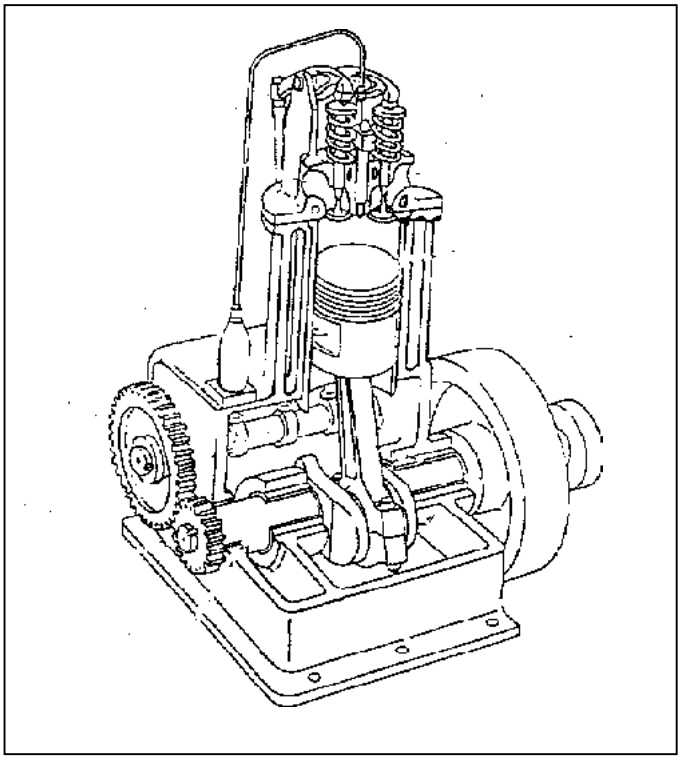
DIESEL ENGINEERING

FOR PACIFIC ISLAND MARINERS

RESTRICTED CLASS 6-MASTER/ENGINEER
SPC 022B



TRAINER'S GUIDE

SECRETARIAT OF THE PACIFIC COMMUNITY

GOVERNMENT OF TAIWAN/ROC

TABLE OF CONTENTS

GENERAL INFORMATION

1. Introduction

This Trainer's Guide has been designed to assist trainers who are delivering and assessing the Diesel Engineering module (SPC 022B), as part of a Restricted Class 6 Master/Engineer course for mariners in the Pacific region. It is a guide to the learning outcomes that need to be delivered, along with suggested assessment methods and assessment criteria (evidence). It is to be used in conjunction with the Diesel Engineering Learner's Guide as well as suggested reference material listed in the Course Information section of this guide.

The Restricted Class 6 Diesel Engineering module has been designed and is intended for skipper/engineers working on boats powered by a diesel engine under 250kw, which are less than 15 metres in length and operating in near coastal waters. The content of the module has been modeled on the Engineering Knowledge module (SPC 022A) of the Class 6 Master/Engineer course developed by the SPC Regional Maritime Programme, but modified to meet the lesser requirements of skipper/engineers who will be operating less complicated engineering systems in restricted waters. Compliance with local regulations should be sought before the module is offered.

The intention is that the resources provide a generic benchmark for Pacific Island countries and territories when delivering their Restricted Class 6 Master/Engineer course. While the general learning outcomes need to be adhered to, it is anticipated that delivery will be targeted to concentrate on areas most applicable to the maritime sector in each country. The wide variety of boats, engines and types of operations in the Pacific Island region means local priorities will be different and that needs to be reflected in the delivery methodology.

2. Programme development

The resources were produced with financial support from the Government of Taiwan/ROC and compiled by Alastair Robertson, tutor at the New Zealand School of Fisheries, Nelson, New Zealand.

They were developed through consultation with staff of the Fisheries Training Section, Coastal Fisheries Programme, Secretariat of the Pacific Community and regional experts on fishing and maritime training. Resources from Australia and New Zealand, SPC training materials and valuable resource material such as the *Australian Boating Manual* by Captain Dick Gandy were used as a guideline to developing materials that were relevant to small-boat operators in the Pacific Island region.

COURSE INFORMATION

1. Module name

Diesel Engineering SPC 022B.

2. Prerequisites

There are generally no prerequisites for completing the Diesel Engineering module. However the prerequisites for the Class 6 Master/Engineer certificate (Full or Restricted) are a Safety Certificate and some sea time. Refer to local regulations for any specific country requirements.

3. Course duration

4 days (at the discretion of the course provider).

4. Assessment

Assessment methods are suggested in the document for each element of competence, however assessors may feel other combinations are also appropriate. Wherever possible practical demonstration and assessment should be used although this is subject to available resources. With oral and written assessments (when practical assessment is not appropriate or possible), a decision needs to be made in regard to the language or other difficulties a candidate may encounter. An Assessment Guidelines section is included in this Trainer's Guide. It provides a more comprehensive outline of the skills and knowledge a candidate should be able to demonstrate or describe when being assessed and follows the learning outcomes of the course.

Assessment should be conducted separately for each module section as it is completed and the result recorded. This will allow for flexibility in delivery and give a person initially unsuccessful or absent the opportunity to be reassessed only on the section they haven't completed. It is suggested a holistic assessment orally and/or written at the successful completion of all sections or components could be used and then a certificate issued.

5. Recognition of Prior Learning (RPL)

RPL is an integral part of any competency-based system of training and assessment and should be used where appropriate to assess competence within the Diesel Engineering module. Similarly, recognition should be given to an approved certificate, covering the same content, that has been obtained from the same or another training provider.

6. Resources

The resources required to successfully deliver appropriate training and assessment for the Diesel Engineering module are varied and successful delivery can be accomplished without some resources. However, the Diesel Engineering module should be very much a hands-on course and every effort will need to be made to simulate real conditions.

Ideally the provider will have access to small, diesel-propelled, vessels or to engine parts and models so that much of the training and assessment can be very practically focussed.

Resources that may be used include:

- Classroom with desks
- Workshop with small engines and tools
- Overhead Projector
- Overhead Transparencies for the diesel Engineering module
- Whiteboard
- TV and video
- Appropriate training videos
- Parts of diesel engines
- Posters showing engine parts and systems

Recommended trainer's reference material:

- *Australian Boating Manual* by Captain Dick Gandy

1. MANAGE A MARINE DEISEL ENGINE

Learning Outcome	Method of Assessment	Assessment Criteria (Evidence)
1.1 Describes the operating cycle of a 2 and 4 stroke engine.	1. Oral/practical demonstration	Given a model, cut away engine or using sketches explains and describes • the operational cycle of a 2 stroke engine. • the operational cycle of a 4 stroke engine. • the significant differences between 2 and 4 stroke engines.
1.2 Describes the principle components of a basic diesel engine.	1. Oral/practical demonstration	Given a model, or simple diagram , or a cut away diesel engine, identifies the major components.
1.3 Describes the basic components of the lubrication system.	1. Oral/Practical demonstration	Given a diesel engine in situ, or a simple diagram of a lubrication system • identifies individual components and explains their function.
1.4 Describes the basic components of a fuel system	1. Oral/practical demonstration	Given a diesel engine in situ or a simple diagram of a fuel system from tank to injector • identifies individual components and explains their function. •
1.5 Describes how a marine diesel engine is cooled.	1. Oral/practical demonstration.	Given a diesel engine in situ or a simple diagram, Identifies individual components and explains their functions

2. ENGINE OPERATION

Learning Outcome	Method of Assessment	Assessment Criteria (Evidence)
2.1 Follows correct and safe pre-start and start up procedures.	1. Oral /written 2. Practical demonstration.	Prepares and starts a diesel engine on board a small vessel, or describes this in detail, or writes a pre-start/start check list.
2.2 Knows what to check if engine fails to start.	1. Oral 2. Practical demonstration	List, describes, or practically demonstrates the checks to be made if a diesel engine fails to start.
2.3 Correctly interprets engine gauge readings	1. Oral 2. Practical demonstration	Lists the causes of gauge readings out of the range of manufacturers specifications.
2.4 Follows correct warm up and cool down practices.	1. Oral 2. Practical demonstration	Explains warm up and cool down requirements .
2.5 Identifies, and takes appropriate action to deal with, an overheated engine.	1 Oral 2 Practical demonstration	Using an engine in situ, which has a heating problem, identifies and rectifies this problem, or explains the causes of overheating and lists the actions taken when the engine overheats.
2.6 Identifies and takes appropriate action to deal with a vessel which slows down when underway	1. Oral	Lists and explains the possible an engine slowing down while underway and the steps which will be taken to rectify this
2.7 Takes appropriate action on finding the engine has a low lube oil pressure	1. Oral 2. Practical demonstration	Lists and explains the actions which will be taken on finding the lube oil pressure is low.

3. ROUTINE MAINTENANCE PROCEDURES

Learning Outcome	Method of Assessment	Assessment Criteria (Evidence)
3.1 Follows manufacturers instructions on routine maintenance to engine	1. Oral and/or written	Lists and describes the procedures followed to routinely maintain the engine with regards to • Oil • Air • fuel • Gearbox
3.2 Develops and uses a check list for routine maintenance tasks around engine and deck	1. Oral and/or written	Makes a specimen check list of the procedures to be followed to routinely maintain the engine and deck machinery. to • Belts • Hoses • Lubrication • Greasing • W inches • Stern gear • Steering gear
3.3 Knows the minimum tools and spare parts which should be carried on board.	1. Oral	Lists the contents of a basic tool box and lists the spare parts which should be carried on board.
3.4 Maintains the drive train and takes remedial action for all faults	1. Oral 2. Practical demonstration	Given an engine in situ, undertakes routine maintenance, identifies any faults on the drive train and fixes these. Or, alternatively, explains drive train maintenance procedures, lists possible faults and explains what should be done to fix these.
3.5 Performs appropriate maintenance to the vessel while it is on the slip for its periodic survey.	2. Oral 3. Practical	Lists and describes and/or undertakes the procedures followed to routinely maintain the vessel while it is on the slip for its periodic survey. To include: • Function and replacement of anodes • Stern tube and bearing • Through- hull valves • Rudder stock and pintles.

4. STEERING SYSTEMS

Learning Outcome	Method of Assessment	Assessment Criteria (Evidence)
4.1 Understands the basic components of small boat steering systems	1. Oral	Explains and describes the basic components and operation of two small boat steering systems, such as • Wire. • Rod • Rack and pinion • Hand hydraulic.
4.2 Undertakes the routine maintenance of a small boat steering system	1. Oral 2. Practical demonstration	Explains and describes how each of the systems listed in 5.1 will be maintained.

5. BILGE SYSTEMS

Learning Outcome	Method of Assessment	Assessment Criteria (Evidence)
5.1 Knows the statutory requirements for bilge systems on vessels under 15m (or the vessel currently being operated.)	1. Oral	Lists the statutory requirements for bilge systems on vessels under 15m (or the vessel currently being operated.)
5.2 Understands and trouble shoots a small boat bilge system relevant to the statutory requirements in 6.1 or which is currently being operated.	1. Oral 2. Practical demonstration	Explains, describes or sketches and/or practically demonstrates a knowledge of a small boat bilge system relevant to the statutory requirements or as is being currently used. Lists 5 causes of malfunction of this system.
5.3 Understands the reasons a vessel can be back flooded through the bilge system and the steps taken to avoid this.	1. Oral 2. Practical demonstration	Explains and describes how a vessel can be back flooded through the bilge system and the steps which should be taken to avoid this.

6. DC BATTERY SYSTEMS

Learning Outcome	Method of Assessment	Assessment Criteria (Evidence)
6.1 Understands how to care for a battery and where it should be fitted in a small boat.	1. Oral	Explains and describes • 4 aspects in the care of a battery • 3 aspects which must be observed when fitting a battery to a small boat.
6.2 Assesses the condition of a battery by using a hydrometer	1. Practical and oral combined	Uses a hydrometer to assess the condition of a battery and reports this condition correctly
6.3 Takes precautions against damage or injury when using a battery.	1. Oral 2. Practical demonstration	Explains and describe and/or practically demonstrates the precautions which should be taken against damage or injury when using a battery.

7. FIRE

Learning Outcome	Method of Assessment	Assessment Criteria (Evidence)
7.1 Knows the major causes of fire in the engine rooms of small vessels	1. Oral	Lists four circumstances which commonly cause fire in the engine room
7.2 Responds appropriately to a machinery space fire	1. Oral 2. Practical	• Explains and describes the actions taken when a fire is found in the engine room.
7.3 Identifies, cares for and uses portable fire extinguishers	1. Oral 2. Practical	- Identifies the class of fire and selects an appropriate extinguisher for this fire. - Charges, or explains how to care for and charge each type of extinguisher.
7.4 Takes appropriate precautions and actions with LPG leaks.	1. Oral 2. Practical	Explains and describes the precautions and actions to be taken to prevent, and to deal with LPG leaks.

ASSESSMENT GUIDELINES

The assessment guidelines are to be used in conjunction with the Restricted Class 6 Diesel Engineering criteria (evidence) and give a more comprehensive outline of the criteria a candidate should be able to list, describe or demonstrate when being assessed.

Learning Outcome	Assessment Criteria (evidence)
1.1.	For a four stroke diesel engine, the explanation should include: • A description of what happens to the air flow, valve positions and diesel injection during for the induction, compression, power and exhaust strokes. For a two stroke diesel engine, the explanation should include • A description of how exhaust and inlet of gas and air is effected, including how air is expelled through the exhaust valve and inducted through the inlet ports. • A description of compression and power is effected including closing of inlet ports and exhaust valve, compression, injection and ignition of fuel and the resultant power stroke. • The function of the blower in a two stroke engine.
1.2	Parts identified should contain eight from the following:] • Engine block • Sump • Cylinder head • Valve cover • Crankshaft • Main bearings • Conrod • Big end bearings • Gudeon pin • Piston • Piston rings • Gear train • Camshaft • Cam followers • Pushrods • Tappets • Valves
1.3	Traces the path of the oil from sump back to sump and names and describes the function of the following: • Pump • Relief valve (or oil pressure switch) • Oil cooler • Oil filter • Crank shaft and gudgeon lubrication • Rocker arm, push rod and tappet lubrication.
1.4	The following parts are correctly identified • Tank • Filler • Breather • Water trap/primary filter • Lift pump • Secondary filter • Overflow to tank • Fuel pump (injector pump) • Injectors

1.5	Identifies the following components Salt water side: • Seacock • Strainer • Salt water pump • Heat exchanger • Overboard discharge. Fresh water side • Header tank • Top up line • Vent lines • Fresh water pump • Engine block • Engine manifold • Thermostat • By pass line • Heat exchange

Learning Outcome	Assessment Criteria (evidence)
2.1	To include the following • No tools lying around on engine • No rags on engine or exhaust • Gearbox in neutral • Seacock open • Freshwater header tank topped up • Inspect hoses and belts • Check fuel for voyage • Open fuel tank • Drain water trap, fuel tank or primary filter • Check the lube oil dipstick and replenish lube oil if needed • Batteries terminals clean, battery charged and topped with distilled water • Switch on power to starter motor • Give some throttle and start engine • Check the oil pressure gauge and overboard discharge • Listen for knocks and visually check the engine. • Looks at the condition of the smoke
2.2	To include • No fuel to engine. (check through fuel lines, filters, bleed system) • No power to starter motor. (check switch is on, battery condition and terminals) • Insufficient crank speed. (check battery condition and all terminals) • Faulty starter motor or solenoid. (replace) • Incorrect grade of lube oil (replace) • Engine worn or faulty timing. (overhaul) • Restriction in air line (replace air filter) • Restricted exhaust (check and remove)
2.3	To include • Fresh water temperature gauge will read between 80^0C to 95^0c when engine is warmed up. • Knowledge of pressure range for current boat • Oil pressure will change with: • Temperature, oil viscosity, revs.
2.4	Answer should include

	• The need to follow manufactures instructions when starting and stopping the engine • A significant reason why engines must be warmed up before the load is applied. • A significant reason why the engine should be left at an idle before shutting down.
2.5	Can identify and explain the cause and remedy for five of the following faults • Out of fuel.(More fuel or other tank) • Blocked primary or secondary filter (change filter, inspect tank for dirt) • Air in the system (bleed system) • Defective lift pump (slack off nut ot outflow side of pump activate priming lever to determine flow, change pump or renew parts) • Defective fuel pump (irregular running, get it serviced) Defective injector (irregular running, black smoke, change injector or get them serviced)
2.6	To include Take of load and reduce engine to an idle. Stop engine if necessary Check overboard discharge. If salt water side: • Seacock closed (no overboard discharge, valve closed – open valve) • Strainer blocked (no or reduced overboard discharge – Shut seacock, clean strainer. • Seawater pump malfunction, broken belt (no overboard discharge - repair or renew pump of impeller, new belt) If freshwater side • Out of fresh water, replace fresh water carefully with hot fresh water) • Thermostat defective or stuck . (Remove thermostat test in hot water, if deflective leave out or replace) • Freshwater pump defective (No FW being circulated repair, possibly the impeller - or replace) • Heat exchanger scaled or blocked (Check by inspection, remove and clean)
2.7	Answer to include, in the following order: • Check oil level and top up if necessary • Check oil viscosity for water or fuel dilution • Check correct grade of oil is being use, if in doubt change oil • Check and change oil filter. • Remove and check oil gauge. This is all which can be done on the on board situation accept one of the following three: • Remove sump and check oil pump and sump strainer • Remove sump and check releif valve or pressure switch • If all else fails have engine checked for worn main bearings, crank shaft.

Learning Outcome	Assessment Criteria (evidence)
3.2	The list to contain 5 of the following • Checks on belts and ensures spares are carried each trip (week) • Checks on hoses each time the engine is started or daily, ensure spares or means of replacing each hose is carried, spare hose clips • Places to oil daily • Grease nipples and caps which need greasing each trip (week) • Greasing of nipples and moving parts on winches and winch clutches • Greasing of stuffing box • Greasing or maintenance needed to steering system.
3.3	List, or write a list, of essential tools which should be carried on board which should include 6 of the following: • Hammer • Cold chisel • Open ended and ring spanners for engine • Socket set for engine. • 2 sizes adjustable spanners • Screw driver(s) • Pliers or vice grips • Pipe wrench • Torch and batteries Lists, or writes a list, of essential spare parts to contain 5 from the list below: • Belts of each size being used • Pipes and hose clips • Impeller • Packing • Material from which to cut a gasket • Rags • Bulbs and fuses
3.4	To include: • Checks gearbox oil and keeps to correct level with correct grade of oil. • Checks stern gland for leaking and tightens gland if needed. • Lubricates gland if nipple or grease cap fitted. • After tightening gland, checks gland for overheating.
3.5	List to include • Check and replace the anodes • Inspect propeller and other non ferrous parts for electrolysis • Inspect stern bearing for wear (shaft drawn every two years) • Open gratings and though hull valves for inspection • Inspect rudder stock and pintles for wear.

Learning Outcome	Assessment Criteria (evidence)
4.1	Describes the steering system which is currently being used and one other
4.2	Describes how the systems listed in 5.1 will be maintained. Answer may contain • greasing or lubrication • filling oil reservoirs • Inspections for ware, chafe, wire sprags

Learning Outcome	Assessment Criteria (evidence)
5.1	Explains the statutory requirements for vessels under 15 m

5.2	• Draws a sketch of a bilge system (this may be the one being operated or a "standard" system". The drawing must work, contain all parts and be safe.
	• From this sketch, or if the sketch is of a very simple system, from a sketch provided, identify five possible causes of malfunction, such as
	  • Blocked strainers
	  • Pump blocked
	  • Pump clutch or belt slipping.
	  • Pump impeller broken
	  • Air in lines from leaking glands
	  • Air in lines from holes in lines
	  • Air in lines from valves to other compartments not being totally closed (dirt under valve).

5.3	Describes the cause of back flooding and how to prevent it. Prevention should include: • Not leaving deck hose in water. • Making sure all valves are shut. • Periodically overhauling all non return valves.

Learning Outcome	Assessment Criteria (evidence)
6.1	Identifies 4 aspects of the care of a battery from the following: • Terminals clean, • Terminals tight and greased with Vaseline • Plates always covered (Distilled water). • Cover always on battery box except when maintaining. • Not left discharged for long periods Three aspects of fitting a battery from the following: • In a battery box with ventilation holes. (lets gas escape) • Battery box to have a lid. (prevents accidental short circuit). • In a dry area with no salt water spray but good ventilation. • Where it can be easily accessed for taking the SG.
6.2	Given a battery and a hydrometer correctly reports the charge in each cell. Alternatively describes the procedure and what indicates good, medium and poor charge.
6.3	Explains the causes of damage or injury when using a battery as follows: • The chances of explosion due to hydrogen gas being emitted when charging. • The chances of sparks/ explosion or fire if something like a spanner is accidentally dropped to short circuit the terminals. • Acid burns if the hydrometer is used carelessly

Learning Outcome	Assessment Criteria (evidence)
7.1	Identifies 4 causes of fire in the engine room from the following list: • Poor housekeeping • Oil leaks • Hot surfaces • Defective exhaust lagging • Auto ignition (e.g. oil dripping onto a hot surface) • Faulty electrical wiring.
7.2	Lists the steps taken if fire is found in the engine room as follows: • Sound the alarm and muster crew • Stop the engine and shut off any fuel supply • One crew member to quickly tackle the fire with portable extinguisher or whatever is available. Make sure the correct extinguisher is used. • If fire is not immediately extinguished close all ventilation to the fire. • Keep adjacent areas cool with water • Watch for re-ignition of fire
7.3	Shown a variety of fire extinguishers identifies their class and states the type of fire they should be used for. Charges, or explains how to charge each type of extinguisher (uses makers instructions). Explains how to care for extinguishers.
7.4	Explains both petrol fumes and LPG gas are highly explosive and heavier than air and will thus collect in the bilges. Actions when a leak is found: • Stop leak by closing gas bottle or removing petrol source. • Make sure there are no naked flames in engineroom or the chance of sparks. • Ventilate the bilges so that there is a good through draft • Keep bilges ventilated until sure all gas has been ventilated out. In the absence of a gas alarm, use the sense of smell.