



BOILERMAKER

2016

Based on the 2005 Alberta Course Outline
pg. 5 for Program Structure



Preface

This Apprenticeship Curriculum Standard is intended to assist instructional staff in the design and delivery of technical, in-class training in support of the Boilermaker program.

This document contains all the technical training elements required to complete the Boilermaker apprenticeship program and has been developed based on the 2005 Alberta Course Outline. Alberta's Course Outline can be found on the Tradesecrets website (<http://www.tradesecrets.gov.ab.ca>).

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Table of Contents

Preface	1
Acknowledgements.....	2
Essential Skills Profiles.....	4
Nova Scotia Program Structure	5

PROGRAM CONTENT

Entry Level.....	7
Level 1	22
Level 2	33
Level 3	43
Formulas.....	56
Document Evaluation Form	57

Essential Skills Profiles

Human Resources and Skills Development Canada (HRSDC) defines Essential Skills as “The skills needed for work, learning and life. They provide the foundation for learning all other skills and enable people to evolve with their jobs and adapt to workplace change.”

HRSDC has developed Essential Skills profiles which describe how each of the nine Essential Skills is used by workers in an occupation.

These profiles include:

- A brief description of the occupation;
- A list of the most important Essential Skills;
- Examples of tasks that illustrate how each Essential Skill is applied;
- Complexity ratings that indicate the level of difficulty;
- The physical aspects of performing the job and the attitudes that workers feel are needed to do the job well;
- Future trends affecting Essential Skills.

The Essential Skills profiles can be found on the HRSDC website:

<http://www.rhdcc-hrsc.gc.ca/eng/workplaceskills/LES/profiles/profiles.shtml>

The development and improvement of these Essential Skills is inherent throughout the apprenticeship training program as apprentices work towards achieving journeyman status.

Program Structure - Nova Scotia Apprenticeship Program

The courses listed below are required technical training in the Nova Scotia Boilermaker Apprenticeship Program.

Unit Code	Title	Page
Entry Level (6 Weeks)		
Section 1-A	Common Hazards	8
Section 1-B	Proper Use of Safety Equipment	9
Section 1-C	Workers' Compensation Board	10
Section 1-D	Related Knowledge	10
Section 1-E	Emergency First Aid and C.P.R.	10
Section 1-F	Mathematics	11
Section 2-A	Ropes	12
Section 2-B	Lifting Devices	13
Section 2-C	Signals	13
Section 3-A	Tools	14
Section 3-B	Flame Cutting	15
Section 3-C	Electric Arc Welding	17
Section 4-A	Metallurgy	18
Section 4-B	Basic Materials	19
Section 4-C	Trade Related Components	21
Level 1 (6 Weeks)		
Section 1-A	Instruments	23
Section 1-B	Power Tools (Electric and Pneumatic)	23
Section 1-C	Shop Equipment	23
Section 1-D	Metallurgy	24
Section 1-E	Cutting, Welding and Related Processes	25
Section 2-A	Basic Drafting	27
Section 2-B	Identification of Pressure Vessels	28
Section 2-C	Introduction to Layout	29
Section 2-D	Materials Preparation and Assembly	30
Section 2-E	Basic Mathematics	30
Section 3-A	Wire Rope	31
Section 3-B	Block and Tackle	31
Level 2 (6 Weeks)		
Section 1-A	Heat Treatment	34
Section 1-B	Related Knowledge	35
Section 2-A	Wire Rope Drums	36
Section 2-B	Advanced Block and Tackle	36
Section 2-C	Cranes	37
Section 2-D	Hoisting and Jacking Equipment	37
Section 2-E	Scaffolds	38
Section 2-F	Rigging Prints	38
Section 3-A	Mathematics	38
Section 3-B	Drawing Interpretation	39
Section 3-C	Layout and Fabricating	39

Unit Code	Title	Page
Section 3-D	Fibreglass Fitting	40
Level 3 (6 Weeks)		
Section 1-A	Testing of Materials	44
Section 1-B	Inspection	44
Section 2-A	Layout	45
Section 2-B	Fitting	46
Section 3-A	Boilers	47
Section 3-B	Tanks	49
Section 3-C	Condensers and Exchangers	51
Section 3-D	Introduction to Other Heavy Industry	53
BLMR-1830	Program Review (<i>Nova Scotia Specific Unit of Instruction</i>)	55
Nova Scotia Boilermaker Apprenticeship Program: All courses are required.		

Entry Level

NOTE: The hours noted are for guidance and should be adhered to as closely as possible.

ENTRY LEVEL TECHNICAL TRAINING

**BOILERMAKER TRADE
COURSE OUTLINE**

UPON SUCCESSFUL COMPETION FO THIS PROGRAM, THE APPRENTICE SHOULD BE ABLE TO PERFORM THE FOLLOWING OUTCOMES AND OBJECTIVES.

SECTION ONE:GENERAL SAFETY38 HOURS

This section presents information on accident prevention, first aid, the operation of fire fighting equipment and Workplace Hazardous Material Information System (W.H.M.I.S.).

The safety subject matter taught in this section must also be stressed in the appropriate sections throughout the Boilermaker training program.

A. Common Hazards 14 Hours

Outcome: Recognize and apply safe working procedures and practices.

1. Identify potential fatal hazards in confined space entry:
 - a) entering without testing
 - b) lack of retesting
 - c) not blanking or locking out
 - d) lack of ventilation
 - e) inert gases
 - f) use of oxygen
 - g) cutting /welding hoses and valves
 - h) welding without checking neighbouring compartments
 - i) sludge in confined space
 - j) lack of respiratory protection
 - k) possible toxic or flammable material
 - l) improper rescue procedures

2. Locate and identify legislation and regulations pertinent to "Confined Space Entry":
 - a) definition of confined space
 - b) employer's responsibilities
 - c) employee's responsibilities
 - d) code of practice for entry and work in confined spaces
 - e) safety training

3. Describe the following hazards in confined space entry:
 - a) enclosed spaces
 - b) partially enclosed spaces
 - c) natural ventilation
 - d) oxygen deficiency
 - e) explosive and toxic liquids and gases
 - i) hydrogen sulfide
 - ii) carbon monoxide
 - iii) liquid materials
 - f) decaying organic matter in confined space

- g) fire triangle
 - h) lower and upper explosive limits
4. Preplan confined space entry:
 - a) atmospheric testing and monitoring
 - b) procedures
 - c) preparations
 - d) safety equipment and clothing.
 - e) ground fault interrupters.
 - f) explosion proof lighting.
 - g) rescue equipment.
 5. Identify and describe a permit system for confined space entry.
 6. Introduction to W.H.M.I.S. (Workplace Hazardous Materials Information System)
 - a) Describe what W.H.M.I.S. is, its rationale and major elements.
 - b) Define what is meant by a W.H.M.I.S. label and distinguish between supplier and workplace labels and other means of identification.
 - c) Describe what is meant by the following classifications:
 - i) prohibited product
 - ii) restricted product
 - iii) controlled product
 - d) Explain what a Material Safety Data Sheet (M.S.D.S.) is, its purpose and limitations. Describe the roles and responsibilities of employer, supplier and worker in the education of workers.
 - f) Other subject areas as deemed appropriate and deliverable by the training establishments.
 7. Identify other hazards
 - a) Recognize and correct common causes of accidents in the work environment.
 - b) Carry out work activities in a manner conducive to a maximum possible standard of shop safety.
 - c) Recognize, report and/or eliminate fire hazards existing in the work environment.
 - d) Recognize various classes of fires and be aware of the extinguishing medium for use in each case.
 - e) Effectively operate fire-extinguishing equipment to extinguish various classes of fires. Demonstrate knowledge of the fall restraint, fall arrest program.

B. Proper Use of Safety Equipment..... 3 Hours

Outcome: Identify and demonstrate the proper use of safety equipment.

1. Demonstrate the proper use of the following safety equipment:
 - a) welding helmets
 - b) boots
 - c) glasses
 - d) goggles/shields
 - e) safety harness
 - f) clothing
 - g) dust filters / respirators
 - h) fresh air breathing equipment
 - i) air movers
 - j) safety showers / eyewash stations
 - k) fire fighting equipment
 - l) hearing protection equipment
 - m) head protection

2. Identify safety features incorporated on various pieces of equipment.

C. Workers' Compensation Board (W.C.B.) 1 Hour

1. Complete and remit the appropriate forms as may be required by the W.C.B.:
 - a) form to be completed
 - b) methods of completing
 - c) where to remit
2. Interpret Workers' Compensation Board regulations.

D. Related Knowledge 6 Hours

Outcome: Recognize and apply expectable interpersonal skills.

1. Recognize and assess the responsibilities to:
 - a) oneself
 - b) the public
 - c) fellow workers
 - d) supervisory personnel (foreman and employer)
 - e) work opportunities
 - f) provincial government departments
 - g) the unions
2. Determine good public relations with other trades as well as problems and public needs:
 - a) co-operation with allied trades
 - b) co-ordination with other trade functions
 - c) recognition of problems in all phases
 - d) consideration of public needs
3. Apprenticeship orientation
 - a) Describe the apprenticeship training system.
 - b) Identify the training profile
 - c) Describe the responsibilities of the apprentice and employer.
 - d) Discuss the contents of the apprenticeship training logbook.

E. Emergency First Aid and C.P.R. 8 Hours

Outcome: Administer immediate on the spot first aid to persons with minor injuries and administer temporary emergency first aid to the more seriously injured, as deemed adequate until qualified medical personnel is available.

1. Explain the responsibilities and duties of the first aid person.
2. Explain the diagnoses for:
 - a) respiratory failure
 - b) burns
 - c) body injury
3. Applying artificial respiration
 - a) Explain the process of freeing the victim of breathing restrictions.
 - b) Explain the process of applying mouth-to-mouth respiration.

4. Describe the emergency treatment procedure for:
 - a) assessing injury
 - b) moving the patient
 - c) arresting bleeding
 - d) completing Workers' Compensation Board forms
5. Explain the methods of treating various burns and quenching a fire on a victim.
6. Basic C.P.R.

F. Mathematics 6 hours

1. Fractions

Outcome: Solve problems involving fractions

1. Identify key terms and concepts used in working with fractions.
2. Change fractions to a common denominator.
3. Solve problems using whole numbers and fractions.
4. Solve problems using whole numbers and fractions in practical applications.
5. Solve squares and square roots.

2. Decimals

Outcome: Solve problems involving decimals

1. Read and write decimal fractions.
2. Round decimal fractions to specified place values.
3. Convert decimal inches to a fraction with a practical denominator.
4. Convert decimal feet to feet and inches with a practical denominator.
5. Convert fractions to decimals.
6. Add and subtract decimal fractions.
7. Multiply and divide decimal fractions.

3. Metric and Imperial Measurement

Outcome: Solve problems involving Metric and Imperial measure

1. Identify commonly used metric units of measurement.
2. Convert between units of measurement.

3. Convert imperial units: feet to inches, square inches to square feet, and cubic measures to gallons.

SECTION TWO: BASIC RIGGING..... 36 HOURS

A. Ropes..... 28 Hours

Outcome: Apply safe work practices and procedures when using ropes.

1. Define and describe fibre ropes:
 - a) Define lays of fibre ropes.
 - b) Describe why a certain fibre would be used.
 - c) List factors and formulas for fibre ropes.
 - d) Care of and material designation.
2. Define and describe synthetic ropes
 - a) Describe types of synthetic ropes why and when used.
 - b) Explain formulas for different types of synthetic ropes.
 - c) Explain proper methods of care and handling.
3. Define and describe wire ropes
 - a) List the types of steel for wire ropes.
 - b) List and explain:
 - i) four basic types of lays
 - ii) advantages of lays
 - iii) available type of core
 - iv) where cores are used.
 - c) Describe the four basic classifications of wire ropes
 - d) Explain W.L.L. (Working Load Limits) and when a wire is unsafe.
 - e) Material designation and care
4. Define and describe Working Load Limits (W.L.L.)
 - a) Be aware of W.L.L. formulas and factors.
5. Identify and describe uses of the following knots. .
 - a) bowline
 - b) self-centring bowline
 - c) running bowline
 - d) clove hitch
 - e) half hitch
 - f) rolling hitch
 - g) reef (square) knot
 - h) single and double sheet bend
 - i) timbre knot
 - j) triple sliding hitch
6. Define and describe material handling.
 - a) hooks clips and shackles
 - b) wire rope
 - c) chain
 - d) wire rope clips, types and methods of application
 - e) methods of application

7. Demonstrate slings and hitches used for preparing and lifting materials.
8. Tie knots and hitches and be aware of load limits.
9. Demonstrate proper use of slings and tag lines.
10. Demonstrate proper use and location of sling configurations on loads for lifting:
 - a) smooth heavy loads
 - b) long flexible loads
 - c) off balance loads
 - d) heavy fragile units
11. Splice fibre and nylon ropes:
 - a) short splice
 - b) eye with side splice
 - c) crown knot and back splice
12. Test knots and splices.

B. Lifting Devices 4 Hours

Outcome: Apply safe work practices and procedures when using lifting devices.

1. Lift and describe mobile cranes
 - a) types of mobile cranes
 - b) parts of a mobile crane
 - c) parts of a crawler
 - d) safe operating and working practices
2. Demonstrate uses and safe working practices for:
 - a) air hoists
 - b) come along
 - c) wire rope pullers (tirfor)
 - d) chainfalls

C. Signals 4 Hours

Outcome: Identify and demonstrate the safe use of signals.

1. List and demonstrate signals used for moving equipment and hoisting.
2. Describe methods and precautions in using hand signals.
3. Describe and demonstrate voice communications
 - a) radio (2 way and walkie talkie)
 - b) current technology
4. Describe precautions used in voice communication.

SECTION THREE:TOOLS, CUTTING AND WELDING 62 HOURS

The welding instruction under this section shall not be to the level of a proficient and skilled Welder. The intent is to train the potential apprentices to a level where they may operate the required equipment in a safe manner, and perform such operations of metal cutting and welding as to make temporary attachment of component parts, prior to the finish welding required by a certified Welder.

A. Tools 22 Hours

Outcome: Identify and use tools safety.

1. Identify, illustrate or describe the safe operation and maintenance of the following hand tools:
 - a) spirit level
 - b) plumb bob
 - c) hammers
 - d) chisels
 - i) sharpening
 - ii) removal of mushroomed or fractured head
 - e) screw drivers
 - f) pliers
 - g) clamps
 - h) bolt cutters
 - i) hacksaws
 - j) files
 - k) punches and pins
 - i) connecting bar
 - ii) bull pins
 - iii) line up bars (drift pins)
 - iv) centre punch
 - v) prick punch
 - l) various types of squares
 - m) scribes
 - n) dividers
 - o) chalk line
 - p) vises
 - q) trammel points
 - r) measuring tools
2. Recognize safety hazards related to general shop safety.
3. Perform all operations in a safe manner in accordance with the Occupational Health and Safety Act and the rules and regulations of specific facilities.
4. Identify the following wrenches:
 - a) structural offset (spud wrench)
 - b) sockets and attendant drives
 - c) adjustable
 - d) combination
 - e) open end
 - f) box end
 - g) set screw (Allen)
 - h) torque
 - i) pipe
5. Identify, illustrate or describe the safe operation and maintenance of the following power and pneumatic tools:
 - a) hand drills
 - b) electric grinders
 - c) air grinders
 - d) pedestal grinders

- e) pneumatic chipping hammers
- 6. Safely and efficiently operate pneumatic (air) and/or electrically powered portable and stationary drilling equipment.
- 7. Identify and use twist drills.
- 8. Operate and maintain reaming equipment.
- 9. Use and maintain threading equipment for the production of internal and external threads
- 10. Use a disc grinder to safely:
 - a) clean torch-cut edges
 - b) remove tacks/scabs
 - c) cut off
 - d) wire brush (remove layers of paint, rust, etc.)
 - e) sand
- 11. Mount grinder wheels on a pedestal and portable grinder.
- 12. Perform the following operations using a grinder:
 - a) grind carbon steel of various shapes to remove metal, scale, slag and burrs
 - b) regrind chisels, punches, screw drivers and drifts to the correct size and geometry
 - c) buff surfaces

B. Flame Cutting..... 20 Hours

Outcome: Safety use oxy-fuel cutting equipment.

- 1. Identify and describe oxy-fuel cutting equipment
 - a) describe the construction of oxygen and acetylene and other fuel gas cylinders.
 - b) describe the different sizes of cylinders.
 - c) explain the procedure for handling, transporting and storing cylinders.
 - d) state the procedure for handling faulty cylinders.
 - e) explain the procedure for filling cylinders.
 - f) explain the construction and purpose of a manifold system.
 - g) identify and select correct fuel gases for manual and automatic flame cutting of carbon steel.
- 2. Identify and describe regulators
 - a) Describe the purpose of a regulator.
 - b) Describe the basic construction and pressures involved for a single stage and double stage regulator.
 - c) Demonstrate the correct adjustments and balancing of regulators.
- 3. Identify and describe hoses
 - a) Explain the construction of hoses.
 - b) Identify hoses and fittings.
 - c) State the procedure for the repair and maintenance of hoses.
- 4. Identify and describe oxy-fuel tips
 - a) Describe the design and construction of cutting tips.
 - b) Explain the operating principles of a cutting tip.
- 5. Describe and demonstrate:
 - c) care and maintenance of tips
 - d) correct selection of tips

6. Explain and demonstrate setting-up of oxy-fuel equipment:
 - a) Explain and demonstrate the correct placement and securing of cylinders.
 - b) Explain and demonstrate the clearing and checking of cylinder valves.
 - c) Attach regulators safely and correctly
 - d) Correct selection and installation of flashback arrestors.
 - e) Attach correctly the barrel and tip.
 - f) Explain the correct procedure in checking for leaks.
 - g) Check to assure that the regulators were not used for any other purpose than for what they were intended
 - h) Demonstrate safe set-up procedures.

7. Explain and demonstrate pressures and flame adjustments:
 - a) Explain and demonstrate the correct regulator adjustments and balancing procedures.
 - b) List the reasons for backfires and flashbacks.
 - c) Define flame propagation.
 - d) Ignite the torch using the recommended striker.
 - e) Explain and demonstrate the different types of flames and uses.
 - f) List and demonstrate the acceptable shutting down procedure

8. Explain and demonstrate fire prevention and controls:
 - a) Identify the types of fire extinguishers available and where used.
 - b) Define hazardous areas in construction.
 - c) Describe how to prevent fires

9. Perform manual cutting of various thicknesses of material
 - a) straight line and bevel cutting on plate steel.
 - b) cuts on various structural steel shapes.
 - c) circle cutting.
 - d) hole piercing.
 - e) radial cutting

10. Describe expansion and contraction
 - a) Describe how to control expansion, contraction and distortion resulting from, welding and cutting.
 - b) Identify and describe forces resulting from expansion and contraction for the straightening or bending of structural members.

C. Electric Arc Welding..... 20 Hours

Outcome: Identify and demonstrate the basic use of electric arc welding equipment.

1. Define and explain basic electricity
 - a) open circuit voltage
 - b) arc voltage.
 - c) alternating current and direct current.
 - d) resistance.
 - e) duty cycle
 - f) reverse and straight polarity.
 - g) heat distribution using reverse or straight polarity.
 - h) voltage loss.

2. Describe arc welding machines
 - a) basic components and operation of an alternating current transformer.

- b) basic components and operation of AC-DC rectifier.
 - c) basic components and operation of an AC and DC generator.
 - d) multi-process inverter welding power source.
 - e) advantages and disadvantages of the various types of welding machines.
3. Explain the day to day maintenance required for welding machines. UOC: 003240
 4. Describe the accessories for welding machines
 - a) cable construction.
 - b) cable sizing.
 - c) various types of electrode holders and explain the maintenance required.
 - d) cable lugs, quick connectors and ground clamps.
 5. Describe the controls on a welding machine and the relation to the different voltage and amperage settings.
 6. Explain the numerical definitions of electrodes.
 7. Describe the following safety equipment:
 - a) Describe and wear proper welding apparel.
 - b) State the use of protective screens.
 - c) Describe a welding helmet and illustrate the proper placement of lenses.
 - d) Describe and illustrate safe housekeeping practices.
 - e) List the rays involved with welding and the effects associated with these rays.
 - f) Describe the procedures to protect oneself and the general public from harmful rays.
 - g) list the reasons for grounding of electrical equipment.
 8. Demonstrate the ability to weld stringer beads on available mild steel in the flat position using E6010 or E6011 filler material.
 9. Demonstrate the ability to weld lap welds on 1/4" (6 mm) mild steel in the flat and horizontal positions using E6010 and E7018 filler material
 10. Demonstrate the ability to weld tee welds on available mild steel in the flat and horizontal position using E6010 and E7018 filler material
 11. Demonstrate the ability to weld a corner joint using E6010 or E7018 filler material.
 12. Demonstrate acceptable welding procedures to prevent distortion, etc. for all the joints

SECTION FOUR: MATERIALS KNOWLEDGE..... 44 HOURS

A. Metallurgy 10 Hours

Outcome: Identify and demonstrate the basic knowledge of physical and mechanical properties of metal.

1. List six elements which are always present in steel.
2. Describe the special significance's of carbon in steel.
3. Describe the function of the following elements in steel

- a) carbon
 - b) manganese
 - c) sulphur
 - d) silicon
 - e) iron
 - f) phosphorus
4. Describe the effects of carbon and the other elements on the:
- a) physical properties of steel
 - b) weld ability of steel
5. Differentiate between ferrous and non-ferrous metals.
6. Describe the operation of a blast furnace and production of pig iron.
7. Describe the production of cast iron in the Cupola furnaces and the uses of cast iron.
8. Describe the production of carbon steel, alloy steel and stainless steel with reference to the following furnaces in which they are produced
- a) basic oxygen furnaces
 - b) open hearth furnaces
 - c) electric furnaces
 - d) induction furnaces
 - e) vacuum furnaces
9. Describe the following steels:
- a) killed steel
 - b) semi-killed steel
 - c) rimmed steel
 - d) cast steel
10. Define the following mechanical properties of plain carbon steel:
- a) stress
 - b) strain
 - c) elasticity
 - d) ductility
 - e) toughness
 - f) yield point
 - g) yield strength
 - h) tensile strength
 - i) compression strength
 - j) elastic limit
 - k) brittleness
 - l) malleability
 - m) impact strength
 - n) elongation
 - o) torsion strength
11. Define the following physical properties of plain carbon steel:
- a) colour
 - b) melting point
 - c) density
 - d) weight density
 - e) heat and electrical conductivity
 - f) specific heat
 - g) corrosion resistance

12. Name the four basic types of carbon steel
13. Name the five basic types of steels
14. Describe how the amount of carbon in ferrous material determines whether a material is steel or a cast iron
15. Explain how low-alloy, high-tensile steels differ from low carbon steels
16. Determine the main advantage of low-alloy steel.
17. Describe the significance's of AISI steel numbers
18. Describe the applications of different types of steel for a specific use.

B. Basic Materials..... 20 Hours

Outcome: Identify and demonstrate basic material knowledge.

1. Identify all structural shapes by their respective designations (old and new).
2. Explain specific parts of structural shapes as per the designations.
3. Explain the meaning of nominal dimensions.
4. Explain the information which must be given when ordering wide flange beams.
5. Explain the meaning of the terms camber and sweep.
6. Identify the following structural shapes
 - a) HSS 101.6 x 101.6 x 7.95
 - b) W610 x 113
 - c) MC 18 x 42.7
 - d) S12 x 35
7. Define the classification of a steel plate with reference to thickness and width.
8. Describe the following designations of a carbon steel plate:
 - a) ASTM A-36 A-283 A-285 A-515 A-516
 - b) CSA G40.20/21M Standard
 - c) AISI System
9. Explain the purpose and applications of clad steel and other cladding materials.
10. Identify and select welded bar gratings used for stairways and platforms.
11. Identify and select an expanded mesh and expanded mesh grating by its standard sizing.
12. Identify and differentiate the designation as applied for pipe and tube.
13. Describe the pipe schedules with reference to the old and new designation.
14. Differentiate between the imperial and metric designation of pipe.
15. Explain the difference between material designations given as ASTM A53 and ASTM A120
16. Perform pipe cutting to size using a pipe cutter and/or oxyfuel cutting process.
17. Perform cutting/threading of pipe using manual and mechanical process.
18. Identify the following standard designation:
 - a) 2-NPT
 - b) 3-8NPS
19. Describe the fixed and aligning threaded fasteners.

20. Interpret nut and bolt markings to determine physical properties and type of material they are made of.
21. Describe and select the bolt grading as designated by SAE and ASTM.
22. Identify the following standard designations:
 - a) standard M20 x 2.5
 - b) standard bolt $\frac{3}{8}$ - 16NC
 - c) standard bolt ASTM A325M
 - d) standard bolt ASTM A490
23. Determine the bolt threads length for bolts and screws up to 6 inches in length.
24. Determine the wrench sizes with related reference to the bolt major diameter.
25. Define bolts, studs and screws. :
26. Describe the differences between the American Standard Unified Thread and the Metric Thread.
27. Identify the following standard thread:
 - a) $\frac{9}{16}$ – 18 UNF-2B
 - b) $\frac{13}{4}$ – 15 UN-2A
 - c) M30 x 3
28. Identify the pipe fittings listed and describe their function:
 - a) nozzles UOC: 004660
 - b) couplings UOC: 004670
 - c) tees UOC: 004680
 - d) elbows UOC: 004690
 - e) flanges (including slip-on and welding neck) UOC: 004700
 - f) blanking plates UOC: 004710
 - g) plugs UOC: 004720
 - h) valves
29. List the pressure ratings used for forged steel flanges.
30. Identify the following standard designations:
 - a) 4"-RFLWN/RFLWN-300#
 - b) 3"-S.O.F.-600#
 - c) 90°-2"-LRE
31. Explain the meaning of a specification given as short radius elbow.
32. Name the valve used to prevent backflow.

C. Trade Related Components..... 16 Hours

Outcome: Identify trade related components.

1. Identify the pressure vessel components listed and describe their functions
 - a) heads
 - b) man ways
 - c) davits
 - d) trays
 - e) domes
 - f) hand holes
 - g) repads

- h) ductwork
- i) demisters
- j) vortex breakers
- k) catwalks and ladders

2. Determine the working function of the following:
 - a) vortex breaker
 - b) demister
 - c) repad
 - d) plug
3. Define the difference between the elliptical, dished and hemispherical pressure vessel heads.
4. Define mounting of a Davit for both vertical and horizontal opening.
5. Describe the shapes and minimum standard dimensions of hand hole openings.
6. Determine the minimum diameter used for a circular manhole opening.
7. Determine the use of a steam-dome and tray fittings.

LEVEL 1

LEVEL 1 TECHNICAL TRAINING

**BOILERMAKER TRADE
COURSE OUTLINE**

UPON SUCCESSFUL COMPETITION FO THIS PROGRAM, THE APPRENTICE SHOULD BE ABLE TO PERFORM THE FOLLOWING OUTCOMES AND OBJECTIVES.

SECTION ONE:.....TOOLS, CUTTING AND WELDING..... 64 HOURS

A. Instruments 4 Hours

Outcome: Demonstrate the ability to use measuring instruments.

1. Set up transit and tripod including:
 - a) connecting transit to tripod
 - b) setting up over a given point
 - c) levelling
 - d) focusing
2. Use a transit to measure:
 - a) elevation
 - b) vertical deviation
 - c) angular deviation (triangulate)
3. Demonstrate and transfer elevation points using a water level.
4. Demonstrate the skills and abilities in precision measuring using a micrometer (Metric and Imperial).

B. Power Tools (Electric and Pneumatic) 6 Hours

Outcome: Demonstrate the safe use of power tools

1. Demonstrate the proper and safe use of the following portable power tools:
 - a) drills and reamers
 - b) tube expanders (identification only)
 - c) impacts (wrenches and hammer drills)
 - d) pipe threading and cutting equipment

C. Shop Equipment 8 Hours

Outcome: Identify and demonstrate the safe use of shop equipment.

1. Describe the types of drilling machines.
2. List and describe set-up procedures for drilling machines.
3. Identify and describe drills and drilling tools.
4. Describe drill bit geometry and its sharpening procedures.
5. Determine drilling speeds and feeds.
6. Sharpen drill bits.
7. Set up a drill press and drill multi-diameter holes from $\frac{1}{8}$ " to 2" to an accuracy of $\frac{1}{32}$ ".

8. Describe how to set up power rolls for the following operations:
 - a) form a full cylinder
 - b) form a partial cylinder
 - c) form a cone (reducer)
 - d) form a partial and full ring
9. Calculate metal length before forming, including:
 - a) bend allowance
 - b) flat sections
 - c) seam allowance, e.g. root opening
10. Describe how to perform the following operations on a shearing and punching machine safely and correctly:
 - a) set up and punch holes in plate, angles, channels and I-beams
 - b) shear angles at 45° and 90° with heel inside and outside
 - c) shear flat bar, rounds and square bar
 - d) notch and cope plate and structural shapes
 - e) cut to an accuracy of 1/16" for length and within 2° for angle cuts
11. Describe how to set up a power brake press for the following operations:
 - a) form 90 degree bends
 - b) form oblique angle bends
 - c) form a half cylinder
 - d) form a half cone (reducer)
 - e) form a partial section square to rotated square
 - f) form a partial section of square to round
12. Determine the correct methods of positioning dies for specific operations.
13. Describe the following power saws:
 - a) horizontal and vertical band saws
 - b) power hack saws
 - c) cold saws

D. Metallurgy..... 14 Hours

The areas under this section shall be kept at a level of reasonable understanding by the apprentice and shall be of useful knowledge readily applicable to their work. The intent is not to advance to a Metallurgist status but rather acquaint the apprentice with a knowledge applicable to a working understanding of metal properties.

Outcome: Identify and demonstrate the basic knowledge of physical and mechanical properties of metal.

1. List the basic mechanical and physical properties of metals.
2. Identify the following metals:
 - a) white cast iron
 - b) gray cast iron
 - c) low carbon steel
 - d) high carbon steel
 - e) chromium-nickel steel (stainless)
 - f) high manganese steel
 - g) nickel

- h) aluminum
- 3. Determine the hardness of metal by using a file and compare to the Brinnell Hardness scale.
- 4. Describe how welding processes (heating) influence steel structures
- 5. Describe how heat from welding causes
 - a) residual stresses
 - b) structural stresses
- 6. Describe methods of preventing or reducing distortion.
- 7. Describe methods of controlling distortion by applying the correct welding procedures and preheat.
- 8. Describe methods of correcting distortion including
 - a) peening
 - b) grooving and re-welding
 - c) straightening
 - d) clamping and stress relieving
 - e) welding on opposite side
 - f) local heating, etc.
- 9. Effect of alloys on the oxidization (cutting) action
- 10. Determine the effect of carbon in its relationship to the weldability and flame cutting of steel.
- 11. Determine the effect of alloys in their relationship to the weldability and cutting action in steels.
- 12. Explain the principle of heat straightening methods.
- 13. Explain the significance of cold working metals.
- 14. List advantages of hot working metals
- 15. Describe mechanical and physical effects of metals after hot and cold forming.

E. Cutting, Welding and Related Processes 32 Hours

The welding instruction under this section shall not be to the level of a proficient and skilled Welder. The intent is to train the apprentice to a level where he may operate the required equipment in a safe manner, and perform such operations of metal cutting and welding as to make temporary attachment of component parts, prior to the finish welding required by a certified Welder.

Outcome: Demonstrate the safe use of cutting, welding and related process equipment.

- 1. Describe heat straightening.
- 2. Demonstrate techniques of flame straightening on a:
 - a) plate
 - b) pipe
 - c) distorted header
 - d) distorted structural member
- 3. Describe cutting processes involved in cutting alloy steels and non-ferrous metals plasma-arc and water jet cutting.
- 4. Explain correct cutting techniques and common cutting faults.
- 5. Perform flame cutting skills involving radial cuts.
- 6. Demonstrate flame cutting skills on:
 - a) pressure vessel heads

- b) pressure vessel shells
 - c) structural shapes
7. Interpret weld joint preparations, joint edge preparation and joint tolerances from drawings.
 8. Determine if metal conditions require special cleaning methods.
 9. Explain the manufacturing specification control for arc welding electrodes.
 10. List the functions of coating for arc welding electrodes.
 11. List the functions of the slag for arc welding electrodes.
 12. Explain the effects of alloy additions to the coating for arc welding electrodes.
 13. Explain static and dynamic loading for arc welding electrodes.
 14. Explain the proper storage of low hydrogen electrodes.
 15. Explain the reasons for selecting a welding machine for a specific task.
 16. Explain the consideration to be taken when installing an arc-welding machine in a shop environment
 17. Recognize these other welding processes, GTAW, GMAW and thermal spray.
 18. Demonstrate how to set up arc air gouging equipment correctly and safely without causing damage to the equipment and its accessories:
 19. Determine for each welding operation the required:
 - a) joint spacing
 - b) holding or clamping devices
 - c) number and spacing of tack welds
 - d) pre-setting/distortion allowances of joint member current type, polarity and voltage
 - e) correct welding procedures
 20. Interpret welding symbols as standardised by the American Welding Society:
 - a) parts UOC: 006400
 - b) materials preparation
 - c) weld types
 - d) dimensioning
 - e) position UOC: 006440
 - f) execution (field or shop)
 - g) finish (flush, chip or grind)
 21. Demonstrate the ability to weld in the vertical and horizontal positions using E6010 or E6011 filler material.
 22. Demonstrate the ability to weld lap welds on ¼" (6 mm) mild steel in the vertical and horizontal positions using E6010 and E7018 filler material.
 23. Demonstrate the ability to weld a flat and horizontal butt weld on ¼" (6 mm) mild steel using E6010 or E7018 filler material.

SECTION TWO: DRAWING INTERPRETATION 84 HOURS

This section consists of lectures and supporting shop practices on the progressive preparation of materials for the proper sequence to successfully fabricate a small project beginning with the print and selection of materials to the finished project.

A. Basic Drafting 27 Hours

Interpretation and correlation of information found on multi-sheet complex prints, including material, identification on parts, orientation and layout of structure or parts of a structure utilizing to the fullest actual working prints on vessels, tanks, precipitators and boilers.

Outcome: Identify the basic knowledge of drawing interpretation.

1. Use minimum drafting equipment to assist in developing principles of drawing construction.
2. Read drawings, prints or sketches and properly fold and protect them for immediate and future use.
3. Read and interpret the proper use of signs, symbols and abbreviations as may be required.
4. Identify line types and uses, analyse the proper lettering and where it is used relative to the associated terminology.
5. Identify the correct placement of dimensions applying the unidirectional system.
6. Recognize the style of lettering with reference to sizing and placement.
7. Describe the following parts of a drawing:
 - a) title block
 - b) scale
 - c) contract numbers
 - d) section on same and different sheets
 - e) revisions
 - f) parts and identification marking
8. Give the main reason for a sectional view.
9. Explain a cutting-plane line
10. Explain a section line
11. List three types of sections.
12. List two requirements for a multi-view projection.
13. Give examples of parts which need one or two views only
14. State the difference between primary and secondary auxiliary views.
15. Define the right and left hand views.
16. Name two advantages for using partial views.
17. Define the principle of orthographic projection
18. Explain the principle and applications of an isometric projection.
19. Describe materials and techniques used in freehand sketching.
20. Sketch freehand to available materials and techniques used, to convey information to other workmen to produce the subject item, such as small tanks, frames, stands, brackets, etc.
21. Identify the signs, symbols and abbreviations on drawings compiled from standards generally used on the following components:
 - a) materials preparation
 - b) structural and plate
 - c) fired and unfired pressure vessels
 - d) tank
 - e) heat exchangers
 - f) precipitators

22. Interpret the following basic welding symbols and abbreviations:
 - a) weld
 - b) supplementary symbols
 - c) specifications
 - d) groove and weld dimensions
 - e) contour
 - f) method of finish
 - g) single and double breaks in arrow line
 - h) standard rules for reading welding symbols
 - i) location of symbols on drawings
23. Communicate weld requirements through use of basic welding symbols.

B. Identification of Pressure Vessels 7 Hours

Outcome: Demonstrate the basic knowledge of pressure vessels, tanks and boilers.

1. Recognize industries that fall under the “heavy” category
2. Identify the boilermaker’s involvement, safety hazards and safe working procedures in the following heavy industrial sectors
 - a) nuclear generating stations
 - b) hydro generating stations
 - c) fossil fuel generating stations
 - d) oil refineries
 - e) pulp and paper mills
 - f) steel plants
3. Identify water tube boilers with reference to the position of tubes and drums.
4. Identify the firetube boiler with respect to the position of a furnace.
5. Explain the working principle of water tube and firetube boilers
6. Describe the types of fired vessels.
7. Describe shell and tube sheet construction.
8. Identify boiler tubes.
9. Describe the function of a firebox
10. Explain the purpose of stays.
11. Explain the purpose of buckstays.
12. Describe the scope and limitations of ASME boiler and pressure vessel code.
13. Identify platforms, ladders, walkways and other typical structures related to boilers.
14. Describe the working principle of heat exchanger.
15. State the reason for heat exchanger baffles.
16. Explain heat exchanger sizing and type designation.
17. Describe shell and tube sheet construction.
18. Identify platforms, ladders, walkways and other typical structures related to heat exchangers
19. Describe the working principle of distillation towers.

20. Identify platforms, ladders, walkways and other typical structures related to distillation towers.
21. Describe the basic types of storage tanks.
22. Identify platforms, ladders, walkways and other typical structures related to tanks.
23. Identify procedures and equipment used in basic tank erection.
24. Explain how to safely and efficiently carry out basic tank erection practices.

C. Introduction to Layout 18 Hours

Outcome: Perform basic layout skills.

1. Identify, select and use types of basic measuring, checking and layout tools in terms of:
 - a) available types
 - b) standard features
 - c) design characteristics
 - d) maximum obtainable accuracy
 - e) applications
 - f) correct method of use
 - g) correct handling
 - h) storage and maintenance procedures
 - i) required conditions of use
2. Perform the following basic geometrical constructions:
 - a) construct a line segment equal to a given line segment
 - b) construct an angle to a given angle
 - c) bisect a given angle, layout 45, 60, 30 degree angles
 - d) construct a line perpendicular to a given line through a given point on the line
 - e) bisect a given line segment
 - f) construct a line perpendicular to a given line through a given point outside the line
 - g) construct a line parallel to a given line through a given point
 - h) construct a tangent to a given circle through a given point on the circle
 - i) divide a line segment into any number of equal parts
 - j) circumscribe a circle about a triangle
 - k) locate the centre of a given circle
 - l) inscribe a circle in a given triangle
 - m) construct regular polygons with any number of flats
 - n) inscribe and circumscribe regular polygons
 - o) layout an angle
 - p) inscribe a given radius into right angle, acute angle and obtuse angle turns
 - q) bisect a given arc
 - r) construct an ellipse using three different methods
3. Using the parallel line development method, develop a pattern for a rectangular piece of ducting cut at an angle
4. Using the parallel line development method, develop a pattern for a two piece 90 degree elbow.

D. Materials Preparation and Assembly 12 Hours

Outcome: Describe and demonstrate material preparation skills.

1. Explain and describe the layout procedure for properly marking-up an assembly for:

- a) cutting
 - b) braking
 - c) shearing
 - d) rolling
 - e) drilling
 - f) punching
2. Describe the purpose for templates:
 - a) materials used to make templates
 - b) types of templates
 3. Develop the following templates:
 - a) bending (sweep)
 - b) marking (gusset plates)
 - c) pattern (pipe turns)
 4. Describe the procedures for identifying fabricated assemblies:
 - a) item numbers
 - b) material identification
 - c) job and contract numbers
 - d) erection sequencing

E. Basic Mathematics 20 Hours

Mathematics has been determined as being an integral component of the technical training when it is applied in the strictest terms of trade involvement specifically being totally related. Due to the nature of application in the trade of Boilermakers, the mathematics given under this section shall be flexible and applied to the work where feasible.

Outcome: Solve mathematical problems.

1. Solve simple arithmetic problems by applying the principles of:
 - a) whole numbers
 - b) decimal numbers
 - c) fractional numbers
 - d) mixed numbers
2. Use linear measurements to compute perimeters of the following shapes
 - a) rectangles
 - b) squares
 - c) triangles
 - d) circles
3. Solve linear measurement problems using the Imperial and Metric measurement systems:
 - a) Perform arithmetic operations with length.
 - b) Perform arithmetic operations with weights and capacities.
 - c) Perform arithmetic operations with volumes.
 - d) Express units of area measure.
 - e) Express units of volume measure.
 - f) Perform combining calculation on practical applications using various units of measure.
 - g) Compute conversions from Imperial to Metric and visa versa.

SECTION THREE: GENERAL RIGGING 32 HOURS

A. Wire Rope 12 Hours

Outcome: Identify and perform basic rigging skills using wire rope.

1. Identify sizing of hooks, clips and shackles.
2. Name two types of wire rope clips.
3. Use formula to determine the number of clips required.
4. State the differences of shackle pin diameter and size of its bow.
5. Determine the types of loading recommended for shoulderless eyebolts.
6. Calculate the working load limits (WLL) derived from formulas to calculate the (WLL) for all parts.
7. Define the design significance of grommet slings.
8. Describe the preferred application for a double wrap basket hitch.
9. Determine the centre of gravity for different types of loads such as:
 - a) structural members of a different designation
 - b) regular plates
 - c) irregular shapes of plates
 - d) assemblies
10. Define the choker stress formula.
 - a) Apply the W.L.L. into various load and sling configurations.
 - b) Use table and charts for slings and general rope hardware.

B. Block and Tackle 20 Hours

Outcome: Demonstrate and identify knowledge of block and tackle.

1. Demonstrate or describe safe work practices of block and tackle involving reeving techniques
 - a) square
 - b) skip
 - c) tandem
 - d) equalizer sheaves
 - e) lacing
 - f) reeving of simple and multi-blocks up to 24 parts
2. Calculate the mechanical advantage of block and tackle systems
3. Determine the working load limits that can be lifted with a given rigging arrangement.

LEVEL 2

LEVEL 2 TECHNICAL TRAINING

BOILERMAKER TRADE COURSE OUTLINE

UPON SUCCESSFUL COMPETITION FO THIS PROGRAM, THE APPRENTICE SHOULD BE ABLE TO PERFORM THE FOLLOWING OUTCOMES AND OBJECTIVES.

SECTION ONE:.....MATERIALS AND RELATED KNOWLEDGE 30 HOURS

A. Heat Treatment..... 10 Hours

Outcome: Demonstrate the knowledge of material designations and the effect of heat on metals.

1. Describe the forming of steel from the ingot stage to the finished product such as:
 - a) plates
 - b) sheets
 - c) bars
 - d) rods
 - e) tubes
 - f) rails
 - g) pipes
 - h) structural shapes
2. Define the following terms:
 - a) hot rolled
 - b) cold rolled
 - c) tempered
 - d) annealed
 - e) normalized
 - f) galvanized
3. Interpret C.S.A. 40.20/21 standard for structural steel
4. Interpret the SAE/AISI for a given plain carbon steel to determine its carbon content, method of manufacture and weldability.
5. Interpret the ASTM specification for a given plain carbon steel to determine its strength, usage and weldability.
6. Interpret the AISI system for designating stainless steels Series 200, 300 and 400.
7. Identify major sources of heat used for heat treatment: UOC: 008690
 - a) flame
 - b) natural gas and compressed air
 - c) annealing furnace or ovens
8. Identify the three factors which are contingent to proper hardening of steel.
9. List the reasons for tempering some metal after heat treating.
10. Describe procedures for controlling hardness in the heat affected zone of a weld.
11. List three rules which help in determining the need for preheating carbon steel prior to welding.
12. List four advantages in preheating of carbon steel for metal arc welding.
13. Identify effects of various stages of heat treatment:

- a) expanding and shrinking
- b) stress relieving
- c) annealing
- d) normalizing
- e) preheating
- f) post heating

14. Describe grain structures in terms of:

- a) ferrite
- b) cementite
- c) pearlite
- d) austenite
- e) martensite

15. Describe normalizing and annealing processes and give reasons for them.

16. Describe post-weld heating as a means to:

- a) relieve stresses
- b) improve toughness
- c) increase strength and durability

17. Describe stress relieving as a post-weld method to:

- a) reduce residual stresses
- b) improve service life of the weldment

18. Describe the importance of correct temperatures and correct heating and cooling rates.

19. Describe measures to control and check temperatures during preheating and postweld heating.

20. Describe the influence of the following on the micro-structure of the weld area:

- a) the rate of heating
- b) the time at temperature
- c) the rate of cooling

B. Related Knowledge 20 Hours

Outcome: Apply basic worksite business practices.

1. Develop a resume for employment purposes.
2. Identify types of work-orders and their content with respect to:
 - a) quantity and quality of product
 - b) customer I.D.
 - c) graphic support
 - d) time and material availability
 - e) responsibilities
3. Interpret and explain the technical - administrative procedures related to the following documents:
 - a) invoices
 - b) purchase orders
 - c) shipping and receiving slips
 - d) requisition orders
 - e) payable, personal and company cheques
4. Communication on the job
 - a) List two efficient communication media used between management and workers.
 - b) Demonstrate effective communication with your co-workers.

5. Project progress reports
 - a) Write brief reports outlining the progress of a fabrication or assembly project.
6. Plant tours (choice of some of the following):
 - a) steel fabrication shops (vessel and structural)
 - b) rolling mills (available types)
 - c) operational job sites (with permitting authority)
 - d) foundries (when and where time permits)
7. Guest Speakers
 - a) unions
 - b) management
 - c) Apprenticeship Training Division
 - d) production representatives
8. Define the role and mission of the labour union organization.
9. Identify different production environments among local metal fabrication and assembly shops.
10. Assess the capabilities and specialty of machinery and metal working equipment among local enterprises.
11. Identify and describe an erection site at a typical power generating plant.
12. Describe the assembly sequences involving an erection of power boiler as observed during the excursion tour.

SECTION TWO:ADVANCED RIGGING 52 HOURS

A. Wire Rope Drums..... 4 Hours

Outcome: Demonstrate the working knowledge of wire rope drums.

1. Describe and state fleet angles for grooved and smooth drums.
2. Determine the required wire rope drum capacity.
3. Describe and demonstrate spooling procedures.

B. Advanced Block and Tackle 12 Hours

1. Determine the lead line force when the number of parts and load weight including rope size are known.
2. Identify the factors which determine the amount of wire rope needed for a reeving system.
3. Name three types of sheaves, friction bearings and the coefficient of friction expressed in percent.
4. Raise and lower a load using a reeved system.

C. Cranes..... 2 Hours

Outcome: Identify and demonstrate the knowledge of cranes and signals.

1. Identify and describe the following cranes
 - a) hydraulic

- b) conventional
 - c) rough terrain
 - d) high capacity cranes and new technology
2. Demonstrate or describe the following terms related to cranes:
 - a) general uses
 - b) use of tables
 - c) signals
 - d) boom assembly and disassembly
 - e) components
 - f) breakdown for transportation
 - g) safety precaution
 3. Name four major types of mobile cranes.
 4. Demonstrate the knowledge of signals
 5. Determine the basic procedures for the crane boom installation and removal.
 6. List the basic conditions for counterweight installation and removal.
 7. Determine the positioning of all pins at boom assembly.
 8. Determine the reason for and load reduction when jib is fitted on the boom.
 9. Determine in degrees the jib offset allowance in reference to the centreline.
 10. List three negative implications when crane is only 3 degrees out of level.

D. Hoisting and Jacking Equipment..... 10 Hours

Outcome: Describe and demonstrate the safe use of hoisting and jacking equipment.

1. Safe uses and calculations for hoisting and jacking equipment
2. Describe the proper use of chain falls, tiffors and come longs.
3. Calculate stress and explain the uses and safety hazards of high lines.
4. Perform rigging, hoisting and jacking operations in a safe and responsible manner in accordance with the Occupational Health and Safety Act and any other applicable regulations.
5. Rig loads safely and correctly for:
 - a) straight lifts
 - b) drifting
 - c) turning
6. Determine the positioning of tuggers
7. Determine air pressure requirements of tuggers
8. Determine anchor points of tuggers and hoists.
9. Describe safe and secure attachment of blocks to tuggers and hoists.
10. Describe types of hoists.
11. Describe the following jacking systems
 - a) skates, rollers and cribbing
 - b) air bags
 - c) hydraulic lifts

E. Scaffolds..... 8 Hours

Outcome: Describe the safe use of scaffolds.

1. Describe the complete set-up of all scaffolds and needle beams:
 - a) set-up.
 - b) plank inspection.
 - c) plank placing and securing.
 - d) ladder.
 - e) swingstage scaffolding.
 - f) suspended scaffolding.
 - g) needle beams.
 - h) modular platforms.
2. Describe the safe use of self-propelled work platforms.

F. Rigging Prints 2 Hours

Outcome: Interpret rigging prints.

1. Interpret from a rigging print the information required to position a crane for any lifting operation.

SECTION THREE: LAYOUT AND FITTING 98 HOURS

A. Mathematics 18 Hours

Outcome: Solve mathematical problems.

1. Compute squares and square roots of numbers
2. Apply square roots calculation in solving right angle triangle problems using Pythagorean Theorem.
3. Compute areas of flat planes
 - a) squares
 - b) parallelograms
 - c) triangles
 - d) rectangles
 - e) circles
 - f) sectors
4. Compute the surface areas of:
 - a) regular shaped solids, tanks and cylinders
 - b) pyramids and cones
 - c) prisms and cylinders
 - d) areas, radii, arc length, circumferences, central angles and diameters of circles
 - e) altitudes and bases of common polygons
 - f) circular sectors and segments
 - g) common polygons, given bases and altitudes
 - h) more complex figures consisting of two or more common polygons
5. Calculate volumes, capacities and weights of:
 - a) prisms and cylinders
 - b) pyramids and cones
 - c) spheres

B. Drawing Interpretation 24 Hours

Outcome: The ability to interpret drawings.

1. Demonstrate how to fabricate the following using drawing interpretation skills
 - a) vessels
 - b) tanks
 - c) boilers
 - d) related structures
2. Demonstrate how to erect vessels, tanks, boilers and related structures from drawing interpretation skills.
3. Interpret structural steel erection drawings.
4. Introduction to computer produced drawings.

C. Layout and Fabricating 30 Hours

Outcome: Demonstrate the knowledge of layout, fabrication practices and procedures.

1. Read a drawing and describe the component(s) used in the development and fabrication process.
2. List and describe the types, uses and care of plate layout tools.
3. Layout angles to meet the requirements of the fabrication from the drawing.
4. List and describe the abbreviations applicable to plate layout and development.
5. Calculate practical problems on squares, rectangles and circles for transfer to the plate for development and fabrication.
6. Develop a layout using basic geometric constructions on plate.
7. Read a drawing, determine the materials required and layout the pattern on the plate.
8. Develop a layout for the geometric construction of bolt circles, manholes, flanges and ellipses.
9. Layout and fabricate the following:
 - a) ladders and platforms
 - b) a davit for vertical and horizontal opening
 - c) a header
 - d) pipe turns and offsets
 - e) square ducts
 - f) cylinders and cones
 - g) pressure vessel shells
10. Perform radial nozzle installation.

D. Fibreglass Fitting 26 Hours

Outcome: Demonstrate the basic safe work practices related to fibre reinforced plastics.

1. Identify skills required to install fibreglass fittings:
 - a) blueprints
 - b) drilling
 - c) bolting
 - d) understanding types of resin

- e) cutting
 - f) grinding
 - g) laminating glass
2. Identify and describe the resins and fibreglass materials required to facilitate repairs on round and flat surfaces.
 3. Describe the uses of fibreglass in pulp mills, chemical plants and refineries.
 4. Describe where boilermakers use fibreglass in tanks, silos, stacks, breeching and piping.
 5. Define the purpose of the following fibreglass materials:
 - a) polyester resins
 - b) catalysts
 - c) promoters
 - d) surfacing veil
 - e) mat
 - f) woven roving
 - g) acetone
 - h) methylene chloride
 - i) air dry additive
 6. Perform the skills required to safely handle and store the chemicals required to assemble fibreglass pipe.
 7. Perform the skills required to facilitate repairs on round and flat surfaces.
 8. Describe the following tools and materials used for preparation and assembly
 - a) power cutter (skill saw)
 - b) power disc sander
 - c) extension cords
 - d) rags
 - e) wax paper (feeler wrapper)
 - f) rubber gloves
 - g) paper coveralls
 - h) face shields
 - i) safety goggles
 9. Describe the following measuring equipment
 - a) paper or plastic mixing cups
 - b) mixing sticks
 - c) plastic bucket graduated for measuring resin
 - d) glass for measuring promoters and catalysts
 - e) mixing pails
 10. Describe the following lay-up equipment
 - a) 10 mil surfacing veil
 - b) 1 1/2 oz. mat
 - c) woven roving
 - i) Describe the following procedures or equipment
 - a) tight fit up
 - b) sanding
 - c) filler
 - d) saturate mat

- e) stagger cut lengths
- f) mix resin and catalyst
- g) apply 10 mil surface veil
- h) remove air
- i) sand entire weld
- j) apply resin and air dry mix
- k) heat lamps
- l) application methods
- m) hand lay-up
- n) spray lay-up
- o) cutting, fitting and surface preparation
- p) outside joint (structural)
- q) inside joint (liner)

LEVEL 3

LEVEL 3 TECHNICAL TRAINING

BOILERMAKER TRADE COURSE OUTLINE

UPON SUCCESSFUL COMPETITION FO THIS PROGRAM, THE APPRENTICE SHOULD BE ABLE TO PERFORM THE FOLLOWING OUTCOMES AND OBJECTIVES.

SECTION ONE:.....MATERIALS AND RELATED KNOWLEDGE 30 HOURS

A. Testing of Materials 10 Hours

Outcome: Describe testing materials.

1. Describe the following types of destructive testing
 - a) tensile test
 - b) bend test
 - c) impact test
2. Differentiate between destructive and non-destructive testing of material.
3. Define the ultimate tensile strength.
4. Describe the principle involved in testing the steel toughness.
5. Describe the free-bend test used in weld testing.
6. Describe the following types of non-destructive testing
 - a) radiographic
 - b) ultrasonic
 - c) dye penetrate
 - d) hydrostatic
 - e) vacuum and air
7. State how a dye penetrate is used in determining the soundness of a weld area.
8. Describe the principle of ultrasonic testing.
9. Perform magnetic particle testing on a defective weld using a magnetic particle-testing unit.
10. Describe applications and limitations of vacuum and air testing
11. Perform visual inspection on a welded specimen and summarize the results.
12. Explain the principle and scope of radiographic testing.
13. Determine how radiographic inspection will show hidden defects in a weld.

B. Inspection 20 Hours

Outcome: Perform basic inspection practices.

1. Inspect and interpret material and welds with reference to:
 - a) soundness, size and shape
 - b) plate thickness and prescribe quality of material
 - c) positions of circumferential and longitudinal seams
 - d) heads, their opening and reinforcement
 - e) skirt, diameters and minimum thickness

- f) base rings and anchor bolt chairs
 - g) saddles, welded or shipped loose
 - h) shell openings, limitations and reinforcement
 - i) internals and removable internals
 - j) internal/external piping and flanges
 - k) ladders, platform and lugs
 - l) all fabrication tolerances within limits
2. Identify the characteristics of acceptable quality of components and parts based on:
 - a) code specifications
 - b) drawing requirements
 - c) general usage
 3. List four factors contingent to production flow in fabrication and assembly of pressure vessels.
 4. List three types (stages) of a product quality control.
 5. Describe two methods which can be used to improve production and productivity of fabrication processes.
 6. Describe the preparation for shipment of a final product with respect to the following components:
 - a) inside and outside of the vessel
 - b) finished surfaces
 - c) flanged openings
 - d) threaded openings
 - e) bolts and nuts
 - f) small parts and loose internals
 - g) loading and securing the vessel
 - h) markings and special instructions

SECTION TWO: LAYOUT AND FITTING 50 HOURS

A. Layout 30 Hours

Outcome: Demonstrate the ability to do advanced layout.

1. Interpret drawings to layout and fabricate square, round and elliptical holes.
2. Determine roll and brake capacity and allowances and proper direction to roll or bend.
3. Demonstrate power rolling equipment and recognize how to perform the following operations:
 - a) form a partial cylinder
 - b) form a partial cone
 - c) form a full ring
 - d) form a full cylinder and frustum of a cone
4. Develop templates using geometry, parallel lines, radial lines and triangulation using these templates to layout on plate in the proper sequence by setting square and to required angles and supporting same.
5. Develop patterns for various objects made in the shop using the triangulation method:
 - a) oblique pyramid
 - b) oblique cone
 - c) square to round transition
 - d) round to square transition
 - e) square to rotated square transition
 - f) square to round oblique transition

B. Fitting..... 20 Hours

Outcome: Describe and perform advanced and fitting techniques.

1. Fit pipes and shell section components from drawings by using the proper layout procedure, assemble with the proper tools and fitting aids, know the misalignment allowances, fit shells to shells, heads to heads, layout on shells, heads, repads and nozzles, fit tray rings and downcomer bars, ladder and platform clips, davits, skirts or bases and all other miscellaneous components.
2. Develop patterns for various objects fabricated in the shop using the radial development method:
 - a) pyramidal shapes (hopper)
 - b) hopper cut at an angle
 - c) variety of right circular cones with different upper and lower shapes
3. Describe how to fit up circumferential seams
4. Describe how to fit up and align longitudinal seams
5. Describe how to fit up shell to shell of equal thickness
6. Describe how to fit up shell to shell of unequal thickness
7. Describe how to fit up shell to head
8. Describe how to fit up reinforcing pads to nozzle and shell
9. Describe how to fit up repads to heads
10. Describe how to layout and fit up nozzle, coupling and structural components to the shell and head
11. Describe how to layout a vessel base ring and skirt openings
12. Describe how to assemble and fit up absorbing tower trays and down comers
13. Describe how to fabricate and assemble davit parts for vertical and horizontal openings including hinges
14. Describe how to install a tangential nozzle

SECTION THREE:TRADE RELATED COMPONENTS 100 HOURS

Special emphasis should be placed on procedures used in installation, shut-downs and emergency repairs and recognition of the time limitations of shut-downs and emergency repairs.

A. Boilers..... 30 Hours

The boiler print course should be complemented by boiler components and erection procedure practice, where suitable shop equipment and time will permit.

Outcome: Describe the basics of boilers and their components.

1. Describe rigging and welding procedures for the following Boiler components:
 - a) structure
 - b) drums
 - c) headers
 - d) tubes
 - e) platens
 - f) buck stays
 - g) casing
 - h) fire door
 - i) super heater elements
 - j) reheat elements
 - k) economiser
 - l) air heater
 - m) deaerator
 - n) water treatment
2. Describe the working operation of a water tube boiler.
3. Describe boiler tube installation procedures, for the following:
 - a) preparation of tube sheets
 - b) tube sizes
 - c) tube material
 - d) expanding limits
 - e) fit up of tube
 - f) tube bending
 - g) seal welding
 - h) tack tubes
 - i) self feed expander
 - j) retractive
 - k) lubrication
 - l) mandrels
 - m) over rolling
 - n) under rolling
 - o) micrometers and gauges
 - p) belling
 - q) ferrules
 - r) repairing leaks
 - s) testing
4. Identify the following auxilliary boiler equipment, steam generator components and state their function, material origin, and any special features:
 - a) drums and headers

- b) platen and buckstays
 - c) super heater and reheater
 - d) economiser and air heater
 - e) deaerator
 - f) air ducts
 - g) stacks and breaching
 - h) condenser
 - i) fans, I.D. and F.D.
 - j) intake and discharge lines
 - k) precipitators
 - l) wet and dry electrostatic precipitators
 - m) stokers
 - n) burners
 - o) bag houses
 - p) scrubbers
 - q) selective catalytic reducers
 - r) air cooled condensers (ACC)
 - s) testing and codes
5. Identify boiler tube designation with respect to sizing and quality of material.
 6. Describe the function of tubes in various arrangements.
 7. Identify the two basic methods used to fabricate tubes.
 8. Determine the tube bending procedures with reference to:
 - a) long radius bends
 - b) short radius bends
 - c) very short radius bends (super heater section)
 - d) using field type equipment
 9. List methods of tube attachments.
 10. Describe basic procedures for watertube boiler tube installation including the preparation and cleaning process.
 11. Identify and describe standard propulsive tube expander.
 12. Identify and describe retractive expander.
 13. Explain the principle of tube expansion including the theory involving the flow of tube material.
 14. Describe the usual adopted tube expanding procedures stating the upper and lower limitations.
 15. List tube expanding, checking and measuring devices in use.
 16. Define the purpose of tack tubes.
 17. Identify and explain the following additional operations involving tube forming or welding:
 - a) expanded and beaded
 - b) beaded and seal welded
 - c) expanded and welded
 - d) expanded and bevel welded
 - e) expanded and flared
 - f) expanded by prosser method
 - g) expanded with ferrules
 18. Explain the following terms which are associated with the tube hole arrangement:
 - a) circumferential pitch
 - b) alignment

- c) pitch
- d) removal space
- e) longitudinal pitch
- f) diagonal pitch

19. Set-up and perform tube rolling operations.
20. Set-up and perform tube bending operations.
21. Set-up and perform tube installations and tube removals.
22. Describe and perform procedures for tube repair(s):
 - a) knowledge of Boiler code and local regulations
 - b) identify tube(s) to be repaired
 - c) mark tube(s) for cutting
 - d) cut out tube(s)
 - e) prevent tube blockage
 - f) prepare existing tube ends
 - g) prepare replacement tube(s)
 - h) fit and tack replacement tube(s)
 - i) variation of tube repair
 - j) window weld
 - k) appropriate preparation for different wall thickness

B. Tanks 30 Hours

The tank print course should be complemented by tank components and erection procedure practice, where suitable shop equipment and time will permit.

Outcome: Identify and describe the knowledge of tanks.

1. Know and identify the different types of materials described under this topic:
 - a) carbon steel
 - b) alloy steel
 - c) nonferrous metals
 - d) gauges and plates
 - e) mesh and screen
2. Determine the tank steel plate standard used for shells and decks with reference to the A.P.I. specification.
3. Distinguish between the scope of A.P.I. 650 and A.P.I. 620 standard and tank repair code A.P.I. 651 or 653
4. Prepare materials for welding by proper preparation, spacing, alignment and safety.
5. Identify the type of welding and joint preparation for a tank bottom, shell and deck.
6. Determine the type of welding on: roof to the top angle, bottom to shell, shell to the top angle
7. State the rule for vertical and horizontal seam openings.
8. Perform the fit up and alignment of tank horizontal and vertical seams.
9. Describe the differences of the following types of tanks:
 - a) vertical and horizontal (cylindrical)
 - b) closed top or open (vented)
 - c) elevated spheres

- d) penstock
 - e) scroll cases
10. Identify the typical horizontal, vertical and spherical type of tank settings.
 11. State the difference between the penstock and scroll or spiral casing.
 12. Describe the environmental and economical advantages of closed top tank design.
 13. Describe the difference between a cone roof, hemispherical roof and a floating roof.
 14. Explain the following terms associated with floating roofs:
 - a) hard top floater
 - b) pontoon floater
 - c) double-deck floater
 15. Describe the difference between a flat (butt or lap) floor, orange peel floor and a hopper floor.
 16. Describe the basic steps in laying out flat tank floor.
 17. Describe the procedures involving minimum flat lap welding and flushing lapped plates.
 18. Describe the uses of balance beams, knee braces, key plates, clamps, dogs and wedges as used in tank construction.
 19. Perform fit up using key plates, leaf springs, finger bars and pins, wedges and dogs, clamps and nuts.
 20. Layout key plate lugs on the shell plate sections prior to being set up in position.
 21. Layout shell plate with reference to the vertical seams staggering.
 22. Layout and erect typical tank scaffolding.
 23. Describe the complete tank erection procedures of the components listed:
 - a) site preparation
 - b) floor
 - c) first shell ring
 - d) succeeding rings
 - e) top angle
 - f) roof supports and roof
 - g) ladders, stairways and platforms, etc.
 - h) shell fittings
 - i) testing and repairs if required
 24. State the general condition of tank foundation and list negative effects encountered during an erection due to uneven surfaces.
 25. Perform layout and fit up at a typical flat bottom lap joint.
 26. Layout and erect the first shell ring
 27. Erect and properly space the succeeding rings.
 28. Perform layout and fit up of the top angle.
 29. Layout and fit up a conical self supported roof.
 30. Layout and fit up shell, roof and bottom openings for a given:
 - a) manway
 - b) cleanout
 - c) water or fluid drawoff elbow
 - d) drawoff sump
 - e) inlet outlet

- f) overflow venting
- g) walkway, stairway and ladders

31. Describe how to test tank bottom, shell and roof using one or two of the approved methods of testing.
32. Inspect all seams for unwelded spots and faulty welding.
33. Differentiate inspection requirement for large and small tanks specified by the API. 650 and API. 620.
34. Describe cathodic protection.

C. Condensers and Exchangers 30 Hours.

The condensers and exchangers print course should be complemented by erection and maintenance practice, where suitable shop equipment and time will permit.

Outcome: Identify and demonstrate the knowledge of condensers and exchangers.

1. Identify different types of exchangers as listed below:
 - a) single pass
 - b) multi pass
 - c) split flow
 - d) double split flow
 - e) divided flow
 - f) cross flow
 - g) kettle type reboiler
2. Identify different design of heat exchangers as classified by the T.E.M.A. with reference to:
 - a) front stationary head
 - b) rear head
3. Identify different types of tubes as listed:
 - a) expanded
 - b) welded
 - c) materials
4. Identify heat exchanger and condenser tubes with respect to:
 - a) types of material and job application
 - b) material designation
 - c) standard sizes and gauges
 - d) tolerances
 - e) fabrication and bending procedures
5. Identify the different shells as listed below:
 - a) Identify types of baffles, their function and installation procedures.
 - b) Identify four different tube sheet layouts and state their preference of application.
 - c) Determine the pitch for a triangular tube sheet layout.
 - d) Identify the various qualities of material for different applications.
6. Explain the following types of heads:
 - a) channel and removable cover
 - b) bonnet
 - c) channel integral with tube sheet
 - d) pull through and floating head
 - e) outside packed floating head
7. Describe tube expanding procedures for condensers and exchangers:
 - a) tube sheet layout

- b) number of tubes
 - c) type of metals
 - d) length of tubes
 - e) diameter of tube (O.D.)
 - f) wall thickness of tubes
 - g) tube sheet or header thickness
 - h) expansion required
 - i) lubrication
8. List the basic steps associated with tube installation
 9. State the recommended tube expansion sequences with reference to tube sheet layout, its area and shape.
 10. Measure the inside diameter of a tube.
 11. Calculate the expanded diameter of a tube.
 12. Determine the percentage wall reduction as recommended for ferrous and non-ferrous materials.
 13. List recommended lubricants.
 14. Identify the optimum length of expanded seat.
 15. Explain the reason for grooved seats
 16. Identify the factors affecting the quality of an expanded joint with reference to:
 - a) surface of hole
 - b) roundness of hole
 - c) cleanliness of hole
 - d) expansion past the inner edge of tube sheet
 - e) overheating
 - f) roller speed
 - g) mechanical properties of tube and tube sheet
 - h) lubrication or lack of it
 - i) over expansion and indication of it
 17. Describe expanding equipment listed to install condenser and exchanger tubes:
 - a) compressor
 - b) air motor
 - c) electric motor
 - d) tube and mills
 - e) tube expanders
 - f) fly cutters
 - g) tube cutters
 - h) tube cleaning
 - i) tube removal tools
 - j) micrometers
 - k) torque wrench
 18. Describe the specific characteristics of air and electrically powered expander drives including the accessories and controls.
 19. Describe tube end milling equipment, set up and techniques employed.
 20. Determine the reason for the mandrel conical shape.
 21. State the purpose of bell roll(s).
 22. Identify the propulsive type of expander.

23. Demonstrate the ability to identify and use the following tools:
 - a) fly and tube cutters
 - b) tube removal tools
 - c) torque wrench
 - d) micrometers and gauges
24. Explain the principle involving explosive tube expansions.
25. Perform tube expansions into tube sheet using electrical and air powered expander drives.
26. Perform tube flaring using flaring tools.
27. Describe the procedure to locate, remove, replace and test for defects when making repairs to exchangers.
28. Inspect for tube leakage involving removal of:
 - a) cover or bonnet
 - b) shell cover and floating head
 - c) channel
29. Perform hydrostatic test of shell using test ring (on types S & T).
30. Remove the tube bundle, inspect and replace it.
31. Assemble the heat exchanger and perform proper stud tightening procedures.
32. Perform tube plug installation and identify plug material compatibility related to the tube.
33. Identify the possible safety features associated with heat exchangers, testing, inspections and repairs.

D. Introduction to Other Heavy Industry 10 Hours

Outcome: Identify and describe other heavy industry.

1. Identify practices used in the erection of penstocks and surge tanks.
2. Identify the function of all components needed for the erection of penstocks and surge tanks:
 - a) footings
 - b) tie bars
 - c) spiders
 - d) tie straps
3. Describe how nuclear generating works.
4. Identify special procedures used when working on nuclear plants and components:
 - a) problems specific to nuclear plants
 - b) material which cannot be used
 - c) difference in metals
 - d) quality control
 - e) special materials
 - f) radiation
 - g) radiation hazards
 - h) weldment requirements
 - i) expanding requirements

BLMR-1830 Program Review
(Nova Scotia Unit of Instruction)

Learning Outcomes:

- Upon successful completion of this unit, the apprentice will complete a study plan based on the National Occupational Analysis.

Objectives and Content:

1. Identify areas of the program where knowledge of theory is weakest.
2. Identify areas where workplace experience is lacking or weak.
3. Identify resources necessary to address areas of shortfall.
4. Identify timelines to address areas of weakness.

Suggested Learning Activities:

1. Conduct a mock certification exam to be used for diagnostic purposes.
2. Review the National Occupational Analysis.
3. Review the Apprentice Logbook.
4. Review the Exam Preparation information found at www.nsapprenticeship.ca under Exam Preparation.
5. Conduct a final mock certification exam.

Resources:

These are the recommended resources to use in the delivery of this unit:

- Exam Preparation information, including videos, occupational analyses, exam counseling sheets, practice exams and sample questions, and other study materials and resources, can be found at www.nsapprenticeship.ca under Exam Preparation.
- Apprentice's personal logbook
- Applicable codes and regulations
- Program texts

Evaluation: pass/fail

Formulas

The courses listed below are required technical training in the Nova Scotia Boilermaker Apprenticeship Program.

Formula Sheet

$$\text{Working Load Limit} = \text{Dia}^2 \times 8$$

$$\text{Circumference} = C = \pi D \quad \text{or} \quad C = 2\pi r$$

$$\text{Lead Line Pull} = \frac{WT}{R}$$

$$\text{Pythagorean Theorem} = a^2 + b^2 = c^2$$

$$\text{Mean Diameter} = OD - 1 \text{ PL THK} \\ ID + 1 \text{ PL THK}$$

$$\text{Factors for the Angle of Cut} = \frac{\text{Angle of Turn}}{\# \text{ of welds} \times 2}$$

$$\text{Area of Rectangle} = L \times W$$

$$\text{Area of Circle} = A = \pi r^2$$

$$\text{Arc Length} = \frac{\text{Arc Length Angle} \times C}{360^\circ}$$

$$\text{Wrench Size} = 1\frac{1}{2} \times \text{bolt size} + \frac{1}{8}''$$

$$\text{Volume of Cube} = L \times W \times H$$

$$\text{Tension in 1 Sling} = \frac{W}{N} \times \frac{L}{V}$$

$$\text{Clip Spacing} = 6 \times \text{rope's dia.}$$

$$V - \text{Block Opening for a } 90^\circ \text{ Air Bend on Heavier Plate} = 10 \times \text{THK of PL}$$

$$\text{Length of bolt} = \text{Length of grip} + \text{washer THK} + \text{nut THK} + 2 \text{ Threads}$$

$$\text{Number of Wire Rope Clips} = 4 \times \text{rope dia.} + 1$$

Nova Scotia Document Evaluation Form

Thank you for your interest in the development and revision of this document. Upon review of the document, please record your feedback in relation to the following items:

- course division and organization
- relevancy of the content
- errors or omissions
- other suggestions for improvement and consideration

Overall comments are to be entered on this evaluation form and specific changes are to be entered directly on the document in the relevant area(s). When making proposed corrections(s) in the document, please use red ink. When all feedback has been recorded, return this evaluation form along with the document to the Apprenticeship Office noted at the bottom of the page.

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