



THE ADVANCED  
USER GUIDE  
*OF*

MODEL MARINE  
STEAM PLANTS

# INTRODUCTION TO MSM MODEL MARINE STEAM PLANTS.



Welcome to our advanced guide on building a steam-powered model boat using MSM Steam Plants. If you're already familiar with the hobby and have a background in model boat building, this guide is designed for you. This guide provides a comprehensive and in-depth look at the different components of the steam plant, their functions, and the advanced techniques to fit them into your model boat. You'll gain an understanding of the intricacies of the steam plant, including the different types of engines and their unique characteristics. The guide covers everything from the size and type of boilers and tanks to the radio control systems, providing a wealth of information for the experienced builder.

## **Title**

*The Advanced User Guide of Model Marine Steam Plants*

## **Author**

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Whether you're looking to refine your skills or simply expand your knowledge, this guide is the perfect resource for anyone interested in steam-powered model boat building.

The first section introduces the items that comprise an integrated steam plant. Except for the engines, each of the items has the same function – just the sizes change. The function of each item is detailed in later sections of this guide. With the engines, there are two basic, but very different designs – “Slide Valve” and “Oscillating”. The Integrated Steam Plant article has an oscillating engine, but the same description would be used for a slide-valve engine.

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# QUICK BASICS RECAP

IN THE BASICS OF MODEL MARINE STEAM PLANTS GUIDE WE COVERED THE FOUNDATIONS OF STEAM PLANT OPERATIONS, THESE ARE SOME QUICK OUT TAKES OF WHAT WAS COVERED.

- The major components of an MSM Steam Plant are a boiler, a gas burner and a refillable gas tank.
- A Boiler generates steam to drive the engine, it is heated by the gas burner that is fed from the refillable gas tank containing a commonly available butane gas.
- Inside the boiler, the centre flue has a series of cross pipes that increase the area of water subjected to heating, making steam generation more efficient.
- The refillable gas tanks are sized to match the boiler, which in turn are sized to match the engine being used. The boat size ultimately determines what combination is required to properly power the chosen boat.
- Proper lubrication is crucial for the smooth operation of any steam engine, and that's where displacement lubricators come in. These devices allow steam, on its way to the engine, to carry a special Steam Oil into the engine to lubricate the internal moving parts.
- There are two different designs of engines in the MSM range, oscillating and side valve
- All engines are “double acting” in that steam is admitted to the bottom and then the top of the cylinder each 360-degree rotation of the drive shaft (called a crankshaft).
- A slide valve engine controls the entry of steam to the engine cylinders. The basic variants are single and twin cylinder, vertical and horizontal, non-reversing and reversing models.
- Oscillating engines two cylinders – one on each side of a “trunk”. The trunk has four ports on each side that match the two cylinder ports to deliver and exhaust the steam. The trunk also has a flat rotating valve on the top that can be moved to regulate the delivery of high-pressure steam to the cylinders, allowing the low-pressure steam to exhaust and can change the rotation direction of the crankshaft

# WHAT IS AN INTEGRATED STEAM PLANT?

In MSM terms it is an assembly of properly matched components fitted to a corrosion resistant mounting plate that can be operated as supplied - just by adding consumables, items like gas, water, and oil. Given the consumables, the plant can be operated on the bench. Without the need of radio controls (RC).

Physically, in a properly planned model boat, it can be fitted into the boat, the crankshaft connected to the propeller shaft, the RC links connected, and the model is ready for the pond! You will recognise the simplification implied here but excluding the otherwise trivial items.

Our Integrated Steam Plants are "Install & Run" - no if's or but's!

**Figure 1**

*Shows the MSM version with relevant annotated terminology, of a 3 inch horizontal boiler with a Clyde twin-cylinder oscillator engine. Front side*



**Figure 2**

*Shows the MSM version with relevant annotated terminology, of a 3 inch horizontal boiler with a Clyde twin-cylinder oscillator engine. Back side*







All the components for the complete running of the plant are mounted on a brass-based tray with folded up sides all around, to collect the inevitable oil and water splashes that will occur during running. This design allows for the plant to be easily fitted into the boat and for easy removal for maintenance.

MSM offers “standard” steam plants for several Caldercraft RC model boats. These are custom designed for fitting, or retrofitting, to specific models in the Caldercraft range:

Imara - Twin Screw

North Light - Clyde Puffer

Joffre - Tyne Tug

The following RC models can be fitted with a standard steam plant:

- Imara - Single Screw 3” Boiler/Clyde engine
- Marie Felling - Harbour Tug 3” Boiler/Clyde engine
- Resolve - Salvage Tug 4” Boiler/Twin Clyde engines

Details of each plant can be found on the products pages - “Steam Plants” if you are viewing this as a digital download you can follow this [link](#)

Modifications to other products are generally difficult to do - but we are always happy to help

# PRODUCT PACKAGING

To ensure that our products arrive undamaged when being sent all over the world, we have developed special packaging. Pictures of the packaging of the Clyde (P/N 5009K) and Avon (P/N 5027K) oscillator Self Assembly kits follow. The components are covered with another layer of foam and placed in a shipper box along with the supporting documentation.



Figure 3

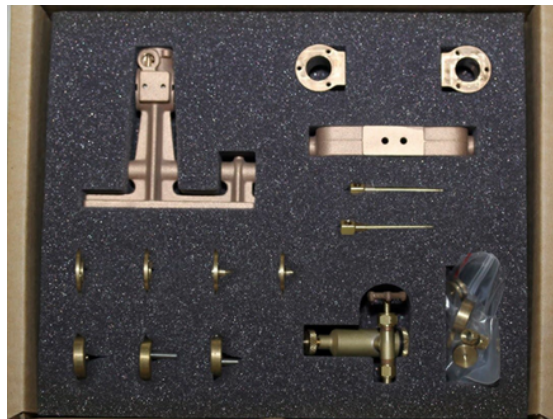


Figure 4

Except where the “Econo” boiler is required, the packaging of all complete steam plants, are despatched with the complete assembly almost ready to run as delivered. Attached are photos of how the plants are packaged. The steam plant illustrated is a Custom plant being sent to the UK for fitting in Caldercraft Joffre.

The steam plant is secured to a plywood baseboard with bolts through the baseboard and secured with 3 mm Nyloc nuts to prevent them loosening from vibration during transport.

The white double corrugated box shown above is remove from the First outer box, the steam plant secured to the baseboard is lowered into the First outer box, the white inner box is placed over it securing the base board firmly in place to protect the plant when the box is inverted. The first outer box is then sealed. Ready for insertion in the Second outer box.

The finished First outer box is sealed into a Second outer box, to be surrounded by 40mm foam on all six faces as illustrated below. This minimises the chance of damage to the plant from the hazards of being handled while in transit.

The burner assembly, boiler flue and the conical top cover for vertical boilers are packed separately in second carton and all supporting documentation. It is recommended that the plant should be left secured to the base board when preparing the plant for its first run.

*All that is required then is to:*

- Remove the four nuts holding the refillable gas tank in place,
- Fill the boiler, displacement lubricator and gas tank,
- Fit the flue pipe, add the cone top (vertical boilers only) calibrate the burner and fit it in place and attach it to the gas tank, and start the plant up. We recommend that you leave the plant The Nyloc nuts holding the steam plant to the base can be removed when you are comfortable with its operation. The individual steps listed are fully explained in the following material.

When packaging a steam plant with an “Econo” boiler, the boiler is dismantled and separately wrapped since it only sits on the burner when in use

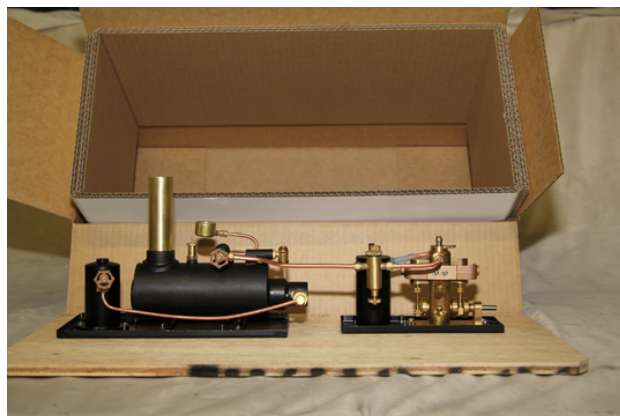


Figure 5 - shows the inner box



Figure 6 - shows the second outer box

# MSM ENGINE TYPES

As noted previously basic functions - e.g., piston, cylinder, crankshaft was covered in "The Basics of Model Steam Plants Guide"

All MSM engines are designated as "double-acting" engines.

The *twin-cylinder oscillators* have full speed and reversing control using a single servo.

All the *slide valve engines* are available with and without reversing gear. The single-cylinder versions of both engine types are not recommended for marine use because they can stall if the piston stops at the top or bottom dead centre and will need a slight finger push on the flywheel to re-start.

While the Stephenson's reversing gear fitted to the slide valve engines, provides a measure of speed control, it is recommended that a separate RC-controlled valve be fitted in the steam line if fine control of engine speed is required. Radio Control (RC) features are only available on twin-cylinder engines.

The whole MSM engine range is suitable for static installations where the "nudge" is readily available if needed.

# EXTERNAL LUBRICATION OF ENGINES

The industry wide description for the product to be used is called "Light Machine Oil" - which covers a very, very, very wide range of lubricants. For those seeking a local supply of a suitable oil it will be generally identified as a "clear stainless oil for sewing machines."

In their simplest form, making instructions for lubricating model engines and other items that have moving parts is like the instructions given to new army recruits years ago:

*"If it moves, salute it - if it doesn't move, paint it!"*

The analogy here is almost the inverse:

*"If it moves, oil it - if it doesn't move, ignore it!"*

The oil cup shown below is fitted on "Big 4" engines where appropriate and is obvious. Many components being driven by cams that have small holes in their hubs for oiling, but generally you need to drop a little oil on every component that rubs on another, where the rubbing occurs. It does not need to be a flood of oil just a drop in the right spot can do the job. It's up to you to find the right spot.



## CAUTION

"WD40 is not a lubricant". It seems to be considered as a "cleaner" - or some such other form of words, but frequently advised that it should not be used as an engine lubricant.

- The oil brand "Three in One" was isolated as not being suitable for the purpose being discussed here.

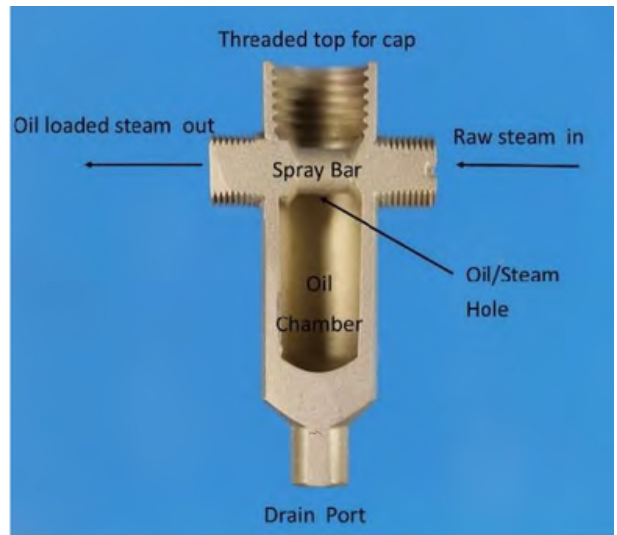
Irrespective of your choice of oil remember *"If it moves, oil it!"*

# DISPLACEMENT LUBRICATORS

It is important that the internal parts of an engine are properly lubricated. A *special steam oil* (see page 10) is used. The steam oil is injected into the steam before it enters the engine by using a displacement lubricator. Following is a cut away section of Figure 1 that shows the inside of an “in line” version, it is labelled Figure 7.5 below;

All three of the MSM products have the critical element of a “spray bar”. This has a small hole in it, pointing down. When the correct level of steam oil is added, the steam passing through the spray bar collects a minute amount of steam oil and condenses some steam to water. This condensate, being denser than the steam oil, goes to the bottom of the oil chamber and lifts the oil to make it available for further collection by the passing steam.

The purpose of the three MSM models is outlined beneath their figures for your reference.



**Figure 7.5**



**Figure 7**

*A non-adjustable in line model, for special steam plant configurations, particularly for custom plants with the TVR1 slide valve engine.*



**Figure 9**

*Incorporates the steam cock (valve) and is used on oscillating engines.*



**Figure 8**

*Is an adjustable model, used on all slide-valve engines. It is adjustable to allow the correct setting of steam oil use for the different amounts of steam oil required for twin and single-cylinder engines, consistent with the design objectives of the “Big 4” engines.*



# STEAM OIL EXPLAINED

lubricates the internal working parts of the engine in what can be very hostile conditions. It comes in a variety of grades with the heaviest being used in large high operating temperature engines down to the lightest grade as offered by MSM - International Grade 460. Retail suppliers of this are rare and manufacturers have minimum order quantities that are too large for an individual to buy and use.

The most readily available supplier will be a local steam club that is able to stock the larger quantity and fill smaller bottles for use by members and visitors.

We are not aware of any restrictions on posting the bottles of oil we offer - given we pay due attention to secure packaging. Non-use of the recommended steam oil can lead to accelerated and irreparable wearing of moving parts inside the engine.

[Click to read a very good article about steam oil.](#)

# BOILERS

All boilers are of centre flue design and made to International Construction Standards Details are set out in the boiler test certificate as shown in the following images. One of these accompanies every MSM boiler and should be kept in a safe place to enable quick access if needed to satisfy any party with safety concerns. The images show a certificate for a 3" horizontal boiler. Similar information is supplied for all MSM boilers. The first two images are the formal certification of the boiler construction and test conditions. The second two images have safety instructions and technical details of the boiler.



**Figure 10**

A certificate for a 3” horizontal boiler. Similar information is supplied for all MSM boilers. The figure shows a formal certification of the boiler construction and test conditions.

# Boiler Specification & Test Certificate

## “Miniature Steam” 3 Inch Horizontal Boiler

P/N 5045

**This boiler** has been manufactured to comply within the relevant sections of the Australian Miniature Boiler Safety Committee, (AMBSC) code part 3 Issue 1.0 - 2006 Sub-Miniature Boilers and AMBSC code part I . Issue 7 - 2001 Copper Boilers.

**This boiler** has undergone a static hydraulic pressure test, at twice the designed working pressure of 60 psi (4 bar—413 kpa) to ensure soundness of construction.

**Material Specifications;**

**Barrel;** 3" (76.2mm) OD x 1.6 mm wall thickness to Australian Standard AS 1572—1985 Copper and Copper Alloys—Seamless Tubing for Engineering Purposes

**Tube End Plates;** 1.6mm Copper plate to Australian Standard AS 1566—1985 Copper and Copper Alloys—Rolled Flat Products.

**Heating tubes:** 9.53 mm (3/8") OD x 1.2 mm wall thickness to Australian Standard AS 1572—1985 Copper and Copper Alloys—Seamless Tubing for Engineering Purposes. Eight tubes are arranged in a spiral.

**Bush Material;** Leaded Gunmetal to Australian Standard 1567—1985 Copper and Copper Alloys, Wrought Rods, Bars and Sections.

**Cast Components:** Copper Alloy No C87500

**O-Rings;** EPDM Steam Type

Test Certificate

I certify that this boiler Serial #**MSB** has been built to the above specification & has undergone an initial hydraulic pressure test of 120 psi. (8 bar - 826 kpa) and successfully passed,. The normal operating pressure of this boiler is 60 psi (4 bar -413 kpa)

Signed:..... Dated.....

Miniature Steam Pty Ltd,  
 A.B.N. 21 975 946 436  
 PO Box 16 Montrose Victoria 3765 Australia.  
 Phone: +61 3 9728 2711  
 Email info@miniaturesteammodels.com  
 Website www.miniaturesteammodels.com

Figure 11

A certificate for a 3" horizontal boiler. Similar information is supplied for all MSM boilers. The figure shows a formal certification of the boiler construction and test conditions.



**PLEASE READ THIS DOCUMENT CAREFULLY AND FAMILIARISE YOURSELF  
WITH OUR RECOMMENDATIONS FOR USE OF THIS STEAM BOIL-**

- This boiler is **NOT A TOY** and supervision should be given at all times to persons not familiar with the operating procedures, particularly to children
- 
- **NEVER** operate a boiler above its recommended working pressure—approximately 60 psi maximum for this boiler
- 
- A boiler in steam will be very hot, it is recommended that gloves or protection should be worn if it is being handled while hot.
- 
- Hot water or steam may be vented from the safety valve whilst in operation. Do not lean over or handle the boiler when in steam
- 
- Safety valves should be checked for operation prior to raising steam. This can be done by easing the safety valve stem and checking that the spring is functioning correctly.
- 
- Copper boilers are not subject to corrosion in the same manner as steel boilers, however they could become coated with scale over a long period of use. It is therefore recommended that distilled or filtered rain water be used.
- 
- Periodically check the O-ring seals (EPDM Steam O-rings) for signs of fatigue and replace when necessary. Replacements are available from Miniature Steam or most bearing shops.
- 
- Always ensure all pressure has been relieved from the boiler before refilling.
- 
- If the boiler does accidentally run dry we strongly recommend that it undergo a hydraulic pressure test to ensure safe and correct operation of the fittings and to ensure the integrity of silver soldered joints in the boiler.
- 

### **BOILER SAFETY VALVE**

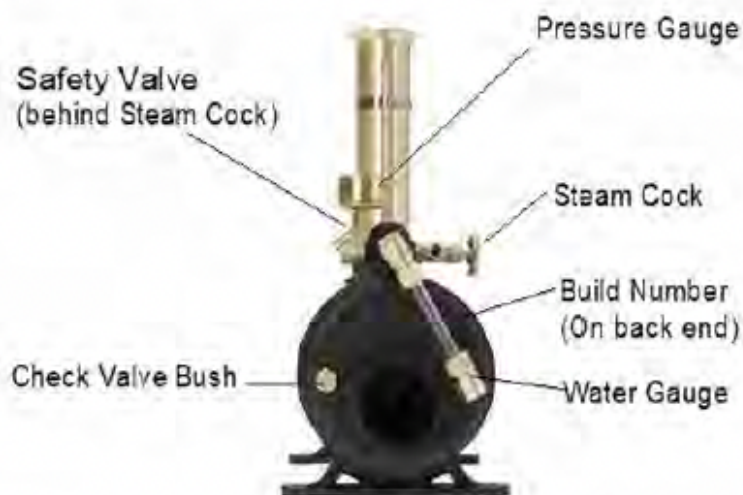
This safety valve has been designed for use with model steam boilers 76 mm (3") in diameter & pressure ranges of 2 bar (30 psi—200 kPa) to 4 bar (60 psi—400 kPa). The valve has been pneumatically tested and set for operation at approximately 55 -65 psi and the purchaser should make the final pressure release setting when first steaming the boiler.

A stainless steel ball & compression spring are used for longevity, mounting thread is 3/8" x 32 ME

*Figure 12*

*A certificate for a 3" horizontal boiler. Similar information is supplied for all MSM boilers. The figure shows safety instructions that come with documentation of the boiler.*





**This boiler is supplied for use as follows:**

- Normal water refilling is done by removing the safety valve and refilling to approximately 75% of full volume—as illustrated on the sight glass.
- A manual or automatic boiler feed pump can be connected through the Check Valve Bush. (Threaded 1/4" x 40 ME). An appropriate Check Valve and a manually operated Boiler Feed Pump can be purchased separately from Miniature Steam.
- The burner supplied with this package requires a safe Butane/Propane (70/30) gas mix. LPG is NOT to be used. Please read carefully the calibration instructions supplied with the burner.

**PLEASE NOTE CAREFULLY THE RECOMMENDATIONS ON THE OPPOSITE PAGE**

**Dimensions:**

Diameter	3 inch	76.2 mm
Width including stand	3.5 inch	90 mm
Height top of steam dome	4.4 inch	110 mm
Height top of steam pressure gauge	4.9 inch	125 mm
Height top of steam flue	8.7 inch	220 mm
Length without burner	6.3 inch	160 mm
Length with burner attached	7.9 inch	200 mm
Weight dry	1.2 kg	
Working pressure	60 psi (4 bar), (400 kPa).	
Test pressure	120 psi (8 bar) (800 kPa)	

**Figure 13**

*A certificate for a 3" horizontal boiler. Similar information is supplied for all MSM boilers. The figure shows technical details of the boiler instructions that come with documentation*

## BOILERS (CONT)

The steam cock fitted to the refillable gas tanks gives coarse control of the burner. A separate gas control valve is recommended for fine control of gas and water usage.

A check valve port is included on 3" & 4" boilers and is a 1/4" x 40 tpi fitting that is delivered with a blanking nut fitted. It is provided to allow for easy connection of a boiler feedwater pump or as part of a gas regulator installation.

An optional "steam vent pipe" may be fitted to 3" & 4" boilers. It is intended to be a stylish way of venting the steam from the safety valve when it releases.

Also, a whistle can be fitted on 3" boilers when running oscillator and vertical slide-valve engines and 4" boilers for all engine types.

Separate water filling ports are fitted to all boilers and should be obvious - except for the 3" vertical and the "Econo" vertical boilers, where the top cone has to be lifted to access it.

The water level sight glass is important for maintaining the proper operation of the boiler. When operating the boiler a water level should show at all times.

When filling the boiler the water level should be visible at the top (Leave a small gap in the line of sight), and if it is not showing at the bottom, it is time to stop and refill the boiler.

Feature > Boiler >	2" Horizontal	2" Vertical	2" Special	3" Horizontal	3" Vertical	4" Horizontal
Whistle	NO	NO	NO	Option	Option	Option
Steam Vent Pipe	NO	NO	NO	Standard	NO	Standard
Auxiliary Port (plugged)	NO	NO	NO	Standard	Standard	Standard
Pressure Gauge	0-60 psi	0-60 psi	0-60 psi	0-60 psi	0-60 psi	0-80 psi

**Figure 14**

*Shows the descriptions/annotations typify what could be shown for all our boilers, with the following opt*

# SAFETY VALVES

All these valves have simple, adjustable spring-loaded relief balls/surfaces that progressively release pressure when the setting is passed. They are not "pop" valves that trigger at a set pressure. When calibrating them as per instructions, the set pressure is what is showing on the gauge when steam is first released. If heating continues the volume of steam ejected will increase.

There are 3 designs that are matched to requirements of 2", 3" & 4" boilers as follows:



P/N 4027 0-60 psi. -  
used on all 2" boilers and  
the 3" vertical boiler

P/N 4131 0-60 psi. -used  
specifically for the 4"  
horizontal boiler

P/N 4132 0-60 psi -  
used on the 3"  
Horizontal boiler

## *Adjusting the operating pressure:*

P/N's 4131 & 4027 are screwed into the boiler barrel and can be adjusted by loosening the lock nut on the top of the valve and turning the nut inside it shown above each type. The inside nut of P/N 4131 has a slotted head while P/N 4027 has four holes best moved with small, pointed tweezers. P/N 4132 must be removed from the boiler, the lock nut on the shaft loosened with a spanner and the adjustment made on the adjusting (second) nut. Obviously, care must be taken to tighten the locking nuts after an adjustment.

*The recommended operating pressure for ALL boilers is 35 psi.*

Note that the appropriate setting is NOT made at the factory— it must be set by the user as part of the commissioning process as the setting can vary depending on location.

# BOILER/ENGINE WORKING TABLE

There is a direct relationship between the required size of the boiler and the size of the engine and the appropriate boat length for the current range of MSM products. The following table illustrates the options available: If a plant is being configured with other third-party components the above sizing can be used as a guideline but please note that MSM boilers have superior steam-generating efficiency when compared with most other boilers of similar size. the above recommendations to cover these situations.

Engine Name	Boiler >>>> Engine type	2"	3"	4"	Approx. Boat Length	Approx Maximum Prop. Dia.
Avon	Double acting, twin cylinder 8 mm bore/ 11 mm stroke. Oscillator	Yes	Yes		600 - 900mm	45mm
Tyne	Double acting single cylinder 11 mm bore/stroke. Oscillator	Yes			X	X
Clyde	Double acting, twin cylinder 11 mm bore/stroke. Oscillator		Yes	Yes	1300mm	50mm
Echuca	Double acting, single cylinder 19 mm bore/stroke. Slide valve		Yes	Yes	X	X
Pevensey	Double acting, single cylinder 19 mm bore/stroke. Slide valve		Yes	Yes	X	X
Mildura	Double acting, twin cylinder 19 mm bore/stroke. Slide valve			Yes	2500mm	75mm
Gem	Double acting, twin cylinder 19 mm bore/stroke. Slide valve			Yes	2500mm	75mm
Twin Avon	Two engines powered by a single boiler			Yes	2200mm	LH & RH 45mm
Twin Tyne	Two engines powered by a single boiler		Yes		X	X
Twin Clyde	Two engines powered by a single boiler			Yes	2500mm	LH & RH 50mm



# GAS FOR MODEL STEAM BOILERS

There are three types of gas commonly used in firing model steam boilers. All may be labelled as LPG (Liquid Petroleum Gas) but for the reasons set out below it is important to use their correct names. They are Propane, Butane, and Isobutane. In Australia, Propane is commonly labelled as LPG when used in motor vehicles, barbecues, and the like. The tanks are always constructed with heavy-duty sheet steel and have a special "POL" connection system. Each gas is stored in liquid form which vaporises in the tank as gas is drawn off and should burn off in its gaseous form.

Gas Properties	Isobutane	Butane	Propane
Chemical Formula	C <sub>4</sub> H <sub>10</sub>	C <sub>4</sub> H <sub>10</sub>	C <sub>3</sub> H <sub>8</sub>
Energy Content: MJ/m <sup>3</sup>	110.4	111.4	95.8
Energy Content: MJ/kg	45.59	47.39	49.58
Energy Content: MJ/L	25.0	27.5	25.3
Boiling Temp: C°	-11.75	-0.4	-42
Pressure @ 21°C: kPa	310.9	215.1	858.7
Flame Temp: C°	1975	1970	1967
Expansion: m <sup>3</sup> /L	0.234	0.235	0.270
Gas Volume: m <sup>3</sup> /kg	0.402	0.405	0.540
Relative Density: H <sub>2</sub> O	0.60	0.58	0.51
Relative Density: air	2.07	2.00	1.53
L per kg	1.669	1.724	1.96
kg per L	0.60	0.58	0.51
Specific Gravity @25°C	2.06	2.07	1.55
Density @ 15°C: kg/m <sup>3</sup>	2.533	2.544	1.899

**Figure 15**

*the table is presented courtesy of ELGAS Ltd.*

*Source: [www.elgas.com.au](http://www.elgas.com.au)*

The liquid-to-gas conversion occurs at or above specific temperatures for each gas. Propane vaporises at -42°C, Isobutane at -11.75°C and Butane at -0.4°C. They are all colourless and odourless in their raw state and denser than air— i.e.

They will sink to the lowest solid level possible when air is present. This is the reason it is recommended that refillable gas tanks working inside the hull of a boat be removed from the boat and refilled in the open air.

## RECOMMENDED GAS MIXTURE

Our standard recommendation is to use a gas with a maximum of 30% propane and a balance of either butane or isobutane or a mixture of both. The propane acts as a propellant as well as being useful for burning as the tank empties. We have had reports that the low-temperature performance of isobutane drops off more quickly than an isobutane/propane mix. We have not substantiated this but consider, if correct, that it is caused by the iso-butane alone having a faster decline of pressure as the tank pressure drops than where propane is present. Also, we have advice that in the USA there is an 80% butane/ 20% isobutane product that is probably less expensive and has better cold vapour pressure than 70-30 Butane/Propane.

Pure butane is satisfactory at ambient temperatures of about +5°C and above and pure iso-butane is down to about -9°C. These temperatures are "about" and higher than the defined "boiling point" because there is a gradual decay in the rate at which the liquid vaporises as the temperature approaches the "boiling point". Apart from the ambient temperature, there are two other factors that influence the temperature of the liquid gases in the tank.

The first is that when refilling a refillable tank, the temperature of both the master tank and the tank being refilled falls. The refillable tank should at least be felt warm before refitting it to the steam plant. If available a hair dryer can rapidly warm the cold or frosted tank. Also a short dunk in warm water can be helpful. Re-connecting a tank that has frost on it is asking for a short run! Similarly, as the gases from the refillable tank burn off, the remaining liquid in the tank cools and can steam. This is most likely to occur in cool climates when running with pure butane progressively reach a temperature where gas generation declines to a point where the boiler stops generating.

## IDENTIFYING THE GAS IN RETAIL OUTLETS – 70/30 BUTANE/PROPANE.

Unfortunately, the part of the gas industry dealing with retailing these gases in small tanks has not established standards for the presentation of the labelling of the contents of the tanks involved. In an extensive search, we could find no specification for the type of container that should be used for storing and selling retail quantities of the various gases used for model steam boilers, with one exception. Propane (LPG) is extensively sold in heavy steel tanks for use in domestic situations for outdoor barbecues, heaters etc. These are too heavy to be used in model marine situations and are excluded in the following discussion. Given the wide range of brands available on the market we have found that a good way of identifying a 70/30 gas tank, after giving up on trying to understand the label, is inspecting the fitting on the top of the tank.

## VAPOUR PRESSURE

This is a technically correct term for the gas pressure in the tank shown as “psig” or “pounds per square inch gauge” as displayed by a standard imperial measure pressure gauge, or “bar” in metric measurements. (1 bar = 14.5 psig).

		Vapor Pressure (psig)					
Mixture		Propane (C <sub>3</sub> H <sub>8</sub> ) (%)	100	70	50	30	0
		Butane (C <sub>4</sub> H <sub>10</sub> ) (%)	0	30	50	70	100
Temperature	(°C)	(°F)					
	-42.2	-44	0	0	0	0	0
	-34.4	-30	6.8	0	0	0	0
	-28.8	-20	11.5	4.7	0	0	0
	-23.3	-10	17.5	9	3.5	0	0
	-17.8	0	24.5	15	7.6	2.3	0
	-12.2	10	34	20.5	12.3	5.9	0
	-6.67	20	42	28	17.8	10.2	0
	-1.11	30	53	36.5	24.5	15.4	0
	4.44	40	65	46	32.4	21.5	3.1
	10	50	78	56	41	28.5	6.9
	15.6	60	93	68	50	36.5	11.5
	21.1	70	110	82	61	45	17
	26.7	80	128	96	74	54	23
	32.2	90	150	114	88	66	30
	37.8	100	177	134	104	79	38
	43.3	110	204	158	122	93	47

**Figure 16**  
The table shows how the gas pressure in a tank, decays as the temperature of a gas in it, decreases. The yellow highlight section is the one of most interest here in that we generally recommend the 70/30 butane/propane mix but have commented on the 100% butane as being acceptable in temperate climates.

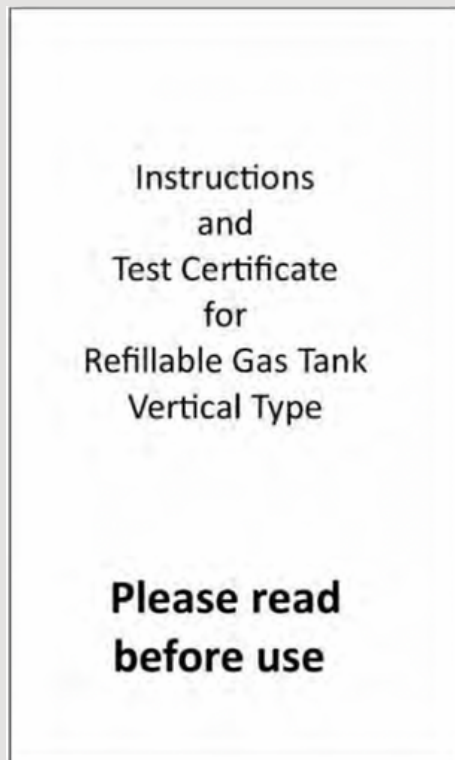
There are two qualifiers to that earlier statement:

1. Recently have had reports of the gas jets blocking easily. We believe that the cheap 100% butane tanks are filled with very low-grade gas that easily clogs the gas jets.
2. Irrespective of the ambient conditions, if the rate of consumption of gas from a tank of butane is very rapid, the tank will cool quickly, and may well get down the temperature scale to where the evaporating (boiling) of the liquid gas slows and may eventually cause the boiler to stop for lack of heating.

We believe that a gas pressure of about 20psi is required to produce a minimum heat for a boiler, “more pressure is better” if you can achieve it. Then you can control the engine speed by adjustments to the gas flow, varying the rate of steam production. Isobutane is also included in the relevant gases that are commercially available. We could not find an equivalent set of data as in the table, but one reliable reference stated: “Isobutane has about 64% less vapour pressure than propane but about 44% more than butane (at 21°C)”. We think this is an endorsement for its use in cool gas situations, whether environmental, or induced by the operating conditions.

# MSM REFILLABLE GAS TANKS

All refillable gas tanks are made to International Construction Standards. Details are set out in the test boiler certificate as shown in the following images. As with boiler test certificates one of these accompanies every MSM refillable gas tank and should be kept in safe place to enable quick access if asked for by any person with safety concerns.



*Figure 17 & 18*

*show the formal test certificate for the gas tanks that come with MSM products*



*Figure 19 & 20*

*Show the instructions and illustrations, for refilling the tank from a master tank that come with MSM products*

## REFILLABLE GAS TANK INSTRUCTIONS

The graphic shown opposite is a typical layout of a gas tank.

The refillable gas tank is intended for use with Low Pressure Gas only..It requires a maximum 70/30 Butane/Propane gas mix or Butane/ISO Butane/Propane mix.as available in most disposable canisters. If the mixed gas is used then the Propane content **MUST NOT** be greater than 30%.

This Gas Tank is fitted with a RONSON valve for easy filling. A refill adaptor is available as an option, this adaptor screws on to the thread of EN417 and AS2030 compliant disposable canisters that are available from most Camping and Disposal Stores.

The tank is designed to accept approximately 70% of its volume as a full charge for reasons of safety, as in high ambient temperatures it prevents excessive pressure build up in the tank and prevents liquid gas reaching the burner.

### Filling the Gas Tank

Remove the tank from its location and place it on a level surface in well ventilated open air or in the palm of your hand in open air. With the refill valve at the top, gently slide the nozzle of the adaptor into the cone of the refill valve. Keeping the nozzle in a vertical straight line, open the gas control whie gently applying downward pressure. Some gas will escape from the gas control valve.

When liquid gas vents from the gas control valve close the valve and remove the refill tank.

### Safety Procedures

**NEVER** carry out the refilling process near a naked flame or in a confined space, if the refillable gas tank is mounted in a boat it should be removed for filling. When gas is drawn from the tank by the burner the tank will cool,condensate on the out side of the tank will indicate this condition, as coolingtakes place the burer performance will drop off, to help reduce this you canmount the tank in close proximity to the Boiler or on an extended boiler basemount, this will enable the radiant heat from the boiler to gently warm the tank and assist in giving consistent gas evaporation thus a consistent flame.

**DO NOT OVER HEAT THE GAS TANK.**

There is an o-ring used to seal the shaft on the control valve if this becomes damaged spares are available. **SHOULD YOU SUSPECT A LEAK IN YOUR INSTALLATION CHECK BY IMMERSION IN A MILD SOAPY WATER SOLUTION, NEVER WITH A NAKED FLAME**

# REFILLING A GAS TANK FROM A MASTER TANK

Instructions are as follows:

- Ensure the gas cock (valve) is closed.
- Disconnect the gas pipe from the tank, using the knurled nut.
- Remove the gas tank and place it on a firm base in a well-ventilated space,
- Open the tank gas cock a small amount to bleed off any residual gas. Leave the cock open.
- Screw the refill adapter onto the master gas tank
- invert the master tank and insert the tip of adapter into the valve and, holding the master tank vertically over the tank being refilled, as illustrated above, and press down firmly.
- There may be a small hiss of gas leaking as the valve in the tank engages the adapter. If there is a significant gas leakage withdraw the master tank and try again. Both the valve and the adapter can be damaged if this step is not carried out properly.



**Figure 21**

*Show the adapters and the example of it connected for refill*

- The receiving tank will be full when liquid gas appear trickles out of the gas tank cock. Depending on the receiving tank size and ambient temperature the transfer of liquid gas can take several minutes
- Withdraw the master tank and close the gas tank cock.
- Replace the filled gas tank back on its screws in the boat and reconnect the gas line.

There is an alternative to opening the tank gas valve and watching the gas tank valve. The tank valves are designed to enable release of liquid gas when the tank is at a correct level. We recommend the above procedure because the discharge vent on the tank valve can block on some valves. We have no record of our improved design valves have this problem, but the above procedure is the safest to follow. Also, it reminds you to remove the tank from the boat!



**Figure 22**

*The special valve shown is used to fit onto the top of the refill master tank and allow direct connection to the burner in situations where a refillable gas tank is not required.*



# CENTER FLUE BOILER BURNER COMPONENTS

This sets out details of the range of Miniature Steam burners and their components. These burners are suitable for centre flue boilers only.

Essentially there are separate burner assemblies for each boiler size:

- 2" vertical and horizontal (P/N 4057 & P/N 4058) boilers, Jet P/N 2159
- 3" vertical & horizontal boilers (P/N 5049 & P/N 4060), Jet P/N 2157
- 4" horizontal boiler (P/N 5270), Jet P/N 2158
- The 2" Vertical "Econo" boiler (P/N 4056) Jet P/N 2158, has the same cast ceramic insert as the other 2" boilers but it is mounted in a burner surround that sits under the boiler.

Each burner set has the appropriate, highly efficient, and unique MSM CAST CERAMIC burner insert shown in *figure 23*. This is sealed into the burner shroud as shown in *figure 24*. When properly calibrated the burner flame "dances" above the insert.



*Figure 23*



*Figure 24*



*Figure 25*

This is the design for all MSM burners, except for the 2" "Econo" Vertical Boiler Burner (P/N 4027) where the boiler sits on top of the assembly. The ceramic insert for this model is the same as that used on the standard 2" Vertical & Horizontal burners.

The Gas Cocks (valves) all gas tanks are all fitted with a 1/4 x 32 tpi male thread connection.

*Figure 26*

*The burner shroud is connected to the gas source (Master tank or Refillable tank) with a gas pipe shown, fitted with a 1/4 x 32 tpi knurled nut for making manual connections when refilling a tank.*



This also carries the gas jet in the end of the nozzle that is moved in the brass air tube on the shroud to adjust the air/gas mix when calibrating the burner flame. Special sized jets are required for each boiler burner. They are not commercially available.

The gas tap shown in figure 22 (page 19) is used in static installations where there is plenty of room for the larger disposable gas tanks. It has our standard 1/4 x 32 tpi threaded fitting for connecting the gas pipe.

# CALIBRATING THE BURNERS

## THE BURNER OPERATION

The burner converts gas into heat by burning a gas and air mixture in the burner assembly to create heat. MSM burners use individually designed cast ceramic burner inserts to provide maximum burner efficiency for each boiler. There are two components that enable the adjustment to the burner flame.

The first is the gas pipe that delivers gas from the gas tank to the burner. It is attached to the gas tank by a knurled nut for easy removal.



Figure 27

At the burner end the pipe is soldered into a brass tube that has a gas jet in the end. The jet limits the amount of gas allowed into the burner, is specific to each burner and not a commercially available jet size.

The second component is the gas mixer tube fixed to the bottom section of the burner shroud that allows the tube carrying the jet to slide in and out. It has a locking screw for securing a setting. The calibration of the burner flame is carried out by sliding the jet holder tube in/out of the gas mixer tube variously exposing an air hole to vary the amount of air admitted to the burner to mix with the gas.

## CAST CERAMIC BURNERS

MSM cast ceramic burners are specifically designed to provide optimum burning characteristics in enclosed spaces such as the centre flue or firebox of a boiler. They differ from other ceramic burners made from heating tiles designed for radiant room heaters.

The gas/air mixture of a MSM cast ceramic burner, burns outside the ceramic insert. This results in a more efficient transfer of heat to the boiler's heating surface. The burner also remains relatively cool thus improving the thermal efficiency of the burner and minimizing the chance of back burning.

Please note that when the burner "roars" it is probably operating efficiently. 2" and 3" boilers have a steady sound where the 4" boiler has a "stuttering" sound imposed over the top of the roar. These sounds are normal for MSM burners.

As the gas supply may vary by location and from batch to batch, it is advisable to undertake a calibration process before starting up a boiler for the first time and when changing gas batches.



Figure 28  
Shows a gas pipe

### CALIBRATING PROCEDURE

To achieve the correct burning characteristics of the unit with any gas batch, the jet holder is moved in the air/gas mixing tube to establish a correct air/gas ratio in the fire tube.

*Instructions are as follow:*

- Connect the gas source to the burner gas pipe and insert the jet holder into the gas mixer tube
- Remove the burner assembly from the boiler and place it on a firm surface with the burner facing up. (Note: keep your fingers away from the burner shroud
- It may heat uncomfortably during the calibration process!)
- Start by sliding the jet holder in the gas mixer tube to leave the air holes about 2/3 closed.
- Turn on the gas at the gas tank and light the burner. You should see a lazy flame flecked with yellow. If not, adjust the jet holder to achieve this. This position indicates that insufficient air is being added to the gas/air mix.
- Slide the jet holder to expose more of the air holes until the flame is blue but is "dancing" on the surface of the burner. This indicates that there is too much air in the gas/air mix



*Figure 29*

- Move the jet holder back to reduce the air hole exposure until a stable blue flame is evident. This is the optimum setting for the air/gas mixture.
- Secure the jet holder in the gas mixer tube in this position with the Allen key supplied by tightening the stainless steel 3 mm grub screw or slotted head screw provided.
- Turn the gas off and allow the burner to cool a little before reinserting it in the boiler fire tube. Refer to figure 29 for what you should see when the burner is correctly calibrated.
- Once the burner is fitted in position on the boiler, it is usually lit by opening the gas valve and applying a lighted gas torch to the top of the flue/stack. The gas "pops" and burns back to the burner. Use of a lighted match is not recommended
- It requires the hand to be hazardly close to the burning gas at the top of the flue

# MSM OIL TRAPS

The steam oil that is carried into the cylinder with the high-pressure steam is not consumed, its lubricating properties deteriorate, and it is taken out of the engine in the exhaust steam in a continuing process.

Environmental rules require the oil to be separated from the steam and disposed of separately. The separation is done in one of these traps.

MSM oil traps work by creating a vortex that separates the oil to the sides of the trap, leaving clean steam to exhaust to the atmosphere.

An alternative design is to direct the incoming exhaust steam at a vertical plate placed directly opposite the entry point. This causes the oil content to separate from the exhaust steam and drop down from the plate into the trap. In both designs the waste oil can be removed by a syringe used solely for this purpose. Be careful NOT to use this syringe for filling the boiler with water.

Most of this documentation is written with the assumption the oil trap only has one input line from one engine. Normally a rubber hose is pushed onto a 5 mm fitting on the exhaust oil trap to make that connection. A hard connection can be made on request.

The large horizontal trap shown in *figure 31* with one input and one output, is most used with twin cylinder marine installations. This design can have oil traps that can handle, 2,3 & 4 inputs with one output as shown below in figures 30-36. Since multiple engines are not often found in a marine installation, these designs are often sought by clients with static installations of multiple engines "on the bench



**Figure 30**  
Small Vertical oil trap. single engine



**Figure 32**



**Figure 33**  
Large Vertical oil trap. single engine



**Figure 31**  
Large horizontal oil trap. single engine



**Figure 34**  
Small Vertical oil trap. Twin engine

**Figure 35**  
Large horizontal oil trap. Triple engine



**Figure 36**  
Large horizontal oil trap. Four exhaust inputs with dual drain ports



# SELECTING A MSM STEAM PLANT

MSM Places has great value in offering "turnkey" solutions to installing a steam plant in a model boat.

Fundamentally they are aimed to be a "set & forget" installation. We can offer many variants and have developed the following groupings to assist clients to determine which variant to select for their chosen boat or finding a boat that can accommodate a chosen plant.

The basic issue is to select a plant that will power a particular length boat and to make sure the boat has adequate space to fit the plant.

*The groupings are:*

- Boats up to 800mm long and room to comfortably accommodate the specified footprint of the plants recommended.
- Boats from 600mm to 1.2m and room to comfortably accommodate the specified footprint of the plants recommended.
- Boats over 1.2m long and room to comfortably accommodate the specified footprint of the plants recommended

In figure 37 (page 25), these groupings come under the definition of boat length

## FIGURE 37 GLOSSARY

*Footprint:*

The dimensions of the area the plant needs in the boat for installation and sensible operation of the plant – at least the size of the mounting tray. In ALL cases the crankshaft goes beyond the tray boundary to allow for connection of universals in the propeller drive train. In some cases the burner jet holder and shroud may also exceed the tray boundary. It is also used to define the dimension of the area on a steam plant tray that is available for fitting a client supplied engine. (Custom engine steam plants)

*Plant Part Number:*

This shows the MSM part number that can be used to identify the steam plant to "Search" for further detailing of the recommended plant as defined in this table. The links show the layout assembled plant (and pictures where available), details the components used and total price for the plant.

*Boiler:*

This links to the specific boiler used for the various plants to assist clients in making their selection. Operating details of each boiler is accessed with each link.

*Engine:*

This link enables an instant view of the details of the engines being offered in the standard plants.

*Tray Footprint/Dimension:*

This is the actual Width x Length of the tray - the plant footprint. The space available for a "Custom" engine is shown in Products page Custom engines. Effectively this is the length of the MSM engine in that specific plant.

*Steam Line Connections to Engine:*

All 2" & 3" Boilers use 5/32 copper pipe with 1/4 x 40 nut & tail. Boiler connection to Tyne, Avon & Clyde use 1/4 x 40 nut and tail. 4" boiler uses 3/16 copper pipe and 5/16 x 32 nut and tail.

## SELECTING A MSM STEAM PLANT (CONT)

*Figure 37 - Plant comparison information*

BOAT LENGTH	STEAM PLANT P/N	BOILER	ENGINE	FOOTPRINT MM
Under 800 mm	<a href="#"><u>4052</u></a>	<a href="#"><u>2" Horizontal</u></a>	<a href="#"><u>Tyne</u></a>	85 x150
Under 800 mm	<a href="#"><u>4072</u></a>	<a href="#"><u>2" Horizontal</u></a>	<a href="#"><u>Avon</u></a>	85 x 235
Under 800 mm	4038	<a href="#"><u>2" Vertical</u></a>	<a href="#"><u>Tyne</u></a>	85 x 170
Under 800 mm	4071	<a href="#"><u>2" Vertical</u></a>	<a href="#"><u>Avon</u></a>	85 x 180
Under 800 mm	<a href="#"><u>4033</u></a>	<a href="#"><u>2" Econo Vertical</u></a>	<a href="#"><u>Tyne</u></a>	90 x 190
Under 800 mm	<a href="#"><u>4034</u></a>	<a href="#"><u>2" Econo Vertical</u></a>	<a href="#"><u>Avon</u></a>	90 x 190
800 > 1200 mm	<a href="#"><u>4087</u></a>	<a href="#"><u>3" Horizontal</u></a>	<a href="#"><u>Avon</u></a>	95 x 250
800 > 1200 mm	<a href="#"><u>4050</u></a>	<a href="#"><u>3" Horizontal</u></a>	<a href="#"><u>Clyde</u></a>	95 x 250
800 > 1200 mm	<a href="#"><u>4049</u></a>	<a href="#"><u>3" Vertical</u></a>	<a href="#"><u>Clyde</u></a>	95 x 210
800 > 1200 mm	<a href="#"><u>4088</u></a>	<a href="#"><u>3" Vertical</u></a>	<a href="#"><u>Avon</u></a>	95 x 210
+1200 mm >	<a href="#"><u>4086</u></a>	<a href="#"><u>4" Horizontal</u></a>	<a href="#"><u>Twin Clyde</u></a>	135 x 350
+1200 mm >	<a href="#"><u>4073</u></a>	<a href="#"><u>4" Horizontal</u></a>	<a href="#"><u>Mildura</u></a>	145 x 350

# IMPERIAL VS METRIC - WHEN DOES IT MATTER?

The world communities are very much individuals when it comes to standardising how to describe "things"- like weight, length, value..... etc. These "things" exist in our world but there is no single definition for most, if not all, that can be used universally.

The majority are used by custom acceptance in the social/industrial environment in which they were created and are used.

In our industry we must cope with a mixture of the two systems - "imperial" and "metric" based "things" with relatively easy understanding! MSM Uses both, each use consistent with what is believed to be the most common.

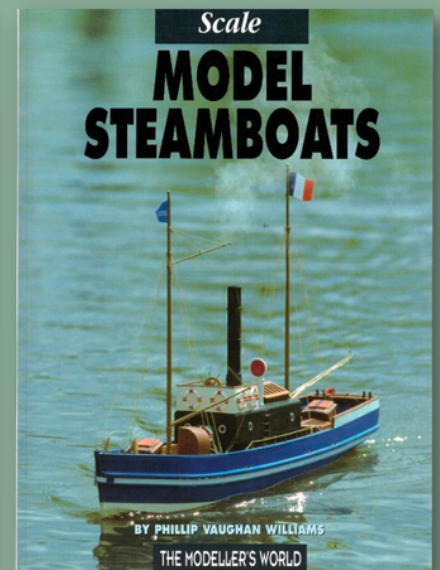
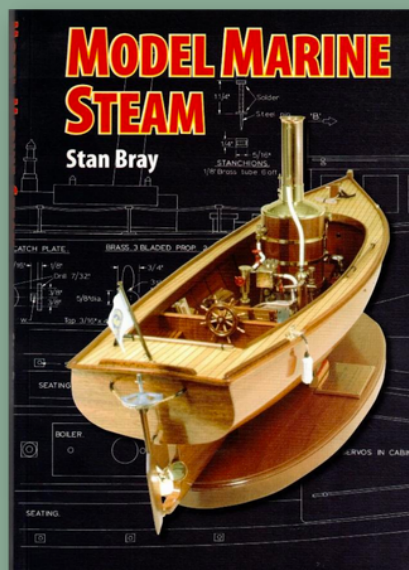
## THANKS FOR TAKING THE TIME.

If this guide has helped you finish your build then we are very pleased, and we would love to hear all about it.

### CONTACT US

A recently released book that may be of interest is "Making Model Steam Boats by STEPHEN BODILEY"

The following two books are recommended for further reading.



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