

# Plumbing Systems

## Quick Connect Plumbing System

Whale Quick Connect fittings ensure a high integrity, reliable, plumbing system solution, specifically designed for use in mobile applications.

## Save Time and Money by Using Whale Quick Connect

Fittings and pipework design ensures easy installation and re-usability of components.

The simple two step installation procedure does not require special tools to make a watertight connection.

### Features and Benefits

- Unique 'Double Gripper' design provides secure lifelong pipework retention even at excessive pressures
- The innovative 'cage collet' eliminates leaks where fittings are installed close to tight bends
- Collet has internal support ring ensuring o ring seal is held in position and does not distort or leak under pressure
- High integrity single piece moulding improves the strength of the fittings
- Outer sleeve incorporates collet cover, thus preventing accidental pipework release
- Collet clips are not necessary and therefore reduce installation time
- Pipework includes measured cut marks, designed to be a visual guide to ensure that fittings are pushed fully home

### Whale Quick Connect Semi-Rigid Pipework

Whale Quick Connect colour coded semi-rigid pipework is available in 12 mm, 15 mm, and 22 mm sizes in standard or high performance (Whalex) PE materials. The pipework's flexibility enables tight bends to be formed, hence reducing both the number of fittings and time required at installation. Whale Quick Connect semi-rigid pipework offers the integrity of metal, but the usability of plastic, and is fully tested and recommended for use with the complete range of Whale fittings (see pages 82-83).

### Minimum Bend Radii Recommendations

All grades of Whale Quick Connect semi-rigid pipework are flexible and can be bent into a tight radius to facilitate easy installations. This reduces the number of fittings required and the cost of the total water system.

Whale Tubing	Minimum Bend Radius
15mm	75mm

This product is protected by the following granted patents:  
 United States Patent No. US 6,349,978; German Patent No. 69810350.5 (EP(DE) 1 032 785); French Patent No. FR 1 032 785; United Kingdom Patent No. GB 2 331 564; and Dutch Patent No. NL 1 032 785.

### Installation Guide

**Step 1** Cut pipework to length by making a straight clean cut using Whale cutters WX7950 (WX7951-USA only) (see **fig.1**)

**Step 2** Simply push the pipework length into the fitting to the second internal stop (see **fig. 2**)

**Step 3** To release pipework: Push back the grey collet into the fitting, then hold the collet in and pull out the pipework length (see **fig. 3 and 4**)



Fig 1



Fig 3



Fig 2



Fig 4

The Whale Quick Connect products are protected by the following patents  
 UK Patent Number: 2331564, European Patent Number: 1032785  
 USA Patent Number: 6349978

Materials	
Whale Quick Connect Fittings	Glass-filled Polypropylene
Whale Quick Connect Pipework	Polyethylene

Recommended Maximum Operating Conditions	Maximum Pressure	Maximum Temperature
	Hot Water	6 bar (90 psi)
Cold Water	12 bar (180 psi)	20°C (68 °F)

Minimum Bend Radius	
Quick Connect 15 mm Pipework	75 mm

**Minimum Storage Temperature**

The minimum dry storage temperature is -40 °C (-40 °F)

**Note:** It is vital that the system is fully winterized to prevent frost damage.



WARNING

**WARNING:** Temperature Settings – To prevent scalding, (regardless of the water heating method or the control devices used), the temperature for the hot water supplied to the faucets and showers should be controlled in the range of 50 °C to 60 °C (110 °F to 140 °F) with a fail safe set at 82 °C (180 °F).

**CAUTION:** Ideally, the temperature should be set at 46 °C (115 °F) for health and safety reasons, higher settings will increase the risk of scald injury. Those at greatest risk of scald injury include children, the elderly, disabled, and diabetics.

## Fail Safe Controls



WARNING

**WARNING:** In a typical marine installation, it is vital to incorporate primary and fail safe controls for water temperature and pressure. Please see list below:

**PRIMARY CONTROLS:**

**Thermostatic Mixer Valve:** WX1599B

**Pressure Switch:** WU7207(B) - In-Line Pressure Switch or included in the Universal Pressure Pump (see page 77)

**Pressure Regulator:** WX1595B - Pressure Relief Valve - 6 bar 1/2" Female

**Expansion Vessel:** Accumulator Tank

**FAIL SAFE CONTROLS:**

WX1595B - Pressure / Temperature Relief Valve

(For typical installation of these necessary controls see page 55)

(For a full list of our part numbers see pages 92-93)

(For advice on specific installation requirements contact Whale - see contact details)

**Note:** The patented Whale Plumbing System is specifically designed to be use in "mobile" applications. Whale Quick Connect fittings and Whalex pipework (any) are covered for 10 years from date of purchase (except WX1599). For use with Whale plastic tubing and grooved stems only.

## Quick Connect Pipework and Fittings

### 15 mm



**WX1502(B)**  
15 mm Equal Tee



**WX1503(B)**  
15 mm Equal Elbow



**WX1504(B)**  
15 mm Equal Straight



**WX1508B**  
End Plug (Brass)



**WX1509B**  
Stem Adaptor 12 mm – 15 mm



**WX1511B**  
Stem Adaptor 11 mm – 15 mm



**WX1520B**  
Adaptor 15 mm Female  
15 mm Compression Fitting  
(Brass)



**WX1521(B)**  
Stem Tee



**WX1522(B)**  
Stem Elbow



**WX1546B**  
End Stop



**WX1571(B)**  
3 Way Valve (Brass)



**WX1573B**  
Shut-off Valve (Brass)



**WX1574(B)**  
Shut-off Valve



**WX1575B**  
Stem Shut-off Valve (Brass)



**WX1576B**  
Stem Shut-off Valve



**WX1577B**  
Stem Ice Maker Fitting (Brass)



**WX1578B**  
Stem Ice Maker Fitting With  
15 mm Equal Tee (Brass)



**WX1582(B)**  
Check Valve - Non Return  
Valve (Brass)

### Threaded 3/4"



**WX1516B**  
Adaptor 3/4" BSP Male



**WX1542(B)**  
Adaptor 3/4" BSP Female



**WX1552B**  
Adaptor 3/4" Garden Hose Thread  
(Green) Female

### Threaded 3/8"



**WX1538 / WX1538(B)**  
Adaptor 3/8" BSP Female



**WX1539B**  
Stem Adaptor 3/8" Female (Brass)



**WX1563(B)**  
Stem Adaptor 3/8" NPT Male (Brass)



**WX1583B**  
Adaptor 3/8" BSP Male

#### Part Numbers Explanation:

B Suffix: refers to items available only in bulk packed quantities for high volume production OEM use

(B) Suffix: refers to items available in either retail packaging (e.g. WX1502) or in bulk packed quantities for high volume production OEM use (e.g. WX1502B).

**Please note - For lead free brass connections in line with USA federal regulations, please contact Whale support.**

### Threaded 1/2"



**WX1080B**  
Adaptor 1/2" BSP Male - 10 mm  
Compression Fitting (Brass)



**WX1513B**  
Adaptor 1/2" NPT Male (Brass) -  
15 mm



**WX1514B**  
Adaptor 1/2" BSP Male - 15 mm



**WX1515(B)**  
Faucet Tail Assembly Adaptor 1/2"  
BSP Male - 15 mm



**WX1519B**  
Flexible Heater Connector 1/2" NPT  
Male 1/2" BSP Female  
Length - 350 mm (14")



**WX1524(B)**  
Stem Adaptor 1/2"  
NPT Male (Brass)



**WX1531(B)**  
Elbow Adaptor 1/2" BSP  
Female - 15 mm



**WX1532(B)**  
Adaptor 1/2" Female - 15 mm



**WX1533B**  
Adaptor 1/2" BSP Female (Brass) -  
15 mm



**WX1534(B)**  
15 mm Stem with None Return Valve  
Adaptor 1/2" NPT Male (Brass)



**WX1536B**  
Adaptor 1/2" BSP (Green)  
(Short Wings) Female



**WX1567B**  
1/2" NPT Male - 1/2" BSP Male  
Shower Bulkhead Adaptor (Brass)



**WX1587(B)**  
Stem Adaptor 1/2"  
BSP Male - 15 mm

## Quick Connect Pipework and Fittings

PIPEWORK

### Flexible Hose Fittings 1/2"



**WX1544(B)**  
1/2" Hose Connector (Brass)



**WX1584(B)**  
Stem Adaptor 1/2"  
Flexible Hose Male



**WX1585B**  
Tee 1/2" barb X 1/2" barb X 1/2" barb



**WX1586B**  
Tee 1/2" barb X 15 mm WX X 1/2" barb



**WX1591(B)**  
Stem Elbow 1/2" Flexible Hose

### Flexible Hose Fittings 3/4"



**WX1555B**  
Tee 3/4" barb X 3/4" barb X 3/4" barb



**WX1556B**  
Tee 3/4" barb X 15 mm WX  
X 3/4" BARB



**WX1557B**  
Tee 3/4" barb X 1/2" barb X 3/4" barb



**WX1558B**  
Tee 1/2" barb X 1/2" barb X 3/4" barb



**WX1592(B)**  
Stem Elbow 3/4" Flexible Hose



**WX1593(B)**  
Stem Adaptor 3/4" Flexible Hose



**WX2259B**  
Adaptor 22 Spigot X 3/4" barb

### Other Connections



**WX1517B**  
9/16" X 24 UNEF Male Faucet Tail  
Adaptor (Brass) suitable for Gröhe  
Faucets



**WX1535B**  
Stem Adaptor 1/8" Hose (Brass)  
for Windsreen Washer



**WX1537B**  
Stem Adaptor 1/4"  
NPT Female (Brass)



**WX1566B**  
Tank Fitting Assembly



**WX2260B**  
End Stop 22mm Spigot



**WX1528(B)**  
Adaptor 5/8" - 15mm

### Plumbing Safety Fittings



**WX1595B**  
Pressure Relief Valve - 6 bar  
1/2" Female



**WX1599B**  
Thermostatic Mixer Valve 1/2" Male  
(Brass) 15 mm and Check Valve /  
Non-Return Valve  
Note: This product is covered by 1  
year warranty

### Flexible Hose Fittings Other



**WX1548B**  
3/8" Hose Connector (Brass)



**WX1597(B)**  
Stem Adaptor 3/8" Flexible Hose

### Colour Coded Tubing



**WX7152**  
Standard Semi-Rigid Pipework  
15 mm Blue 10 m (33 ft)



**WX7152B**  
Standard Semi-Rigid Pipework  
15 mm Blue 50 m (164 ft)



**WX7154**  
Standard Semi-Rigid Pipework  
15 mm Red 10 m (33 ft)



**WX7154B**  
Standard Semi-Rigid Pipework  
15 mm Red 50M (164 ft)



**WX7156**  
Standard Semi-Rigid Pipework  
15 mm Green 10 m (33 ft)



**WX7156B**  
Standard Semi-Rigid  
Pipework 15 mm Green 50 m (164 ft)



**WX7162B**  
WHALEX Semi-Rigid Pipework 15 mm  
High Performance Blue 50 m (164 ft)



**WX7562B**  
WHALEX Semi-Rigid Pipework 15 mm  
High Performance Blue 152 m (500 ft)



**WX7164B**  
WHALEX Semi-Rigid Pipework 15 mm  
High Performance Red 50 m (164 ft)



**WX7564B**  
WHALEX Semi-Rigid Pipework 15 mm  
High Performance Red 152 m (500 ft)



**WX7166B**  
WHALEX Semi-Rigid Pipework 15 mm  
High Performance Green 50 m (164 ft)



**WX7168B**  
WHALEX Semi-Rigid Pipework 15 mm  
High Performance White 50 m (164 ft)

### Tools



**WX7950**  
Pipework Cutters - must be used to cut  
Whale Semi-Rigid Pipework



**WX1569B**  
Pipework Mounting Clip (White)



**WX1565(B)**  
Pipework Mounting Clip (Black)

WHALEX Pipework is NSF61 listed and has the benefits of a more scratch-resistant surface and greater durability.

## Simple to use – Easy to install

The Quick Connect system can be used by anyone to install additional outlets or to replumb your boat or recreational vehicle.

**The Whale Quick Connect fittings offer many benefits, all ensuring a high integrity plumbing system.**

- Unique 'Double Gripper' provides secure lifelong tube retention even at excessive pressures.
- Collet has internal support ring ensuring O-ring seal is held in position and does not distort or leak under pressure.
- The innovative, tube supporting, 'cage collet' design eliminates leaks where fittings are close to tight bends.
- High integrity single piece moulding improves the reliability and strength of fittings.
- Outer sleeve incorporates collet cover, thus preventing accidental tube release.
- No collet clips are used thus the Whale system reduces costs, speeds up installation time and ensures complete installation every time.

### Specifications

	Max Pressure	Max Temperature
Hot Water	6 bar (87 psi)	65°C (150°F)
Cold Water	12 bar (174 psi)	20°C (68°F)

Whale Tubing	Min. Bend Radius
15mm	75mm

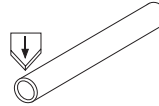
The patented Whale® plumbing system is specifically designed to be used in 'mobile' applications. Whale Quick Connect fittings and WhaleX pipework (only) are covered for 10 years from date of purchase (except WX1599). For use with Whale plastic tubing and grooved stems only.

## Whale® Pipework Systems

### The Leader in Water System Technology

#### To assemble - 2 simple steps

Fig. 1



Cut to length by making a straight clean cut (use Whale tube cutters WX7950/WX7951)

Fig. 2



Simply push the tube into the fitting up to the 2nd internal stop

#### To disconnect

Fig. 3



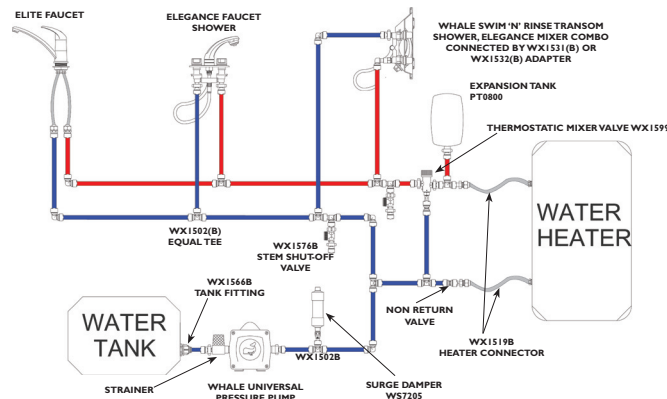
Push back on the grey collet against the face of fitting

Fig. 4



Hold the collet in and pull out the tube

#### Typical Installation



The Whale Quick Connect products are protected by the following patents  
 UK Patent number: 2331564. European Patent number: 1032785. USA Patent number 6349978

Ref No: 180.95\_0808\_v2



PIONEERS IN QUICK  
 CONNECT PLUMBING FOR  
 ALMOST 20 YEARS

SAVE TIME  
 AND MONEY

Award Winning  
 Innovation

- EASY INSTALLATION
- RE-USABILITY
- WATERTIGHT CONNECTION





















WHALE EXPERTISE BUILT ON OVER 40 YEARS  
 IN FRESHWATER, BILGE, GREY/BLACK  
 WASTE MANAGEMENT





Whale Water Systems,  
 Old Belfast Road, Bangor, Co. Down, BT19 1LT  
[www.whalepumps.com](http://www.whalepumps.com)

# QUICK CONNECT SYSTEM – PARTS LIST AND CODES






## 15MM

	EQUAL TEE	WX1502(B)
	EQUAL ELBOW	WX1503(B)
	EQUAL STRAIGHT	WX1504(B)
	END PLUG (BRASS)	WX1508B
	STEM ADAPTER 12mm - 15mm	WX1509B
	STEM ADAPTER 11mm - 15mm	WX1511B
	ADPTR 15mm FEM - 15mm COMPRESSION (BRASS)	WX1520B
	STEM TEE	WX1521(B)
	STEM ELBOW	WX1522(B)
	END STOP	WX1546B
	3 WAY VALVE (BRASS)	WX1571B
	SHUT-OFF VALVE (BRASS)	WX1573B
	SHUT-OFF VALVE	WX1574(B)
	STEM SHUT-OFF VALVE (BRASS)	WX1575B
	STEM SHUT-OFF VALVE	WX1576B
	STEM ICE MAKER FITTING (BRASS)	WX1577B
	STEM ICE MAKER FITTING WITH EQUAL TEE (BRASS)	WX1578B
	CHECK VALVE/NON RETURN VALVE (BRASS)	WX1582(B)












## THREADED 3/4"

	ADAPTER 3/4" BSP MALE - 15mm	WX1516B
	ADAPTER 3/4" BSP FEMALE	WX1542(B)
	ADAPTER 3/4" GARDEN HOSE THREAD GREEN	WX1552B
	ADAPTER 3/4" MALE - 1/2" MALE (BRASS)	WX1568B






## THREADED 3/8"

	ADAPTER 3/8" BSP FEMALE (BRASS)	WX1538(B)
	ADAPTER PLASTIC 3/8" BSP FEMALE	CS1538(B)
	STEM ADAPTER 3/8" BSP FEMALE (BRASS)	WX1539B
	STEM ADAPTER 3/8" NPT MALE (BRASS)	WX1563(B)
	ADAPTER 3/8" BSP MALE	WX1583(B)








## THREADED 1/2"

	ADAPTER 1/2" BSP MALE - 10mm COMPRESSION (BRASS)	WX1080B
	ADAPTER 1/2" NPT MALE (BRASS) - 15mm	WX1513B
	ADAPTER 1/2" BSP MALE - 15mm	WX1514B
	TAP TAIL ADAPTER 1/2" BSP MALE - 15mm	WX1515(B)
	FLEXIBLE HEATER CONNECTOR 1/2" NPT MALE - 1/2" BSP FEMALE (LENGTH 350mm)	WX1519B
	STEM ADAPTER 1/2" NPT MALE (BRASS)	WX1524(B)
	ELBOW ADAPTER 1/2" BSP FEMALE - 15mm	WX1531(B)
	ADAPTER 1/2" BSP FEMALE - 15mm	WX1532(B)
	ADAPTER 1/2" BSP FEMALE (BRASS) - 15mm	WX1533B
	15mm STEM WITH NON RETURN VALVE ADAPTER 1/2" NPT MALE (BRASS)	WX1534(B)
	ADAPTER 1/2" BSP FEMALE GREEN (SHORT WINGS)	WX1536B
	1/2" NPT - 1/2" BSP MALE BULKHEAD ADAPTER (BRASS)	WX1567B
	STEM ADAPTER 1/2" BSP MALE - 15mm	WX1587(B)







## FLEXIBLE HOSE FITTINGS 1/2"

	1/2" HOSE CONNECTOR (BRASS)	WX1544(B)
	STEM ADAPTER 1/2" FLEXIBLE HOSE MALE	WX1584(B)
	TEE 1/2" BARB x 1/2" BARB x 1/2" BARB	WX1585B
	TEE 1/2" BARB x 15 WX x 1/2" BARB	WX1586B
	STEM ELBOW 1/2" FLEXIBLE HOSE	WX1591(B)



## FLEXIBLE HOSE FITTINGS 3/4"

	TEE 3/4" BARB x 3/4" BARB x 3/4" BARB	WX1555B
	TEE 3/4" BARB x 15 WX x 3/4" BARB	WX1556B
	TEE 3/4" BARB x 1/2" BARB x 3/4" BARB	WX1557B
	TEE 1/2" BARB x 1/2" BARB x 3/4" BARB	WX1558B
	STEM ELBOW 3/4" FLEXIBLE HOSE	WX1592(B)
	STEM ADAPTER 3/4" FLEXIBLE HOSE	WX1593(B)
	ADAPTER 22 SPIGOT x 3/4" BARB	WX2259B



## OTHER CONNECTIONS

	9/16" x 24 MALE TAP TAIL ADAPTER (BRASS) FOR GRÖHETAPS	WX1517B
	15mm STEM ADAPTER - 1/2" HOSE (BRASS) FOR WINDSCREEN WASHER	WX1535B
	STEM ADAPTER 1/4" NPT FEMALE (BRASS)	WX1537B
	TANK FITTING ASSEMBLY	WX1566B
	END STOP 22mm SPIGOT	WX2260B
	ADAPTER 5/8" - 15mm	WX1528(B)













## PLUMBING SAFETY FITTINGS

	PRESSURE RELIEF VALVE - 6 BAR, 1/2" FEMALE	WX1595B
	THERMOSTATIC MIXER VALVE 1/2" MALE (BRASS) 15mm & CHECK VALVE / NON RETURN VALVE (Note: This product is covered by a one year warranty)	WX1599B





## FLEXIBLE HOSE FITTINGS OTHER

	3/8" HOSE CONNECTOR (BRASS)	WX1548B
	STEM ADAPTER 5/8" FLEXIBLE HOSE	WX1597(B)

## TUBING

	TUBE 15mm BLUE SEMI-RIGID PIPEWORK (1 YEAR WARRANTY)	10m (33')	WX7152
	TUBE 15mm RED SEMI-RIGID PIPEWORK (1 YEAR WARRANTY)	50m (164')	WX7152B
	TUBE 15mm GREEN SEMI-RIGID PIPEWORK (1 YEAR WARRANTY)	10m (33')	WX7154
	TUBE 15mm RED SEMI-RIGID PIPEWORK (1 YEAR WARRANTY)	50m (164')	WX7154B
	TUBE 15mm GREEN SEMI-RIGID PIPEWORK (1 YEAR WARRANTY)	10m (33')	WX7156
	TUBE 15mm RED SEMI-RIGID PIPEWORK (1 YEAR WARRANTY)	50m (164')	WX7156B
	WHALEX TUBE 15mm BLUE SEMI-RIGID (HIGH PERFORMANCE)	50m (164')	WX7162B
	WHALEX TUBE 15mm RED SEMI-RIGID (HIGH PERFORMANCE)	152m (500')	WX7562B
	WHALEX TUBE 15mm GREEN SEMI-RIGID (HIGH PERFORMANCE)	50m (164')	WX7164B
	WHALEX TUBE 15mm RED SEMI-RIGID (HIGH PERFORMANCE)	152m (500')	WX7564B
	WHALEX TUBE 15mm GREEN SEMI-RIGID (HIGH PERFORMANCE)	50m (164')	WX7166B
	WHALEX TUBE 15mm WHITE SEMI-RIGID (HIGH PERFORMANCE)	50m (164')	WX7168B

## TOOLS

	TUBE CUTTERS (OUTSIDE USA)	WX7950
	TUBE CUTTERS (USA ONLY)	WX7951
MUST BE USED TO CUT WHALE SEMI RIGID PIPEWORK		
	TUBE MOUNTING CLIP (BLACK)	WX1565(B)
	TUBE MOUNTING CLIP (WHITE)	WX1569B

B Suffix refers to bulk quantities for OEM use.  
Parts with (B) suffix are available in bulk or retail packs.  
Parts with no B/(B) suffixes are only available in retail packs.

**QUICK CONNECT**



**12-15-22<sub>MM</sub>**

**TECHNICAL  
DESIGN GUIDE**



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Ref. No. 162/53



## 1 INTRODUCTION

The purpose of this guide is to highlight the key operating parameters encountered within the fresh water plumbing systems of 'mobile' units (e.g. leisure marine and RV's). Through a clear understanding of these parameters, best practice design considerations will be outlined which, if adopted, should result in systems which are safe to use and give many years of trouble free service.

## 2. OPERATING PARAMETERS

Unlike most 'domestic' applications which tend to be open/vented, plumbing systems in 'mobile' units tend to be 'closed' systems. They can also be subjected to physical vibration and stress. It is important therefore to understand the implications of these parameters when designing the plumbing systems.

### 2.1 Closed Systems

By this we mean the entire plumbing system of necessity tends to be totally sealed. Items such as open header tanks, vent pipes and open vented loops (for practical reasons) tend not to be used and consequently problems associated with pressure build up may occur (Fig. 1).

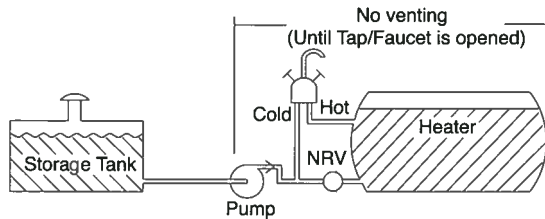


Fig. 1 Simple Closed System

### 2.2 Pressure

The source of pressure (and flow) in most mobile units is generally understood to be a pump. The pressure generated being controlled to normally no more than 45 p.s.i. (3 bar) via either an integral or remote pressure switch. Alternatively some systems may be connected to city/mains water supplies through a special connector incorporating a pressure regulator. These sources of system pressure are generally well understood and easily predicted. However what may not be fully appreciated is the impact of heating the water within a closed system.

#### 2.2.1. Water Expansion

When water is heated, it expands by approximately 4.5% (by volume) over the temperature range from freezing to boiling. Clearly since water, being a liquid, is incompressible a volume (air gap) should be provided to prevent generation of very high pressures (air being compressible and acting as a spring). Ideally this air gap would be provided for in the water heater itself - Fig.2(a). Alternatively an external expansion vessel can be plumbed into the hot outlet line close to the heater - Fig. 2(b). Failure to allow for thermal expansion can generate extremely high pressures which in fact may only be limited by pressure relief valves or system component failure.

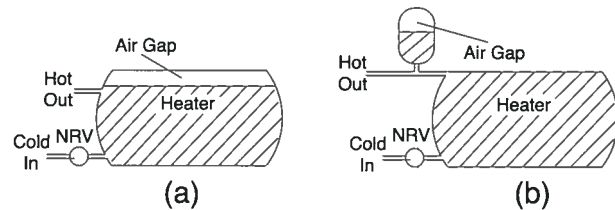


Fig. 2

Careful consideration should be given to the size of this air gap and the table below can be used to calculate the volumetric expansion given the temperature range.

Degrees F(C)	Volume (Units)	Degrees F(C)	Volume (Units)	Degrees F(C)	Volume (Units)	Degrees F(C)	Volume (Units)
39.1(4)	1	86(30)	1.00425	131(55)	1.01423	176(80)	1.02872
50(10)	1.00025	95(35)	1.00586	140(60)	1.01678	185(85)	1.03213
59(15)	1.00083	104(40)	1.00767	149(65)	1.01951	194(90)	1.0357
68(20)	1.00171	113(45)	1.00967	158(70)	1.02241	203(95)	1.03943
77(25)	1.00286	122(50)	1.01186	167(75)	1.02548	212(100)	1.04332

To calculate the appropriate volume the fact that the airgap will be compressed when the system is pressurised must also be considered. This can be estimated using the expression  $P_1 V_1 = P_2 V_2$  (assuming constant temperature) (Boyle's law).

### Worked Example

Assuming a water heater contains water at ambient temperature of 50°F(10°C) which is to be heated to 140°F (60°C) what size of air gap should be provided assuming the system can be pressurised initially to 45 p.s.i.(3 bar).

From the table:

Water expansion over this temp range is approximately 1.7%.

22.7 ltr. becomes 23.1 ltr (6 US gals becomes 6.102 US gals)

Thus 0.4ltr (0.102 US gals) of an air gap must still remain after the system is pressurised to allow for further expansion due to the temperature increase.

Using  $P_1 V_1 = P_2 V_2$  ( $P$  = absolute pressure) ( $V$  = volume of air gap)

$$14.5 V_1 = 59.5 \times 0.4$$

$$V_1 = 1.64 \text{ ltr.}$$

$$14.5 V_1 = 59.5 \times 0.102$$

$$V_1 = 0.42 \text{ gals}$$

Therefore an air gap to accommodate at least 1.64 ltr. should be provided.

Therefore an air gap to accommodate at least 0.42 gals. should be provided.

N.B. Clearly if it were possible to reach higher temperatures then a greater air gap would be required. (Eg. At 185°F (85°C) in the above example rather than 140°F (60°C)an air gap to accommodate 3.6 ltr (1 US gal) minimum should be allowed for).

### 2.2.2 Pressure Control

To control the pressure noted above, and to comply with best practice, both primary and fail-safe control is strongly recommended. The following table shows these devices with the recommended settings as appropriate and their location within the plumbing circuit is shown in Fig. 3 below.

PRIMARY CONTROLS		
PRESSURE SWITCH	Controls pumps pressure	45 p.s.i. (3 bar)
PRESSURE REGULATOR	Controls city/mains water pressure	80 p.s.i. (5.5 bar)
EXPANSION VESSEL	Controls water expansion	see 2.2.1
FAIL-SAFE CONTROL		
PRESSURE RELIEF VALVE	Backup for primary controls	87 p.s.i. (6 bar)

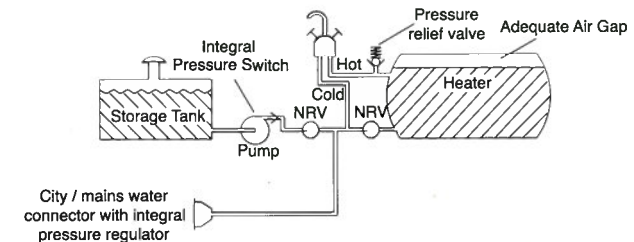


Fig. 3 Schematic Showing Pressure Controls



### 2.3. Temperature

Water may be heated in mobile units in a variety of ways including:-

- electric heating elements
- diesel water heater
- propane water heater
- hot engine coolant circulating through heat exchanger (calorifier).

#### 2.3.1. Temperature Control

As with pressure control best practice dictates that both primary and fail-safe temperature controls should be fitted.

#### 2.3.2. Heating Electrical Elements

These should be fitted with a control thermostat (which may be adjustable in the range 110°F - 140°F (43°C - 60°C) and a fail-safe thermostat which would be set at a higher temperature 180°F (82°C) to switch off the electrical supply and require a manual reset.

#### 2.3.3. Diesel & Propane Heaters

Most proprietary diesel and propane heaters are fitted with both primary and fail-safe manually resettable controls.

N.B. Before manually resetting any fail-safe device the reason for the fail-safe device being activated should be investigated and put right.

#### 2.3.4. Heat Exchangers

Modern engines run more efficiently at higher temperatures consequently many have pressurised coolant systems which allow for running temperatures close to boiling point ie. 212°F (100°C). Clearly if coolant is passed, uncontrolled through a heat exchanger, given time (even with inefficient heat exchangers) the temperature of the heated fresh water will reach unsafe levels.

Two methods of primary control can be used.

##### (a) Thermostatic Control Valve (Fig.4)

This preferred method of control requires that the valve is inserted into the coolant feed line to the heat exchanger from the engine and the sensing bulb (which is connected to the valve with a length of capillary tube) is attached directly to the upper side of the hot water storage tank. The valve can then be set to cut off hot coolant supply when the heated water reaches the desired temperature.

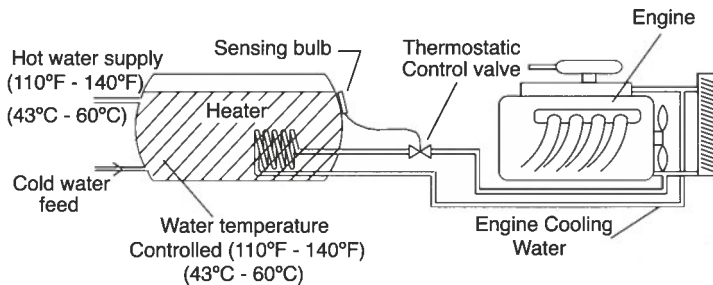


Fig. 4 Arrangement for Thermostatic Control Valve

##### (b) Thermostatic Mixer Valve (Fig.5)

This device has three ports one (1) of which should be connected directly to the hot water outlet from the heat exchanger. The second port (2) is connected to the cold water supply. Water exiting the third port (3) has been mixed (within the valve) to achieve the control temperature set by the control knob and should be connected to the hot water system.

Clearly with the latter device the temperature of the hot water within the exchanger is very high and referring to section 2.2.1 additional volume to compensate for expansion will be required.

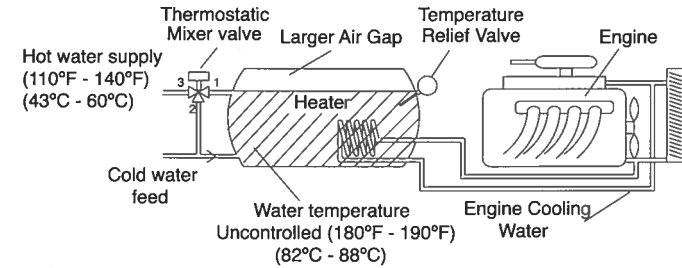


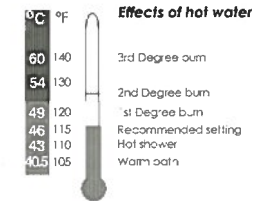
Fig. 5 Arrangement for Thermostatic Mixer Valve

Fail-safe control for both (a) & (b) is effected by a temperature relief valve.

#### 2.3.5. Temperature Settings

Regardless of the water heating method or the control devices used the temperature of the hot water supplied to taps & showers should be controlled in the range of 110°F - 140°F (43°C - 60°C) with fail-safe set at 180°F (82°C).

**CAUTION: Ideally the temperature should be set at 115°F (46°C) for health and safety reasons higher settings will increase the risk of scald injury. Those at greatest risk of scald injury include children, elderly, disabled and diabetics.**



#### 2.4 Fail-safe Devices

The fail-safe devices referred to (pressure and temperature relief valves) earlier may be combination units commonly referred to as P/T (Pressure/Temperature) valves and must not be used as the only/primary method of control.

Where these devices are fitted in boats their discharge ports must have an unrestricted overboard discharge where city mains water regulators are fitted to comply with industry standards and more importantly to eliminate the risk of flooding the boat.

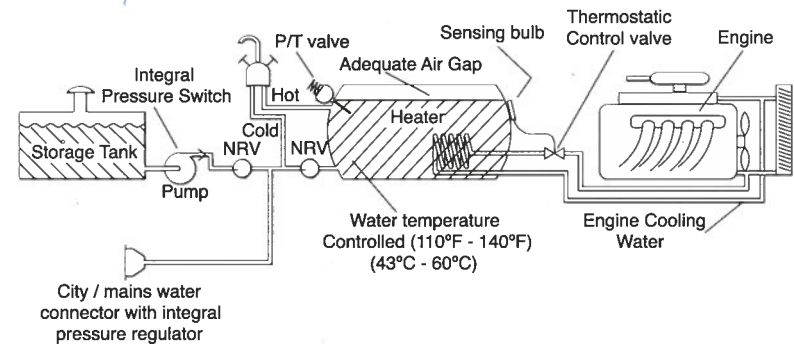


Fig. 6 Recommended arrangement.

### 3. INSTALLATION

As with operating parameters, differences exist between mobile units and typical 'domestic applications'. Most mobile installations use lower cost plastic tubing and fittings which are lightweight and are fitted in less rigid structures. The following recommendations apply to such installations in mobile units and should be adopted accordingly.

#### 3.1 Connections to Water Heaters

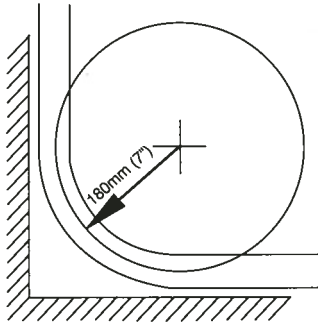
Semi rigid tubing and plastic pipe fittings should not be directly coupled to water heaters and should be kept at a minimum of 350mm (14") remote from the water heater. Connection to the water heater should be effected using metal or metal braided pipe designed for the purpose.

#### 3.2 Bulk Head Connections

Some plastic fittings have quick release mechanisms which are activated by depressing the end of the fittings. These unprotected fittings should not be used up against through - holes in bulk heads where the tubing emerges. The risk here is that as a result of flexing and stresses in the mobile unit the fittings could be pulled against the bulk head activating the release mechanism thus causing a leak. Potential solutions may require special bulk head fittings, collet covers or clips.

#### 3.3 Tube Bend Radii

Care must be exercised when bending semi rigid tubing. Some grades of tubing are more resilient than others and less likely to 'kink' but as a general guideline bend radii should always exceed 7 inches (180 mm).



**N.B. With tight bend radii 'kinking' may not at first be apparent but over time and especially in hot water lines 'kinks' may form.**

#### 3.4 Tubing Ties

In order to keep tubing runs tidy and organised 'cable ties' and/or clips are frequently used. Care needs to be taken when clipping down the tubing not to apply undue side load to the plumbing connector as some connectors are not designed to cope with this side load and leaks may occur as a result.

#### 3.5 Design Service

Whale not only provide a complete range of quality system components but are happy to answer any technical queries and offer a complete system design service.

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Illustrations are for guidance purposes only.

#### Warranty

The Whale Water System pipe fittings and tubing are for use within Leisure Marine and Recreational Vehicle portable water systems. The operating conditions of the plumbing system must not exceed those as specified in the guide. Munster Simms Engineering Limited guarantees that the product will correspond with their specification at the time of delivery and it will be free from defects in material and workmanship for 12 months from the date of purchase. No liability will be assumed where third party plumbing components are incorporated into the Whale plumbing system. For specific details please contact Munster Simms Engineering Ltd.

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