Content:** This course provides the student with a thorough technical understanding of joint designs, programmable gas tungsten arc welding equipment and methods of welding carbon and stainless steel pipe.

E. **Testing:** To be determined.

3.5 Plasma Arc Welding and Cutting (PAW/C) (48 Hours)

A. **Skills Description:** Upon completion, the student should be able to effectively use the Plasma Arc Welding and Cutting processes for production and maintenance work.

B. **Prerequisites:** The one week Plasma Arc Welding and Cutting (PAW/C) course is open to only those who have completed the Gas Tungsten Arc Welding (GTAW) course.

C. **Course Objective:** The courses specifically provides the student with the knowledge and skill to set-up and adjust equipment, and to properly manipulate the plasma torch.

D. **Course Content:** This course provides training to develop the skills necessary to produce

E. Quality welds on aluminum, carbon and stainless steel plate up to 1/8 in. thick in the Flat (1G) and Horizontal (2G) positions. The course also provides training for plasma cutting of these materials.

F. **Testing:** Test includes visual inspections of welds on aluminum and stainless steel in the Horizontal (2G) and Vertical (3GUP) positions.

3.6 Gas Metal Arc Welding – Short Circuiting Transfer (GMAW-SC) (48 Hours)

A. **Skills Description:** Upon completion of this course, the student will be able to perform production and maintenance welding on carbon steel plate including high volume transfer fabrication, sheet metal assembly and repair.

B. **Prerequisite:** The student shall have successfully completed the Oxy-Fuel Welding and Cutting (OFW/C) course, or in lieu thereof must be demonstrate skill using the OFW process, to successfully pass a visual and guided bend test of a groove weld on $^{3}/_{16}$ in. carbon steel plate in the Flat (1G) position.

C. **Course Objective:** To enable the student to produce quality multiple pass fillet welds and groove welds on carbon steel plate in all positions, using short circuiting transfer. Quality is determined through visual inspection and mechanical testing in accordance with AWS requirements.

D. **Course Content:** This course is designed to provide the student with a thorough technical understanding of welding safety, gas metal arc welding, gas metal arc equipment adjustments, metal transfer techniques and shielding gases. It also provides training to develop the skill necessary to make quality gas metal arc welds in all positions on carbon steel from 1/16 in. sheet to 3/8 in. plate, single pass and multiple pass, using the gas metal arc short circuit transfer (GMAW-SC) process. The course also illustrates problems associated with various welding conditions and other useful information.

E. **Testing:** Tests include two written quizzes on welding, and a visual and AWS guided bend test in the Horizontal (2G) and Vertical (3GDN progression down) positions.

3.7 Gas Metal Arc Welding – Spray Transfer (GMAW-SP) (1 Week: 40 Hours)

A. **Skills Description:** Upon completion of this course, the student will be able to perform structural welding related to buildings and bridges and production welding on medium to heavy assemblies using spray transfer with the GMAW-SP process.

B. **Prerequisite:** The student must have successfully completed the Oxy-Fuel Welding and Cutting (OFW/C) course, or in lieu thereof must demonstrate skill by successfully passing a visual and guided bend test of a groove weld, using the OFW process, on 3/16 in. carbon steel plate in the Flat (1G) position.

C. **Course Objectives:** To develop the ability to produce quality fillet and groove welds on carbon steel in the flat and horizontal positions using spray and globular metal transfers.

D. **Course Content:** This course provides training on metal spray and globular transfer. . The spray and globular transfers provide for high deposition rates, which limit their use to flat (1G) and horizontal (2G) position welding.

E. **Testing:** Tests include one visual guided side bend test and one visual cut and etch test. Spray and globular transfers will be used.

3.8 Gas Metal Arc Welding: Pipe (GMAW) (2 Weeks: 70 Hours)

A. **Skills Description:** Upon completion of this course, the student should be able to perform service and transmission pipeline related work.

B. **Prerequisite:** The student must have successfully passed one of the Gas Metal Arc Welding (GMAW) courses, GMAW-SC or GMAW-SP, or in lieu thereof pass a 3/8 in. plate open root guided bend test in the horizontal (2G) and vertical (3G down positions) using the GMAW process.

C. **Course Objective:** To provide training to develop the skills necessary to produce quality single vee groove welds on Schedule 40 carbon steel pipe in the 2G, 5G, or 6G fixed positions, using short circuiting arc metal transfer. Welds are inspected in accordance with ASME Section IX requirements.

D. **Course Content:** This course provides the student with a thorough technical understanding of gas metal arc welding and preparation for welding pipe including pipe welding defects and repair techniques.

E. **Testing:** Tests include two written quizzes on welding and two practical tests on pipe welded in the 5G and 6G positions. The tests include visual examination and guided bend tests.

3.9 Gas Metal Arc Welding: Aluminum (GMAW-AL) (1 Week: 40 Hours)

A. **Skills Description:** Upon completion of this course, the student will be able to perform production and maintenance welding on nonferrous metals using the gas metal arc (GMAW) process.

B. **Prerequisite:** The student must have successfully completed the Oxy-Fuel Welding and Cutting (OFW/C) course, or in lieu thereof must demonstrate skill by successfully passing a visual and guided bend test of a groove weld on 3/16 in. carbon steel plate in the Flat (1G) position, using the OFW process.

C. **Course Objective:** This course enables the student to produce quality fillet and groove welds on aluminum plate in all positions.

D. **Course Content:** This course is designed to provide training to develop welding skills on 0.125 in. and 0.250 in aluminum plate. Fillet and groove welds are produced in all positions, measured by visual examination and mechanical tests.

E. **Testing:** Tests include one visual and single-Vee groove weld and guided bend test on 3/8 plate in the vertical (3G) progression up, position.

3.10 Flux Core Arc Welding (FCAW) (2 Weeks: 70 Hours)

A. **Skills Description:** Upon completion of this course, the student will be able to perform structural welding related to buildings and bridges and production work related to heavy equipment manufacturing using the gas metal arc welding: flux core (GMAW-FC) process.

B. **Prerequisite:** The student must have successfully completed the Oxy-Fuel Welding and Cutting (OFW/C) course, or in lieu thereof, must be demonstrate skill by successfully passing a visual and guided bend test of a groove weld on 3/16 in. on carbon steel plate in the Flat (1G) position, using the OFW process.

C. **Course Objective:** This course enables the student to produce quality fillet and groove welds on carbon steel plate using small diameter electrode wires, large diameter gas shielded electrode wires and large diameter self-shielded electrode wires.

D. **Course Content:** This course is designed to provide training to develop welding skills on carbon steel plate using small diameter and large diameter flux-cored electrodes (with and without shielding gas) in all positions on fillet and groove welds.

E. **Testing:** Tests include two quizzes plus a visual inspection and guided bend tests on groove welds in the vertical (3G) and overhead (4G) positions using small diameter wire. Also a visual and guided bend test on a horizontal (2G) groove weld using large diameter wire with shielding gas; and a visual and guided bend test on a horizontal (2G) groove weld using large diameter wire with no shielding gas.

3.11 Shielded Metal Arc Welding: Basic (SMAW) (4 Weeks: 96 Hours)

A. **Skills Description:** Upon completion, the student will be able to perform production welding, millwright work, general maintenance or construction, bridge code welds and other related structural work, as well as preparation for pipe welding using the SMAW process.

B. **Prerequisite:** The student must have successfully completed the Oxy-Fuel Welding and Cutting (OFW/C) course, or in lieu thereof, must demonstrate skill by successfully passing a visual and guided bend test of a groove weld on 3/16 in. carbon steel plate in the Flat (1G) position, using the OFW process.

C. **Course Objective:** To enable the student to produce quality multi-pass fillet welds and groove welds in all positions using E6010 and E7018 electrodes. This course also develops skills to perform welds in accordance with AWS, ASME and other related codes.

D. **Course Content:** This course provides the student with a thorough technical understanding of arc welding, welding safety, arc welding power sources, electrode classifications and selection. It also provides training to develop the skills necessary to make quality SMAW welds in all positions on mild steel from 3/16 in. to 1 in. (5 mm to 25 mm) plate, single pass and multiple pass, using mild steel electrodes, low hydrogen electrodes, and iron powder electrodes, using both AC and DC welding current.

E. **Testing:** Tests include two written quizzes on welding, a visual and groove weld bend test in the vertical and overhead positions using E6010 and E7018 electrodes.

3.12 Shielded Metal Arc Welding: Pipe Uphill (SMAW-UP) (4 Weeks: 96 Hours)

A. **Skills Description:** Upon completion of the course, the student will have developed skills for process and pressure piping work as well as for the welding of vessels in the (5G) uphill progression and techniques.

B. **Prerequisite:** The student must have successfully passed the SMAW Basic course, or in lieu thereof must be demonstrate skill by successfully completing the following tests:

- a visual and fillet weld AWS break test in the horizontal (2G) position using E6010 electrode;
- a fillet weld visual test in the vertical (3G) up position using E7018 electrodes.
- a visual and AWS guided bend test on a groove weld in the vertical (3G) position using E6010 and E7018 electrodes;
- a visual test on a fillet weld lap joint in the overhead (4F) position using E6010 and E7018 electrodes.

C. **Course Objective:** To enable the student to produce quality, multi-pass groove welds with and without backing on carbon steel pipe in all positions using E610 & E7018 electrodes and to produce open root single vee groove welds on carbon steel pipe in all positions using E6010 & E7018 using uphill progression. The quality of welds will be in accordance with the AWS D1.1 and ASME requirements. This course also develops skills necessary for welding to ASME Section IX requirements.

D. **Course Content:** This course provides the student training to develop skills necessary to produce quality multi-pass groove welds with backing on pipe in all positions. The student will also be able to produce quality open root single vee groove welds in all positions. In addition, welding related information is included about procedure and welder qualification on destructive and nondestructive testing methods.

E. **Testing:** Tests include four quizzes on welding and a groove weld visual inspection and guided bend test on single vee groove welds on carbon steel pipe with and without backing in the 2G, 5G & 6G positions.

3.13 Shielded Metal Arc Welding: Pipe Downhill (SMAW-DW) (4 Weeks: 96 Hours)

A. **Skills Description:** Upon completion of the course, the student will have developed skills for process and pressure piping work as well as for the welding of natural gas piping using 5GDN (downhill progression) and techniques.

B. **Prerequisite:** The student must have successfully passed the SMAW Basic course, or, if the student has not completed this course, skill must be determined by successfully completing the following tests:

- a visual and fillet weld AWS break test in the horizontal position (E6010)
- a fillet weld visual test in the vertical up position (E7018)
- a visual and AWS guided bend test on a groove weld in the vertical (5G) position using E6010 and E7018 electrodes
- a visual test on a fillet weld lap joint in the overhead position using E6010 and E7018 electrodes.

C. **Course Objective:** To produce quality, multi-pass groove welds with or without backing in pipe in all positions using E6010 electrodes. To produce open root single vee groove welds on pipe in all positions (2G & 5GDN: downhill progression) using E6010 electrodes. The quality of welds is in accordance with the API-1104 and ASME requirements. This course specifically develops skills for API –1104 including branch connections, but may also be applied to the root pass on process piping welds in accordance with ANSI/ASME welding procedures.

D. **Course Content:** This course provides training to develop skills necessary to produce quality multi-pass groove welds with or without backing on pipe in all positions. The student will also be able to produce quality open root single vee groove welds in all positions. In addition, welding related information is included about procedures and welder qualification on destructive and nondestructive testing methods.

E. **Testing:** To be determined.

3.14 Oxy/Fuel Torch Brazing (TB) (1 Week: 35 Hours)

A. **Skills Description:** Upon completion of this course, the student will be able to perform basic brazing on light gauge material as well as standard wall copper tubing.

B. **Prerequisite:** None

C. **Course Objective:** To produce quality brazed joints in the Flat Flow (1FF), Horizontal Flow (2HF), and Vertical Flow (3VU) positions.

D. **Course Content:** This course provides the student with a thorough understanding of the torch brazing process including brazing materials, fluxes, torch adjustment, gasses and brazing techniques for performing braze welding on light gauge ferrous and non-ferrous materials.

E. **Testing:** Tests include one written quiz on brazing and two socket joints in copper tube in the Flat Flow (1FF) position and two socket joints in copper in the vertical up flow (3VU) position.

SECTION B: TYPICAL TECHNICAL TRAINING CURRICULUM

4.0 Welding Overview for Engineers, Designers and Drafters (8 Hours)

A. **Skills Description:** Upon completion of this course, the student should have a basic understanding of engineering requirements for welding including, welding definitions, welding symbols, welding processes, inspection methods, and weld acceptance criteria.

B. **Prerequisite:** None

C. **Course Objective:** To provide Engineers and designers with an introduction to welding in order to be more effective in communicating welding requirements on project drawings and specifications.

D. **Course Content:** This course provides the student with a basic introduction and overview of welding definitions, welding symbols, welding processes, inspection methods, and weld acceptance criteria.

E. **Testing:** None

4.1 Welding Inspection for Welders (40 Hours)

A. **Skills Description:** Upon completion of this course, the student should have a basic understanding of requirements for welding including, welding definitions, welding symbols, welding processes, inspection methods, and weld acceptance criteria.

B. **Prerequisite:** None

C. **Course Objective:** To provide welders with an introduction to welding inspection in order to be more effective in producing welds that meet design specifications.

D. **Course Content:** This course provides the student with a basic introduction and overview of welding definitions, welding symbols, welding processes, inspection methods, and weld acceptance criteria.

E. **Testing:** None