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PROGRAM OUTLINE

Marine Mechanical Technician

SKILLED TRADES BC

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SKILLED TRADES BC

MARINE MECHANICAL TECHNICIAN
PROGRAM OUTLINE

APPROVED BY INDUSTRY

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Developed by
SkilledTradesBC
Province of British Columbia

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Section 1

INTRODUCTION

Marine Mechanical Technician

Foreword

This Program Outline is for use in Marine Mechanical Technician industry training classes sponsored by SkilledTradesBC and will be used as a guide for instructors in the formal classroom portions of industry training.

Practical demonstration and trainee participation should always be integrated with classroom sessions.

Safe working practices, though not always specified in each of the competencies and learning tasks, are an implied part of the program and should be stressed throughout the apprenticeship.

This Program Outline includes a list of recommended reference textbooks that are available to support the learning objectives and the minimum shop requirements needed to support instruction.

SAFETY ADVISORY

Be advised that references to the WorkSafeBC safety regulations contained within these materials do not/may not reflect the most recent Occupational Health and Safety Regulation (the current Standards and Regulation in BC can be obtained on the following website: http://www.worksafebc.com). Please note that it is always the responsibility of any person using these materials to inform him/herself about the Occupational Health and Safety Regulation pertaining to his/her work.

Acknowledgements

The Program Outline was prepared with the advice and direction of an industry steering committee convened initially by the Transportation Career Development Association (transCDA) members include:

- Glenn Spartz
- Ian MacPherson
- Chris Gough

Industry Subject Matter Experts retained to assist in the development of Program Outline content:

- Marine Industry Workforce Development Committee
- West Coast Boatyard Association
- BC Yacht Building Association
- BC Marine Trades Association

Industry Subject Matter Experts retained as outline reviewers:

- Ben Cook
- Russell Oye

Facilitators:

- Jen Rasmussen, Transportation Career Development Association of BC
- Greg Shorland, Transportation Career Development Association of BC

SkilledTradesBC would like to acknowledge the dedication and hard work of all the industry representatives appointed to identify the training requirements of the Marine Mechanical Technician occupation.

How to Use this Document

This Program Outline has been developed for the use of individuals from several different audiences. The table below Describe how each section can be used by each intended audience.

Section	Training Providers	Employers/ Sponsors	Apprentices	Challengers
Program Credentialing Model	Communicate program length and structure, and all pathways to completion	Understand the length and structure of the program	Understand the length and structure of the program, and pathway to completion	Understand challenger pathway to Certificate of Qualification
OAC	Communicate the competencies that industry has defined as representing the scope of the occupation	Understand the competencies that an apprentice is expected to demonstrate in order to achieve certification	View the competencies they will achieve as a result of program completion	Understand the competencies they must demonstrate in order to challenge the program
Training Topics and Suggested Time Allocation	Shows proportionate representation of general areas of competency (GACs) at each program level, the suggested proportion of time spent on each GAC, and percentage of time spent on theory versus practical application	Understand the scope of competencies covered in the technical training, the suggested proportion of time spent on each GAC, and the percentage of that time spent on theory versus practical application	Understand the scope of competencies covered in the technical training, the suggested proportion of time spent on each GAC, and the percentage of that time spent on theory versus practical application	Understand the relative weightings of various competencies of the occupation on which assessment is based
Program Content	Defines the objectives, learning tasks, high level content that must be covered for each competency, as well as defining observable, measureable achievement criteria for objectives with a practical component	Identifies detailed program content and performance expectations for competencies with a practical component; may be used as a checklist prior to signing a recommendation for certification (RFC) for an apprentice	Provides detailed information on program content and performance expectations for demonstrating competency	Allows individual to check program content areas against their own knowledge and performance expectations against their own skill levels
Training Provider Standards	Defines the facility requirements, tools and equipment, reference materials (if any) and instructor requirements for the program	Identifies the tools and equipment an apprentice is expected to have access to; which are supplied by the training provider and which the student is expected to own	Provides information on the training facility, tools and equipment provided by the school and the student, reference materials they may be expected to acquire, and minimum qualification levels of program instructors	Identifies the tools and equipment a tradesperson is expected to be competent in using or operating; which may be used or provided in a practical assessment

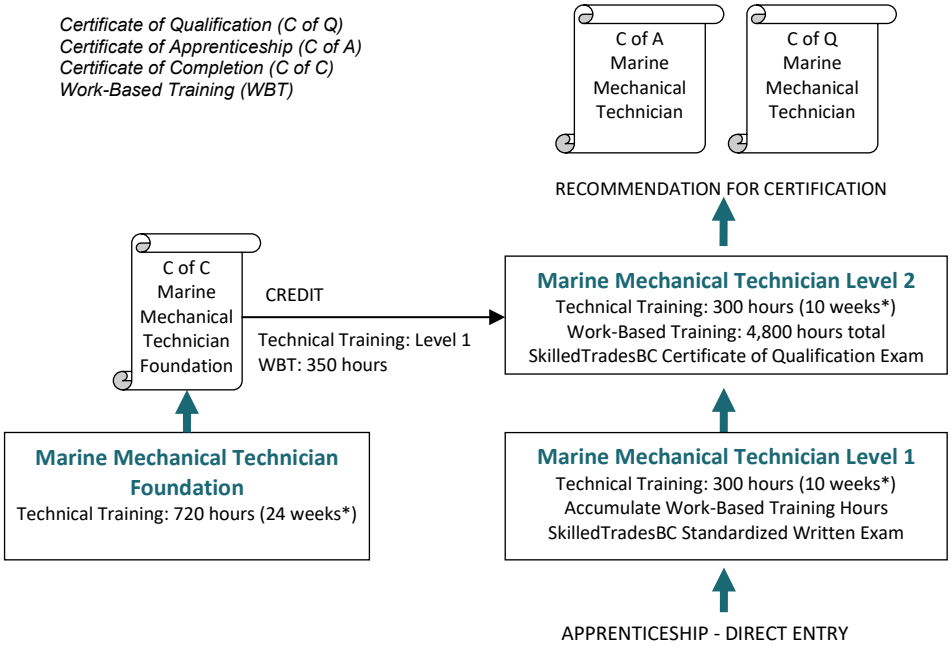
Section 2

PROGRAM OVERVIEW

Marine Mechanical Technician

Program Credentialing Model

This graphic provides an overview of the Marine Mechanical Technician Program apprenticeship pathway:



**Suggested duration based on 30-hour week*

CROSS-PROGRAM CREDITS

Individuals who hold the credentials listed below are entitled to receive partial credit toward the completion requirements of this program:

C of Q Inboard/ Outboard Mechanic	Technical Training: None Work-Based Training: 2,250** hours
C of Q Marine Service Technician	Technical Training: None Work-Based Training: 1,125** hours
C of Q Automotive Service Technician	Technical Training: None Work-Based Training: 2,250** hours
C of Q Heavy Duty Equipment Technician	Technical Training: None Work-Based Training: 2,250** hours
C of Q Diesel Engine Mechanic	Technical Training: None Work-Based Training: 2,250** hours
C of Q Truck and Transport Mechanic	Technical Training: None Work-Based Training: 2,250** hours
C of Q Motorcycle Technician	Technical Training: None Work-Based Training: 2,250** hours

***Individuals holding more than one of the above credentials will only be awarded credit for one credential totaling no more than 2,250 WBT hours.*

Occupational Analysis Chart

MARINE MECHANICAL TECHNICIAN

Occupation Description: “Marine Mechanical Technician” means a person who installs, troubleshoots, repairs and maintains engines, drive trains and other mechanical, electrical and fluid systems typically used in the recreational marine industry. Some light commercial and industrial applications are serviced. This work involves all aspects of repairs to diesel engines, gasoline engines, outboard engines, conventional inboard drive trains and stern drives.

OCCUPATIONAL SKILLS A	Use tools and equipment A1	Work safely A2	Follow safe yard and marina practices A3	Operate vessels A4	Use documentation A5	Use fasteners and fittings A6
	Describe and use composites A7	Select and use lubricants and coolants A8				
VESSEL SYSTEMS **B**	Describe Thru-hulls B1	Describe cabin heating systems B2	Describe A/C and refrigeration theory B3	Describe safe propane installations B4	Describe davits, hoists and windlasses B5	Describe fire suppression equipment and lock outs B6
	Inspect and repair mechanical and electrical steering systems B7	Describe and install fresh/waste water plumbing systems B8	Describe water makers B9	Service and install bilge pump systems B10		
HYDRAULIC EQUIPMENT C	Describe hydraulic theory and system components C1	Service and install hydraulic steering systems C2	Diagnose and repair hydraulic equipment C3			

Program Overview

METAL WORKING D	Perform metal fabrication operations D1	Use oxy-acetylene torch D2				
	1	1				
ELECTRICAL E	Describe principles of electrical theory E1	Read and use electrical schematics E2	Use electrical measurement and diagnostic equipment E3	Describe storage battery types and applications E4	Select, install and test batteries E5	Service and install AC chargers and inverters E6
	1	1	1	1	1	1
	Diagnose alternators and charging faults E7	Diagnose engine starters and solenoids E8	Install DC electrical wiring and circuits for electrical equipment E9	Diagnose wiring and electrical components E10	Diagnose and install alarms, gauges and senders E11	Service and install gensets E12
	1	1	1	1	1	1
ENGINE SUPPORT SYSTEMS F	Service and install fuel tanks F1	Inspect and install fuel lines F2	Service fuel pumps and filters F3	Describe fuels and fuel additives F4	Describe inboard and I/O exhaust systems types and design F5	Inspect and repair exhaust systems F6
	1	1	1	1	2	2
	Describe engine room/compartment layout and ventilation F7					
	2					
ENGINES G	Describe reciprocating engine theory and operation G1	Diagnose and repair engine cooling systems G2	Perform leak down, cylinder balance and compression tests G3	Disassemble, inspect and reassemble engines G4	Measure engine components and specific machining requirements G5	Perform engine component adjustment procedures G6
	1	2	2	2	2	2

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BOAT TRAILERS H	Describe and service boat trailers H1				
	1				
MARINE DRIVE SYSTEMS I	Diagnose propellers I1	Remove and install propellers I2	Install I/O drives I3	Service and diagnose stern drive components I4	Repair transom housings I5	Describe jet drive and surface piercing drives I6
	2	2	2	2	2	2
	Service inboard drive trains I7	Diagnose inboard transmissions and V-drives I8	Diagnose drive train vibration sources I9	Install and service engine mounting systems I10	Diagnose and repair O/B drive components I11	Service thrusters and trim tabs I12
	2	2	2	2	2	2
IGNITION SYSTEMS J	Service ignition systems J1	Diagnose ignition system faults J2	Diagnose and repair conventional ignition systems J3	Diagnose and repair electronic ignition systems J4		
	2	2	2	2		
CONTROL SYSTEMS K	Diagnose and repair engine control systems K1	Describe autopilot types, systems K2				
	2	2				
FUEL DELIVERY L	Diagnose diesel injector pumps L1	Diagnose and service diesel injectors L2	Service diesel fuel transfer pump and primary fuel systems L3	Inspect and treat diesel fuel L4	Service engine preheat systems L5	Service turbochargers and intercoolers L6
	2	2	2	2	2	2
	Service gasoline fuel system components L7	Diagnose and repair gasoline fuel systems faults L8	Diagnose and repair oil injection systems L9			
	2	2	2			

Training Topics and Suggested Time Allocation

MARINE MECHANICAL TECHNICIAN – LEVEL 1

			% of Time Allocated to:		
		% of Time	Theory	Practical	Total
Line A	**OCCUPATIONAL SKILLS**	**18%**	**60%**	**40%**	**100%**
A1	Use tools and equipment	3%	✓	✓	
A2	Work safely	3%	✓	✓	
A3	Follow safe yard and marina practices	2%	✓		
A4	Operate vessels	1%	✓		
A5	Use documentation	1%	✓		
A6	Use fasteners and fittings	1%	✓	✓	
A7	Describe and use composites	3%	✓	✓	
A8	Select and use lubricants and coolants	4%	✓	✓	
Line B	**VESSEL SYSTEMS**	**18%**	**75%**	**25%**	**100%**
B1	Describe Thru-hulls	2%	✓		
B2	Describe cabin heating systems	2%	✓		
B3	Describe A/C and refrigeration theory	2%	✓		
B4	Describe safe propane installations	1%	✓		
B5	Describe davits, hoists and windlasses	2%	✓		
B6	Describe fire suppression equipment and lock outs	1%	✓		
B7	Inspect and repair mechanical and electrical steering systems	2%	✓	✓	
B8	Describe and install fresh/waste water plumbing systems	4%	✓	✓	
B9	Describe water makers	1%	✓		
B10	Service and install bilge pump systems	3%	✓	✓	
Line C	**HYDRAULIC EQUIPMENT**	**10%**	**62%**	**38%**	**100%**
C1	Describe hydraulic theory and system components	4%	✓		
C2	Service and install hydraulic steering systems	3%	✓	✓	
C3	Diagnose and repair hydraulic equipment	3%	✓	✓	
Line D	**METAL WORKING**	**6%**	**30%**	**70%**	**100%**
D1	Perform metal fabrication operations	3%	✓	✓	
D2	Use oxy-acetylene torch	3%	✓	✓	
Line E	**ELECTRICAL**	**32%**	**52%**	**48%**	**100%**
E1	Describe principles of electrical theory	4%	✓		
E2	Read and use electrical schematics	1%	✓		
E3	Use electrical measurement and diagnostic equipment	3%	✓	✓	
E4	Describe storage battery types and applications	2%	✓		
E5	Select, install and test batteries	2%	✓	✓	
E6	Service and install AC chargers and inverters	1%	✓	✓	
E7	Diagnose alternators and charging faults	2%	✓	✓	
E8	Diagnose engine starters and solenoids	2%	✓	✓	
E9	Install DC electrical wiring and circuits for electrical equipment	2%	✓	✓	

			% of Time Allocated to:		
		% of Time	Theory	Practical	Total
E10	Diagnose wiring and electrical components	3%	✓	✓	
E11	Diagnose and install alarms, gauges and senders	2%	✓	✓	
E12	Service and install gensets	5%	✓	✓	
Line F	**ENGINE SUPPORT SYSTEMS**	**8%**	**48%**	**52%**	**100%**
F1	Service and install fuel tanks	2%	✓	✓	
F2	Inspect and install fuel lines	1%	✓	✓	
F3	Service fuel pumps and filters	3%	✓	✓	
F4	Describe fuels and fuel additives	2%	✓		
Line G	**ENGINES**	**6%**	**100%**	**0%**	**100%**
G1	Describe reciprocating engine theory and operation	6%	✓		
Line H	**BOAT TRAILERS**	**2%**	**100%**	**0%**	**100%**
H1	Describe and service boat trailers	2%	✓		
	Total Percentage for Marine Mechanical Technician Level 1	**100%**			

Training Topics and Suggested Time Allocation

MARINE MECHANICAL TECHNICIAN – LEVEL 2

			% of Time Allocated to:		
		% of Time	Theory	Practical	Total
Line F	**ENGINE SUPPORT SYSTEMS**	**3%**	**67%**	**33%**	**100%**
F5	Describe inboard and I/O exhaust systems types and design	1%	✓		
F6	Inspect and repair exhaust systems	1%	✓	✓	
F7	Describe engine room/compartment layout and ventilation	1%	✓		
Line G	**ENGINES**	**22%**	**37%**	**63%**	**100%**
G2	Diagnose and repair engine cooling systems	2%	✓	✓	
G3	Perform leak down, cylinder balance and compression tests	2%	✓	✓	
G4	Disassemble, inspect and reassemble engines	16%	✓	✓	
G5	Measure engine components and specific machining requirements	1%	✓	✓	
G6	Perform engine component adjustment procedures	1%	✓	✓	
Line I	**MARINE DRIVE SYSTEMS**	**39%**	**37%**	**63%**	**100%**
I1	Diagnose propellers	2%	✓	✓	
I2	Remove and install propellers	2%	✓	✓	
I3	Install I/O drives	6.5%	✓	✓	
I4	Service and diagnose stern drive components	4%	✓	✓	
I5	Repair transom housings	4%	✓	✓	
I6	Describe jet drive and surface piercing drives	1%	✓		
I7	Service inboard drive trains	6.5%	✓	✓	
I8	Diagnose inboard transmissions and V-drives	4%	✓	✓	
I9	Diagnose drive train vibration sources	2%	✓	✓	
I10	Install and service engine mounting systems	3%	✓	✓	
I11	Diagnose and repair O/B drive components	2%	✓	✓	
I12	Service thrusters and trim tabs	2%	✓	✓	
Line J	**IGNITION SYSTEMS**	**12%**	**31%**	**69%**	**100%**
J1	Service ignition systems	2%	✓	✓	
J2	Diagnose ignition system faults	4%	✓	✓	
J3	Diagnose and repair conventional ignition systems	2%	✓	✓	
J4	Diagnose and repair electronic ignition systems	4%	✓	✓	
Line K	**CONTROL SYSTEMS**	**7%**	**55%**	**45%**	**100%**
K1	Diagnose and repair engine control systems	5%	✓	✓	
K2	Describe autopilot types, systems	2%	✓		
Line L	**FUEL DELIVERY**	**17%**	**35%**	**65%**	**100%**
L1	Diagnose diesel injector pumps	4%	✓	✓	

			% of Time Allocated to:		
		% of Time	Theory	Practical	Total
L2	Diagnose and service diesel injectors	2.5%	✓	✓	
L3	Service diesel fuel transfer pump and primary fuel systems	0.5%	✓	✓	
L4	Inspect and treat diesel fuel	1%	✓	✓	
L5	Service engine preheat systems	2%	✓	✓	
L6	Service turbochargers and intercoolers	2%	✓	✓	
L7	Service gasoline fuel system components	2%	✓	✓	
L8	Diagnose and repair gasoline fuel systems faults	2%	✓	✓	
L9	Diagnose and repair oil injection systems	1%	✓	✓	
	Total Percentage for Marine Mechanical Technician Level 2	**100%**			

Section 3

PROGRAM CONTENT

Marine Mechanical Technician

Level 1

Marine Mechanical Technician

Line (GAC): A OCCUPATIONAL SKILLS

Competency: A1 Use tools and equipment

Objectives

To be competent in this area, the individual must be able to

- Describe the principles of FRP construction techniques, especially with regard to factors that influence or are influenced by mechanical installations.
- Describe the principles of steel and aluminum construction techniques, especially with regard to factors that influence or are influenced by mechanical installations.
- Describe the function and use of common trade measurement tools
- Demonstrates the accurate use of common trade measurement tools
- Describe engine overhaul tools and their use
- Uses engine overhaul tools to disassemble and reassemble major engine components

LEARNING TASKS	CONTENT
1. Describe principles of FRP vessel construction	• FRP materials • Molds and molding • One-off construction • FRP reinforcing structures • Design and construction considerations for mechanical installations
2. Describe principles of metal vessel construction	• Construction in steel • Construction in aluminum • Construction techniques • Design and construction considerations for mechanical installations
3. Describe the function and use of trade measurement tools	• Measurement terminology • Imperial and metric systems • Scales • Micrometers • Callipers • Laser measurement tools • Temperature measurement tools • Pressure measurement tools
4. Demonstrate the correct application and use of measurement tools	• Imperial and metric systems • Scales • Micrometers • Callipers • Laser measurement tools • Temperature measurement tools • Pressure measurement tools

LEARNING TASKS	CONTENT
5. Describe engine overhaul tools and their use	• Dial bore gauge • Ring compressor • Micrometer and depth gauge • Valve spring compressor • Plasticgauge • Seal and sleeve installers • Harmonic balancer installation/removal tool • Speedy sleeves
6. Use engine overhaul tools	• Dial bore gauge • Ring compressor • Micrometer and depth gauge • Valve spring compressor • Plasticgauge • Seal and sleeve installers • Harmonic balancer installation/removal tool • Speedy sleeves

Achievement Criteria

Performance: A1 Use tool and equipment

Conditions: The learner will require:

- Tools
- Test equipment
- Manufactures Specifications
- A work place or training environment
- Equipment with Occupational Skills

Criteria: The learner will be competent once the performance criteria is met:

- Followed safe work practices throughout entire task including lock out procedures
- Conducted in a logical manner
- Conducted according to manufacturer's specifications
- Conducted according to work place requirements

Line (GAC): A OCCUPATIONAL SKILLS

Competency: A2 Work safely

Objectives

To be competent in this area, the individual must be able to

- Describe the elements of safe working practices in a marine industry workplace
- Describe common hazards and risks of accident/injury in a marine industry workplace
- Describe WHMIS, labelling of hazardous materials, and use of MSDS documents
- Describe safe handling and labelling hazardous materials commonly found in the recreational marine industry workplace
- Describe the reasons and use of personal protection gear for prevention of injury or illness from exposure to hazardous materials by inhalation and skin contact.
- Describe the use of eye protection and hearing protection gear
- Demonstrates proper use of respirators, skin protection, eye and hearing protection gear
- Describe the nature and stages of fire development and correct procedures to follow upon the event of a workplace fire.
- Describe the use of smothering, water and fire extinguishers for suppressing a workplace fire
- Demonstrates the use of fire extinguishers to put out a fire in a supervised firefighting demonstration setting.
- Describe the common hazards related to working in confined spaces in typical marine industry settings and proper safe working procedures.
- Describe the hazards associated with falling into deep water and safety precautions for working around water.
- Describe lockout/tagging procedures to prevent personal injury or equipment damage from inadvertent starting or energizing of shop power equipment.
- Describe lockout/tagging procedures to prevent personal injury or equipment damage from inadvertent starting of engines or activation of machinery.
- Describe tagging procedures to prevent inadvertent use of a vessel or systems when critical components or alarms are inoperable.

LEARNING TASKS	CONTENT
1. Describe safe work practices	• Awareness of hazards and risks • Ladders and scaffolds • Power tool and equipment safety • Heavy lifting equipment safety • Muscular, repetitive stress and lifting • Electrical safety • Fire prevention
2. Describe common marine workplace hazards and risks	• Untidiness, tripping hazards • Falls • Exposure to chemicals, dusts, fumes • Fire and explosion hazards
3. Describe WHMIS regulations, labelling and use of MSDS	• Purpose of WHMIS • MSDS • Labelling
4. Describe safe handling and labelling of common marine industry hazardous materials	• Solvents • Paints • Fuels • Compressed gas

5. Describe use of Personal Protective Equipment (PPE)	• Respirator and cartridge types and uses
	  ○ Protection from dusts
	  ○ Respirator fit test
	• Gloves
	• Protective clothing
	• Eye protection
	• Hearing protection

6. Describe stages of fire development and appropriate response upon discovering a fire in the workplace	• Types of flammable materials • Stages of fire development • Sounding the alarm • Location and protection of others • Fire fighting decisions • Preparation for arrival of firefighters
7. Describe common firefighting tools in the workplace	• Use of smothering materials • Water • Fire extinguisher types, identification and use
8. Demonstrate the use of portable fire extinguishers	• P.A.S.S. ○ Pull

LEARNING TASKS	CONTENT
	○ Aim ○ Squeeze ○ Sweep
9. Describe safe practices for working in confided spaces	• Fire hazards • Engine rooms and mechanical hazards • Fumes, oxygen depletion and CO hazards • Working alone, "buddy" systems and communications
10. Describe hazards associated with working near deep water	• Hypothermia • Means of getting to safety • Life jacket/pfd use • Working alone, 'buddy' systems and communications
11. Describe lockout/tagging procedures for electrical shop tools and equipment, and vessel engine and systems	• Distribution panels • Power tools • Engine starting • Tagging to prevent engine/vessel use • Disconnection of alarm systems

Achievement Criteria

Performance: A2 Work Safely

Conditions: The learner will require:

- Tools
- Test equipment
- Manufactures Specifications
- A work place or training environment
- Equipment with Occupational Skills

Criteria: The learner will be competent once the performance criteria is met:

- Followed safe work practices throughout entire task including lock out procedures
- Conducted in a logical manner
- Conducted according to manufacturer's specifications
- Conducted according to work place requirements

Line (GAC): A OCCUPATIONAL SKILLS

Competency: A3 Follow safe yard and marina practices

Objectives

To be competent in this area, the individual must be able to

- Describe the use of common vessel hauling equipment
- Describe the methods and techniques for blocking vessels on shore
- Ties common knots and secures vessels safely to docks
- Describe the procedures, equipment and techniques for lifting engines and other heavy equipment in and out of vessels.
- Demonstrates the safe use of heavy lifting equipment for lifting engines and other heavy equipment in and out of vessels.
- Describe the correct procedures for winterizing and laying up engines, peripheral equipment and other vessel systems
- Describe the proper and legal procedures for disposing of hazardous materials commonly found in the marine industry workplace.
- Describe procedures for dealing with accidental spills in the workplace or in the water
- Describe emerging emissions control regulation related to marine engines

LEARNING TASKS	CONTENT
1. Describe common hauling and blocking techniques	• Straddle lift equipment • Marine ways • Ramps and trailers • Blocking and jack stands • Bilge blocking sailboats
2. Secures vessels to docks	• Heaving lines • Common knots, half hitch, bowline • Securing to cleats • Running dock lines • Fenders and protection from damage
3. Describe procedures and techniques for lifting engines	• Jacks • Chain hoists • Support structures • Cranes, forklifts • Protection of the vessel • Personal safety
4. Describe procedures for winterizing or storing engines	• Cooling systems • Fuel systems • Lubrication • Anti-corrosion measures

LEARNING TASKS	CONTENT
5. Describe procedures for winterizing or laying up other vessel systems	• Batteries • Plumbing systems • Ventilation • Covers, shrink-wrap systems
6. Describe environmentally sound practices for disposing of chemicals, paints and anti-fouling residue	• Hazardous chemicals, solvents, paints • Anti-fouling paint and residue • Environmental implications of improper disposal • Legal implications of improper disposal
7. Describe environmentally sound practices for disposing of oils, fuels and coolants	• Used oil disposal • Fuel disposal • Coolants disposal
8. Describe procedures for minimizing damage from accidental spills of contaminants	• Cleaning up spills in the shop or vessels • Spills in the water
9. Describe emissions control regulations and standards applicable to recreational marine industry	• Emissions control regulation

Achievement Criteria

Performance: A3 Follow safe yard and marina practices

Conditions: The learner will require:

- Tools
- Test equipment
- Manufactures Specifications
- A work place or training environment
- Equipment with Occupational Skills

Criteria: The learner will be competent once the performance criteria is met:

- Followed safe work practices throughout entire task including lock out procedures
- Conducted in a logical manner
- Conducted according to manufacturer's specifications
- Conducted according to work place requirements

Line (GAC): A OCCUPATIONAL SKILLS

Competency: A4 Operate vessels

Objectives

To be competent in this area, the individual must be able to

- Describe the typical procedures for commissioning new engines pre-start, initial starting and post-start
- Describe typical procedures for conducting sea trials following commissioning of new engines or repair work
- Inspects engine hook-ups, performs engine pre-start procedures and completes performance checks while vessel is under way.
- Describe the basic elements of vessel types, hull forms, performance, stability and propulsion system configurations.

LEARNING TASKS	CONTENT
1. Describe typical procedures for commissioning new engines	• OEM commissioning instructions and specifications • Warranty issues • Pre-start engine hook-ups and inspection • Initial start and inspection • Post start procedures and inspection
2. Describe sea trial procedures	• OEM specifications for initial engine use • Use of checklist • Wide open speed test
3. Describe vessel design considerations using correct terminology	• Vessel types • Hull forms and hull speed • Performance factors • Stability factors • Propulsion system layouts

Achievement Criteria

Performance	A4 Operate vessels
Conditions	The learner will require: • Tools • Test equipment • Manufactures Specifications • A work place or training environment • Equipment with Occupational Skills
Criteria	The learner will be competent once the performance criteria is met: • Followed safe work practices throughout entire task including lock out procedures • Conducted in a logical manner • Conducted according to manufacturer's specifications • Conducted according to work place requirements

Line (GAC): A OCCUPATIONAL SKILLS

Competency: A5 Use documentation

Objectives

To be competent in this area, the individual must be able to

- Describe the common sources of technical data related to the trade and their means of access.
- Demonstrates an ability to read and comprehend the terminology, technical data, drawings, charts and graphs related to the trade
- Describe the use of browsers and search engines to access technical and manufacturers' information on the internet.
- Describe the reasons for industrial standards, how they are applied in the workplace and what organizations provide standards related to the trade.

LEARNING TASKS	CONTENT
1. Describe common sources of technical information related to the job	• Manufacturers' publications • Industry publications • Internet information
2. Demonstrate an ability to read and comprehend technical data	• Marine industry terminology • Manuals and instructions • Technical drawings • Charts and graphs
3. Describe use of internet browser	• Function of the internet • URLs and address protocols
4. Describe the use of internet search engines	• Common search engines • Effective search techniques • Major sites related to the trade
5. Describe the intent and use of industrial standards	• Reasons for standards development • Applicability of standards on the job • Documentation
6. Describe current marine industry standards organizations related to the trade	• ABYC • ABC

Achievement Criteria

Performance	A5 Use documentation
Conditions	The learner will require: • Tools • Test equipment • Manufactures Specifications • A work place or training environment • Equipment with Occupational Skills
Criteria	The learner will be competent once the performance criteria is met: • Followed safe work practices throughout entire task including lock out procedures • Conducted in a logical manner • Conducted according to manufacturer's specifications • Conducted according to work place requirements

Line (GAC): A OCCUPATIONAL SKILLS

Competency: A6 Use fasteners and fittings

Objectives

To be competent in this area, the individual must be able to

- Describe common fasteners used in the marine mechanical workplace
- Selects and uses fasteners for typical applications on the job

LEARNING TASKS	CONTENT
1. Describe common threaded fasteners used in the marine mechanical workplace	• Materials • Threads and pitches • Pipe threads and fittings • Hardness and grades • Metric and Imperial sizes • Fastener identification and description
2. Use common mechanical workplace fasteners	• Fastener selection • Thread repair • Torque and use of torque wrench • Sealants • Broken fastener removal • Helicoils

Achievement Criteria

Performance: A6 Use fasteners and fittings

Conditions: The learner will require:

- Tools
- Test equipment
- Manufactures Specifications
- A work place or training environment
- Equipment with Occupational Skills

Criteria: The learner will be competent once the performance criteria is met:

- Followed safe work practices throughout entire task including lock out procedures
- Conducted in a logical manner
- Conducted according to manufacturer's specifications
- Conducted according to work place requirements

Line (GAC): A OCCUPATIONAL SKILLS

Competency: A7 Describe and use composites

Objectives

To be competent in this area, the individual must be able to

- Describe the principles of FRP construction techniques, especially with regard to factors that influence or are influenced by mechanical installations.
- Describe the principles of steel and aluminum construction techniques, especially with regard to factors that influence or are influenced by mechanical installations.
- Describe common FRP resins and reinforcements, their use and cure factors
- Describe basic gel coat repair procedures
- Performs basic FRP structural repairs
- Describe the types and uses of adhesives, sealants, bedding compounds and epoxy for typical applications in the marine workplace.
- Describe the types and uses of cleaners, de-greasing agents and cleaning solvents for typical applications in the marine workplace.

LEARNING TASKS	CONTENT
1. Describe principles of FRP vessel construction	• FRP materials • Molds and molding • One-off construction • FRP reinforcing structures • Design and construction considerations for mechanical installations
2. Describe principles of metal vessel construction	• Construction in steel • Construction in aluminum • Construction techniques • Design and construction considerations for mechanical installations
3. Describe polyester and epoxy resins	• Polyester resin • Epoxy resin • Cure factors • Measuring and mixing
4. Describe common reinforcement materials	• Chopped strand mat • Fibreglass roving and cloth
5. Describe techniques for FRP reinforcing structures	• Damage assessment • Bonding • Use of cores • Wood cores
6. Describe gel coat repair	• Gel coat characteristics • Repair techniques

LEARNING TASKS	CONTENT
7. Performs basic repairs to FRP structures	• Repairs
8. Describe the types and applications of common adhesives, sealants and bedding compounds used in the marine industry	• Adhesives • Sealants • Bedding Compounds • Anaerobic thread and bearing sealants
9. Describe the use of epoxy as an adhesive, waterproof sealant and repair media	• Epoxy characteristics • Mixing applying and curing • Repair options with epoxy
10. Describe the types and uses of cleaners, de-greasers and solvents used in the marine workplace	• Cleaners • De-greasing agents • Solvents used in cleaning

Achievement Criteria

Performance — A7 Describe and use composites

Conditions — The learner will require:

- Tools
- Test equipment
- Manufactures Specifications
- A work place or training environment
- Equipment with composites

Criteria — The learner will be competent once the performance criteria is met:

- Followed safe work practices throughout entire task including lock out procedures
- Conducted in a logical manner
- Conducted according to manufacturer's specifications
- Conducted according to work place requirements

Line (GAC): A OCCUPATIONAL SKILLS

Competency: A8 Select and use lubricants and coolants

Objectives

To be competent in this area, the individual must be able to

- Describe the properties, identification and use of engine oils used in marine equipment
- Describe the properties, identification and use of transmission fluids and gear oils used in marine equipment
- Describe the properties and uses of greases for marine equipment
- Describe the properties and use of coolants in marine engine cooling systems.
- Describe the properties of engine coolants, assessment of coolant properties and procedures for changing coolant.
- Removes and replaces coolant
- Describe common problems with engine and drive train lubricants and basic on-site tests for diagnosing problems.
- Describe techniques for taking oil samples for lab tests
- Interprets lab test reports
- Describe the techniques and procedures for changing engine oil/filters, transmission oil and gear oil
- Changes engine oil/filters, transmission oil and gear oil

LEARNING TASKS	CONTENT
1. Describe the properties and use of engine oils	• Engine oil types and identification • Properties of engine oils • Engine oil selection • Filtration
2. Describe the properties and use of drive train lubricants	• Transmission fluids and properties • Gear oils and properties
3. Describe the properties and use of greases	• Types of grease • Properties and applications of greases
4. Describe properties and use of coolants in engine cooling systems	• Coolant properties • Anti-freeze protection • OEM specifications • Additives • Monitoring coolant levels
5. Describe coolant assessment	• Visual inspection • Hydrometer inspection • Supplemental Coolant Additives (SCA) tests
6. Removes and replace coolant	• Remove • Replace

LEARNING TASKS	CONTENT
7. Describe on-site inspections of engine oils and drive train lubricants	• Engine oil problems • Transmission oil problems • Gear oil problems • Visual inspections and characteristics • Odour inspections and characteristics • Feel
8. Describe sampling procedures for submitting samples for lab tests	• Sampling techniques
9. Interprets and understands lab reports from lubricant tests	• Lab report format and terminology
10. Describe techniques for changing engine oil and filters	• Checking oil levels • Procedures for removing engine oil and filters • Procedures for replacing filters and oil
11. Describe techniques for changing transmission oil	• Checking transmission oil levels • Transmission oil removal and replacement • Transmission filters
12. Describe techniques for changing gear oil in drive units	• Checking gear oil levels • Procedures for oil removal and replacement
13 Performs engine oil changes	• Checking oil levels • Oil and filter removal and replacement
14. Performs transmission oil changes	• Checking transmission oil levels • Transmission oil removal and replacement • Transmission filters
15. Performs gear oil changes	• Checking gear oil levels • Oil removal and replacement

Achievement Criteria

Performance	A8 Select and use lubricants and coolants
Conditions	The learner will require: • Tools • Test equipment • Manufactures Specifications • A work place or training environment • Equipment with Occupational Skills
Criteria	The learner will be competent once the performance criteria is met: • Followed safe work practices throughout entire task including lock out procedures • Conducted in a logical manner • Conducted according to manufacturer's specifications • Conducted according to work place requirements

Line (GAC): B VESSEL SYSTEMS

Competency: B1 Describe Thru-hulls

Objectives

To be competent in this area, the individual must be able to

- Describe the sizing, locating and safety standards considerations for the installation of thru-hulls in all vessels.
- Describe the correct materials used and procedures for thru-hull installations in RFP, metal and wood hulls.
- Installs thru-hulls in FRP, metal and wood hulls.

LEARNING TASKS	CONTENT
1. Describe the general requirements for thru-hull installation	• Sizing and locating • Materials • Valves • ABYC standards
2. Describe thru-hull installation in FRP materials	• Single skin FRP • Cored FRP • Reinforcing structures • Sealing
3. Describe thru-hull installation in metal and wood	• Steel hulls • Aluminum hulls • Wood hulls • Corrosion prevention

Achievement Criteria

Performance: B1 Describe Thru-hulls

Conditions: The learner will require:

- Tools
- Test equipment
- Manufactures Specifications
- A work place or training environment
- Equipment with Vessel Systems

Criteria: The learner will be competent once the performance criteria is met:

- Followed safe work practices throughout entire task including lock out procedures
- Conducted in a logical manner
- Conducted according to manufacturer's specifications
- Conducted according to work place requirements

Line (GAC): B VESSEL SYSTEMS

Competency: B2 Describe cabin heating systems

Objectives

To be competent in this area, the individual must be able to

- Describe types, selection considerations and components of natural draft, forced air and hot water cabin heating systems.
- Describe proper installation considerations and procedures for installing natural draft, forced air and hot water cabin heating systems.

LEARNING TASKS	CONTENT

1. Describe the installation considerations and procedures for installing natural draft heaters	• Heater selection
	• Types
	  ○ Propane
	  ○ Diesel
	  ○ Hot water
	• ABYC standards

2. Describe the installation considerations and procedures for installing forced air heaters	• Heater selection and component location • Component installation • Ducting installations • Fuel and power hookup
3. Describe the installation considerations and procedures for installing hot water heating systems	• Heater selection and component location • Component installation • Water line installation • Fuel and power hookup • Engine coolant 'bus' heaters

Achievement Criteria

Performance	B2 Describe cabin heating systems
Conditions	The learner will require: • Tools • Test equipment • Manufactures Specifications • A work place or training environment • Equipment with Vessel Systems
Criteria	The learner will be competent once the performance criteria is met: • Followed safe work practices throughout entire task including lock out procedures • Conducted in a logical manner • Conducted according to manufacturer's specifications • Conducted according to work place requirements

Line (GAC): B VESSEL SYSTEMS

Competency: B3 Describe A/C and refrigeration theory

Objectives

To be competent in this area, the individual must be able to

- Describe the principles of refrigeration theory, components of refrigeration systems and refrigeration equipment commonly found on recreational vessels.

LEARNING TASKS	CONTENT
1. Describe the theory and basic operation of refrigeration equipment	• Principles of refrigeration
2. Describe the main components of refrigeration equipment	• Compressors • Heat exchange coils • Electrical controls
3. Describe refrigerators and air conditioning systems	• Ice box construction and installation • Refrigerators and freezer installations • Air conditioning installations

Achievement Criteria

Performance	B3 Describe A/C and refrigeration theory
Conditions	The learner will require: • Tools • Test equipment • Manufactures Specifications • A work place or training environment • Equipment with Vessel Systems
Criteria	The learner will be competent once the performance criteria is met: • Followed safe work practices throughout entire task including lock out procedures • Conducted in a logical manner • Conducted according to manufacturer's specifications • Conducted according to work place requirements

Line (GAC): B VESSEL SYSTEMS

Competency: B4 Describe safe propane installations

Objectives

To be competent in this area, the individual must be able to

- Describe the characteristics of propane gas and safety considerations.
- Describe common regulatory codes and standards.
- Describe safe installations of storage tanks and fuel supply lines.

LEARNING TASKS	CONTENT
1. Describe the basic properties of propane and the safety hazards associated with its use in vessels	• Density • Flammability • Odour • Pressure • Safety considerations
2. Describe regulatory codes and standards	• Basic code requirements for land-based systems • ABYC standards • Pipe identification markings
3. Describe the safe installation of propane tanks and fuel supply lines	• Propane tank containment • Piping and distribution lines • Regulators and pressure valves • Valve solenoids and controls • Alarms and detectors

Achievement Criteria

Performance: B4 Describe safe propane installations

Conditions: The learner will require:

- Tools
- Test equipment
- Manufactures Specifications
- A work place or training environment
- Equipment with Vessel Systems

Criteria: The learner will be competent once the performance criteria is met:

- Followed safe work practices throughout entire task including lock out procedures
- Conducted in a logical manner
- Conducted according to manufacturer's specifications
- Conducted according to work place requirements

Line (GAC): B VESSEL SYSTEMS

Competency: B5 Describe davits, hoists and windlasses

Objectives

To be competent in this area, the individual must be able to

- Describe the selection, location and installation considerations for installing davits and hoists in FRP, metal or wood vessels.
- Describe the installation of davits and hoists, power hook up and rigging requirements.
- Describe the function and selection of electric and hydraulic anchor windlasses
- Describe the installation techniques and power/control hook-ups for anchor windlasses

LEARNING TASKS	CONTENT
1. Describe the selection and location of davits and hoists	• Davit and hoist types and applications • Sizing and location
2. Describe the structural reinforcement considerations for installation and reinforcement methods	• Determining loads • Reinforcement techniques for FRP structures • Reinforcement techniques for metal and wood structures
3. Describe the installation and hook up of davits and hoists	• Hydraulically powered hoists • Electrically powered hoists • Rigging davits and hoists
4. Describe function and operation of anchor windlasses	• Windlass and ground tackle selection • Electric windlasses • Hydraulic windlasses • Rodes and gypsies
5. Describe installation and hook up of anchor windlasses	• Structural reinforcement for FRP, metal and wood • Electrical and control hook-ups • Hydraulic hookups

Achievement Criteria

Performance	B5 Describe davits, hoists and windlasses
Conditions	The learner will require: • Tools • Test equipment • Manufactures Specifications • A work place or training environment • Equipment with Vessel Systems
Criteria	The learner will be competent once the performance criteria is met: • Followed safe work practices throughout entire task including lock out procedures • Conducted in a logical manner • Conducted according to manufacturer's specifications • Conducted according to work place requirements

Line (GAC): B VESSEL SYSTEMS

Competency: B6 Describe fire suppression equipment and lock outs

Objectives

To be competent in this area, the individual must be able to

- Describe typical fire suppression equipment installed on recreational vessels and common inspection procedures.
- Describe safety hazards associated with fire suppression equipment and safe lock out procedures.

LEARNING TASKS	CONTENT
1. Describe fire suppression equipment	• Equipment types • Basic components • Installation criteria • Inspection procedures
2. Describe safety hazards associated with fire suppression equipment and lock out procedures	• Safety hazards • Lock out procedures

Achievement Criteria

Performance: B6 Describe fire suppression equipment and lock outs

Conditions: The learner will require:

- Tools
- Test equipment
- Manufactures Specifications
- A work place or training environment
- Equipment with Vessel Systems

Criteria: The learner will be competent once the performance criteria is met:

- Followed safe work practices throughout entire task including lock out procedures
- Conducted in a logical manner
- Conducted according to manufacturer's specifications
- Conducted according to work place requirements

Line (GAC): B VESSEL SYSTEMS

Competency: B7 Inspect and repair mechanical and electrical steering systems

Objectives

To be competent in this area, the individual must be able to

- Describe the function and operation of rudders, quadrants, tubes, glands and typical cable operated steering systems.
- Describe diagnosing, servicing and repair of rudders, glands and cable systems.
- Diagnoses, services and repairs mechanical steering gear.

LEARNING TASKS	CONTENT
1. Describe function and operation of cable operated steering systems	• Rudders, posts and quadrants • Tubes and glands • Push-pull cable steering • Dual cable systems • Sailboat pedestal systems
2. Describe diagnosing, servicing and repair techniques for mechanical steering	• Cable inspection and adjustment • Cable replacement • Rudder, quadrant, gland repair/replacement
3. Describe electric powered steering systems	• Motors • Control system
4. Diagnose, service and repair mechanical and electrical steering systems	• Procedures for cable/pulley and pedestal systems • Procedures for push-pull cable systems

Achievement Criteria

Performance: B7 Inspect and repair mechanical and electrical steering systems

Conditions: The learner will require:

- Tools
- Test equipment
- Manufactures Specifications
- A work place or training environment
- Equipment with Vessel Systems

Criteria: The learner will be competent once the performance criteria is met:

- Followed safe work practices throughout entire task including lock out procedures
- Conducted in a logical manner
- Conducted according to manufacturer's specifications
- Conducted according to work place requirements

Line (GAC): B VESSEL SYSTEMS

Competency: B8 Describe and install fresh/waste water plumbing systems

Objectives

To be competent in this area, the individual must be able to

- Describe the function, components and installation of fresh water plumbing systems.
- Describe the function, components and installation of waste water plumbing systems.
- Installs and repairs fresh water systems
- Installs and repairs waste water systems

LEARNING TASKS	CONTENT
1. Describe the function and components of fresh water plumbing systems	• Tanks • Pumps • Pipes, hose and fittings • Hot water systems • System layout
2. Describe the function and components of waste water plumbing systems	• Environmental regulations • Holding tanks • Marine toilets • Pipes, hose and fittings • Anti-siphon equipment • Macerator pumps • Vacuum systems • Waste treatment systems • Grey water systems
3. Performs installation and repairs of fresh water systems	• Tanks • Pumps • Pipes, hose and fittings • Hot water systems
4. Performs installation and repairs of waste water systems	• Holding tanks • Marine toilets • Pipes, hose and fittings • Anti-siphon equipment • Macerator pumps • Vacuum systems • Waste treatment systems • Grey water systems

Achievement Criteria

Performance	B8 Describe and install fresh/waste water plumbing systems
Conditions	The learner will require: • Tools • Test equipment • Manufactures Specifications • A work place or training environment • Equipment with Vessel Systems
Criteria	The learner will be competent once the performance criteria is met: • Followed safe work practices throughout entire task including lock out procedures • Conducted in a logical manner • Conducted according to manufacturer's specifications • Conducted according to work place requirements

Line (GAC): B VESSEL SYSTEMS

Competency: B9 Describe water makers

Objectives

To be competent in this area, the individual must be able to

- Describe the theory and basic operation of desalination systems.
- Describe the major components of desalination systems and their operation.
- Describe typical diagnosing, routine service and storage procedures for desalinators.

LEARNING TASKS	CONTENT
1. Describe principles of desalinator theory and equipment operation	• Principles of desalination equipment • Water purity and standards for safe consumption
2. Describe components of desalination equipment and their operation	• Intakes • Pressure pumps • Membranes • Control valves and systems • Sterilizers
3. Describe typical desalinator diagnosing and servicing procedures	• Diagnosing techniques • Membrane servicing • Routine inspection and maintenance • Long-term storage procedures

Achievement Criteria

Performance: B9 Describe water makers

Conditions: The learner will require:

- Tools
- Test equipment
- Manufactures Specifications
- A work place or training environment
- Equipment with Vessel Systems

Criteria: The learner will be competent once the performance criteria is met:

- Followed safe work practices throughout entire task including lock out procedures
- Conducted in a logical manner
- Conducted according to manufacturer's specifications
- Conducted according to work place requirements

Line (GAC): B VESSEL SYSTEMS

Competency: B10 Service and install bilge pump systems

Objectives

To be competent in this area, the individual must be able to

- Describe the function, components and installation considerations for manual, powered and submersible pumps and switching equipment and system installation considerations.
- Describe the correct procedures for installing manual and powered bilge pump systems.
- Installs and services manual and powered bilge pump systems.

LEARNING TASKS	CONTENT
1. Describe the function and components of bilge pump systems	• Selection and location of bilge pump systems • Manual pumps • Powered pumps • Submersible pumps • Automatic operation • Switch types and location • Plumbing • Check valves
2. Install and service bilge pump systems	• Pump location and installation • Plumbing installation • Anti-siphon equipment

Achievement Criteria

Performance: B10 Service and install bilge pump systems

Conditions: The learner will require:

- Tools
- Test equipment
- Manufactures Specifications
- A work place or training environment
- Equipment with Vessel Systems

Criteria: The learner will be competent once the performance criteria is met:

- Followed safe work practices throughout entire task including lock out procedures
- Conducted in a logical manner
- Conducted according to manufacturer's specifications
- Conducted according to work place requirements

Line (GAC): C HYDRAULIC EQUIPMENT

Competency: C1 Describe hydraulic theory and system components

Objectives

To be competent in this area, the individual must be able to

- Describe theory, components and operation of modern 2-stroke outboard engines.
- Describe theory, components and operation of modern 4-stroke outboard engines
- Describe hydraulic theory, hydraulic system pumps, valves, motors, cylinders, hydraulic oil and power distribution systems.

LEARNING TASKS	CONTENT
1. Describe hydraulic theory	• Theory underlying hydraulic power systems
2. Describe power trim and tilt systems	• Electrical systems and components • Hydraulic systems and components
3. Describe hydraulic system components and their function	• Pumps • Tanks and pick-ups • Valves • Motors • Cylinders • Filters • Hydraulic oil
4. Describe hydraulic system distribution components	• Plumbing • Hoses and fittings • Distribution considerations

Achievement Criteria

Performance: C1 Describe hydraulic theory and system components

Conditions: The learner will require:

- Tools
- Test equipment
- Manufactures Specifications
- A work place or training environment
- Hydraulic Equipment

Criteria: The learner will be competent once the performance criteria is met:

- Followed safe work practices throughout entire task including lock out procedures
- Conducted in a logical manner
- Conducted according to manufacturer's specifications
- Conducted according to work place requirements

Line (GAC): C HYDRAULIC EQUIPMENT

Competency: C2 Service and install hydraulic steering systems

Objectives

To be competent in this area, the individual must be able to

- Describe the function and components of hydraulic steering systems, pumps, helm stations, cylinders and steering system layouts for single and multiple station installations.
- Installs and services hydraulic steering systems, selecting and making up lines, bleeding and diagnosing.

LEARNING TASKS	CONTENT
1. Describe the function and components of hydraulic steering systems	• Helm pumps • Power assisted systems • Multiple station systems • Steering cylinder types and configurations • System layout
2. Install and service hydraulic systems	• Fluids • Pipe, hose selection • Running lines • Bleeding the system • Diagnosing and servicing

Achievement Criteria

Performance: C2 Service and install hydraulic steering systems

Conditions: The learner will require:

- Tools
- Test equipment
- Manufactures Specifications
- A work place or training environment
- Hydraulic Equipment

Criteria: The learner will be competent once the performance criteria is met:

- Followed safe work practices throughout entire task including lock out procedures
- Conducted in a logical manner
- Conducted according to manufacturer's specifications
- Conducted according to work place requirements

Line (GAC): C HYDRAULIC EQUIPMENT

Competency: C3 Diagnose and repair hydraulic equipment

Objectives

To be competent in this area, the individual must be able to

- Describe diagnosing procedures and techniques for fault finding common marine hydraulic system problems.
- Performs repair procedures for correcting typical hydraulic system problems
- Describe proper procedures for installing and servicing hydraulic motors and cylinders for typical marine applications.
- Performs proper procedures for installing and servicing hydraulic motors and cylinders for typical marine applications.

LEARNING TASKS	CONTENT
1. Describe procedures and techniques for diagnosing typical hydraulic system faults	• Serviceable components • Non-serviceable components (pumps, cylinders) • Diagnosing techniques • Detecting leaks • Pump faults • Air in system and bleeding • Oil contamination
2. Performs repair procedures to correct hydraulic system faults	• Serviceable components • Leaks • Pump faults • Air in system and bleeding • Oil contamination
3. Describe procedures for installing and servicing hydraulic motors	• Motor types
4. Describe procedures for installing and servicing hydraulic cylinders	• Cylinder types
5. Install and service hydraulic motors and cylinders	• Install • Service

Achievement Criteria

Performance	C3 Diagnose and repair hydraulic equipment
Conditions	The learner will require: • Tools • Test equipment • Manufactures Specifications • A work place or training environment • Hydraulic Equipment
Criteria	The learner will be competent once the performance criteria is met: • Followed safe work practices throughout entire task including lock out procedures • Conducted in a logical manner • Conducted according to manufacturer's specifications • Conducted according to work place requirements

Line (GAC): D METAL WORKING

Competency: D1 Perform metal fabrication operations

Objectives

To be competent in this area, the individual must be able to

- Describe the metals commonly found in the recreational marine industry, their main properties and uses.
- Describe the basic metalworking operations, including cutting, drilling, tapping, cutting threads, filing, grinding and bending in various common marine metals.
- Performs basic metalworking techniques with common marine metals.

LEARNING TASKS	CONTENT
1. Describe marine metals, their properties and applications in the marine industry	• Steels • Aluminum • Bronze • Other non-ferrous metals • Compatibility with non metallic materials
2. Describe the common metalworking operations found in the marine mechanical field	• Cutting • Drilling • Tapping and cutting threads • Bending • Filing and grinding • Tools and equipment • Blades and bits for various metals
3. Perform basic metalworking operations	• Cutting • Drilling • Tapping and cutting threads • Bending • Filing and grinding

Achievement Criteria

Performance	D1 Perform metal fabrication operations
Conditions	The learner will require: • Tools • Test equipment • Manufactures Specifications • A work place or training environment • Equipment with Metal Working
Criteria	The learner will be competent once the performance criteria is met: • Followed safe work practices throughout entire task including lock out procedures • Conducted in a logical manner • Conducted according to manufacturer's specifications • Conducted according to work place requirements

Line (GAC): D METAL WORKING

Competency: D2 Use oxy-acetylene torch

Objectives

To be competent in this area, the individual must be able to

- Describe the common welding types and techniques and their application in the marine industry workplace.
- Describe the principles and components of oxy-acetylene equipment.
- Uses oxy-acetylene equipment safely to perform basic heating, cutting, brazing and soldering operations.

LEARNING TASKS	CONTENT
1. Describe common welding techniques used in the recreational marine industry workplace	• Oxy-acetylene • Brazing • Techniques used for stainless and aluminum
2. Describe principles and components of oxy-acetylene equipment	• Principles of operation • Regulators • Hose • Tips • Heat ranges of metals
3. Use oxy-acetylene equipment for heating and cutting	• Fire prevention considerations • Heating metal components • Cutting metals • Brazing and soldering

Achievement Criteria

Performance: D2 Use oxy-acetylene torch

Conditions: The learner will require:

- Tools
- Test equipment
- Manufactures Specifications
- A work place or training environment
- Equipment with Metal Working

Criteria: The learner will be competent once the performance criteria is met:

- Followed safe work practices throughout entire task including lock out procedures
- Conducted in a logical manner
- Conducted according to manufacturer's specifications
- Conducted according to work place requirements

Line (GAC): E ELECTRICAL

Competency: E1 Describe principles of electrical theory

Objectives

To be competent in this area, the individual must be able to

- Describe AC and DC power
- Describe Ohm's law and relationships between voltage, current and resistance
- Calculates voltage drop in typical circuits.

LEARNING TASKS	CONTENT
1. Describe difference between DC and AC power	• Principles of electricity • Direct current power • Alternating current power
2. Describe Ohm's law relationships between voltage, current and resistance	• Ohm's Law • Voltage, current, resistance • Calculations applying Ohm's Law
3. Describe voltage drop in electrical circuits and perform voltage drop calculations	• Voltage drop in circuits • Calculation of voltage drop • Use of voltage drop tables • ABYC standards

Achievement Criteria

Performance: E1 Describe principals of electrical theory

Conditions: The learner will require:

- Tools
- Test equipment
- Manufactures Specifications
- A work place or training environment
- Equipment with Electrical

Criteria: The learner will be competent once the performance criteria is met:

- Followed safe work practices throughout entire task including lock out procedures
- Conducted in a logical manner
- Conducted according to manufacturer's specifications
- Conducted according to work place requirements

Line (GAC): E ELECTRICAL

Competency: E2 Read and use electrical schematics

Objectives

To be competent in this area, the individual must be able to

- Identifies and Describe symbols used in schematics for switches, lights, motors, fuses/breakers, alarm senders/detectors, solenoids and gauges.
- Identifies and traces electrical circuits in a schematic and Describe their function.

LEARNING TASKS	CONTENT
1. Identifies common symbols used in electrical schematics	• Switches • Lights • Motors • Fuses and breakers • Alarm senders and detectors • Solenoids • Gauges
2. Identifies electrical circuits in a schematic and their function	• Representation of circuits in schematics • Typical marine engine circuitry

Achievement Criteria

Performance	E2 Read and use electrical schematics
Conditions	The learner will require: • Tools • Test equipment • Manufactures Specifications • A work place or training environment • Equipment with Electrical
Criteria	The learner will be competent once the performance criteria is met: • Followed safe work practices throughout entire task including lock out procedures • Conducted in a logical manner • Conducted according to manufacturer's specifications • Conducted according to work place requirements

Line (GAC): E ELECTRICAL

Competency: E3 Use electrical measurements and diagnostic equipment

Objectives

To be competent in this area, the individual must be able to

- Describe where, why and how to use continuity testers, test light, multi-meters and amprobes
- Uses continuity testers, multi-meters and amprobes to measure and analyze electrical circuits

LEARNING TASKS	CONTENT
1. Describe the function and use of electrical measurement and testing equipment	• Continuity tester • Multi-meter • Amprobe
2. Demonstrate the proper use of electrical measurement and testing equipment	• Continuity tester • Multi-meter • Amprobe

Achievement Criteria

Performance: E3 Use electrical measurements and diagnostic equipment

Conditions: The learner will require:

- Tools
- Test equipment
- Manufactures Specifications
- A work place or training environment
- Equipment with Electrical

Criteria: The learner will be competent once the performance criteria is met:

- Followed safe work practices throughout entire task including lock out procedures
- Conducted in a logical manner
- Conducted according to manufacturer's specifications
- Conducted according to work place requirements

Line (GAC): E ELECTRICAL

Competency: E4 Describe storage battery types and applications

Objectives

To be competent in this area, the individual must be able to

- Describe types of DC storage batteries in common marine use
- Describe battery applications, recharging, capacity and battery banks

LEARNING TASKS	CONTENT
1. Describe marine battery types	• Principles of DC storage batteries • Starting (cranking) batteries • Deep cycle batteries • Conventional wet cell • Closed cell (sealed), gel cell
2. Describe battery use and capacities	• Engine starting • House battery applications • Battery banks • Recharging • Capacity

Achievement Criteria

Performance: E4 Describe storage battery types and applications

Conditions: The learner will require:

- Tools
- Test equipment
- Manufactures Specifications
- A work place or training environment
- Equipment with Electrical

Criteria: The learner will be competent once the performance criteria is met:

- Followed safe work practices throughout entire task including lock out procedures
- Conducted in a logical manner
- Conducted according to manufacturer's specifications
- Conducted according to work place requirements

Line (GAC): E ELECTRICAL

Competency: E5 Select, install and test batteries

Objectives

To be competent in this area, the individual must be able to

- Calculates battery requirements for various marine applications
- Installs batteries in vessels to ABYC standards
- Inspects and tests batteries for faults and proper function

LEARNING TASKS	CONTENT
1. Calculate battery storage requirements	• Cranking and heavy loads • House battery requirements
2. Install batteries in vessels	• ABYC standards • Battery boxes • Location • Securing • Ventilation • Battery switches • Cables and terminals • Grounding
3. Inspects and test batteries	• Inspection • Electrolyte testing • Load testing

Achievement Criteria

Performance: E5 Select, install and test batteries

Conditions: The learner will require:

- Tools
- Test equipment
- Manufactures Specifications
- A work place or training environment
- Equipment with Electrical

Criteria: The learner will be competent once the performance criteria is met:

- Followed safe work practices throughout entire task including lock out procedures
- Conducted in a logical manner
- Conducted according to manufacturer's specifications
- Conducted according to work place requirements

Line (GAC): E ELECTRICAL

Competency: E6 Service and install AC chargers and inverters

Objectives

To be competent in this area, the individual must be able to

- Describe battery charger types,
- Describe battery charging control and monitoring equipment
- Describe inverters and charger/inverters installation procedures and diagnosing
- Installs battery chargers and inverters

LEARNING TASKS	CONTENT
1. Describe AC powered battery chargers and battery management equipment	• Battery charger types • Charging relays (ACR) • Echo chargers • Battery monitors • Charger installation and diagnosing
2. Describe inverters and charger/inverters	• Inverters • Inverter installation and diagnosing

Achievement Criteria

Performance	E6 Service and install AC chargers and inverters
Conditions	The learner will require: • Tools • Test equipment • Manufactures Specifications • A work place or training environment • Equipment with Electrical
Criteria	The learner will be competent once the performance criteria is met: • Followed safe work practices throughout entire task including lock out procedures • Conducted in a logical manner • Conducted according to manufacturer's specifications • Conducted according to work place requirements

Line (GAC): E ELECTRICAL

Competency: E7 Diagnose alternators and charging faults

Objectives

To be competent in this area, the individual must be able to

- Describe alternator operation and typical malfunctioning
- Describe testing and diagnosing techniques
- Tests alternator function and diagnoses typical malfunctions

LEARNING TASKS	CONTENT
1. Describe alternator and regulator operation	• Alternator functions • Alternator types and components • Alternator selection • Output • Regulators and multi-stage regulators • Breaker protection • Connection
2. Describe alternator malfunctions and diagnostic techniques	• Common malfunctions • Testing • Diagnosing techniques • Charging gauges, warning systems
3. Test and diagnose alternators	• Testing • Diagnosing techniques • Charging gauges, warning systems

Achievement Criteria

Performance: E7 Diagnose alternators and charging faults

Conditions: The learner will require:

- Tools
- Test equipment
- Manufactures Specifications
- A work place or training environment
- Equipment with Electrical

Criteria: The learner will be competent once the performance criteria is met:

- Followed safe work practices throughout entire task including lock out procedures
- Conducted in a logical manner
- Conducted according to manufacturer's specifications
- Conducted according to work place requirements

Line (GAC): E ELECTRICAL

Competency: E8 Diagnose engine starters and solenoids

Objectives

To be competent in this area, the individual must be able to

- Describe the operation of engine starting systems, including starter motors, solenoids and pre-heat
- Describe common starter system problems and diagnosing techniques
- Diagnoses and repairs typical starter system malfunctions

LEARNING TASKS	CONTENT
1. Describe engine starters and related components	• Engine starters • Starter solenoids • Glow plugs and solenoids • Air heaters
2. Diagnose starter malfunctions	• Starter motor problems • Solenoid problems • Diagnosing techniques • Power supply • Shutdown systems

Achievement Criteria

Performance: E8 Diagnose engine starters and solenoids

Conditions: The learner will require:

- Tools
- Test equipment
- Manufactures Specifications
- A work place or training environment
- Equipment with Electrical

Criteria: The learner will be competent once the performance criteria is met:

- Followed safe work practices throughout entire task including lock out procedures
- Conducted in a logical manner
- Conducted according to manufacturer's specifications
- Conducted according to work place requirements

Line (GAC): E ELECTRICAL

Competency: E9 Install DC electrical wiring and circuits for electrical equipment

Objectives

To be competent in this area, the individual must be able to

- Describe DC electrical circuit components and proper installation techniques
- Installs typical electrical circuitry using appropriate conductors, components and installation techniques that meet ABYC standards.

LEARNING TASKS	CONTENT
1. Describe electrical circuit components	• Wire types and sizing • Colour coding • Devices and connectors • Fuses and breakers • Electrical Panels • ABYC standards
2. Install typical electrical circuits	• Wire selection • Routing and securing • Connectors and terminals • Anti-corrosion measures and heat-shrink insulation • Labelling

Achievement Criteria

Performance	E9 Install DC electrical wiring and circuits for electrical equipment
Conditions	The learner will require: • Tools • Test equipment • Manufactures Specifications • A work place or training environment • Equipment with Electrical
Criteria	The learner will be competent once the performance criteria is met: • Followed safe work practices throughout entire task including lock out procedures • Conducted in a logical manner • Conducted according to manufacturer's specifications • Conducted according to work place requirements

Line (GAC): E ELECTRICAL

Competency: E10 Diagnose wiring and electrical components

Objectives

To be competent in this area, the individual must be able to

- Describe the typical electrical system faults and symptoms of trouble on vessels
- Diagnoses typical electrical system faults on vessels using test equipment
- Describe the causes of galvanic corrosion, compatibility of metals in the marine environment and steps commonly taken to prevent or reduce corrosion.

LEARNING TASKS	CONTENT
1. Describe typical electrical system faults on vessels	• Physical damage • Corrosion • Overheating/overloading • Short circuits • Grounding faults
2. Diagnose typical electrical system faults on vessels	• Short circuits • Grounding faults • Using test equipment
3. Describe galvanic corrosion in metals and steps to control damage	• Galvanic series • Compatibility of metals • Corrosion assessment • Stray current corrosion • Bonding • Anodes • Active corrosion protection equipment • Coatings

Achievement Criteria

Performance: E10 Diagnose wiring and electrical components

Conditions: The learner will require:

- Tools
- Test equipment
- Manufactures Specifications
- A work place or training environment
- Equipment with Electrical

Criteria: The learner will be competent once the performance criteria is met:

- Followed safe work practices throughout entire task including lock out procedures
- Conducted in a logical manner
- Conducted according to manufacturer's specifications
- Conducted according to work place requirements

Line (GAC): E ELECTRICAL

Competency: E11 Diagnose and install alarms, gauges and senders

Objectives

To be competent in this area, the individual must be able to

- Describe the function, components and installation techniques for typical engine gauges, alarms and safety alarm systems in vessels, including heat detectors, pressure detectors, fire and gas alarm systems, tachometers, fuel gauges and bilge water alarms.
- Locates, installs and diagnoses gauges, detectors/senders and safety alarm systems

LEARNING TASKS	CONTENT
1. Describe components and function of engine alarms and gauges	• Heat detectors and gauges • Pressure gauges and senders • Engine alarms • Tachometers • Fuel gauges
2. Describe components and function of vessel alarm systems	• Fire/smoke alarm systems • Gasoline fume alarms • Propane alarms • CO alarms • Bilge water alarms
3. Locates and install gauges, senders and alarm systems	• Detector/sender locations • Alarms and alarm panel locations • Installation techniques • Testing techniques
4. Diagnose gauges, senders and alarm systems	• Tagging and warnings while servicing alarms • Diagnose techniques for detector/senders

Achievement Criteria

Performance	E11 Diagnose and install alarms, gauges and senders
Conditions	The learner will require: • Tools • Test equipment • Manufactures Specifications • A work place or training environment • Equipment with Electrical
Criteria	The learner will be competent once the performance criteria is met: • Followed safe work practices throughout entire task including lock out procedures • Conducted in a logical manner • Conducted according to manufacturer's specifications • Conducted according to work place requirements

Line (GAC): E ELECTRICAL

Competency: E12 Service and install gensets

Objectives

To be competent in this area, the individual must be able to

- Describe the function of self-contained AC generators and the criteria to be considered when installing a new system
- Installs gensets in vessels, including reinforcing structures, insulation, and electrical hook-ups to manufacturer's specifications and to meet applicable ABYC standards.
- Diagnoses genset electrical malfunctions and services generator components

LEARNING TASKS	CONTENT
1. Describe AC genset function and installation criteria	• AC gensets • Selection of size and output • Location in vessel • Installation criteria and techniques • Sound insulation • Electrical hook-up
2. Install genset in vessel to manufacturer's specifications	• Genset installation considerations • Reinforcement structures • Insulating • Exhaust systems
3. Diagnose electrical malfunctions and service genset generator components	• Diagnosing techniques • Service requirements and procedures

Achievement Criteria

Performance: E12 Service and install gensets

Conditions: The learner will require:

- Tools
- Test equipment
- Manufactures Specifications
- A work place or training environment
- Equipment with Electrical

Criteria: The learner will be competent once the performance criteria is met:

- Followed safe work practices throughout entire task including lock out procedures
- Conducted in a logical manner
- Conducted according to manufacturer's specifications
- Conducted according to work place requirements

Line (GAC): F ENGINE SUPPORT SYSYEMS

Competency: F1 Service and install fuel tanks

Objectives

To be competent in this area, the individual must be able to

- Describe fuel tank materials, construction and proper installation to ABYC standards for gasoline and diesel installations.
- Describe fuel level sender and gauges, installation and diagnosing.
- Selects, installs, inspects, cleans and services fuel tanks.

LEARNING TASKS	CONTENT
1. Describe fuel tanks and fuel tank installations	• Materials and construction • Installation • Corrosion concerns • Pressure testing • ABYC standards
2. Describe fuel level senders and gauges	• Types of senders • Installation, electrical connections and grounding • Diagnosing
3. Install and service fuel tanks	• Selection • Securing and reinforcing • Fuel tank inspection • Fuel tank cleaning

Achievement Criteria

Performance F1 Service and install fuel tanks

Conditions The learner will require:

- Tools
- Test equipment
- Manufactures Specifications
- A work place or training environment
- Equipment with Engine Support Systems

Criteria The learner will be competent once the performance criteria is met:

- Followed safe work practices throughout entire task including lock out procedures
- Conducted in a logical manner
- Conducted according to manufacturer's specifications
- Conducted according to work place requirements

Line (GAC): F ENGINE SUPPORT SYSYEMS

Competency: F2 Inspect and install fuel lines

Objectives

To be competent in this area, the individual must be able to

- Describe fuel tank plumbing, fuel lines and installation to ABYC standards.
- Installs fuel delivery and return lines from tank to engine hookup using rigid and flex lines to ABYC standards.
- Inspects fuel lines for leaks, wear and deterioration

LEARNING TASKS	CONTENT
1. Describe fuel tank plumbing	• Fuel fill and vent plumbing • Fuel pickup and return plumbing • Valves and fittings • Fuel lines, sizing, OEM specs • ABYC standards
2. Install fuel lines	• Fuel line selection, sizing, cutting • Installing/connecting valves and fittings • Rigid fuel lines and fittings • Flex fuel lines and fittings • Running lines and securing • Safety working with gasoline
3. Inspects fuel lines	• Inspecting for leaks • Inspecting for wear and deterioration • Manometer use

Achievement Criteria

Performance: F2 Inspect and install fuel lines

Conditions: The learner will require:

- Tools
- Test equipment
- Manufactures Specifications
- A work place or training environment
- Equipment with Engine Support Systems

Criteria: The learner will be competent once the performance criteria is met:

- Followed safe work practices throughout entire task including lock out procedures
- Conducted in a logical manner
- Conducted according to manufacturer's specifications
- Conducted according to work place requirements

Line (GAC): F ENGINE SUPPORT SYSYEMS

Competency: F3 Service fuel pumps and filters

Objectives

To be competent in this area, the individual must be able to

- Describe the function and operations of mechanical and electric gasoline and diesel fuel pumps
- Describe the function and selection of gasoline and diesel fuel filters and water separators
- Services gasoline and diesel fuel pumps and filters

LEARNING TASKS	CONTENT
1. Describe gasoline and diesel fuel pumps	• Gasoline systems • Diesel systems • Mechanical lift pumps • Electric fuel pumps
2. Describe gasoline and diesel fuel filters and water separators	• Gasoline filters • Diesel filters • Primary and secondary filters • Water separators • Sizing • Filter elements
3. Service gasoline fuel pumps and filters	• Inspection • Selection • Element replacement procedures
4. Service diesel fuel pumps and filters	• Inspection • Selection • Element replacement procedures

Achievement Criteria

Performance: F3 Service fuel pumps and filters

Conditions: The learner will require:

- Tools
- Test equipment
- Manufactures Specifications
- A work place or training environment
- Equipment with Engine Support Systems

Criteria: The learner will be competent once the performance criteria is met:

- Followed safe work practices throughout entire task including lock out procedures
- Conducted in a logical manner
- Conducted according to manufacturer's specifications
- Conducted according to work place requirements

Line (GAC): F ENGINE SUPPORT SYSYEMS

Competency: F4 Describe fuel and fuel additives

Objectives

To be competent in this area, the individual must be able to

- Describe the characteristics of gasoline and diesel fuel, additives and common problems/solutions associated with contamination and deterioration.

LEARNING TASKS	CONTENT
1. Describe the characteristics of gasoline and common problems	• Characteristics of gasoline • Grades • Common contamination and deterioration problems
2. Describe the characteristics of diesel fuel and common problems	• Characteristics of diesel fuel • Grades • Common contamination and deterioration problems • Biological growth
3. Describe the use of additives and fuel 'polishing' procedures	• Additives for gasoline • Additives for diesel • Fuel 'polishing'

Achievement Criteria

Performance: F4 Describe fuel and fuel additives

Conditions: The learner will require:

- Tools
- Test equipment
- Manufactures Specifications
- A work place or training environment
- Equipment with Engine Support Systems

Criteria: The learner will be competent once the performance criteria is met:

- Followed safe work practices throughout entire task including lock out procedures
- Conducted in a logical manner
- Conducted according to manufacturer's specifications
- Conducted according to work place requirements

Line (GAC): G ENGINES

Competency: G1 Describe reciprocating engine theory and operation

Objectives

To be competent in this area, the individual must be able to

- Describe the history, theory and operation of basic internal combustion engines
- Describe and identifies the types of engines commonly in use in the modern marine industry
- Describe the routine inspection of engines and engine function
- Performs routine inspections of engines and engine function

LEARNING TASKS	CONTENT
1. Describe the history and basic operation of internal combustion engines	• History • Basic components and functions • Spark ignition • Compression ignition • 4 – cycle engines • 2 – cycle engines
2. Describe operation of gasoline engines	• Gasoline and spark ignition • Carburetion systems • Fuel injection systems • Ignition systems • 4 – cycle engines • 2 – cycle engines
3. Describe operation of diesel engines	• Diesel fuel and compression ignition • Fuel injection systems • 4 – cycle diesels • 2 – cycle diesels
4. Describe modern diesel engine operation and operation or function of major components	• Mechanical injection systems • Common rail injection systems • Electronic injection systems • Induction systems • Lubrication systems • Turbochargers/Intercoolers
5. Describe routine engine inspections	• Visual inspections • Integrity of hoses, lines, cables, belts • Control system function • Cooling system function and integrity • Anodes • Exhaust system function and integrity

LEARNING TASKS

CONTENT

- Lubrication levels and fluids inspection
- Inspections for temperature and overheating
- Electrical system function
- Gauges and alarms function
- Transmission and clutch function
- Engine mounts integrity and alignment
- Recognizing abnormal engine use

Achievement Criteria

Performance — G1 Describe reciprocating engine theory and operation

Conditions — The learner will require:

- Tools
- Test equipment
- Manufactures Specifications
- A work place or training environment
- Equipment with Engines

Criteria — The learner will be competent once the performance criteria is met:

- Followed safe work practices throughout entire task including lock out procedures
- Conducted in a logical manner
- Conducted according to manufacturer's specifications
- Conducted according to work place requirements

Line (GAC): H BOAT TRAILERS

Competency: H1 Describe and service boat trailers

Objectives

To be competent in this area, the individual must be able to

- Identify boat trailer components
- Explain their operation.
- Demonstrate service procedures

LEARNING TASKS	CONTENT
1. Describe boat trailer frames	• Materials used • Types of construction • Method of corrosion protection • Suspenion system

2. Describe boat trailer brakes	• Types of brake systems
	  ○ Disc
	  ○ Drum
	  ○ Hydralic
	• Brake system compnents
	  ○ Brake activation systems

3. Describe and service wheel bearings	• Types of wheel bearings • Service of wheel bearings
4. Describe and service boat trailer wiring	• Color code • Types of wire • Types of vehicle connections
5. Describe boat trailer winches	• Manual winches • Electric winches
6. Describe boat trailer set-up	• Boat support • Balance • Fastening boat to trailer
7. Describe boat trailer hitches	• Classification • Regulations

Achievement Criteria

Performance	H1 Describe and service boat trailers
Conditions	The learner will require: • Tools • Test equipment • Manufactures Specifications • A work place or training environment • Equipment with Boat Trailers
Criteria	The learner will be competent once the performance criteria is met: • Followed safe work practices throughout entire task including lock out procedures • Conducted in a logical manner • Conducted according to manufacturer's specifications • Conducted according to work place requirements

Level 2

Marine Mechanical Technician

Line (GAC): F ENGINE SUPPORT SYSYEMS

Competency: F5 Describe inboard and I/O exhaust system types and design

Objectives

To be competent in this area, the individual must be able to

- Describe conventional wet exhaust system installations for raw water or heat exchanger cooled engines.
- Describe dry exhaust system installations
- Describe I/O exhaust system installations

LEARNING TASKS	CONTENT
1. Describe wet exhaust systems	• Mixing elbows and anti-siphon systems • Elbow height • Water lift mufflers • Wet exhaust system plumbing and outlets
2. Describe dry exhaust systems	• Exhaust stack installations • Sound and heat insulation
3. Describe I/O exhaust systems	• Connection to drive leg • Shutters

Achievement Criteria

Performance: F5 Describe inboard and I/O exhaust system types and design

Conditions: The learner will require:

- Tools
- Test equipment
- Manufactures Specifications
- A work place or training environment
- Equipment with Engine Support Systems

Criteria: The learner will be competent once the performance criteria is met:

- Followed safe work practices throughout entire task including lock out procedures
- Conducted in a logical manner
- Conducted according to manufacturer's specifications
- Conducted according to work place requirements

Line (GAC): F ENGINE SUPPORT SYSYEMS

Competency: F6 Inspect and repair exhaust systems

Objectives

To be competent in this area, the individual must be able to

- Describe procedures for inspecting and repairing inboard engine wet or dry exhaust systems.
- Performs procedures for inspecting and repairing inboard engine wet or dry exhaust systems.

LEARNING TASKS	CONTENT
1. Describe procedures for inspecting and servicing exhaust systems	• Leaks, wear and deterioration of components • Mixing elbows • Anti-siphon loops and valves • Mufflers • Manometer use • Water separators • Dry exhaust systems
2. Perform procedures for inspecting and repairing inboard exhaust systems	• Leaks, wear and deterioration of components • Mixing elbows • Anti-siphon loops and valves • Mufflers • Manometer use • Water separators • Dry exhaust systems

Achievement Criteria

Performance: F6 Inspect and repair exhaust systems

Conditions: The learner will require:

- Tools
- Test equipment
- Manufactures Specifications
- A work place or training environment
- Equipment with Engine Support Systems

Criteria: The learner will be competent once the performance criteria is met:

- Followed safe work practices throughout entire task including lock out procedures
- Conducted in a logical manner
- Conducted according to manufacturer's specifications
- Conducted according to work place requirements

Line (GAC): F ENGINE SUPPORT SYSYEMS

Competency: F7 Describe engine room/compartment layout and ventilation

Objectives

To be competent in this area, the individual must be able to

- Describe engine room layouts, clearances, insulation, oil containment and recommended locations for tanks and batteries.
- Describe requirements for aspirated air and cooling ventilation and calculates aspirated air requirements

LEARNING TASKS	CONTENT
1. Describe engine space components and equipment	• Clearances • Insulation and soundproofing • Oil containment • Peripheral equipment • Blowers/ventilators • Batteries and tanks
2. Describe and calculates engine aspiration air and ventilation requirements	• Engine aspirated air requirements • Aspirated air calculations • Cooling ventilation • Ambient temperatures

Achievement Criteria

Performance: F7 Describe engine room/compartment layout and ventilation

Conditions: The learner will require:

- Tools
- Test equipment
- Manufactures Specifications
- A work place or training environment
- Equipment with Engine Support Systems

Criteria: The learner will be competent once the performance criteria is met:

- Followed safe work practices throughout entire task including lock out procedures
- Conducted in a logical manner
- Conducted according to manufacturer's specifications
- Conducted according to work place requirements

Line (GAC): G ENGINES

Competency: G2 Diagnose and repair engine cooling systems

Objectives

To be competent in this area, the individual must be able to

- Describe the basics of engine cooling, types of cooling systems, heat exchangers, pumps and coolants
- Describe procedures for diagnosing and repairing common engine cooling system problems or failures.
- Diagnoses common engine cooling system problems or failures and performs repair or replacement procedures.

LEARNING TASKS	CONTENT
1. Describe the function and the components of common marine engine cooling systems	• Engine cooling basics • Raw water engine cooling • Heat exchanger systems • Oil and transmission cooling • Thermostats • Circulation pumps • Raw water pumps • Sizing, intakes and flow considerations • Coolants and corrosion considerations • Anodes
2. Describe procedures for diagnosing and repair common engine cooling system problems	• Common causes of engine overheating • Intakes, strainers and plumbing • Raw water pumps • Circulation pumps • Thermostats • Restrictions in elbow/riser • Heat exchangers • Causes for running cool • Salt and deposits blockages
3. Diagnoses and repair cooling system components	• Engine overheating • Intakes, strainers and plumbing • Raw water pumps • Circulation pumps • Thermostats • Restrictions in elbow/riser • Heat exchangers • Running cool • Salt and deposits blockages

Achievement Criteria

Performance	G2 Diagnose and repair engine cooling systems
Conditions	The learner will require: • Tools • Test equipment • Manufactures Specifications • A work place or training environment • Equipment with Engines
Criteria	The learner will be competent once the performance criteria is met: • Followed safe work practices throughout entire task including lock out procedures • Conducted in a logical manner • Conducted according to manufacturer's specifications • Conducted according to work place requirements

Line (GAC): G ENGINES

Competency: G3 Perform leak down, cylinder balance and compression tests

Objectives

To be competent in this area, the individual must be able to

- Describe compression problems, equipment used and procedures for conducting leak down and compression tests.
- Conducts leak down and compression tests

LEARNING TASKS	CONTENT
1. Describe the purpose and procedures for conducting leak down, cylinder balance and compression tests	• Compression loss problems • Equipment used for leak down tests • Performing leak down tests • Equipment used for compression tests • Procedures for leak down and compression tests
2. Conducts leak down, cylinder balance and compression tests	• Performs leak down, cylinder balance and compression tests

Achievement Criteria

Performance: G3 Perform leak down, cylinder balance and compression tests

Conditions: The learner will require:

- Tools
- Test equipment
- Manufactures Specifications
- A work place or training environment
- Equipment with Engines

Criteria: The learner will be competent once the performance criteria is met:

- Followed safe work practices throughout entire task including lock out procedures
- Conducted in a logical manner
- Conducted according to manufacturer's specifications
- Conducted according to work place requirements

Line (GAC): G ENGINES

Competency: G4 Disassemble, inspect and reassemble engines

Objectives

To be competent in this area, the individual must be able to

- Describe the techniques for disassembly, inspection of engine components and re-assembly.
- Performs engine disassembly, inspection of engine components and re-assembly procedures
- Describe the procedures for clearing water from engines that have been submerged, damage assessment and re-starting

LEARNING TASKS	CONTENT
1. Describe techniques used for disassembling and assembling major engine components	• OEM specifications and wear limits • Cleanliness • Cylinder heads • Cylinder blocks • Valves, valve seats and guides • Camshafts, gears, train, flywheels • Crankshafts • Pistons and rods • Bearings • Seals and gaskets • Oil pump, journals and flow chart
2. Perform engine disassembly, inspection and reassembly procedures	• OEM specifications and wear limits • Cleanliness • Cylinder heads • Cylinder blocks • Valves, valve seats and guides • Camshafts, gears, train, flywheels • Crankshafts • Pistons and rods • Bearings • Seals and gaskets • Oil pump, journals and flow chart
3. Describe procedures for salvaging recovered marine engines	• Fresh water procedures • Salt water procedures • Preparation for salvage operation • Preparation of tools, equipment and supplies required • Electrical components • Gearbox • Oil and water removal from engine

LEARNING TASKS	CONTENT
	components • Cranking and starting procedures • Follow up procedures

Achievement Criteria

Performance	G4 Disassemble, inspect and reassemble engines
Conditions	The learner will require: • Tools • Test equipment • Manufactures Specifications • A work place or training environment • Equipment with Engines
Criteria	The learner will be competent once the performance criteria is met: • Followed safe work practices throughout entire task including lock out procedures • Conducted in a logical manner • Conducted according to manufacturer's specifications • Conducted according to work place requirements

Line (GAC): G ENGINES

Competency: G5 Measure engine components and specific machining requirements

Objectives

To be competent in this area, the individual must be able to

- Describe inspection and measurement procedures for major engine components
- Describe machining requirements, procedures, allowable tolerances and documentation for machining engine components being overhauled
- Performs inspection, measurement and makes machining recommendations for rebuilding major engine components

LEARNING TASKS	CONTENT
1. Describe inspection and measurement procedures for major engine components	• Cylinder heads • Cylinder bore • Valves and valve seats • Camshafts • Crankshaft • Pistons and rods • Bearings • OEM specifications • Tolerances and wear limits
2. Describe machining requirements and procedures for machining engine components being overhauled	• Requirements for machining • Machining procedures • Allowable tolerances • Documentation and specifications for machining work
3. Perform inspection, measurement and makes machining recommendations for rebuilding major engine components	• Inspection • Measurement • Machining recommendations

Achievement Criteria

Performance	G5 Measure engine components and specific machining requirements
Conditions	The learner will require: • Tools • Test equipment • Manufactures Specifications • A work place or training environment • Equipment with Engines
Criteria	The learner will be competent once the performance criteria is met: • Followed safe work practices throughout entire task including lock out procedures • Conducted in a logical manner • Conducted according to manufacturer's specifications • Conducted according to work place requirements

Line (GAC): G ENGINES

Competency: G6 Perform engine component adjustment procedures

Objectives

To be competent in this area, the individual must be able to

- Describe tools and procedures for adjusting engine components for proper operation
- Performs procedures for adjusting engine components for proper operation

LEARNING TASKS	CONTENT
1. Describe engine component adjustment procedures	• Valves • Timing • Injectors • Carburetors • Governors and speed adjustment
2. Perform engine component adjustment procedures	• Valves • Timing • Injectors • Carburetors • Governors and speed adjustment

Achievement Criteria

Performance	G6 Perform engine component adjustment procedures
Conditions	The learner will require: • Tools • Test equipment • Manufactures Specifications • A work place or training environment • Equipment with Engines
Criteria	The learner will be competent once the performance criteria is met: • Followed safe work practices throughout entire task including lock out procedures • Conducted in a logical manner • Conducted according to manufacturer's specifications • Conducted according to work place requirements

Line (GAC): I MARINE DRIVE SYSTEMS

Competency: I1 Diagnose propellers

Objectives

To be competent in this area, the individual must be able to

- Describe the basic function of propellers, the types and materials commonly in use and the mathematical relationships related to diameter and pitch.
- Describe common propeller problems, diagnoses and recommended correction
- Inspects propellers, makes diagnoses and recommendations for corrective action

LEARNING TASKS	CONTENT
1. Describe properties of propellers and how they work	• Propeller types and characteristics • Materials used for propellers • Blade numbers • Diameter and power relationship • Pitch • Common applications • Folding props • Specialty propellers • Director
2. Describe common propeller problems and how they can be diagnosed	• Damage • Cavitation • Corrosion • Fit to shaft • Rubber hubs • Incorrect sizing/selection
3. Diagnoses common propeller problems and recommends repair solutions	• Damage assessment • Hub damage • Balance • Pitch alteration • Blade number

Achievement Criteria

Performance	I1 Diagnose propellers
Conditions	The learner will require: • Tools • Test equipment • Manufactures Specifications • A work place or training environment • Equipment with Marine Drive Systems
Criteria	The learner will be competent once the performance criteria is met: • Followed safe work practices throughout entire task including lock out procedures • Conducted in a logical manner • Conducted according to manufacturer's specifications • Conducted according to work place requirements

Line (GAC): I MARINE DRIVE SYSTEMS

Competency: I2 Remove and install propellers

Objectives

To be competent in this area, the individual must be able to

- Describe propeller and prop shaft relationship and techniques for removing and installing propellers.
- Removes and installs propellers properly and safely

LEARNING TASKS	CONTENT
1. Describe propeller and prop shaft tapers, keyways and techniques for removal and installation	• Tapers • Keys and keyways • Securing with nuts and pins • Prop pullers • Use of heat • Prop removal techniques • Heavy propellers • Prop installation • Bushings
2. Remove and install propellers	• Tapers • Keys and keyways • Securing with nuts and pins • Prop pullers • Use of heat • Prop removal techniques • Heavy propellers • Prop installation • Bushings

Achievement Criteria

Performance: I2 Remove and install propellers

Conditions: The learner will require:

- Tools
- Test equipment
- Manufactures Specifications
- A work place or training environment
- Equipment with Marine Drive Systems

Criteria: The learner will be competent once the performance criteria is met:

- Followed safe work practices throughout entire task including lock out procedures
- Conducted in a logical manner
- Conducted according to manufacturer's specifications
- Conducted according to work place requirements

Line (GAC): I MARINE DRIVE SYSTEMS

Competency: I3 Install I/O drives

Objectives

To be competent in this area, the individual must be able to

- Describe procedures for transom assembly and drive leg component installation new or as replacement
- Performs procedures for transom assembly and drive leg installation on I/O vessels, new and as replacement

LEARNING TASKS	CONTENT
1. Describe procedures for installation of I/O units in vessels	• Selection and location • Transom preparation • Transom plate and assembly installation • I/O leg installation • Alignment with engine • Exhaust elbow height requirements and installation
2. Preforms procedures for installation of I/O units in vessels	• Selection and location • Transom preparation • Transom plate and assembly installation • I/O leg installation • Alignment with engine • Exhaust elbow height requirements and installation

Achievement Criteria

Performance	I3 Install I/O drives
Conditions	The learner will require: • Tools • Test equipment • Manufactures Specifications • A work place or training environment • Equipment with Marine Drive Systems
Criteria	The learner will be competent once the performance criteria is met: • Followed safe work practices throughout entire task including lock out procedures • Conducted in a logical manner • Conducted according to manufacturer's specifications • Conducted according to work place requirements

Line (GAC): I MARINE DRIVE SYSTEMS

Competency: I4 Service and diagnose stern drive components

Objectives

To be competent in this area, the individual must be able to

- Describe current types of stern drive function and components.
- Describe procedures for diagnosing, teardown, repair and re-assembly of stern drive components
- Services and diagnoses I/O stern drives and transom assemblies
- Disassembles, repairs and re-assembles I/O stern drives and transom assemblies

LEARNING TASKS	CONTENT
1. Describe stern drive engine drive leg components	• Housing structure • Stern drive identification • Bearings • Transmissions • Shift and clutch designs, mechanical and electric • Shift adjusting procedures • Gearcases (regular, counter-rotation, duoprop) • Gear patterns • Shafts and seals • Failure analysis • Shimming procedures • Universal joints • Gimbal housings and bearings
2. Describe procedures for diagnosing and repair of stern drive components	• Housing • Bearings • Shafts and seals • Transmission • Shifting gear • Shimming • Universal joints • Gimbal housings and bearings • Teardown and reassembly using special tools and techniques • Re-sealing • Pressure and vacuum testing
3. Perform procedures for diagnosing and repair of stern drive components	• Diagnosing and diagnoses • Teardown, repair and reassembly

Achievement Criteria

Performance	I4 Service and diagnose stern drive components
Conditions	The learner will require: • Tools • Test equipment • Manufactures Specifications • A work place or training environment • Equipment with Marine Drive Systems
Criteria	The learner will be competent once the performance criteria is met: • Followed safe work practices throughout entire task including lock out procedures • Conducted in a logical manner • Conducted according to manufacturer's specifications • Conducted according to work place requirements

Line (GAC): I MARINE DRIVE SYSTEMS

Competency: I5 Repair transom housing

Objectives

To be competent in this area, the individual must be able to

- Describe procedures for disassembly, repair, re-assembly and sealing of transom (gimbal) housings and bearings
- Performs correct procedures for disassembly, repair and re-assembly of transom housings and bearings

LEARNING TASKS	CONTENT
1. Describe procedures for disassembly, repair and reassembly of transom (gimbal) housings and bearings	• Disassembly and inspection • Gimbal bearing alignment • Gimbal ring and steering pins • Universal joint bellows • Exhaust bellows • Shift cable and bellows • Anti-corrosion bonding devices
2. Perform procedures for disassembly, repair and reassembly of transom (gimbal) housings and bearings	• Disassembly and inspection • Gimbal bearing alignment • Gimbal ring and steering pins • Universal joint bellows • Exhaust bellows • Shift cable and bellows • Anti-corrosion bonding devices

Achievement Criteria

Performance: I5 Repair transom housing

Conditions: The learner will require:

- Tools
- Test equipment
- Manufactures Specifications
- A work place or training environment
- Equipment with Marine Drive Systems

Criteria: The learner will be competent once the performance criteria is met:

- Followed safe work practices throughout entire task including lock out procedures
- Conducted in a logical manner
- Conducted according to manufacturer's specifications
- Conducted according to work place requirements

Line (GAC): I MARINE DRIVE SYSTEMS

Competency: I6 Describe jet drive and surface piercing drives

Objectives

To be competent in this area, the individual must be able to

- Describe the components and function of common conventional inboard drive train systems
- Describe the components, operation and basic diagnosing and repair procedures for jet drive systems.
- Describe the components, operation and basic diagnosing and repair procedures for surface piercing drive systems.

LEARNING TASKS	CONTENT
1. Describe components and function of conventional inboard drive trains	• Transmissions • V-drives, close coupled and remote • Drive plates • Trolling valves • Shaft couplings, fixed, flex • Shafts • Bearings • Universal joint installations • Conventional stuffing boxes • Dripless seals • Cutless bearings • Struts
2. Describe components and operation of jet drive systems	• Components and operation • Diagnosing and repair procedures • Teardown procedure • Inspection, shimming, reassembly
3. Describe components and operation of surface piercing drives	• Components and operation • Diagnosing and repair procedures

Achievement Criteria

Performance	I6 Describe jet drive and surface piercing drives
Conditions	The learner will require: • Tools • Test equipment • Manufactures Specifications • A work place or training environment • Equipment with Marine Drive Systems
Criteria	The learner will be competent once the performance criteria is met: • Followed safe work practices throughout entire task including lock out procedures • Conducted in a logical manner • Conducted according to manufacturer's specifications • Conducted according to work place requirements

Line (GAC): I MARINE DRIVE SYSTEMS

Competency: I7 Service inboard drive trains

Objectives

To be competent in this area, the individual must be able to

- Describe common faults, diagnosing and repair/replacement and servicing of conventional drive train components
- Diagnoses, services and repairs common inboard drive train components

LEARNING TASKS	CONTENT
1. Describe procedures for diagnosing and servicing inboard drive trains	• Shaft couplings • Shafts • Bearings, steady bearings • Universal joint installations • Conventional stuffing boxes • Dripless seals • Cutless bearings • Struts
2. Diagnose, service and repair inboard drive train components	• Coupling installations • Shaft removal and replacement • Shaft inspection and alignment • Bearing inspection and servicing • Conventional stuffing box gland servicing and re-packing • Dripless seal installation • Cutless bearing replacement

Achievement Criteria

Performance: I7 Service inboard drive trains

Conditions: The learner will require:

- Tools
- Test equipment
- Manufactures Specifications
- A work place or training environment
- Equipment with Marine Drive Systems

Criteria: The learner will be competent once the performance criteria is met:

- Followed safe work practices throughout entire task including lock out procedures
- Conducted in a logical manner
- Conducted according to manufacturer's specifications
- Conducted according to work place requirements

Line (GAC): I MARINE DRIVE SYSTEMS

Competency: I8 Diagnose inboard transmissions and V-drives

Objectives

To be competent in this area, the individual must be able to

- Describe components and procedures for diagnosing common inboard transmission problems
- Describe components and procedures for diagnosing common V-drive transmission problems
- Diagnose common inboard drive transmission problems and removes/replaces transmission
- Diagnose common V-drive transmission problems and removes/replaces V-drive

LEARNING TASKS	CONTENT
1. Describe procedures for diagnosing common inboard engine transmissions	• Clutches • Gearboxes • Controls • Trolling valves • Oils, contamination, leaks
2. Describe procedures for diagnosing common V-drive units	• V-drive components • Drive plates • Servicing and diagnosing
3. Perform procedures for diagnosing common inboard drive transmissions	• Clutch faults and diagnosis • Transmission faults and failures, diagnosis • Transmission removal/replacement • Clutch and transmission adjustments
4. Perform procedures for diagnosing V-drive units	• V-drive faults and diagnosis • V-drive removal/replacement

Achievement Criteria

Performance: I8 Diagnose inboard transmissions and V-drives

Conditions: The learner will require:

- Tools
- Test equipment
- Manufactures Specifications
- A work place or training environment
- Equipment with Marine Drive Systems

Criteria: The learner will be competent once the performance criteria is met:

- Followed safe work practices throughout entire task including lock out procedures
- Conducted in a logical manner
- Conducted according to manufacturer's specifications
- Conducted according to work place requirements

Line (GAC): I MARINE DRIVE SYSTEMS

Competency: I9 Diagnose drive train vibration sources

Objectives

To be competent in this area, the individual must be able to

- Describe the common sources of drive train vibration and techniques for identifying vibration sources
- Diagnose vibration problems in vessels and recommends appropriate repair procedures

LEARNING TASKS	CONTENT
1. Describe common sources of drive train vibration problems and procedures for diagnosing	• Alignment problems • Shaft straightness/damage • Coupling run-out • Engine mounts • Bearings and struts • Propeller problems
2. Perform procedures for diagnosing drive train vibration problems	• Diagnosing techniques • Checking shaft alignment and straightness • Mount condition and compatibility • Propeller problems, suitability

Achievement Criteria

Performance	I9 Diagnose drive train vibration sources
Conditions	The learner will require: • Tools • Test equipment • Manufactures Specifications • A work place or training environment • Equipment with Marine Drive Systems
Criteria	The learner will be competent once the performance criteria is met: • Followed safe work practices throughout entire task including lock out procedures • Conducted in a logical manner • Conducted according to manufacturer's specifications • Conducted according to work place requirements

Line (GAC): I MARINE DRIVE SYSTEMS

Competency: I10 Install and service engine mounting systems

Objectives

To be competent in this area, the individual must be able to

- Describe the basic drive train components of current outboard engine units.
- Describe common engine mount systems used with marine engines
- Inspects, adjusts and replaces engine mounts and repairs engine beds

LEARNING TASKS	CONTENT
1. Describe common engine mount systems used with marine engines	• Engine beds and engine loads • Vibration control • Flexible mounts • Fixed mounts • Sizing for application
2. Install and service common engine mount systems	• Engine mount inspection • Engine mount adjustment • Replacing engine mounts • Engine bed repairs

Achievement Criteria

Performance: I10 Install and service engine mounting systems

Conditions: The learner will require:

- Tools
- Test equipment
- Manufactures Specifications
- A work place or training environment
- Equipment with Marine Drive Systems

Criteria: The learner will be competent once the performance criteria is met:

- Followed safe work practices throughout entire task including lock out procedures
- Conducted in a logical manner
- Conducted according to manufacturer's specifications
- Conducted according to work place requirements

Line (GAC): I MARINE DRIVE SYSTEMS

Competency: I11 Diagnose and repair O/B drive components

Objectives

To be competent in this area, the individual must be able to

- Describe the basic drive train components of current outboard engine units.
- Describe tools and procedures for diagnosing and repairing modern outboard drive legs and drive train components.
- Performs procedures for diagnosing and repairing modern outboard drive legs and drive trains.

LEARNING TASKS	CONTENT
1. Describe outboard engine drive leg components	• Housing structure and components • Bearings • Shafts and seals • Impellers • Clutch types and designs • Gearboxes and gear patterns • Shift designs, mechanical • Electrical shift systems • Gear oils • Counter-rotation
2. Describe procedures for diagnosing and servicing outboard drive leg components	• Housing (teardown and reassembly) • Bearings (using special tools and techniques) • Shimming procedures • Shafts and seals • Impellers • Gearboxes, clutches, controls • Failure analysis • Pressure and vacuum testing gearcases
3. Perform procedures for diagnosing and servicing outboard drive leg components	• Housing teardown and reassembly • Component inspection and diagnosing • Setting up and shimming gearcases

Achievement Criteria

Performance	I11 Diagnose and repair O/B drive components
Conditions	The learner will require: • Tools • Test equipment • Manufactures Specifications • A work place or training environment • Equipment with Marine Drive Systems
Criteria	The learner will be competent once the performance criteria is met: • Followed safe work practices throughout entire task including lock out procedures • Conducted in a logical manner • Conducted according to manufacturer's specifications • Conducted according to work place requirements

Line (GAC): I MARINE DRIVE SYSTEMS

Competency: I12 Service thrusters and trim tabs

Objectives

To be competent in this area, the individual must be able to

- Describe the function, components and operation of hydraulic and electric powered bow and stern thrusters, their diagnosing and servicing.
- Describe the function, components and operation of hydraulic and electric powered trim tabs, their diagnosing and servicing.
- Diagnose, services and repairs serviceable components of thrusters and trim tabs.

LEARNING TASKS	CONTENT
1. Describe the operation and components of bow and stern thrusters	• Function of thrusters • Hydraulic thrusters components • Electric thrusters components • Servicing considerations • Diagnosing
2. Describe the operation and components of powered trim tabs	• Function of trim tabs • Hydraulic trim tab components • Electric trim tab components • Diagnosing
3. Diagnose, service and repair thrusters and trim tabs	• Serviceable and non-serviceable components

Achievement Criteria

Performance	I12 Service thrusters and trim tabs
Conditions	The learner will require: • Tools • Test equipment • Manufactures Specifications • A work place or training environment • Equipment with Marine Drive Systems
Criteria	The learner will be competent once the performance criteria is met: • Followed safe work practices throughout entire task including lock out procedures • Conducted in a logical manner • Conducted according to manufacturer's specifications • Conducted according to work place requirements

Line (GAC): J IGNITION SYSTEMS

Competency: J1 Service ignition systems

Objectives

To be competent in this area, the individual must be able to

- Describe routine service of conventional electric ignition systems, and electronic ignition systems
- Service conventional ignition systems, and electronic ignition systems

LEARNING TASKS	CONTENT
1. Describe procedures for routine service of conventional electric ignition systems	• Spark plug assessment and replacement • OEM specifications • Distributor component assessment and replacement • Wire harness inspection • Timing adjustments
2. Performs routine service of conventional electric ignition systems	• Spark plug assessment and replacement • Distributor component assessment and replacement • Wire harness inspection • Timing adjustments
3. Describe procedures for routine servicing of electronic ignition systems	• OEM specifications • Timing adjustment • Diagnostic equipment
4. Performs routine servicing of electronic ignition systems	• Diagnostic equipment • Timing adjustment

Achievement Criteria

Performance J1 Service ignition systems

Conditions The learner will require:

- Tools
- Test equipment
- Manufactures Specifications
- A work place or training environment
- Equipment with Ignition System

Criteria The learner will be competent once the performance criteria is met:

- Followed safe work practices throughout entire task including lock out procedures
- Conducted in a logical manner
- Conducted according to manufacturer's specifications
- Conducted according to work place requirements

Line (GAC): J IGNITION SYSTEMS

Competency: J2 Diagnose ignition system faults

Objectives

To be competent in this area, the individual must be able to:

- Describe diagnosing and repair of conventional ignition systems, electronic ignition systems and computer controlled systems.
- Diagnose and repair conventional ignition systems, electronic ignition systems and computer controlled systems.

LEARNING TASKS	CONTENT
1. Describe diagnosing techniques for conventional electric ignition systems	• Diagnosing tools • Spark plug faults • Weak spark • No spark • Diagnosing component failure • Wire harness faults • Timing faults
2. Diagnose conventional electric ignition system problems	• Diagnostic tools • Timing light
3. Describe diagnosing techniques for electronic and computer controlled ignition systems	• Electronic diagnostic equipment • Proprietary diagnostic software
4. Diagnose electronic and computer controlled ignition system problems	• Use of computer and electronic test equipment and software

Achievement Criteria

Performance: J2 Diagnose ignition system faults.

Conditions: The learner will require:

- Tools
- Test equipment
- Manufactures Specifications
- A work place or training environment
- Equipment with Ignition System

Criteria: The learner will be competent once the performance criteria is met:

- Followed safe work practices throughout entire task including lock out procedures
- Conducted in a logical manner
- Conducted according to manufacturer's specifications
- Conducted according to work place requirements

Line (GAC): J IGNITION SYSTEMS

Competency: J3 Diagnose and repair conventional ignition systems

Objectives

To be competent in this area, the individual must be able to

- Describe diagnosing tools and techniques for conventional ignition systems
- Diagnose and repairs conventional ignition systems

LEARNING TASKS	CONTENT
1. Describe diagnosing techniques for conventional ignition systems	• Diagnosing tools • Spark plug faults • Weak spark, no spark • Spark gap testers • Diagnosing component failure • Wire harness faults • Timing faults • Timing and synchronization procedures
2. Diagnose and repairs conventional ignition system problems	• Diagnosing procedures • Component repair and replacement • Timing and synchronization procedures • Flywheels, magnets

Achievement Criteria

Performance	J3 Diagnose and repair conventional ignition systems
Conditions	The learner will require: • Tools • Test equipment • Manufactures Specifications • A work place or training environment • Equipment with Ignition System
Criteria	The learner will be competent once the performance criteria is met: • Followed safe work practices throughout entire task including lock out procedures • Conducted in a logical manner • Conducted according to manufacturer's specifications • Conducted according to work place requirements

Line (GAC): J IGNITION SYSTEMS

Competency: J4 Diagnose and repair electronic ignition systems

Objectives

To be competent in this area, the individual must be able to

- Describe tools and techniques for diagnosing electronic ignition systems found on current outboard engines.
- Diagnose, diagnose and repairs/replaces components of electronic ignition systems.

LEARNING TASKS	CONTENT
1. Describe diagnosing techniques for electronic ignition systems	• Electronic diagnostic equipment • Electronic ignition system components • Diagnosing techniques • Spark gap testers • DVA meter
2. Diagnose electronic ignition system problems	• Coils • Trigger • Stator • Switchbox • CDI • CDM • Measurement units • Flywheels and magnets

Achievement Criteria

Performance: J4 Diagnose and repair electronic ignition systems

Conditions: The learner will require:

- Tools
- Test equipment
- Manufactures Specifications
- A work place or training environment
- Equipment with Ignition System

Criteria: The learner will be competent once the performance criteria is met:

- Followed safe work practices throughout entire task including lock out procedures
- Conducted in a logical manner
- Conducted according to manufacturer's specifications
- Conducted according to work place requirements

Line (GAC): K CONTROL SYSTEMS

Competency: K1 Diagnose and repair engine control systems

Objectives

To be competent in this area, the individual must be able to

- Describe the types, characteristics and basic operation of engine control systems found on recreational vessel installations.
- Describe the basic diagnosing techniques for engine control system problems.
- Diagnose, repairs and adjusts serviceable components of engine control systems.

LEARNING TASKS	CONTENT
1. Describe engine control systems commonly found on vessel installations	• Mechanical/cable • Hydraulic powered • Air powered • Electronic • Throttle controls • Gearshift controls • Engine shut down controls • Trolling valves • PTO's
2. Describe basic diagnosing techniques for common recreational marine engine control systems	• Mechanical/cable • Hydraulic powered • Air powered • Electronic • Throttle controls • Gearshift controls • Engine shut down controls • Trolling valves • PTO's
3. Diagnose and perform repairs and adjustments to serviceable components of engine control systems	• Serviceable components of hydraulic, air and electronic control systems • Diagnosing and adjustment

Achievement Criteria

Performance	K1 Diagnose and repair engine control systems
Conditions	The learner will require: • Tools • Test equipment • Manufactures Specifications • A work place or training environment • Equipment with Control Systems
Criteria	The learner will be competent once the performance criteria is met: • Followed safe work practices throughout entire task including lock out procedures • Conducted in a logical manner • Conducted according to manufacturer's specifications • Conducted according to work place requirements

Line (GAC): K CONTROL SYSTEMS

Competency: K2 Describe autopilot types and systems

Objectives

To be competent in this area, the individual must be able to

- Describe the common autopilot systems, how they function and their main components.
- Describe the basic diagnosing techniques for autopilot system problems.

LEARNING TASKS	CONTENT
1. Describe common autopilot systems function and components	• Wheel mounted mechanical systems • Hydraulic systems • Control units • Compass units • Drives • Remote wireless controls
2. Describe basic diagnosing techniques for common recreational marine autopilot systems	• Wheel mounted mechanical systems • Hydraulic systems • Control units • Compass units • Drives

Achievement Criteria

Performance: K2 Describe autopilot types and systems

Conditions: The learner will require:

- Tools
- Test equipment
- Manufactures Specifications
- A work place or training environment
- Equipment with Control Systems

Criteria: The learner will be competent once the performance criteria is met:

- Followed safe work practices throughout entire task including lock out procedures
- Conducted in a logical manner
- Conducted according to manufacturer's specifications
- Conducted according to work place requirements

Line (GAC): L FUEL DELIVERY

Competency: L1 Diagnose diesel injector pumps

Objectives

To be competent in this area, the individual must be able to

- Describe diagnosing techniques for current diesel fuel injection systems
- Diagnose injection pump problems and adjusts pump timing

LEARNING TASKS	CONTENT
1. Describe diagnosing common rail systems	• Diagnostic procedures
2. Describe diagnosing electronic fuel injection systems	• Diagnostic procedures
3. Diagnose typical fuel injection pump faults	• Transfer pressure • Fuel delivery • Injector pipes • Pump timing • Bosch type pumps • Conventional pumps

Achievement Criteria

Performance	L1 Diagnose diesel injector pumps
Conditions	The learner will require: • Tools • Test equipment • Manufactures Specifications • A work place or training environment • Equipment with Fuel Delivery
Criteria	The learner will be competent once the performance criteria is met: • Followed safe work practices throughout entire task including lock out procedures • Conducted in a logical manner • Conducted according to manufacturer's specifications • Conducted according to work place requirements

Line (GAC): L FUEL DELIVERY

Competency: L2 Diagnose and service diesel injectors

Objectives

To be competent in this area, the individual must be able to

- Describe common diesel fuel injectors and diagnosing/servicing techniques
- Diagnose and service fuel injector faults
- Inspects, cleans, tests and sets up injectors

LEARNING TASKS	CONTENT
1. Describe types and configurations of common fuel injectors	• Types
2. Diagnose injector faults	• Locating faulty injector • Symptoms of injector faults
3. Service fuel injectors	• Injector inspection • Cleaning • Testing spray pattern • Re-assembly and setting pressure

Achievement Criteria

Performance: L2 Diagnose and service diesel injectors

Conditions: The learner will require:

- Tools
- Test equipment
- Manufactures Specifications
- A work place or training environment
- Equipment with Fuel Delivery

Criteria: The learner will be competent once the performance criteria is met:

- Followed safe work practices throughout entire task including lock out procedures
- Conducted in a logical manner
- Conducted according to manufacturer's specifications
- Conducted according to work place requirements

Line (GAC): L FUEL DELIVERY

Competency: L3 Service diesel fuel transfer pump and primary fuel systems

Objectives

To be competent in this area, the individual must be able to

- Describe diesel fuel primary systems, pumps, filters and lines
- Troubleshoots and services primary fuel delivery systems

LEARNING TASKS	CONTENT
1. Describe diesel fuel transfer systems	• Mechanical pump configurations and operation • Electric pump configurations and operation • Filters • Lines and fittings
2. Service diesel fuel pumps and primary systems	• Fuel line inspection • Fuel Filter servicing • Service fuel pumps

Achievement Criteria

Performance: L3 Service diesel fuel transfer pump and primary fuel systems

Conditions: The learner will require:

- Tools
- Test equipment
- Manufactures Specifications
- A work place or training environment
- Equipment with Fuel Delivery

Criteria: The learner will be competent once the performance criteria is met:

- Followed safe work practices throughout entire task including lock out procedures
- Conducted in a logical manner
- Conducted according to manufacturer's specifications
- Conducted according to work place requirements

Line (GAC): L FUEL DELIVERY

Competency: L4 Inspect and treat diesel fuel

Objectives

To be competent in this area, the individual must be able to

- Describe characteristics and qualities of diesel fuel
- Describe identification of fuel quality problems
- Identify fuel quality and contamination problems
- Select and use fuel additives to treat fuel quality problems

LEARNING TASKS	CONTENT
1. Describe characteristics of different grade and qualities of diesel fuel	• Base oils and diesel characteristics • Grades • Additives • BTUs • Flammability • Flow characteristics
2. Describe techniques for identifying problems with fuel quality	• Solids contamination • Microbial contamination • Water • Fuel deterioration
3. Inspect and perform basic analysis techniques for identifying fuel problems	• Visual inspections for contaminants • Sampling for lab. analysis
4. Select and use appropriate fuel additives to treat fuel quality problems	• Biocide treatments • Water displacement • Lubrication • Cetane enhancers • Low temperature additives

Achievement Criteria

Performance	L4 Inspect and treat diesel fuel
Conditions	The learner will require: • Tools • Test equipment • Manufactures Specifications • A work place or training environment • Equipment with Fuel Delivery
Criteria	The learner will be competent once the performance criteria is met: • Followed safe work practices throughout entire task including lock out procedures • Conducted in a logical manner • Conducted according to manufacturer's specifications • Conducted according to work place requirements

Line (GAC): L FUEL DELIVERY

Competency: L5 Service engine preheat systems

Objectives

To be competent in this area, the individual must be able to

- Describe engine pre-heating systems and components
- Describe engine pre-lubricating systems
- Diagnose and repair engine pre-heating systems

LEARNING TASKS	CONTENT
1. Describe common engine pre-heating systems	• Glow plugs • Relays and solenoids • Coolant heaters • Intake heaters • Fuel heaters
2. Diagnose and repair glow plug and pre-heating systems	• Testing glow plugs • Relays and solenoids • Electrical faults • Coolant heaters • Intake heaters
3. Describe engine pre-lubrication systems	• Engine pre-lub systems

Achievement Criteria

Performance: L5 Service engine preheat systems

Conditions: The learner will require:

- Tools
- Test equipment
- Manufactures Specifications
- A work place or training environment
- Equipment with Fuel Delivery

Criteria: The learner will be competent once the performance criteria is met:

- Followed safe work practices throughout entire task including lock out procedures
- Conducted in a logical manner
- Conducted according to manufacturer's specifications
- Conducted according to work place requirements

Line (GAC): L FUEL DELIVERY

Competency: L6 Service turbochargers and intercoolers

Objectives

To be competent in this area, the individual must be able to

- Describe basic servicing procedures for turbochargers and intercoolers
- Performs basic servicing procedures for turbochargers and intercoolers

LEARNING TASKS	CONTENT
1. Describe basic servicing procedures for intercoolers	• Inspection • Cleaning
2. Describe inspection of turbochargers	• Float • Damage • Seal leakage • Boost pressure • Plumbing
3. Perform basic inspection and test procedures for turbochargers and intercoolers	• Float • Damage • Seal leakage • Boost pressure • Plumbing

Achievement Criteria

Performance: L6 Service turbochargers and intercoolers

Conditions: The learner will require:

- Tools
- Test equipment
- Manufactures Specifications
- A work place or training environment
- Equipment with Fuel Delivery

Criteria: The learner will be competent once the performance criteria is met:

- Followed safe work practices throughout entire task including lock out procedures
- Conducted in a logical manner
- Conducted according to manufacturer's specifications
- Conducted according to work place requirements

Line (GAC): L FUEL DELIVERY

Competency: L7 Service gasoline fuel system components

Objectives

To be competent in this area, the individual must be able to

- Describe gasoline engine tanks and fuel delivery systems
- Describe the components and operation of carburetors and air intake equipment
- Describe the components and operation of gasoline fuel injection systems
- Describe and carries out routine servicing procedures for gasoline fuel supply components
- Describe and carries out routine servicing and adjustment procedures on carburetors
- Describe and carries out routine servicing and adjustment procedures on fuel injection systems

LEARNING TASKS	CONTENT
1. Describe carburetors	• Carburetor types and operation • Aspirated air systems, filters, flame arrestors
2. Describe servicing procedures for carbureted fuel systems	• Filters • Fuel lines, inspection, repair • Safety • Carburetor adjustments
3. Perform routine inspection and servicing procedures for carbureted systems	• Carburetor tuning
4. Describe servicing procedures for fuel injection systems	• Routine inspection and adjustment
5. Perform routine inspection and servicing procedures for fuel injection systems	• Injection pumps • Fuel injectors • Timing
6. Describe fuel injection systems	• Fuel injection system components and operation

Achievement Criteria

Performance	L7 Service gasoline fuel system components
Conditions	The learner will require: • Tools • Test equipment • Manufactures Specifications • A work place or training environment • Equipment with Fuel Delivery
Criteria	The learner will be competent once the performance criteria is met: • Followed safe work practices throughout entire task including lock out procedures • Conducted in a logical manner • Conducted according to manufacturer's specifications • Conducted according to work place requirements

Line (GAC): L FUEL DELIVERY

Competency: L8 Diagnose and repair gasoline fuel systems faults

Objectives

To be competent in this area, the individual must be able to

- Describe repair procedures on carbureted fuel systems and fuel injected systems
- Perform diagnosing and repair procedures on carbureted fuel systems and fuel injected systems

LEARNING TASKS	CONTENT
1. Describe common diagnosing and repair procedures for carbureted fuel systems	• Starting problems • Low power problems • Intermittent running problems • Vapour lock problems
2. Perform diagnosing and repair procedures for carbureted systems	• Starting problems • Low power problems • Intermittent running problems • Vapour lock problems
3. Describe common diagnosing and repair procedures for fuel injection systems	• Diagnostic procedures • Repair procedures
4. Perform diagnosing and repair procedures for fuel injection systems	• Diagnose • Repair

Achievement Criteria

Performance: L8 Diagnose and repair gasoline fuel systems faults

Conditions: The learner will require:

- Tools
- Test equipment
- Manufactures Specifications
- A work place or training environment
- Equipment with Fuel Delivery

Criteria: The learner will be competent once the performance criteria is met:

- Followed safe work practices throughout entire task including lock out procedures
- Conducted in a logical manner
- Conducted according to manufacturer's specifications
- Conducted according to work place requirements

Line (GAC): L FUEL DELIVERY

Competency: L9 Diagnose and repair oil injection systems

Objectives

To be competent in this area, the individual must be able to

- Describe 2-stroke oil injection systems, diagnosing and servicing procedures
- Perform diagnosing and servicing procedures on 2-stroke outboard oil injection systems

LEARNING TASKS	CONTENT
1. Describe diagnosing procedures for 2 stroke oil injection systems	• Oil tank auto fill system • Flow circuits • Oil pumps, pump output • Flow control • Warning systems, RPM limiting • 2 stroke oils for injection systems • Priming and bleeding procedures
2. Perform diagnosing procedures for 2 stroke oil injection systems	• Diagnosing and diagnostic procedures • Service and repair procedures

Achievement Criteria

Performance: L9 Diagnose and repair oil injection systems

Conditions: The learner will require:

- Tools
- Test equipment
- Manufactures Specifications
- A work place or training environment
- Equipment with Fuel Delivery

Criteria: The learner will be competent once the performance criteria is met:

- Followed safe work practices throughout entire task including lock out procedures
- Conducted in a logical manner
- Conducted according to manufacturer's specifications
- Conducted according to work place requirements

Section 4

TRAINING PROVIDER STANDARDS

Facility Requirements

Classroom Area

- 35 to 40 sq. ft. per trainee

Shop Area

- 115 to 135 sq. ft. per trainee
- Ceiling height 12 ft. minimum

Lab Requirements

- 115 to 135 sq. ft. per trainee
- Ceiling height 12 ft. minimum

Student Facilities

- Tool Storage: 5 sq. ft. per student

Instructor's Office Space

- 120 to 150 sq. ft

Other

- N/A

Tools and Equipment

Shop Equipment

Required

- Air Compressor
  - 5HP
- Air Tools
  - Air lines
  - Blow gun
- Anit-Freeze teester
  - Hydrometer
  - Propylene glycol
- Bearing heater
- Black light
- Breaker bar
  - 3/8”drive
  - ½” drive
- Compressor
  - Mechanical spring
  - Piston ring
  - Valve spring
- Connecting rod aligners
- Coolant systems pressure/ vacume tester
- Cutting Equipment
  - Side cutter
  - Tube cutter
  - Wire cutter
  - Shears
  - Utility knife
- Drift
- Drill bit set
- Drill press
- Drill electric hand
  - 3/8”
  - ½”
- Engine Cords
- Files
  - Flat
  - Round
- Flaring tools
- Flywheel holders
  - Outboard

- Flushing tools
- Fuel recovery and storage systems
- Funnels
- Gear case oil filler
- Gear case tester
    - Pressure
    - Vacume
- Gear case stand
- Glass bead machine
- Grease gun
- Grinders
    - Bench
    - Angle
    - Valve
- Hammers
    - Impact
    - Ball peen
    - Rubber
    - Sledge
    - Slide
- Heat gun
- Honing Equipment
    - Cylinder
    - Ball
    - Stone
- Hot air gun
- Impact driver set
- Labeling kit
- Level protractor
- Lights
    - Pen
    - 110V trouble
- Magnaflux Equipment
- Mirror
    - Inspection
- Oil drain pumps
- Pilers
    - Standard
    - Adjustable joint
    - Needle nose
    - Side Cutters
    - Vise grips
    - Retaining (snap) ring external

    - Retaining (snap) ring internal
    - Insulated handles for ingnition testing
- Presses
    - Arbor
    - Bushing
    - Hand
    - Bearing clamps
- Pry bar
- Pullers
    - Bearing
    - Gear
    - Heavy duty
    - Mechanical
    - Torque
    - Propeller
- Punches
- Reamers
- Ridge reamers
- Ring Compressors
- Ring Expander
- Saws
    - Hacksaw
    - Hole saw
    - Resiprocating
- Screwdrivers
    - Set flat
    - Set Philips
    - Set Robertson
- Seal Driver
- Shims
- Snap rings
- Socket extentions
    - 3/8”
    - ½”
- Sockets
    - ¼” drive set,SAE and metric
    - 3/8” drive set SAE and metric
    - 1/2” drive set SAE and metric
    - 3/8” drive spark plug set
    - 3/8” drive Allen head SAE and metric
    - ½” universal drive
    - 3/8” universal drive
- Straight edge
- Strobe light

- Stud extractor
- Surface plate
- Tap and die set
    - SEA
    - Metric
- Test tank
- Test tank ventilation system
- Thread chaser
- Thread file
- Thread inserts
- Torch
    - Propane
    - Butane
- Torx drivers
    - Set male
    - Set female
- Tube bender (manual)
- U-joint service tool
- Vacume cleaners
- Vacume pump
- Variable Resistor
- Welding equipment
    - Cart
    - Torches
    - Sparker
- Wrenches (SEA and metric)
    - Allen
    - Air impact
    - Spark plug
    - Torque
        - ¼
        - 3/8" in/lb
        - 3/8" ft/lb
    - Pipe
    - Adjustable (crescent)
    - Hex
    - Combination (long/short)
    - Flare
    - Adjustable hook spanner
    - Adjustable face piun spanner
- Wrench
    - Oil filter removal
- Carbon Scraper

- Cleaning Tank
- Tack cloths
- Hot tank degreaser
- Scrapers
- Solvent washer
- Vapour Degreaser
- Wire Brushes
    - Steel
    - Stainless
    - Brass
- Clamps
- Dolly
- Engine Repair stand
- Ground strap
- Hydraulic hand jack
- Mobile Hoist (capable of lifting 2000lb)
- Outboard motor tote (500-600lb)
- Portable engine crane
- Slings
- Vices

Shop (Facility) Tools

Standard Tools

- Battery charger
- Battery cable
- Batter load tester
- Circuit tester (self powered test light)
- Crimping tool/ wire strippers
    - Small
    - Large
- Hydrometer
- Meter
    - VOA digital with dwell meter
    - VOA analog
    - Tachometer
    - DVA adapter
- Pliers (insulated)
- Power bars
- Remote starter switch
- Soldering iron/ gunrosin core solder
- Spark tester (ignition)
- Timing light

- Belt tension gauge
- Boost pressure gauge
- Calibrated vessel
- Calipers
    - Outside
    - Inside
    - SAE
    - Metric
- Compression gauge
- Connection rod gauge
- Dial bore gauge
- Dial gauge base
    - Magnetic
    - Clam on
- Dial indicator
    - SAE
    - Metric
- Feeler gauge
    - Standard
    - Non-magnetic
    - Long set
- Flow gauge
- Fuel pressure and vacume gauge
- Hydraulic pressure gauge
- Laser temperature reader
- Mechanical pressure gauge
- Metal rulers
    - SAE
    - Metric
- Micrometers
    - Depth
    - Gauge
    - SAE
    - Metric
    - Inside
    - Outside
- Oil temperature gauge
- Plasti- gauge
- Pyrometer
- Small hole gauges
- Spark plug gap tool
- Sprong scale
- Squares

- Steel rules
  - SAE
  - Metric
- Stethoscope
- Strightedge
- Tachometer
- Tape measure
- Telescoping gauge
- Vacume gauge
- Verniers
  - SAE
  - Metric

Specialty Tools

- Armature
- Battery/starter clearance tester
- Carburetor tools
- Computer
  - Internet connected
  - Laptop
  - OEM software as required
- Computer printer
- Fuel quality test kit
- Injector tester
- Leakdown tester
- Module tester
- Portable OEM diagnostic equipment (as required for OEM equipment)
- Scanning tools
- Thermostat tester
- Valve guide service kit
- Valve spring tester

Student Equipment (supplied by school)

Required

- Ear protection
- Eye wash station
- Face wash station
- Face shield
- Fire extinguishers
- First aid kit
- Respirator

Recommended

- Apron
- Leggings

Student Tools (supplied by student)

Required

- Safety glasses and goggles
- Gloves
    - Leather
    - Rubber

Reference Materials

Recommended Resources

Author	Title
• Brady, Robert N.	Automotive and Small Truck Fuel Injection Systems
• Brady, Robert N.	Automotive Computers and Digital Instrumental
• Calder, Nigel,	Marine Diesel Engines: Maintenance, Troubleshooting, and Repair
• Calder, Nigel,	Boatowner's Mechanical & Electrical Manual: How to Maintain, Repair, and Improve Your Boat's Essential Systems
• Calder, Nigel,	Refrigeration for Pleasure Boats: Installation, Maintenance & Repair
• Collier, Everett,	The Boatowner's Guide to Corrosion
• Dagel, John F.	Diesel Engine Repair
• John Deere Corp.	Fundamentals of Service (F.O.S.) Bearings and Seals
• John Deere Corp.	Fundamentals of Service (F.O.S.) Identification of Failed Parts
• John Deere Corp.	Fundamentals of Service (F.O.S.) Electrical Systems
• John Deere Corp.	Fundamentals of Service (F.O.S.) Electronics and Electrical Systems
• John Deere Corp.	Fundamentals of Service (F.O.S.)Hydraulics, Compact Equipment
• John Deere Corp	Fundamentals of Service (F.O.S.) Engine – Compact Equipment
• Norman, Scarff & Cosinchock	Diesel Technology
• Seddon, Donald,	Diesel Troubleshooter
• Sperry Corp.	Mobile Hydraulics
• Stagner, Eugene W.,	Understanding the Outboard Motor
• Stockel, Martin,	Auto Mechanics Fundamentals
• Toboldt, Johnson & Gauthier	Automotive Encyclopedia
• Vickers Corp.	Mobile Hydraulics

Instructor Requirements

Occupation Qualification

The instructor must possess:

- BC Certificate of Qualification Inboard/Outboard Mechanic
  or
- BC Certificate of Qualification Marine Mechanical Technician
  or
- BC Certificate of Qualification Heavy Duty Mechanic

Work Experience

A minimum of 10 years' experience working in the industry as a journeyperson.

Instructional Experience and Education

It is preferred that the instructor also possesses one of the following:

- Provicial (BC) Instructors Diploma – not mandatory
- Completion of the Train the Trainer program – not mandatory

Appendices

Appendix A

Assessment Guidelines

Assessment Guidelines – Level 1

Level 1 Grading Sheet: Subject Competency and Weightings

PROGRAM: IN-SCHOOL TRAINING:	MARINE MECHANICAL TECHNICIAN LEVEL 1		
LINE	**SUBJECT COMPETENCIES**	**THEORY WEIGHTING**	**PRACTICAL WEIGHTING**
A	OCCUPATIONAL SKILLS (18%)	15%	10%
B	VESSEL SYSTEMS (18%)	15%	15%
C	HYDRAULIC EQUIPMENT (10%)	10%	15%
D	METAL WORKING (6%)	3%	2%
E	ELECTRICAL (32%)	25%	35%
F	ENGINE SUPPORT SYSTEMS (8%)	20%	20%
G	ENGINES (6%)	10%	0%
H	BOAT TRAILERS (2%)	2%	3%
	Total	100%	100%
In-school theory & practical subject competency weighting		60%	40%
Final in-school percentage score		IN-SCHOOL%	

In-school Percentage Score Combined theory and practical subject competency multiplied by	80%
Standardized Level Exam Percentage Score The exam score is multiplied by	20%
Final Percentage Score	**FINAL**%

Assessment Guidelines – Level 2

Level 2 Grading Sheet: Subject Competency and Weightings

PROGRAM: IN-SCHOOL TRAINING:	MARINE MECHANICAL TECHNICIAN LEVEL 2		
LINE	**SUBJECT COMPETENCIES**	**THEORY WEIGHTING**	**PRACTICAL WEIGHTING**
F	ENGINE SUPPORT SYSTEMS (3%)	5%	2%
G	ENGINES (22%)	20%	25%
I	MARINE DRIVE SYSTEMS (39%)	30%	35%
J	IGNITION SYSTEMS (12%)	15%	15%
K	CONTROL SYSTEMS (7%)	15%	5%
L	FUEL DELIVERY (17%)	15%	18%
	Total	100%	100%
In-school theory/practical subject competency weighting		60%	40%
Final in-school percentage score Apprentices must achieve a minimum 70% as the final in-school percentage score to be eligible to write the Certificate of Qualification Exam.		IN-SCHOOL%	

All apprentices who complete Level 2 of the Marine Mechanical Technician program with a FINAL level percentage score of 70% or greater will write the SkilledTradesBC Marine Mechanical Technician Certificate of Qualification (CofQ) examination as their final assessment.

SkilledTradesBC will enter the apprentices' Marine Mechanical Technician CofQ examination mark in SkilledTradesBC Portal. A minimum percentage score of 70% on the examination is required for a pass.