

SKILLED**TRADES**^{BC}

PROGRAM OUTLINE

Marine Electrician

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MARINE ELECTRICIAN PROGRAM OUTLINE

**APPROVED BY INDUSTRY
AUGUST 2014**

**Developed by
SkilledTradesBC
Province of British Columbia**

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Section 1
INTRODUCTION
Marine Electrician

Foreword

This Program Outline was developed by the Resource Training Organization in accordance with the General Regulations made pursuant to the “Industry Training and Apprenticeship Act” of British Columbia. The Marine Electrician endorsement program is designed for Red Seal electricians who wish to obtain additional training specific to working in the marine industry. A Marine Electrician is someone who:

- works safely and communicates effectively in a marine environment;
- is knowledgeable in the use of test equipment for troubleshooting;
- is familiar with the structure and layout of a ship;
- is knowledgeable in the proper application and installation of transits, cabling and terminations necessary in the marine industry;
- is familiar with marine codes and regulations applicable to the marine industry;
- is familiar with electrical ship systems such as main and auxiliary power generation, storage, propulsion, electrolysis, navigational lighting, domestic lighting, hydraulic, pneumatic, communication and alarm;
- is familiar with maintenance reporting, logging, scheduling, etc. through a maintenance management system.

The Program Outline was prepared through a series of workshops with the advice and assistance of subject matter experts working in the marine industry. The Program Outline is intended for use as a guide for training providers, instructors, apprentices and their sponsors.

This Program Outline is separated into four main sections which include:

The Introduction - Contains this Foreword; Acknowledgements that list all of the participants who were involved in the creation of this document; as well as a section called “How to Use this Document” which provides an oversight on how this document can be used.

The Program Overview - Contains a Credentialing Model that shows the path and time requirements for the apprentice; an Occupational Analysis Chart that has the General Areas of Competency (GAC) and the individual competencies, and a Training Topics and Suggested Time Allocation which provides a suggested percentage of time for the theory and practical components for each GAC in this program.

The Program Content - Represents individual General Areas of Competencies, which are further separated into competencies defined by Learning Objectives, Learning Tasks and Content.

The Training Provider Standards - The Facility Requirements section provides minimal requirements for facilities seeking designation and upgrade. The Tools and Equipment section lists the tools required to cover the competencies of this program. The Reference Material section is a collection of materials used for learning guides by the apprentice and instructors for the theory and at times the practical portion of the program. Finally, the Instructor Requirements section provides the level of knowledge and experience that each instructor must have to competently provide instruction in this program.

Practical instruction through demonstration and through student participation should be integrated within classroom sessions. Safe working practices, even though not always specified in each operation or topic, are an implied part of the program and should be stressed throughout the apprenticeship. It is the responsibility of employers to ensure safety training for the apprentices working on their work sites.

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 development of the Marine Electrician endorsement program was initiated through consultation with the following industry representatives:

- Rudi Spotzl, Seaspan Vancouver Shipyards
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- John Pesa, IBEW 213 (Port Coquitlam)
- Philip Venoit, IBEW 230 (Victoria)
- Mike Gabriele, McRae Electrical Ltd. (Burnaby)
- Doug McLaren, Allied Shipbuilders Ltd. (North Vancouver)
- Andy Cleven, Electrical Joint Training Committee (Burnaby)
- Art Pol, BC Ferries (Deas Dock)
- Alex Rueben, IMTARC (Victoria)

Industry Subject Matter Experts retained to assist in the development of the occupational analysis chart and program outline include:

- | | |
|--|---|
| <ul style="list-style-type: none"> • John Pinnock, Fleet Maintenance Facility - Cape Breton • Art Pol, Fleet Maintenance Unit - BC Ferries • Adrien Livingston, IBEW Local 230 • Doug McLaren, Allied Shipbuilders • Rob Greer, Seaspan • Tjakko Wezeman, BC Ferries • John Pesa, IBEW 213 (Port Coquitlam) • Lucas Lindlay, Seaspan • Chuck Gilbert, Schneider Electric • Raj Takhar, Seaspan | <ul style="list-style-type: none"> • Mike Gabriele, McRae Electrical Ltd. (Burnaby) • Scott McCullough, Fleet Maintenance - National Defence • Mark Baxter, Fleet Maintenance - National Defence • Shawn Mostad, Fleet Maintenance - National Defence • Keith Stevenson, Fleet Maintenance - National Defence • Kris Harding, Emery Electric • Guy Barrett, Emery Electric |
|--|---|

Facilitators:

- Dan McFaull, North Pacific Training (June 2013)
- Jim Light, RJL Development Industries (Feb 2014)
- Evelyn Taylor, RTO (June 2013 and Feb 2014)

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

How to Use this Document

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

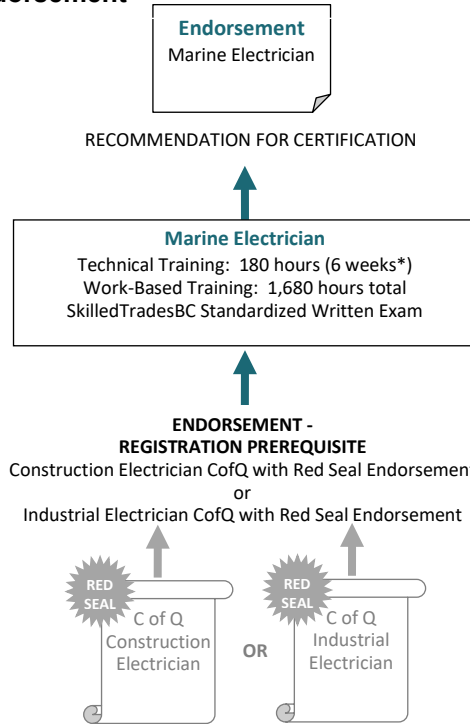
Section	Training Providers	Employers/ Sponsors	Apprentices	Challengers
Program Credentialing Model	Communicate program length and structure, and all pathways to completion	Understand the length and structure of the program	Understand the length and structure of the program, and pathway to completion	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, measurable 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 individuals to check program content areas against their own knowledge and performance expectations against their own skill levels
Training Provider Standards	Defines the facility requirements, tools and equipment, reference materials (if any) and instructor requirements for the program	Identifies the tools and equipment an apprentice is expected to have access to; which are supplied by the training provider and which the student is expected to own	Provides information on the training facility, tools and equipment provided by the school and the student, reference materials they may be expected to acquire, and minimum qualification levels of program instructors	Identifies the tools and equipment a tradesperson is expected to be competent in using or operating; which may be used or provided in a practical assessment

Section	Training Providers	Employers/ Sponsors	Apprentices	Challengers
Appendix – Glossary of Acronyms			Defines program specific acronyms	

Section 2
PROGRAM OVERVIEW
Marine Electrician

Program Credentialing Model

Marine Electrician Optional Post-Certification Endorsement



**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

None

Occupational Analysis Chart

MARINE ELECTRICIAN

Occupation Description: A Marine Electrician understands electrical installation and maintenance of electrical equipment in a marine environment and is responsible for the safe operation and distribution of AC and DC electrical power to the various ship systems. Marine electricians apply and install transits, cabling and terminations, interpret marine electrical drawings, interpret and apply marine codes and regulations, use test equipment for troubleshooting ship systems such as main and auxiliary power generation, propulsion, navigational lighting, domestic lighting, hydraulic, pneumatic, communication and alarm, and use maintenance management systems.

Marine Industry Knowledge A	Use terminology related to ships A1	Describe hazards in shipboard and shipyard work environments A2	Apply regulations and standards A3						
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Marine Wiring Methods B	Install marine electrical cables and transits B1	Terminate cable shielding specific to marine cables B2	Install packing of transits and deck tubes B3	Install wireways B4	Install corrosion protection in a marine environment B5				
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Power Generation C	Install and maintain prime mover controls C1	Install and maintain power generator protective relays C2	Describe main and auxiliary power generation and related controls C3						
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Power Distribution D	Describe shipboard power distribution D1	Install and maintain switchboards, motor control centers, power distribution centres and panelboards D2	Describe shore power systems D3	Install and maintain power sources D4	Install and maintain temporary services D5	Install, maintain and troubleshoot lighting systems D6			
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Program Overview

Shipboard Systems and Controls E	Describe marine control systems E1	Describe alarm and monitoring systems E2	Describe marine communication systems E3	Describe cathodic protection E4	Describe marine navigation systems E5	Install and maintain batteries E6
	EN	EN	EN	EN	EN	EN
Testing and Troubleshooting F	Describe routine testing and certification F1	Describe and perform insulation testing F2	Describe and interpret schematics and wiring diagrams F3			
	EN	EN	EN			

Training Topics and Suggested Time Allocation

MARINE ELECTRICIAN

		% of Time	% of Time Allocated to:		
			Theory	Practical	Total
Line A	Marine Industry Knowledge	15%	100%	0%	100%
A1	Use terminology related to ships		✓		
A2	Describe hazards in shipboard and shipyard work environments		✓		
A3	Apply regulations and standards		✓		
Line B	Marine Wiring Methods	20%	80%	20%	100%
B1	Install marine electrical cables and transits		✓		
B2	Terminate cable shielding specific to marine cables		✓	✓	
B3	Install packing of transits and deck tubes		✓	✓	
B4	Install wireways		✓		
B5	Install corrosion protection in a marine environment		✓		
Line C	Power Generation	10%	100%	0%	100%
C1	Install and maintain prime mover controls		✓		
C2	Install and maintain power generator protective relays		✓		
C3	Describe main and auxiliary power generation and related controls		✓		
Line D	Power Distribution	25%	80%	20%	100%
D1	Describe shipboard power distribution		✓		
D2	Install and maintain switchboards, motor control centres, power distribution centers and panelboards		✓		
D3	Describe shore power systems		✓		
D4	Install and maintain power sources		✓	✓	
D5	Install and maintain temporary services		✓		
D6	Install, maintain and troubleshoot lighting systems		✓	✓	
Line E	Shipboard Systems and Controls	20%	80%	20%	100%
E1	Describe marine control systems		✓		
E2	Describe alarms and monitoring systems		✓		
E3	Describe marine communication systems		✓		
E4	Describe cathodic protection		✓		
E5	Describe marine navigation systems		✓		
E6	Install and maintain batteries		✓	✓	
Line F	Testing and Troubleshooting	10%	80%	20%	100%
F1	Describe routine testing and certification		✓		
F2	Describe and perform insulation testing		✓	✓	
F3	Describe and interpret schematics and wiring diagrams		✓		
Total Percentage for Marine Electrician		100%			

PROGRAM CONTENT

Marine Electrician

Line (GAC): **A Marine Industry Knowledge**
Competency: **A1 Use terminology related to ships**

Objectives

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

- Use correct terminology for shipboard structures, spaces, equipment and systems
- Use correct terminology for shipyard fixtures and equipment

LEARNING TASKS

1. Use shipboard terminology

CONTENT

- Shipboard structures/area layout
- Beam
- Draft
- Port
- Starboard
- Frame numbers
- Deck levels
- Bulkhead
- Watertight doors
- Transits
- Glands
- Bilge
- Decks and deckplates
- Confined spaces
- Tanks
- Interior spaces
- Shipboard equipment
- Communication systems
- Lighting
 - Ship services
 - Emergency
 - Normal
 - Transitional
 - Supplementary
- Alarms and monitoring
 - Flood
 - Gas detection
 - Bilge
 - Temperature
 - Shutdowns
 - Machinery condition
 - Liquid level monitoring
- Steering
- Propulsion

LEARNING TASKS

2. Use shipyard terminology

CONTENT

- Essential services
- Power generation
 - Main/auxiliary
 - UPS backup power system
- Potable water
- Waste management
 - Sewage treatment
 - Grey water
 - Incinerator
 - Compactor
 - Oil waste (oily water)
- Deck equipment
 - Winches
 - Anchors
 - Davits
 - Anchor windlass
- Fire detection/suppression systems
 - Halon
 - CO₂
 - Water deluge
- Navigational aids
 - Radar
 - Gyro
 - Bridge equipment
 - Compass
 - Sonar
 - Satellite
 - Voyage Data Recorder (VDR)
 - Clearances
 - Navigational lighting
 - GPS
- Shipyard equipment
 - Temporary venting
 - Temporary lighting
 - Ship to shore connections
 - Dry dock
 - Graving dock
- Mobile equipment
 - Ship elevators/syncrolift

Line (GAC): **A Marine Industry Knowledge**
Competency: **A2 Describe hazards in shipboard and shipyard work environments**

Objectives

To be competent in this area, the individual must be able to describe hazards common to most shipboard and shipyard work environments.

LEARNING TASKS

1. Describe hazards found in the shipboard and shipyard work environment

CONTENT

- HazMat
 - Asbestos
 - Biohazards
 - Radiation
 - Environmental awareness
- Spill response
- Confined space
- CO₂
- Hot work
- Flooding
- Shipboard safety systems
- Working at heights (fall protection)
- Overhead hazards (crane, etc.)
- Rigging
- Dropped objects
- Lockout and tagging

Line (GAC): **A Marine Industry Knowledge**
Competency: **A3 Apply regulations and standards**

Objectives

To be competent in this area, the individual must be able to describe and apply site or job specific regulations and standards related to electrical work in the Shipbuilding and Repair industry.

LEARNING TASKS

CONTENT

- | | |
|---|--|
| <p>1. Describe and apply Transport Canada regulations</p> | <ul style="list-style-type: none"> • Ships Electrical Standards TP127E |
| <p>2. Describe and apply other regulations and standards related to electrical work in the Shipbuilding and Repair industry</p> | <ul style="list-style-type: none"> • Site or job specific • Class society <ul style="list-style-type: none"> ○ Lloyds of London • IEEE • IEC • ISO • Defence standards • Other trade related regulations <ul style="list-style-type: none"> ○ Fire Detection & Extinguishing Equipment Regulations ○ Small Fishing Vessel Inspection Regulations ○ Large Fishing Vessel Inspection Regulations ○ Collision Regulations ○ Hull Construction Regulations ○ Small Vessel Regulations ○ Towboat Crew Accommodation Regulations ○ Arctic Shipping Pollution Prevention Regulations ○ Search Initiator Buoy Regulations ○ Ships Elevator Regulations ○ Marine Machinery Regulations |

Line (GAC): **B Marine Wiring Methods**
Competency: **B1 Install marine electrical cables and transits**

Objectives

To be competent in this area, the individual must be able to describe marine cables and cable transits.

LEARNING TASKS

1. Describe variations found in marine electrical installations

2. Describe installation of marine cables and cable transits

CONTENT

- Conductor phasing colours
- Labeling numbers and/or lettering

- Marine cable types
 - Foil type
 - Double shielded
 - Armoured and non-armoured
 - Stranded wire vs. solid wire
- Cable support methods
- Cable separation
- Types and application of cable transits
 - Block-style transits
 - Sleeve transits
 - Poured transits
 - Multi-cable transits
- Types of bulkheads
- Glands/deck tubes
- Junction boxes, cabinets, enclosures
- Cable connectors
 - Hazardous area locations
 - Dry connector
 - Liquid tight connector
 - Strain relief
- Tagging (identification)

Line (GAC): **B Marine Wiring Methods**
Competency: **B3 Install packing of transits and deck tubes**

Objectives

To be competent in this area, the individual must be able to describe and demonstrate packing of transits and deck tubes.

LEARNING TASKS

CONTENT

- | | |
|---|---|
| 1. Describe installation of transits | <ul style="list-style-type: none"> • Packing • Sizing • Manufacturer’s guidelines • Types of bulkheads <ul style="list-style-type: none"> ○ Transport Canada rules • Specialized tools and equipment <ul style="list-style-type: none"> ○ Block system ○ Putty system ○ Manufacturer’s specifications |
| 2. Demonstrate packing of transits | <ul style="list-style-type: none"> • Block-style transits • Vertical packing • Horizontal packing • Deck tubes (stuffing) |

Achievement Criteria

Performance The individual will be able to use block-style transits and demonstrate vertical and horizontal packing, including deck tubes and stuffing tubes.

Conditions In a lab setting as part of a practical project, given the required tools and equipment.

Criteria Within specifications, safety standards and time frames acceptable to industry.

Line (GAC): **B** **Marine Wiring Methods**
Competency: **B4** **Install wireways**

Objectives

To be competent in this area, the individual must be able to describe and install wireways.

LEARNING TASKS

1. Describe wireways

2. Describe installation of wireways

CONTENT

- Banding
- Supporting cables
- Fire resistant strapping
- Mixing of conductor types (power, communication)
- Separation of cable types
- Weight rating (manufacturer's guidelines)
- Parallel wireways/redundant systems

- Structural placement of wireways
- Layout and routing
 - Engineered vs. built in place
 - Structural integrity

Line (GAC): **B Marine Wiring Methods**
Competency: **B5 Install corrosion protection in a marine environment**

Objectives

To be competent in this area, the individual must be able to describe corrosion protection methods in a marine environment.

LEARNING TASKS

CONTENT

- | | |
|---|---|
| <p>1. Describe causes of corrosion</p> | <ul style="list-style-type: none"> • Dissimilar metals • Salt spray-moisture • Improper sealing <ul style="list-style-type: none"> ○ Incompatible metals ○ Improper coatings |
| <p>2. Describe selection of metals for corrosion protection</p> | <ul style="list-style-type: none"> • Types of metals used in fasteners and fittings <ul style="list-style-type: none"> ○ Aluminum ○ Stainless ○ Copper ○ Brass • Compatibility |
| <p>3. Describe corrosion protection methods</p> | <ul style="list-style-type: none"> • Proper sealing • Proper coatings |

Line (GAC): C **Power Generation**
Competency: C1 **Install and maintain prime mover controls**

Objectives

To be competent in this area, the individual must be able to describe the installation and maintenance of prime mover controls.

LEARNING TASKS

CONTENT

- | | |
|--|---|
| <p>1. Describe types of prime movers</p> | <ul style="list-style-type: none"> • Diesel • Gas turbine • Steam • LNG • Electric motor |
| <p>2. Describe prime mover controls</p> | <ul style="list-style-type: none"> • Governors/speed controls <ul style="list-style-type: none"> ○ Engine throttle control systems • Starting circuits <ul style="list-style-type: none"> ○ Air starters ○ Electric starters ○ Hydraulic starters • Permissives and Interlocks • Monitoring • Sensors <ul style="list-style-type: none"> ○ Speed pickups ○ Temperature ○ Pressure ○ Limit switches • Actuators/solenoids |
| <p>3. Describe the maintenance of prime mover controls</p> | <ul style="list-style-type: none"> • Governor calibration • Batteries • Sensor calibration |

Line (GAC): C **Power Generation**
Competency: C2 **Install and maintain power generator protective relays**

Objectives

To be competent in this area, the individual must be able to describe types of power generator protective relays.

LEARNING TASKS

1. Describe types of power generator protective relays and their functions

CONTENT

- Reverse power
- Over-current
- Under/over voltage
- Reverse current
- Under frequency
- Prime mover faults
- Ground fault
- Phase differential
- Loss of field

Line (GAC): C **Power Generation**
Competency: C3 **Describe main and auxiliary power generation and related controls**

Objectives

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

- Describe main and auxiliary power generation systems
- Describe controls related to main and auxiliary power systems

LEARNING TASKS

1. Describe marine power generation

2. Describe controls

CONTENT

- Main propulsion
- Auxiliary

- Power management
- Load sharing
- Automatic transfer
 - Open transition
 - Closed transition
- Speed control/frequency
 - Load control
- Circuit breaker control
 - Remote operation
- Voltage control

Line (GAC): **D Power Distribution**
Competency: **D1 Describe shipboard power distribution**

Objectives

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

- Describe transformer and panelboard configuration
- Describe single line diagrams
- Describe equipment grounding and ground detection systems

LEARNING TASKS

CONTENT

- | | |
|---|--|
| 1. Describe transformer configuration | <ul style="list-style-type: none"> • 3-phase 3-wire delta • 3-phase 4-wire wye • Open delta |
| 2. Describe panelboard configuration | <ul style="list-style-type: none"> • 3-phase 3-wire delta • 3-phase 4-wire wye |
| 3. Describe equipment grounding | <ul style="list-style-type: none"> • Metal parts • Grounding conductor • Grounding connection |
| 4. Describe ground fault and ground detection systems | <ul style="list-style-type: none"> • Grounded systems • Ungrounded systems |
| 5. Interpret single line diagrams of shipboard power distribution systems | <ul style="list-style-type: none"> • Common symbols • Conductor sizes • Transformer data • Available fault current |

Line (GAC): **D Power Distribution**
Competency: **D3 Describe shore power systems**

Objectives

To be competent in this area, the individual must be able to describe shore power systems.

LEARNING TASKS

CONTENT

- | | |
|---|---|
| <p>1. Describe typical components of shore systems</p> | <ul style="list-style-type: none"> • Frequency converter • Primary switchgear • Transformer • Secondary switchgear • Grounding^[SEP] • Cable Positioning Device (CPD)^[SEP] • Power/control cables |
| <p>2. Describe safety interlocks</p> | <ul style="list-style-type: none"> • Mechanical • Electrical <ul style="list-style-type: none"> ○ Interlocks ○ Permissives |
| <p>3. Describe protection functions</p> | <ul style="list-style-type: none"> • Overcurrent • Ground fault • Phase rotation |
| <p>4. Describe grounding methods</p> | <ul style="list-style-type: none"> • Ungrounded system • Solid neutral grounding system • Low impedance neutral grounding system • High impedance neutral grounding system • Ground potential transformer method |
| <p>5. Describe wiring methods for connection to shore systems</p> | <ul style="list-style-type: none"> • High voltage considerations • Cable management • Ship classification |

Line (GAC): **D Power Distribution**
Competency: **D4 Install and maintain power sources**

Objectives

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

- Describe different types of power systems
- Install and maintain power sources

LEARNING TASKS

CONTENT

- | | |
|---------------------------------------|--|
| 1. Describe types of power sources | <ul style="list-style-type: none"> • Static power supply units • AC - DC: Rectifiers <ul style="list-style-type: none"> ○ Battery Charging Rectifiers ○ DC Power Supplies • DC - AC: Inverters • AC - AC: Frequency Converters (Changers) • DC - DC: Voltage Converters • UPS Systems: Uninterruptible Power Supply Systems |
| 2. Install and maintain power sources | <ul style="list-style-type: none"> • Batteries and charging systems • UPS Systems • Frequency Converters |

Achievement Criteria

Performance	The individual will be able to install and maintain batteries and charging systems, UPS systems and frequency converters.
Conditions	In a lab setting as part of a practical project, given the required tools and equipment.
Criteria	Within specifications, safety standards and time frames acceptable to industry.

Line (GAC): **D Power Distribution**
Competency: **D5 Install and maintain temporary services**

Objectives

To be competent in this area, the individual must be able to describe, install and maintain temporary services.

LEARNING TASKS

CONTENT

- | | |
|---|--|
| <p>1. Describe types of temporary services</p> | <ul style="list-style-type: none"> • Power • Lighting • Assured grounding / GFCIs • Ventilation systems • Fire fighting systems • Temporary fire alarm systems <ul style="list-style-type: none"> ○ Temporary connection to general fire alarm system ○ Temporary stand-alone fire alarm system • Regulatory requirements • Workplace best practices <ul style="list-style-type: none"> ○ Standard Operating Procedures ○ Safe Working Practices |
| <p>2. Describe the installation and maintenance of temporary power and lighting</p> | <ul style="list-style-type: none"> • Installation to avoid tripping hazards • Access/egress considerations • Maintenance / inspection to ensure good operating condition |
| <p>3. Describe the installation and maintenance of assured grounding/GFCIs</p> | <ul style="list-style-type: none"> • WorkSafe BC variances to allow assured grounding in lieu of GFCIs |
| <p>4. Describe the maintenance of ventilation systems</p> | <ul style="list-style-type: none"> • Power supply testing • GFCI & assured grounding testing |

Line (GAC): D **Power Distribution**
Competency: D6 **Install, maintain and troubleshoot lighting systems**

Objectives

To be competent in this area, the individual must be able to describe, install and service different types of lighting systems.

LEARNING TASKS

CONTENT

- | | |
|--|---|
| <p>1. Describe types of lighting systems</p> | <ul style="list-style-type: none"> • Normal • Transitional • Emergency <ul style="list-style-type: none"> ○ Search lighting ○ Embarkation lighting • Supplementary • Locations as per regulatory requirements |
| <p>2. Install lighting systems</p> | <ul style="list-style-type: none"> • Batteries • Load testing • Regulatory testing/walk-through • Fixtures (luminaires) <ul style="list-style-type: none"> ○ Sealed ○ Vapour-proof ○ Marine certified fixtures ○ Ingress protection (IP) rating ○ Deck lights |
| <p>3. Maintain and troubleshoot lighting systems</p> | <ul style="list-style-type: none"> • Testing power sources • Ground fault testing • Battery maintenance and testing <ul style="list-style-type: none"> ○ Regulatory requirements |

Achievement Criteria

Performance The individual will be able to connect and test lighting systems.
Conditions In a lab setting as part of a practical project, given the required tools and equipment.
Criteria Within specifications, safety standards and time frames acceptable to industry.

Line (GAC): **E Shipboard Systems**
Competency: **E1 Describe marine control systems**

Objectives

To be competent in this area, the individual must be able to describe types of shipboard systems and their principle operation.

LEARNING TASKS

CONTENT

- | | |
|---|--|
| <p>1. Describe types of shipboard systems</p> | <ul style="list-style-type: none"> • Steering • Propulsion • Synchros and servos • Liquid management • Navigation • Fire detection and suppression • Engine control • Oil and ventilation shutdown |
| <p>2. Describe the integration of shipboard systems</p> | <ul style="list-style-type: none"> • Hydraulic • Pneumatic • Electro-mechanical |

Line (GAC): **E Shipboard Systems and Controls**
Competency: **E2 Describe alarm and monitoring systems**

Objectives

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

- Describe types of alarm systems and monitoring equipment
- Describe the components and principle operation of alarms and monitoring equipment

LEARNING TASKS

CONTENT

- | | |
|--|---|
| <p>1. Describe types of alarm systems</p> | <ul style="list-style-type: none"> • Machinery <ul style="list-style-type: none"> ○ Engines ○ Tanks ○ Compartment flood ○ Bilge • Fire detection and alarms <ul style="list-style-type: none"> ○ Smoke detectors ○ Heat detectors ○ Flame (UV/IR) • Door status <ul style="list-style-type: none"> ○ Fire door status ○ Water tight status • General alarms <ul style="list-style-type: none"> ○ Gas detection ○ Freon ○ CO₂ ○ HVAC |
| <p>2. Describe the basic components of alarm systems</p> | <ul style="list-style-type: none"> • Monitoring panel • Data collectors • PLC control and monitoring systems • Sensors and transducers <ul style="list-style-type: none"> ○ Level ○ Pressure ○ Temperature • Annunciation <ul style="list-style-type: none"> ○ Mimic display ○ Horn ○ Strobe lights ○ Other |
| <p>3. Describe fire suppression systems</p> | <ul style="list-style-type: none"> • Halon suppression • CO₂ suppression • Water mist suppression • Fire damper control • Door control |

Line (GAC): **E** **Shipboard Systems and Controls**
Competency: **E3** **Describe marine communication systems**

Objectives

To be competent in this area, the individual must be able to describe the principle operation of internal communication systems.

LEARNING TASKS

CONTENT

- | | |
|--|---|
| <ol style="list-style-type: none"> 1. Describe internal communication systems
 2. Maintain communications systems
 3. Use two-way radio | <ul style="list-style-type: none"> • Intercom • Public address • Sound-powered phones
 • Sound-powered phones
 • Operation • Protocol |
|--|---|

Line (GAC): **E Shipboard Systems and Controls**
Competency: **E4 Describe cathodic protection**

Objectives

To be competent in this area, the individual must be able to describe the principles of cathodic protection.

LEARNING TASKS

CONTENT

- | | |
|---|---|
| <p>1. Describe cathodic protection systems</p> | <ul style="list-style-type: none"> • Principles of electrolysis • Sacrificial • Impressed current (ICCP) • Shaft grounding • Current and voltage standards • Alarms |
| <p>2. Describe the installation, testing and maintenance of cathodic protection systems</p> | <ul style="list-style-type: none"> • Regular testing • Isolation • Changing anodes |

Line (GAC): **E Shipboard Systems and Controls**
Competency: **E5 Describe marine navigation systems**

Objectives

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

- Describe the components and integration of navigation systems
- Describe the operation of navigation systems

LEARNING TASKS

CONTENT

- | | |
|---|---|
| <p>1. Describe the components of navigation systems</p> | <ul style="list-style-type: none"> • Radios • Antennae • Radar • Sonar/depth sounder • Voyage data recorder (VDR) • Gyro compass • GPS systems • Satellite communications • Navigation lighting • Automated Identification Systems (AIS) • Auto-pilot • Electronic charts • Meteorological systems |
| <p>2. Describe the installation of navigation systems</p> | <ul style="list-style-type: none"> • Manufacturer’s specifications • Regulatory requirements |
| <p>3. Describe the maintenance of navigation systems</p> | <ul style="list-style-type: none"> • Battery/UPS • Radio tests (watt meter) • Certification test requirements |

Line (GAC): **E** **Shipboard Systems and Controls**
Competency: **E6** **Install and maintain batteries**

Objectives

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

- Describe installation of batteries
- Describe and perform battery testing
- Replace batteries

LEARNING TASKS

CONTENT

1. Describe installation of batteries/accumulators	<ul style="list-style-type: none"> • Regulatory requirements <ul style="list-style-type: none"> ○ TP127E
2. Describe types of batteries	<ul style="list-style-type: none"> • Construction and assembly • Flooded lead acid • Ni-CAD • AGM • Sealed gel cell • Lithium
3. Describe battery testing procedures	<ul style="list-style-type: none"> • Testing procedures • Safety requirements • Charging and discharging
4. Describe procedures for charging and discharging batteries	<ul style="list-style-type: none"> • Types of battery chargers <ul style="list-style-type: none"> ○ Float ○ Equalize • Discharging
5. Perform routine replacement of batteries	<ul style="list-style-type: none"> • Preventative maintenance schedule

Achievement Criteria

Performance The individual will be able to replace, recharge, discharge and test batteries.
Conditions In a lab setting as part of a practical project, given the required tools and equipment.
Criteria Within specifications, safety standards and time frames acceptable to industry.

Line (GAC): F **Testing and Troubleshooting**
Competency: F1 **Describe routine testing and certification**

Objectives

To be competent in this area, the individual must be able to describe routine testing and certification requirements.

LEARNING TASKS

1. Describe routine testing and certification requirements

CONTENT

- TP127E requirements
 - Testing and inspection at manufacturer's plant
 - Testing rotating machines
 - Testing switchboards and motor control centres
 - Testing main propulsion cables
 - Testing transformers for lighting and power
 - Testing static power supplies
 - Initial testing and inspection onboard ship
 - Periodic inspections
- Insulation testing
- Documentation requirements
- Primary generator testing
- Backup power testing
 - Emergency generator
 - Battery
 - UPS

Line (GAC): F **Testing and Troubleshooting**
Competency: F2 **Describe and perform insulation testing**

Objectives

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

- Describe and perform insulation megohm (Megger) testing
- Describe hi-pot and impulse testing

LEARNING TASKS

CONTENT

- | | |
|---|--|
| <p>1. Describe insulation (Megger) testing on cables and motors</p> | <ul style="list-style-type: none"> • Compliance requirements <ul style="list-style-type: none"> ○ IEEE Std 43-2000: IEEE Recommended Practice for Testing Insulation Resistance of Rotating Machinery ○ IEEE Std 522-2004: IEEE Guide for Testing Turn Insulation of Form-Wound Stator Coils for Alternating-Current Electric Machines • Documentation/paperwork • Testing new installations • Disturbed cable testing <ul style="list-style-type: none"> ○ Vibration ○ Water ingress • Precautions <ul style="list-style-type: none"> ○ Electronics ○ Damaging components |
| <p>2. Perform insulation testing on cables</p> | <ul style="list-style-type: none"> • Panel circuits • Power feeders • Switchboard |
| <p>3. Perform winding insulation testing on motors and generators</p> | <ul style="list-style-type: none"> • Surge testing • Core loss testing • Temperature-rise test • Insulation resistance test • High potential test • Overload test • Communication test |
| <p>4. Perform switchboard testing</p> | <ul style="list-style-type: none"> • High potential test • Insulation resistance test |

Achievement Criteria

Performance	The individual will be able to perform megohm testing on circuits, feeders, switchboards and motor windings.
Conditions	In a lab setting as part of a practical project, given the required tools and equipment.
Criteria	Within specifications, safety standards and time frames acceptable to industry.

Line (GAC): **F Testing and Troubleshooting**
Competency: **F3 Describe and interpret schematics and wiring diagrams**

Objectives

To be competent in this area, the individual must be able to describe and interpret electrical single line drawings, layout drawings, schematics and wiring diagrams applicable to the marine industry.

LEARNING TASKS

CONTENT

- | | |
|---|--|
| <p>1. Describe schematics and wiring diagrams</p> | <ul style="list-style-type: none"> • Schematics • Wiring diagrams • Single-line diagrams • Variations among drawing standards and symbols • Lighting layout • Power layout • Communication/Networking |
| <p>2. Interpret schematics and wiring diagrams</p> | <ul style="list-style-type: none"> • Installation • Troubleshooting |
| <p>3. Interpret ship general arrangement drawings</p> | <ul style="list-style-type: none"> • Hull drawings • Mechanical drawings |

Section 4

TRAINING PROVIDER STANDARDS

Facility Requirements

Classroom Area

- 1,000 sq. ft. for a class size of 16 students
- Comfortable seating suitable for training, teaching, and lecturing
- Instructional media to include multimedia projector, projections screen, and whiteboards
- In-room temperature regulation and ventilation
- Lighting controls (for lights and shades or blinds)
- Compliance with all local and national fire code and occupational safety requirements

Shop Area

- 200 sq. ft. per student
- Well heated and ventilated
- 20 ft. high ceilings
- Lighting appropriate to detailed work

Lab Requirements

- Fully operational, representative equipment (refer to *Shop Equipment* and *Shop Tools*)

Student Facilities

- Adequate lunch room as per WorkSafeBC requirements
- Adequate washroom facilities as per WorkSafeBC requirements
- Personal storage lockers

Instructor's Office Space

- 150 sq. ft. per instructor, with a desk, chairs and materials storage/filing system

Other

- N/A

Tools and Equipment

The equipment list below is based on the standard class size of 16 learners. The facilities must be in compliance with the appropriate zone bylaw for instructional use.

Shop Tools & Equipment

Required

- 8 Power supply stations (with fixed and variable AC and DC outputs and metering)
- 8 Sets of resistors, capacitor and inductors for circuit analysis labs
- 8 3-phase transformer stations
- 8 3-phase motor control stations (with assorted reduced-voltage/current magnetic starters, reversing starters, electronic starters, control and time-delay relays, assorted pilot devices, as necessary)
- 8 3-phase squirrel-cage motors (assorted 6-lead, 9-lead and 12-lead)
- 4 3-phase wound-rotor motors and controllers
- 2 Multi-speed motors and controllers
- 4 3-phase synchronous motor and controllers
- 2 Power factor correction capacitors, 3-phase
- 4 Power factor correction capacitors, single-phase
- 8 Single-phase, capacitor-start, dual-voltage motors
- 1 Single-phase, shaded-pole motor
- 1 Single-phase, universal motor
- 8 Single-phase magnetic starters
- 4 Reversing drum switches
- 2 3-phase alternator synchronizing panel with metering and controls
- 2 3-phase alternators with prime movers
- 8 DC motor control stations (with assorted magnetic and/or electronic starters)
- 8 DC motors, compound type
- 8 Oscilloscopes, dual-trace
- 8 Analogue multimeters
- 8 Digital multimeters
- 8 Wattmeters
- 8 Clamp-on ammeters
- 4 Phase-sequence indicators
- 4 Meggers
- 4 Hand-held tachometers
- 2 Motor rotation indicators
- 2 Watt-hour meters
- * Misc. conductors and raceways for demo purposes
- * Misc. transits and glands
- * Vertical and horizontal packing
- * Deck tubes (stuffing tubes)
- 8 Electronic trainers for discrete components
- 8 Function (signal) generators
- 8 3-phase rectifier boards
- 2 Electronic soft start controller
- 4 Power quality analyzers
- 17 Computer workstations with associated software programs
- 1 Laser printer
- 1 Multi (computer) projector
- 8 PLC workstation, with associated software
- 8 PLC simulator display board
- 8 Digital logic and OpAmp trainer
- 8 Transducer fundamentals trainer for automated controls
- 4 Adjustable speed DC drive c/w motor

- 4 Variable frequency AC drive c/w motor
- 2 Conventional zoned fire alarm system c/w initiating, signal and alarm devices
- 2 Addressable fire alarm system c/w initiating, signal and alarm devices
- 2 Intrusion alarm system
- 2 Intercom system
- 1 UPS system
- 8 Data cabling installation and test equipment
- 1 Fibre optic tool kit
- * Sound-powered telephone systems

* As Required

Shop (Facility) Tools

Standard Tools

- Meggers

Specialty Tools

- Banding tools and equipment
 - Stainless steel tye wraps

Student Tools (supplied by student)

- Hand tools (standard hand tools)

Required

- Safety glasses
- Safety boots
- Other PPE as required

Reference Materials

Required Reference Materials

- TP127E Transport Canada Ships Electrical Standards
www.tc.gc.ca/publications/en/tp127/pdf/hr/tp127e.pdf
- Canadian Electrical Code
- IEEE 45 Institute of Electrical and Electronic Engineers Recommended Practice for Electrical Installations on Shipboard

Recommended Resources

- IEEE Std 43-2000: IEEE Recommended Practice for Testing Insulation Resistance of Rotating Machinery
- IEEE Std 522-2004: IEEE Guide for Testing Turn Insulation of Form-Wound Stator Coils for Alternating-Current Electric Machines

ONLINE REFERENCE MATERIALS

Following is a list of useful online reference resources. Some are available as PDF downloads.

Automatic Identification Systems	http://www.nmea.org/Assets/nmea%20collision%20avoidance%20through%20ais.pdf Free online publication or download in PDF format.
Marine Electrical Knowledge	https://cupdf.com/document/marine-electrical-knowledge-5681d33a6211b.html?page=28 Free online publication or download in PDF format.
Martin's Marine Engineering Page	http://www.dieselduck.info This website offers a wide range of Marine Engineering topics and a library of useful marine industry resources.
Use of coatings to control corrosion of maritime structures	https://www.porttechnology.org/technical-papers/use-of-coatings-to-control-corrosion-of-maritime-structures/ Free online publication or download in PDF format.
Sound-Powered Telephone Talkers' Training Manual	https://www.jumpjet.info/Emergency-Preparedness/Neighborly-Response/Outside/Sound-Powered-Telephone-Talkers-Manual.pdf Free online publication or download in PDF format.

Instructor Requirements

Occupation Qualification

The instructor must possess:

- Construction Electrician CofQ with Red Seal endorsement & Marine Electrician endorsement
OR
- Industrial Electrician CofQ with Red Seal endorsement & Marine Electrician endorsement

Work Experience

A minimum of 5 years of experience working as a journeyperson in the Shipbuilding and Repair industry.

Instructional Experience and Education


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

- Instructor's Certificate (minimum 30 hr course)
- Instructor's must have or be registered in an Instructor's Diploma Program or equivalent to be completed within a five year period
- Bachelor's OR Master's degree in Education

Appendices

Appendix A

GLOSSARY OF ACRONYMS

AGM.....	Absorbed glass mat
AIS.....	Automated identification systems
CEC	Canadian Electrical Code
CPD	Cable positioning device 
GFCI.....	Ground fault circuit interrupter
GPS.....	Global positioning system
HVAC	Heating, ventilation and air conditioning
ICCP	Impressed current cathodic protection
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronic Engineers
IP	Ingress protection
ISO	International Organization for Standardization
LNG.....	Liquefied natural gas
PLC.....	Programmable logic controller
UPS.....	Uninterruptible power supply
UV/IR.....	Ultraviolet/infrared
VDR.....	Voyage data recorder

Appendix B**CERTIFYING AUTHORITIES****Canada**

- Canadian Standards Association (CSA)
- Underwriters Laboratories of Canada (ULC)
- National Research Council of Canada (NRC)

United States of America

- ETL Testing Laboratories Inc. (ETL)
- Factory Mutual Research Corp. (FM)
- M&T Laboratories
- Underwriters Laboratories (UL)
- United States Testing Company Inc.

Europe**Germany**

- Physikalisch Technische Bundesanstalt (PTB)

Denmark

- Danmarks Elektriske Materielkontrol (DEMKO)

Norway

- Norges Elektriske Materielkontrol (NEMKO)

Sweden

- Svenska Elektriske Materielkontrollanstalten (SEMKO)

United Kingdom

- British Approvals Services for Electrical Equipment in Flammable Atmospheres (BASEEFA)
- Electrical Equipment Certification Service (EECS)