



**Skilled  
Trades**  
Ontario

**Métiers  
spécialisés**  
Ontario

Apprenticeship  
Curriculum Standard

Marine Engine Technician

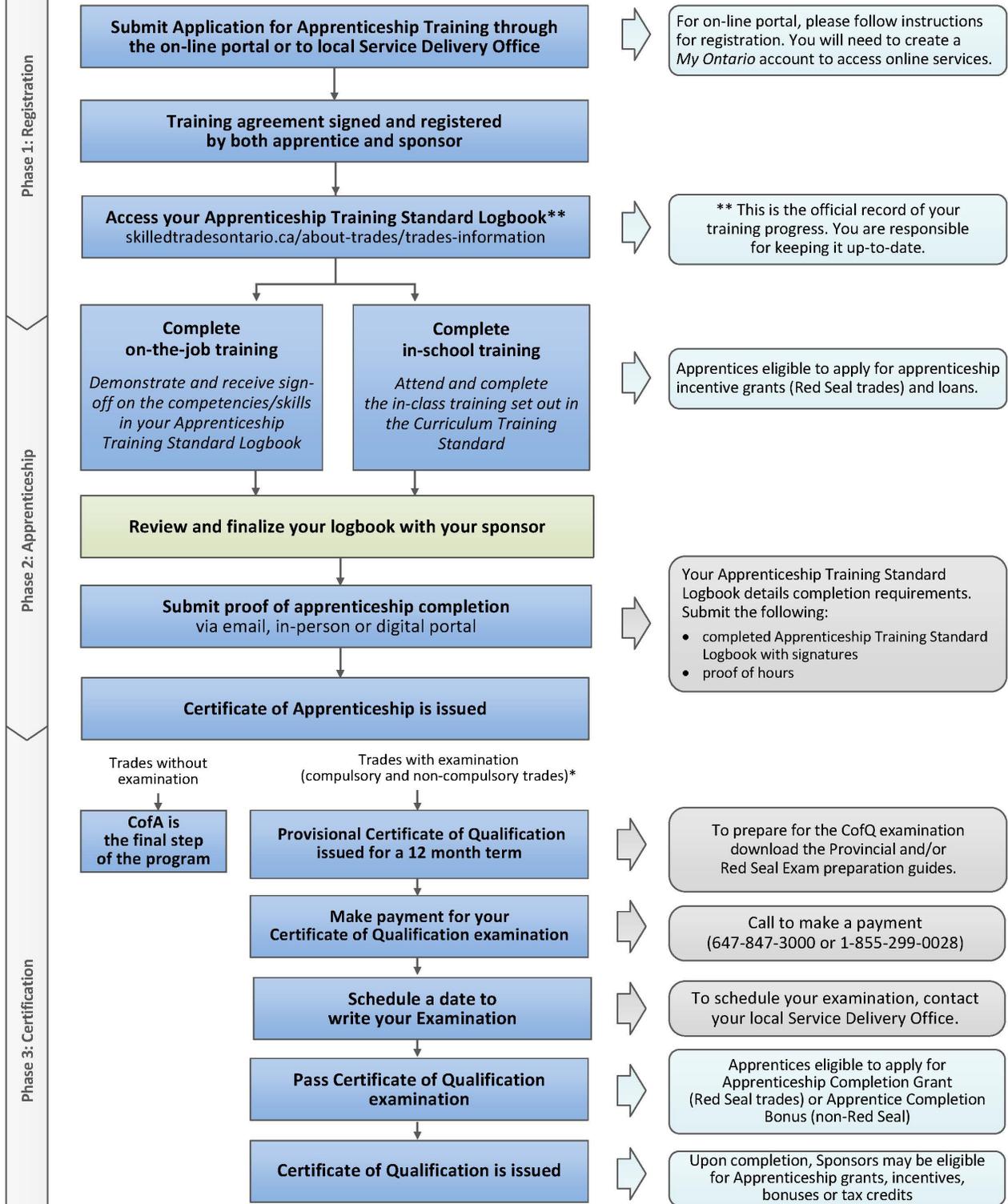
Level 3

435B

2014



# Apprenticeship Pathway to a Certificate of Qualification



\* For a list of trades subject to a certification examination, visit: [skilledtradesontario.ca](http://skilledtradesontario.ca)

<b>Table of Contents</b>
--------------------------

Preface.....	1
Introduction .....	2
Level 3.....	3
Program Summary of Reportable Subjects .....	4
S1443 Work Practices and Procedures.....	5
S1443.1 Terms and Definitions.....	6
S1443.2 Marine Hardware, Adhesives and Sealants.....	8
S1443.3 Damage Identification and Repair.....	10
S1443.4 Sail Boats .....	12
S1443.5 In-Water Marine Handling Devices .....	14
S1444 Propulsion Systems .....	16
S1444.1 Outboard Systems.....	17
S1444.2 Inboard/Outboard Systems.....	19
S1444.3 Inboard Systems.....	22
S1444.4 Propellers .....	24
S1445 Advanced Engine Systems .....	26
S1445.1 Engine Mechanical System Repairs .....	27
S1445.2 Engine Lubrication Systems .....	30
S1445.3 Intake Cooling and Exhaust Systems .....	32
S1445.4 Engine Electrical Systems .....	35
S1446 Electronic Fuel Management Systems.....	38
S1446.1 Computer Fundamentals .....	40
S1446.2 Gasoline Engine Electronic Fuel Management.....	42
S1446.3 Diesel Engine Electronic Fuel Management.....	44
S1447 Handling, Rigging, Running and Storing .....	46
S1447.1 Out of Water Boat Handling Equipment.....	48
S1447.2 Boat Rigging.....	51
S1447.3 Pre-Delivery and Test Run .....	53
S1447.4 Seasonal Storage .....	55

S1448	Auxiliary Systems.....	58
S1448.1	Auxiliary Hydraulic Systems.....	60
S1448.2	AC/DC Electrical Systems and Appliances .....	64
S1448.3	Alternative Power Sources .....	67
S1448.4	Marine Plumbing Systems .....	69
S1448.5	Safety Regulations and Equipment.....	71

**Please Note:** This Standard has been revised to reflect the visual identity of Skilled Trades Ontario (STO) which replaced the Ontario College of Trades on January 1, 2022. The content of this Standard may refer to the former organization; however, all trade specific information or content remains relevant and accurate based on the original date of publishing.

Please refer to STO's website: [skilledtradesontario.ca](http://skilledtradesontario.ca) for the most accurate and up to date information. For information about BOSTA and its regulations, please visit [\*\*Building Opportunities in the Skilled Trades Act, 2021 \(BOSTA\)\*\*](#).

Any updates to this publication are available on-line; to download this document in PDF format, please follow the link: [Skilled Trades Ontario.ca](http://Skilled Trades Ontario.ca).

© 2022, Skilled Trades Ontario. All rights reserved. No part of this publication may be reproduced in any form whatsoever without the prior permission from Skilled Trades Ontario.

*Maintained with transfer to Skilled Trades Ontario 2014 (V100)*

### **Preface**

This curriculum standard for the Small Engine Technician, Marine Engine Technician & Turf Equipment Technician trade programs is based upon the on-the-job performance objectives, located in the industry-approved training standard.

The curriculum is organized into 3 levels of training. The Reportable Subjects Summary chart (located on page 4) summarizes the training hours for each reportable subject.

The curriculum identifies the learning that takes place in-school. The in-school program focuses primarily on the theoretical knowledge and the essential skills required to support the performance objectives of the Apprenticeship Training Standards.

Employers/Sponsors are expected to extend the apprentice's knowledge and skills through practical training on a work site. Regular evaluations of the apprentice's knowledge and skills are conducted throughout training to verify that all apprentices have achieved the learning outcomes identified in the curriculum standard.

It is not the intent of the in-school curriculum to perfect on-the-job skills. The practical portion of the in-school program is used to reinforce theoretical knowledge. Skill training is provided on the job.

Please refer to Skilled Trades Ontario website ([www.skilledtradesontario.ca](http://www.skilledtradesontario.ca)) for the most accurate and up-to-date information about Skilled Trades Ontario. For information on *Building Opportunities in the Skilled Trades Act, 2021 (BOSTA)* and its regulations, please visit [Building Opportunities in the Skilled Trades Act, 2021, S.O. 2021, c. 28 - Bill 288 \(ontario.ca\)](http://www.skilledtradesontario.ca/building-opportunities-in-the-skilled-trades-act-2021-s.o.-2021-c.-28-bill-288)

### **Pre-requisites**

In order to advance to Level 2 of the apprenticeship program, an individual must have completed all of the units outlined in Level 1. Similarly, in order to advance to Level 3 of the program, an individual must have completed all of the units outlined in Level 1 and 2.

### **Hours Disclaimer** (if applicable)

It is agreed that Training Delivery Agents (TDAs) may need to make slight adjustments (with cause) according to particular apprentice needs and may deviate from the unit sequencing and the prescribed practical and theoretical hours shown within the standard. However, all TDAs will comply with the hours at the reportable subject level.

### **Suggested Equipment for Training Delivery Agencies**

Personal and Safety Equipment: Personal protective equipment is at the discretion of the TDA who must conform to Ontario Provincial Health and Safety Regulations.

## Introduction

This curriculum standard for the Small Engine Technician & Marine Engine Technician trades is designed down from the learning outcomes, which were in turn developed from the industry-approved training standard.

The curriculum is organized into three levels of training, each including reportable subjects containing like or similar learning outcomes to reflect the units of the training standard. The hours charts indicates how the curriculum can be delivered in the current block release format and summarizes the hours of training for each reportable by level.

The reportable subjects are cross-referenced to the training standard for ease of comparison.

Each reportable subject and learning outcome identifies a recommended number of training hours. This hour allotment is broken into hours for instruction in theory and practical application. The division of the curriculum into reportable subjects that follow a natural progression of learning through the levels and branches of training will allow training centers and apprentice's flexibility in program delivery while still observing the importance of sequencing learning in a logical progression.

The curriculum is framed by and includes specific references to performance objectives in the Apprenticeship Training Standards for Small Engine Technician and Marine Engine Technician. However, it identifies only the learning that takes place off the job, in a training centre. The in-school program focuses primarily on the theoretical knowledge required to master the performance objectives of the Training Standards. Employers are expected to extend the apprentice's knowledge and skills through appropriate practical training on the work site. Regular evaluations of the apprentice's knowledge and skills is conducted throughout training to assure that all apprentices have achieved the learning outcomes identified in the curriculum standard. The balance between theoretical and practical evaluation is identified for each unit of learning outcomes.

# Level 3

**Program Summary of Reportable Subjects**

<b>Number</b>	<b>Reportable Subjects</b>	<b>Hours Total</b>	<b>Hours Theory</b>	<b>Hours Practical</b>
S1443	Work Practices and Procedures	21	17	4
S1444	Propulsion Systems	39	19	20
S1445	Advanced Engine Systems	54	20	34
S1446	Electronic Fuel Management Systems	30	17	13
S1447	Handling, Rigging, Running and Storing	36	21	15
S1448	Auxiliary Systems	60	32	28
	<b>Total</b>	<b>240</b>	<b>126</b>	<b>114</b>

Number:	S1443		
Title:	<b>Work Practices and Procedures</b>		
Duration:	Total Hours: 21	Theory: 17	Practical: 4
Prerequisites:	Level 1 and Level 2, Reportable Subjects		
Content:	1.1 Terms and Definitions (2/0)		
	1.2 Hardware, Adhesives and Sealants (2/1)		
	1.3 Damage Identification and Repair (6/0)		
	1.4 Sail Boats (3/0)		
	1.5 In-Water Marine Handling Devices (4/3)		

**Evaluation & Testing:**

Minimum of one mid-term test during the 8 week term  
Final exam at end of term  
Periodic quizzes

**Instructional and Delivery Strategies:**

Assignments related to theory and appropriate application skills

**Reference Materials:**

*Workplace Safety and Insurance Act, 1997*  
*Occupational Health and Safety Act, 1990*  
*Employment Standards Act, 2000*  
*Labour Relations Act, 1995*  
*Employment Insurance Act, 1996*  
*Ontario College of Trades and Apprenticeship Act, 2009*  
*Apprenticeship and Certification Act, 1998*  
Canadian Standards Association (CSA)  
Workplace Hazardous Materials Information System (WHMIS)  
Canadian Coast Guard

**Recommended Equipment List:**

Approved Storage and Disposal Container  
WHMIS Materials  
Approved Fire Extinguishers  
Appropriate Hand and Power Tools  
Appropriate Lifting, Rigging and Blocking Equipment  
Compressed Air Supply  
Equipment Rigging Equipment  
Fuel Storage Tanks  
Water Test Tanks

Number: S1443.1  
Title: **Terms and Definitions**  
Duration: Total Hours: 2 Theory: 2 Practical: 0  
Prerequisites: Level 1 and Level 2, Reportable Subjects  
Cross Reference to Training Standard: 6380.04, 6381.02, 6393.01 to 6393.03

### **General Learning Outcomes**

Upon successful completion, the apprentice is able to define marine trade related terms and definitions in accordance with government safety regulations, and approved industry standards.

### **Learning Outcomes and Content**

1.1.1 Define water craft orientation terminology. (1/0)

Port

Bow

Forward

Starboard

Stern

Aft

Chine, strake, pad

Gunwale

Free board

1.1.2 Define water craft movement terminology. (.5/0)

Hard to starboard

Hard to stern

1.1.3 Define craft operation terminology. (.5/0)

Docking

Launching

Anchoring

Handling

Navigation

Communication

Towing

**Number:** S1443.2  
**Title:** **Marine Hardware, Adhesives and Sealants**  
**Duration:** Total Hours: 3 Theory: 2 Practical: 1  
**Prerequisites:** Level 1 and Level 2, Reportable Subjects  
**Cross Reference to Training Standard:** 6383.05, 6385.04, 6385.07, 6386.01 to 6386.03, 6387.11, 6387.14, 6390.03, 6390.06, 6390.09, 6390.12, 6392.03, 6394.03, 6394.04

### **General Learning Outcomes**

Upon successful completion, the apprentice is able to describe marine hardware, adhesives and sealant construction features and installation procedures in accordance with government safety regulations, manufacturer's recommendations and specifications and approved industry standards.

### **Learning Outcomes and Content**

1.2.1 Describe the selection, function and construction features of marine hardware. (1/0)

Function, types and applications

Fundamentals:

- corrosion protection
- effects of vibration
- leak prevention

Temperatures:

- ambient
- operational

Hardware:

- cleats
- screws
- bolts and nuts
- brackets and hinges
- thru hulls
- clamps

Sealants/adhesives:

- material compatibility
- environment
- pressures
- vacuum
- applied torque

1.2.2 Describe marine hardware installation procedures. (1/0)

Surface preparation

Fastener installation

Through-bolt and backing plate

Sealant/adhesive selection and application

1.2.3 Install marine hardware. (0/1)

Surface preparation

Fastener installation

Through-bolt and backing plate

Sealant/adhesive application

**Number:** S1443.3  
**Title:** **Damage Identification and Repair**  
**Duration:** Total Hours: 6 Theory: 6 Practical: 0  
**Prerequisites:** Level 1 and Level 2, Reportable Subjects  
**Cross Reference to Training Standard:** 6384.01, 6384.15, 6385.01, 6385.04, 6385.07, 6386.01 to 6386.03, 6387.01, 6387.04, 6387.08, 6387.12, 6387.15, 6388.01, 6388.04, 6389.01, 6389.04, 6390.01, 6390.04, 6390.07, 6390.10, 6390.13, 6392.01, 6392.04, 6394.01, 6394.04

### **General Learning Outcomes**

Upon successful completion, the apprentice is able to describe marine vessel damage identification and repair procedures in accordance with government safety regulations, manufacturers' recommendations and specifications and approved industry standards.

### **Learning Outcomes and Content**

1.3.1 Describe the main types of marine vessel corrosion damage and maintenance procedures. (3/0)

Corrosion damage and prevention:

- explain the theory of galvanic corrosion and stray current corrosion
- determine the function of anti-corrosion devices used in the marine drive system
- demonstrate procedures to check vessel conditions and efficiency
- explain the function of hull-bonding systems and demonstrate the system layout
- determine the use of special materials to combat corrosion
  - lubricants
  - paints
  - sealers

Determine condition and maintain components as required:

- grounding straps
- clips, continuity washers and straps
- explain the maintenance requirements of devices used to combat galvanic and stray current corrosion

1.3.2 Describe maintenance and damage repair procedures for marine vessels.  
(3/0)

Describe the manufacturing process and the characteristics of:

- fiberglass and resins
- thermo plastics
- thermo-setting plastics
- epoxy
- gel coat
- metal
- wood

Determine level of damage

- structural
- non-structural
- cosmetic

Describe procedures to refinish minor cosmetic damage to refinish wood, metal and fiberglass hulls and decks to specifications or as specifically instructed:

- explain the process to identify damage
  - fiberglass
  - thermo plastics
  - thermo-setting plastics
  - gel coat
  - non-ferrous metal
  - metal
  - wood
- explain the process of surface preparation
  - grinding
  - sanding
  - filling
- explain the process to finish surfaces
  - primer coat
  - finish coat
  - wet sanding
  - compounding
  - cleaning/polishing/protecting

**Number:** S1443.4  
**Title:** **Sail Boats**  
**Duration:** Total Hours: 3 Theory: 3 Practical: 0  
**Prerequisites:** Level 1 and Level 2, Reportable Subjects  
**Cross Reference to Training Standard:** 6381.04; 6383.01 to 6383.06, 6394.01 to 6394.04

### **General Learning Outcomes**

Upon successful completions of the reportable subject, the apprentice is able to describe sail boat set up procedures in accordance with government safety regulations, manufacturers' recommendations and specifications and approved industry standards.

### **Learning Outcomes and Content**

1.4.1 Identify the fundamentals, types and application of sail boat rigging equipment. (2/0)

Identify commonly used types of sailboat rigging and determine the proper location of:

- shrouds
- stays
- halyard

Determine the function and demonstrate the operation of sailboat rigging hardware such as:

- shackles
- spreaders
- turnbuckles
- split shrouds
- halyard
- winches
- roller furling
- lightning protection

Identify and determine the function of mast steps

Describe the procedures for selection of handling equipment required to support and lift mast in relation to:

- weight
- type of material
- physical dimensions
- maneuverability and versatility using:
  - slings
  - cradles
  - winches

1.4.2 Describe the skills required to correctly step and un-step sailboat masts in accordance with manufacturers' standards. (1/0)

Decommissioning

Storage

Re-commissioning

Mast-handling

Mast-mounted electronic equipment

Roller furling

Describe the selection procedures for the handling equipment required to support and lift mast in relation to:

- weight
- type of material
- physical dimensions
- manoeuvrability and versatility using:
  - slings
  - cradles
  - winches

Number: S1443.5  
Title: **In-Water Marine Handling Devices**  
Duration: Total Hours: 7 Theory: 4 Practical: 3  
Prerequisites: Level 1 and Level 2, Reportable Subjects  
Cross Reference to Training Standard: 380.01, 6380.04, 6381.04, 6393.01 to 6393.03

### General Learning Outcomes

Upon successful completion, the apprentice is able to describe the fundamentals of marine in water handling devices in accordance with government safety regulations, manufacturer's recommendations and specifications and approved industry standards.

### Learning Outcomes and Content

1.5.1 Identify and use in-water marine handling devices. (1/2)

Introduction to properties of ropes and knots:

- types of ropes
  - polypropylene
  - nylon
  - manila
- types of knots
  - bowline
  - timber hitch
  - square knot
  - half hitch
  - reef knot
  - clove hitch
  - cat's paw
  - triple sliding knot
- types of splices

Safe working loads

Tying of ropes and hitches

- 1.5.2 Demonstrate the application of lines, cleats and chocks for: (1/1)
- docking
  - launching
  - anchoring
  - handling
  - towing
  - mooring
  - fenders

- 1.5.3 Identify anchor types and explain anchoring procedures. (2/0)

Types of anchors

Types of attachments

Anchoring procedures for varying conditions

<b>Evaluation Structure</b>		
Theory Testing	Practical Application Testing	Final Assessment
35%	35%	30%

<b>Number:</b>	S1444		
<b>Title:</b>	<b>Propulsion Systems</b>		
<b>Duration:</b>	Total Hours: 39	Theory: 19	Practical: 20
<b>Prerequisites:</b>	Level 1 and Level 2, Reportable Subjects		
<b>Content:</b>	2.1 Outboard Systems (3/6)		
	2.2 Inboard/Outboard Systems (4/10)		
	2.3 Inboard Systems (8/4)		
	2.4 Propellers (4/0)		

**Evaluation & Testing:**

Minimum of one mid-term test during the 8 week term  
Final exam at end of term  
Periodic quizzes

**Instructional and Delivery Strategies:**

Assignments related to theory and appropriate application skills

**Reference Materials:**

*Workplace Safety and Insurance Act, 1997*  
*Occupational Health and Safety Act, 1990*  
*Employment Standards Act, 2000*  
*Labour Relations Act, 1995*  
*Employment Insurance Act, 1996*  
*Ontario College of Trades and Apprenticeship Act, 2009*  
*Apprenticeship and Certification Act, 1998*  
Canadian Standards Association (CSA)  
Workplace Hazardous Materials Information System (WHMIS)  
Canadian Coast Guard

**Recommended Equipment List:**

Approved Storage and Disposal Containers  
WHMIS Materials  
Approved Fire Extinguishers  
Appropriate Lifting, Rigging and Blocking Equipment  
Appropriate Equipment and Unit Vehicles  
Appropriate Hand and Power Tools  
Digital Volt, Ampere and Ohmmeters (Multi- Meters)  
Gear Oil Installation Pump  
Grease Gun  
Module Testers  
Service Information Systems  
Soldering Equipment  
Compressed Air Supply Equipment

Number: S1444.1  
Title: **Outboard Systems**  
Duration: Total Hours: 9 Theory: 3 Practical: 6  
Prerequisites: Level 1 and Level 2, Reportable Subjects  
Cross Reference to Training Standard: 6390.01 to 6390.04

### General Learning Outcomes

Upon successful completion, the apprentice is able to test and repair outboard systems in accordance with government safety regulations, manufacturer recommendations and specifications and approved industry standards.

### Learning Outcomes and Content

2.1.1 Define the fundamentals of outboard systems. (1/0)

Mid-section

Coolant pumps

Gear cases

2.1.2 Describe the construction features and principles of operation of outboard system components. (1/0)

Housings

Shafts:

- drive
- shift
- propeller

Gears

Shims

Bearings

Seals

Lubricants

Coolant pumps

Shift controls

2.1.3 Diagnose, test and disassemble outboard systems. (1/3)

Identify symptoms of malfunction such as:

- bent propeller or propeller shaft
- bearing and gear noise
- leaking oil seals
- slipping propeller clutch

Perform gear housing vacuum/pressure tests

Remove and disassemble gear case

Inspect and measure components for wear or damage

2.1.4 Reassemble, adjust and maintain outboard systems. (0/3)

Reassemble:

- gear case
- water pump

Retest vacuum/pressure

Fill with lubricant

Install and adjust

Number: S1444.2  
Title: **Inboard/Outboard Systems**  
Duration: Total Hours: 14 Theory: 4 Practical: 10  
Prerequisites: Level 1 and Level 2, Reportable Subjects  
Cross Reference to Training Standard: 6390.01, 6390.05 to 6390.07

### General Learning Outcomes

Upon successful completion, the apprentice is able to test and repair inboard/outboard systems in accordance with government safety regulations, manufacturer's recommendations and specifications and approved industry standards.

### Learning Outcomes and Content

2.2.1 Define the fundamentals of inboard/outboard systems. (1/0)

Couplers

Transom assembly

Stern drive assembly:

- upper unit
- lower unit
- cooling
- shifting
- counter rotating

2.2.2 Describe the construction features and principles of operation of inboard/outboard system components. (2/0)

Shafts:

- input
- drive
- output

Universal joints

Gimbal housing:

- bearing
- bellows

Gimbal ring

Bell housing

Gears

Clutches

Shims

Bearings/bushings

Seals

Lubricants

Coolant pumps

Shift controls

2.2.3 Diagnose, test and disassemble inboard/outboard systems. (1/5)

Identify symptoms of malfunction such as:

- coupler slippage/vibration
- universal joint noise
- gimbal bearing vibration
- bellows failure
- gimbal ring wear
- bearing and gear noise
- bent or broken shafts
- leaking oil seals
- slipping propeller clutch

Perform vacuum/pressure tests

Remove and disassemble inboard/outboard systems:

- upper stern drive unit
- lower stern drive unit
- bell housing

Inspect and measure components for wear or damage

2.2.4 Reassemble, adjust and maintain inboard/outboard systems. (0/5)

Reassemble:

- upper stern drive unit
- lower stern drive unit
- bell housing

Retest vacuum/pressure

Fill with lubricant

Grease all fittings

Check engine alignment

Install and adjust

**Number:** S1444.3  
**Title:** **Inboard Systems**  
**Duration:** Total Hours: 12 Theory: 8 Practical: 4  
**Prerequisites:** Level 1 and Level 2, Reportable Subjects  
**Cross Reference to Training Standard:** 6390.01, 6390.08 to 6390.10

### General Learning Outcomes

Upon successful completion, the apprentice is able to test and repair inboard systems in accordance with government safety regulations, manufacturer's recommendations and specifications and approved industry standards.

### Learning Outcomes and Content

2.3.1 Define the fundamentals of inboard systems. (2/0)

Direction of rotation

Flex plate coupler

Transmissions:

- reduction gears
- straight drives
- V-drives

Shafts and couplers

Shaft logs

Struts and Cutlass bearings

2.3.2 Describe the construction features and principles of operation of inboard system components. (3/0)

Transmissions:

- mechanical shift
- hydraulic shift
- rotation
  - reduction gears
  - V-drives

Shafts, couplers and dampers

Shaft logs and stern tubes

Struts and Cutlass bearings

Lubricants and fluids

2.3.3 Diagnose, test and disassemble inboard systems. (2/2)

Identify symptoms of malfunction such as:

- fluid condition
- rattle
- vibration
- slippage
- clutch grabbing
- shift noise
- bearing and gear noise
- leaking oil seals
- leaking shaft logs

Remove and disassemble transmission

Inspect and measure components for wear or damage

2.3.4 Reassemble, adjust and maintain inboard systems. (1/2)

Reassemble transmission:

- index oil pump
- fill with lubricant

Shaft-to-engine alignment

Shaft log packing replacement and adjustment

**Number:** S1444.4  
**Title:** **Propellers**  
**Duration:** Total Hours: 4 Theory: 4 Practical: 0  
**Prerequisites:** Level 1 and Level 2, Reportable Subjects  
**Cross Reference to Training Standard:** 6390.01, 6390.02, 6390.03, 6390.05, 6390.06, 6390.08, 6390.09

### General Learning Outcomes

Upon successful completion, the apprentice is able to describe propeller applications, testing and maintenance in accordance with government safety regulations, manufacturer's recommendations and specifications and approved industry standards.

### Learning Outcomes and Content

2.4.1 Define the fundamentals of propellers. (2/0)

Terminology, purpose, function, types:

- materials and manufacturing methods
- diameter
- pitch
- number of blades
- propeller parts
- performance/efficiency
  - cavitation
  - ventilation
  - slippage

2.4.2 Describe the construction features and applications of propellers. (1/0)

Right and left hand rotation designs

Hub and mounting designs

Advantages and disadvantages of:

- various materials
- choosing the correct propeller
  - work application
  - water ski application
  - normal duty
  - sport application
  - high performance application

2.4.3 Describe testing and maintenance procedures on propellers. (1/0)

Blade inspection

Hub inspection

Removal and installation procedures:

- inboard propellers
  - seized propellers
  - locking devices
  - keyways
  - pullers
- outboard propellers
  - corrosion prevention
  - torque
  - locking devices
  - lubricants
- inboard/outboard propellers
  - corrosion prevention
  - torque
  - locking devices
  - lubricants

Evaluation Structure		
Theory Testing	Practical Application Testing	Final Assessment
15%	55%	30%

Number:	S1445		
Title:	<b>Advanced Engine Systems</b>		
Duration:	Total Hours: 54	Theory: 20	Practical: 34
Prerequisites:	Level 1 and Level 2, Reportable Subjects		
Content:	3.1 Engine Mechanical System Repairs (6/24)		
	3.2 Engine Lubrication Systems (3/2)		
	3.3 Intake Cooling and Exhaust Systems (3/4)		
	3.4 Engine Electrical Systems (8/4)		

**Evaluation & Testing:**

Minimum of one mid-term test during the 8 week term  
Final exam at end of term  
Periodic quizzes

**Instructional and Delivery Strategies:**

Assignments related to theory and appropriate application skills

**Reference Materials:**

*Workplace Safety and Insurance Act, 1997*  
*Occupational Health and Safety Act, 1990*  
*Employment Standards Act, 2000*  
*Labour Relations Act, 1995*  
*Employment Insurance Act, 1996*  
*Ontario College of Trades and Apprenticeship Act, 2009*  
*Apprenticeship and Certification Act, 1998*  
Canadian Standards Association (CSA)  
Workplace Hazardous Materials Information System (WHMIS)  
Canadian Coast Guard

**Recommended Equipment List:**

Approved Storage and Disposal Containers  
WHMIS Materials  
Approved Fire Extinguishers  
Appropriate Lifting, Rigging and Blocking Equipment  
Appropriate Equipment and Unit Vehicles  
Appropriate Hand and Power Tools  
Digital Volt, Ampere and Ohmmeters (Multi- Meters)  
Battery Load Testers  
Ignition Spark Testers  
Module Testers  
Service Information Systems  
Soldering Equipment  
Compressed Air Supply Equipment

Number: S1445.1  
Title: **Engine Mechanical System Repairs**  
Duration: Total Hours: 30 Theory: 6 Practical: 24  
Prerequisites: Level 1 and Level 2, Reportable Subjects  
Cross Reference to Training Standard: 6392.01 to 6392.04

### General Learning Outcomes

Upon successful completion, the apprentice is able to perform engine mechanical system repairs in accordance with government safety regulations, manufacturer's recommendations and specifications and approved industry standards.

### Learning Outcomes and Content

3.1.1 Define the fundamentals of outboard and inboard marine engines. (1/0)

Review the following engine terms:

- swept, clearance, total volume
- horsepower
- torque
- compression ratio
- thermal efficiency
- volumetric efficiency
- work

Orientation:

- horizontal
- vertical

Rotation:

- clockwise
- counter-clockwise

Effects of high RPM

Effects of high load

3.1.2 Describe the construction features and principles of operation of marine outboard and inboard engines. (2/0)

Crankshafts

Flywheels

Pistons

Camshafts

Lifters:

- hydraulic
- roller

Cylinder heads:

- valves
- rotators
- springs

Gaskets

Seals

Bearings

3.1.3 Diagnose, test, disassemble and inspect two-and-four-stroke marine outboard and inboard engines. (2/14)

Perform compression test

Perform cylinder leakage test

Perform pressure/vacuum test

Disassemble outboard engine blocks

Disassemble inboard engine blocks

Inspect and measure components for wear and damage

Report service requirements

3.1.4 Reassemble, adjust and maintain engine components using appropriate tools as established by the manufacturer maintaining all clearance limitations and specifications. (1/10)

Reassemble two-and-four stroke cycle engines

Reassemble outboard engines

Reassemble inboard engines

**Number:** S1445.2  
**Title:** **Engine Lubrication Systems**  
**Duration:** Total Hours: 5 Theory: 3 Practical: 2  
**Prerequisites:** Level 1 and Level 2, Reportable Subjects  
**Cross Reference to Training Standard:** 6392.01 to 6392.04

### **General Learning Outcomes**

Upon successful completion, the apprentice is able to test and describe maintenance procedures for marine two-and-four-stroke cycle engine lubrication systems in accordance with government safety regulations, manufacturer's recommendations and specifications and approved industry standards.

### **Learning Outcomes and Content**

- 3.2.1 Review the fundamentals of engine lubrication systems. (1/0)
- Oil characteristics, properties, additives, and classifications of two-stroke and four-stroke cycle engine lubricants
  - Engine lubrication equipment
  - Lubrication system cooling
  - Significance of selecting correct lubricating oils
  - Significance of selecting correct oil filters
- 3.2.2 Describe the construction features and principles of operation of marine engine lubrication systems and components. (2/0)
- Gear, piston and rotor type oil pumps
  - Oil injection systems
  - Pre-mixture systems
  - Oil coolers and heat exchangers
  - Piston cooling
  - By-pass, full flow
  - Remote oil filters and hoses
  - Increased capacity systems

3.2.3 Inspect, test, adjust and maintain engine lubrication systems according to manufacturers' maintenance procedures. (0/2)

Inspect engine oil level and condition Inspect engine for visible oil leaks

Perform engine oil pressure test

Perform oil injection bleeding procedure

Adjust oil injection pump

Perform engine oil and filter replacement procedures

Number:	S1445.3		
Title:	<b>Intake Cooling and Exhaust Systems</b>		
Duration:	Total Hours: 7	Theory: 3	Practical: 4
Prerequisites:	Level 1 and Level 2, Reportable Subjects		
Cross Reference to Training Standard:	6392.01 to 6392.04		

### General Learning Outcomes

Upon successful completion, the apprentice is able to perform intake cooling and exhaust system inspection, testing and repairs in accordance with government safety regulations, manufacturer's recommendations and specifications and approved industry standards.

### Learning Outcomes and Content

3.3.1 Define the fundamentals of marine intake, cooling and exhaust systems. (1/0)

Volumetric efficiency

Manifold vacuum and exhaust back pressure

Ported vacuum

Thermal expansion and contraction

Cooling mediums

Safety factors:

- flame arresters
- wet exhausts

3.3.2 Describe the construction features and principles of operation of intake, cooling and exhaust systems. (2/0)

Intake systems:

- flame arresters
- manifolds
- gaskets

Cooling systems:

- open circuit
- closed circuit
- filtration

Exhaust systems:

- manifolds
- risers
- shutters
- hoses
- mufflers
- baffles
- reliefs
- through propeller

3.3.3 Inspect, test and repair intake, cooling and exhaust systems and components. (0/4)

Intake:

- perform visual inspection
  - components
  - seals and gaskets
- clean
  - flame arrester
  - air box

Cooling:

- inspect operation
- determine service intervals
- perform visual inspection
  - components
  - hoses
  - belts
  - effects of overheating
  - leaks
- test
  - delivery pressure and quality
  - volume
  - closed circuit
  - pressure test
  - coolant inspection
  - thermostat operation
- repair or replace
  - pump and impeller
  - thermostat
  - coolant
  - relief

Exhaust:

- perform inspection for:
  - restrictions
  - noise
  - leaks
- repair or replace
  - gaskets
  - manifolds
  - risers
  - hoses
  - clamps
  - mufflers
  - reliefs
  - shutters
  - baffles

Number:	S1445.4		
Title:	<b>Engine Electrical Systems</b>		
Duration:	Total Hours: 12	Theory: 8	Practical: 4
Prerequisites:	Level 1 and Level 2, Reportable Subjects		
Cross Reference to Training Standard:	6392.01 to 6392.04		

## General Learning Outcomes

Upon successful completion, the apprentice is able to perform marine engine electrical system inspection, testing and repairs in accordance with government safety regulations, manufacturer's recommendations and specifications and approved industry standards.

## Learning Outcomes and Content

### 3.4.1 Define the fundamentals of marine engine electrical systems. (3/0)

Ignition protection:

- starting
- charging
- ignition
- batteries
- accessories
- connections

Distributor type ignition systems

Marine batteries

Alternator type charging systems:

- ratings

### 3.4.2 Describe the construction features and principles of operation of marine engine electrical systems. (4/0)

Alternator type charging systems:

- types
- stators
- rotors
- fields
- rectifiers/regulators
- cooling
  - rotation

Distributor type ignition systems:

- types
- distributors
- caps
- rotors
- wires
- drives
- shafts
- advance mechanisms
- dwell

Marine type batteries:

- types
- ratings
- switching devices
- installation guidelines

3.4.3 Inspect, test, adjust and maintain marine engine electrical systems. (1/4)

Charging systems:

- perform visual inspection
  - belts
  - pulleys
  - wires and connections
- test output
- test rectifier
- isolate alternator from regulator
- adjust belt tension

Ignition systems:

- perform visual inspection
  - wires, cap, rotor, coil
  - corrosion of components
  - cracks and arcing
  - distributor mount
  - looseness
- perform peak output voltage test
- test for dwell variation
- remove and reinstall distributor
- adjust and maintain
  - points
  - dwell
  - spark plug gap
  - ignition timing

<b>Evaluation Structure</b>		
<b>Theory Testing</b>	<b>Practical Application Testing</b>	<b>Final Assessment</b>
10%	60%	30%

Number:	S1446		
Title:	<b>Electronic Fuel Management Systems</b>		
Duration:	Total Hours: 30	Theory: 17	Practical: 13
Prerequisites:	Level 1 and Level 2, Reportable Subjects		
Content:	4.1	Computer Fundamentals (3/0)	
	4.2	Gasoline Engine Electronic Fuel Management (9/9)	
	4.3	Diesel Engine Electronic Fuel Management (5/4)	

**Evaluation & Testing:**

Minimum of one mid-term test during the 8 week term  
Final exam at end of term  
Periodic quizzes

**Instructional and Delivery Strategies:**

Assignments related to theory and appropriate application skills

**Reference Materials:**

Workplace Safety and Insurance Act, 1997  
Occupational Health and Safety Act, 1990  
Employment Standards Act, 2000  
Labour Relations Act, 1995  
Employment Insurance Act, 1996  
Ontario College of Trades and Apprenticeship Act, 2009  
Apprenticeship and Certification Act, 1998  
Canadian Standards Association (CSA)  
Workplace Hazardous Materials Information System (WHMIS)  
Canadian Coast Guard

**Recommended Equipment List:**

Approved Storage and Disposal Containers  
WHMIS Materials  
Approved Fire Extinguishers  
Appropriate Lifting, Rigging and Blocking Equipment  
Appropriate Equipment and Unit Vehicles  
Appropriate Hand and Power Tools  
Digital Volt, Ampere and Ohmmeters (Multi- Meters)  
Battery Load Testers  
Ignition Spark Testers  
Module Testers  
Fuel Pressure Gauges  
Injector Testers

Injection Pump Testers

Service Information Systems

Soldering Equipment

Compressed Air Supply Equipment

**Number:** S1446.1  
**Title:** **Computer Fundamentals**  
**Duration:** Total Hours: 3 Theory: 3 Practical: 0  
**Prerequisites:** Level 1 and Level 2, Reportable Subjects  
**Cross Reference to Training Standard:** 6381.01, 6381.03, 6384.01, 6384.10, 6385.01, 6385.02

### General Learning Outcomes

Upon successful completion, the apprentice is able to explain the fundamentals of computer operation and components in accordance with government safety regulations, manufacturer's recommendations and specifications and approved industry standards.

### Learning Outcomes and Content

4.1.1 Define the fundamentals of onboard computers. (1/0)

History, purpose, function

Fundamentals:

- analog/digital signals
- binary systems
- logic gates
- onboard computer modules
- multiplexing
- fiber optics

4.1.2 Describe the construction features, types and applications of onboard computers. (1/0)

Input devices

Central processing unit (CPU)

Random access memory (RAM)

Read only memory (ROM)

Data storage

Output devices

4.1.3 Explain the principles of operation of onboard computers. (1/0)

Analog to digital converters

Signal filtration

Central processing unit (CPU)

Random access memory (RAM)

Read only memory (ROM)

Processing cycle

Logic sequencing

Data storage

Electronic control module (ECM) integral outputs

**Number:** S1446.2  
**Title:** Gasoline Engine Electronic Fuel Management  
**Duration:** Total Hours: 18 Theory: 9 Practical: 9  
**Prerequisites:** Level 1 and Level 2, Reportable Subjects  
**Cross Reference to Training Standard:** 6385.01 to 6385.04

### General Learning Outcomes

Upon successful completion, the apprentice is able to perform the inspection and testing procedures of gasoline engine electronic fuel management systems in accordance with government safety regulations, manufacturer's recommendations and specifications and approved industry standards.

### Learning Outcomes and Content

4.2.1 Identify the fundamentals of gasoline engine electronic fuel management systems. (2/0)

Introduction to the latest electronic fuel management systems

4.2.2 Describe the construction features, types and operating principles of gasoline engine electronic fuel management systems and components. (6/0)

Single-point injection systems:

- throttle body units
- injectors
- pulse width
- input sensors
- output actuators
- electronic control unit
- fuel pressure regulator

Multi-point injection:

- injectors
- pulse width
- input sensors
- output actuators
- power control unit
- fuel pressure regulator

Types:

- sequential fire
- group / batch fire

4.2.3 Perform inspection and testing procedures of gasoline engine electronic fuel management systems and components. (1/9)

Input devices:

- temperature sensors
- manifold absolute pressure sensor
- air flow sensor
- oxygen sensor
- throttle position sensor
- engine speed / position sensor
- battery voltage
- switch inputs

Output devices:

- malfunction indicator lights
- fuel injectors
- ignition coils
- idle speed control
- solenoids, relays
- control modules

Describe fuel pressure testing and relate to run-ability problems

Perform an injector balance test

Identify and locate related fuel injection components of single and multi-point injection systems

Connect and operate diagnostic test equipment:

- pressure gauges
- vacuum gauges
- electronic equipment
- module testers
- computer diagnostic equipment
- digital tachometers
- oscilloscopes

<b>Number:</b>	S1446.3		
<b>Title:</b>	<b>Diesel Engine Electronic Fuel Management</b>		
<b>Duration:</b>	Total Hours: 9	Theory: 5	Practical: 4
<b>Prerequisites:</b>	Level 1 and Level 2, Reportable Subjects		
<b>Cross Reference to Training Standard:</b>	6385.01, 6385.06, 6385.07		

## General Learning Outcomes

Upon successful completion, the apprentice is able to perform the inspection and testing procedures of diesel engine electronic fuel management systems in accordance with government safety regulations, manufacturer's recommendations and specifications and approved industry standards.

## Learning Outcomes and Content

4.3.1 Describe the construction, features, types and principles of operation of diesel engine electronic fuel management systems. (5/0)

Electro hydraulic nozzles:

- solenoid actuated
- piezo actuated

Electronic control units/module:

- inputs
- outputs
- sensors
- switches
- multi-plexing – data buss wiring and communication

Common rail fuel systems:

- simple common rail systems
- amplified common rail Systems
  - fuel rail function
  - fuel rail pressures and control
  - fuel circuit routing
  - high pressure pumps
  - fuel distribution

Electronic unit injector fuel systems (EUI):

- single actuated units
- dual actuated units
  - fuel sub system routing
  - primary circuit control
  - secondary circuit control
  - cam shaft profiles
  - effective stroke

4.3.2 Describe and perform inspection and testing procedures of diesel engine electronic fuel management systems and components. (0/4)

Visual inspection of system

Identify high and low pressure components

Perform on-board scanned diagnostic procedures

Perform active diagnostic procedures

Access system fault codes

Perform customer data programming

Outline the data reprogramming process

<b>Evaluation Structure</b>		
<b>Theory Testing</b>	<b>Practical Application Testing</b>	<b>Final Assessment</b>
35%	35%	30%

Number:	S1447		
Title:	<b>Handling, Rigging, Running and Storing</b>		
Duration:	Total Hours: 36	Theory: 21	Practical: 15
Prerequisites:	Level 1 and Level 2, Reportable Subjects		
Content:	5.1 Out of Water Boat Handling Equipment (5/0)		
	5.2 Boat Rigging (5/7)		
	5.3 Pre-Delivery and Test Run (5/5)		
	5.4 Seasonal Storage (6/3)		

**Evaluation & Testing:**

Minimum of one mid-term test during the 8 week term  
Final exam at end of term  
Periodic quizzes

**Instructional and Delivery Strategies:**

Assignments related to theory and appropriate application skills

**Reference Materials:**

Workplace Safety and Insurance Act, 1997  
Occupational Health and Safety Act, 1990  
Employment Standards Act, 2000  
Labour Relations Act, 1995  
Employment Insurance Act, 1996  
Ontario College of Trades and Apprenticeship Act, 2009  
Apprenticeship and Certification Act, 1998  
Canadian Standards Association (CSA)  
Workplace Hazardous Materials Information System (WHMIS)  
Canadian Coast Guard

**Recommended Equipment List:**

Approved Storage and Disposal Containers  
WHMIS Materials  
Approved Fire Extinguishers  
Appropriate Lifting, Rigging and Blocking Equipment  
Appropriate Equipment and Unit Vehicles  
Appropriate Hand and Power Tools  
Digital Volt, Ampere and Ohmmeters (Multi- Meters)  
Battery Load Testers  
Ignition Spark Testers  
Module Testers  
Fuel Pressure Gauges  
Injector Testers  
Injection Pump Testers  
Service Information Systems  
Soldering Equipment



Number: S1447.1  
Title: **Out of Water Boat Handling Equipment**  
Duration: Total Hours: 5 Theory: 5 Practical: 0  
Prerequisites: Level 1 and Level 2, Reportable Subjects  
Cross Reference to Training Standard: 6391.01 to 6391.03, 6393.01

### General Learning Outcomes

Upon successful completion, the apprentice is able to identify out of water boat handling procedures in accordance with government safety regulations, manufacturers' recommendations and specifications and approved industry standards.

### Learning Outcomes and Content

5.1.1 Describe out of water handling equipment and hardware. (1/0)

Trailers

Forklifts

Travel lifts

Hoists and cranes

Hardware:

- thimbles
- slings
- spreaders
- clevis
- shackles
- equalizer bars

5.1.2 Describe the assembly procedures of new boat trailers as shipped by the manufacturers. (1/0)

Explain government regulations regarding trailers

Assembly of trailer to manufacturers' specifications:

- frame assembly
- wheel installation
- roller and bunk installation
- winch and cable installation

Adjustments of trailer fit to vessel:

- hull dimensions
- shape
- weight distribution
- adjustment of rollers and banks

5.1.3 Describe specified hitch operations. (.5/0)

Explain government regulations regarding hitch operations

Fasten trailer to tow vehicle:

- operation of hitch mechanism
- safety chain connection
- breakaway connection
- tongue weight

5.1.4 Describe the required trailer safety checks. (1.5/0)

Explain government regulations regarding trailer safety checks

Visual inspection

Safety checks for:

- brakes
- lighting
- hitch requirements
- weld inspection

Identify when to refer to an automotive service technician or truck and coach technician

5.1.5 Describe routine service and preventative maintenance of trailers to Ministry of Transportation and manufacturers' specifications. (1/0)

Hydraulic functions

Cable fastening

Chain attaching

Wiring (electrical)

Maintenance and replacement of tires

Wheel-bearing service and replacement

Basic vehicle routine maintenance

Brake service

Greasing and lubrication

High strength fastening operations

Number: S1447.2  
Title: **Boat Rigging**  
Duration: Total Hours: 12 Theory: 5 Practical: 7  
Prerequisites: Level 1 and Level 2, Reportable Subjects  
Cross Reference to Training Standard: 6383.05, 6394.01 to 6394.04

## General Learning Outcomes

Upon successful completion, the apprentice is able to perform rigging of boats in accordance with government safety regulations, manufacturer's recommendations and specifications and approved industry standards.

## Learning Outcomes and Content

5.2.1 Interpret manufacturers' recommendations and specifications for rigging of boats with the required equipment. (5/0)

Installation of outboard, inboard/outboard and inboard engines

Fuel system conductors:

- gasoline flex hoses and fittings
- gasoline tubing and fittings
- diesel dual flex hoses and fittings
- vibration free conductor mounting devices

Steering systems:

- steering gear assemblies
- steering cables, brackets and fittings

Shift, throttle controls and harness assemblies:

- control box
- cables, brackets and fittings

Under water boat accessories:

- thru-hulls
- transducers
- pick-ups

Basic electrical systems

5.2.2 Perform boat rigging procedures. (0/7)

Select the appropriate tools for rigging:

- jigs
- templates
- drills

Install engines

Install equipment:

- fuel system components
- steering systems
- shift, throttle controls and harness assemblies
- basic electrical systems
- accessories

Number:	S1447.3		
Title:	<b>Pre-Delivery and Test Run</b>		
Duration:	Total Hours: 10	Theory: 5	Practical: 5
Prerequisites:	Level 1 and Level 2, Reportable Subjects		
Cross Reference to Training Standard:	6383.01 to 6383.06		

### General Learning Outcomes

Upon successful completion, the apprentice is able to perform boat pre-delivery and test run procedures in accordance with government safety regulations, manufacturer's recommendations and specifications and approved industry standards.

### Learning Outcomes and Content

5.3.1 Describe pre-delivery inspection (PDI) and set-up procedures for boats, as per manufacturer's recommendations and specifications. (3/0)

Identify marine vessel pre-delivery inspection procedures for:

- overall appearance and cosmetic damage
- mounting and installation of fuel systems, safety devices, steering systems, instrumentation, controls and accessories
- engine and drive system fluid levels and lubrication
- engine adjustments including
  - idle speed and mixture
  - shift cables
  - steering cable alignment
  - ignition timing
  - trim angle
  - trim tab
- propeller selection criteria for:
  - size
  - type and style
  - boat operating conditions
  - boat style and applications

5.3.2 Complete PDI documentation. (0/1)

5.3.3 Perform running test as per PDI documentation. (0/4)

Set-up and monitor test equipment including:

- tachometer
- charging voltage and amperage
- vacuum gauge
- computer diagnostic equipment

Perform in-water testing procedures for:

- idle speed and mixture
- shift cable operation
- steering response
- engine power and torque
- vessel stability
- tilt and trim operation

5.3.4 Review Transport Canada requirements set out in the Transport Canada Safe Boating Guide in relation to Small Vessel Regulations. (1/0)

5.3.5 Describe handling procedures in various conditions. (1/0)

For crafts equipped with:

- Outboard, inboard/outboard, inboard
  - single
  - twin

**Number:** S1447.4  
**Title:** **Seasonal Storage**  
**Duration:** Total Hours: 9 Theory: 6 Practical: 3  
**Prerequisites:** Level 1 and Level 2, Reportable Subjects  
**Cross Reference to Training Standard:** 6381.04, 6394.01 to 6394.04

### General Learning Outcomes

Upon successful completion, the apprentice is able to describe boat storage procedures in accordance with government safety regulations, manufacturers' recommendations and specifications and approved industry standards.

### Learning Outcomes and Content

#### 5.4.1 Perform engine storage and re-commissioning procedures. (2/2)

Seasonal storage of engines including:

- draining coolants (if water)
- manifolds
- tubing
- hoses
- mufflers
- pipes
- auxiliary systems
- single point draining system
- lubrication
- corrosion protection
- eliminating condensation accumulations
- fogging
- protecting from elements
- blocking off exhaust system
- blocking off carburetor, horn or air intake system

Seasonal storage of fuel systems:

- draining
- stabilizing
- eliminating accumulation of condensation (ethanol testing)

5.4.2 Describe drive system storage and winterizing procedures. (1/0)

Drain water and inspect for service of:

- outboard drives
- inboard/outboard drives
- jet drives

Replace lubricants as required

Grease fittings and linkage points

Eliminate condensation and protect internal parts from rust

5.4.3 Describe fresh water, grey water and black water system storage and re-commissioning procedures according to manufacturer's guidelines and government regulations. (2/0)

Fresh water systems:

- tanks
- pumps
- lines
- fittings
- accessories

Grey water systems:

- shower sumps
- bilge pumps
- sump pumps
- lines
- valves

Black water systems:

- tanks
- pumps
- lines
- filters
- toilets

5.4.4 Describe and perform boat storage procedures. (1/1)

Installation of winter wrap:

- frames
- tarps
- shrink wrap
- ventilation

<b>Evaluation Structure</b>		
<b>Theory Testing</b>	<b>Practical Application Testing</b>	<b>Final Assessment</b>
35%	35%	30%

Number:	S1448		
Title:	<b>Auxiliary Systems</b>		
Duration:	Total Hours: 60	Theory: 32	Practical: 28
Prerequisites:	Level 1 and Level 2, Reportable Subjects		
Content:	6.1 Auxiliary Hydraulic Systems (6/7)		
	6.2 AC/DC Electrical Systems and Appliances (11/12)		
	6.3 Alternative Power Sources (7/2)		
	6.4 Marine Plumbing Systems (4/7)		
	6.5 Safety Regulations and Equipment (4/0)		

**Evaluation & Testing:**

Minimum of one mid-term test during the 8 week term  
Final exam at end of term  
Periodic quizzes

**Instructional and Delivery Strategies:**

Assignments related to theory and appropriate application skills

**Reference Materials:**

*Workplace Safety and Insurance Act, 1997*  
*Occupational Health and Safety Act, 1990*  
*Employment Standards Act, 2000*  
*Labour Relations Act, 1995*  
*Employment Insurance Act, 1996*  
*Ontario College of Trades and Apprenticeship Act, 2009*  
*Apprenticeship and Certification Act, 1998*  
Canadian Standards Association (CSA)  
Workplace Hazardous Materials Information System (WHMIS)  
Canadian Coast Guard

**Recommended Equipment List:**

Approved Storage and Disposal Containers  
WHMIS Materials  
Approved Fire Extinguishers  
Appropriate Lifting, Rigging and Blocking Equipment  
Appropriate Equipment and Unit Vehicles  
Appropriate Hand and Power Tools  
Digital Volt, Ampere and Ohmmeters (Multi- Meters)  
Refrigeration Pressure Gauge Set  
High Voltage Safety Equipment  
Battery Load Testers

Ignition Spark Testers

Module Testers

Service Information Systems

Soldering Equipment

Compressed Air Supply Equipment

Number: S1448.1  
**Title: Auxiliary Hydraulic Systems**  
Duration: Total Hours: 13 Theory: 6 Practical: 7  
Prerequisites: Level 1 and Level 2, Reportable Subjects  
Cross Reference to Training Standard: 6389.01 to 6389.04

### General Learning Outcomes

Upon successful completion, the apprentice is able to inspect and maintain auxiliary marine hydraulic systems in accordance with government safety regulations, manufacturers' recommendations and specifications and approved industry standards.

### Learning Outcomes and Content

6.1.1 Review the fundamentals of hydraulic systems. (1/0)

Pascal's law

Boyle's law

Charles' law

Hydraulic mechanical advantage

Pressure, force and area

Flow and speed:

- measure of flow loss
- effects of viscosity

Definitions

6.1.2 Describe the construction features, types and applications of marine hydraulic systems. (2/0)

Power trim and tilt:

- trim tabs

Hydraulic controls:

- steering
- shifting and throttle control
- bow thrusters
- stabilizers

Hydraulic swim platforms:

- dinghy davit systems

6.1.3 Explain and demonstrate the operating principles of marine hydraulic systems. (1/2)

Hydraulics as applied to:

- pumps (manual, gear, vane, piston, centrifugal, diaphragm, positive and non-positive displacement)
- valves
- actuators
- reservoirs
- oil coolers
- filtration

Hydraulic fluids:

- types
- viscosity
- additives
- fire supportive
- fire resistant
- compatibility
- oxidation
- catalytic action
- rust and corrosion

Hydraulic system effects from:

- atmospheric pressure
- head pressure
- vacuum
- heat

Read and interpret hydraulic system graphs, symbols and schematic sketches as per manufacturer's service information

6.1.4 Inspect and test marine hydraulic systems and repair/replace components as per manufacturers' and industry standards. (1/3)

Inspect lines, fittings, hoses:

- leakage
- routing
- mounting
- wear

Inspect pumps:

- wear
- leakage
- excessive clearances

Inspect motors:

- wear
- leakage
- excessive clearances

Inspect valves:

- wear
- leakage
- excessive clearances

Inspect actuators (cylinders and motors):

- wear
- leakage
- excessive clearances

Pressure test hydraulic systems

Inspect hydraulic fluids:

- types, viscosity and additives
- fire supporting
- fire resistive
- compatibility
- oxidization
- catalytic action
- rust and corrosion

6.1.5 Perform maintenance and installation procedures for marine hydraulic systems as per manufacturers' and industry standards. (1/2)

Preventative maintenance:

- fluid levels
- adjustments
- filters
- oil changes
- bleeding

Interpret a maintenance schedule

Installation guidelines:

- mounting
- line routing
- supporting
- bonding
- leak-proofing

**Number:** S1448.2  
**Title:** AC/DC Electrical Systems and Appliances  
**Duration:** Total Hours: 23 Theory: 11 Practical: 12  
**Prerequisites:** Level 1 and Level 2, Reportable Subjects  
**Cross Reference to Training Standard:** 6384.01 to 6384.15, 6394.01 to 6394.04

### General Learning Outcomes

Upon successful completion, the apprentice is able to inspect and maintain AC/DC electrical systems and appliances in accordance with government safety regulations, manufacturer's recommendations and specifications of approved industry standards.

### Learning Outcomes and Content

6.2.1 Describe the construction features, types and applications of AC/DC electrical systems, accessories and appliances. (5/0)

AC systems:

- safety
- accessories
- appliances
- wiring
- components

DC systems:

- safety
- accessories
- appliances
- wiring
- components

Requirements for installation of AC/DC systems, accessories and appliances

Requirements for onboard battery charging:

- switches
- isolators
- battery combiners
- automatic charging relay

6.2.2 Identify the installation and maintenance requirements of AC/DC systems, accessories and appliances. (2/4)

Read and interpret:

- electrical system schematic diagrams
- manufacturer's specifications
- industry standards

Plan accessory or appliance installation:

- mounting
- conductors
  - routing
  - support
  - bundling
  - identification
  - size
  - termination
- circuit protection
  - over current
    - types
    - location
    - size
  - ground fault circuit protection
  - grounding and bonding

6.2.3 Perform installation procedures for AC/DC electrical systems, accessories and appliances. (0/5)

Read and interpret:

- electrical system schematic diagrams
- manufacturer's specifications
- industry standards

Accessory or appliance installation:

- mounting
- conductors
  - routing
  - support
  - bundling
  - identification
  - size
  - termination

- circuit protection
  - over current
    - types
    - location
    - size
  - ground fault circuit protection
  - grounding and bonding

6.2.4 Maintain, test and diagnose AC/DC systems, accessories and appliances. (1/3)

Standard battery service

Inspect and test electrical systems:

- safety
- integrity
- unwanted resistance
- corrosion
- operation
- physical damage

Winterizing procedures for systems, accessories and appliances

6.2.5 Describe the fundamentals, types and applications of marine communication and navigation systems. (3/0)

Very high frequency radios (VHF)

Global positioning system (GPS)

Radar

Auto-pilot

Compass

NMEA 0183

NMEA 2000

Describe routing of wires to prevent magnetic interference

Identify radio interference factors

Number: S1448.3  
Title: **Alternative Power Sources**  
Duration: Total Hours: 9 Theory: 7 Practical: 2  
Prerequisites: Level 1 and Level 2, Reportable Subjects  
Cross Reference to Training Standard: 6394.01 to 6394.04

### General Learning Outcomes

Upon successful completion, the apprentice is able to identify, repair and maintain marine alternative power sources in accordance with government safety regulations, manufacturer's recommendations and specifications and approved industry standards.

### Learning Outcomes and Content

6.3.1 Define the fundamentals of marine alternative power sources. (1/0)

Generators

Inverters

Wind

Solar

Load calculations

6.3.2 Describe the construction features, types and applications for marine alternative power sources. (4/0)

Manufacturer, model, type and output capabilities:

- identification plate
- specification plate
- specific service manual

Generators:

- housings
- couplers
- armatures
- brushes
- pole shoes

- rectifiers
- diodes
- governors
- polarity

Inverters:

- true sign wave
- modified sign wave

Solar

Wind

Regulators:

- mechanical
- electronic

Multi-power source switching devices

6.3.3 Inspect, test and diagnose marine alternative power sources. (1/2)

Generator output:

- voltage
- amperage
- frequency

Inverters:

- battery voltage and capacity
- output wattage

Solar:

- voltage
- amperage

6.3.4 Maintenance of alternative power sources. (1/0)

Generator engine

Generator drive

Solar

Number: S1448.4  
Title: **Marine Plumbing Systems**  
Duration: Total Hours: 11 Theory: 4 Practical: 7  
Prerequisites: Level 1 and Level 2, Reportable Subjects  
Cross Reference to Training Standard: 6394.01 to 6394.04

### General Learning Outcomes

Upon successful completion, the apprentice is able to describe, repair and maintain marine plumbing systems in accordance with government safety regulations, manufacturer's recommendations and specifications and approved industry standards.

### Learning Outcomes and Content

6.4.1 Define the fundamentals of marine plumbing systems. (1/0)

White potable water

Grey waste water

Black waste water

6.4.2 Describe the construction features, types and applications of marine plumbing systems. (2/0)

Potable or non-potable water:

- tanks
- dockside water regulators
- dumps
- accumulators/pressure tanks
- lines and fittings
- faucets
- ice makers
- hot water tanks
  - electric
  - heat exchangers
- toilets

Waste water:

- grey
  - sink drains
  - shower/tub drains
  - sump pumps
- black
  - toilet drains
  - macerator pumps
  - toilets
  - manual
  - electric
  - vacuum generated
- waste tanks

6.4.3 Install, inspect and maintain marine plumbing systems. (1/7)

Design and build a hot and cold water system

Design and build a waste water system

Disassemble and reassemble a manual toilet

Describe operation of a manual toilet

Describe winterizing techniques

Number: S1448.5  
**Title: Safety Regulations and Equipment**  
Duration: Total Hours: 4 Theory: 4 Practical: 0  
Prerequisites: Level 1 and Level 2, Reportable Subjects  
Cross Reference to Training Standard: 6380.01 to 6380.07, 6381.04, 6394.01 to 6394.04

### General Learning Outcomes

Upon successful completion, the apprentice is able to interpret marine safety regulations and, operate and repair marine safety equipment in accordance with government safety regulations, manufacturers' recommendations and specifications and approved industry standards.

### Learning Outcomes and Content

6.5.1 Define the fundamentals of marine safety, regulations and equipment. (2/0)

Fire extinguishers

Fume detectors

Distress signaling devices

Navigation lights

Anchor safety

Bilge pumps

Ventilation

Review the certification requirements set out in the *Technical Standards & Safety Act, 2000*, O. Reg. 215/01, O. Reg. 211/01, s. 6 (1) and O. Reg. 211/01, s. 8 (1) in relation to propane appliances.

6.5.2 Describe the construction features, types, applications and maintenance of marine safety, regulations and equipment. (2/0)

Fire extinguishers:

- class
- manual
- automatic

Fume detectors:

- carbon Monoxide
- multi-gas

Distress signaling devices:

- flares
- flare guns

Coast guard requirements for navigation lighting:

- power supply
- switches
- bulbs
- sockets
- lenses
- location
- height

Anchor safety:

- types
- rode
- scope
- bad weather techniques

Bilge pump:

- manual
- electric
- automatic
- capacity

Ventilation:

- fans
- blowers
- hoses
- natural

<b>Evaluation Structure</b>		
<b>Theory Testing</b>	<b>Practical Application Testing</b>	<b>Final Assessment</b>
30%	40%	30%



**Skilled  
Trades**  
Ontario

**Métiers  
spécialisés**  
Ontario

[skilledtradesontario.ca](http://skilledtradesontario.ca)