

BROADCROWN GENERATORS

# Installation, Operation and Maintenance Guide

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## 1. INTRODUCTION

The information contained within this manual is intended to give basic, general information for guidance on the installation, operation and maintenance of Broadcrown Generators; and is not intended to replace the more detailed definitive information available elsewhere. It is extremely important that the instructions given in the technical publications of each component manufacturer are followed in every respect and that all safety precautions are complied with.

**In line with the Broadcrown policy of continuous improvement and development, the company reserves the right to change the information contained within this manual without notice. Customers should therefore ensure that they have the latest information available before starting any work on a generator.**

Customers are respectfully reminded that it is the generator users responsibility to ensure that all work of any kind affecting the generator in any way is carried out by competent and responsible personnel, employed by competent and responsible companies.

Every generator may be identified by a serial number and model number which may be found on the rating plate fixed on to the alternator and on the side of the control panel (see fig. 1). Both of these numbers should be quoted whenever a specific generator is referred to, ***this is very important when ordering spare parts.***

For further information or assistance of any kind, including the provision of spare parts, please contact your local Broadcrown Distributor, or contact us direct at:

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## 2. SAFETY

### 2.1 General

All Broadcrown Generators are designed to be perfectly safe when operated, maintained and worked upon in the recommended manner. However overall responsibility for safety lies with the personnel who install, operate and maintain the generator. Only trained, qualified and competent personnel must carry out all work, of any kind, performed on any generator.

Every effort should be made to identify a hazard before it results in injury or equipment damage. Before any procedure is carried out, personnel should be satisfied that the procedure is safe and will not result in damage to equipment.

**WARNING** All, warnings, safety precautions and cautions contained within this manual, and in all component manufacturers literature, must be complied with.



Failure to comply with this information may result in injury, death, or damage to equipment. This may also invalidate your guarantee. *If in doubt ask!*

**WARNING** Before beginning any type of work on a generator, ***make absolutely certain that the engine cannot be started***; be especially careful when working on automatically starting generators.



### 2.2 Mechanical Safety Hazards

Overspeed is an extremely dangerous hazard with consequent danger to life and limb of nearby personnel. Adequate overspeed protection must always be provided and be fully operational at all times.

All moving parts, except controls that may need to be operated by hand, must be adequately guarded.

All surfaces, which may be hot enough to cause even the slightest injury, must be adequately guarded.

Fuel tanks must be located well away from exhaust systems or any source of ignition e.g. naked flames, sparks, or electric arcing.

Fuel and oil piping must be kept well away from exhaust systems or any source of ignition e.g. naked flames, sparks, or electric arcing.

Fuel and oil piping and fuel tanks must not be positioned where there is any risk of leakage entering any air intake system, especially the engine air intake system.

**WARNING** Fuel or oil leakage into an engine combustion air intake may result in the engine running in an uncontrolled manner with possible overspeed and consequent danger to the life and limb of nearby personnel. There may also be severe damage to the engine and nearby equipment.



Fuel pipes must always be made from fire resistant material {to withstand at least 220<sup>0</sup>C (430<sup>0</sup>F)}.

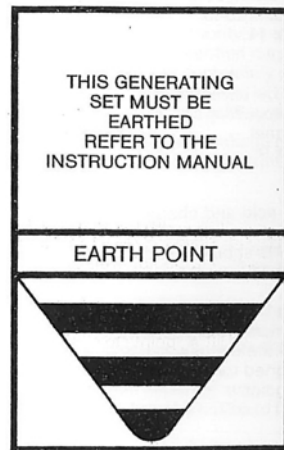
Enclosures must never be made from materials that are (or add to) a fire risk.

### 2.3 Electrical Safety Hazards

All conductors, contacts and terminations must be of more than adequate rating in order to avoid risk of fire.

All insulating material must be capable of withstanding any degree of heat to which it may be exposed.

All equipment must be bonded to a suitable common earth terminal, which must be adequately rated. This terminal must be labeled to meet the requirements of I.E.E. regulations and any other relevant authority.



**Fig. 1 An Earth Terminal Label**

Always ensure that all electrical connections are made to comply with the requirements of all relevant codes of practice, standards or the requirements of other relevant bodies.

Any part of any equipment, which is potentially live, must be adequately guarded.

### 2.4 Fire And Explosion Hazards

Oils, fuels and gases found in association with generators are usually flammable and often potentially explosive.

Fully functional fire extinguishers, of a type recommended by the fire authority, must be available and kept in an accessible position where they are secure from theft and unlikely to be behind or in any fire e.g. next to the access door.

Never store flammable liquids or oily material near the generator.

Repair leaks of fuel, oil etc as soon as possible and clean up any spillage immediately.

The generator room must always be adequately ventilated.

Do not allow any source of ignition, e.g. smoking, flames or sparks near fuel, oil, or batteries.

Switch off or disconnect the power to the auxiliary battery charger before connecting or disconnecting it.



## 2.5 Installation, Lifting And Towing Hazards

### **WARNING**



Never use or install a generator in any hazardous environment unless it has been designed for, and is certificated for, use in that environment.

Before towing a mobile generator, make quite sure that all towing equipment e.g. coupling to towing vehicle, lights indicators, tyres and especially brakes are fully functional and in good order.

Make quite sure that no one rides in or on any part of a mobile generator or stands or walks between the generator and the towing vehicle.

Make quite sure that all lifting equipment (including the supporting building structure) has a safe working load well in excess of that needed for the load, and is in a satisfactory condition.

Always lift a generator by means of a sling, spreader bar, hooks and shackles fixed to the baseframe lifting lugs, and never by engine or alternator lifting points. Always use stabilising links between spreader beam and generator (see fig.2).

Keep everyone well away from a generator when it is being lifted or is suspended.

Always ensure that fuel storage systems comply with all relevant regulations, codes and requirements.

Engine exhaust fumes must be piped outdoors in such a manner as to ensure hazard free dispersal in compliance with all relevant standards, codes and other requirements. All hot exhaust components must be either lagged or guarded for safety reasons, and should in any case be kept well away from any combustible material.

### **2.6 Chemical Hazards**

Never take into your mouth fuel, battery electrolyte, coolant, oil or any other lubricant, and avoid skin contact. If swallowed, get medical help immediately. In the case of skin contact, wash the affected area as soon as possible with soap and water.

Replace clothing that has been contaminated with fuel, lubricating oil or coolant as soon as possible, and never place oily cloths into pockets.
















Always wear protective clothing, together with eye and hand protection when working with batteries. If skin, eyes or clothing comes into contact with battery electrolyte, wash the contact area with large amounts of water, preferably running water.

### **2.7 Noise**

Adequate ear protection must always be worn when in the proximity of a running generator.







2.8 Health Hazards - please see Appendix 1.

2.9 Table 1 Symbols Used Within This Manual

WARNING		SUSPENDED LOADS		WEAR EYE PROTECTION	
CAUTION		EMERGENCY STOP		WEAR EAR PROTECTION	
DANGER HOT SURFACE		GUARDS MUST BE FITTED		WEAR HAND PROTECTION	
DANGER LIVE WIRES		DANGER BATTERY ACID		WEAR PROTECTIVE FOOTWEAR	
FLAMMABLE		NO SMOKING		WEAR HEAD PROTECTION	
KEEP TIDY		NO SOURCE OF IGNITION		WEAR PROTECTIVE CLOTHING	

## 2.10 Table 2: The Main Safety Precautions To Be Taken When Working On A Generator

**Note:** the table below does not cover every possible safety risk. All personnel should be alert at all times to the possibility of unexpected safety risks.

<p>Protective Clothing</p> 	<ul style="list-style-type: none"> <li>• Always wear overalls.</li> <li>• Always wear eye protection.</li> <li>• Always wear protective footwear.</li> <li>• Never wear ties, jewellery, metal watch straps or loose clothing of any sort</li> </ul>
<p>Starting the generator</p> 	<ul style="list-style-type: none"> <li>• Always be sure that you can stop the engine before you start it.</li> <li>• Disable all means of starting the engine before carrying out any work on the generator.</li> <li>• Always hold the stop lever in the stop position when cranking the engine.</li> <li>• Never hold the stop lever in the run position.</li> <li>• Never start a generator with a disconnected governor linkage.</li> </ul>
<p>Stop the generator</p> 	<ul style="list-style-type: none"> <li>• Before carrying out any work on the generator, except in the case of changing “change over” oil or fuel filters.</li> </ul>
<p>Fit guards</p> 	<ul style="list-style-type: none"> <li>• Over exposed belt drives and other rotating parts.</li> <li>• Over exposed hot surfaces.</li> <li>• Over exposed engine air inlets</li> <li>• Over all electrical terminals.</li> </ul>
<p>Emergency shutdown system</p> 	<ul style="list-style-type: none"> <li>• Always be sure that you can stop the engine.</li> <li>• Always check that the protection system is fully functional.</li> </ul>
<p>Lifting heavy loads</p> 	<ul style="list-style-type: none"> <li>• Never work alone.</li> <li>• Always use the recommended lifting equipment.</li> <li>• Always wear head protection.</li> <li>• Never stand underneath or close to suspended loads.</li> </ul>

**Table 2: (Continued) Summary Of The Main Safety Precautions To Be Taken When Working On A Generator**







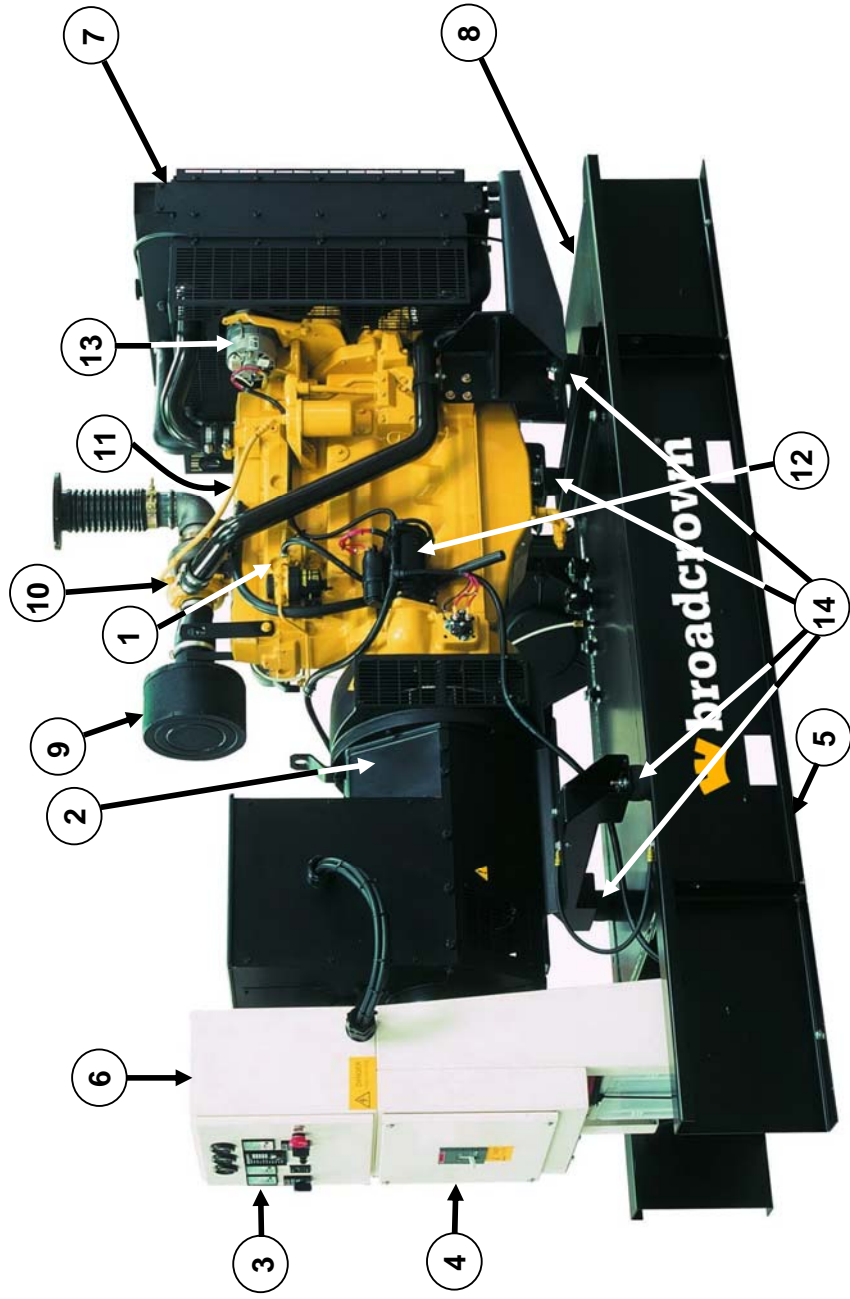
<p>Hand Protection</p> 	<ul style="list-style-type: none"> <li>• Always wear when removing a radiator or heat exchanger filler cap.</li> <li>• Always wear when working with antifreeze or coolant inhibitors</li> <li>• Always wear when working with lubricating oil or diesel fuel</li> <li>• Always wear when working with battery acid or electrolyte.</li> </ul>
<p>Ear protection</p> 	<ul style="list-style-type: none"> <li>• Always wear ear protection when working near any source of loud noise.</li> </ul>
<p>Exhaust</p> 	<ul style="list-style-type: none"> <li>• Always check for leakage.</li> <li>• Always check that guards are fastened in position.</li> <li>• Always check for excessive smoke.</li> <li>• Always check that the exhaust gasses are dispersing well away from dwellings or work places.</li> </ul>
<p>Mains (public utility) voltage</p> 	<ul style="list-style-type: none"> <li>• Always disconnect the mains electricity supply to the generator before carrying out any work on the generator.</li> <li>• Always check that all of the electrics are earthed to national and local safety standards.</li> </ul>
<p>Good housekeeping</p> 	<ul style="list-style-type: none"> <li>• Never leave loose items on or near the generator.</li> <li>• Always deposit oily cloths in a fireproof container</li> <li>• Remember that an untidy workplace is an unsafe workplace.</li> </ul>
<p>Toxic or very toxic</p> 	<ul style="list-style-type: none"> <li>• Never ingest (swallow) or take into the mouth for any reason.</li> <li>• Avoid skin contact</li> <li>• Do not breathe in vapour or fumes.</li> </ul>

Fig. 2 A Typical Broadcrown Generator



- |                             |  |                                       |
|-----------------------------|--|---------------------------------------|
| 1. Diesel Engine            | 6. Generator rating Label<br>(on the reverse side) | 10. Turbocharger                      |
| 2. Alternator               | 7. Radiator  | 11. Engine governor (on reverse side) |
| 3. Control Panel            | 8. Batteries                                       | 12. Starter Motor                     |
| 4. Output Circuit Breaker   | 9. Air Filter                                      | 13. Battery Charging Alternator       |
| 5. Baseframe With Fuel Tank |  | 14. Vibration Isolators               |

### **3. INSTALLATION**

#### **3.1 Mounting Of The Generator**

Broadcrown Generators are delivered already assembled on a rigid baseframe that supports the complete pre-tested assembly. This assembly must be mounted on a suitable foundation. The foundation must be capable of supporting the weight of the generator, the operational stresses and vibrations produced.

The design of all generator foundations must be carried out by Broadcrown Design Department in conjunction with a qualified and competent civil engineer.

#### **3.2 General Considerations**

When installing a generator it is essential, that provision be made for maintenance in the form of repairs and servicing. This includes accessibility, adequate lifting equipment, suitable lighting and sufficient accessible power points. Major points to consider are:

#### **3.3 Servicing And The Replacement Of Consumables:**

- Lubricating oil filter
- Fuel filter
- Air filter
- Drive belts
- Crankcase breather
- Access to dipstick
- Topping up, draining and refilling of the cooling system
- Topping up, draining and refilling of lubricating oil

#### **3.4 Removal Of Defective Components And Refitting Or Replacement Of Repaired Units:**

- Engine
- Main alternator
- Cylinder heads
- Oil sump
- Timing case
- Coolant pump
- Starter motor
- Battery charging alternator
- Fuel pump
- Flexible mountings

#### **3.5 General Guide Lines**

Only use fuel and oil piping that is made from specified materials, leaking oil of any type is a fire hazard. It is particularly important to avoid materials that may be damaged or destroyed by fire and release quantities of fuel or oil onto an existing fire.

Always keep pipes containing flammable substances away from sources of heat especially exhaust pipes, manifolds, turbochargers etc.

Always ensure that pipes are sited away from situations where they may chafe, corrode or be subject to electrical arcing (12 volts, or less, may cause arcing).

Insulate exhaust systems, using lagging and muffs over flexible sections. However dry turbochargers and dry engine exhaust manifolds must not be lagged.

Keep exhaust pipes well away from anything that may be damaged by heat e.g. woodwork. If in doubt always protect by heat shields. If a remote radiator or cooling tower is used, some form of forced ventilation of the engine room will be necessary, usually by means of an electric fan. Any installation of this type should be approved by Broadcrown Design Department **before installation begins**.

Install a fire extinguishing system in the engine room that meets the requirements of the national and local legislation, and have it inspected by the fire authorities

Locate batteries in a well-ventilated area, with access for routine maintenance. Always keep the length of starter cables as short as possible.

Ensure that there are sufficient facilities and access so that the generator can be removed and reinstalled. Keep it that way


Provide adequate lighting and sufficient accessible power points.


Install a lifting beam, **which must have an adequate Safe Working Load**, in the roof.

All moving parts, especially rotating shafts must be adequately guarded.

Ensure cables are adequately supported and do not come in contact with liquid of any sort.

### 3.6 Lifting And Handling Procedures For Generators

**WARNING**  Lifting gear must only be used by trained and qualified personnel. Any load, which exceeds the maximum safe limit for manual handling, must be lifted by purpose made lifting gear. This lifting gear must be checked to ensure that it has an adequate Safe Working Load, is undamaged and has been adequately maintained. Failure to comply with this warning may result in injury, death, or damage to equipment.

**WARNING**  **Generators must only be lifted by means of the identified lifting lugs on the baseframe (see Fig. 2). Do not use the engine lifting brackets, the alternator lifting lugs or any other lifting point. Stabilising linkages must always be used (See Fig.2).**

Generators should always be lifted by means of purpose made lifting equipment (see Fig.2). All lifting gear must be fit for purpose, in good condition, and have a Safe Working Load in excess of the load being lifted.

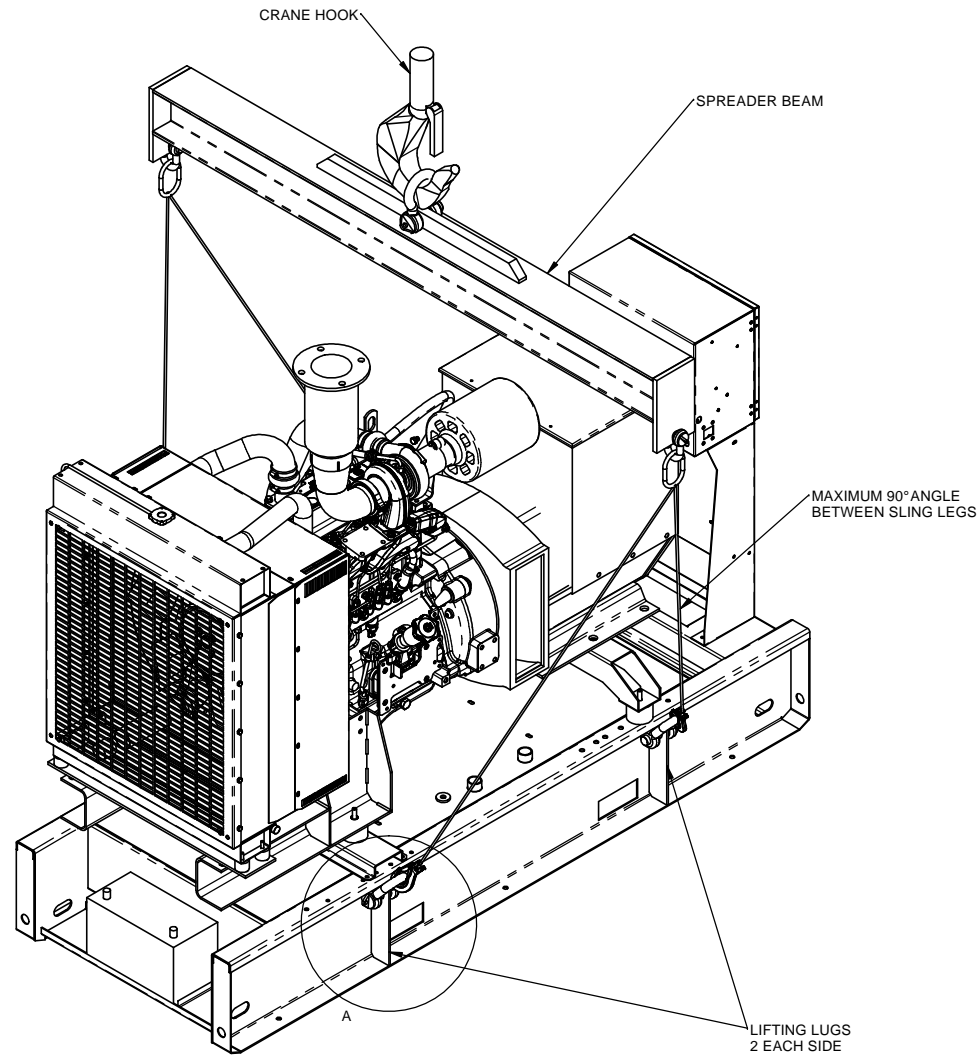
The objective should be to ensure a safe secure, well balanced and stable load. Do not omit the stabilising linkages (see Fig. 2). The lifting point should be over the centre of gravity of the load, and the maximum included angle between lifting straps or chains should not be exceeded (see Fig. 2).

**Note:** as a final check before lifting, always check to see that no damage will result from the lift. It may be necessary to remove some generator components or to reposition shackles, chains or lifting hooks in order to avoid damage.

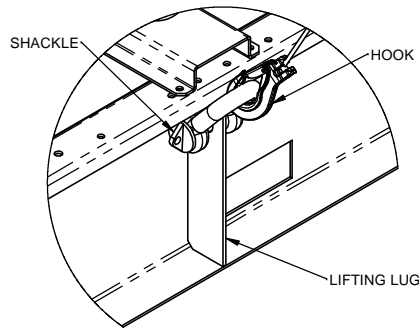
# Recommended Method For Lifting an Open Generator

PLEASE SEE THE GEN ASSY DRAWINGS FOR INDIVIDUAL MODEL WEIGHTS

PLEASE ENSURE THE GEN SET IS LEVEL WHILST LIFTING



NOTE:- STABILISING TIES MAY BE USED TO STEADY THE LOAD



DETAIL A  
SCALE 2 : 15

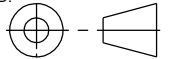
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NOTES - MECHANICAL

TOLERANCES:

GENERAL TOLERANCES: +/- 5mm  
 FABRICATION: +/- 3mm  
 HOLE CENTRES: +/- 1mm  
 OTHER TOLERANCES AS OTHERWISE STATED WHERE REQUIRED

GEOMETRICAL AND OTHER TOLERANCES AS STATED.



THIRD ANGLE PROJECTION

DESCRIPTION

Recommended Method For Lifting an Open Set Generator

SHEET 1 of 1

CREATED BY: S BEAN

DATE: 22/5/12

MODIFIED BY:

DATE:

CHECKED BY: P RUTTER

DATE: 22/5/12

ISSUE: A

DRAWING No:

**CGA023**



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MATERIAL:

FINISH:

1

2

3

4

5

6

7

8

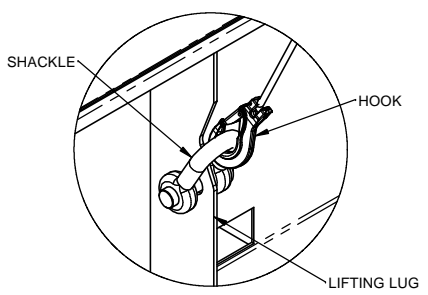
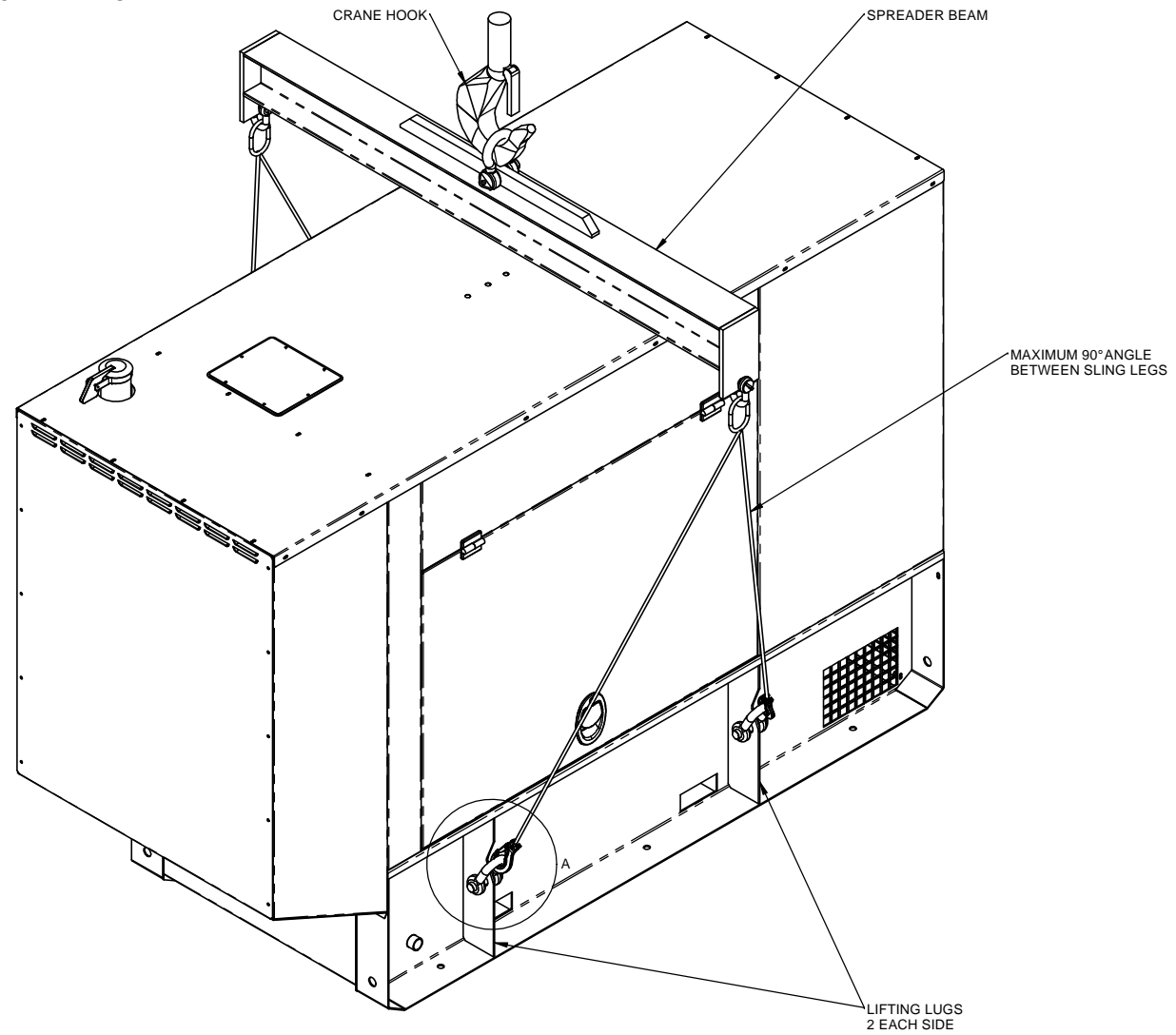


# Recommended Method For Lifting a Canopied Generator (without Center Point Lift)

PLEASE SEE THE GEN ASSY DRAWINGS FOR INDIVIDUAL MODEL WEIGHTS

PLEASE ENSURE THE GEN SET IS LEVEL WHILST LIFTING.

PLEASE ENSURE THE DOOR ARE CLOSED BEFORE LIFTING



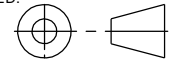
DETAIL A  
SCALE 2 : 15

REV	DETAILS	APP'D	DATE

NOTES - MECHANICAL

TOLERANCES:  
 GENERAL TOLERANCES: +/- 5mm  
 FABRICATION: +/- 3mm  
 HOLE CENTRES: +/- 1mm  
 OTHER TOLERANCES AS OTHERWISE STATED WHERE REQUIRED

GEOMETRICAL AND OTHER TOLERANCES AS STATED.



THIRD ANGLE PROJECTION

DESCRIPTION  
 Recommended Method For Lifting a Canopied Generator (Without CPL)

SHEET 1 of 1	
CREATED BY:	S BEAN
DATE:	09/05/12
MODIFIED BY:	
DATE:	
CHECKED BY:	P RUTTER
DATE:	09/05/12
ISSUE:	A

DRAWING No:  
**CGA018**

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 tel: +44 (0) 1889 272200  
[www.broadcrown.com](http://www.broadcrown.com)

MATERIAL:	
FINISH:	

A  
B  
C  
D  
E  
F  
G  
H

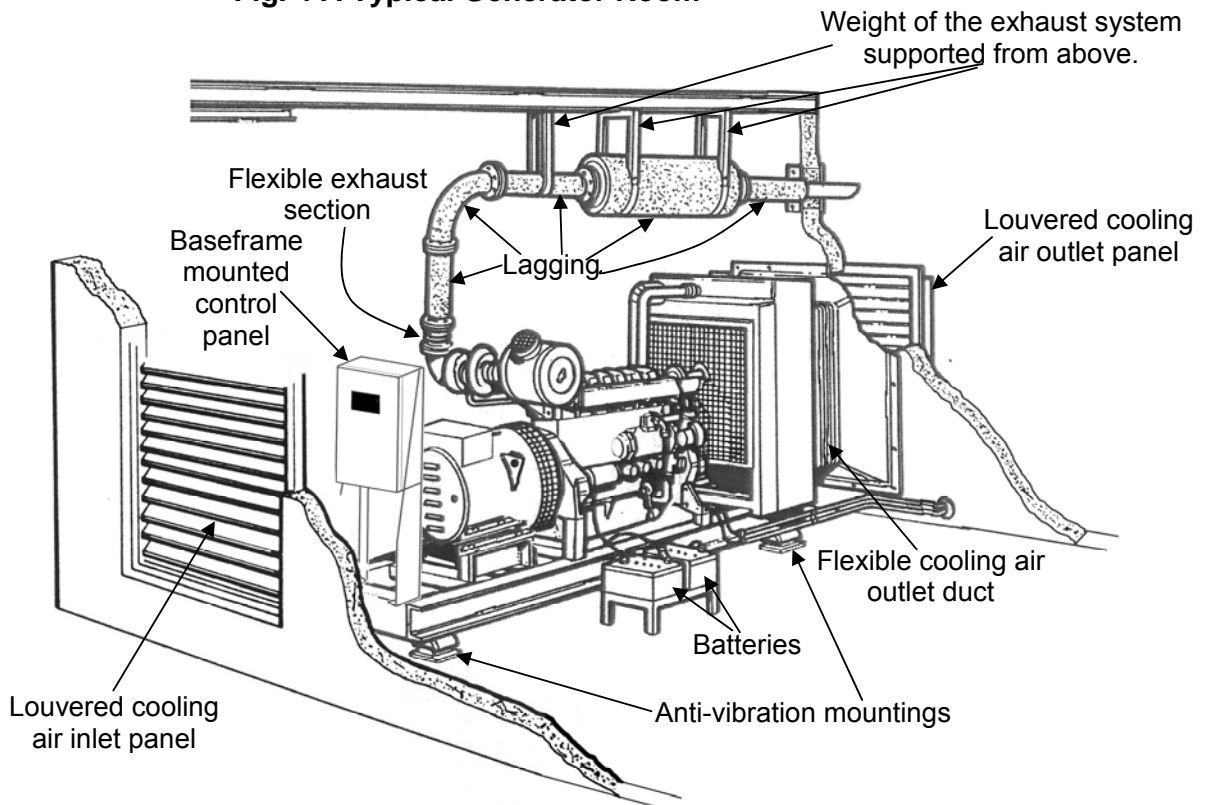
1 2 3 4 5 6 7 8

### 3.7 Generator Set Room Layout

When deciding on the suitability of a proposed generator room layout the following points should be considered: -

- Is there sufficient space available for the installation?
- Is the load bearing capacity of the floor adequate for the weight of the generator; and will it withstand the stresses and vibrations of the running set?
- Does the building have adequate ventilation, **and is it of satisfactory design**, to give an adequate air supply where it is needed?
- Is there access to supply fuel, lubricating oil and coolant?
- Is there access for cabling?
- Can that the engine exhaust be dispersed to atmosphere without exceeding the maximum backpressure?
- Can suitable combustion air filters and exhaust system be accommodated within the generator room?
- If an existing building is to be used, will any proposed alterations to the building reduce its structural strength?
- Remember that generator noise may be attenuated (reduced) by acoustic treatment.

**Fig. 4 A Typical Generator Room**



### 3.8 Vibrations


All Broadcrown generators are fitted with anti-vibration mountings, it is therefore very important that all connections to the set must be flexible in order to absorb vibrations and movement satisfactorily. The exhaust must be supported by the engine room structure e.g. the wall or roof, and must incorporate a flexible section of pipe or bellows fitted as near to the turbocharger or exhaust manifold as is practicable. All other connections i.e. fuel pipes, cooling air ducting, electrical connections conduit and ducting must be flexible and of a type unaffected by vibration or movement of any kind.

### 3.9 Multiple Generator Set Installations In The Same Generator Set Room


Multiple generator set installations are usually approached as a series of independent single installations. There are certain points however that apply specifically to multiple installations, in particular:

Multiple exhausts should not, under any circumstances, be connected to a common exhaust system either with other engines or any other equipment e.g. boilers (see section "Exhausts")

If a common remote radiator or cooling tower is used for all of the engines, some form of forced ventilation of the engine room will be necessary, usually by means of an electric fan.

	<p><b>WARNING:</b> Combining the exhausts from multiple Generator set installations and/or other plant e.g. boiler exhausts into a common exhaust system may result in an explosion risk and also in engine damage due to the effects of motoring a non-running, unlubricated turbocharger, and also the effects of exhaust condensate and carbon deposits on non-running engines. This may invalidate your guarantee.</p>
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### 3.10. Exhaust System

	<p><b>WARNING</b> Turbochargers and dry engine exhaust manifolds must not be lagged. All other exposed hot surfaces should be fitted with guards or lagged.</p>
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#### 3.10.1 Exhaust Function

The function of the exhaust is to pipe the exhaust gases from the engine manifold and discharge them, at a controlled noise level, outside the generator room, in a manner that ensures a satisfactory dispersal of the exhaust gases and particulates.

#### 3.10.2 Exhaust Back Pressure


Engines give optimum performance when the resistance to exhaust gas flow (back pressure) is below a certain limit. The total exhaust system should not impose backpressure on the engine greater than that recommended by the manufacturer. (See the engine manufacturers manuals).

Excessive backpressure will cause incomplete combustion and reduced scavenging of the cylinders. The results will be loss in power output, high exhaust temperature and the formation of soot. This soot could build up on the turbocharger blades, and, as pieces of carbon break off, the rotor would become unbalanced resulting in reduced reliability

Maximum exhaust backpressure figures vary between naturally aspirated and turbo-charged engines and also from manufacturer to manufacturer, (please refer to the latest edition of the engine manufacturers manuals).

### 3.10.3 Exhaust Installation

The weight of the exhaust must be supported by the engine room structure e.g. the wall or roof, and must incorporate a flexible section of pipe or bellows fitted as near to the turbocharger or exhaust manifold as is practicable.

	<p><b>CAUTION:</b> Flexible exhaust pipes should not be used to form bends, since they will lock solidly, cease to be flexible, and will eventually fail. Flexible bellows must never be fitted in an extended condition, since they will cease to be flexible and will eventually fail.</p>
---	--

- The exhaust system should be designed before beginning the installation. The main objectives should be to: -
- Ensure that the exhaust backpressure of the complete system is less than the maximum limit laid down by the engine manufacturer.
- Keep the weight of the exhaust system off engine manifolds and turbochargers by independent support for the exhaust system.
- Allow for expansion and contraction.
- Provide adequate flexibility particularly if the generator is mounted on anti-vibration mountings.
- Reduce exhaust noise.
- Ensure proper dispersal of exhaust gases and particulates.

The exhaust outlet must be situated so as to minimise the effects of noise, prevent exhaust gases entering vulnerable air inlets e.g. building ventilation inlets, dwelling/work places, engine air intakes etc.

Exhaust outlets should be kept free of rain, snow etc, ideally either by a horizontal outlet or flap valves. If flap valves are used, they should be regularly checked for free operation, since the hinges can be affected by soot and corrosion with resultant restriction of the exhaust system.

Where an exhaust system rises vertically from the engine, a small drain should be fitted to the lowest point of the system in order to remove the condensate that comes from the exhaust gases

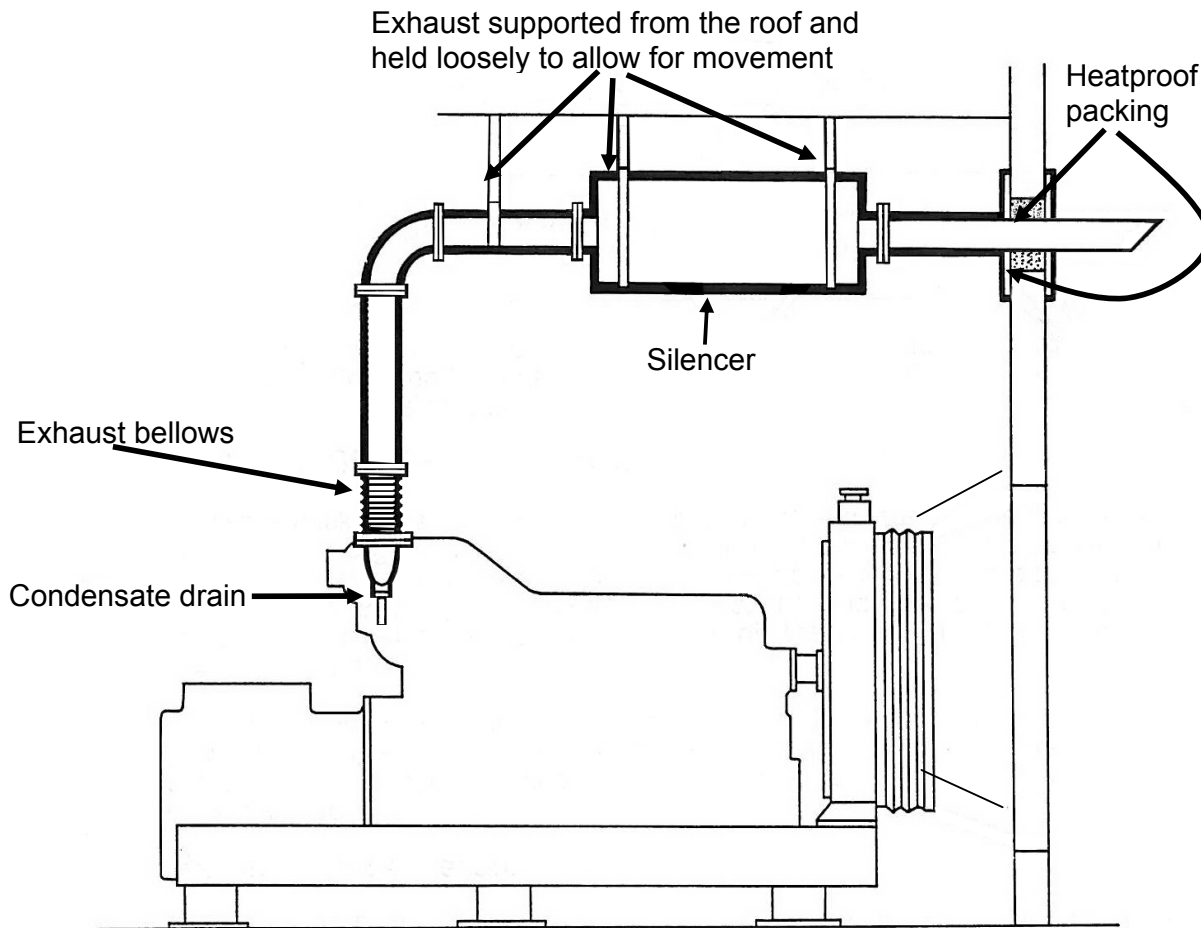
Heat from an exhaust system causes two main problems, these are: -

- Danger of injury to personnel by burning.
- Danger of heat damage to nearby equipment.

There may also be an increase in temperature in the engine room, which may result in the necessity for a larger radiator and cooling fan.

The most practical solution to these problems is to lag the exhaust system inside the generator room.

**Fig. 5 A Typical Exhaust Installation**



### **3.10.4 Exhaust Fittings**

Standard generators are supplied with standard industrial/residential silencers and either a flexible exhaust section or exhaust bellows. Details of the connections between these items are as follows:-

Broadcrown open generators with exhausts of nominal bore diameter up to and including 75mm (3in) diameter generally have split cuff fittings. Whereas those of 100mm (4in) diameter and above have BS 10 Table 'D' Flange fittings.

Standard Broadcrown Generators with exhaust systems of 100mm (4in) diameter and above generally are fitted with BS 10 Table 'D' flange fittings.

Please refer to the product data sheet and installation drawings for specific model information.

**Table 3. BS 10 Table D Exhaust Flanges**

Nominal Bore of Silencer		Diameter of Flange		Pitch Circle Diameter of Bolt Holes		Number of Bolts	Diameter of Bolt Holes	
(mm)	[in]	(mm)	[in]	(mm)	[in]		(mm)	[in]
50	2	153	6	114	4.5	4	18	0.7
65	2.5	165	6.5	127	5	4	18	0.7
80	3	185	7.25	146	5.75	4	18	0.7
100	4	216	8.5	178	7	4	18	0.7
125	5	255	10	210	8.25	8	18	0.7
150	6	280	11	235	9.25	8	18	0.7
175	7	305	12	260	10.25	8	18	0.7
200	8	337	13.25	292	11.5	8	18	0.7
225	9	370	14.5	324	12.75	8	18	0.7
250	10	407	16	356	14	8	22	0.87
300	12	460	18	406	16	12	22	0.87
350	14	530	20.75	470	18.5	12	24	0.95
375	15	553	21.75	495	19.5	12	24	0.95
400	16	580	22.75	521	20.5	12	24	0.95
450	18	642	25.25	584	23	12	24	0.95
500	20	705	27.75	641	25.25	16	24	0.95
600	24	826	32.5	756	29.75	16	26	1.00

## 3.11 Cooling System

### 3.11.1 General



**CAUTION:** When the generator is running, the coolant level must be checked/topped up daily. Always wear hand protection when working with engine coolants

All Broadcrown Generators are powered by water cooled diesel engines

It is essential that the cooling system is designed for the installation and works efficiently.

For a complete, detailed description of the cooling system, please see the engine manufacturers manuals.

**Note:** - The radiator cooling fan on a generator set extracts air away from the machinery in order to provide a flow of fresh cool air. This is the opposite direction to the system fitted to road vehicles.

In many cases engines are fitted with turbochargers and in some cases the hot charge air delivered from the turbochargers is cooled before entering the engine. This may be achieved in several ways, please see the engine manufacturers manuals for complete details.

Customers wishing to install remote radiators or other non-standard forms of cooling are strongly advised to consult Broadcrown Design Department for advice.

### 3.11.2 Anti-Freeze And Cooling Water Treatment



**WARNING** Always stop the engine and allow it to cool before topping up the cooling system. Always wear hand protection when working with anti-freeze or cooling water treatment agents.

Untreated water should not be used as engine coolant, since chemical reactions may occur which can result in corrosion of engine components and chemical deposits, which may block the cooling system. A solution of either water and universal anti-freeze or water and coolant treatment agent (inhibitor or corrosion resist) must be used. (See the Engine Manufacturers manuals and other technical literature).

### 3.11.3 Cooling Water Treatment (Inhibitors Or Corrosion Resist)



**CAUTION** It is important to consult the appropriate engine manufacturers literature when deciding on which cooling water treatment to employ. This is because engines vary in their design; some may contain different materials than others.

Inhibitors (corrosion resist) are used to provide protection against corrosion and keep the heat transfer surfaces clean in order to maintain cooling efficiency. They must be approved by the engine manufacturer and suitable for use with all the materials in the cooling system. See the Engine Manufacturers manuals and other technical literature, for details of approved water treatment.

### 3.12 Aids To Starting

#### 3.12.1 Mains (Public Utility) Powered Engine Coolant Heaters

If required, the engine may be fitted with an engine coolant heater, of which there are several types available. These will heat the engine coolant and maintain it at a temperature of approximately 30°C to 40°C (80°F to 100°F). These heaters are especially useful in very cold ambient temperatures. They must be fitted in compliance with the manufacturers instructions.

### 3.13 Engine Breather

The engine breather is designed to prevent a build up of pressure in the crankcase. Many engines in the Broadcrown range have closed circuit engine breathing fitted as standard or available as an optional extra.

However certain engines have open breathing, in this case it is advisable that the fumes are piped out of the engine room and safely dispersed to the atmosphere.

#### **WARNING**



Engine breather fumes contain combustion by-products and droplets of lubricating oil. These are known to cause serious health problems if inhaled. Always wear hand protection when handling the breather element.

### 3.14. Fuel System

#### 3.14.1 Diesel Fuel Specification

Almost all diesel engines are capable of running on a very wide range of fuels. However all Broadcrown diesel engine powered generators should be run on fuel which meets the latest edition of British Standard Specification 2869: Class A1 or A2.

If it is intended to use fuels other than the above, Broadcrown Service Department must be contacted for advice on the suitability of this fuel and if suitable, that suitable lubricating oil is used, and to establish acceptable oil and filter change intervals.

Before considering the use of unrecommended fuels, operators should be aware of the following potential problems that may result.

- The generator may not be able to accept the expected load.
- Low grade diesel fuel may result in the necessity to use more expensive lubricating oil, and more frequent lubricating oil and filter changes.
- Fuels that are not volatile enough or do not burn properly may cause poor starting and running especially under non-standard operating conditions.
- The use of unrecommended fuels may also result in harmful deposits in the engine, cylinder bore glazing, and corrosion resulting in reduced reliability, and more frequent overhauls.
- The use of low grade fuels may result in substantially increased exhaust emissions, with an increased exhaust odour and darker exhaust.



### 3.15 Lubricating Oil System

**WARNING:** when working with lubricating oil, overalls and hand protection must be worn at all times. Any oil soaked clothing should be removed and the contact area washed with soap and water immediately. Oil soaked cloths, rags, etc should not be placed in pockets. Disposable gloves must be worn when contact with used engine oil is possible. Replace gloves after each use or if they become damaged. Ensure good personal hygiene practices are followed at all times. Always store oily rags and clothing in a fireproof container



**CAUTION:** Generators powered by John Deere engines are delivered containing priming oil. This oil is a “running in” oil which allows engine components (e.g. piston rings and cylinder liners) to “bed in”. It is not intended for and must not be used for more than 100 hours of running or a 3 month time period, whichever is the sooner. After this time it must be replaced by a diesel engine lubricating oil that meets or exceeds the specification laid down by the engine manufacturer. (See the engine manufacturers manuals).



**CAUTION:** Running in oil must be changed after 100 hours operation or a three month time period, whichever is the sooner. Following this first oil change, the normal oil change intervals may be followed for that particular engine model. Failure to change the running in oil at the interval specified above, or to use a suitable uncontaminated diesel engine lubricating oil may cause engine damage and may invalidate the warranty.

Generators powered by engines other than John Deere engines will have their lubricating oil drained from the sump before despatch to the customer. This will, under normal circumstances, give up to 12 months preservation



#### 3.15.1 Recommended Lubricating Oils

The type, grade and quantity of oil to be used must comply with the specification given in the engine manufacturers manuals.

#### 3.15.2 Lubricating Oil Service

The lubricating oil, and filter, must be changed at the recommended intervals given in the engine manufacturers manuals.

#### 3.15.3 Extended Servicing Interval Oil System

In order to reduce the servicing interval an oil level regulating valve may be used in conjunction with an oil make up tank. This system should be installed in compliance with the technical literature of both the engine manufacturer and the valve manufacturer.

## 3.16 Batteries

**WARNING:** Topping up or changing the electrolyte in any battery must not be done near any source of ignition, e.g. naked flames or sparks. Do not smoke. Hand and eye protection must be worn.



### 3.16.1 General

Batteries mounted as near to starter motors as is practicable, keeping cables short in order to minimise voltage drop.

**WARNING** Should the battery electrolyte come into contact with the skin, wash immediately with plenty of water. If it should come into contact with the eyes, flush with water using an eye bath and seek immediate medical attention. Do not try to neutralise the electrolyte whilst it is on eyes or the skin.



### 3.16.2 Preparing A Battery For Service

Most batteries supplied for engine starting purposes are dry charged as standard, however options include wet charged and various maintenance free types.

**WARNING:** Hydrogen and oxygen gases are emitted from batteries with liquid electrolyte, particularly if they are moved, knocked or shaken. These gases contain droplets of corrosive electrolyte.



#### 3.16.2.1 Lead Acid Batteries With Liquid Electrolyte

Before use, remove the seals from the vent plugs or break the seal across the vent in the lid and fill to 5mm (1/4in) above the plates with pure dilute sulphuric acid of the following specific gravity:-

In Temperate Climates - 1.280

In Tropical Climates - 1.260

Replace the vent plugs (ensuring that the Vent holes are not obstructed) and allow the battery to stand 1 to 2 hours after filling. At the end of this time, the electrolyte level may have fallen, and the batteries may need a further addition of the same specific gravity acid in order to restore the original level.

When diluting acid always add the acid to the water and not the other way round.

#### 3.16.2.2 Lead Acid Batteries With Gel Electrolyte

These batteries contain a gellified electrolyte, and so cannot leak and can be used in any position except upside down. They are sealed with a special pressure valve which should never be opened and are completely maintenance free for life.

#### 3.16.2.3 AGM Lead Acid Batteries

These batteries contain an electrolyte, which is retained in a spongy separator of glass fibre, and so cannot leak and can be used in any position. They are sealed with a special pressure valve which should never be opened and are completely maintenance free for life.

#### 3.16.2.4 Nickel Cadmium (Alcad) Alkaline Batteries

The nickel cadmium battery differs from lead acid batteries in a number of ways. For practical purposes, the major difference is that the electrolyte is not acid but alkaline (caustic), consisting mainly of potassium hydroxide (caustic potash) solution.

**WARNING:** Should the electrolyte come into contact with the skin, wash immediately with plenty of water and seek immediate medical attention. If it should come into contact with the eyes, flush with water and seek immediate medical attention. Do not try to neutralise the electrolyte with acid whilst it is on eyes or the skin.



**WARNING:** Always wear rubber gloves, long sleeves and eye protection when topping up a battery. Never top up a battery near an ignition source (e.g. spark, flame or electric arcing) and don't smoke.



Ni-Cd batteries require little maintenance other than periodic visual inspection and check of the electrolyte level. The electrolyte level should be at least 15mm above the minimum level mark. It is normal for the electrolyte level to differ between individual cells due to different amounts of gas in the separators.

Top up each cell with clean distilled or de-ionised water only.

**Note:-** Do not use the same filling equipment as for lead acid batteries.

### 3.16.3 Battery Installation

#### 3.16.3.1 Clean Connections

Clean the battery lead terminals before fitting onto the battery. Dirty or corroded terminals will cause a bad contact that may result in a reduced starting current.

If the terminals are corroded, wipe over the affected parts with a solution of sodium carbonate (washing soda) or ammonia, dry off and finally smear over a film of petroleum jelly to prevent further corrosion.

**Note:-** Make sure that the sodium carbonate (washing soda) solution or ammonia does not enter the cells.

#### 3.16.3.2 Polarity Check

Make sure that the positive terminal of the battery is connected to the positive connection of the system and the negative terminal of the battery to the negative connection.

#### 3.16.3.3 Fitting Into A Battery Housing

When fitting a battery, do not over tighten the clamping bolts or the battery container may be damaged. The battery leads must have sufficient length and flexibility to prevent strain on the battery terminals. The battery leads should be bolted tightly to the battery terminals.

#### 3.16.3.4 Inspection

Batteries should be installed so that inspection and topping up is possible. The top of the battery and the surrounding parts should be kept clean, dry and free from oil and dirt. Ventilation should be the maximum possible. This is particularly important when the battery is in close proximity to the engine, with consequent high battery temperature.

### 3.16.4 Battery Charging Alternator

**CAUTION:** Running the engine with the batteries disconnected may damage the battery charging alternator.



#### 3.16.4.1 General

The battery-charging alternator charges and maintains the battery in a charged condition when the generator is running. A flat battery will be charged in the least time and a healthy battery will be held in that condition.

#### 3.16.5 Mains (Public Utility) Powered Battery Charger

This is a mains (public utility) powered battery charger which will keep the battery in a fully charged condition where the generator runs infrequently. The battery charger should be of the automatic float charge type, and must be used in conjunction with a relay that disconnects the charger when the battery charging alternator is functioning.

### 3.17 CABLING

#### 3.17.1 Current Carrying Capacity Of Power Cables


##### 3.17.1.1 Nominal Current

##### Equation 1. The Nominal Current Per Phase Of A Three-Phase Generator

$$\text{Nominal Current per phase (A)} = \frac{\text{Nominal kVA rating} \times 1000}{\text{Nominal voltage} \times \sqrt{3}}$$

##### 3.17.1.2 Suitable Cables To Carry A Given Continuous Current

The ratings given below apply to flexible 'Coil Leads' (i.e. EPR/CSP) at an ambient temperature of 25°C (77°F). In the case of ambient temperatures in excess of 25°C (77°F), the current carrying capacity of the cable should be de-rated. If single core cables are used the rating of these cables will be reduced if they are run together in a bunch.

**CAUTION:**  The following table is for guidance only, a competent electrical installation engineer should advise on specific site requirements.

**Table 4. Suitable Cables To Carry A Given Continuous Current**

Max. Continuous Current Carrying Capacity (Amps)	Nominal Cross-Sectional Area Of Conductor (mm <sup>2</sup> )	Nominal Conductor Stranding (Number/mm <sup>2</sup> )
39	4	56/0.3
54	6	84/0.3
70	10	80/0.4
94	16	126/0.4
131	25	196/0.4
162	35	276/0.4
196	50	396/0.4
251	70	360/0.5
304	95	475/0.5
352	120	608/0.5
406	150	756/0.5
463	185	925/0.5
546	240	1121/0.5
840	300	1525/0.5
1010	400	2013/0.5

**Note:** For larger sizes of generators it will be necessary to use more than one cable per phase. Please refer to the manufactures technical data for de-rating information.

### 3.17.2 Main Power Cables

#### 3.17.2.1 General

The power output cables of a generator must be capable of carrying the output of that generator (including any over load capacity) **plus a safety margin**. The cable size must allow for the type of cable being used, ambient temperature, voltage drop, insulation material and installation method. The cable manufacturers technical literature should be consulted when deciding the size and type of cable to be used.

**Note:** When the load is well balanced across the phases, it is normally permissible to use a neutral conductor that is smaller than the phase conductors. However the size of the neutral conductor should never be less than half the size of the phase conductors.

**CAUTION:** If it is decided to use single core cables, the rating of these cables will be reduced if they are installed bunched together.



All connections to a generator should be flexible in order to resist vibration with no solid conduit or pipe connections. It is recommended that XLPE/SWA/LSF or BUTYL cable is used for the main power cabling from a generator, with a single anti-vibration loop (**not multiple coils**) made where the cable enters the generator terminal box. If the generator is mounted on anti-vibration mountings, then PILCSWAC or the larger sizes of XLPE/SWA/LSF should not be used even with an anti-vibration loop in the cable. However It may be possible to partially use these cables, if they run to a terminal box, with a short length of flexible cabling between the terminal box and the generator.

#### 3.17.2.2 Cable Support

Power cables must be adequately supported throughout their length with provision made at the alternator end to allow for the effects of vibration and movement of the generator, when starting and stopping.

#### 3.17.2.3 Cable Protection

Wherever cables pass into the alternator and generator control panel, smooth bored bushes and the correct protective glands must be fitted. Gland plates may be supplied with the alternator and control panel. If single cored cables are to be used, gland plates should either be made of non-ferrous material or slots should be cut between the cable entry points.

#### 3.17.2.4 Cable Connections

Power cables must be fitted with suitable connecting lugs, which must be crimped into position with a purpose designed crimping tool. The correct size of bolts with flat and spring washers must always be used to connect the power cables to the alternator and control panel terminals.



The generator must be adequately earthed (see “Earthing” section). Failure to do this may result in injury or death

### **3.17.3 Cabling From The Control Panel To The Load**

#### **3.17.3.1 General**

The outgoing terminals are situated inside the cover of the circuit breaker box. Either a 4 core cable or 4 single core cables may be used but should be as flexible as possible to allow for movement of the generator

#### **3.17.3.2 Cable Protection**

Holes should be drilled in the panel and suitable bushes or cable glands fitted in order to prevent chafing.

#### **3.17.3.3 Cable Connections**

Power cables must be fitted with suitable connecting lugs, which must be either soldered or crimped into position with a purpose designed crimping tool. The correct size of bolts with flat and spring washers must always be used to connect the cables.

#### **3.17.3.4 Cabling Needed**

The cables needed for all generators are:-

1. Circuit breaker to load cable.

Cable 1 (above) will carry the full output of the generator and should be sized accordingly.

If the generator is to be an automatic mains failure or automatic start type, the following cables will be required in addition to that above: -

2. Control cables to carry the start/stop signals.
3. Cable for external (mains powered) battery charger.

Cables 2 and 3 (above) should be a minimum size of 1.5mm<sup>2</sup>, insulated with PVC.

If the generator is to be used with an automatic transfer panel, the following cables will be required in addition to those above: -

4. Mains supply to automatic transfer panel cable.
5. Automatic transfer panel to load cable.

Cables 4 and 5 (above) will carry the full installation load and should be sized accordingly.

### **3.17.4 Control Panel Cables For Floor Standing, Single Running, Generators**

The cables to be connected to these generators are as follows: -

Generator to control panel.

Control panel to load.

### **3.17.5 Control Cables From Generator To Control Panel.**

In the vast majority of cases, this wiring will be run through wiring looms. However if for any reason looms are not to be used then all of the control panel wiring to the generator must be wired via a baseframe mounted terminal box.

For further information please refer to the specific generator wiring diagram and control panel wiring diagram for the generator.

### **3.17.6 Control Panel Cables For Floor Standing Automatically Starting Generators**

The cables required for automatic starting panels are as follows:-

1. Alternator to circuit breaker or contactor.
2. Control cables to provide start and stop signals.
3. Cable for external (mains powered) battery charger.

If the generator is to start automatically, then the following cables will also be required:-

4. Mains supply to mains contactor.
5. Cable from contactor to load.

Cable 1 will carry the full output of the generator and should be sized accordingly. Cables 2 and 3 should be a minimum of 1.5mm<sup>2</sup> and PVC insulated. . Cables 4 and 5 will carry the full installation load and should be sized accordingly

### **3.17.7 Control Panel Cables For Floor Standing, Automatically Starting upon Mains Failure, Generators**

The cables to be connected to these generators are as follows: -

1. Generator to control panel.
2. Mains supply to control panel.
3. Control panel to load.
4. Control cables from generator to control panel.

Cables 1, 2 and 3 carry the full load of the generator of mains and should be sized accordingly. Cable 4 should be a minimum of 1.5mm<sup>2</sup> PVC insulated, and should be connected between the control panel and terminals in the engine terminal box mounted on the generator baseframe. These terminals are numbered to correspond with the terminal numbers of the control panel.



### 3.18 EARTHING

**WARNING:** All generators together with their control and switchgear panels must be adequately earthed before being put into service. Failure to do this may result in injury or death. This information is for guidance only, a competent electrical installation engineer should advise on specific site requirements.



#### 3.18.1 General

These guidelines give a general guide to earthing practices; however all earthing must comply with the latest editions of the following regulations: -

- I.E.E. Regulations in countries where these apply.
- Any local wiring regulations
- The local supply authority regulations (if applicable).
- Association Of British Generator Manufacturers code of practice.

#### 3.18.2 Earthing System

A complete earthing system consists of an earth electrode, earth lead, earth terminal and an earth continuity conductor. The earth electrode may consist of one or more copper clad steel rods driven into the ground.

**CAUTION:** Never use any part of a water or gas main as an earth.



The earth lead must be a copper conductor of adequate cross-section area, connecting the earth terminal to the earth electrode. The size and type of this conductor must comply with the latest edition of the I.E.E. Regulations.

##### 3.18.2.1 Earthing Conductors and Connections

The connection between the earthing lead and the earth rod(s) should be protected from damage, and also be accessible for inspection.

**A sign indelibly marked with the words “Safety Electrical Earth - Do Not Remove” in legible type not less than 5mm high must be permanently fixed at the point of connection.**

The earth continuity conductor is a conductor that bonds all non current carrying metalwork in the installation to the earth terminal. The size of the conductor may be obtained from the latest edition of the I.E.E. Regulations.

All metal parts of the generator except current carrying parts, must be connected to the Earth Continuity Conductor (E.C.C.). The E.C.C. in turn must be connected to the consumer’s earth terminal, and the earth terminal earthed to an earth electrode.

The number of rods required to form a satisfactory earth electrode depends upon the ground resistance. The earth loop resistance (of which the earth electrode resistance may be part) must be low enough that in the event of an earth fault occurring, sufficient current will flow to operate the protective circuit breakers or fuses. The fault path value may be found by using the formula given in the I.E.E. Regulations.

### **3.18.2.2 Earthing Where A Mains Supply (Public Utility) Exists In Addition To The Generator**

The supply authority will usually give consent for the consumer's earth terminal to be connected to the supply authority's earth electrode. However it will be necessary to install a separate earth electrode where:-

- The consumer is the sole user of the supply authority's transformer.
- The consumer is on a Protective Multiple Earthing (PME) system;
- The consumer shares a transformer with others.
- Where four-pole changeover contactors are fitted.
- Where the generator is the sole source of supply,
- The supply authority will not consent to the connection of the generator earth to the supply authority's earth electrode.

### **3.18.2.3 Water Or Gas Mains Supply**

Water or gas mains supplies should be bonded to the E.C.C. at a point as close as is practicable to the point of entry into the consumer's premises. Where an insulation section is fitted, the connection must be made to the metalwork on the consumer's side of the insulating section.

### **3.18.2.4 Mobile Generators**

Any electricity supply by a mobile generator, e.g. trailer mounted or transportable, must have independent earth electrodes connected to both the Earth Continuity Conductor and the neutral.

A detachable cable connection from the generator to the load, with either bolted connections for phase, neutral and earth conductors is also required. An alternative adequately rated shrouded plug and socket, may be used. The preferred type of flexible cables are vulcanised rubber with PCP or TR sheath, vulcanised rubber insulated, with PCP sheath, or butyl rubber insulated with heat, oil resisting and flame retardant (HQFR) sheath. All plugs, sockets and cables must comply with the latest edition of the relevant British Standards. All cables must be used uncoiled and kept as short as possible.

**Note:** - Never connect the earth point of the generator, or control panel, to an existing earth point without **valid** official permission being given by the relevant authorities.

## 4. OPERATING A GENERATOR

### 4.1 Derating A Generator


At altitudes higher than 100m Above Mean Sea Level (AMSL), the reduction of atmospheric pressure begins to induce a reduction in the performance of internal combustion engines due to the lower oxygen content of thinner air. High ambient temperature and humidity can also affect engine performance in the same way.

This affects the operation of all types of internal combustion engine powered equipment. The maximum power output of equipment of this type must be corrected when the altitude, ambient temperature or humidity exceed the specified maximum (see below).

Similarly, an alternator will have a reduced output at altitudes and ambient temperatures higher than the specified maximum (see below). This is due to the reduced cooling effect of thinner air at altitude, and the extra cooling required at higher ambient temperatures.

The de-rated output of a generator will always be equal to the reduced engine output.

***This must always be less than the alternator capacity.***

**CAUTION:**  The power output from the engine must be set so that the alternator capacity is always greater than the power available from the engine.

Should the site conditions be known before dispatch then the generator will be set to give the correct output, for that site, during test, at the factory.

The rating plate (attached to the control panel and alternator see fig. 1) will give the maximum ambient temperature and altitude at which it can operate and deliver the stated power.

### 4.2 ISO 3046 Standard Conditions-

Normally both an engine and an alternator will be set at the factory to operate at ISO 3046 standard conditions, these are:

Maximum Ambient Temperature (at the combustion air inlet)	25°C
Minimum Barometric Pressure	100kPa (110m altitude)
Maximum Humidity	60%

**Note:** - 100kPa = 1 bar = 1 Atmosphere = 110 metres altitude (above sea level).

### 4.3 Derating An Engine

De-rating an engine involves calculating and setting the reduced power output when site conditions exceed ISO 3046 standard conditions (given above).

Should the site conditions exceed those given in section 3.18.2, the engine must be de-rated as instructed in the engine manufacturers manuals.

### 4.4 Derating An Alternator

The derated output from an alternator needs to be calculated when site conditions exceed ISO 3046 standard conditions (given above). Under these conditions, it is necessary to calculate the reduced capacity of the alternator in order to make certain that the alternator capacity is greater than the engine power output. The de-rated power from the engine must always be less than the de-rated output from the alternator.

Typical de-rating factors to be applied to the nominal alternator rating are as follows:

**Ambient Temperature Typical Derate**

UP TO:	40°C (104°F)	0%
	45°C (113°F)	3%
	50°C (122°F)	6%
	55°C (131°F)	9%


**Altitude Typical Derate**

UP TO:	1000 metres (3280 feet)	0%
	1500 metres (4900 feet)	3%
	2000 metres (6500 feet)	6%
	2500 metres (8200 feet)	9%
	3000 metres (9800 feet)	12%

The total de-rating factor for the alternator is obtained by adding together the de-rate percentage for both site temperature and altitude.

**4.5 Derating Generators Powered By Yanmar Engines**

The tables and graphs below give the recommended percentage power reductions for a range of different conditions of altitude and humidity. Information from either the graphs or charts (below) may be used.

	<b>CAUTION:</b> These power reduction figures are those recommended by the manufacturer at the time of the issue of this publication and may not be the latest information available.
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**Note:** As long as the coolant working temperature does not exceed the recommended 102°C (215°F), a safe and steady load can be maintained.

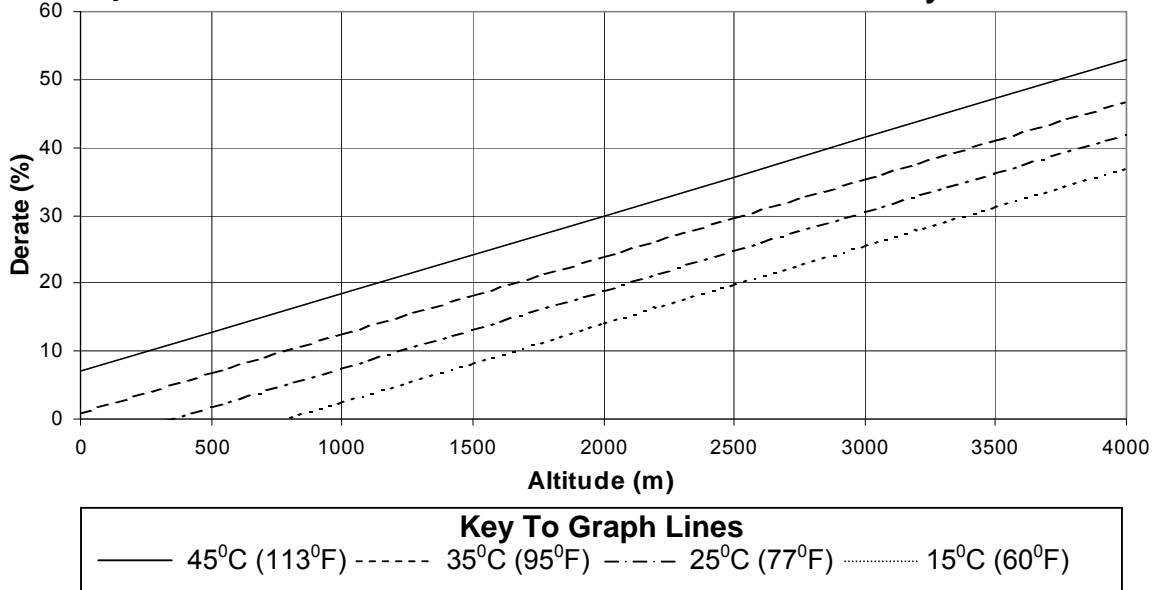
**Example:**

If a generator is to be installed at 1000 metres above sea level in an average temperature of 15°C with a relative humidity of 60% or below, then a 2.6% de-rate should be applied to the base rated power. I.e. if the rated power is 22kW the available power will be 21.43kW.

**Table 7 Derating Factors (%) For Yanmar Engines AT 60% Humidity**

		Temperature (°C) [°F]			
		15[59]	25[77]	35[95]	45[113]
<b>Altitude (m) [ft]</b>	<b>0 [0]</b>	0.0	0.0	1.0	7.0
	<b>500[1640]</b>	0.0	1.8	6.7	12.7
	<b>1000[3280]</b>	2.6	7.6	12.5	18.5
	<b>1500[4921]</b>	8.3	13.3	18.2	24.2
	<b>2000[6562]</b>	14.0	19.0	23.9	29.9
	<b>2500[8202]</b>	19.8	24.8	29.7	35.7
	<b>3000[9843]</b>	25.5	30.5	35.4	41.4
	<b>3500[11483]</b>	31.2	36.2	41.1	47.1
	<b>4000[13124]</b>	37.0	42.0	46.9	52.9

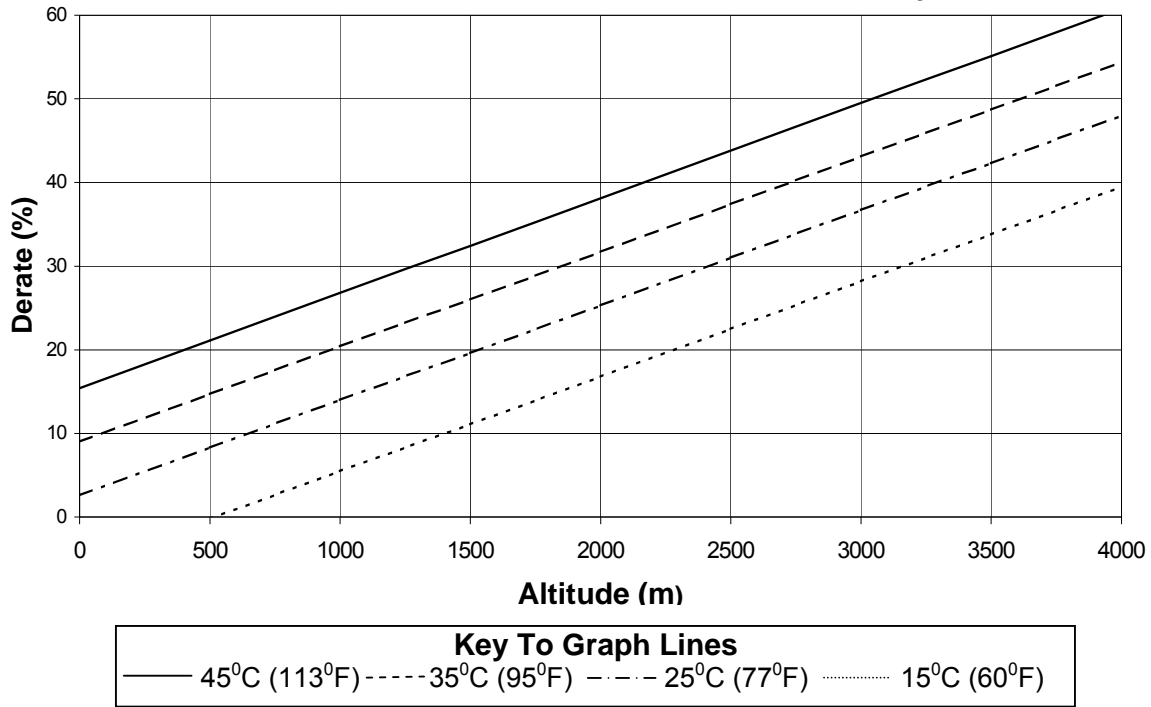
**Graph 1 Yanmar Derate Chart at 60% Relative Humidity**



**Table 8 Derating Factors (%) For Yanmar Engines AT 100% Humidity**

		Temperature (°C) [°F]			
		15[59]	25[77]	35[95]	45[113]
Altitude (m) [ft]	0 [0]	0.0	2.6	9.0	15.4
	500[1640]	0.0	8.3	14.7	21.1
	1000[3280]	5.5	14.0	20.4	26.8
	1500[4921]	11.1	19.6	26.0	32.4
	2000[6562]	16.8	25.3	31.7	38.1
	2500[8202]	22.5	31.0	37.4	43.8
	3000[9843]	28.2	36.7	43.1	49.5
	3500[11483]	33.8	42.3	48.7	55.1
	4000[13124]	39.5	48.0	54.4	60.8

**Graph 2 Yanmar Derate Chart at 100% Relative Humidity**



#### 4.6 Starting And Running A Generator

All generators are fitted with a control system that will either control the generator automatically, or allow it to be controlled manually by the operator if necessary. There are also protection devices fitted to all generators that will shut down the set and/or sound an alarm in case of malfunction.

##### **WARNING**



Always make sure that you can stop an engine before it is started. Never run an engine without it's automatic protection system being fully functional, to do so may result in injury, death or damage to equipment.

##### **WARNING**



Before beginning any type of work on a generator, make absolutely certain that the engine cannot be started; be especially careful when working on automatically starting generators.

#### 4.7 Pre Start Checks (Applicable To All Generators In All Circumstances)

1. Disable all forms of starting.
2. Check the engine lubricating oil and coolant levels, top up as necessary. Do not remove the coolant filler cap while the engine is hot.
3. Check the fuel level, fill/top up as necessary. Always wear protective clothes and hand protection, do not smoke or have any source of ignition nearby
4. Check the tension and the condition of all drive belts. Re-tension or replace as necessary.
5. Check all hoses for leaks, deterioration or loose connections. Replace or tighten connections as necessary.
6. Check all battery terminals for corrosion and loose/bad connections, clean and retighten as necessary. Do not smoke or have any source of ignition nearby.
7. Check the battery electrolyte level, and top up with de-ionised water as necessary. Do not smoke or have any source of ignition nearby.
8. Check the air filter restriction indicator (if fitted) and replace the air filter if necessary.
9. Make sure that all cooling airways are unobstructed
10. Remove any unnecessary unsecured items from the generator and its vicinity, and clean up any dirt or dust that may have accumulated on any part of the generator.
11. Check for fuel, coolant and lubricating oil leaks. Repair as necessary and clean up any spillage.
12. Make sure that the alternator output circuit breaker is in the off position.

#### 4.8 Initial Startup With Key Start Panel

This is the procedure when starting a generator for the first time after installation or return to service after repairs or extensive maintenance.

1. Carry out the pre-start checks given in Section 4.2.
2. Fit the starting batteries to the engine, positive terminal first.
3. Prime the lubricating oil system as instructed below.
  - Disable the stop/run solenoid by disconnecting an activating (electrical feed) wire. This will prevent the engine from starting.
  - Crank the engine over by turning the key to the run position (fully clockwise) and pressing the start button for about 6 seconds. After this return the key switch to the stop position.
  - The above cranking procedure should be repeated until oil pressure is seen to register on the oil pressure gauge. If oil pressure has not registered after four cranking procedures, do not proceed further, until the cause of the oil pressure failure has been investigated and cured.
  - After satisfactorily priming the lubricating oil system, reconnect the activating wire to the stop/run solenoid.
4. Bleed/prime the fuel system by means of the hand operated priming pump, see the engine manufacturers manuals for detailed instructions.
5. Start the engine. Turn the key switch fully clockwise to the “run” position and wait for 7 seconds to allow the pre-heater (if fitted) to heat the induction air. Then press the “start” button. When the engine starts, release the “start” button and allow the engine to run. Do not alter the setting on the key switch.
6. When attempting to start the engine, do not crank the engine over for more than 7 seconds; if it has not started by this time, stop cranking and turn the key switch to the “off” position, wait at least 10 seconds and then try again. If the engine has still not started after 4 attempts, stop and investigate the cause of the failure to start.
7. Run the engine for at least 1 minute and then stop it. Do not allow the engine to get hot. Remove the coolant filler cap (not with the engine hot), and wait for at least 5 minutes to allow any trapped air to escape. Top up the cooling system and replace the filler cap.
8. Restart the engine following the procedure given in instruction 5 (above).
9. Check the control panel for signs of operational faults. Oil pressure should be normal within about 10 seconds, and coolant temperature should be normal and stable after about 10 – 15 minutes.
10. Listen for any unusual vibrations or noises.
11. Check the output voltage and frequency as indicated on the control panel. The output voltage should be the rated voltage, and the no load frequency should be slightly higher than the loaded frequency (about 2Hz). Only trained, qualified and competent personnel should carry out these checks.



12. Check the phase rotation of the generator by means of a three-phase rotation meter to the terminals on the generator side of the circuit breaker. Only trained, qualified and competent personnel should carry out this test.

**WARNING:** Do not connect the load cables until after the phase rotation check has been completed and the phase rotation is seen to be satisfactory.



13. Shutdown the generator by turning the key switch fully anti-clockwise.
14. The load cables may now be connected to the output side of the circuit breaker ready for normal operation.

**WARNING:** Always switch the main circuit breaker off, shutdown the generator and disable all means of starting the engine before connecting or disconnecting the load cables.



#### 4.9 Routine Startup With Key Start Panel

This is the procedure to be followed for routine starting of a generator, after it has been running satisfactorily with no reason to expect problems of any sort.

**Note:** - The engine will not start if any faults are indicated on the control panel. Any faults must be investigated and repaired before trying to restart the engine.

1. Carry out the pre-start checks given in section 4.2.
2. Start the engine. Turn the key switch fully clockwise to the “run” position and wait for 7 seconds to allow the pre-heater (if fitted) to heat the induction air. Then press the “start” button. When the engine starts, release the “start” button and allow the engine to run. Do not alter the setting on the key switch.
3. When attempting to start the engine, do not crank the engine over for more than 7 seconds if it has not started by this time. Stop cranking and turn the key switch to the “off” position, wait at least 10 seconds and then try again. If the engine has still not started after 4 attempts, stop and investigate the cause of the failure to start.
4. Check the control panel for signs of faulty operation. Oil pressure should be normal within about 10 seconds, and coolant temperature should be normal and stable after about 10 – 15 minutes.
5. Listen for any unusual vibrations or noises.
6. Switch the alternator output circuit breaker on.
7. The load that can be applied to a generator on starting, with a cold engine {20<sup>0</sup>C (68<sup>0</sup>F)}, is typically 50% of the rated load. With the generator at normal operating temperature {about 80<sup>0</sup>C (176<sup>0</sup>F)} however the maximum load that can be applied is usually 70% to 100% of the rated load. It should be noted that normal operating temperature can be achieved before startup by means of coolant pre-heating devices (if fitted). Full load acceptance data is given in the generator technical data sheet.
8. The engine must be using the correct grade of engine lubricating oil.

#### **4.10 Initial Startup For Automatically Starting Generators**

This is the procedure when starting a generator for the first time after installation or return to service following extensive maintenance.



Carry out the pre-start checks given in Section 4.2.

Fit the starting batteries to the engine, positive terminal first.



Prime the lubricating oil system

- a. Disable the stop/run solenoid by disconnecting an activating (electrical feed) wire. This will prevent the engine from starting.
- b. Crank the engine over by turning the key to the run position (fully clockwise) and pressing the start button for about 6 seconds. After this return the key switch to the stop position.
- c. The above cranking procedure should be repeated until oil pressure is seen to register on the oil pressure gauge. If oil pressure has not registered after four cranking procedures, do not proceed further, until the cause of the oil pressure failure has been investigated and cured.
- d. After satisfactorily priming the lubricating oil system, reconnect the activating wire to the stop/run solenoid.
- e. Start the engine by turning the control switch to the “run” position. The engine, will automatically crank over until either the engine starts or if the engine has not started after 3 attempts, in which case the control panel will indicate “Fail To Start” and lock the control system. If this happens, do not proceed further, investigate and rectify the cause of the failure to start.
- f. Run the engine for at least 1 minute and then stop it. Do not allow the engine to become hot. Remove the coolant filler cap (not with the engine hot), and wait for at least 5 minutes to allow any trapped air to escape. Top up the cooling system and replace the filler cap.
- g. Restart the engine following the procedure given in section 4.5.1. And check the control panel for signs of operational faults. Oil pressure should be normal within about 10 seconds, and coolant temperature should be normal and stable after about 10 – 15 minutes.
- h. Listen for any unusual vibrations or noises.
- i. Check the output voltage and frequency as indicated on the control panel. The output voltage should be the rated voltage, and the no load frequency should be slightly higher than the loaded frequency (about 2Hz). Trained, qualified and competent personnel should only carry out any necessary adjustments.

- j. Check the phase rotation of the generator by means of a three-phase rotation meter to the terminals on the generator side of the circuit breaker. Only trained, qualified and competent personnel should carry out this test.

 	<b>WARNING</b> Do not connect the load cables until after the phase rotation check has been completed. Shutdown the generator by turning the control switch to the stop position.
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- k. Check the operation of the remote start system by turning the control switch to “Auto”. Activate the remote start control and check that the generator goes through its starting procedure. De-activate the remote start signal and the generator should stop.
- l. The load cables may now be connected to the output side of the circuit breaker ready for normal operation.

 	<b>WARNING</b> Always switch the main circuit breaker off, shutdown the generator and disable all means of starting the engine before connecting or disconnecting the load cables.
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#### 4.11 Routine Manual Startup For Automatically Starting Generators.

This is the procedure to be followed for routine starting of a generator, after it has been running satisfactorily with no reason to expect problems of any sort.

**Note:** - The engine will not start if any faults are indicated on the control panel. Any faults must be investigated and repaired before trying to restart the engine.

- a. Carry out the pre-start checks Section 4.2.
- b. Start the engine. Turn the control switch to the “run” position.
- c. The engine will automatically crank over until either the engine starts or if the engine has not started after 3 attempts, in which case the control panel will indicate “Fail To Start” and lock the control system. If this happens, do not proceed further, investigate and rectify the cause of the failure to start.
- d. Check the control panel for signs of faulty operation. Oil pressure should be normal within about 10 seconds, and coolant temperature should be normal and stable after about 10 – 15 minutes.
- e. Listen for any unusual vibrations or noises.
- f. Check the control panel for signs of operational faults. Oil pressure should be should be normal within about 10 seconds, and coolant temperature should be normal and stable after about 10 – 15 minutes.
- g. Switch the alternator output circuit breaker on, and apply the load.

- h. **Note:** -The load that can be applied to a generator on starting, with a cold engine {20<sup>0</sup>C (68<sup>0</sup>F)}, is typically 50% of the rated load. With the generator at normal operating temperature {about 80<sup>0</sup>C (176<sup>0</sup>F)} however the maximum load that can be applied is usually 70% to 100% of the rated load. It should be noted that normal operating temperature can be achieved before startup by means of coolant pre-heating devices (if fitted). Full load acceptance data is given in the generator technical data sheet.
- i. The engine must be using the correct grade of engine lubricating oil.
- j. Shutdown the generator.
- k. Switch the alternator output circuit breaker off.
- l. Let the generator run for approximately 5 minutes off load, in order to cool down satisfactorily, and then turn the control switch to the stop position.

**Note: - the Emergency stop button may be pressed at any time to stop the engine when necessary. In an emergency it is not necessary to disconnect the load first.**

#### **4.12 Routine Automatic Startup For Automatically Starting Generators.**

This is the procedure to be followed for routine starting of a generator, after it has been running satisfactorily with no reason to expect problems of any sort.

**Note:** - The engine will not start if any faults are indicated on the control panel. Any faults must be investigated and repaired before trying to restart the engine.

1. Carry out the pre-start checks given in Section 4.2.
2. Start the engine. Turn the control switch to the “Auto” position.
3. Switch the alternator output circuit breaker on.
4. The generator will now start automatically when it receives the signal to do so.
5. Shutdown the generator.
6. When the start signal is removed, the generator will shut down after running on no load for a preset period of approximately 5 minutes in order to cool down satisfactorily.


**Note: - the Emergency stop button may be pressed at any time to stop the engine when necessary. In an emergency it is not necessary to disconnect the load first.**


## 5. GENERATOR MAINTENANCE

### 5.1 General


All maintenance procedures must be carried out as recommended by the component manufacturers at the recommended times and to the procedures specified in the manufacturers technical literature.

All maintenance procedures must only be carried out by trained and competent personnel.

**WARNING**  All safety precautions, warnings and cautions contained within this manual, and in all component manufacturers literature, must be understood and complied with. Failure to comply with this information may result in injury, death, or damage to equipment, and/or may invalidate your guarantee.

**WARNING**  Before beginning any type of work on a generator, make absolutely certain that the engine cannot be started; be especially careful when working on automatically starting generators.

The generator and its surroundings should be kept clean and tidy. There should be no loose items either on or around the generator, and any oil or fuel deposits or films cleaned off with a non-flammable, water based, industrial cleaning agent.

**WARNING**  Do not use flammable cleaning agents or solvents on a generator due to the fire risk and also due to the general Health and Safety risks of using liquids not intended for cleaning purposes.

### 5.2 Preventative Maintenance

#### 5.2.1 Daily Or Weekly In The Case Of Standby Generators.

The pre-start checks given in Section 4.2, together with those given in the engine manufacturers manuals, should be performed once daily or weekly in the case of standby generators. There is no need to repeat these checks should the generator need to be started later that day.

#### 5.2.2 Every Two Weeks For Generators That Have Not Run During That Period

Start up and run the generator for 5 minutes in order to check that everything is operating satisfactorily.

**Note:** - Do not run the engine at a low load for longer than 5 minutes, since this will result in incomplete fuel combustion with consequent lubricating oil dilution and higher carbon deposits.

### **5.2.3 Monthly For Generators That Have Not Run On Load During That Period**

After performing the daily checks, start up and run the generator for about 1½ hours on at least 50% load in order to check that everything is operating satisfactorily.

### **5.2.4 Six Monthly Or After 250hours Running, Whichever Is The Sooner**

Carry out the daily checks.

Tighten all electrical connections.

Tighten all exhaust fasteners.

Start up and run the generator for about 1½ hours on at least 50% load in order to check that everything is operating satisfactorily. Visually check the meters and gauges for malfunctions of any type.

### **5.2.5 After 500hours Running.**

All fasteners must be checked for tightness; the torque on these fasteners must comply with the tables given in the component manufacturers manuals.

### 5.3 To Remove The Engine And Alternator Together As An Assembly

- ***Make quite sure that the mains (Public Utility) electrical power supply to the control panel, alternator anti-condensation heater and all auxiliary equipment e.g. auxiliary battery charger and coolant heater have been disconnected.***
- Disconnect the starting batteries and remove them.
- Remove the bolts retaining the canopy (if fitted), disconnect the exhaust system and remove the canopy.
- Label all connections and cables to the control panel to ensure that they may be re connected correctly.
- Remove the control panel from the base frame, drain the coolant and disconnect the radiator from the engine.
- Remove the bolts holding the radiator to the base frame and remove the radiator.
- Remove the bolts holding the engine and alternator assembly to the base frame.
- The engine and alternator assembly may now be lifted away from the base frame ***provided that the lifting lugs on both the engine and alternator are used to bear the load.***

### 5.4 To Remove The Engine Leaving The Alternator In Position

- ***Make quite sure that the mains (Public Utility) electrical power supply to the control panel, alternator anti-condensation heater and all auxiliary equipment e.g. auxiliary battery charger and coolant heater have been disconnected.***
- Disconnect the starting batteries and remove them.
- Remove the bolts retaining the canopy (if fitted), disconnect the exhaust system and remove the canopy.
- Label all connections on the engine wiring loom so that they may be re-connected correctly, and remove the wiring loom.
- Drain the coolant from both the engine and radiator and disconnect all connections between engine and radiator.
- Remove the bolts holding the radiator to the base frame and remove the radiator.
- Remove the bolts holding the engine to the baseframe and loosen the alternator mounting bolts.
- If the alternator has one set of feet, then the front end of the alternator will need to be supported either by packing from below or by suspension from above.
- Remove the alternator cooling fan guards.
- Support the weight of the rotor assembly by using soft (e.g. wood) packing in order not to damage the cooling fan.
- Remove the bolts holding the flexible coupling to the engine flywheel.
- Support the weight of the engine by means of an overhead crane.
- Remove the bolts holding the alternator to the flywheel housing.
- The engine may now be moved forward away from the alternator and finally lifted away from the base frame.

## 5.5 To Remove The Alternator Leaving The Engine In Position

- ***Make quite sure that the mains (Public Utility) electrical power supply to the control panel, alternator anti-condensation heater and all auxiliary equipment e.g. auxiliary battery charger and coolant heater have been disconnected.***
- Disconnect the starting batteries
- Remove the bolts retaining the canopy (if fitted), disconnect the exhaust system and remove the canopy.
- Label all connections on the wiring loom so that they may be re-connected correctly when necessary, and remove the wiring loom.
- Remove the bolts holding the alternator to the baseframe and loosen the engine mounting bolts.
- Remove the alternator cooling fan guards.
- Turn the alternator rotor so that a pole is positioned at the lowest point of the rotor, and support the weight of the rotor assembly by using soft (e.g. wood) packing in order not to damage the cooling fan.
- Remove the bolts holding the flexible coupling to the engine flywheel.
- Support the weight of the alternator by means of an overhead crane.
- Remove the bolts holding the alternator to the flywheel housing.
- The alternator may now be moved backwards away from the engine and finally lifted away from the base frame.

## 5.6 Engine Maintenance

### 5.6.1 General

For full detailed information on engine maintenance and troubleshooting, please see the engine manufacturers manuals.

## 5.7 Radiator Maintenance

### 5.7.1 General

Radiators should always be filled with soft water (see the engine manufacturers manuals) that has had a proportion of either anti-freeze or coolant inhibitor (corrosion resist) added. This solution must meet the specifications given in the engine manufacturers manuals.

### 5.7.2 External Maintenance

In time the radiator matrix may become partially blocked with insects, leaves and other loose debris.

To remove these blockages, firstly cover the engine and alternator with a tarpaulin or something similar, and then spray a low pressure (1.72bar or 25lb/in<sup>2</sup>) steam jet through the radiator matrix from the front of the engine (towards the generator). Spraying in the opposite direction will not free all of the blockages and may wedge some material immovably in the matrix. Stubborn blockages may need treating with a low pressure hot water hose with added proprietary detergent.



### 5.7.3 Internal Maintenance

**WARNING** *Before beginning any type of work on a generator, make absolutely certain that the engine cannot be started; be especially careful when working on automatically starting generators.*



If recommended coolants have not been used, then there may be a build up of lime scale and corrosion in the coolant passages, this may be removed as follows:

Drain the radiator and disconnect all coolant carrying pipes from the radiator.

Blank off these pipes and make sure that they are watertight.

Prepare a solution of a proprietary chemical de-scaling solution that meets the requirements of both the engine and radiator manufacturers.

Working to the manufacturers instructions, fill the radiator with the solution, allow the recommended time for it to work and drain it away. Repeat if necessary.

Neutralise the de-scaling solution to the manufacturers instructions, flush through with clean water, and pressure test to twice the working pressure of the radiator to show up any leaks etc.

**Note:-** If there is any doubt about the overall condition of the radiator, then it should be replaced.

### 5.8 Alternator Maintenance

**WARNING** *Before beginning any type of work on a generator, make absolutely certain that the engine cannot be started; be especially careful when working on automatically starting generators.*



#### 5.8.1 General

The alternator manufacturers manuals will provide complete information on alternator maintenance together with a troubleshooting guide.

The alternator should be cleaned whenever necessary, by the following method. Disconnect the mains power supply (public utility) and wipe clean the external surfaces of the alternator and the ventilation screens. If necessary use a vacuum cleaner, but never use water or water based cleaning agents, steam or compressed air.

The alternator air filters (if fitted) should also be cleaned if necessary, by removing the filters and washing them in a detergent solution.

A winding insulation test should be periodically carried out following the procedures given in the alternator manufacturers manual. This procedure should be carried out before an initial start (see sections 4.3 and 4.5) and after every 3 to 6 months depending upon the ambient humidity levels.


## APPENDIX 1

### HEALTH AND SAFETY

#### Diesel Engine Lubricating Oil

See Broadcrown C.O.S.H.H Assessment Sheets BCGA 001, and BCGA 003.

Diesel engine lubricating oil may be encountered either as unused or used oil.

	<p><b>WARNING:</b> Diesel engine lubricating oil is a recognised cause of dermatitis and skin cancer (used oil only). Overalls and disposable protective gloves should always be worn. Eye protection should also be used if there is any risk of splashing. Oily clothing should be removed as soon as possible, and any area of skin contact immediately washed with soap and water. Do not put anything oily into clothing pockets.</p>
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In addition to the above warning, lubricating oil is a low level toxin (if less than 0.5l {1US pint} is ingested); it is also considered a mild eye irritant.

Always observe a high standard of personal hygiene.

Always clean up any oil spillage immediately, and be sure to remove any hazard of slipping by means of sand or other proprietary absorbent substance recommended for the purpose. Do not wash spilt oil into drains.

Always store in sealed high density polyethylene or mild steel containers that are clearly labeled with the contents and a fire hazard warning.

Droplets of engine oil should not be inhaled, never run an engine in an enclosed space without the engine breather outlet being piped away to where it may be safely discharged to atmosphere.

Where necessary, oil should be disposed of either by recycling or at a local authority approved disposal point.

#### In Case Of Emergency

##### Eye Contact

Wash the eyeball with running water for a minimum of ten minutes. Get medical assistance if irritation persists

##### Ingestion (swallowing)

**Do not induce vomiting.** Seek medical aid.

##### Skin Contact

Wash the area of contact immediately with soap and water. Do not wear oil soaked clothing.

##### Fire

Small fires may be fought with foam, dry powder, CO<sub>2</sub>, sand or earth.

Large fires should be fought by trained staff wearing breathing apparatus using foam or dry powder.

**Never use water on oil fires.**

## Anti-Freeze And Coolant Inhibitors

See Broadcrown C.O.S.H.H Assessment Sheet BCGA 004

Anti-freezes and inhibitors recommended for Broadcrown Generators fall into two main groups, those based upon ethylene glycol (MEG), and those based upon propylene glycol (also known as mono-propylene glycol or MPG). ***The preferred type is that based upon propylene glycol because of its much lower toxicity.***

### Ethylene Glycol (MEG) Based Anti-Freezes

**WARNING:** Ethylene glycol has an attractive smell and taste and is life threatening if swallowed. No coolant should never be tasted or taken into the mouth for any reason. ***If Ethylene glycol based antifreeze has been swallowed, emergency medical aid must be sought at once.*** If ethylene glycol based antifreezes are to be used, always use supplies that contain an added adversant (bitter tasting additive). Store in sealed high-density polyethylene or mild steel containers that are clearly labeled with the contents, the appropriate symbol and the legend "Toxic". Keep these containers well away from everyone, especially children and animals.



In addition to the above warning, ethylene glycol is absorbed through the skin, but this is much less dangerous than if swallowed.

### Propylene Glycol (MPG) And Ethylene Glycol (MEG) Based Anti-Freezes

Avoid skin contact where possible, but if it does occur, remove soaked clothing and wash the underlying skin with soap and water.

If swallowed get medical aid immediately, do not induce vomiting.

In the case of eye contact wash the eyeball with running water until the anti-freeze is cleared.

For small fires use CO<sub>2</sub> or BCF extinguishers. For larger fires use foam or dry powder. Breathing apparatus should always be worn.

Always absorb any spillage and dispose of safely. Do not wash anti-freeze down drains.

Always dispose of used anti-freeze safely at a suitable disposal point approved by the local authority.

## Lead Acid Batteries

See Broadcrown C.O.S.H.H. Assessment Sheet BCGA 007

**WARNING** When mixing sulphuric acid and water to produce electrolyte, be aware that much heat will be created during this process. Therefore always use earthenware vessels or lead lined wooden boxes and never use plastic or glass vessels. Always wear protective clothing and eye protection. Put the water into the mixing vessel, and add the acid a little at a time, stirring slowly and continuously. Always add the acid to the water, never add the water to the acid, or it will splash dangerously due to the violence of the reaction.



Saline eyewash solution and an eyebath should always be available wherever contact with electrolyte is possible,

Always follow the manufacturers instructions when working with or handling lead acid batteries, electrolyte or sulphuric acid.

The electrolyte in lead acid batteries is dilute sulphuric acid, which is corrosive and poisonous. Hydrogen and oxygen gases are emitted from batteries with liquid electrolyte, particularly if they are moved or shaken. These gases contain droplets of corrosive electrolyte. These batteries also give off explosive gases during charging.

Always wear protective clothing together with hand and eye protection

Keep all forms of ignition e.g. naked flames, smoking well away from lead acid batteries, and beware of potential ignition sources such as electric arcing. Do not wear nylon clothing due to the risk of sparks from static electricity.

Always use tools with insulated handles.

Keep conductive materials e.g. metal tools, items of jewellery away from battery terminals.

Should the electrolyte come into contact with the skin, wash the contact area with a large amount of water (preferably running water). Do not try to neutralise the acid whilst it is on the skin. Seek medical attention immediately.

Should the electrolyte come into contact with the eyes, wash the eyes with a large amount of water (preferably running water). Follow this with an eyewash of saline solution. Do not try to neutralise the acid whilst it is in the eyes. Seek medical attention immediately.

## **Alkaline Batteries**

See Broadcrown C.O.S.H.H. Assessment Sheet BCGA 008

Saline eyewash solution and an eyebath should always be available wherever contact with electrolyte is possible,

Always follow the manufacturers instructions when working with or handling alkaline batteries or their electrolyte.

The electrolyte in alkaline batteries is dilute potassium hydroxide, which is corrosive and may result in burns to eyes and skin.

Always wear protective clothing together with hand and eye protection when working with the electrolyte.

Keep all forms of ignition e.g. naked flames, smoking well away from alkaline batteries, and beware of potential ignition sources such as electric arcing. Do not wear nylon clothing due to the risk of sparks from static electricity.

Always use tools with insulated handles.

Keep conductive materials e.g. metal tools, items of jewellery away from battery terminals.

Should the electrolyte come into contact with the skin, wash the contact area with a large amount of water (preferably running water) and then cover it with dry gauze. Do not try to neutralise the electrolyte whilst it is on the skin. Seek medical attention immediately.

Should the electrolyte come into contact with the eyes, wash the eyes with a large amount of water (preferably running water). Follow this with an eyewash of saline solution. Do not try to neutralise the electrolyte whilst it is in the eyes. Seek medical attention immediately.