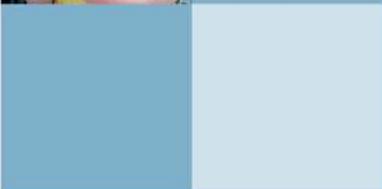
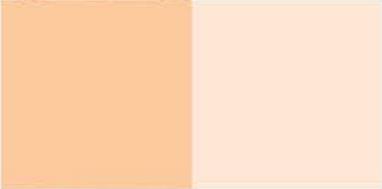
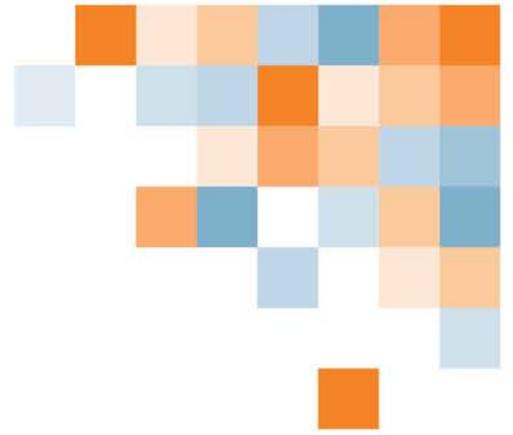


ita
YOUR TICKET.



PROGRAM OUTLINE

Marine Mechanical Technician



The latest version of this document is available in PDF format on the ITA website
www.itabc.ca

To order printed copies of Program Outlines
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MARINE MECHANICAL TECHNICIAN PROGRAM OUTLINE

**APPROVED BY INDUSTRY
DECEMBER 2013**

**Developed by
Industry Training Authority
Province of British Columbia**



TABLE OF CONTENTS

Section 1 INTRODUCTION.....	4
Foreword	5
Acknowledgements	6
How to Use this Document.....	7
Section 2 PROGRAM OVERVIEW	9
Program Credentialing Model	10
Occupational Analysis Chart	11
Training Topics and Suggested Time Allocation – Level 1	15
Training Topics and Suggested Time Allocation – Level 2.....	17
Section 3 PROGRAM CONTENT	19
Level 1 Marine Mechanical Technician	20
Level 2 Marine Mechanical Technician	78
Section 4 TRAINING PROVIDER STANDARDS	124
Facility Requirements.....	125
Tools and Equipment	126
Reference Materials	134
Instructor Requirements.....	135
Appendices	136
Appendix A Assessment Guidelines	137
Assessment Guidelines – Level 1	138
Assessment Guidelines – Level 2.....	139



Section 1

INTRODUCTION

Marine Mechanical Technician



Foreword

This Program Outline is for use in Marine Mechanical Technician industry training classes sponsored by the Industry Training Authority 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

The Industry Training Authority 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



Section	Training Providers	Employers/ Sponsors	Apprentices	Challengers
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

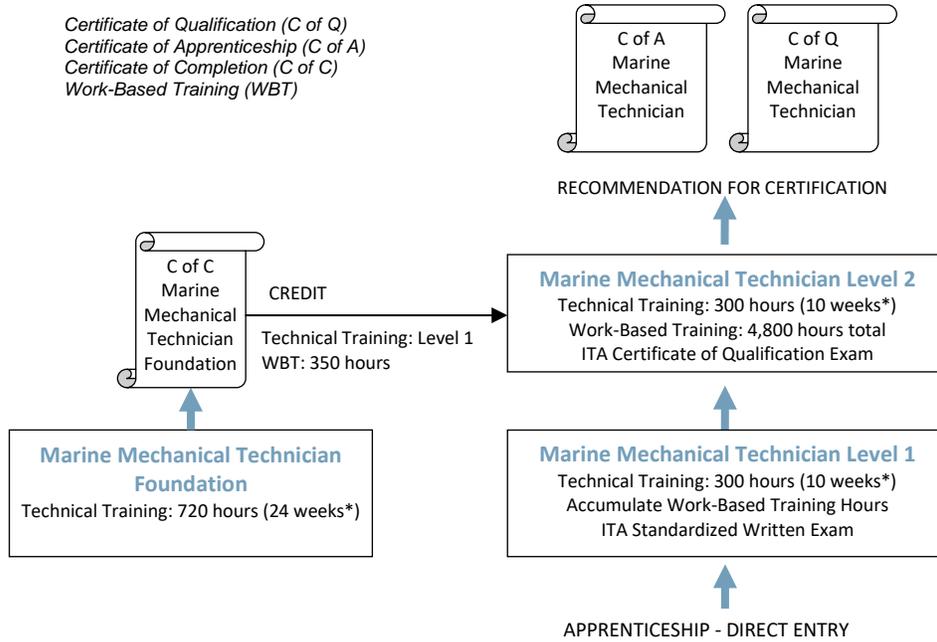
PROGRAM OVERVIEW

Marine Mechanical Technician



Program Credentialing Model

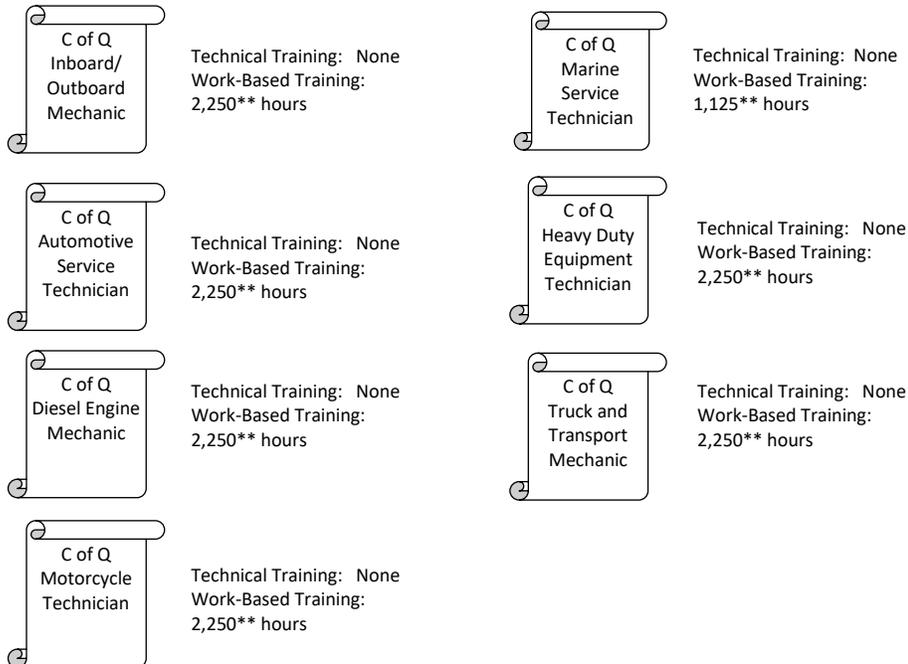
This graphic provides an overview of the Marine Mechanical Technician Program apprenticeship pathway:



**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:



***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 1	Work safely A2 1	Follow safe yard and marina practices A3 1	Operate vessels A4 1	Use documentation A5 1	Use fasteners and fittings A6 1		
	Describe and use composites A7 1	Select and use lubricants and coolants A8 1						
	VESSEL SYSTEMS B	Describe Thru-hulls B1 1	Describe cabin heating systems B2 1	Describe A/C and refrigeration theory B3 1	Describe safe propane installations B4 1	Describe davits, hoists and windlasses B5 1	Describe fire suppression equipment and lock outs B6 1	
		Inspect and repair mechanical and electrical steering systems B7 1	Describe and install fresh/waste water plumbing systems B8 1	Describe water makers B9 1	Service and install bilge pump systems B10 1			
		HYDRAULIC EQUIPMENT C	Describe hydraulic theory and system components C1 1	Service and install hydraulic steering systems C2 1	Diagnose and repair hydraulic equipment C3 1			



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			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		



BOAT TRAILERS
H

Describe and service boat trailers					H1
1					

MARINE DRIVE SYSTEMS
I

Diagnose propellers					I1
2					

Remove and install propellers					I2
2					

Install I/O drives					I3
2					

Service and diagnose stern drive components					I4
2					

Repair transom housings					I5
2					

Describe jet drive and surface piercing drives					I6
2					

Service inboard drive trains					I7
2					

Diagnose inboard transmissions and V-drives					I8
2					

Diagnose drive train vibration sources					I9
2					

Install and service engine mounting systems					I10
2					

Diagnose and repair O/B drive components					I11
2					

Service thrusters and trim tabs					I12
2					

IGNITION SYSTEMS
J

Service ignition systems					J1
2					

Diagnose ignition system faults					J2
2					

Diagnose and repair conventional ignition systems					J3
2					

Diagnose and repair electronic ignition systems					J4
2					

CONTROL SYSTEMS
K

Diagnose and repair engine control systems					K1
2					

Describe autopilot types, systems					K2
2					



FUEL DELIVERY L	Diagnose diesel injector pumps L1 <table border="1"> <tr> <td>2</td> <td></td> <td></td> <td></td> <td></td> </tr> </table>	2					Diagnose and service diesel injectors L2 <table border="1"> <tr> <td>2</td> <td></td> <td></td> <td></td> <td></td> </tr> </table>	2					Service diesel fuel transfer pump and primary fuel systems L3 <table border="1"> <tr> <td>2</td> <td></td> <td></td> <td></td> <td></td> </tr> </table>	2					Inspect and treat diesel fuel L4 <table border="1"> <tr> <td>2</td> <td></td> <td></td> <td></td> <td></td> </tr> </table>	2					Service engine preheat systems L5 <table border="1"> <tr> <td>2</td> <td></td> <td></td> <td></td> <td></td> </tr> </table>	2					Service turbochargers and intercoolers L6 <table border="1"> <tr> <td>2</td> <td></td> <td></td> <td></td> <td></td> </tr> </table>	2				
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Service gasoline fuel system components L7 <table border="1"> <tr> <td>2</td> <td></td> <td></td> <td></td> <td></td> </tr> </table>	2					Diagnose and repair gasoline fuel systems faults L8 <table border="1"> <tr> <td>2</td> <td></td> <td></td> <td></td> <td></td> </tr> </table>	2					Diagnose and repair oil injection systems L9 <table border="1"> <tr> <td>2</td> <td></td> <td></td> <td></td> <td></td> </tr> </table>	2																							
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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%	✓	✓	



		% of Time Allocated to:			
		% of Time	Theory	Practical	Total
E9	Install DC electrical wiring and circuits for electrical equipment	2%	✓	✓	
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%	✓		



		% of Time Allocated to:			
		% of Time	Theory	Practical	Total
Line L	FUEL DELIVERY	17%	35%	65%	100%
L1	Diagnose diesel injector pumps	4%	✓	✓	
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: 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

1. Describe safe work practices

2. Describe common marine workplace hazards and risks

3. Describe WHMIS regulations, labelling and use of MSDS

4. Describe safe handling and labelling of common marine industry hazardous materials

5. Describe use of Personal Protective Equipment (PPE)

6. Describe stages of fire development and appropriate response upon discovering a fire in the workplace

7. Describe common firefighting tools in the workplace

8. Demonstrate the use of portable fire extinguishers

CONTENT

- 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

- Untidiness, tripping hazards
- Falls
- Exposure to chemicals, dusts, fumes
- Fire and explosion hazards

- Purpose of WHMIS
- MSDS
- Labelling

- Solvents
- Paints
- Fuels
- Compressed gas

- Respirator and cartridge types and uses
 - Protection from dusts
 - Respirator fit test
- Gloves
- Protective clothing
- Eye protection
- Hearing protection

- Types of flammable materials
- Stages of fire development
- Sounding the alarm
- Location and protection of others
- Fire fighting decisions
- Preparation for arrival of firefighters
- Use of smothering materials
- Water
- Fire extinguisher types, identification and use
- P.A.S.S.



LEARNING TASKS

CONTENT

- 9. Describe safe practices for working in confined spaces

- 10. Describe hazards associated with working near deep water

- 11. Describe lockout/tagging procedures for electrical shop tools and equipment, and vessel engine and systems

- Pull
- Aim
- Squeeze
- Sweep

- Fire hazards
- Engine rooms and mechanical hazards
- Fumes, oxygen depletion and CO hazards
- Working alone, “buddy” systems and communications

- Hypothermia
- Means of getting to safety
- Life jacket/pfd use
- Working alone, ‘buddy’ systems and communications

- 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

- | | |
|---|--|
| <ol style="list-style-type: none"> 1. Describe common hauling and blocking techniques
 2. Secures vessels to docks
 3. Describe procedures and techniques for lifting engines
 4. Describe procedures for winterizing or storing engines | <ul style="list-style-type: none"> • Straddle lift equipment • Marine ways • Ramps and trailers • Blocking and jack stands • Bilge blocking sailboats • Heaving lines • Common knots, half hitch, bowline • Securing to cleats • Running dock lines • Fenders and protection from damage • Jacks • Chain hoists • Support structures • Cranes, forklifts • Protection of the vessel • Personal safety • Cooling systems • Fuel systems • Lubrication • Anti-corrosion measures |
|---|--|



LEARNING TASKS

5. Describe procedures for winterizing or laying up other vessel systems
6. Describe environmentally sound practices for disposing of chemicals, paints and anti-fouling residue
7. Describe environmentally sound practices for disposing of oils, fuels and coolants
8. Describe procedures for minimizing damage from accidental spills of contaminants
9. Describe emissions control regulations and standards applicable to recreational marine industry

CONTENT

- Batteries
- Plumbing systems
- Ventilation
- Covers, shrink-wrap systems
- Hazardous chemicals, solvents, paints
- Anti-fouling paint and residue
- Environmental implications of improper disposal
- Legal implications of improper disposal
- Used oil disposal
- Fuel disposal
- Coolants disposal
- Cleaning up spills in the shop or vessels
- Spills in the water
- 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

1. Describe typical procedures for commissioning new engines

2. Describe sea trial procedures

3. Describe vessel design considerations using correct terminology

CONTENT

- OEM commissioning instructions and specifications
- Warranty issues
- Pre-start engine hook-ups and inspection
- Initial start and inspection
- Post start procedures and inspection
- OEM specifications for initial engine use
- Use of checklist
- Wide open speed test
- 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

- | | |
|--|--|
| <ol style="list-style-type: none"> 1. Describe common sources of technical information related to the job 2. Demonstrate an ability to read and comprehend technical data 3. Describe use of internet browser 4. Describe the use of internet search engines 5. Describe the intent and use of industrial standards 6. Describe current marine industry standards organizations related to the trade | <ul style="list-style-type: none"> • Manufacturers' publications • Industry publications • Internet information • Marine industry terminology • Manuals and instructions • Technical drawings • Charts and graphs • Function of the internet • URLs and address protocols • Common search engines • Effective search techniques • Major sites related to the trade • Reasons for standards development • Applicability of standards on the job • Documentation • 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: 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

- | | |
|--|--|
| <ol style="list-style-type: none"> 1. Describe principles of FRP vessel construction
 2. Describe principles of metal vessel construction
 3. Describe polyester and epoxy resins
 4. Describe common reinforcement materials
 5. Describe techniques for FRP reinforcing structures
 6. Describe gel coat repair | <ul style="list-style-type: none"> • FRP materials • Molds and molding • One-off construction • FRP reinforcing structures • Design and construction considerations for mechanical installations
 • Construction in steel • Construction in aluminum • Construction techniques • Design and construction considerations for mechanical installations
 • Polyester resin • Epoxy resin • Cure factors • Measuring and mixing
 • Chopped strand mat • Fibreglass roving and cloth
 • Damage assessment • Bonding • Use of cores • Wood cores
 • Gel coat characteristics • Repair techniques |
|--|--|



LEARNING TASKS

7. Performs basic repairs to FRP structures
8. Describe the types and applications of common adhesives, sealants and bedding compounds used in the marine industry
9. Describe the use of epoxy as an adhesive, waterproof sealant and repair media
10. Describe the types and uses of cleaners, de-greasers and solvents used in the marine workplace

CONTENT

- Repairs
- Adhesives
- Sealants
- Bedding Compounds
- Anaerobic thread and bearing sealants
- Epoxy characteristics
- Mixing applying and curing
- Repair options with epoxy
- 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

- | | |
|--|--|
| <ol style="list-style-type: none"> 1. Describe the properties and use of engine oils 2. Describe the properties and use of drive train lubricants 3. Describe the properties and use of greases 4. Describe properties and use of coolants in engine cooling systems 5. Describe coolant assessment 6. Removes and replace coolant | <ul style="list-style-type: none"> • Engine oil types and identification • Properties of engine oils • Engine oil selection • Filtration • Transmission fluids and properties • Gear oils and properties • Types of grease • Properties and applications of greases • Coolant properties • Anti-freeze protection • OEM specifications • Additives • Monitoring coolant levels • Visual inspection • Hydrometer inspection • Supplemental Coolant Additives (SCA) tests • Remove • Replace |
|--|--|



LEARNING TASKS

7. Describe on-site inspections of engine oils and drive train lubricants

8. Describe sampling procedures for submitting samples for lab tests

9. Interprets and understands lab reports from lubricant tests

10. Describe techniques for changing engine oil and filters

11. Describe techniques for changing transmission oil

12. Describe techniques for changing gear oil in drive units

13. Performs engine oil changes

14. Performs transmission oil changes

15. Performs gear oil changes

CONTENT

- Engine oil problems
- Transmission oil problems
- Gear oil problems
- Visual inspections and characteristics
- Odour inspections and characteristics
- Feel

- Sampling techniques

- Lab report format and terminology

- Checking oil levels
- Procedures for removing engine oil and filters
- Procedures for replacing filters and oil

- Checking transmission oil levels
- Transmission oil removal and replacement
- Transmission filters

- Checking gear oil levels
- Procedures for oil removal and replacement

- Checking oil levels
- Oil and filter removal and replacement

- Checking transmission oil levels
- Transmission oil removal and replacement
- Transmission filters

- 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

1. Describe the general requirements for thru-hull installation

2. Describe thru-hull installation in FRP materials

3. Describe thru-hull installation in metal and wood

CONTENT

- Sizing and locating
- Materials
- Valves
- ABYC standards

- Single skin FRP
- Cored FRP
- Reinforcing structures
- Sealing

- 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

- | | |
|--|---|
| <ol style="list-style-type: none"> 1. Describe the installation considerations and procedures for installing natural draft heaters
 2. Describe the installation considerations and procedures for installing forced air heaters
 3. Describe the installation considerations and procedures for installing hot water heating systems | <ul style="list-style-type: none"> • Heater selection • Types <ul style="list-style-type: none"> ○ Propane ○ Diesel ○ Hot water • ABYC standards • Heater selection and component location • Component installation • Ducting installations • Fuel and power hookup • 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

- | | |
|---|--|
| <ol style="list-style-type: none"> 1. Describe the theory and basic operation of refrigeration equipment 2. Describe the main components of refrigeration equipment 3. Describe refrigerators and air conditioning systems | <ul style="list-style-type: none"> • Principles of refrigeration • Compressors • Heat exchange coils • Electrical controls • 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

- | | |
|---|--|
| <ol style="list-style-type: none"> 1. Describe the basic properties of propane and the safety hazards associated with its use in vessels
 2. Describe regulatory codes and standards
 3. Describe the safe installation of propane tanks and fuel supply lines | <ul style="list-style-type: none"> • Density • Flammability • Odour • Pressure • Safety considerations
 • Basic code requirements for land-based systems • ABYC standards • Pipe identification markings
 • 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

<ol style="list-style-type: none"> 1. Describe the selection and location of davits and hoists 2. Describe the structural reinforcement considerations for installation and reinforcement methods 3. Describe the installation and hook up of davits and hoists 4. Describe function and operation of anchor windlasses 5. Describe installation and hook up of anchor windlasses 	<ul style="list-style-type: none"> • Davit and hoist types and applications • Sizing and location • Determining loads • Reinforcement techniques for FRP structures • Reinforcement techniques for metal and wood structures • Hydraulically powered hoists • Electrically powered hoists • Rigging davits and hoists • Windlass and ground tackle selection • Electric windlasses • Hydraulic windlasses • Rodes and gypsies • 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

- | | |
|---|--|
| <ol style="list-style-type: none"> 1. Describe fire suppression equipment
 2. Describe safety hazards associated with fire suppression equipment and lock out procedures | <ul style="list-style-type: none"> • Equipment types • Basic components • Installation criteria • Inspection 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

- | | |
|---|---|
| <ol style="list-style-type: none"> 1. Describe function and operation of cable operated steering systems
 2. Describe diagnosing, servicing and repair techniques for mechanical steering
 3. Describe electric powered steering systems
 4. Diagnose, service and repair mechanical and electrical steering systems | <ul style="list-style-type: none"> • Rudders, posts and quadrants • Tubes and glands • Push-pull cable steering • Dual cable systems • Sailboat pedestal systems
 • Cable inspection and adjustment • Cable replacement • Rudder, quadrant, gland repair/replacement
 • Motors • Control system
 • 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

1. Describe the function and components of fresh water plumbing systems

2. Describe the function and components of waste water plumbing systems

3. Performs installation and repairs of fresh water systems

4. Performs installation and repairs of waste water systems

CONTENT

- Tanks
- Pumps
- Pipes, hose and fittings
- Hot water systems
- System layout

- Environmental regulations
- Holding tanks
- Marine toilets
- Pipes, hose and fittings
- Anti-siphon equipment
- Macerator pumps
- Vacuum systems
- Waste treatment systems
- Grey water systems

- Tanks
- Pumps
- Pipes, hose and fittings
- Hot 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

1. Describe principles of desalinator theory and equipment operation

2. Describe components of desalination equipment and their operation

3. Describe typical desalinator diagnosing and servicing procedures

CONTENT

- Principles of desalination equipment
- Water purity and standards for safe consumption

- Intakes
- Pressure pumps
- Membranes
- Control valves and systems
- Sterilizers

- 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): **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

- | | |
|---|--|
| <p>1. Describe hydraulic theory</p> | <ul style="list-style-type: none"> • Theory underlying hydraulic power systems |
| <p>2. Describe power trim and tilt systems</p> | <ul style="list-style-type: none"> • Electrical systems and components • Hydraulic systems and components |
| <p>3. Describe hydraulic system components and their function</p> | <ul style="list-style-type: none"> • Pumps • Tanks and pick-ups • Valves • Motors • Cylinders • Filters • Hydraulic oil |
| <p>4. Describe hydraulic system distribution components</p> | <ul style="list-style-type: none"> • 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

1. Describe the function and components of hydraulic steering systems

2. Install and service hydraulic systems

CONTENT

- Helm pumps
- Power assisted systems
- Multiple station systems
- Steering cylinder types and configurations
- System layout
- 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

1. Describe procedures and techniques for diagnosing typical hydraulic system faults

2. Performs repair procedures to correct hydraulic system faults

3. Describe procedures for installing and servicing hydraulic motors

4. Describe procedures for installing and servicing hydraulic cylinders

5. Install and service hydraulic motors and cylinders

CONTENT

- Serviceable components
- Non-serviceable components (pumps, cylinders)
- Diagnosing techniques
- Detecting leaks
- Pump faults
- Air in system and bleeding
- Oil contamination

- Serviceable components
- Leaks
- Pump faults
- Air in system and bleeding
- Oil contamination

- Motor types

- Cylinder types

- 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

- | | |
|--|--|
| <ol style="list-style-type: none"> 1. Describe marine metals, their properties and applications in the marine industry
 2. Describe the common metalworking operations found in the marine mechanical field
 3. Perform basic metalworking operations | <ul style="list-style-type: none"> • Steels • Aluminum • Bronze • Other non-ferrous metals • Compatibility with non metallic materials
 • Cutting • Drilling • Tapping and cutting threads • Bending • Filing and grinding • Tools and equipment • Blades and bits for various metals
 • 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

1. Describe common welding techniques used in the recreational marine industry workplace

2. Describe principles and components of oxy-acetylene equipment

3. Use oxy-acetylene equipment for heating and cutting

CONTENT

- Oxy-acetylene
- Brazing
- Techniques used for stainless and aluminum

- Principles of operation
- Regulators
- Hose
- Tips
- Heat ranges of metals

- 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

1. Describe difference between DC and AC power

2. Describe Ohm's law relationships between voltage, current and resistance

3. Describe voltage drop in electrical circuits and perform voltage drop calculations

CONTENT

- Principles of electricity
- Direct current power
- Alternating current power

- Ohm's Law
- Voltage, current, resistance
- Calculations applying Ohm’s Law

- 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

1. Identifies common symbols used in electrical schematics

2. Identifies electrical circuits in a schematic and their function

CONTENT

- Switches
- Lights
- Motors
- Fuses and breakers
- Alarm senders and detectors
- Solenoids
- Gauges

- 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

1. Describe the function and use of electrical measurement and testing equipment

2. Demonstrate the proper use of electrical measurement and testing equipment

CONTENT

- Continuity tester
- Multi-meter
- Amprobe

- 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: **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

- | | |
|---|---|
| <ol style="list-style-type: none"> 1. Describe AC powered battery chargers and battery management equipment
 2. Describe inverters and charger/inverters | <ul style="list-style-type: none"> • Battery charger types • Charging relays (ACR) • Echo chargers • Battery monitors • Charger installation and diagnosing
 • 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: **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

1. Describe engine starters and related components

2. Diagnose starter malfunctions

CONTENT

- Engine starters
- Starter solenoids
- Glow plugs and solenoids
- Air heaters

- 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: **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

<ol style="list-style-type: none"> 1. Describe typical electrical system faults on vessels 2. Diagnose typical electrical system faults on vessels 3. Describe galvanic corrosion in metals and steps to control damage 	<ul style="list-style-type: none"> • Physical damage • Corrosion • Overheating/overloading • Short circuits • Grounding faults • Short circuits • Grounding faults • Using test equipment • Galvanic series • Compatibility of metals • Corrosion assessment • Stray current corrosion • Bonding • Anodes • Active corrosion protection equipment • Coatings
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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

- | | |
|---|---|
| <ol style="list-style-type: none"> 1. Describe components and function of engine alarms and gauges
 2. Describe components and function of vessel alarm systems
 3. Locates and install gauges, senders and alarm systems
 4. Diagnose gauges, senders and alarm systems | <ul style="list-style-type: none"> • Heat detectors and gauges • Pressure gauges and senders • Engine alarms • Tachometers • Fuel gauges
 • Fire/smoke alarm systems • Gasoline fume alarms • Propane alarms • CO alarms • Bilge water alarms
 • Detector/sender locations • Alarms and alarm panel locations • Installation techniques • Testing techniques
 • 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

- | | |
|---|---|
| <ol style="list-style-type: none"> 1. Describe AC genset function and installation criteria
 2. Install genset in vessel to manufacturer's specifications
 3. Diagnose electrical malfunctions and service genset generator components | <ul style="list-style-type: none"> • AC gensets • Selection of size and output • Location in vessel • Installation criteria and techniques • Sound insulation • Electrical hook-up
 • Genset installation considerations • Reinforcement structures • Insulating • Exhaust systems
 • 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 SYSTEMS

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

- | | |
|---|--|
| <p>1. Describe fuel tanks and fuel tank installations</p> | <ul style="list-style-type: none"> • Materials and construction • Installation • Corrosion concerns • Pressure testing • ABYC standards |
| <p>2. Describe fuel level senders and gauges</p> | <ul style="list-style-type: none"> • Types of senders • Installation, electrical connections and grounding • Diagnosing |
| <p>3. Install and service fuel tanks</p> | <ul style="list-style-type: none"> • 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 SYSTEMS

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

- | | |
|---|--|
| <ol style="list-style-type: none"> 1. Describe gasoline and diesel fuel pumps
 2. Describe gasoline and diesel fuel filters and water separators
 3. Service gasoline fuel pumps and filters
 4. Service diesel fuel pumps and filters | <ul style="list-style-type: none"> • Gasoline systems • Diesel systems • Mechanical lift pumps • Electric fuel pumps
 • Gasoline filters • Diesel filters • Primary and secondary filters • Water separators • Sizing • Filter elements
 • Inspection • Selection • Element replacement procedures
 • 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 SYSTEMS

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

- | | |
|---|--|
| <ol style="list-style-type: none"> 1. Describe the characteristics of gasoline and common problems
 2. Describe the characteristics of diesel fuel and common problems
 3. Describe the use of additives and fuel 'polishing' procedures | <ul style="list-style-type: none"> • Characteristics of gasoline • Grades • Common contamination and deterioration problems
 • Characteristics of diesel fuel • Grades • Common contamination and deterioration problems • Biological growth
 • 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
 - Manufacturers 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

- | | |
|--|---|
| <ol style="list-style-type: none"> 1. Describe the history and basic operation of internal combustion engines
 2. Describe operation of gasoline engines
 3. Describe operation of diesel engines
 4. Describe modern diesel engine operation and operation or function of major components
 5. Describe routine engine inspections | <ul style="list-style-type: none"> • History • Basic components and functions • Spark ignition • Compression ignition • 4 – cycle engines • 2 – cycle engines
 • Gasoline and spark ignition • Carburetion systems • Fuel injection systems • Ignition systems • 4 – cycle engines • 2 – cycle engines
 • Diesel fuel and compression ignition • Fuel injection systems • 4 – cycle diesels • 2 – cycle diesels
 • Mechanical injection systems • Common rail injection systems • Electronic injection systems • Induction systems • Lubrication systems • Turbochargers/Intercoolers
 • Visual inspections • Integrity of hoses, lines, cables, belts • Control system function • Cooling system function and integrity • Anodes • Exhaust system function and integrity • Lubrication levels and fluids inspection |
|--|---|



LEARNING TASKS

CONTENT

- 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

1. Describe boat trailer frames

2. Describe boat trailer brakes

3. Describe and service wheel bearings

4. Describe and service boat trailer wiring

5. Describe boat trailer winches

6. Describe boat trailer set-up

7. Describe boat trailer hitches

CONTENT

- Materials used
- Types of construction
- Method of corrosion protection
- Suspension system
- Types of brake systems
 - Disc
 - Drum
 - Hydraulic
- Brake system components
 - Brake activation systems
- Types of wheel bearings
- Service of wheel bearings
- Color code
- Types of wire
- Types of vehicle connections
- Manual winches
- Electric winches
- Boat support
- Balance
- Fastening boat to trailer
- 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 SYSTEMS**
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

- | | |
|---|--|
| <ol style="list-style-type: none"> 1. Describe wet exhaust systems
 2. Describe dry exhaust systems
 3. Describe I/O exhaust systems | <ul style="list-style-type: none"> • Mixing elbows and anti-siphon systems • Elbow height • Water lift mufflers • Wet exhaust system plumbing and outlets
 • Exhaust stack installations • Sound and heat insulation
 • 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 SYSTEMS

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

- | | |
|---|--|
| <p>1. Describe procedures for inspecting and servicing exhaust systems</p> | <ul style="list-style-type: none"> • Leaks, wear and deterioration of components • Mixing elbows • Anti-siphon loops and valves • Mufflers • Manometer use • Water separators • Dry exhaust systems |
| <p>2. Perform procedures for inspecting and repairing inboard exhaust systems</p> | <ul style="list-style-type: none"> • 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



LEARNING TASKS

3. Diagnoses and repair cooling system components

CONTENT

- 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

1. Describe the purpose and procedures for conducting leak down, cylinder balance and compression tests

2. Conducts leak down, cylinder balance and compression tests

CONTENT

- 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

- 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



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

- | | |
|--|---|
| <ol style="list-style-type: none"> 1. Describe inspection and measurement procedures for major engine components
 2. Describe machining requirements and procedures for machining engine components being overhauled
 3. Perform inspection, measurement and makes machining recommendations for rebuilding major engine components | <ul style="list-style-type: none"> • Cylinder heads • Cylinder bore • Valves and valve seats • Camshafts • Crankshaft • Pistons and rods • Bearings • OEM specifications • Tolerances and wear limits
 • Requirements for machining • Machining procedures • Allowable tolerances • Documentation and specifications for machining work
 • 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

- | | |
|---|--|
| <p>1. Describe engine component adjustment procedures</p> | <ul style="list-style-type: none"> • Valves • Timing • Injectors • Carburetors • Governors and speed adjustment |
| <p>2. Perform engine component adjustment procedures</p> | <ul style="list-style-type: none"> • 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

1. Describe properties of propellers and how they work

2. Describe common propeller problems and how they can be diagnosed

3. Diagnoses common propeller problems and recommends repair solutions

CONTENT

- Propeller types and characteristics
- Materials used for propellers
- Blade numbers
- Diameter and power relationship
- Pitch
- Common applications
- Folding props
- Specialty propellers
- Director

- Damage
- Cavitation
- Corrosion
- Fit to shaft
- Rubber hubs
- Incorrect sizing/selection

- 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: 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

1. Describe procedures for installation of I/O units in vessels

2. Performs procedures for installation of I/O units in vessels

CONTENT

- Selection and location
- Transom preparation
- Transom plate and assembly installation
- I/O leg installation
- Alignment with engine
- Exhaust elbow height requirements and installation

- 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



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

- | | |
|---|--|
| <ol style="list-style-type: none"> 1. Describe procedures for disassembly, repair and reassembly of transom (gimbal) housings and bearings
 2. Perform procedures for disassembly, repair and reassembly of transom (gimbal) housings and bearings | <ul style="list-style-type: none"> • Disassembly and inspection • Gimbal bearing alignment • Gimbal ring and steering pins • Universal joint bellows • Exhaust bellows • Shift cable and bellows • Anti-corrosion bonding devices
 • 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



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: **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

- | | |
|--|--|
| <ol style="list-style-type: none"> 1. Describe procedures for diagnosing common inboard engine transmissions
 2. Describe procedures for diagnosing common V-drive units
 3. Perform procedures for diagnosing common inboard drive transmissions
 4. Perform procedures for diagnosing V-drive units | <ul style="list-style-type: none"> • Clutches • Gearboxes • Controls • Trolling valves • Oils, contamination, leaks
 • V-drive components • Drive plates • Servicing and diagnosing
 • Clutch faults and diagnosis • Transmission faults and failures, diagnosis • Transmission removal/replacement • Clutch and transmission adjustments
 • 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

- | | |
|---|---|
| <ol style="list-style-type: none"> 1. Describe common sources of drive train vibration problems and procedures for diagnosing
 2. Perform procedures for diagnosing drive train vibration problems | <ul style="list-style-type: none"> • Alignment problems • Shaft straightness/damage • Coupling run-out • Engine mounts • Bearings and struts • Propeller 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

- | | |
|--|---|
| <ol style="list-style-type: none"> 1. Describe common engine mount systems used with marine engines
 2. Install and service common engine mount systems | <ul style="list-style-type: none"> • Engine beds and engine loads • Vibration control • Flexible mounts • Fixed mounts • Sizing for application
 • 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



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

1. Describe the operation and components of bow and stern thrusters

2. Describe the operation and components of powered trim tabs

3. Diagnose, service and repair thrusters and trim tabs

CONTENT

- Function of thrusters
- Hydraulic thrusters components
- Electric thrusters components
- Servicing considerations
- Diagnosing

- Function of trim tabs
- Hydraulic trim tab components
- Electric trim tab components
- Diagnosing

- 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

- | | |
|--|--|
| <ol style="list-style-type: none"> 1. Describe procedures for routine service of conventional electric ignition systems
 2. Performs routine service of conventional electric ignition systems
 3. Describe procedures for routine servicing of electronic ignition systems
 4. Performs routine servicing of electronic ignition systems | <ul style="list-style-type: none"> • Spark plug assessment and replacement • OEM specifications • Distributor component assessment and replacement • Wire harness inspection • Timing adjustments
 • Spark plug assessment and replacement • Distributor component assessment and replacement • Wire harness inspection • Timing adjustments
 • OEM specifications • Timing adjustment • Diagnostic equipment
 • 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

1. Describe diagnosing techniques for conventional electric ignition systems
2. Diagnose conventional electric ignition system problems
3. Describe diagnosing techniques for electronic and computer controlled ignition systems
4. Diagnose electronic and computer controlled ignition system problems

CONTENT

- Diagnosing tools
- Spark plug faults
- Weak spark
- No spark
- Diagnosing component failure
- Wire harness faults
- Timing faults
- Diagnostic tools
- Timing light
- Electronic diagnostic equipment
- Proprietary diagnostic software
- 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: **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

- | | |
|--|--|
| <ol style="list-style-type: none"> 1. Describe diagnosing techniques for electronic ignition systems
 2. Diagnose electronic ignition system problems | <ul style="list-style-type: none"> • Electronic diagnostic equipment • Electronic ignition system components • Diagnosing techniques • Spark gap testers • DVA meter
 • 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



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

1. Describe common autopilot systems function and components

2. Describe basic diagnosing techniques for common recreational marine autopilot systems

CONTENT

- Wheel mounted mechanical systems
- Hydraulic systems
- Control units
- Compass units
- Drives
- Remote wireless controls

- 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

- | | |
|--|---|
| <ol style="list-style-type: none"> 1. Describe diagnosing common rail systems 2. Describe diagnosing electronic fuel injection systems 3. Diagnose typical fuel injection pump faults | <ul style="list-style-type: none"> • Diagnostic procedures • Diagnostic procedures • 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

1. Describe types and configurations of common fuel injectors
2. Diagnose injector faults
3. Service fuel injectors

CONTENT

- Types
- Locating faulty injector
- Symptoms of injector faults
- 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: **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

1. Describe characteristics of different grade and qualities of diesel fuel

2. Describe techniques for identifying problems with fuel quality

3. Inspect and perform basic analysis techniques for identifying fuel problems

4. Select and use appropriate fuel additives to treat fuel quality problems

CONTENT

- Base oils and diesel characteristics
- Grades
- Additives
- BTUs
- Flammability
- Flow characteristics
- Solids contamination
- Microbial contamination
- Water
- Fuel deterioration
- Visual inspections for contaminants
- Sampling for lab. analysis
- 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

- | | |
|---|---|
| <ol style="list-style-type: none"> 1. Describe common engine pre-heating systems
 2. Diagnose and repair glow plug and pre-heating systems
 3. Describe engine pre-lubrication systems | <ul style="list-style-type: none"> • Glow plugs • Relays and solenoids • Coolant heaters • Intake heaters • Fuel heaters
 • Testing glow plugs • Relays and solenoids • Electrical faults • Coolant heaters • Intake heaters
 • 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

- | | |
|--|--|
| <ol style="list-style-type: none"> 1. Describe basic servicing procedures for intercoolers 2. Describe inspection of turbochargers 3. Perform basic inspection and test procedures for turbochargers and intercoolers | <ul style="list-style-type: none"> • Inspection • Cleaning • Float • Damage • Seal leakage • Boost pressure • Plumbing • 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

<ol style="list-style-type: none"> 1. Describe carburetors 2. Describe servicing procedures for carbureted fuel systems 3. Perform routine inspection and servicing procedures for carbureted systems 4. Describe servicing procedures for fuel injection systems 5. Perform routine inspection and servicing procedures for fuel injection systems 6. Describe fuel injection systems 	<ul style="list-style-type: none"> • Carburetor types and operation • Aspirated air systems, filters, flame arrestors • Filters • Fuel lines, inspection, repair • Safety • Carburetor adjustments • Carburetor tuning • Routine inspection and adjustment • Injection pumps • Fuel injectors • Timing • 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

- | | |
|---|--|
| <ol style="list-style-type: none"> 1. Describe common diagnosing and repair procedures for carbureted fuel systems
 2. Perform diagnosing and repair procedures for carbureted systems
 3. Describe common diagnosing and repair procedures for fuel injection systems
 4. Perform diagnosing and repair procedures for fuel injection systems | <ul style="list-style-type: none"> • Starting problems • Low power problems • Intermittent running problems • Vapour lock problems
 • Starting problems • Low power problems • Intermittent running problems • Vapour lock problems
 • Diagnostic procedures • Repair procedures
 • 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

1. Describe diagnosing procedures for 2 stroke oil injection systems

2. Perform diagnosing procedures for 2 stroke oil injection systems

CONTENT

- 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

- 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
- Anti-Freeze tester
 - Hydrometer
 - Propylene glycol
- Bearing heater
- Black light
- Breaker bar
 - 3/8" drive
 - 1/2" 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"
 - 1/2"
- 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 ignition 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
 - Res reciprocating
- Screwdrivers
 - Set flat
 - Set Philips
 - Set Robertson
- Seal Driver
- Shims
- Snap rings
- Socket extensions
 - 3/8"
 - 1/2"
- Sockets
 - 1/4" 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
 - 1/2" 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
- Battery 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

<u>Author</u>	<u>Title</u>
• 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 journeyman.

Instructional Experience and Education

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

- Provincial (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 ITA Marine Mechanical Technician Certificate of Qualification (CofQ) examination as their final assessment.

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