HOT WATER

MANUAL

Compiled by

Rheem Australia Pty Ltd

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The term "Rheem" used in this manual refers to products sold under the Rheem brand name or the manufacturer or distributor of these products. Rheem Australia Pty Ltd is a wholly owned company of Paloma of Japan, a world leader in water heater technology and manufacture.

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Introduction

The purpose of this book is to provide a handy reference for people engaged in the field of hot water. Plumbing students, tradespeople, technical college teachers and hydraulic consultants should find the book a useful guide to ensuring cost-effective, efficient and reliable hot water to the many and varied users of hot water.

Rheem Australia Pty Ltd has been manufacturing water heaters in Australia since 1939. During these years, Rheem has built up a wealth of experience and knowledge of water heating practices. This expertise covers all facets of the industry including water heater design and manufacture, water heater sizing and specification for all types of industrial, commercial and domestic applications and installation and servicing of these products.

To ensure that Rheem continues to develop its expertise and share it with others, Rheem has representatives on many relevant committees associated with our industry. Among others, these committees include many associated with:

- Standards Australia Ltd
- The Australian Gas Association
- The Gas Appliance Manufacturers' Association of Australia
- The Australian Electrical and Electronic Manufacturers' Association

It is by continued involvement through these groups and interaction with various other organisations such as the Australian Greenhouse Office and many electrical, gas and water supply authorities throughout Australia that Rheem can maintain a leadership position within the industry and ensure its products and services are in line with the requirements of Australians, now and into the future.

Rheem's dedication over the years to the water heating industry has placed Rheem in a position to compile an authoritative manual on hot water. This manual has been published drawing on the knowledge contained in previous editions of this manual as well as the input of various Rheem employees whose experience and knowledge on various topics is both deep and authoritative. This combination ensures the information is completely up-to-date, yet built upon on the lessons of over 60 years.

It is impossible for this manual to contain all of the knowledge Rheem has built over the years. Situations will arise that require particular attention to cover specific circumstances. Additionally, there will no doubt be suggestions for improvement to this manual. In either case please feel free to contact your nearest Rheem office on 132 552 or commercialsales@rheem.com.au to discuss your needs.

Despite the detail set out in this manual, it must be remembered that:

- Product designs, functions and specifications are constantly changing and although every effort has been made to ensure the information contained in this manual is correct and current at the time of printing it is always possible that the information will have changed in the meantime.
- This is necessarily a concise manual and it cannot cover every conceivable situation that might arise.
- No matter how much one can learn from reading information there is no substitute for the training and experience of a qualified tradesperson or hydraulic designer.

For these reasons Rheem cannot accept any liability with respect to any alleged loss or damage that might arise if the information has become outdated or if the circumstances are such that it would have been prudent for the person concerned to have employed the services of someone expert and experienced in the field.

We trust this manual will be of value to you.

Rheem Technical Marketing

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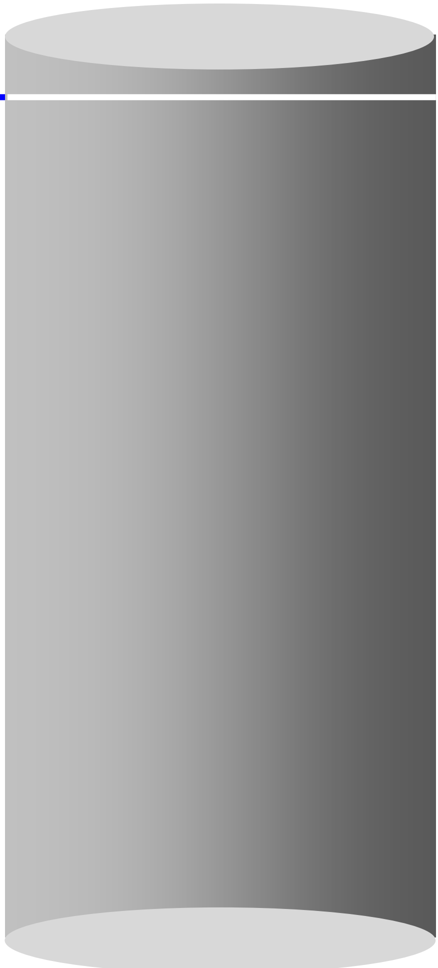
Contents

Chapter 1

Introduction to Water Heating



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This Chapter Covers:

Fundamental theory of water heaters, including

- ► The major classifications of water heaters, with a detailed treatment of their advantages and disadvantages
- ► An introduction to gas, electric and solar power
- ► The basic design of gas, electric and solar water heaters

This chapter also covers basic theory used in later chapters of this book.

TYPES OF WATER HEATERS

Major Classifications

Definition: A hot water system can be defined as an installation of one or more water heaters, plus the associated cold and hot water plumbing, which can supply hot water to one or a number of outlets. This definition is general, and covers many types of water heater, each with advantages and disadvantages. Water heaters are generally divided into five broad classes:

Instantaneous Water Heaters

The instantaneous unit is designed to heat water only at the time it is being used, rather than relying on any form of storage. Instantaneous water heaters are normally connected directly to mains water supply. When a hot tap is opened, the flow of water activates a valve or switch causing gas or electricity to flow to heat the water as it passes through the system; this stops when the hot tap is closed. An integral water governor controls the flow rate of the water to the hot taps. These units can be single point heaters, as in a bath heater, or multipoint, supplying several outlets.

Storage Water Heaters

A storage unit is designed to hold a useful quantity of hot water in a thermally insulated container ready for immediate use. As hot water is used, cold water enters the storage tank to replace it. Reheating continues after the flow of hot water has ceased. These units can be designed either to store and supply hot water at mains pressure, or to store water at atmospheric pressure and distribute it by means of gravity. Again, these water heaters can be single point water heaters (e.g. sink water heaters) or multipoint water heaters. These are also known as "direct storage" units.

Heat Exchange - Coil Heaters

This type of unit consists of a heat exchanger, usually in the form of a coil of copper tubing immersed in a thermally insulated container of static heated water. Cold potable water, at mains pressure, passes through the heat exchanger and picks up heat from the stored water. The stored water is then reheated to bring it back to its original temperature. These are sometimes referred to as "indirect storage" units.

Heat Exchange - Calorifiers

Similar to coil heaters, except the location of the heating water and potable water are reversed. Hot water, generated by some remote appliance, passes through a heat exchanger immersed in a container of stored potable water. The stored water, heated by the heat exchanger, is drawn off when a hot tap is opened. The remote supply of hot water (which is often circulated through the heat exchanger by a pump), can be provided by a water heating appliance (i.e. a boiler), or can be waste heat recovered from some other process. This type of hot water production is usually confined to commercial or industrial uses. These units are also "indirect storage" units.

Commercial Water Heaters (Boilers)

This method of heating water is similar to the instantaneous method. Water is heated as it passes through the water heater and may then go directly to the point of use or pass into an insulated storage tank. Circulation may be by natural convection but is more frequently pumped. Commercial water heaters are used where large quantities of hot water are required and are often connected to calorifiers to provide an indirect storage system.

The term “boiler” is commonly used to describe these appliances. The term “boiler” does not apply to appliances which heat water or other liquids to a temperature lower than the normal atmospheric boiling temperature of the liquid. The term “boiler” does not apply to Raypak water heaters.

Classifying By Storage Pressure

- ***Mains pressure units***: Water is stored and delivered at mains pressure so hot and cold water is at the same pressure.
- ***Reduced pressure units*** (medium pressure): Pressure limiting valves, reduction valves, ratio valves or overhead feed tanks connected to the cold water connection of the water heater reduce the pressure of the delivered hot water to below that of full mains pressure.
- ***Gravity units*** (low pressure): A cold water cistern fitted to the storage tank ensures the water is stored at atmospheric pressure and gravity is used to distribute the hot water to the points of use. This system relies on the storage tank being located well above the draw off points.

Classification By Distribution Method

- ***Single point units***: These are designed to supply water to one tap only. The water heater may be of the instantaneous or storage type.
- ***Multipoint units***: These units have sufficient water flow capacity and thermal input to provide consistent supplies of hot water to several taps simultaneously. Again, these units may be of the storage or instantaneous design.
- ***Push through units***: Also known as "free outlet" water heaters, these units store water at atmospheric pressure, but when the tap is opened mains pressure water is delivered. This is achieved by controlling the cold water supply to the water heater by what appears to be the hot tap at the point of use. On opening this tap, cold mains pressure water is allowed to enter the storage tank and push the hot water out of an uninhibited outlet at the point of use. When the tap is closed, the water in the storage tank returns to atmospheric pressure. (described in more detail later in this chapter).

Instantaneous	Storage	Heat exchange - coil heaters	Heat exchange - calorifiers	Commercial water heaters (Boilers)
Size				
Small size can allow unobtrusive installation.	Physically larger than instantaneous, requiring more space.	For comparable performance approximately twice the size of a storage unit is needed.	Sized to store large quantities of potable water for commercial or industrial use.	Smaller than storage unit of comparable thermal input but may require a separate storage tank.
Fuel supply				
Needs much larger gas pipes or electrical cables and creates a heavy demand when hot water is being used.	Normal fuel supply adequate and demand much lighter than instantaneous.	Normal fuel supply adequate and demand much lighter than instantaneous.	Uses no fuel directly as water is heated by other means and then circulated.	Will need a supply large enough to heat the normally high hot water demand.
Flow of hot water				
Dependant on size of unit. Relatively high pressure drop across heat exchanger can limit performance.	Mains pressure units allow use of multiple taps at one time. Reduced pressure units do not give consistent multipoint use.	Dependant on design of unit. Relatively high pressure drop across heat exchanger can limit performance.	Dependant on means used to provide circulation, pipe sizing and pressure in installation.	Dependant on means used to provide circulation, pipe sizing and pressure in installation.
Quantity of hot water				
Restricted to capacity of water heater to heat instantaneously.	Restricted to initial storage capacity and recovery rate. If draw-off rate exceeds recovery rate, hot water will eventually be exhausted.	Once initial volume of hot water stored within the heat exchanger is used, drops quickly; then flow rate has to be low for water at a usable temperature.	Restricted to initial storage capacity and recovery rate, which is usually quite large.	Restricted to capacity of water heater to heat instantaneously. Additional storage tanks often used to provide hot water for peak demands.

Table 1.1: Advantages and disadvantages of the major types of water heating systems

Instantaneous	Storage	Heat exchange - coil heaters	Heat exchange - calorifiers	Boilers
Temperature of hot water				
Entirely depends on: cold water temperature; flow rate; adequacy of fuel supply. Recent models include a thermostat and electronic controls to provide a constant temperature by modulating the thermal input or the water flow rate.	Constant for approximately 90% of the storage capacity. This volume is the delivery capacity.	Temperature drops dramatically after initial draw then progressively as draw continues. Unit suitable for warmer climates only.	Constant throughout approximately 90% of the storage capacity.	Controlled by water heater thermostat as long as the flow rate does not exceed water heater capacity.
Operation efficiency				
Low standby losses as no stored water is maintained at temperature but large fuel usage at each draw-off before water is at usable temperature increases running costs.	Standby losses higher than instantaneous but special hot water tariffs are available for most storage units.	Standby losses slightly higher than storage units as unit normally operates at higher temperature than storage.	Depends entirely on initial hot water source. Standby losses from storage tank are dependent on type of insulation used. Also consider heat losses from circulation pipes.	Primary flow and return needs to be insulated. High heat loss if storage tank badly insulated.

Table 1.1 (cont): Advantages and disadvantages of the major types of water heating systems

The Displacement Principle

The displacement principle in water heating relies on the well known property of fluids whereby hot water floats above cold water, in the same way that hot air rises above cold air.

Storage water heaters are designed with the hot water outlet near the top of the tank, with the cold water inlet at the bottom. As hot water is drawn out of the top of the tank, an identical quantity of cold water replaces it down below. We can say that the hot water has been “displaced” by cold water.

In a well designed water heater, the hot and cold water will coexist for a considerable time without mixing. This allows the maximum hot water to be drawn off at full temperature, and gives maximum time for the cold water to be heated.

The displacement principle is fundamental to the design of storage water heaters, and is the reason they are more flexible in performance than instantaneous or heat exchange units. All Rheem storage gas, electric and solar water heaters work on the displacement principle.

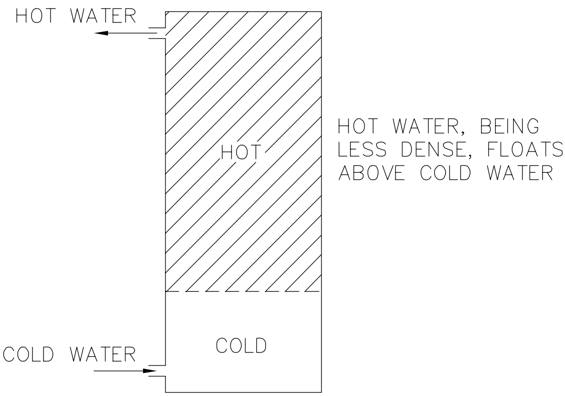


Fig. 1.1 The displacement principle

GAS APPLIANCES

Gas As An Energy Source

How Gases Are Measured

The amount of gas used or sold is given by one of:

- ***Kilogram (kg)*** – only for gases that are stored as liquids.
- ***Cubic metre (m^3)*** - Since gas is compressible, we specify standard temperature and pressure.
- ***Megajoule (MJ)*** – this is the amount of energy it contains. 1 kilowatt hour equals 3.6 Megajoules.

The properties of gas are given by

- ***Heating Value*** – Megajoules per cubic metre of gas. Propane has a heating value of 94MJ/m^3, compared to Natural gas 40 MJ/ m^3.
- ***Density*** – kilograms per litre of gas. Natural gas is lighter than air, so floats. LPG is denser than air, so tends to sink and form potentially explosive pools of gas near leaking appliances.

Chemical Composition Of Gas

Gas is made of small chains of carbon atoms. The simplest unit is methane – one central carbon, with four hydrogen atoms attached to it.

As you chain methane units together, you get heavier gases, such as ethane, propane and butane.

As the gas gets heavier, less pressure is required to compress it into a liquid at room temperature: methane becomes liquid under extreme pressure, propane becomes liquid at 640 kPa, and butane becomes liquid at 80 kPa

Types of Gas

For purposes of discussing commercially useful sources of energy, the most important gases are

- ***Natural gas*** – mostly methane, found naturally underground, often near oil reserves. Once extracted, impurities are removed, and it is piped over long distances to the end user.
- ***LPG (Liquefied Petroleum Gas)*** – a mixture of propane and butane, produced as a by-product of oil refining. It is liquefied, and sold in high pressure cylinders. These cylinders are either sold or rented to the consumer or to industrial installations.

In addition, 4 other types of gas are still in use today:

- ***Town gas*** – Originally based on coal gas, now produced from natural gas, LPG or oil. Made centrally and distributed by pipes to the end user. Largely being replaced by natural gas.
- ***TLP (Tempered LPG)*** – a mixture of LPG and air, compatible with town gas, but easier to produce.
- ***SNG (Simulated Natural Gas)*** – a mixture of LPG and air, but compatible with natural gas. Used in new estates where natural gas will soon become available.
- ***PNG (Processed Natural Gas)*** – natural gas which has been altered to make it compatible with town gas. Used in areas where there is resistance to modifying town gas appliances.

Gas Distribution

Natural gas is not universally available around Australia. Cities and regional centres differ in the penetration of natural gas, and the percentage of households and businesses that have gas connected. Whether gas becomes available to an area is determined by an economic assessment of cost of laying pipes versus expected future revenue flows from gas appliance usage.

Since LPG is readily transportable by road and installations do not require significant capital outlay, we can regard LPG as almost universally available around Australia. However, the higher cost of LPG relative to natural gas, as well as the need to refill or exchange cylinders both tend to limit the usage of the gas.

How Natural Gas Is Sold

Owing to deregulation, gas retailing has developed in a similar way to electricity over the last few years, with most energy companies now offering both gas and electricity to consumers and businesses.

Natural Gas is typically sold by the megajoule. Most providers have different tariff structures for different purposes, such as for heating of water and space heating. Many have a block type tariff structure in which the first block of heat units in the billing period is sold at a higher tariff than subsequent blocks in order to obtain a more equitable return on basic capital costs. Still other tariffs may consist of a standing charge (to cover capital costs) and an additional charge for the gas consumed (to cover production costs).

How LPG Is Sold

Liquefied gases are typically sold by the kilogram or cubic metre. Gas suppliers may have special tariffs for special purposes or differential tariffs according to usage. In many cases the storage vessel is rented to the consumer and the value of this rental should be included as part of the cost of LPG when comparing it with other fuels.

Gas Combustion

Similar to the respiration of living organisms, gas appliances use oxygen to burn the fuel, and produce carbon dioxide and water vapour, plus minor quantities of other gases, as by-products. In the process, energy is released.

Removal Of Combustion By-Products

It is important that all by-products of gas combustion be removed not only from the combustion area but also where people or animals are breathing.

Large fixed appliances are installed with flues to remove such products from the appliances. Smaller appliances may be permitted for unflued installation, but this is only allowed where there is adequate ventilation.

Inadequate ventilation of an unflued appliance will produce undesirable or dangerous effects such as smothering of the flames, imperfect combustion, condensation on walls and ceilings, sooting, smells, and discolouration of painted surfaces or textiles.

In particular, imperfect combustion can produce excessive quantities of carbon monoxide, a colourless, odourless, invisible but highly poisonous gas. There have been cases in recent years of consumer fatalities as a result of improper combustion due to poor appliance installation or servicing. In addition, other combustion by-products such as nitrous oxides or NOx, are irritant gases and are known to exacerbate respiratory conditions such as asthma.

Detecting Improper Combustion

The easiest way to determine if a gas burner is operating correctly is to look at the flame. A well burning gas flame should be sharp and blue. A small amount of yellow tipping is permissible. Excessive yellow tipping is a sign of inadequate oxygen, which results in free carbon particles (ie not combined with oxygen) which colour the flame yellow. Concentrations of carbon monoxide will also be much higher than is safe. Since this represents significant under-combustion, the flame will be cooler than it is designed to be, resulting in lower efficiency.

Gas Appliance Certification

All gas water heaters are required to meet the Certification Requirements for Gas Appliances as published by Standards Australia. Rheem gas water heaters up to 500 MJ/h are all certified to comply with the requirements of AS4552 - Gas Water Heaters. Water heaters exceeding 500 MJ/h input comply with the requirements of AS 3814-2005 - Industrial And Commercial Gas-Fired Appliances. Certification is signified by the certifying body's unique badge.

In addition, all installations must comply with AS5601 – Gas Installations.

Gas Appliance Characteristics

Natural Gas Appliances

In addition to the requirements for compliance and proper gas combustion, all natural gas appliances have the following properties in common:

- Must be fitted with a gas governor. This is a regulating device that prevents the build up of increased gas pressure at the appliance and over gassing of the burner.
- May operate on SNG but will not operate on town gas, PNG, TLP gas or LPG without modification.
- Designed for normal operation at a gas inlet pressure of 1.13 kPa.

LPG Appliances

In addition to the requirements for appliance approval and proper gas combustion, all LPG appliances have the following properties in common:

- LPG appliances do not necessarily have gas governors. However, the installation will have a regulator installed near the cylinder which serves the same purpose.
- LPG appliances should be fitted with 100% safety shut off devices to stop all gas flow should the pilot flame become extinguished.
- LPG appliances are designed for normal operation at a gas supply pressure of 2.75 kPa.

Certification is available in three categories:

(a) propane only

(b) butane only

(c) LPG

Note: A propane only unit will not operate on butane. A butane only unit will operate on propane, but at a much reduced input. The LPG approval is normally at a much lower rating than either propane only or butane only and in effect is the propane rating of a butane only appliance.

Conversion Of Appliances Between Different Gases

Due to differences in pressure and heating value between different gases, appliances which are designed for one type of gas will usually need to be converted before being connected to any other type of gas. Injector sizes and port size for both the main burner and pilots will need to be changed, and which type of gas governor (if any is needed) will also need to be considered.

GAS WATER HEATER DESIGN

Storage Water Heater Design

As the name suggests, storage water heaters contain a useful amount of stored hot water. The stored water is contained in a vessel designed to hold water at a certain working pressure, i.e. mains pressure, medium pressure, etc. The vessel or tank is insulated to minimise heat loss from this stored water. Cold water entering the tank at the base pushes the lighter hot water through the outlet located close to the top of the tank and along the hot water plumbing to the hot taps. If the water heater is sized correctly, there should be enough hot water stored in the tank to provide ample supply for all normal uses. The gas burner located beneath the tank can reheat the water while it is flowing and also between draw offs. In this way, sudden heavy demands are not placed on the gas supply.

The basic requirement in gas storage water heaters is to provide sufficient surface area for the transfer of heat from the products of combustion to the stored water.

The most common design is a storage tank with a single internal (primary) flue. In this design (see Fig. 1.2) the area available for heat transfer is the surface of the bottom of the tank and the internal surface of the submerged length of the flue. The area available can be increased by increasing the flue diameter (up to a point), increasing the area of the flue by the addition of fins or by using multiple flues.

More surface area is available in a "floater" design, where the internal flue is replaced by an external flue in the form of a narrow annular space around the wall of the cylinder. This design is often used in high efficiency storage water heaters, as there is sufficient surface area to obtain high heat transfer to the water, thereby improving the thermal efficiency of the water heater. As well, the design lends itself to the incorporation of a heat trap in the flue way. A correctly designed heat trap will significantly reduce heat losses during standby or maintenance periods by restricting air circulation around the hot cylinder walls.

A "semifloater" with single or multiple internal flues in addition to the external flue sometimes provides the maximum available heat transfer surface area. This type of design is used on water heaters that require rapid recovery rates and, therefore, high thermal inputs. The Rheem Stellar, with a thermal efficiency approaching 90%, utilizes the “semifloater” design.

Each design has advantages and limitations and the design adopted is governed by thermal inputs, storage capacity, dimensional limitations, production techniques and costs.

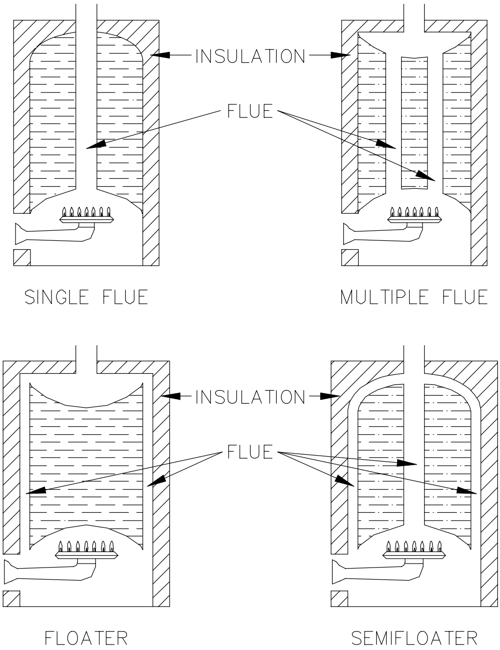


Fig 1.2: Design of gas storage water heaters

Instantaneous Water Heater Design

Instantaneous water heaters do not store any hot water. When a hot tap is turned on, the mains pressure forces cold water through the water section of the water heater, then through a heat exchanger and finally to the hot tap.

The flow of cold water through the water section is regulated by a water governor. The pressure of the flowing water opens a gas valve, which allows gas to the main burner. The gas is immediately lit by either a permanent pilot or a spark produced by battery or electronic ignition. The water, after leaving the water section, passes through a finned copper heat exchanger, which is positioned above the gas burner. Here the water is heated from cold to hot while it is flowing.

The important design features are:

- The gas valve is only opened when the water is flowing, and it shuts as soon as the hot tap is turned off.
- There is no stored hot water in the water heater; all the water is heated as it flows.

- Depending on the type of unit, the temperature of the hot water depends on the flow rate of the water through the heat exchanger, and the temperature of the cold water entering the water heater.
- The gas burner consumes a large quantity of gas while it is in operation. This is necessary to be able to heat the water while it travels through the heat exchanger.

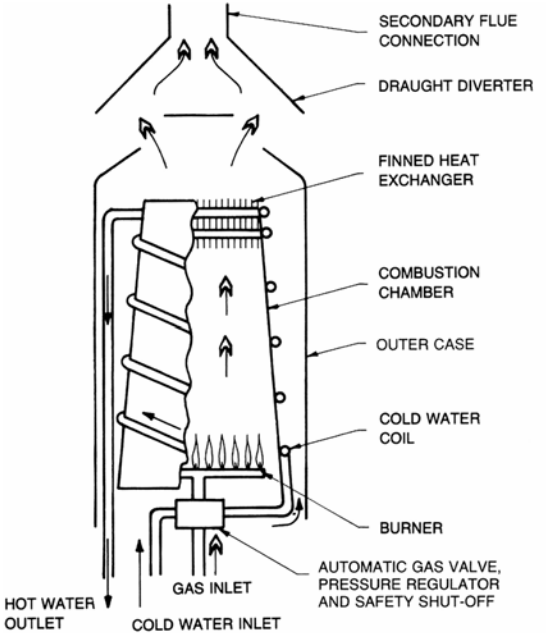


Fig 1.3: Design of a gas instantaneous water heater

Continuous flow water heaters

Continuous flow water heaters are an advanced version of instantaneous water heaters. The major components of this design are a water flow regulator, proportional gas valve, heat exchanger, and cold water bypass.

With this design, the water flow, inlet water and outlet water temperature are constantly measured. The gas flow to the burners and the water flow rate are adjusted to ensure that accurate water temperature is provided and delivered at all times. Electricity is used to ignite the burners.

Electric Appliances

Electricity As An Energy Source

Production Of Electricity

A generator is used to convert motion to electricity. Basically, when a coil is made to rotate between the poles of a magnet, electricity is produced in the coil wires.

Where does the energy come from to create the motion in the first place? There are three methods commonly used in Australia:

- ***Steam*** – produced by burning coal or oil is pressurised then released.
- ***Other engines***- such as diesel or gas powered.
- ***Falling water*** – giving us hydro-electricity.

Other possible methods include nuclear, wind and solar power. Whatever the original energy source, the electricity produced is the same.

Distribution

The "electricity grid" is the network of transmission wires that supplies electricity around the country. As electricity travels over wires, energy is lost via resistance in the wires. The higher the current, the higher the resistive losses. However, use is made of an important principle of electricity:

Power = Current X Voltage.

Thus it is possible to transmit the same power over long distances by increasing the voltage and decreasing the current. This not only reduces losses, but also allows less expensive transmission wires to be used. Transformers are used to step up the voltage at the power station, and step it down again closer to where it is used, with only minor power losses in the process.

How Electricity Is Sold

Electrical energy is sold by the Kilowatt hour.

For most of the Twentieth Century, electricity was sold to consumers and business by government controlled monopolies. Since industry deregulation, many private companies now sell electricity. There are as many different billing methods as there are suppliers. Common methods include:

- Fixed monthly cost plus usage
- Block Tariff – one price for the first few kilowatt hours, then a lower (or higher) price for the next block etc.
- Special Purpose Tariffs – including off-peak hot water.

- Load Based tariff - One price for peak demand, a different price for other times.

How Demand Is Managed

Unlike gas, electricity can't be stored. And unfortunately, electricity usage is not constant throughout the day or year. Electricity supply must be able to cope with peak demand, not just average demand. If it is unable to meet this demand, load shedding, blackouts or rationing of energy may result.

Daily peak demand is typically, though not always, around 6:00pm, whereas minimum demand occurs in the early hours of the morning. On an annual basis, the traditional yearly peak is around July, but split system air conditioning is creating another peak in Summer.

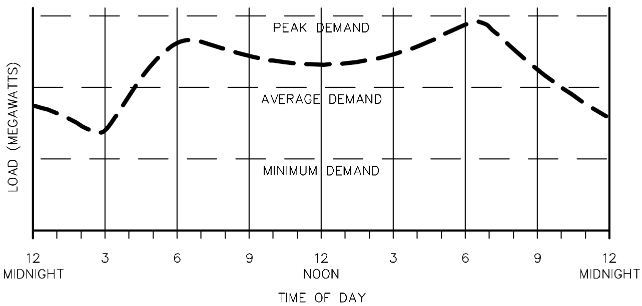


Fig 1.4: Electricity Demand Curve, showing how electricity demand varies over 24 hours

Controlled Energy Supply:

All supply companies are aware of the importance of the system peak, which determines the physical capabilities required in their production and distribution systems. They are also aware of their load factor: the ratio of average demand to peak demand over a particular period (24 hours, 1 month, 1 year, etc.). Accordingly, electricity suppliers are always aiming to reduce peak demand and improve the load factor

The load factor of an electrical distribution area is the ratio of average demand over peak demand in a period. A load factor of 0.5 means average demand is half peak demand.

Electricity providers need to be able to supply enough energy to meet peak demand, even though this peak may only occur for 30 minutes in any month. The higher the peak, the higher is the capital cost of building and expanding plant and distribution infrastructure. Thus it is in the provider's economic interest to reduce this peak as much as possible by using techniques of controlled energy supply.

The main method to achieve this is to offer energy at cheaper rates when it is used at times away from the peak time.

Energy supply is controlled by time switches at each installation and is set to cut in and out at predetermined times or by a system of remote control. In this latter system relay switches are installed at each installation, which can be operated from a central control station as required or according to a program by superimposing an audio frequency signal on to the electrical supply. This signal operates the relay switches without disturbing any other appliance. This type of remote control is known as "ripple control". Although expensive to install, it offers a maximum in flexibility for the supply authority. Ripple control provides the supply authority with numerous "channels" so selected relays may be operated at any time. The connected load is spread over a number of channels so load can be varied as required.

Electrical Characteristics

Most electricity is supplied as alternating current, where voltage goes from a positive high, drops through zero, and continues to a negative low (identical but opposite to the high positive voltage) and then goes up again. This cycle is repeated 50 times per second, also described as 50 Hz.

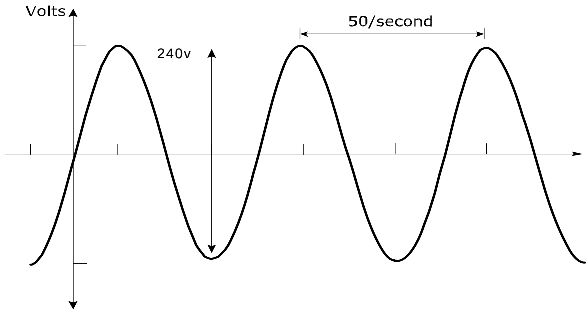


Fig 1.5: an AC wave form

In Australia, there are three types of supply:

- ***Single phase (240V)*** – two wires, one active wire that carries the full ac voltage, the other neutral wire at 0 Volts.
- ***Two phase (415/240V)*** – three wires. Two wires are at 240 Volts, the other neutral wire is at 0 Volts. Timing differences between the ac waves result in there being 415 Volts, not 480, Volts between the two active wires.
- ***Three phase (415/240V)*** – Similar to two phase, but with an extra wire. Three wires are at 240 Volts, the other neutral wire is at 0 Volts. Again, there is 415 Volts between any two active wires.

Variations: Some areas have supplies above or below the nominal 240 Volts/50Hz. Isolated areas may use direct current, which is completely incompatible with alternating current.

Electric Appliance Certification

All electrical appliances are required to meet the certification and test specifications of Standards Australia. For certification purposes, appliances are divided into:

Prescribed appliances: which are required to receive the certification of the Electricity Authority in the State of origin and each such unit must carry the certification number permanently marked on the unit. This certification is automatically recognised by the Electricity Authority in each of the other states. Unvented electric water heaters (i.e. those without a free water surface open to atmosphere at all times) are in this category.

Non-Prescribed Appliances: require the nominal certification for connection to mains from each distributing authority. However, the Electricity Authority in the state of origin can issue a Certificate of Suitability for non prescribed articles and this is automatically recognised by all electricity utilities in Australia. Vented water heaters are not prescribed appliances.

In addition, all electrical appliances except double insulated appliances are required to have an earth connection that will prevent the appliance becoming a hazard if an electrical connection or component becomes faulty.

Standards Australia Requirements

Inspection is carried out according to AS/NZS 60335 - Approval and Test Specification for Electric Water Heaters. This is basically a safety specification to ensure safe operation of the appliance both electrically and physically. It does not lay down requirements for capacity or performance.

Apart from the compulsory AS/NZS 60335, Standards Australia publishes quality and performance specifications eg AS 1056 - Storage Water Heaters and AS 1361 - Heat Exchange Type Electric Water Heaters.

These standards lay down explicit requirements for materials of construction and performance of water heaters. These standards have been prepared to assist purchasers of hot water systems by ensuring satisfactory performance and service.

Hot Water Tariffs

Energy may be available to hot water systems in one of three ways:

- ***off peak*** (or night rate) where energy is available only during a restricted period of 6 to 10 hours, generally at night.
- ***extended off peak*** (or controlled continuous) where energy is available for 16 hours or more each day and turned off only during the overall supply system peak demand periods.
- ***continuous*** where energy is available 24 hours each day.

Because each supply authority has its own mix of domestic, commercial and industrial load, the actual hot water tariffs and their relative prices differ from one to the other.

Storage water heaters of appropriate sizes are suitable for all three. Heat exchange types are not suited to off peak, and instantaneous are suitable only for continuous supply, although they are discouraged by electrical supply authorities owing to the high demand they place on the grid.

Each supply authority has its own regulations covering the conditions to be met before a particular water heater can be connected to a particular tariff. It is important these local requirements be checked before selecting the type and size of water heater to be installed. Typical requirements may include:

- a minimum storage capacity or delivery rating for connection.
- a maximum heating unit rating (which may be based on so many watts per litre) or even a stated fixed rating for the particular capacity.
- non simultaneous operation of multiple heating unit models (see Ch. 5 for a full explanation).

Design Of Electric Water Heaters

Storage Water Heaters

As described earlier, these units typically work on the displacement principle, where hot water is drawn at or near the top of the storage tank, while cold water enters at the bottom. In concept, the design of an electric water heater is simple: an electric heating element directly heats potable water which is contained within an insulated cylinder. Thermostats and other components as described in chapter 5 provide useful features such as higher levels of control.

Push Through Water Heaters

The water heater, usually a 25 L or 50 L electric model, is connected to the mains supply via a tap fitted above basin level in a position similar to the normal hot tap position. When this “hot” tap is opened, cold water pushes hot water out of the basin spout which is permanently vented to atmosphere. When plumbed this way, the unit is suitable for single point use only. The TPR does not normally function, as the expansion of the heated water is relieved through the open vent into the basin.

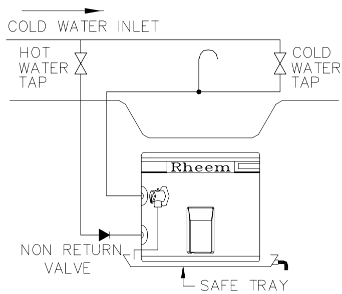


Fig. 1.6 Method of plumbing a push-through heater

SOLAR APPLIANCES

What Is Solar Water Heating

Energy that radiates from the sun is captured in solar collectors and heat is transferred to the water. This differs from *photovoltaic cells* that convert the heat energy to electricity ready for further use.

These collectors work best when exposed to direct sunshine, though radiation scattered through clouds or reflected off other surfaces will also be captured. For this reason, solar heaters can still contribute to water heating even on cloudy days.

In summer, solar radiation is available for about 8 hours each day, where the sun is high enough above the horizon to provide useful amounts of solar energy. During winter, this is reduced to 5-6 hours.

How Solar Energy Is Measured

The level of solar energy that reaches the earth each day is measured in Watts/m^2/day. The figure most commonly quoted is GT, or Total Global Radiation, which includes direct as well as diffuse radiation. This measurement will vary from month to month as well as from location to location. The table in chapter 6 shows monthly average temperatures and solar radiation levels (as received on a correctly oriented flat plate collector) for a number of Australian cities. Notice the following:

- Tropical cities have a more consistent level of solar radiation than southern cities throughout the year.
- Tropical cities do not necessarily have a higher average level of solar radiation than southern cities, due to a lengthy wet season.

Renewable Energy Certificates

The Federal Government has introduced legislation designed to achieve lower greenhouse gas emissions by increasing the amount of electricity generated by renewable energy resources, or by displacing electricity with the use of solar water heaters.

One Renewable Energy Certificate (REC) represents 1MWh of renewable energy produced or 1MWh of non-renewable energy displaced. In the case of displaced energy, a measurement over 10 years is used.

RECs can be traded, purchased and sold which in particular has the benefit of reducing the cost of a solar system for the owner of the system.

The installation of a solar water heater may be eligible for RECs to be created if:

- The solar water heater has certification to AS / NZS 2712:2002 or component certification to this standard if the system capacity is greater than 700 litres.
- The system must be listed on the Renewable Energy Certificate schedule.
- The system is being installed in a new building or the system is replacing an existing electric, gas or solar water heating system. RECs cannot be created when solar heating is retrofitted to an existing electric water heater installation.
- Rheem commercial solar water heating systems are eligible to create RECs only if boosted by Rheem commercial or Raypak water heaters.

Each Rheem solar water heating system has its own table of RECs, which gives the number of RECs in each "zone" in Australia, as defined by the diagram below.

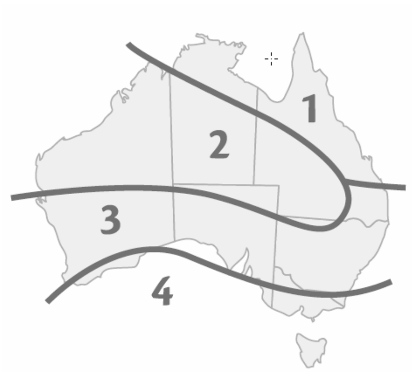


Fig 1.7: Australian zones for REC purposes

SOLAR COLLECTORS

The role of the collector is to receive and possibly concentrate solar radiation, and transfer this energy to water. The following are the most common systems available today.

Flat Plate Collectors

These are constructed as thin, rectangular weatherproof cases, consisting of three layers:

- *Top surface* is low iron glass to allow radiation in but minimise both radiation out as well as wind cooling.
- *Absorber plate* – Once radiation passes through the glass it heats a conducting material such as aluminium, copper or steel. The effectiveness of this plate can be increased by coating the material with a heat absorbing surface such as matt black paint or a more expensive selective surface which can optimise the radiation absorbed and minimise the re-radiation (measured as emissivity).
- *Water channels* are bonded to the absorber plate. This is where heat is transferred to the water.

Advantage: Most popular system in Australia. Reliable and relatively inexpensive.

Disadvantage: as fluid temperature increases, so does radiation loss. Absorber plates coated with selective surfaces suffer less from this problem.

Evacuated Tube Collectors

Made up of 10 to 15 glass tubes, with each tube consisting of two glass tubes:

- *Outer glass tube* – capable of withstanding hail.
- *Inner tube* - coated with high absorption, low reflection material, water passes within this tube and absorbs heat energy.

These tubes are fused together with an insulating vacuum between them to minimise heat loss by convection and conduction.

Advantage: Very efficient, producing high temperature water or steam. Because the collector surface is circular, the suns rays always fall on them at right angles to the surface, which minimises reflection.

Disadvantage: Fragile, higher cost.

Parabolic Tracking Collectors

These collectors are mounted so they rotate on a pivot, allowing the collecting surface to follow the sun during the day, and receive sunlight at near right angles all day.

The collecting surface is usually a long rectangular reflector which is curved around to form a parabolic cross section. Particular shape focuses incident radiation into a central absorbing tube. This tube may be an evacuated tube, a heat pipe filled with heating fluid, or a waterway coated with a selective surface or matt black paint.

Advantage: Capable under the right conditions of producing very high temperatures.

Disadvantage: poor performance unless there is direct radiation.

Heat Pump Collector

Works opposite to a refrigerator. An evaporator on the roof absorbs heat and boils a refrigerant liquid inside. A compressor increases the pressure of the refrigerant gas. A condenser then transfers the heat to the water storage cylinder.

Advantage: No frost associated damage problems. Some energy is collected under all conditions.

Disadvantage: Electrical compressor has high installation and running costs, as an electrically powered compressor is required.

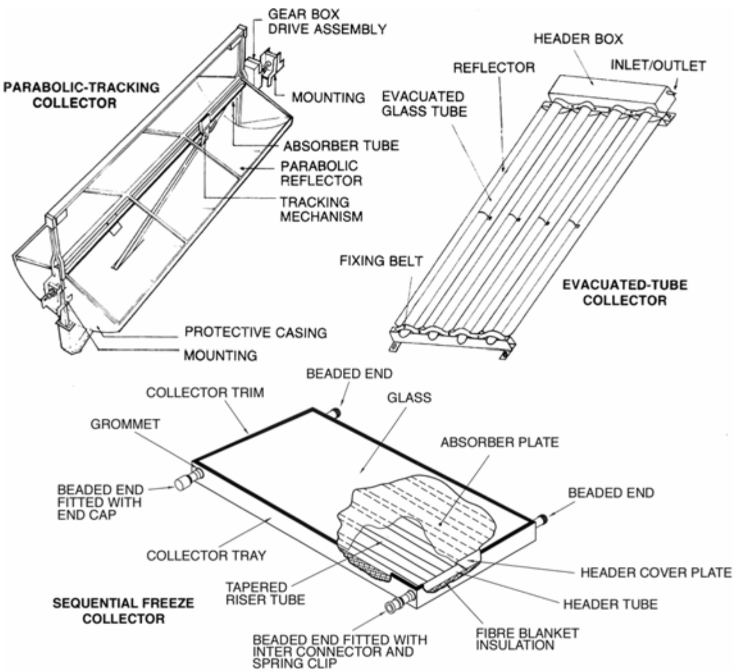


Fig 1.8: Types of solar collectors

Flat Plate Collectors

Orientation And Inclination Of Collectors

When positioning solar collectors, best results are achieved when the sun's rays fall directly at right angles to their face. Consider the following:

Orientation: For southern hemisphere installations, point the collectors roughly north towards the sun. In practice, anywhere between north east and north west will achieve 95% of the result, because the sun travels from east to west during the day, and so for some part of the day, the sun's rays will hit the collectors directly.

Inclination: This is the angle from horizontal. At midday, the sun is not exactly overhead except at the equator. With installations that are further south, the midday sun is lower in the sky, so the collectors need to be titled off horizontal. A couple of rules of thumb are:

- The inclination should be close to the latitude of the installation.
- The tilt needs to be at least 5° in split systems and 10° in close coupled systems to allow for proper operation. So even at the equator, collectors will not be perfectly horizontal.

During winter, the midday sun is even lower in the sky; during summer it is slightly higher. So slightly better results are achieved if you consider:

- For better winter performance, tilt the collectors latitude + 15%.
- For better summer results, tilt the collectors latitude - 10%.

Table 1.2 gives suggested collector angles of inclination for a number of Australian cities, showing clearly the correlation between latitude and inclination angle.

City	Latitude	Inclination Range	City	Latitude	Inclination Range
Adelaide	35°	32°-40°	Hobart	42°	38°-48°
Alice Springs	24°	22°-27°	Mildura	34°	31°-39°
Brisbane	27°	25°-31°	Melbourne	38°	35°-43°
Broken Hill	31°	28°-35°	Perth	32°	29°-36°
Cairns	17°	15°-19°	Port Hedland	20°	18°-23°
Canberra	35°	32°-40°	Rockhampton	24°	22°-27°
Darwin	12°	11°-13°	Sydney	34°	31°-39°
Geraldton	28°	25°-32°	Townsville	19°	18°-21°

Table 1.2: Suggested collector angles of inclination for solar collectors at major Australian cities

CIRCULATION SYSTEMS

Because the means of heating is not located inside the water storage tank, there needs to be some means of transferring heated water to main storage.

Close Coupled Systems

These rely on natural convection (or thermosiphon) to move water through the system. The water storage tank must be positioned above the collector. As water inside the collector is heated, it becomes less dense and rises, flowing naturally into the tank. Similarly, cooler water flows from the bottom of the tank back into the collector for reheating, to complete the circulation cycle.

These units require careful planning as the roof structure must be strong enough to support the weight of the collector plus a full water storage tank. Tanks are usually installed in a horizontal position to distribute weight across a wider area. Some low pressure systems have the tank located out of site within the roof cavity, but still higher than the collector.

The advantage of close coupled systems is that they do not need electricity to circulate water around the system.

Split Systems

When it is impractical or aesthetically unacceptable to place storage tanks on the roof of a building, it is possible to have the tanks located at ground level, with the collectors still on the roof. Since the collectors in this system are at the highest point, some means of circulation is required to keep cold water or fluid moving up, and forcing hot water or fluid down the piping system. A small circulator can achieve this with minimal additional running cost.

The circulator is typically controlled by a differential controller which operates the circulator whenever the temperature in the collectors exceeds the ambient water temperature by approximately 8°C.

Open Circuit Systems

Open circuit, or direct, systems heat the potable water directly through the collector. While typically lower in purchase cost, they cannot be used where freezing is a problem over sustained periods, although some systems do feature a certain level of mild freeze protection. Freezing begins to occur at 4°C ambient temperature. Neither can they be used in poor water quality areas due to corrosion and/or scale build up in the collectors.

Closed Circuit Systems

Closed circuit, or indirect, systems do not heat potable water directly. Instead, an anti-freeze fluid circulates through the collectors, and then through heat exchangers which transfer the heat to stored water. These systems offer excellent protection against damage caused by freezing as well as protecting the collectors from the effects of poor quality water.

Heat Pump Systems

While solar heaters draw energy directly from the sun's radiation, heat pumps draw energy that is contained within the surrounding air.

Heat pumps operate in a reverse manner to a refrigerator, as diagrammed below.

Hot, high pressure refrigerant vapour leaves the compressor and is passed to the heat exchanger. The refrigerant condenses to liquid as it gives up heat to the water drawn from the storage tank through the heat exchanger and back to the tank via a circulating pump. The high pressure liquid passes to the TX valve where it expands and becomes a low pressure liquid refrigerant. Low pressure, low temperature liquid refrigerant passes through the evaporator. The cool refrigerant evaporates to become warm vapour as it obtains energy from the warmer air passing over the evaporator, drawn in by the fan. The warm, low pressure refrigerant vapour is passed to the compressor where it is compressed to a high pressure, high temperature vapour, and the cycle continues.

The advantage of heat pumps is that they move heat rather than create it, which is a much more efficient process. Air sourced systems are typically self contained requiring no further refrigerant work on site, however, the fan can create some noise, similar to a small air conditioner and needs to be considered when selecting this type of water heater.

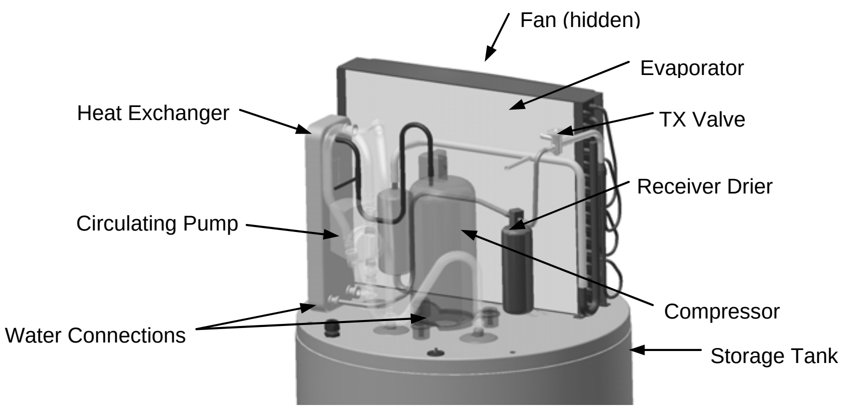
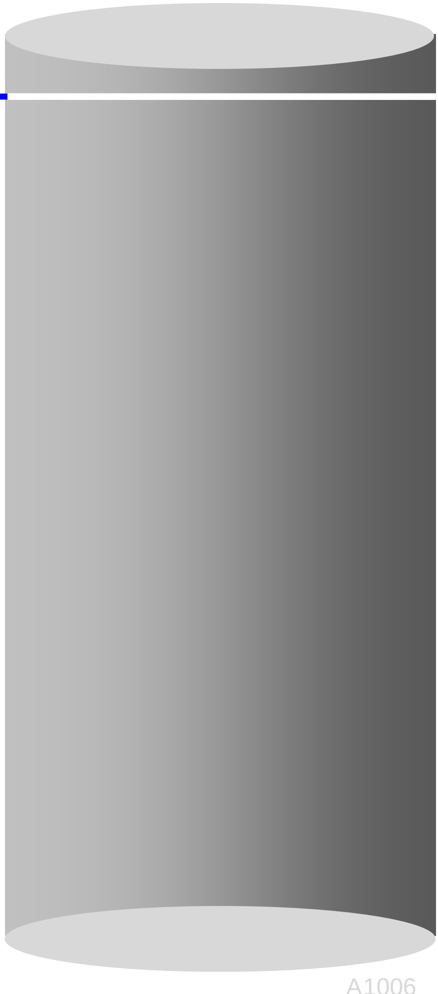


Fig 1.9: Design of a water heater based on the heat pump principle

Chapter 2

Cylinder Construction



This Chapter Covers:

- How water temperature, pressure and chemistry affect design and choice of materials
- A basic overview of storage tank design features and operation
- How cylinder materials are protected from corrosion, in particular using vitreous enamel linings with sacrificial anodes and stainless steel.

This chapter also covers basic theory used in later chapters of this book.

DESIGN CONSIDERATIONS

The vast majority of water heaters sold in Australia today are mains pressure storage water heaters, varying in size from 25 L to 400 L. These tanks store hot water under pressure. They must be designed and manufactured to enable them to withstand a wide range of conditions over their useful life, including:

High temperatures: Water temperatures are often as high as 70 or 75°C, or up to 82°C with commercial water heaters. A heater must withstand this temperature constantly without weakening.

Expansion and Contraction: A storage cylinder undergoes constant expansion and contraction cycles which can weaken inferior grade steels. The expansion and contraction is partly due to the heating and cooling of the cylinder itself. More importantly, changes in pressure inside the cylinder give rise to expansive forces. As the water inside the cylinder is heated, it expands, which increases the pressure of the water in the cylinder. This pressure is reduced again when water is drawn off. These cycles can happen several times per day.

Variations in Water Supply Pressure: Pressure varies throughout Australia depending on location and peak demand.

- *At the low pressure end*, supply pressure can be as low as 200kPa though true mains pressure performance requires pressure of at least 350kPa.
- *At the high pressure end*, water supply pressure can be as high as 1100kPa, though high temperatures, water hammer and fluctuations in supply pressure can make this higher.

Water Chemistry: Mains water is not pure H_20. It contains of dissolved solids that may affect the cylinder life.

- *Low pH*: which has a corrosive effect on exposed metals.
- *Scale*: usually minerals such as calcium and magnesium carbonates which form a deposit on surfaces such as the insides of tubes and on heating elements. This scale is insulating and can cause elements to overheat.
- *Electrolytes*: salts that can carry electric charge. These contribute to galvanic reactions between metals.

Variations in Water Quality: As will be discussed later in this chapter, water from different parts of Australia exhibit significant variations in dissolved solids and pH as well as the tendency of the water to form scale on metallic components.

BASIC CONSTRUCTION

Storage Cylinder

Storage water heaters are designed and built to withstand heat, pressure and corrosion.

The manufacture of the storage cylinder can be understood by dividing the process into these steps:

Choose the steel: Basic variables are:

- *The grade of steel*: Steel grades differ in strength and surface properties and is selected to suit the design operating pressure as well as process requirements.
- *The thickness of steel*: also determines the strength of the end product. Thicker steel is required for larger heaters, because as a sheet of steel covers a wider area, it becomes flimsier unless it is made thicker to compensate.

Cut and punch: The cylinder sheet is cut to size, and holes for valves and fittings are created in a multi punch press. Cylinder ends are formed as discs and drawn into domed ends in large presses.

Cleaning: For mild steel cylinders which will be later enamel lined, the components are grit blasted to remove any mill scale and provide a clean, slightly rough surface for welding and enamel adhesion.

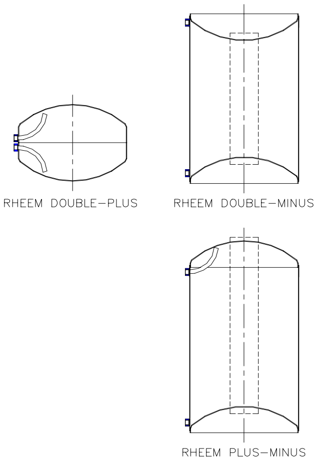
Weld the sheets to form a cylinder: First the main sheet is rolled and welded along its length to form a hollow tube. The cylinder top is welded to the cylinder and in most cases this assembly is enamelled. In the meantime cylinder bottoms and/or flue tubes are assembled and enamelled. The shell/top assembly and bottom/flue assembly are welded to form an enclosed cylinder.

Stainless steel cylinders are welded as a complete assembly. Enamelling is not required, however a pickling and passivation process is required to protect the finished cylinder from corrosion (described later in this chapter)

Hydrostatic Test: Each cylinder is pressurised to its working pressure and checked for leaks before final assembly into a water heater.

Plus and Minus Designs

Rheem water heaters have evolved over the years from double minus cylinders suitable for Coppermatic linings through to plus minus cylinders. A double plus design is used for the 25 and 50 litre water heaters and all stainless steel cylinders. Each change has provided a more compact water heater without reducing the delivered quantity of hot water.



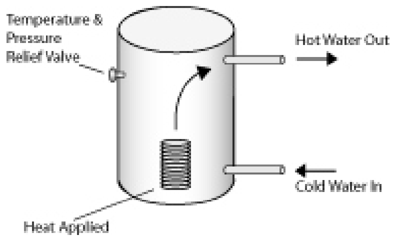
Basic Operation

Cold water enters at the bottom of the cylinder, is heated by an electric element, burner or other means to a preset temperature, and stored until required.

Hot water is drawn off from the top of the cylinder. As this happens, more cold water enters to replace it, using the displacement principle described in Chapter 1.

Water is stored at mains pressure. When both a hot and cold water tap are turned on simultaneously, water comes out of each one at roughly the same pressure. This is a requirement for most automatic mixing valves.

Trapped water builds pressures: A non-return valve in the cold water connection prevents water returning to the mains supply. When all taps are off, no water leaves the system. As the water is heated, the pressure can increase above mains pressure.



Temperature Pressure Relief Valve

To prevent damage to the cylinder, storage water heaters are fitted with a combination Temperature Pressure Relief (TPR) valve.

Pressure Relief

The relief pressure of the valve is the maximum pressure the heater is designed to withstand, and is known as the working pressure or operating pressure of the heater. The maximum supply pressure is typically required to be 20% below this value. If the working pressure is reached (eg due to thermal expansion), the valve releases some water to maintain the pressure at acceptable levels. Typical settings and maximum supply pressures are:

TPR valve setting (kPa)	1400	1000	850
Maximum supply pressure (kPa)	1100	800	680

As a tank increases in diameter, it is less able to withstand high pressures without a significant increase in material thickness, which may not be feasible. Larger diameter Rheem water heaters have their TPR valve set to 1000kPa, which means they can cope with a maximum supply pressure of 800kPa.

The working pressure and the maximum supply pressure of each water heater are clearly indicated on its rating label. If the supply pressure is expected to exceed this value, a pressure limiting valve or pressure reduction valve is needed to reduce the pressure to this level. The pressure limiting valve can be fitted to either the entire cold water supply, or simply to the inlet of the water heater.

Temperature Relief

The TPR valve is fitted with a polythene sensor. Under abnormal high temperature conditions (such as when a thermostat and ECO have failed) the polythene rod expands and pushes against a stainless steel rod which opens the valve to relieve pressure and energy. The relief setting operates at temperatures between 95 and 99°C and will release large volumes of high temperature water. For this reason drainage from the TPR valve must be terminated correctly and be able to withstand constant high temperature water.

Expansion Control Valve

Some water supplies in Australia have a high saturation index which indicates the propensity of water to form or deposit scale. In these waters, carbonate is deposited out of the water onto any hot metallic surface.

In scaling water areas, it is possible the TPR valve can eventually become blocked with carbonate deposits as the scaling water passes through the hot valve body. If the TPR valve were to become totally blocked, the cylinder would eventually distort and fail.

To prevent this occurrence, water heaters installed in scaling water areas must have an expansion control valve (ECV) fitted on the cold supply to the water heater. The ECV must have a pressure relief setting lower than the TPR pressure relief setting. In this way thermal expansion is released via the ECV in preference to the TPR valve. As the ECV is fitted in the cold supply line, water being released is cold, which reduces the propensity to form scale, and carbonate is not deposited onto metallic surfaces. The ECV does not become blocked, thus protecting the cylinder.

The operating pressure of the water heater effectively becomes the pressure setting of the ECV and the maximum supply pressure should be 20% below this value.

Design Certification

Before a new water heater can be released for sale, its design must be certified. A sample is given to an independent, certified, testing authority which tests the heater according to the requirements of all relevant standards.

Over Pressure Test – Ensures a water heater can withstand extremes of pressure. In this test, the tank is pressurised, then inspected. It passes if:

- For gas water heaters, at 1.5 times working pressure, there is no permanent distortion.
- At 2 times working pressure, there is no leakage.
- For electric water heaters, at 2 times working pressure held for 15 minutes, there is no distortion that would cause an electrical fault.
- ***Pulsation Test*** – Ensures a water heater can survive many cycles of being heated and cooled over its useful lifetime. In this test, the tank is filled with water and is pressurised first to working pressure and then to 15% of working pressure. For most heaters, this involves 250,000 cycles of 1400 kPa then 210 kPa or 1000 kPa then 150 kPa.

Delivery Test – Also known as Draw Off, or Stratification Test – Ensures the water heater can deliver an appropriate amount of hot water without a significant drop in temperature. In this test, the volume of water is drawn off and the temperature of the water is measured.

For electric water heaters, the delivered volume needs to be one of:

25 L	31 L	40 L	50 L
60 L	80 L	100 L	125 L
160 L	200 L	250 L	315 L
400 L	500 L	630 L	

The design passes if:

- After the temperature drops 12°C the delivered volume as measured equals, or is greater than, the volume as stated above and on the data plate.

For gas water heaters, there is no restriction on the volume of the heater. The design passes if:

- The volume as measured is within 5% of the volume stated on the data plate.
- There is no more than a 6°C drop in temperature when 70% of the volume is drawn off.

CYLINDER PROTECTION

Most storage cylinders are made of mild steel, which will rust and fail if left unprotected. Some form of protection or lining is required. Like the rest of the cylinder the lining must be able to cope with a wide variety of pressures, temperatures and water quality.

Types Of Protection Used

Historically: Cylinders were made from

- Cusilman bronze, an exotic but expensive alloy
- Galvanised steel, which has a limited life
- Coppermatic cylinders – till 1981, many Rheem heaters were steel lined with copper. These proved successful in good water quality areas but were less effective in poor quality water areas such as Adelaide
- Nylon lining was used by some manufacturers locally and overseas.

Currently, there are two major types of cylinder protection in use:

- ***Vitreous enamel lining in conjunction with cathodic protection*** - A hard, glassy coating up to 0.6mm thick. Enamels are also used to coat baths, certain domestic barbecues and some saucepans and frypans. An anode is used to provide supplementary protection and sacrificially corrodes in preference to the cylinder.
- ***Stainless Steel*** – The correct grade of stainless steel must be selected and post production treatments such as pickling and passivation are used to prevent corrosion of the cylinder.

Pickling and Passivation – Both pickling and passivation are chemical treatments applied to the surface of stainless steel to remove contaminants and assist in the formation of a continuous chromium-oxide, passive film.

Vitreous Enamel

Advantages of Vitreous Enamel

Rheem considers vitreous enamel to be the most appropriate lining to ensure long life under Australian conditions. Its advantages include:

- Insulates as well as protects.
- Withstands extremes of temperature. For demanding applications, two coats can be used.
- The enamel formula can be varied to suit different applications
- It completely separates the metal from any outside contact.
- Suitable for use in most water qualities with the correct anode selected.

Production Sequence of Enamel Lined Water Heaters

Prepare the surface of the steel shell by blasting with an abrasive grit to remove scale, rust, and other residues from manufacturing processes.

Mix the "slip: grind and mix together the ingredients of the enamel, including powdered glassy elements known as "frits", powdered clay, silica, other mineral additives, and water. The viscosity of the slip is adjusted to ensure it can be applied in the appropriate thickness.

Coat the tank: One of two methods:

- *Spray*, using semi automatic equipment. Flow control is used to achieve an even thickness.
- *Flow coating*, where the slip is poured into the finished cylinder and rotated to provide an even coat.
- *Vacuum coating*, where the enamel is drawn into the cylinder under a vacuum and then allowed to drain out under gravity.

Dry off excess moisture: using a drying oven. This leaves the component coated with a chalky "bisque".

Fire at 870°C - 950°C in an industrial furnace. This is where the bisque melts, undergoes chemical change and becomes completely bonded to the steel, to form a hard, glassy enamel coating, hence it is commonly called "glass lined".

Weld, assemble and test: to complete the end product.

Use in Rheem water heaters

Enamel was first used by Rheem in 1969. Since 1982, all Rheem heaters have used one or two coats of enamel.

There are many enamel formulations. Each application and product design requires the development of a new enamel formula, followed by extensive laboratory and field testing. This is done by Rheem in conjunction with raw material suppliers and worldwide Rheem affiliates.

The main classes of enamel used by Rheem are:

Rheemglas Enamel: Designed for use up to 70°C. Rheemglas heaters installed in a single family home come with a 5 year warranty against cylinder failure. First introduced in 1969, with constant development and refinement since then.

Optima Enamel: Designed for use up to 75°C. Combinations of special formulations and thicker coats are used. Optima heaters installed in a single family home come with a 10 year warranty against cylinder failure. Introduced in 1993.

Heavy Duty Enamel: Designed for use up to 82°C, as required for commercial dishwashing machines. Combinations of special formulations, thickness and / or two coats of enamel are used to provide long life in harsh working conditions A Rheem commercial water heater installed in a commercial application has a 5 year warranty against cylinder failure.

Cathodic Protection

Sacrificial Anodes

Metals differ in their tendency to surrender electrons. When two metals are brought into contact in a solution that can conduct electricity (such as water with dissolved salts) then the more "active" one will tend to surrender electrons to the other.

When this happens, the metal that surrenders electrons to the other metal

- Takes on a positive charge
- Dissolves into the water
- Is called an anode

The metal that receives these extra electrons

- Takes on a negative charge
- Surrenders these extra electrons (instead of its own) to oxygen, and is thus protected from oxidation attack
- Is called a cathode

The idea then is to protect steel from oxidising by placing a more active metal in contact with it.

Example: A magnesium anode is directly connected to the inside of a storage cylinder. It is a more active metal than steel. The magnesium rod acts as an anode, by supplying electrons, and therefore sacrificing itself to protect the steel cylinder from corrosion.

Anode Design

The effectiveness of cathodic protection depends on:

- The separation of the two metals in the galvanic series
- The area of steel exposed to corrosion
- The conductivity of water, which depends on the amount of dissolved solids that carry an electric charge.

The first two are controlled by the designer. The last variable varies widely around Australia, and so a number of different anodes are available to suit these conditions, explained further in this chapter.

Anode Replacement

Anodes should be inspected and replaced if necessary as follows:

- Rheemglas: after 8 years
- Optima: After 10 years
- Heavy Duty: after 7 years

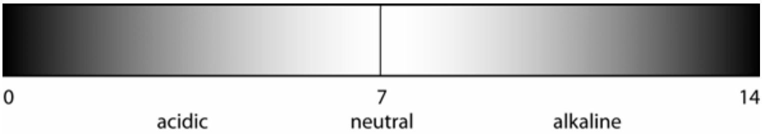
In areas with softened water or where water quality is close to the limit of an anode's specification, an inspection 2-3 years earlier is recommended.

COMPONENT SELECTION

Water Chemistry

pH

This is the acidity or alkalinity of water, measured on a scale of 0 to 14, with 7 being neutral. This is an exponential scale – every increase of 1 pH unit involves a 10 fold decrease in acidity.



Scale

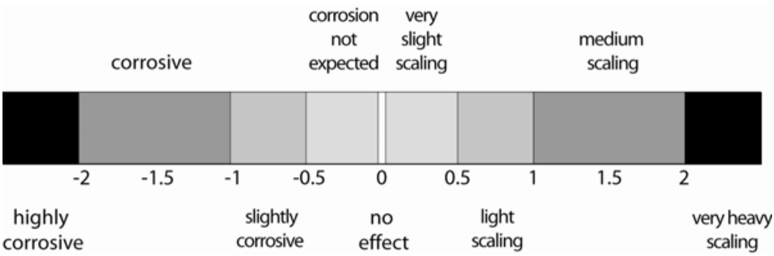
Scale is a limey deposit of minerals such as calcium carbonate that forms on water heater components. Scale formation is exacerbated by

- *Total hardness*, the higher the concentration of hardness minerals greater the propensity to deposit a scale.
- *Higher pH*, ie more alkaline water causes minerals to deposit.
- *Higher temperature* speeds up the rate of formation of deposits.

Saturation Index (SI)

Saturation Index, or Langelier Index, is a calculation used to determine water chemistry as it relates to corrosion and scale formation.

0 means the water is neither scaling nor corrosive, ie neutral. The more positive, the greater is the propensity to form scale. The more negative, the more corrosive is the water.



Total Dissolved Solids (TDS)

This is the concentration of all dissolved minerals in the water, expressed in mg/L.

Water Conductivity

Conductivity is measured in microsiemens/cm.

There is an approximate relationship between Total Dissolved Solids and Conductivity as follows:

TDS = Conductivity x 0.7

Example: a local water supply has been rated as having a conductivity of 715 microsiemens/cm. In order to choose appropriate anodes, the TDS must be established.

Using the formula, the TDS is given by 715 x 0.7 = 500mg/litre.

Selection of Components

The selection of components of Rheem storage water heaters depends on various aspects of water chemistry.

Vitreous Enamel

Vitreous enamel lined water heaters are suitable for water supplies that have a Total Dissolved Solids rating of 2500mg/L or less.

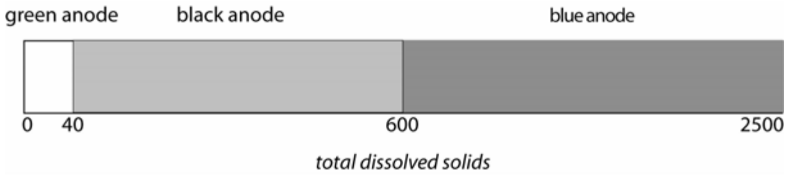
Anodes

Black anode: Most widely used. All areas except extremely high or extremely low conductivity. (specification AS2239 M2) previously known as ASTM specification AZ31b.

Green anode: For areas of very low conductivity (TDS less than 40mg/litre) eg where deionised water, rain water or snow melt is used. (specification AS2239 M1) previously known as ASTM specification M1.

Blue anode: For areas of very high conductivity, where Total Dissolved Solids is higher than 400mg/litre, but less than 2500 mg/litre.(specification AS2239 M5).

Use the chart below to guide selection.



Special note - Hydrogen Generation: If the water supply has a TDS greater than 600 mg/L and the anode has not been changed to a blue one, there is a possibility hydrogen gas could accumulate in the top of the water heater during long periods of non use. If, under these conditions, the water heater has not been used for two or more weeks, the following procedure must be carried out before using any electrical appliances (such as automatic dishwashing machines), that are connected to the hot water supply.

The hydrogen, which is highly flammable, should be vented safely by opening a hot tap and allowing water to flow. There should be no smoking or naked flame near the tap while it is turned on. Any hydrogen gas will be dissipated, indicated by an unusual spurting of the water from the tap. Once the water runs freely again, any hydrogen in the system will have been released.

Stainless Steel

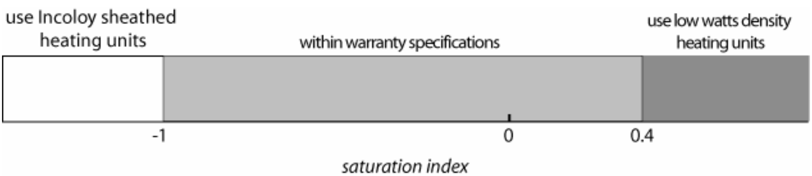
Water heaters made with stainless steel cylinders are affected by a different set of water quality conditions to those made with vitreous enamel.

- *pH* - Low pH waters are acidic and increase the risk of failure by corrosion. Rheem stainless steel water heaters are designed for use in waters with a pH level 6.0 – 8.5.
- *Chloride* – A relationship exists between the alloy grade and chloride level. Basically, higher chloride levels exacerbate corrosion. Rheem stainless steel water heaters are designed for use in waters with a chloride level <250mg/L.
- *Note:* Saturation Index is not a relevant measure to determine the suitability of stainless steel cylinders in a given water quality. However, the Saturation Index is still required for other components as discussed below.

Electric Heating Units

Scale damages heating units by forming an insulating layer around them, and causing them to overheat. For waters that have a Saturation Index greater than +0.8, a low watts density element will give longer life.

For waters with a Saturation Index of less than -1.0, use an element with a corrosion resistant Incoloy sheath around it.



Solar Installations

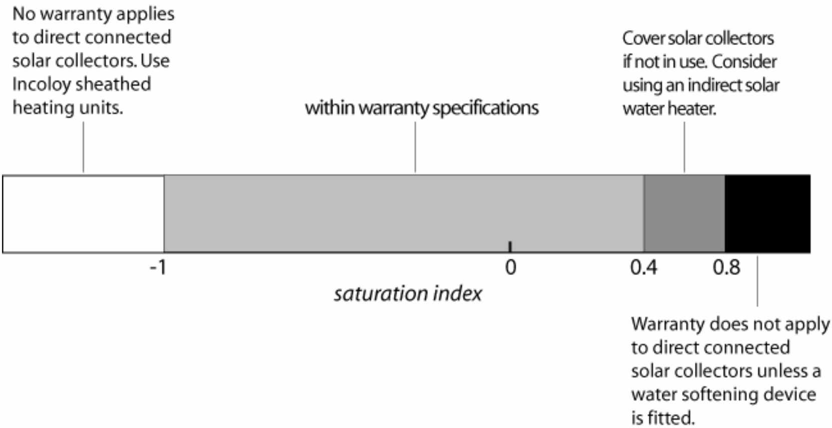
Solar water heaters are available in two types,

Direct – where the solar collectors are directly connected to the water supply and therefore subject to scaling and corrosion in those waters.

- ► In waters where the Saturation Index is between +0.4 and +0.8 the collector array should be covered when the water heater is not intended to be used for extended periods.
- ► Where the saturation index is greater than +0.8 direct connected collectors should not be used unless a water softening device is fitted.
- ► Where the Saturation Index is -1 or lower, warranty does not apply to direct connected solar collectors as the water is too corrosive.

Indirect – where heat transfer fluid passes through the collectors and transfers the heat to the water in the storage tank.

- ► Where the Saturation Index is between +0.4 and +0.8 consideration should be given to using an indirect solar water heater such as Rheem Premier Hiline or Premier Loline. Above +0.8 indirect systems are highly recommended.
- ► Where the Saturation Index is -1 or lower, indirect collectors must be used.



Expansion Control Valves

An Expansion Control Valve must be fitted to the cold water supply line if:

- ► Local regulations require it
- ► The saturation index is greater than +0.4
- ► In corrosive waters where there are sufficient quantities of silica dissolved in the water.

The table below combines much of the discussion of the previous pages into one graph.

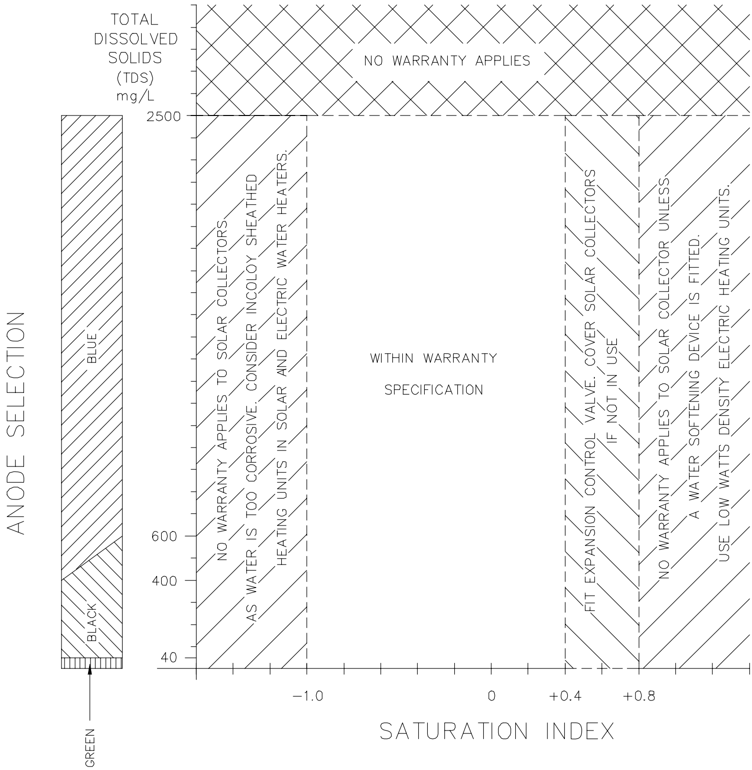


Fig 2.1: Water Quality chart summary

Chapter 3

Rheem Gas Water Heaters - Domestic

This Chapter Covers:

Design, operation and features of domestic gas storage water heaters

- Current models available in the Rheem gas range
- An overview of their main features
- Tables of dimensions, performance, gas usage and other technical data

OVERVIEW OF MODELS

At A Glance

Rheem gas water heaters are available in three product ranges – Rheemglas, Optima, and Stellar - with both indoor and outdoor models available:

	Warranty (yrs)	Anode	Coating	Thermal Efficiency (%)
Rheemglas/RheemPlus	5	Single	Single coat enamel	80
Optima	10	Double	Specially developed enamel	80
Stellar	10	Double	Specially developed enamel	88

Table 3.1a

	Outdoor Models					Indoor Models	
Rheemglas	311090	311135		311170		300135	300170
RheemPlus		314135		314170			
Optima		811135		811170			
Stellar			850330		850360		
Storage Capacity (litres)	85	130	130	160	160	135	170
First hour capacity (litres)	210	275	330	330	360	255	295
No of people (moderate climate)	1-3	2-4	2-5	3-5	3-6	2-4	3-5
No of people (cool climate)	1-2	2-3	2-4	3-4	3-5	2-3	3-4

Table 3.1b

Rheemglas

- 5 year warranty on the cylinder
- Single coat of vitreous enamel
- Single anode protection
- User adjustable thermostat up to 65°C
- 3 star energy rating
- Two Indoor models available in 135 and 170 litre capacities. They have a round jacket and a draught diverter for connection to a 75mm diameter secondary flue. Insulation is CFC-free polyurethane
- Three Outdoor models available in 80, 130 and 160 litre capacities. They are rectangular in shape, with an in-built balanced flue terminal and rigid polystyrene foam for insulation

RheemPlus

- Two outdoor models available in 130 and 160 litre capacities.
- Built in tempering valve ensures water is supplied at temperatures not exceeding 50°C
- Eliminates need for plumbing a tempering valve on site
- High pressure at multiple taps

Optima

- 10 year warranty on the cylinder
- Cylinders are lined with a specially developed vitreous enamel coat for longer cylinder life
- Twin anode provides extra protection
- User adjustable thermostat up to 65°C
- 3 star energy rating
- Two outdoor models available, in 130 and 160 litre capacities. They are rectangular in shape, with an in-built balanced flue terminal and rigid polystyrene foam for insulation

Stellar - High Efficiency

- 10 year warranty on the cylinder and Superflue
- Coating: Specially formulated vitreous enamels on both the inside and outside of the cylinder
- Twin anode provides extra protection
- User adjustable thermostat up to 65°C
- 5 star energy rating
- Higher input gas burners for superior recovery
- Two Outdoor models available in 330 and 360 litre first hour capacities. They have a fully moulded top and front cover to create a smooth rounded look, allowing the units to blend harmoniously with the external home environment.

Common Features

All Rheem gas storage water heaters are AGA certified and offer the following benefits.

Mains Pressure and True Multipoint Operation

All Rheem water heaters have the Mains Pressure Advantage built in. They are designed to provide a steady, hot and strong flow of water at mains pressure. This ensures the hot water is delivered at an equal pressure to the cold water to a number of outlets at the one time, giving true multi-point operation.

Continuous Quick Recovery

Rheem gas water heaters have continuous recovery available 24 hours a day with a specially designed gas burner to achieve maximum thermal efficiency. The burner ignites automatically to heat the incoming cold water. Rheem gas water heaters combine the benefits of storage and recovery providing sufficient hot water for even the most demanding applications.

User Adjustable Temperature Control

A user adjustable gas control allows the user to choose the temperature which best suits their needs.

Manoeuvrability

Rheem gas water heaters are easy to manoeuvre and site in position. All Rheem domestic gas water heaters are designed to fit through a standard doorway. The inlet and outlet connections allow simple and neat connection of pipes to the water heater.

COMPONENTS

All of the features of gas water heaters discussed in chapter 1, as well as the cylinder design aspects in chapter 2, are relevant for the range of Rheem domestic gas water heaters. These include:

Colourbond jacket that resists peeling and blistering, designed to withstand weather extremes and the salty atmosphere in coastal areas.

Insulation – either high-density CFC-free Polyurethane for round jackets, or rigid polystyrene for rectangular jackets, or fibreglass blanket for Stellar models. These provide impact resistance as well as thermal insulation.

Vitreous enamel lining – providing the cylinder with a high level of protection from corrosion.

Sacrificial anodes – either one or two depending on the model. The type of anode material depends on the water quality. The standard anode is magnesium (black).

Temperature and Pressure Relief Valve – to protect the water heater from high pressure due to the expansion of water due to heating.

Eurosit 630 Gas Control – providing:

- A main burner and pilot burner shut-off cock.
- A gas pressure regulator.
- An adjustable setting thermostat.
- A 100% flame failure shut-off.
- An auto resetting over-temperature cut-out switch.

Piezo igniter - giving one touch ignition of the pilot burner.

Thermocouple – to signal loss of pilot flameto the flame safeguard system.

Flue Baffle – located in the primary flue, to slow the exit of flue gases allowing more time for heat to pass from the gases to the water through the flue walls.

Draught Diverter (indoor models only) – sits on top of the water heater with a connection to accept a secondary flue. Prevents updraughts and downdraughts in the secondary flue from interfering with the safe operation of the burner system.

Balanced flue terminal (outdoor models only) – the air intake and flue discharge are located side by side forcing the inlet and outlet pressures to be equal. This ensures reliable flue operation even under extreme wind conditions.

5 Star Energy Rating Of Stellar Water Heaters

The Stellar range of water heaters have achieved a 5 star energy rating with a number of innovations:

- The Stellar Superflue was developed to extract maximum energy from flue gases. The Stellar Superflue increases both performance and efficiency by using the entire surface area of the cylinder for heat transfer removing more energy from flue gases. The design of the baffle enables the flue gases enough momentum to circulate up the primary flue and then down the outside of the cylinder without the need for fan assistance. This aids maximum heat transfer into the stored water, saving both energy and money.
- A low-energy pilot flame rated at approximately (0.35 MJ/h) is used. This pilot is considerably smaller than a normal pilot flame found in water heaters.
- Stellar is designed with a condensate tray to cope with the increased condensation produced in the combustion chamber.

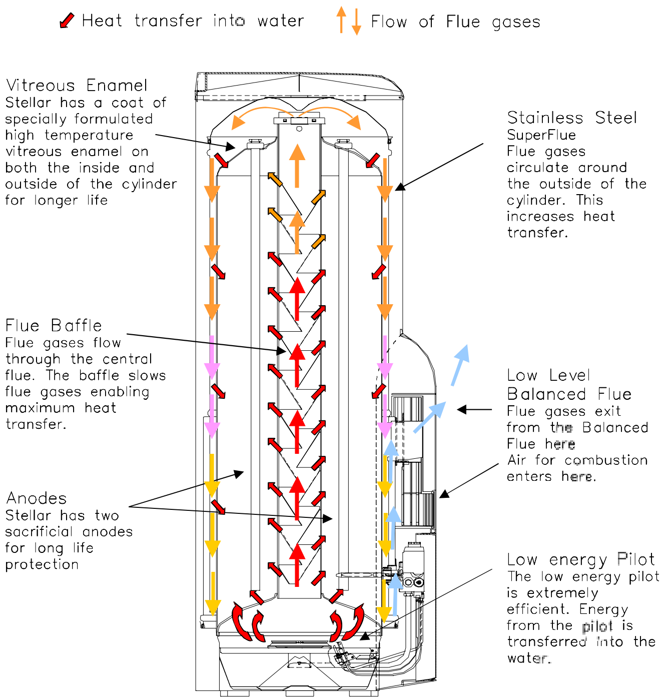


Fig 3.1 - Cutaway of the Rheem Stellar, showing the flow of gases through the Superflue

DIMENSIONS

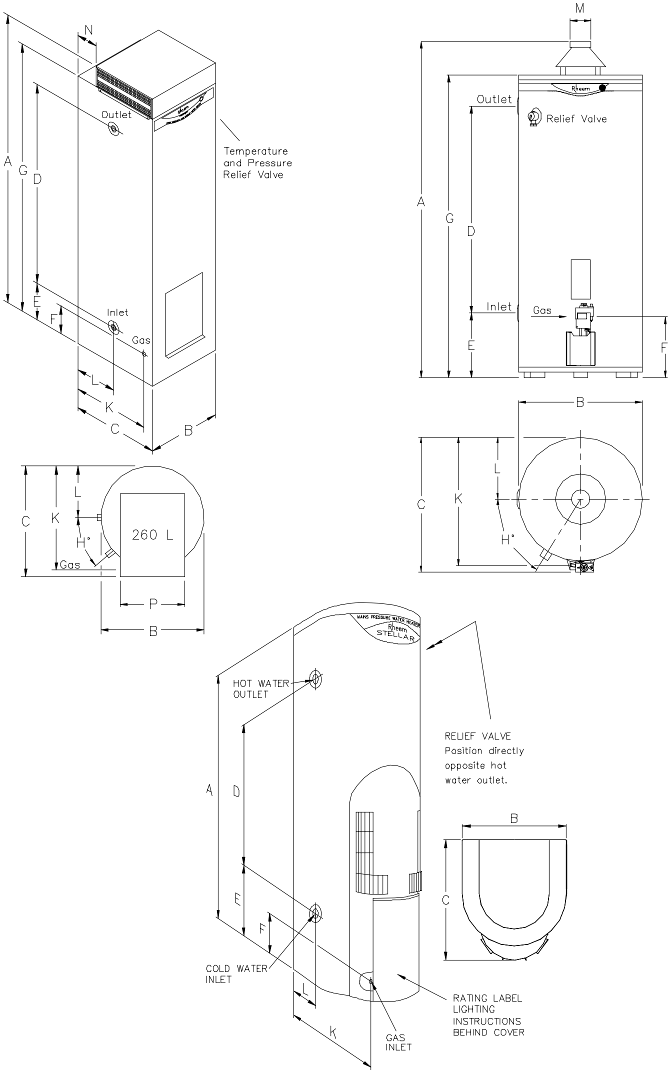


Fig 3.2 - Dimensional diagrams of Rheem gas water heaters

	Outdoor Models					Indoor Models	
Rheemglas	311090	311135		311170		300135	300170
RheemPlus		314135		314170			
Optima		811135		811170			
Stellar			850330		850360		
Storage Capacity (litres)	85	130	130	160	160	135	170
Dimensions mm							
A	1200	1600	1600	1900	1900	1615	1915
B	420	420	485	420	485	425	425
C	500	500	560	500	560	510	510
D	588	988	988	1213	1213	988	1213
E	328	328	328	403	409	328	403
F	298	298	298	298	298	298	298
G	1078	1478	-	1778	-	1490	1790
H (degrees)	-	-	-	-	-	58	58
K	473	473	520	473	520	490	490
L	208	208	252	208	252	213	213
M	-	-	-	-	-	75	75
N	135	135	-	135	-	-	-
Approx Weight Empty kg	52	70	70	81	80	54	63

Table 3.2: Dimensions of the Rheem domestic gas water heater range

PERFORMANCE

The gas consumption, efficiency and hot water delivery of each of the domestic gas heaters is listed on the following pages for each gas type.

Definitions

Storage Capacity is the actual volume of water which the heater can physically hold.

Annual Gas Consumption is as tested to AS 4552.

Thermal Efficiency is as tested to AS 4552.

Gas consumption is the rated maximum gas consumption, expressed as MJ/hr.

1st hour capacity is equivalent to the storage capacity plus the nominal recovery at 45°C rise using natural gas.

1 hour delivery is equivalent to the effective delivery plus the recovery at 45°C rise using natural gas as tested to AS 4552.

2 hour delivery is equivalent to the effective delivery plus the two hours of recovery at 45°C rise using natural gas as tested to AS 4552.

Effective delivery is equal to the storage capacity multiplied by the stratification as tested to AS 4552.

Notes:

Injector sizes, gas consumption and recovery rate details are based on gas compositions found in Australia. Gas compositions may differ from country to country resulting in different injector sizes, gas consumption and recovery rates to those shown in the following tables.

	Outdoor Models					Indoor Models	
Rheemglas (RheemPlus)	311090	311135 314135	-	311170 314170	-	300135	300170
Optima	-	811135	-	811170	-	-	-
Stellar	-	-	850330	-	850360	-	-
Storage Capacity (litres)	85	130	130	160	160	135	170
Efficiency							
Annual Gas Consumption (MJ/yr)	23,979	24,314 25,028	20,310	24,901 25,862	20,650	23,951	24,404
AGA Energy Rating (stars)	3.4	3.2 2.9	5.2	2.9 2.5	5.0	3.4	3.2
Thermal Efficiency (%)	80	81	88	84	89	81	83
Natural Gas Models							
Gas Consumption (MJ/hr)	30	35	42	40	42	30	30
Recovery @ 45°C rise (litres/hr)	125	145	200	172	200	120	126
1 Hour Delivery (litres)	196	247	300	300	324	234	263
2 Hour Delivery (litres)	320	390	500	472	525	355	389
Propane Models							
Gas Consumption (MJ/hr)	30	35	42	40	42	30	30
Recovery @ 45°C rise (litres/hr)	125	145	200	172	200	120	126
1 Hour Delivery (litres)	196	247	300	300	324	234	263
2 Hour Delivery (litres)	320	390	500	472	525	355	389

Table 3.3 – Performance Details of Rheem Domestic Gas Water Heaters

	Outdoor Models					Indoor Models	
Rheemglas	311090	311135	-	311170	-	300135	300170
RheemPlus	-	314135	-	314170	-	-	-
Optima	-	811135	-	811170	-	-	-
Stellar	-	-	850330	-	850360	-	-
Storage Capacity (litres)	85	130	130	160	160	135	170
Town Gas Models							
Gas Consumption (MJ/hr)	27	32	na	38	na	29	29
Recovery @ 45°C rise (litres/hr)	113	132	na	165	na	117	123
1 Hour Delivery (litres)	184	236	na	293	na	230	259
2 Hour Delivery (litres)	296	368	na	457	na	347	381
TLP Models							
Gas Consumption (MJ/hr)	25	30	na	35	na	27	27
Recovery @ 45°C rise (litres/hr)	103	123	na	151	na	109	115
1 Hour Delivery (litres)	174	227	na	279	na	223	251
2 Hour Delivery (litres)	277	349	na	430	na	332	366
Butane / ULPG Models							
Gas Consumption (MJ/hr)	30	30	39/34	30	39/34	25	25
Recovery @ 45°C rise (litres/hr)	124	124	188/163	130	188/163	101	105
1 Hour Delivery (litres)	195	228	288/263	258	311/286	215	242
2 Hour Delivery (litres)	319	353	476/426	388	498/448	316	347

Table 3.3 (cont) – Performance Details of Rheem Domestic Gas Water Heaters

GAS CONSUMPTION

The following charts give the approximate daily gas consumption for each of the Rheem domestic gas water heaters for a range of daily water usages.

The table can be used in 3 ways:

- To calculate the approximate fuel cost of a particular installation, if the average water usage is known.
- To determine the average daily hot water consumption, if the fue consumption is known
- To calculate the service efficiency of a water heater at different levels of daily draw-offs.

Explanations

The table shows the amount of heat energy contained in a given quantity of water plus the amount of gas required for each Rheem domestic gas water heater to heat that water. This figure takes into consideration the water heater's maintenance rate as well as thermal efficiency.

Notes:

All calculations are based on water at a 50°C rise.

Figures do not include an allowance for pipe losses. Where long pipe runs are involved an allowance of 5% to 10% should be added.

Figures are applicable to natural gas, propane, town gas or TLP.

		Outdoor Models					Indoor Models	
Rheemglas		311090	311135	-	311170	-	300135	300170
RheemPlus		-	314135	-	314170	-	-	-
Optima		-	811135	-	811170	-	-	-
Stellar		-	-	850330	-	850360	-	-
Storage Capacity (litres)		85	130	130	160	160	135	170
Daily usage of hot water (L)	**Energy Content of hot water (MJ)**	**Daily Gas Consumption in MJ**						
0	0.0	22	24	15	27	16	23	25
50	10.5	35	36	27	39	28	35	37
100	20.9	47	49	38	51	40	48	50
150	31.4	60	61	50	64	51	60	62
200	41.9	73	74	62	76	63	73	74
250	52.3	86	86	73	88	74	85	86
300	62.8	98	99	85	100	86	98	98
350	73.3	111	111	97	112	98	110	111
400	83.7	124	124	108	124	109	123	123
450	94.2	136	136	120	136	121	135	135
500	104.7	149	149	132	148	133	148	147
750	157.0	212	211	190	209	191	211	208
1000	209.3	276	274	249	270	249	273	269
1250	261.6	339	336	307	331	307	336	330
1500	314.0	403	399	365	391	365	399	392

Table 3.4 – Approximate daily gas consumption in MJ for a range of daily water usages

		Outdoor Models					Indoor Models	
Rheemglas		311090	311135	-	311170	-	300135	300170
RheemPlus		-	314135	-	314170	-	-	-
Optima		-	811135	-	811170	-	-	-
Stellar		-	-	850330	-	850360	-	-
Storage Capacity (litres)		85	130	130	160	160	135	170
Daily usage of hot water (L)	**Energy Content of hot water (MJ)**	**Daily Gas Consumption in Kg**						
0	0.0	0.4	0.5	0.3	0.5	0.3	0.5	0.5
50	10.5	0.7	0.7	0.5	0.8	0.6	0.7	0.8
100	20.9	1.0	1.0	0.8	1.0	0.8	1.0	1.0
150	31.4	1.2	1.2	1.0	1.3	1.0	1.2	1.2
200	41.9	1.5	1.5	1.2	1.5	1.3	1.5	1.5
250	52.3	1.7	1.7	1.5	1.8	1.5	1.7	1.7
300	62.8	2.0	2.0	1.7	2.0	1.7	2.0	2.0
350	73.3	2.2	2.3	2.0	2.3	2.0	2.2	2.2
400	83.7	2.5	2.5	2.2	2.5	2.2	2.5	2.5
450	94.2	2.8	2.8	2.4	2.8	2.4	2.7	2.7
500	104.7	3.0	3.0	2.7	3.0	2.7	3.0	3.0
750	157.0	4.3	4.3	3.8	4.2	3.9	4.3	4.2
1000	209.3	5.6	5.5	5.0	5.5	5.0	5.5	5.4
1250	261.6	6.9	6.8	6.2	6.7	6.2	6.8	6.7
1500	314.0	8.1	8.1	7.4	7.9	7.4	8.1	7.9

Note: to convert the propane consumption to litres, multiply the consumption in kilograms by 1.95

Table 3.5 – Approximate daily gas consumption in Kg for a range of daily water usages

TECHNICAL SPECIFICATIONS

Gas Supply Pressure

The minimum and maximum gas supply pressure to the water heater is shown below. The installer needs to ensure the installation will supply gas within this range to ensure correct operation of the water heater.

	Min Gas Supply Pressure (kPa)	Max Gas Supply Pressure (kPa)
Natural Gas	1.13	3.5
Town Gas	0.75	3.5
Propane	2.75	3.5
Butane	2.75	3.5

Table 3.6 – Gas supply pressures for Rheem gas water heaters

It should be noted all figures shown in Rheem literature and other printed performance data, is based on gas compositions found in Australia. As gas compositions can vary around the world, so too can the thermal inputs into Rheem gas water heaters and related performance data.

Injector Sizes & Test Pressures

	Outdoor Models					Indoor Models	
Rheemglas	311090	311135	-	311170	-	300135	300170
RheemPlus	-	314135	-	314170	-	-	-
Optima	-	811135	-	811170	-	-	-
Stellar	-	-	850330	-	850360	-	-
Storage Capacity (litres)	85	130	130	160	160	135	170
Natural Gas Models							
Injector Size (mm)	2.45	2.6	2.90	2.80	2.90	2.45	2.45
Test Point Pressure (kPa)	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Propane Models							
Injector Size (mm)	1.50	1.65	1.80	1.70	1.80	1.50	1.50
Test Point Pressure (kPa)	2.70	2.70	2.70	2.70	2.70	2.70	2.70
Town Gas and TLP Models							
Injector Size	4.00	4.50	NA	5.60	NA	4.20	4.20
Test Point Pressure	0.45	0.40	NA	0.35	NA	0.44	0.44
Butane (& ULP) Models							
Injector Size	1.40	1.40	1.60	1.40	1.60	1.30	1.30
Test Point Pressure	2.70	2.70	2.70	2.70	2.70	2.70	2.70

Table 3.7 – Injector sizes and test point pressures for Rheem gas water heaters

Gas and Water Connections

	Outdoor Models					Indoor Models	
Rheemglas (RheemPlus)	311090	311135 314135	-	311170 314170	-	300135	300170
Optima	-	811135	-	811170	-	-	-
Stellar	-	-	850330	-	850360	-	-
Storage Capacity (litres)	85	130	130	160	160	135	170
Relief Valve Setting	1400	1400	1400	1400	1400	1400	1400
Expansion Control Valve Setting*	1200	1200	1200	1200	1200	1200	1200
Maximum Water Supply Pressure without ECV	1120	1120	1120	1120	1120	1120	1120
Maximum Water Supply Pressure with ECV	960	960	960	960	960	960	960
Water Connection LHS (RheemPlus)	RP¾/20	RP¾/20 (G¾B)	RP¾/20	RP¾/20 (G¾B)	RP¾/20	RP¾/20	RP¾/20
Gas Connection	RP½/15	RP½/15	RP½/15	RP½/15	RP½/15	RP½/15	RP½/15

* Expansion control valve is not supplied with water heater

Table 3.8 - Gas and Water Connections

Rheem gas water heaters are intended for connection to high or low pressure water supplies, subject to the following conditions:

- The maximum supply pressure does not exceed 80% of the relief valve setting. If it does, a pressure-limiting valve is to be fitted on the cold water supply.
- Mains pressure performance cannot be expected if the pressure of the cold water supply is less than 350 kPa.

Chapter 4

Integrity Electronic Instantaneous Water Heaters

This Chapter Covers:

- Range of electronic instantaneous gas water heaters
- Performance and technical data
- Accessories
- Commercial application systems and specifications

OVERVIEW OF MODELS

At A Glance

The range of Rheem Integrity continuous flow gas water heaters is ideal where lots of hot water is required and space is limited. 4 models are available in 60°C and 50°C versions.

		Model			
Maximum Temperature	**60°C** **50°C**	**871018** **875018**	**871020** **875020**	**871024** **875024**	**871026** **875026**
Flow Rate	L/min @ 25°C Rise	18	20	24	26
Warranty	years	10/3	10/3	10/3	10/3
No Bathrooms		1 + ensuite	2	2 + ensuite	3
AGA Energy Rating	stars	5.1	5.1	5.1	5.2

Table 4.1:Rheem Integrity range

Common Features

Each Integrity model has the following features:

Flame Safe TM

Flame Safe is unique to Rheem Integrity. A plastic film surrounds the entire heat exchanger and will shut down the unit should a serious fault develop.

OK Monitor

Also unique across the Rheem Integrity range, the OK Monitor is positioned on the front cover and allows the technician to perform diagnostic functions without the need to attach remote temperature controllers.

Temperature Controllers

Up to three temperature controllers may be connected to Rheem Integrity

- Bathroom 1
- Bathroom 2
- Kitchen

Fig 4.1: Rheem Integrity

Q Factor Temperature Control

A special feature of Rheem Integrity that enhances temperature control during periods of frequent use. This ensures a constant and consistent delivery of hot water and eliminates unwelcome bursts of cold water known as the ‘cold sandwich’ effect typically associated with instantaneous and continuous flow type water heaters.

Frost Protection

All Rheem Integrity are supplied with frost protection as standard. The frost protection works by energising a series of small electric heaters attached to the water ways when a frost condition is sensed. This system offers frost protection to minus 20°C (including wind chill factor) as long as power is available to the unit. If power is to be unavailable and frost conditions are expected, the water heater should be drained to protect the inner components from damage.

Temperature Controllers

Each Rheem Integrity is suitable for use with up to 3 temperature controllers. In addition, Integrity 26 can be supplied with Deluxe Temperature Controllers.

Temperature Controller Functions

- ***Bathroom 1*** must be used when only 1 bathroom controller is required. Controls temperature between 37 and 50°C.
- ***Bathroom 2*** is used when a second bathroom controller is required. Controls temperature between 37 and 50°C.
- ***Kitchen Controller*** is used when higher temperatures are required at the kitchen or laundry. Controls temperature between 37 and 60°C. Standard Kitchen Controllers feature a ‘bath fill’ mode which emits a beeping sound when a pre-set amount of water has been delivered.
- ***Deluxe Controllers*** optional on the Integrity 26. They provide easy to understand voice prompts. The Deluxe Controllers shut down the water heater and delivery of water when a pre-set amount of water has been delivered. A friendly voice advises the user of the status.

Fig 4.2: Temperature controllers

DELIVERY TEMPERATURES

875 Series

The 875 series Integrity range delivers water not exceeding 50°C in accordance with AS 3498. These models are suitable for installation in applications, without the need for further tempering, where maximum 50°C delivery is a mandatory requirement of AS / NZS 3500. Controllers can still be connected to these models, however, Kitchen Controllers cannot override the maximum delivery setting (displayed as 48°C).

Tempering Valves

Temperature controllers, whilst providing safety for children bathing, do not meet the requirements of AS / NZS 3500 in terms of temperature limiting. Where the maximum temperature is mandated, a tempering valve must be installed prior to fixtures used primarily for bathing. The kitchen and laundry may still be supplied with hot water and the Kitchen Controller, if fitted, will allow hotter water to be delivered to these points. Due to the imbalance of pressure between the cold water supply and the hot water leaving the water heater, Rheem recommends the use of a high performance tempering valve such as the Reliance Manufacturing 'Green Cap' tempering valve.

Solar Boosting

Where a Rheem Integrity is used as a gas booster to a solar pre-heat water heater, the following needs to be considered:

- The solar water heater can generate hot water in excess of 60°C.
- The gas water heater will not ignite when water greater than 58°C enters the water heater, however, there is no means of limiting the temperature of water greater than 60°C.
- Due to the above conditions, temperature controllers are of no value and *must not be installed* as they can provide the user with false information regarding water temperature.
- An 871 series water heater must be installed.

INSTALLATION

The following must be considered when installing Rheem Integrity:

- ***Gas supply*** – due to the high gas input to these water heaters, particular attention needs to be given to the design of the gas supply to ensure the correct pressures are available, particularly when other gas appliances are in use. This is particularly so when using bottled gas.
- ***Water supply*** – maximum and minimum water pressures apply to continuous flow water heaters. See technical specifications.
- ***Electricity supply*** – a weather-proof 10 amp general purpose outlet is required.
- ***Flue clearances*** – Rheem Integrity is suitable for installation outdoors only and installation must comply with the requirements of AS 5601.
- ***Recess box*** – a recess box is available to mount the Rheem Integrity almost flush with the outer wall used in typical masonry skin construction. The recess box is supplied in a galvanised finish for corrosion protection and ready for finishing to match the surrounding built environment. The recess box has bevelled edges to provide a lower profile appearance and a clever anti-theft bracket minimises the risk of theft.
- ***Pipe cover*** – a powder coated pipe cover can be used to cover the water and gas plumbing under the Integrity to provide a neat finish for installations not recessed into the wall

Fig 4.3: Rheem Integrity recess box and pipe cover

Technical Specifications

		Model			
Maximum Temperature	**60°C** **50°C**	**871018** **875018**	**871020** **875020**	**871024** **875024**	**871026** **875026**
Flow Rate	L/min @ 25°C Rise	18	20	24	26
Warranty	years	10/3	10/3	10/3	10/3
No Bathrooms		1 + ens	2	2 + ens	3
AGA Energy Rating	stars	5.1	5.1	5.1	5.1
Gas Input Max	MJ/hr	157	157	188	199
Gas Type		Nat/Prop	Nat/Prop	Nat/LPG	Nat/LPG
Gas Supply Pressure					
Natural Gas	kPa	1.13 – 3.5	1.13 – 3.5	1.13 – 3.5	1.13 – 3.5
LPG	kPa	2.75 – 3.5	2.75 – 3.5	2.75 – 3.5	2.75 – 3.5
Water Supply Pressure					
Maximum	kPa	1000	1000	1000	1000
Minimum	kPa	140	140	140	140
Minimum Flow Rate	L/min	2.7	2.7	2.7	2.7
Frost Protection		Standard			
Gas Connection	BSPM	R ¾ / 20			
Water Connections	BSPM	R ½ / 15	R ¾ / 20*	R ¾ / 20	R ¾ / 20
Approx. Weight	kg	20	20	21	21
Temperature Controllers					
Kitchen	299850	✓	✓	✓	✓
Bathroom 1	299851	✓	✓	✓	✓
Bathroom 2	299852	✓	✓	✓	✓
Deluxe Controllers					
Kitchen	299858	×	×	×	✓
Bathroom 1	299859	×	×	×	✓
Bathroom 2	299860	×	×	×	✓
Recess Box	299849	✓	✓	✓	✓
Pipe Cover	299848	✓	✓	✓	✓

* R ½ / 15 on 875020 model

Table 4.2: Technical Specifications of Rheem Integrity

DIMENSIONS

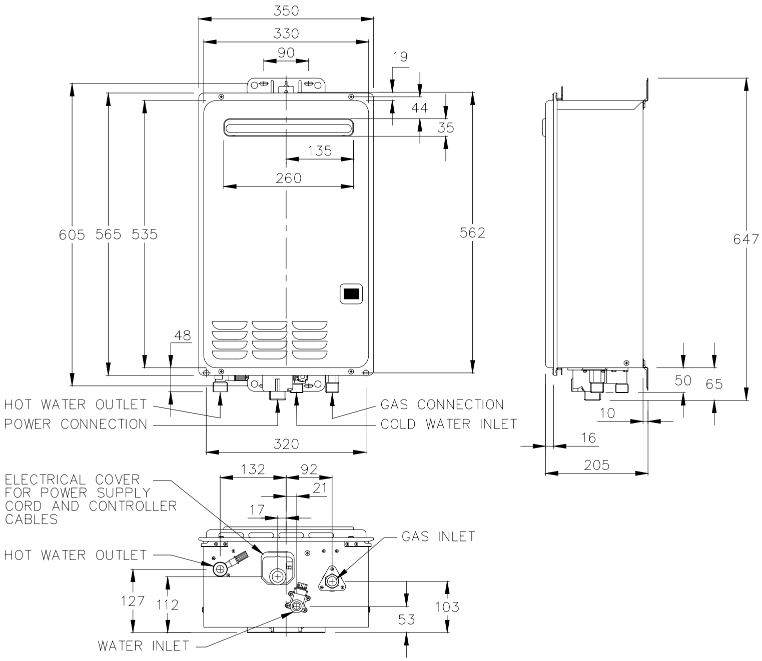


Fig 4.4: Dimensions of Rheem Integrity

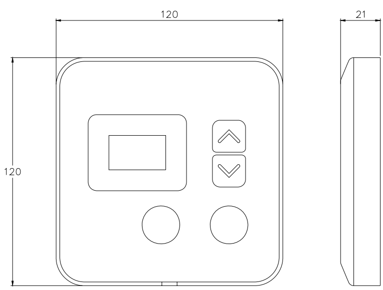


Fig 4.5: Temperature controller dimensions

COMMERCIAL APPLICATIONS

Commpak and Multipak Commercial Hot Water Solutions

Rheem Commpak and Multipak hot water systems utilise banks of electronic instantaneous gas water heaters manifolded in parallel from two to six units. Depending on the system configuration, either mains pressure flow-and-return performance or continuous flow dead-leg performance is available.

Rheem Multipak

Rheem Multipak comprises a bank of water heaters and pressure responsive flow control valves pre-assembled on a lightweight frame. Suitable for dead leg applications, the system's pressure responsive flow control valves stage the ignition of each unit depending on the flow requirements at the time. Storage tanks are not utilised which reduces heat loss during times when heating is not required.

The system is capable of operating with a supply pressure up to 1000kPa and can supply sufficient hot water for up to thirteen 12L/min showers at one time at a 25°C rise.

Fig 4.6: Rheem Multipak MPE 040

Rheem Commpak

Rheem Commpak comprises a bank of water heaters, pump, temperature sensors and controls pre-assembled on a lightweight aluminium frame. Storage tanks are not utilised. The controller and pump combine with the building flow and return circuit to maintain mains pressure, by overcoming the pressure loss normally associated with continuous flow water heaters, and provide for flow diversity.

The pump is also utilised to maintain a constant temperature in the building secondary circuit, eliminating the need for a second pump to perform this function. When the system return temperature reaches set point, the pump automatically shuts down, reducing running costs.

The system is capable of operating with a supply pressure up to 1000kPa. The pump will maintain the pressure in the system equal to the incoming mains pressure, producing a balanced hot and cold water supply to the building and appliances.

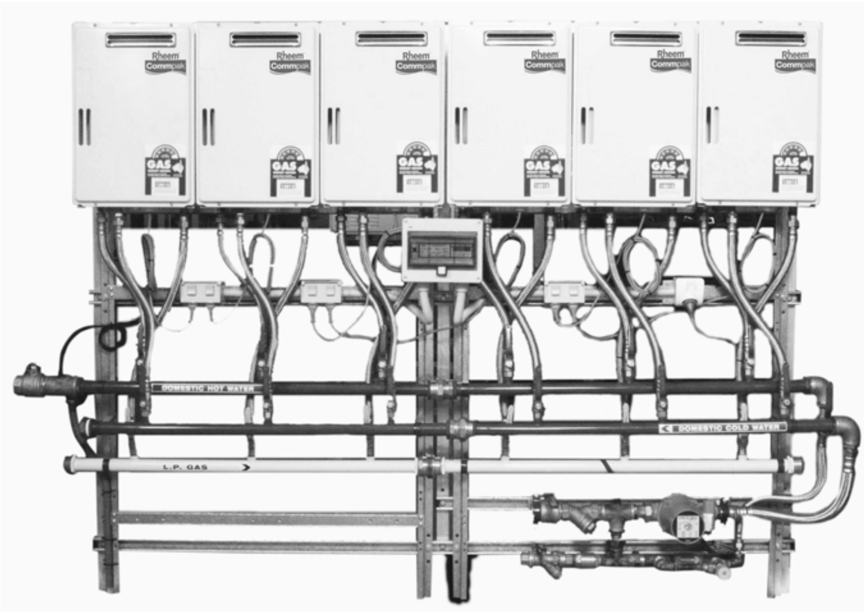


Fig 4.7: Rheem Commpak CPE 120

Basic Construction

Packaged Hot Water System & Ease of installation

Rheem Commpak and Multipak systems are completely factory engineered and packaged requiring only minimal work to be completed on-site, as detailed below:

- Installation and service connections to the package - cold water, hot water and gas.
- Building return connections (Commpak only).
- 240V/50Hz 10A power supply to the controller (Commpak) or each water heater (Multipak).
- Commissioning. Each water heater in a manifold is fully certified, therefore Type B commissioning procedures are not required.

Rheem Commpak and Multipak packages are designed for wall mounting or floor mounting depending on the size. An optional Floor Mounting Frame can be supplied if required.

Commpak Controller Features

A Dicon digital electronic controller is utilised to provide the following functions:

- Digital display of supply and return water temperatures.
- LED indication of pump run and fault conditions.
- Optional audible and visual alarms for fault annunciation purposes.
- Volt free contact for BMS/BAS remote monitoring.

The controller is factory mounted and pre-wired, including individual GPO's for the pump and water heaters, requiring only a 240V/50Hz 10A power supply on-site.

Features

Rheem Commpak and Multipak commercial hot water systems provide the following benefits:

- Reduce installation time on site
- Costing of the water heater installation is simplified and accurate
- Reduces plant space requirements due to the omission of the storage tank and associated plumbing
- Available for use with natural gas or propane
- Commpak maintains mains pressure performance
- Secondary building circulator is not required

- Reduced heat loss
- Multiple banks can be used to provide greater output (Multipak)
- Type A certification is applicable
- All components Water Mark certified

Specifications

- Constant pressure pump with all required plumbing and valving (Commpak)
- Complete cold water and hot water piping, valves and fittings to AS/NZS 3500
- Complete gas piping, valves and fittings to AS5601
- Controller mounted and wired. All Commpak water heaters are pre-wired with individual GPO back to the package controller
- Rheem Commpak and Multipak are suitable for outdoor installation only

Commercial Warranty

- Five (5) years on the heat exchanger.
- One (1) year parts and labour.

Commpak Model		**CPE 040**	**CPE 060**	**CPE 080**	**CPE 100**	**CPE 120**
Input	MJ/hr	390	585	780	975	1170
Installation		Outdoor only				
Recovery Rate @						
50°C rise	L/hr	1545	2320	3090	3865	4640
25°C rise		3090	4640	6180	7730	9280
Peak Flow Rate @						
50°C rise	L/min	37	55	74	92	110
25°C rise		52	77	103	129	155
Dimensions						
Height	mm	1800	1800	1800	1800	1800
Width	mm	710	1065	1420	1775	2130
Depth (Wall Mount/FMF)	mm	350/500	350/500	500	500	500
Clearance in Front	mm	800	800	800	800	800
Cold Water	BSPF	50mm				
Hot Water	BSPF	50mm				
Return	BSPF	25mm				
Gas	BSPM	40mm				
Frost Protection		yes				
Approx Weight	kg	110	135	220	245	270
Wall Mount		standard		-	-	-
Floor Mounting Frame	(FMF)	optional		standard		
Maximum Temperature	°C	80				
Water Supply Pressure						
Max	kPa	1000				
Min	kPa	150				
Gas Supply Pressure						
Natural	kPa	1.13 – 3.5				
Propane	kPa	2.75 – 3.5				
Electrical supply (240V/50Hz)	Amps	10				

Table 4.3: Technical Specifications of Rheem Commpak

Multipak Model		**MPE 040**	**MPE 060**	**MPE 080**	**MPE 100**	**MPE 120**
Input	MJ/hr	398	597	796	995	1194
Installation		Outdoor only				
Recovery Rate @						
50°C rise	L/hr	1580	2365	3155	3945	4735
25°C rise		3160	4730	6310	7890	9470
Peak Flow Rate @						
50°C rise	L/min	26	39	52	66	79
25°C rise		53	79	105	132	158
Minimum Flow Rate	L/min	2.7	2.7	2.7	2.7	2.7
Dimensions						
Height	mm	1800	1800	1800	1800	1800
Width	mm	710	1065	1420	1775	2130
Depth (Wall Mount/FMF)	mm	350/500	350/500	350/500	350/500	350/500
Clearance in Front	mm	800	800	800	800	800
Cold Water	BSPF	40mm				
Hot Water	BSPF	40mm				
Gas	BSPM	40mm				
Frost Protection		yes				
Approx Weight	kg	80	105	160	185	210
Wall Mount		standard				
Floor Mount Frame	(FMF)	optional				
Maximum Temperature	°C	60				
Water Supply Pressure						
Max	kPa	1000				
Min	kPa	150				
Gas Supply Pressure						
Natural	kPa	1.13 – 3.5				
Propane	kPa	2.75 – 3.5				
Electrical supply (240V/50Hz)	Amps	10				

Table 4.4: Technical Specifications of Rheem Multipak

Chapter 5

Rheem Electric Water heaters - Domestic

This Chapter Covers:

Design, operation and features of domestic electric water heaters

- Current models available in the Rheem electric range
- The difference between single and twin element heaters
- The operation of heating units
- Calculations of recovery, water availability, energy usage, and efficiency

Overview of Models

Overview of Models

- ***Rheemglas*** are covered by a 5 year warranty on the cylinder, and feature a single coat of vitreous enamel with single anode protection and trade adjustable thermostats. Capacities range from 25-400 litres.
- ***RheemPlus*** are supplied with an integral tempering valve which ensures water is supplied at temperatures not exceeding 50°C.
- ***Optima*** are covered by a 10 year warranty on the cylinder, and are lined with a specially developed vitreous enamel, and larger mass anode protection to provide longer life. Capacities range from 250-400 litres. Optima water heaters have consumer adjustable thermostats.

All Rheem domestic electric water heaters have either one or two single phase immersion heating units controlled by a contact thermostat. All models are insulated with high density polyurethane foam, are enclosed in Colorbond® steel jackets, and can be installed indoors or outdoors.

Rheemglas Models

Model No.	Delivery (litres)	Heating elements	Connection	No. people (continuous)	No. people (off peak)
111025	20	Single	Left	N/A	N/A
111050	50	Single	Left	1	N/A
171050	50	Single	Right	1	N/A
111080	80	Single	Left	1-2	N/A
171080	80	Single	Right	1-2	N/A
111125*	125	Single	Left	2-3	N/A
171125	125	Single	Right	2-3	N/A
111160*	160	Single	Left	2-4	N/A
162160	160	Twin	Left	2-4	N/A
111250*	250	Single	Left	3-5	1-3
162250	250	Twin	Left	3-5	1-3
111315*	315	Single	Left	4-6	2-4
162315	315	Twin	Left	4-6	2-4
111400	400	Single	Left	5-9	4-6
162400	400	Twin	Left	5-9	4-6

Table 5.1a **also available in RheemPlus versions prefix 121*

Optima Models

Model No.	Delivery (litres)	No. heating elements	Connection	No. of people (continuous)	No. of people (off peak)
411250	250	Single	Left	3-5	1-3
462250	250	Twin	Left	3-5	1-3
411315	315	Single	Left	4-6	2-4
462315	315	Twin	Left	4-6	2-4
411400	400	Single	Left	5-9	4-6
462400	400	Twin	Left	5-9	4-6

Table 5.1b

Fig 5.1: Selection of Rheem electric water heaters

CYLINDER CONSTRUCTION

Since 1981, all water heaters made by Rheem have used a vitreous enamel lining in the cylinder. These cylinders have been the plus minus design i.e. top concave to pressure, bottom convex to pressure instead of the double minus design i.e. both ends convex to pressure which was necessary on copper-lined cylinders (Coppermatics). The 25L and 50L have a double plus design.

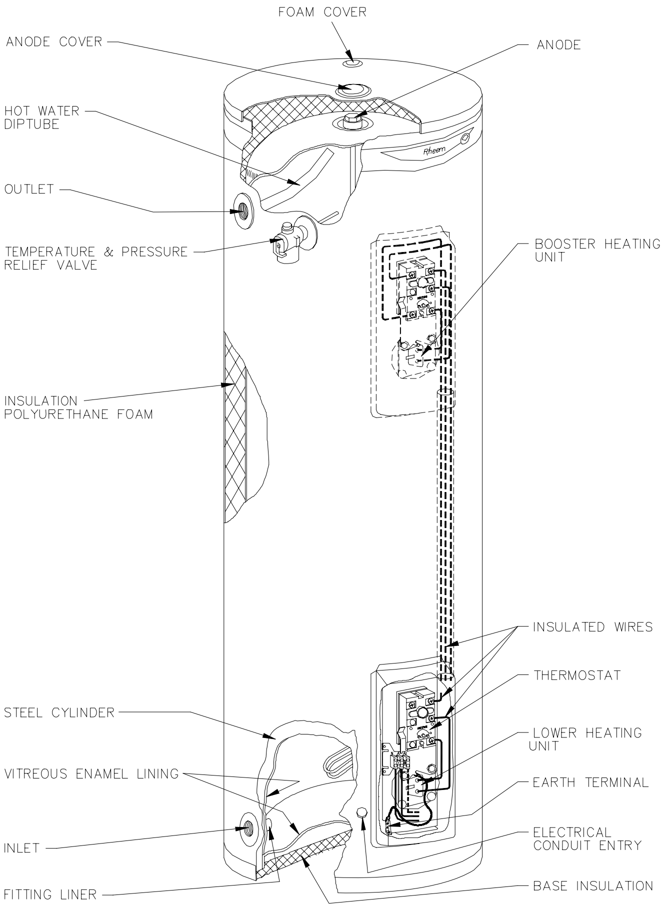


Fig. 5.2: Cutaway view of Rheem electric storage water heater

ELECTRIC HEATER OPERATION

Heating Units

Each water storage cylinder is fitted with at least one tubular single phase immersion heating unit located near the bottom of the tank and controlled by a contact thermostat and over-temperature energy cut out mechanism.

The heating units are attached to the cylinder by a mounting plate and sealed with a rubber gasket and four screws. The tube of the sheath is made from copper, and in addition a resistor is connected between the sheath and the mounting plate to produce a resistance earthed heating unit to reduce unwanted dissipation of the protective anode.

Twin Element Water Heaters

Twin element storage water heaters are provided with two separate heating units, each with its own thermostat and over-temperature energy cut out mechanism. One heating unit is located near the base of the water heater and is designed to heat the whole contents of the storage container. The other heating unit is located part way up the tank to serve as a "booster" and is designed to heat only the upper portion of the contents of the tank in conjunction with the main heating unit circuit.

Twin element water heaters can be wired in two ways:

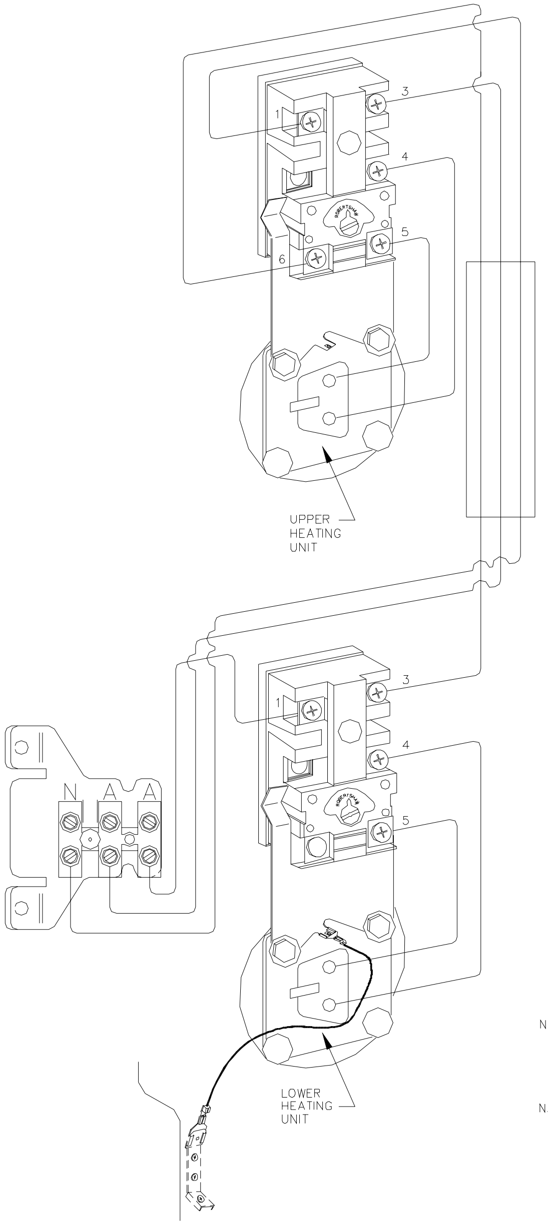
- For non-simultaneous operation, as shown in fig 5.3. This is the standard mode of operation.
- For simultaneous operation, as shown in fig 5.4

How non-simultaneous operation works: The booster heating unit has priority. When cold water is sensed at the booster thermostat, the booster heating unit is energized and maintains hot water in the top portion of the cylinder. When the set temperature is reached, the thermostat switches over to the bottom heating unit. When power is available, the bottom heating unit will be energized to heat the remainder of the tank.

Simultaneous operation: It is possible to wire the heating units for simultaneous operation. This method does not double the heating recovery rate as the top element will cease heating once the top portion has reached the set temperature. It does increase the recovery rate somewhat, but at the same time increases the maximum electrical load.

Temperature Pressure Relief Valve

Pressure relief and thermal relief are provided by a temperature and pressure relief (TPR) valve inserted in an opening near the top and adjacent to the outlet fitting.



NOTES

N.1 UPPER THERMOSTAT ACTIVE WIRE MUST BE CONNECTED TO TERMINAL MARKED 3 AND NEUTRAL TO TERMINAL MARKED 1.
THEY MUST NOT BE REVERSED.

N.2 HEATING UNIT WIRES MAY BE REVERSED TO ASSIST FITMENT TO THERMOSTAT.

Fig. 5.3: ***Twin-element model wiring for non-simultaneous operation***

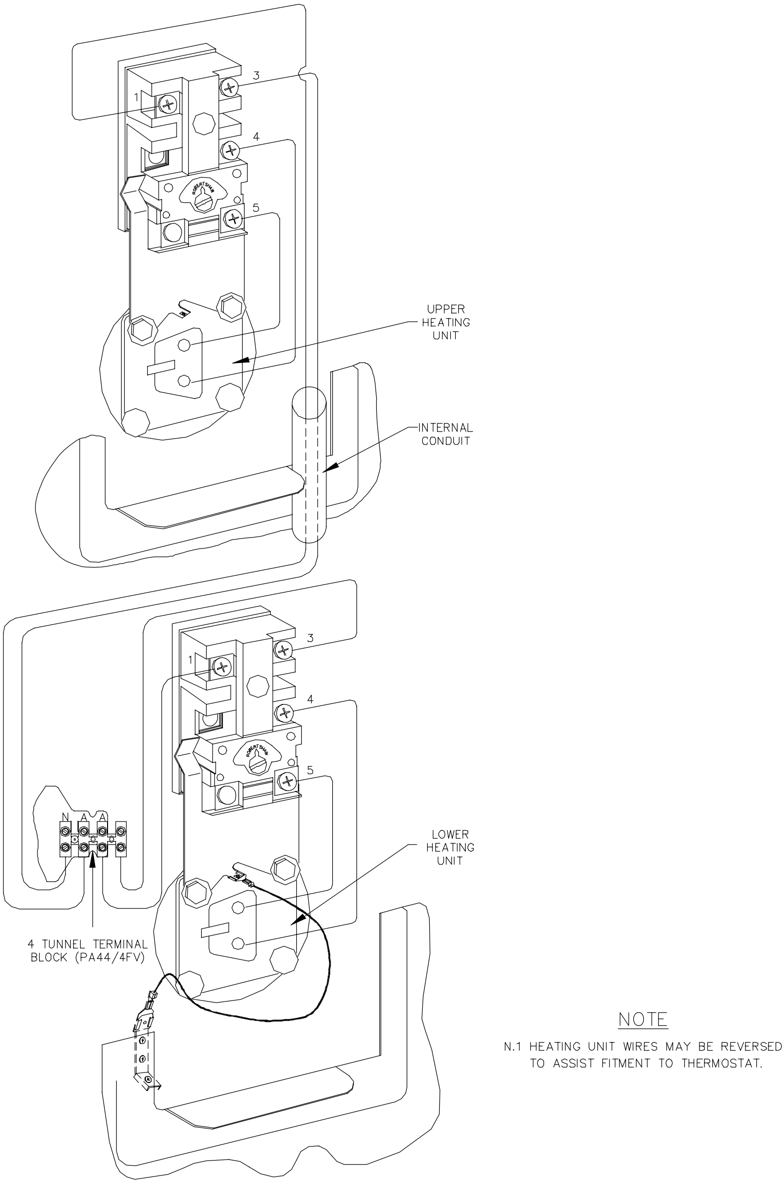


Fig. 5.4: Twin-element model wiring for simultaneous operation

Thermostat

Should the water temperature approach boiling point (due to a malfunction of the thermostat), all energy to the water heater is automatically shut off. This is achieved by a double pole over-temperature cut-out mechanism incorporated in each thermostat.

The cut out requires resetting manually, and this should be done by a competent service operator as the cut out mechanism is inside the unit. At the same time, the service operator will determine the cause of the over temperature condition and take corrective measures if necessary.

Model	Main Heating Unit	Booster Heating Unit
Rheemglas/ RheemPlus	60-70°C Trade adjustable only	60°C
Optima	60-75°C	60°C

Table 5.3: table of thermostat settings

Diptube

All Rheem water heaters are fitted with a diptube at the outlet of the cylinder. This allows the hottest water to be drawn from the top of the cylinder providing maximum delivery and extending the life of the cylinder.

The diptube also acts as an integral heat trap providing an insulation barrier to the plumbing fixtures connected to the water heater. AS3500.4 requires all water heaters to be installed with a heat trap unless one is integral with the water heater. Thus Rheem water heaters do not require the installation of an external heat trap.

INSTALLATION

Connection To Water

Rheem mains pressure electric water heaters are intended for connection to low or high pressure water subject to the following considerations:

- If the maximum supply pressure is likely to exceed 80% of the relief valve setting, a pressure limiting valve is needed on the cold water supply.
- If pressure is less than 350 kPa, then mains pressure performance cannot be expected.

Connection To Electricity

Rheem electric water heaters are designed for either continuous or off-peak tariff, depending on the model. Before proceeding with installation, it is important to know the relevant supply authority's requirements for connections to a particular tariff.

Wiring

Connection of single element water heaters is straightforward and detailed in installation leaflets provided with the product.

Connection of twin element water heaters depends on whether off peak or continuous tariff is used on the booster element. The following illustrations show the electrical connection of a twin element model water heater to the domestic electricity supply in each circumstance:

- ***Figure 5.5*** illustrates utilising the off-peak tariff on the bottom heating unit and continuous tariff on the booster heating unit.
- ***Figure 5.6*** illustrates using the off peak tariff for both heating units. Whilst power is always available to the booster heating unit, energy is charged at the off peak rate. (This method of wiring is allowed in certain areas only.)

You should check with the relevant electricity supply authority before proceeding.

Electrical supply

Electrical connections are for single phase 240 V ac 50 Hz:

Heating units up to 2400 W require a 10 A service.

Heating units up to 3600 W require a 15 A service.

Heating units up to 4800 W require a 20 A service.

Heating units up to 6000 W require a 25 A service.

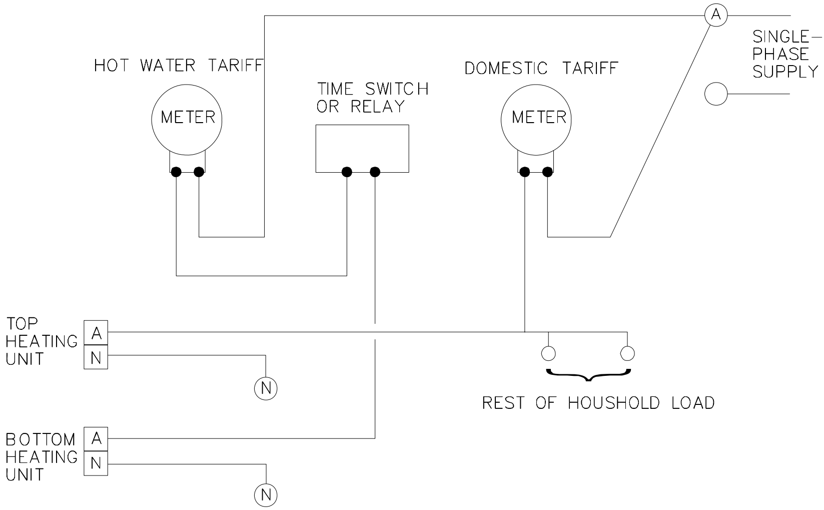


Fig. 5.5: Electrical connection of twin-element water heater (off-peak and continuous)

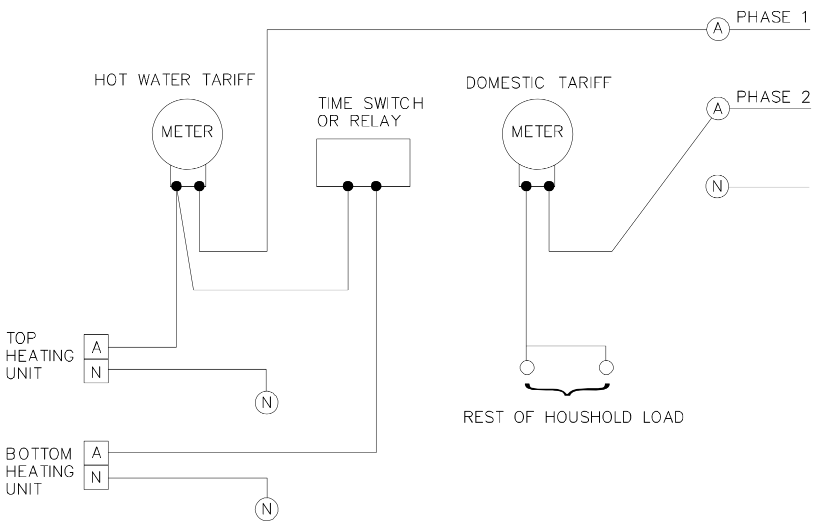


Fig. 5.6: Electrical connection of twin-element water heater (off-peak only)

SPECIFICATIONS

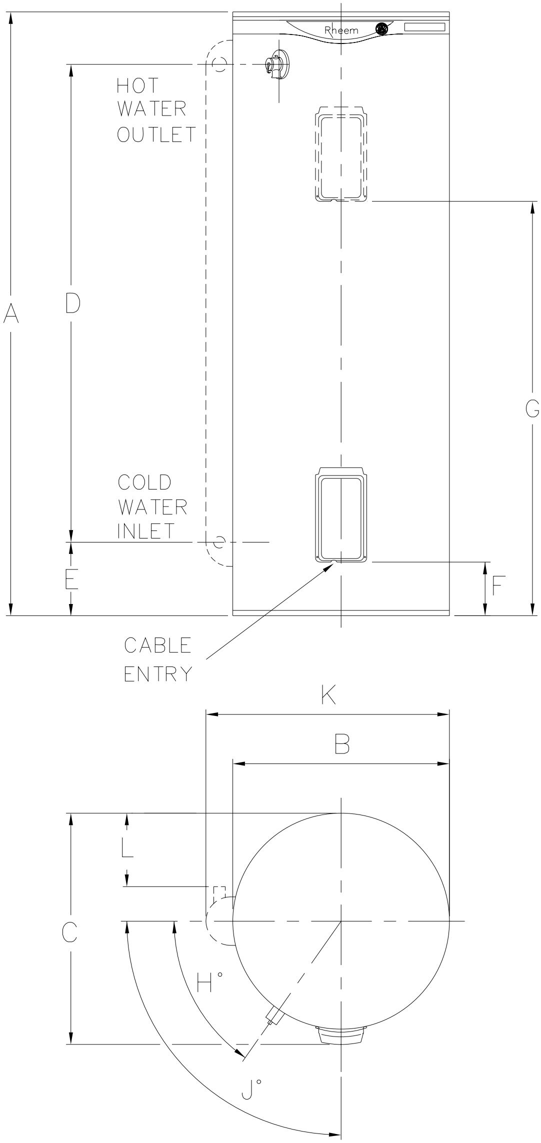


Fig 5.7: Dimensional diagram of Rheem electric water heaters

Dimension	25	50	80	125	160	250	315	400
A (mm)	400	690	940	1340	1610	1395	1640	1840
B (mm)	385	393	480	480	480	640	640	690
C (mm)	420	430	515	515	515	705	705	755
D (mm)	130	393	702	1102	1332	1117	1317	1479
E (mm)	122	137	64	64	104	73	113	121
F (mm)	146	52	84	84	84	128	128	128
G (mm)	-	-	-	-	1085	1005	1255	1346
H (degrees)	26°	26°	23°	23°	23°	32°	32°	30°
J (degrees)	65°	57°	58°	58°	58°	88°	88°	83°
K (mm)	-	-	-	550	550	700	700	-
L (mm)	-	-	-	200	200	270	270	-
Approx weight empty (kg)	18	29	34	46	54	70	87	112
Relief Valve setting (KPa)	1400	1400	1400	1400	1400	1000	1000	1000
ECV Setting (kPa)	1200	1200	1200	1200	1200	850	850	850
Max Supply Pressure without ECV (kPa)	1120	1120	1120	1120	1120	800	800	800
Max Supply Pressure with ECV (kPa)	960	960	960	960	960	680	680	680

Table 5.4: Dimensions and pressure settings of the Rheem electric water heater range

HEATING UNIT RATINGS

Each model of heater is available with a number of different heating unit power ratings. The required rating of a heating unit depends on a number of factors including:

1. The electricity supply authority may lay down requirements setting a maximum limit to the size of heating unit allowed, e.g. many electricity utilities will not permit more than 3600 W rating on a single phase for a water heater.
2. In addition the electricity utility may offer special tariffs subject to stated limitations on element rating (e.g. element rating not to exceed 13.5 W/Litre).
3. In a particular installation the heating unit rating may be limited either by switchboard capacity or distribution wiring (e.g. if only 10 A wiring is available, heating unit rating is restricted to 2400 W maximum).
4. Where only low voltage is available (e.g. 110 V), heating unit rating may be governed by the ability of the internal wiring of the appliance to carry the load.
5. In the case of conventional, off peak heating the heating unit must be capable of reheating the full content of the water heater within the off peak heating period.

Rheem does supply the most common heating unit rating suitable for each state as the standard heating unit rating for that state. Any variations from the standard rating must be clearly specified with the order, and even then the wattage must be one of the following:

1200 W	1800 W	2400W	3000 W
3600 W	4800 W	6000 W	

Current Ratings

Normal internal wiring in Rheem water heaters is 20 A (i.e. maximum 4800 W on 240 V). Water heaters fitted with 6000 W heating units have 25 A wiring.

The thermostat rating is 30 A.

Power Density

Regular heating units have power density not exceeding 150 kW per square metre of heater sheath surface. Where water supplies are scale forming, special low power density heating units are available in order to reduce the formation of scale on the heating unit to an acceptable limit.

Measurement of Heating Unit Rating

Why The Measurement Is Sometimes Required

Occasionally it is necessary to check that the rating marked on a heating unit is correct. Differences between the marked and actual ratings can be due to:

- the fitting of an incorrect heating unit to a water heater
- the heating unit rating not being measured at the rated voltage (a drop of 10% in voltage will reduce wattage by 20%)
- the manufacturing tolerance (SA wiring rules permit a tolerance of ± 10% in wattage at the marked voltage)

Method Of Checking

Ensure there is no other load connected through the tariff meter during this procedure.

1. Turn the water heater off to ensure that the disc stops completely on the meter.
2. Turn the water heater on and make sure the disc rotates by drawing off enough water to make the thermostat cut in.
3. Determine the time in seconds for one revolution of the disc (t). It may be better to time say 10 revolutions and divide the figure by 10 to get an accurate figure for one revolution.
4. Note number of revolutions per kilowatt hour as shown on the meter data plate (N).
5. Determine the element rating in watts using the formula:

$$\frac{3600}{t \times N}$$

Worked Example

Looking at the data plate, you note that the heating unit specifies 100 revolutions of the disk per kilowatt hour. Thus N=100

You turn the heater on and time the disk. You observe 10 revolutions in 150 seconds, which equates to 15 seconds per revolution. Thus t = 15.

Using the formula,

$$\text{Power rating} = \frac{3600}{15 \times 100}$$

$$= 2.4 \text{ KW}$$

Recovery Rating

Recovery At 100% Efficiency

When hot water is released from a water heater, cold water comes in to replace it. The amount of cold water that can be brought up to temperature per hour is the heater's ***recovery rating***.

Recovery rating can be estimated from table 5.5. These are calculated from the known properties of water, and assume no heat loss during recovery (ie 100% efficiency).

Heating unit rating (W)	40°C rise	50°C rise	60°C rise	70°C rise
1200	*26*	21	17	15
1500	32	26	22	18
1800	39	31	26	22
2000	43	34	29	25
2400	52	41	34	29
3000	65	52	43	37
3600	77	62	52	44
4800	103	83	69	59
6000	129	103	86	74

Table 5.5: Recovery rate (Litres/hour) at 100% efficiency

Recovery Of Real Heating Units

The thermal efficiency of an immersion heating unit is quite high, but there will always be some heat loss during the recovery process.

This effect is most noticeable when a small heating unit rating is fitted in a large storage water heater, since there is more time for heat to escape. In calculating recovery ratings an efficiency factor should be allowed varying from 90% on the low heating unit ratings to 98% on the high.

Volume Of Hot Water Available

The approximate amount of hot water available from a water heater for any given period of time can be readily calculated from the previous table, using the following formula:

Hot water available = delivery rate + (recovery rate x time)

Formula Assumptions

This formula applies under the following restrictions:

- It assumes continuous tariff, or while power is available for off peak tariffs.
- Allowance is made for one heating unit only, so it applies to either single heating unit models, or twin heating unit models wired for non-simultaneous operation.

Worked Example

How much water is available from an 80 litre water heater installed with a 3600 Watt heating element over a 2 hour period? Assume a 50°C temperature rise is required.

The delivery rate of an 80 litre heater is 80 litres.

The recovery rate can be read off table 5.5, as 62 litres/hour.

hot water available = 80 + (62 x 2)

= 204 litres

In other words, the water heater can heat up 62 litres of water an hour, so in 2 hours can heat up 62 x 2 = 124 litres. Add this to the water heaters delivery rating of 80 litres, and we have the water available for the first 2 hours of operation.

For convenience, the figures in table 5.6 have been expanded to include this calculation for 1 and 2 hours of operation assuming a 50°C rise in temperature.

Water Delivery (Litres)	Heating Unit (Watts)	Recovery at 50°C rise (litres/hr)	Water available over 1 hour (Litres)	Water available over 2 hours (Litres)
18	2400 3000 3600	41 52 62	59 70 80	100 122 142
50	1200 3600 4800	21 62 83	71 112 133	91 174 216
80	1200 3600 4800	21 62 83	101 142 163	122 204 246
125	1800 3600 4800	31 62 83	156 187 208	187 249 291
160	2400 3600 4800	41 62 83	201 222 243	242 284 326
250	3600 4800	62 83	312 333	374 416
315	3600 4800	62 83	377 398	439 481
400	3600 4800 6000	62 83 103	462 483 503	524 566 606

Table 5.6: Approximate volume of hot water available for single heating unit models on continuous supply and twin-element models wired for non-simultaneous operation

Energy Usage

There are two components to energy usage in water heaters.

1. The heat required to initially heat up a given quantity of water. This is the energy content of water.
2. The heat required to maintain that temperature over time. This is the maintenance energy.

These must be added together to derive the total energy usage for a water heater.

Energy Content Of Water

Table 5.7 gives the amount of energy in kilowatt-hours to heat a given quantity of water by 50°C.

Quantity of water required	Energy required to increase temperature by 50°C (kWh)
50	2.91
100	5.81
150	8.72
200	11.63
250	14.53
300	17.44
350	20.35
400	23.26
450	26.16
500	29.07
750	43.60
1000	58.14
1250	72.67
1500	87.21

Table 5.7: Energy required to heat a given quantity of water.

Maintenance Energy

Definition: This is the energy which has to be supplied to a water heater to maintain its temperature for a whole day, assuming no loss or replacement of water. It is equivalent to the rate at which heat is lost as the unused water heater naturally cools down. The insulation of a water heater greatly reduces this heat loss.

Delivery Rating (Litres)	Maximum Heat Loss required by AS 1056.1 (kWh)	Heat Loss of *single* element Rheem water heaters (kWh)
25	1.18	1.04
50	1.39	1.38
80	1.67	1.62
125	1.95	1.93
160	2.16	2.11
250	2.58	2.53
315	2.86	2.78
400	3.07	2.98

Table 5.8: Heat Loss for Rheem electric water heaters and storage tanks.

Notes on tables 5.8 and 5.9

- Table 5.8 gives heat loss for a range of water heater sizes. The first column gives the allowable heat loss as required by AS 1056.1; the second column gives the heat loss figures as tested for Rheem domestic electric water heaters and storage tanks.
- Table 5.9 is based on operation at 50°C above ambient and daily usage in litres of hot water at 50°C rise.
- Figures are based on test results at 55°C rise, as given in table 5.8, pro rated to 50°C rise.
- Figures are based on the use of 3600 W heating units throughout but can be used with reasonable accuracy for all other wattages.
- Figures do not include an allowance for pipe heat losses. An allowance should be made to suit large installations.
- The figures are based on mains pressure water heaters with a single heating unit only.

Total Energy Usage

Tables 5.7 and 5.8 can now be combined to give the total energy used by a heater for a given daily water usage.

Total energy usage = Energy content of water + maintenance energy

Worked Example

How much energy is used in a day for a 125 litre single element water heater with a daily water usage of 300 litres? Assume a 50°C rise.

From table 5.9, energy content of 300 litres is 17.4 kWh.

300	17.4

From table 5.9, maintenance energy for a 125 litre single element water heater is 1.80 kWh.

1.3	1.5	1.8	1.9

Total daily energy usage is thus 17.4 + 1.8 = 19.2 kWh

For convenience, tables 5.9 and 5.10 show these calculations.

Total Energy Usage Table – Single Element

Water Usage (Litres)	Energy Content	25 L	50 L	80 L	125 L	160 L	250 L	315 L	400 L
0	0	0.9	1.3	1.5	1.8	1.9	2.3	2.5	2.7
50	2.9	3.9	4.2	4.4	4.7	4.8	5.2	5.4	5.6
100	5.8	6.8	7.1	7.3	7.6	7.7	8.1	8.3	8.5
150	8.7	9.7	10.0	10.2	10.5	10.6	11.0	11.2	11.4
200	11.6	12.6	12.9	13.1	13.4	13.5	13.9	14.2	14.3
250	14.5	15.5	15.8	16.0	16.3	16.5	16.8	17.1	17.2
300	17.4	18.4	18.7	18.9	19.2	19.4	19.7	20.0	20.2
350	20.3	21.3	21.6	21.8	22.1	22.3	22.6	22.9	23.1
400	23.3	24.2	24.5	24.7	25.0	25.2	25.6	25.8	26.0
450	26.2	27.1	27.4	27.6	27.9	28.1	28.5	28.7	28.9
500	29.1	30.0	30.3	30.5	30.8	31.0	31.4	31.6	31.8
750	43.6	44.5	44.9	45.1	45.4	45.5	45.9	46.1	46.3
1000	58.1	59.1	59.4	59.6	59.9	60.1	60.4	60.7	60.8
1250	72.7	73.6	73.9	74.1	74.4	74.6	75.0	75.2	75.4
1500	87.2	88.2	88.5	88.7	89.0	89.1	89.5	89.7	89.9

Table 5.9 – Total energy used per day in kilowatt-hours for a range of water heater capacities and water usages.

Table 5.9 summaries the discussion thus far for single element water heaters. The numbers derived in the worked example are highlighted.

Chapter 6

Rheem Solar Water Heaters - Domestic

This Chapter Covers:

Design, operation and energy usage of domestic solar water heaters

- Current models available in the Rheem solar and heat pump range
- An overview of their main features
- Tables of dimensions, performance, and other technical data

A1006

Overview of Models

At A Glance

The Rheem solar water heater product range is extensive, but is broken into three broad categories:

- ***Solar Hiline*** – Thermosiphon systems with storage tanks mounted horizontally above flat plate collectors. Boosting may be by thermostatically controlled electric heating elements or in line gas water heaters.
- ***Solar Loline*** – Flat plate collectors on the roof are connected to a storage tank at ground level. Boosting may be by thermostatically controlled electric heating elements, in line gas water heaters or controlled in tank gas boosting.
- ***Heat Pump*** – Winner of the 2003 Green Plumbers Judges Innovation and New Technology Award, this unit removes heat from ambient air and stores it in the water tank. Collectors on the roof are not required.

Hiline and Loline systems are further defined as follows:

- ***Open Circuit*** – or direct systems heat the potable water directly by the collector. These systems have a limited or no freeze protection strategy and are suited for use in areas of good water quality.
- ***Closed Circuit*** – or indirect systems do not heat potable water directly. Instead, an anti-freeze fluid such as Glycol circulates through the collectors, and then through a heat exchanger which transfers the heat to mains water. This provides excellent freeze protection and is suited for use in poor water quality areas.

With the exception of Premier Hiline, all of Rheem's solar water haters have mains pressure mild steel storage cylinders lined with Rheem's exclusive Multiglaze enamel. This enamel is designed for long life under high water temperature. Premier Hiline units use a lightweight mains pressure stainless steel cylinder which makes the unit ideally suited for roof mounting. The cylinder is insulated with rigid polyurethane foam. The insulation is enclosed in a Colorbond® steel jacket suitable for many years exposure to the Australian climate.

The jacket and its components are rated to IP 34 Degree of Protection as tested against AS 1939 in order for it to be installed outdoors.

Also in this range are the following specialised products:

- ***Solar Convertible Units*** – Allow certain electric storage water heaters to be converted to Loline solar systems.

Rheem Hiline Rheem Loline Rheem Heat Pump

Fig 6.1: Types of Rheem solar and heat pump water heaters

The following chart represents the Rheem domestic solar range:

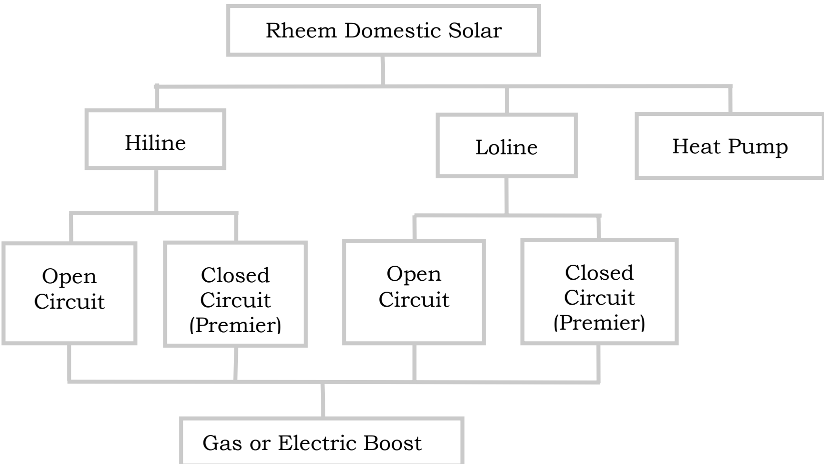


Fig 6.2: Rheem solar and heat pump family tree

SOLAR HILINE

Each model comprises 1 or 2 flat plate collectors with an electric storage tank close coupled on the roof. Water heaters in the Solar Hiline range operate as thermosiphon systems, the workings of which are explained in chapter 1.

Open circuit *Hiline* systems, prefix 52S, are available in 160L and 300L tank sizes made from steel cylinders lined with Multiglaze enamel.

Closed circuit *Premier Hiline* systems, prefix 52H, are available in 180L and 300L tank sizes made from stainless steel.

Components

Collectors

The 52S160 and 52S300 use NPT200 collectors and are not suited for use in areas subject to frost or poor water quality.

The 52H180 and 52H300 use S200 or T200 collectors and offer frost protection to temperatures as low as -28°C. The system is suitable for poor water quality areas.

Temperature Control

52S models are equipped with a *Sunstat valve* to prevent excessive water temperatures occurring in the cylinder. The valve works by closing off the water flow in the collector pipe when a temperature of around 75°C is reached in the tank.

Electric Booster

The storage cylinder is fitted with a single phase boosting heating unit. The heating unit is controlled by a contact thermostat which incorporates a double pole over-temperature cut out.

Gas Boosting Alternative

As an alternative, boosting can be achieved by a gas water heater installed at ground level. The gas booster could be either an instantaneous or storage water heater. In this installation, the electric heating unit in the solar storage tank is not connected to power. The gas water heater is installed downstream of the solar system. Water preheated by the solar water heater passes through the gas water heater and is boosted if required.

Heat Exchanger

The Premier Hiline models have a heat exchanger attached to the outside of the storage cylinder. Glycol, heated as it passes through the collectors, circulates through the heat exchanger and transfers heat into the water in the storage cylinder. The system is “fully flooded” meaning the collectors are permanently filled with glycol. A small air gap exists in the top of the heat exchanger to absorb expansion and contraction of the glycol as it heats and cools.

Specifications

Model Summary

	Warranty		Capacity	Litres raised to 65°C	
52S160 1 x NPT200 collector	Cylinder Labour on Cylinder Collector Parts	5 yr 3 yr 5 yr 1 yr	160 litre 1-2 people	Adelaide, Darwin, Perth Canberra, Brisbane Sydney, Melbourne	125-140 115-125 100-115
52S300 2 x NPT200 collectors	Cylinder Labour on Cylinder Collector Parts	5 yr 3 yr 5 yr 1 yr	300 litre 2-5 people	Adelaide, Darwin, Perth Canberra, Brisbane Sydney, Melbourne	300-325 275-300 250-275
52H180 1 x S200 collector	Cylinder Labour on Cylinder Collector Parts	6 yr 3 yr 6 yr 1 yr	180 litre 1-2 people	Adelaide, Darwin, Perth Canberra, Brisbane Sydney, Melbourne	125-140 115-125 100-115
52H300 2 x S200 collectors	Cylinder Labour on Cylinder Collector Parts	6 yr 3 yr 6 yr 1 yr	300 litre 2-5 people	Adelaide, Darwin, Perth Canberra, Brisbane Sydney, Melbourne	300-325 275-300 250-275

Last column shows approx hot water available per day during best solar month using 100% solar gain

Table 6.1: Rheem Hiline model summary

Dimensions

	52S160	52H180	52S300	52H300
Roof area required	1.4 m wide x 2.5 m deep		2.5 m wide x 2.5 m deep	
Solar Storage Approx Wt Empty (kg)	70	48	100	68
Solar Storage Approx Wt Full (kg)	230	237	400	386
Solar Collector Approx Wt Empty (kg)	40	35	80	70
Solar Collector Approx Wt Full (kg)	42	37	84	74

Table 6.2: Dimensions of the Rheem Hiline range

Performance

	52S160	52S180	52S300	52H300
Storage Capacity (L)	160	180	300	300
Boost Capacity (L)	80	90	160	160
Thermostat Setting	60°C adjustable to 70°C			

Table 6.3: Capacities of the Rheem Hiline range

Plumbing Specifications

	52S160	52S300	52H180	52H300
Cold Water Inlet ("/mm)	GB½/15		DN 20	
Hot Water Outlet ("/mm)	RP ¾/20		G ¾B	
TPR Connection ("/mm)	RP ½/15		RP ½/15	
TPR Setting	1000 kPa		850 kPa	
ECV Setting	850 kPa		700 kPa	
Max Water Supply Pressure without ECV	800 kPa		680 kPa	
Max Water Supply Pressure with ECV	680 kPa		550 kPa	
Frost Protection	Nil		Down to minus 28°C	

Table 6.4: Plumbing specifications of the Rheem Hiline range

SOLAR LOLINE

Loline water heaters are pumped circulation systems where only the solar collectors are mounted on the roof. The storage tank is located separately either externally or internally, depending on the model. The operation of Loline systems is covered in chapter 1.

Open circuit *Loline* systems, prefix 511 and 531, are available in 260, 270, 340 and 430 tank sizes and have a limited frost protection system up to 400m altitude. They are limited for use in areas with good water quality.

Closed circuit *Premier Loline* systems, prefix 590, 591 and 596, are available with a 270L storage tank and are frost protected to -20°C. These systems are suitable for use in areas with poor water quality.

Components

Collectors

The 511 and 531 Loline series use NPT200 collectors and are not suited for use in areas above 400m altitude or where frost is occurrence is common (due to limited frost protection) or poor water quality.

The 590, 591 and 596 Premier Loline series use S200 or T200 collectors and offer frost protection to temperatures as low as -20°C. The system is suitable for use in hard water areas.

Solar Control Unit

Loline pump operation is governed by the solar control unit which may be mounted on the side of the tank or incorporated into the water heater depending on the model. The solar control unit provides the following operational features:

- ***Temperature sensors*** – a cold sensor is located at the base of the cylinder and a hot sensor is located at the top of the collectors.
- ***Temperature differential controller*** – When a temperature differential between the cold and hot sensors greater than 8°C is sensed, the pump is turned on to draw the solar heated water from the collectors into the tank.
- ***Temperature limiter*** – to limit water temperatures in the cylinder to 75°C, the pump is turned off.
- ***Freeze protection*** – During periods of frost, the 511 and 531 series will circulate a small amount of water through the collectors to prevent water in the collector from freezing. The Premier Loline range operates on a drain back principle. When the pump deactivates, the heating fluid returns to the reservoir. This prevents the collectors from freezing.

Electric Boost

The 511 and 591 series storage cylinder is fitted with a single phase 3.6 or 4.8 kilowatt booster element. The heating element is controlled by a contact thermostat with over-temperature cut out.

Four models are available in this range, all of which are suitable for indoor or outdoor installation of the storage tank.

Gas Boost

All Loline series with the exception of model 531260 can be boosted by an in-line instantaneous gas water heater.

The 596 Premier Loline incorporates an integrated in-line instantaneous gas booster.

Model 531260 is a combination solar/gas water heater whereby the gas boosting is controlled by an automatic timer.

All gas boosted water heaters are suitable for outdoor installation only.

Premier Loline

The Premier Loline model 596 270 Has the following additional features:

- ***Flexible installation*** – the storage tank with integrated gas booster can be rotated through almost 180 degrees which will assist installers in meeting gas code requirements with regards to flue termination.
- ***Dual temperature*** – tempered and hot water outlets are provided for convenience and safety.
- ***Factory engineered*** – plumbing to interconnect tank and booster have been factory assembled and hidden behind a cover to provide a neater and faster installation. Solar flow and return connections are conveniently located at the top of the water heater to effect near 180 degree rotation and make for a neater finish. All connections are centrally located making plumbing from left hand or right hand side a breeze.

Heat Exchanger

The Premier Loline models have a heat exchanger located in the centre of the cylinder, similar to the central flue in a storage gas water heater. When solar gain is available at the collectors the pump is activated and heat transfer fluid (glycol) is pumped to the collectors and returns to the heat exchanger under gravity. Patented design of the heat exchanger allows the glycol to transfer the heat into the water contained in the storage cylinder. The system is known as a “drain back” system meaning the glycol drains back from the collectors when further heating is not required or solar gain diminishes.

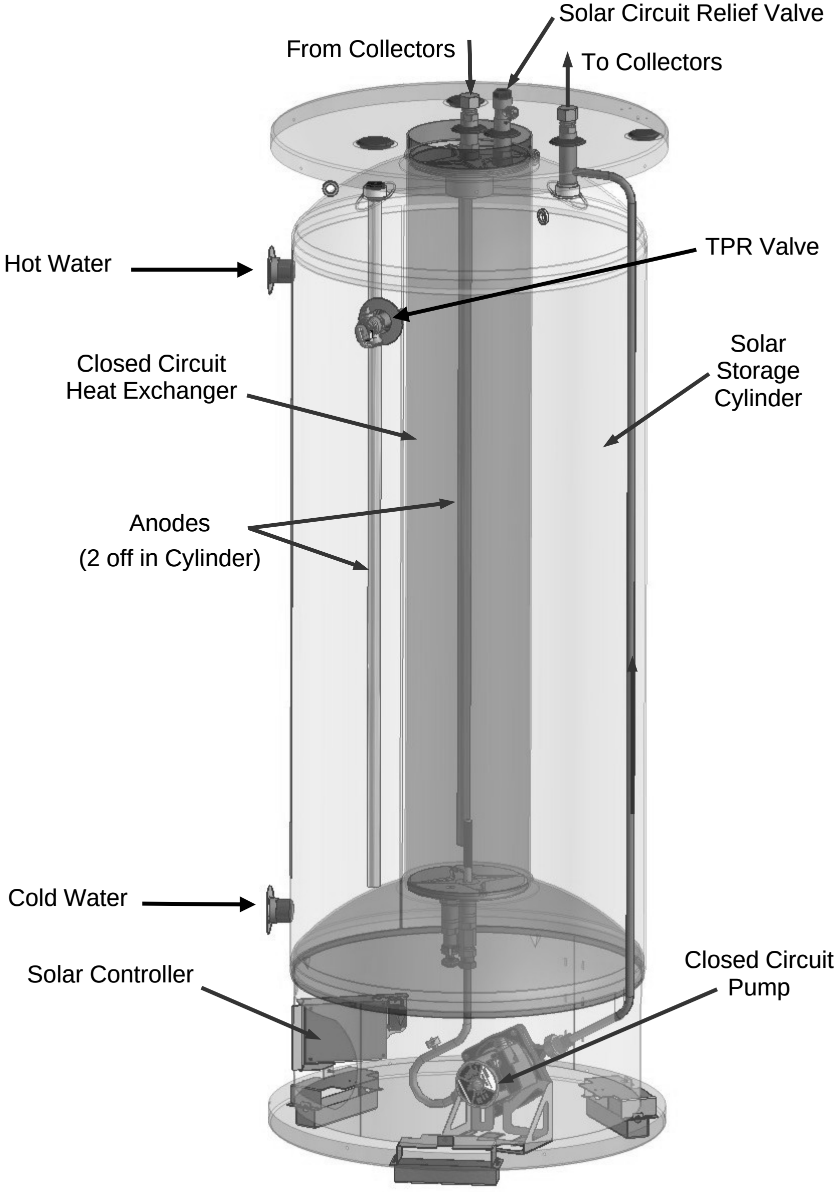


Fig 6.3: Rheem Premier Loline construction

Specifications

Model Summary

	Warranty		Capacity	Litres raised to 65°C	
511270 **elec boost** 2 x NPT200 collectors	Cylinder Labour on Cylinder Collector Parts	5 yr 3 yr 5 yr 1 yr	270 litre 1-3 people	Adelaide, Darwin, Perth Canberra, Brisbane Sydney, Melbourne	240-270 200-240 175-200
511340 **elec boost** 2 x NPT200 collectors	Cylinder Labour on Cylinder Collector Parts	5 yr 3 yr 5 yr 1 yr	325 litre 2-4 people	Adelaide, Darwin, Perth Canberra, Brisbane Sydney, Melbourne	300-325 275-300 250-275
511430 **elec boost** 3 x NPT200 collectors	Cylinder Labour on Cylinder Collector Parts	5 yr 3 yr 5 yr 1 yr	410 litre 3-5 people	Adelaide, Darwin, Perth Canberra, Brisbane Sydney, Melbourne	400-425 375-400 350-375
531260 **in tank gas boost** 2 x NPT200 collectors	Cylinder Labour on Cylinder Collector Parts	5 yr 3 yr 5 yr 1 yr	260 litre 2-5 people	Adelaide, Darwin, Perth Canberra, Brisbane Sydney, Melbourne	240-270 200-240 175-200
591270 **elec boost** 2 x S200 collectors	Cylinder Labour on Cylinder Collector Parts	5 yr 3 yr 5 yr 1 yr	270 litre 1-3 people	Adelaide, Darwin, Perth Canberra, Brisbane Sydney, Melbourne	240-270 200-240 175-200
596270 **integrated gas boost** 2 x S200 collectors	Cylinder Labour on Cylinder Collector Parts	5 yr 3 yr 5 yr 1 yr	270 litre 3-6 people	Adelaide, Darwin, Perth Canberra, Brisbane Sydney, Melbourne	240-270 200-240 175-200
590270 **remote gas boost** 2 x S200 collectors	Cylinder Labour on Cylinder Collector Parts	5 yr 3 yr 5 yr 1 yr	270 litre 3-6 people	Adelaide, Darwin, Perth Canberra, Brisbane Sydney, Melbourne	240-270 200-240 175-200

Last column shows approx hot water available per day during best solar month using 100% solar gain

Table 6.5: Rheem Loline model summary

Dimensions

	511270 electric boost	511340 electric boost	511430 electric boost	531260 gas boost	591270 electric boost	596270 gas boost
Roof Area Required W x D (m)	2.2 x 2.0	2.2 x 2.0	3.3 x 2.0	2.2 x 2.0	2.2 x 2.0	2.2 x 2.0
Solar Storage Approx Wt Empty (kg)	71	88	112	110	147	167
Solar Collector Approx Wt Empty (kg)	80	80	80	80	70	70
Solar Collector Approx Wt Full (kg)	84	84	84	84	74	74

Table 6.6: Dimensions of the Rheem Loline range

Performance

	511270 electric boost	511340 electric boost	511430 electric boost	531260 gas boost	591270 electric boost	596270 gas boost
Storage capacity (L)	270	325	410	260	270	270
Boost capacity (L)	160	200	280	260	125	cont
Thermostat setting		60-70°C		60-65°C	60-70°C	60°C

Table 6.7: Capacities of the Rheem Loline range

Plumbing Specifications

	511270-511430 electric boost	531260 gas boost	591270, 596270, 590270 electric and gas boost
Cold Water Inlet ("/mm)	RP ¾/20	RP ¾/20	RP ¾/20
Hot Water Outlet ("/mm)	RP ¾/20	RP ¾/20	RP ¾/20
TPR Connection ("/mm)	RP ½/15	RP ½/15	RP ½/15
TPR Setting	1000 kPa	1000 kPa	1000 kPa
ECV Setting	850 kPa	850 kPa	850 kPa
Max Water Supply Pressure without ECV	800 kPa	800 kPa	800 kPa
Max Water Supply Pressure with ECV	680 kPa	680 kPa	680 kPa
Frost protection	Up to 400m altitude	Up to 400m altitude	Down to minus 20°C

Table 6.8: Plumbing specifications of the Rheem Loline range

Solar Conversion

Several models in the Rheem electric range are available in convertible configurations. A home owner can purchase one of these Optima or Rheemglas heaters, with the intention of later converting it to a Loline configuration.

A conversion kit is required which consists of a solar control unit, five-way inlet connector and all fittings necessary to complete conversion.

The models available are listed in the following table. Each is available for indoor or outdoor installation.

The technical specifications are identical to the corresponding model, as described in the chapter on domestic electric water heaters.

	No. of people	No. of collectors	Boost capacity (litres)
411 and 462 250	1-3	2	250/50
411 and 462 315	2-4	2	315/50
411 and 462 400	4-6	3	400/90
111 and 162 250	1-3	2	250/50
111 and 162 315	2-4	2	315/50
111 and 162 400	4-6	3	400/90

The larger boost capacity relates to the main heating element when connected to an Off Peak Tariff. The smaller boost capacity relates to the boost element connected to a continuous tariff, if fitted.

Table 6.9: Rheem Solar convertible electric models

COLLECTORS

Rheem Solar collectors

There are currently three types of flat plate collectors in the Rheem range. These are the NPT200, S200 and T200 collectors.

- NPT200 is suitable for use with Rheem Hiline in non frost prone areas. Use in Loline systems is acceptable up to 400m altitude. Designed for use in areas of high solar gain, these collectors utilise an aluminium absorber plate and a black polyester surface coating which reduces the effects of over heating.
- S200 is suitable for use with Rheem Premier indirect systems. Glycol heat exchange fluid passes through the polyester coated steel solar collectors and into a heat exchanger which may partly surround the storage cylinder in the case of Premier Hiline or is immersed in the cylinder in the case of Premier Loline. Glycol offers freeze protection to minus 20°C (Premier Loline) or minus 28°C (Premier Hiline) and also protects collectors from the effects of calcium build up and corrosive water supplies.
- T200 has the same characteristics as the S200 collector but has a Black Chrome selective surface which provides improved solar performance.

Collector Performance

Collector performance is dictated by the design characteristics of the solar collector. Increasing the number of risers improves performance, as does the type of absorber plate, selective surface and insulation. It is not possible for all of the total available radiation to be transferred to the water. The amount of energy transferred depends on the ambient temperature, the temperature of the water leaving the collector and the total global available radiation at the time of day and time of year. This represents the efficiency of the collector for a given set of conditions. As the available radiation levels increase, there is a higher transfer of energy to the water. Also, as the temperature of the collector water increases, the transfer of energy decreases, which is expected.

These figures are as tested by the University of New South Wales in accordance with methods of testing set out in AS 2535.1. It must be remembered that actual daily efficiency of a specific installation will depend on location, weather, draw off volume and draw off pattern.

For calculation purposes, the average daily efficiency of Rheem collectors is listed in the table below.

	Collector Model		
	NPT200	S200	T200
Nominal area (m^2)	1.87	1.87	1.87
Dimensions L x W x D (mm)	1937 X 1022 X 65	1937 X 1022 X 65	1937 X 1022 X 65
Mass empty/full (kg)	40/42	35/37	35/37
Absorber material	Aluminium	Steel	Steel
Selective surface	Black polyester	Black polyester	Black chrome
Number of risers	6	33	33
Casing material	Zincalume®	Zincalume®	Zincalume®
Insulation material (back/sides)	Polyester	Polyester	Glass wool / Polyester
Insulation thickness (mm) (back/sides)	40/20	40/20	40/20
Insulation density (kg/m^3) (back/sides)	12/30	12/30	12/30
Glass	Low iron, toughened	Low iron, toughened	Low iron, toughened
Operating pressure (kPa)	1000	200	200
Average annual efficiency (%)	57	60	63

Table 6.10: Collector details

Solar Contribution

While it is possible to calculate solar contribution, it must be remembered that this is a theoretical maximum. The actual contribution will depend on a number of usage factors.

Control of Auxiliary Heating Units

One of the greatest factors determining solar contribution is the amount of time the auxiliary heating unit, or booster, is in operation.

Switch On Only When Required

During summer, auxiliary heating may be required only every second night, or not at all. During winter it will be required to have the booster turned on. A little experience is all that is required to allow a family to anticipate when it is likely to need auxiliary power.

When auxiliary heating units are left permanently on, water will always be at a minimum of 60°C; however, solar contribution could be reduced by as much as 50%.

Isolation Switch

Electrical boosters have an isolating switch installed in the meter box during installation. Rheem recommends installing an additional switch in a more convenient location, such as a kitchen or laundry, or an automatic timer can be installed in the meter box:

- ***Manual on/off switch***: with a neon indicator to remind that the booster is on.
- ***Automatic timer***: It is suggested the timer be set to activate boosting between the hours of 4pm and 7pm. A second period from 4am to 6am may also be required if heavy draw occurs during the evening.

Tariffs

Continuous Tariff is more expensive but offers more flexibility in that the booster can be turned on at any time.

Off Peak Tariff is less expensive, but requires planning to balance convenience of always having sufficient hot water while still maximising solar contribution. Heavy water usage should, wherever possible, happen early in the day so that the maximum number of daylight hours are available to reheat water.

Gas Boosting

Timer Controlled

The 531260 gas boosted Loline model is supplied with a timer to limit the operation of the burner until after the end of the solar day. The timer should be set to operate from 4:00pm to 6:30pm, which will give the gas burner sufficient time to heat the entire contents of the tank if required. Naturally, any solar contribution received during the day will limit the amount of time the burner operates, and hence the amount of boost energy consumed.

In Line Boosting

In line gas boosting allows maximum solar gain to be collected in the solar storage tank. As long as the pre-heated water in the solar tank is greater than 58°C, it will pass through the gas booster without further heating. If, however, the temperature is less than 58°C, the booster will ignite and heat the water to 60°C.

It should be noted that temperature controllers cannot be used with instantaneous water heaters used as in line gas boosters as the temperature exiting the system can be above the temperature setting of the controller.

Other Factors

Keeping Solar Collectors Clean

Residue left on glass will reduce the amount of sunlight which actually passes through the collectors. The glass should be washed occasionally, particularly after dust storms. More frequent washing is needed in industrial areas, areas near the sea, or where bird liming is a problem.

Keeping Solar Collectors Shade Free

Occasional loping of trees that will shade the collectors will increase the amount of sunlight incident on the collectors.

Correct Sizing

If a solar water system is undersized, the booster will need to be left on for longer periods of time to deliver the required volume of hot water to the household, reducing the effectiveness of the solar water heater.

PRE-INSTALLATION CHECKS

Before a solar water system is installed, there are a number of considerations that will determine exactly what is proposed.

Will A Solar Water Heater Be Effective

- Use a compass to determine the direction which the roof faces. (Do not guess)
- Can sufficient solar collectors be installed properly on the roof, considering space and inclination angle?
- Check for trees or buildings that may shade the roof for part of the day, especially between 9:00 am to 4:00 pm. Consider any smaller trees that may cause problems when they grow, especially on neighbouring properties where permission to trim or lop may not be granted.

Determine The Type Of System

- Will the structure hold the weight of a Hiline system?
- What level of frost protection is required?
- Is it feasible to convert the existing water heater?

Determine The Size Of The System

- Consider the size of the family and their hot water requirements. Consult the latest Rheem literature for guidance.

Determine Positioning Of Main Components

- For Loline systems, determine the position of the solar storage tank, as well as connection plumbing.
- Agree on position of solar boost switch.

SOLAR CALCULATIONS

It is often necessary to calculate the potential contribution solar heating can make to an installations' energy requirements. To this end, solar contribution is defined by:

$$\text{Percentage solar contribution} = \frac{\text{Solar energy available}}{\text{Total energy consumed}} \times 100$$

Example

Calculate the solar contribution for a Rheem Premier Hiline system model 52H300 to replace an existing 125 litre electric water heater supplying a family of five in Sydney using 250L of water per day at 60^{o}C.

Calculate Solar Energy Available

The solar energy available to an installation is found by the following formula.

$$\text{Solar energy available/day (MJ)} = \text{Average radiation /m}^2\text{ per day (MJ/m}^2\text{)} \times \text{Surface area of all collectors (m}^2\text{)} \times \text{Annual collector efficiency (\%)} - \text{Daily tank heat loss (MJ)}$$

Essentially this formula says:

- The higher the radiation in an area, the higher the energy available. This figure is found from table 6.11.
- The greater the collector surface area, the higher the energy available. This is found in the specification table 6.10.
- The higher the efficiency of the collector, the higher the energy available. This should also be given in the specification table. An average of 60% is often used.
- Heat loss from the tank is inevitable.
  An allowance of 2kWh per day is reasonable.

Example

Calculate the energy available from a Rheem Hiline system 52H300 located in Sydney.

Solution: We derive the quantities in the formula:

Average radiation/day	From table 6.11 for Sydney, we see the year round daily average is 18.5MJ/m^2
Collector surface area	With two collectors, each 1.87 m^2 (according to table 6.10), collector area is 2 x 1.87 = 3.74 m^2
Annual collector efficiency	Use 60%
Heat loss	2.0 KWh can be converted to MJ by multiplying by 3.6, to give 7.2 MJ loss per day.

So the formula becomes:

Average daily solar energy available = (18.5 X 3.74 X 0.60) - 7.2

= 34.31 MJ.

Calculate Total Energy Consumed

What is the energy consumed per day by a 125 litre water heater where daily usage is 250 litres, at 60°C.

Solution: This involves 3 steps.

- ***Step 1***: Establish the average temperature rise the water must be heated through.
- ***Step 2***: Use standard tables to find the daily energy requirement for this hot water usage scenario. This figure will be given for a 50°C rise.
- ***Step 3***: Use the actual temperature rise found in step 1 to scale the energy requirement found in step 2.

Step 1 – Temperature Rise

Table 6.11 shows the average ambient temperature for Sydney is 17.7°C. It is customary to reduce this by 2°C to give the cold water temperature.

Thus the average temperature rise is 60 - 15.7 = 44.3°C.

Step 2 – Energy Requirement

From table 5.9, we can read directly that the daily energy usage for a 125 litre water heater where 250 litres is used per day is around 16.3 KWhr.

Multiply this by 3.6 to give 58.7 MJ. Remember this figure is for a 50°C rise in temperature.

Step 3 – Scaling for Actual Temperature Rise

Since the actual temperature rise in step 1 is different from 50°C, we need to scale the energy requirement in step 2 as follows:

Energy requirement for 44.3°C rise	=	58.7 X (44.3/50)
	=	52.0 MJ

Calculate Solar Contribution

We can now apply the formula directly:

Percentage solar contribution	=	(34.31 / 52.0) X 100
	=	66%

In this example, then, the Hiline 52H300 can potentially cover up to 66% of the annual energy needs of this installation.

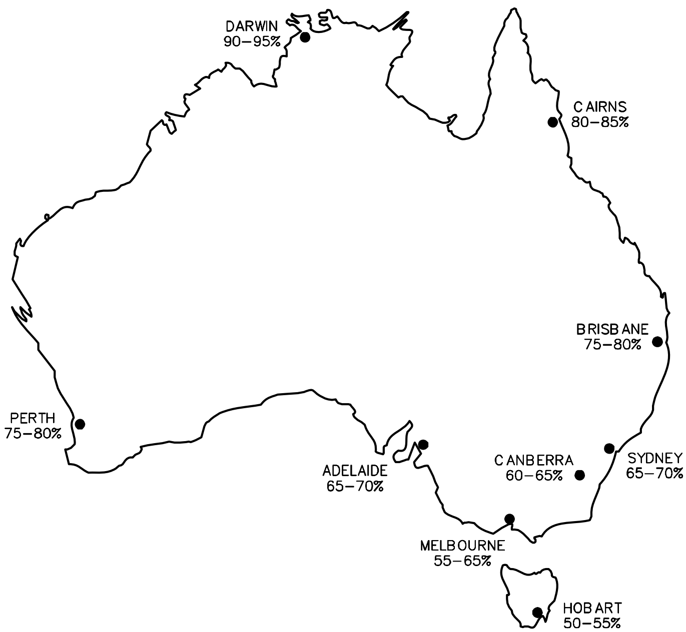


Fig 6.4: Average contribution solar energy can make to water heating

Solar Radiation

Insolation varies from place to place and from day to day. Table 6.11 shows the average daily radiation received on a flat plate collector, inclined at 20°, throughout the year in various Australian cities. Most of Australia has high insolation during the summer months, but the winter radiation varies considerably, depending upon latitude and weather patterns. For this reason, a given size of a Rheem solar system will give higher annual average solar contribution in some areas than in others.

Orientation

Collectors should ideally face north in the southern hemisphere (south in the northern hemisphere), however a system facing up to 45° off north in either direction will experience approximately 5% drop in operating efficiency.

Inclination

Inclination of the collectors should be approximately equal to 90% of the local latitude angle, however, 15 degrees either way is acceptable, with a loss of approximately 5% operating efficiency. Solar collectors may be installed at the roof angle for simplicity of installation and appearance, but must not be installed at an angle less than 10 degrees from the horizontal.

Most roofs have a pitch of approximately 20 – 25 degrees. Rheem solar stands have variable angles from 15 – 28 degrees depending on the type of stand.

Temperature (°C) Radiation (MJ/m²/day)	T R	J	F	M	A	M	J	J	A	S	O	N	D	Ave
Darwin	T	28.3	28.0	28.2	28.4	27.1	25.3	24.9	25.9	27.8	29.1	29.3	28.9	27.6
	R	*17.5*	*18.0*	*20.5*	*23.4*	*23.8*	*23.6*	*24.2*	***24.7***	*23.9*	*22.9*	*21.0*	*18.8*	*21.9*
Cairns / Townsville	T	27.8	27.5	26.8	25.1	22.6	20.1	19.3	20.4	22.5	25.1	26.8	27.7	24.3
	R	*20.5*	*20.6*	*21.8*	*19.6*	*17.5*	*17.8*	*18.5*	*20.4*	***24.0***	*23.8*	*22.2*	*22.3*	*20.8*
Brisbane	T	25.2	24.8	23.5	20.7	17.8	15.3	14.1	15.1	17.9	20.4	22.6	24.2	20.2
	R	***23.2***	*21.4*	*21.2*	*17.9*	*15.3*	*15.5*	*16.3*	*19.1*	*22.4*	*22.3*	*22.6*	*23.0*	*20.0*
Perth	T	24.2	24.6	22.7	19.3	16.0	14.0	13.0	13.2	14.5	16.3	19.2	21.9	18.2
	R	***28.9***	*27.1*	*24.4*	*19.4*	*14.7*	*12.4*	*12.9*	*15.8*	*19.7*	*23.7*	*26.0*	*28.2*	*21.1*
Sydney	T	22.2	22.2	21.2	18.5	15.5	13.1	12.1	13.3	15.5	17.8	19.6	21.3	17.7
	R	*23.4*	*21.6*	*19.3*	*16.0*	*13.1*	*11.9*	*12.6*	*16.2*	*19.6*	*22.0*	*22.8*	***23.5***	*18.5*
Adelaide	T	21.8	22.1	19.8	16.9	14.0	11.8	10.9	11.7	13.4	15.7	18.1	20.0	16.4
	R	***28.2***	*26.7*	*22.6*	*17.7*	*12.8*	*10.6*	*11.4*	*14.7*	*19.0*	*23.0*	*25.8*	*26.4*	*19.9*
Melbourne	T	19.8	20.3	18.2	15.1	12.5	9.9	9.2	10.1	11.7	13.7	15.9	18.1	14.6
	R	***24.4***	*23.0*	*18.9*	*14.3*	*10.2*	*8.3*	*9.3*	*11.7*	*15.3*	*19.1*	*22.0*	*23.6*	*16.7*
Hobart	T	17.2	17.1	15.7	13.4	10.8	8.7	8.2	9.0	10.6	12.3	14.0	15.6	12.7
	R	***23.6***	*22.1*	*17.5*	*13.3*	*9.3*	*7.9*	*9.0*	*11.7*	*15.5*	*19.4*	*21.6*	*22.7*	*16.1*
Canberra	T	20.4	20.1	17.6	13.3	9.3	6.6	5.6	7.0	9.6	12.6	15.6	18.7	13.0
	R	***27.0***	*25.2*	*22.0*	*17.3*	*13.2*	*10.9*	*12.2*	*15.5*	*19.6*	*23.6*	*25.3*	*26.7*	*19.9*

Source: Temperatures – Bureau of Meteorology Climatic Averages
Radiation – Australian Solar Radiation Data Handbook, edition 4, April 2006.
Printed with kind permission of the Australian and New Zealand Solar Energy Society (ANZSES)
The handbook contains further data and can be obtained from ANZSES (www.anzses.org)
Note: Radiation given is average solar radiation incident upon an inclined plane at an angle of 20°, facing true (not magnetic) north.

Table 6.11: Australian Temperature and radiation data

HEAT PUMP

Heat pumps use refrigeration technology similar to a reverse cycle air conditioner or refrigerator to transfer heat from the atmosphere into the water.

They are an alternative to solar water heating when roof space, orientation or shading are not ideal or collectors are not suitable due to aesthetic requirements or caveats.

Operation

Refrigeration Cycle

When heating of the water is required, the heat pump compressor and fan are started. Liquefied refrigerant, which is quite cool, is passed through an evaporator. Ambient air is drawn over the evaporator by the fan and heat from the air is transferred to the refrigerant. The refrigerant boils and changes phase to a gas which generates heat.

The refrigerant pressure and temperature is raised in the compressor and the gas passes through a heat exchanger where the heat is transferred to the water. As the refrigerant loses heat, it returns to a liquid and the process starts again.

Water Cycle

Cold water is drawn from the bottom of the storage cylinder via a pump and riser tube to the heat exchanger located in the heat pump module. The pump speed is controlled to ensure the water is heated to 60°C in a single pass. Heat is transferred from the hot refrigerant gas to the water and is returned to the top of the storage cylinder.

The process continues from the “top down” until the contents of the tank are heated to the required temperature.

This method of top down heating focuses the heat pump’s energy to provide usable hot water rapidly, rather than spreading the heating throughout the tanks contents. This aids in providing the consumer with an abundant supply of hot water without waiting for the entire tank to be heated.

Construction

The Rheem Heat Pump employs a unique modular system whereby the heat pump module and storage tank are supplied in two parts, reducing component weight which makes the unit easier to transport and handle. The two parts fit together during installation, reducing overall foot print requirements and creating a neat one piece water heater.

All refrigeration components are supplied in the heat pump module. Interconnection between the heat pump module and the storage tank occurs at the heat exchanger and is via two flexible water hose connections and two electrical plugs.

A refrigeration technician is not required to effect the installation, simplifying co-ordination of trades.

The design includes a large capacity compressor and evaporator, which provides faster recovery, and a special fan which reduces noise. The Rheem Heat Pump operates at 51dba at 1.5m, which is less than most domestic split air conditioners.

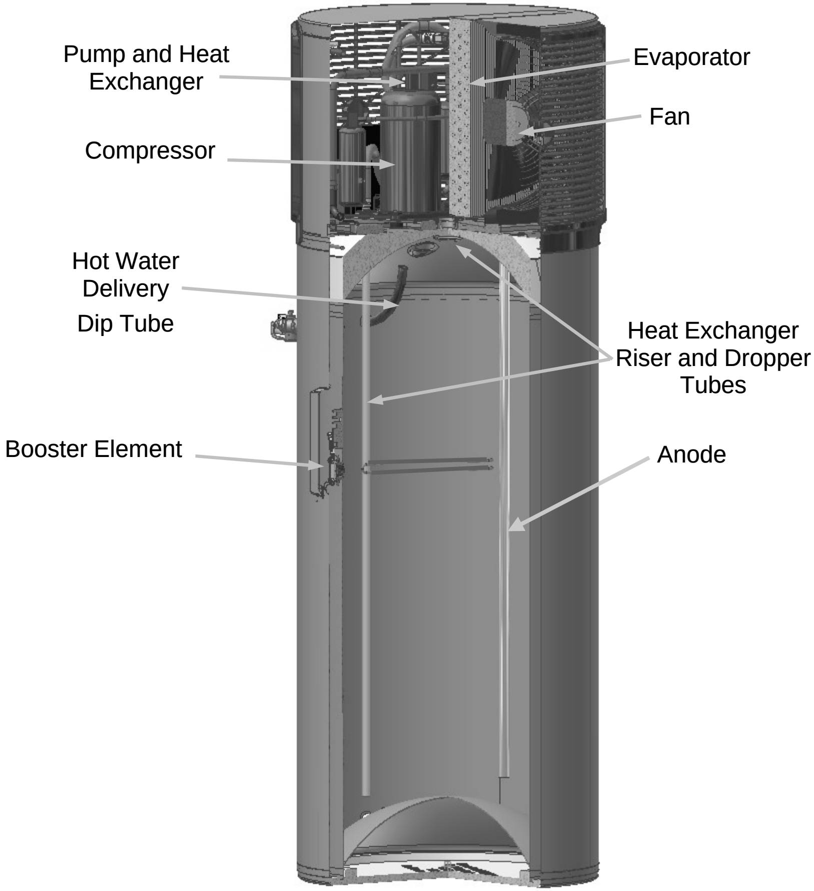


Fig 6.4: Cutaway view of the Rheem 551310 heat pump

Features

The Rheem Heat Pump has many features for the installer and consumer alike. These include:

- Two piece modular construction reduces weight and improves handling.
- Water only connections. Refrigeration trades not required.
- Rapid Top Down heating. Focuses the energy to provide useable hot water faster.
- Cold temperature mode instigates an electric element to ensure hot water, increase component life and reduce late night operating noise.
- Temperature strip monitors the tank temperature at multiple points and provides this information to the heat pump, improving performance.

Fig 6.5: Modular design of the Rheem 551310 heat pump

Boosting

When ambient temperatures approach zero, depending on the humidity, the water vapour in the air exiting the heat pump will begin to freeze, eventually blocking the evaporator surface and rendering the heat pump ineffective. When this occurs, most heat pumps instigate a by-pass mode whereby the hot gas is recirculated through the evaporator to thaw the ice. The effect of this action is fourfold:

- Compressor life is shortened as the unit is operating at the low end of its operational capability.
- Energy is wasted in the de-ice mode.
- Insufficient hot water is generated during this period, leaving the householder with no hot water the following morning.
- The heat pump runs for longer hours, typically during the night, increasing the period noise is emitted during quiet times.

The Rheem heat pump is unique in that when this condition is sensed, the heat pump is switched off and an electric heating element is energized to ensure sufficient hot water is available for consumption. The four situations listed above are overcome.

Other Considerations

Noise

Heat pumps are an effective means of reducing green house gas emissions when siting collectors on the roof is either impractical or aesthetically challenging. However due to the use of a compressor and fan, they do emit a certain amount of noise, similar to a split air conditioning unit.

Special precautions should be taken to ensure the heat pump is not cited near living areas or bedroom windows. Consideration should also be given to neighbouring structures.

Specifications

Model		551310
Storage Capacity	Litres	310
Electric Boost Capacity	Litres	220
Dimensions	Height mm Width mm Depth mm	1870 670 680
Weight (empty) Weight (full)	Kg Kg	135 445
Temperature Setting	°C	60
Hot and Cold Water Connections	"/mm	RP ¾ / 20
Sound Rating	dBA @ 1.5m	51
Rated Power Input (Heat Pump)	Watts	1300
Electric Boost Power Input	kW	2.4 or 3.6
Supply Voltage	Volts	220 - 250
Refrigerant Type		R134a
Co-efficient of Performance (COP) 30°C ambient 20°C ambient 10°C ambient	60% RH 3.8 3.1 2.4	80% RH 3.9 3.2 2.4
Recovery @45°C Rise (Litres/hr) 30°C ambient 20°C ambient 10°C ambient	60% RH 88 71 56	80% RH 92 73 55
Suitable for No. People Moderate Climate Cool Climate		 3-6 3-5
TPR Valve Setting Expansion Control Valve (ECV)* Setting	kPa kPa	1000 850
Maximum Water Supply Pressure Without ECV With ECV	 kPa kPa	 800 680
Minimum Water Supply Pressure	kPa	200

Table 6.12: Specifications of the Rheem heat pump

Chapter 7

Rheem Domestic Water Heaters – Selection Guide

This Chapter Covers:

The criteria used to assist consumers to select the appropriate water heater for their home:

- Fuel type considerations
- Sizing guides
- Other considerations that can affect the decision

THE SELECTION PROCESS

Selection of a water heater needs considerable care. The wrong decision can lead to many years of unsatisfactory supply of hot water, or a water heater with high running costs.

Water heater selection falls into two categories: replacement and new installations. Replacement installations often have more constraints than new installations, and too often, the initial reaction is to replace the water heater with the same size, type and fuel. However, if all the facts and the alternatives are considered, a better and more cost effective way to supply hot water may be found.

Major Considerations

The two most fundamental questions are:

- What fuel type - gas, solar, electric off peak or electric continuous tariff.
- What capacity – This is a more complicated question involving the potential number of inhabitants in a house, the number of hot water-consuming appliances and the climate.

Other Considerations

These can include:

- Indoor or outdoor / space considerations
- Choice of features such as warranty, temperature control or maximum temperature rating
- Environmental considerations

Considering these will result in an informed and helpful proposal to a customer, that will help them decide on a water heater most appropriate to their long term needs and budget.

FUEL TYPE

Most domestic water heaters use either gas, electricity, solar power, or a combination of these fuels.

Step 1- What fuels are available:

- Is reticulated gas available?
- If not, is there a reliable source of LPG in the area?
- Does the electricity supply authority offer an off peak tariff for electricity used to heat water at periods of lower power demand?
- Is the house in a good solar location and is there a suitable north facing roof?

Step 2 – Fuel Cost

At time of publication, the relative cost per unit of energy for each fuel source is as follows:

Solar Energy	On its own has zero fuel cost, though is often supplemented by other "booster" energy sources.
Off Peak Electric, Natural Gas	Offers very low cost energy
LPG	Is higher than natural gas
Continuous Tariff Electricity	Typically the most expensive

Often the best energy source is the one used for cooking, to gain maximum value from tariffs that offer lower rates for increased consumption.

For a proper evaluation to be made, a proposal should indicate capital costs (purchase of heater plus installation costs) as well as several years' running costs for various alternatives. For instance, water heaters connected to off-peak tariffs must be large enough to store hot water for the period when no electricity is available to them. The energy cost savings can often offset the higher initial cost of such a water heater.

Step 3 – Owner's Preference

A decision to install solar water heating can often be made on economic grounds. Where savings are not so great, the client may well be prepared to pay the additional cost to gain long term benefits in energy conservation, pollution reduction and growth of running cost savings.

If solar heating is being considered, thought needs to be given to the type of boosting - gas or electric. In the case of electric boosting, Rheem recommends the booster be connected to off peak tariffs, or a timer be installed to control the boosting period; however, the advice of the electricity supply authority should be sought.

Water Heater Capacity

Step 1 – Number of Users

A water heater should be sized according to the accommodation potential of the house and not necessarily the number of users at present.

Other considerations include:

- ***An appliance that uses hot water*** (e.g. a washing machine) should be considered as another person.
- ***A second bathroom*** should be considered as another person.
- ***A spa*** either installed or likely to be installed, should be considered as another person.

Step 2 – Climate

More hot water is used in colder climates than temperate or tropical climates. The sizing charts in this book take this into consideration.

Step 3 - Determine Whether Continuous Fuel Supply

Non-continuous fuel supplies: (eg solar or off peak tariffs). Water heaters need to heat up a whole day's supply of water during the limited time when fuel is available. In this case, allow 50-60 L of hot water per person per day. Remember to include the number of hot water appliances and the accommodation potential of the house, along with the number of bathrooms.

Continuous fuel supplies: A water heater connected to a continuous fuel supply can be smaller than off peak or solar water heaters as it has the ability to recover hot water between demands. These water heaters should be sized to provide sufficient hot water to meet the daily peak demand during winter when the cold water is at its lowest temperature. The peak demand is the time when most people in the house shower and it may cover a period of ½ hour to 1 hour.

Step 4 – Perform a Basic Calculation of Peak Demand

This step is relevant for storage water heaters on a continuous fuel supply.

Determine the 1 hour availability of the water heater from the hot water availability tables in Chapters 3 and 5. The 1 hour availability consists of the delivery capacity plus the recovery in 1 hour. Divide this availability by:

40 in tropical or hot climates Queensland, Northern Territory

45 in milder climates New South Wales, South Australia and Western Australia

49 in colder climates Victoria, Tasmania, Australian Capital Territory.

(These figures are the approximate volumes in litres of hot water used in a 7 minute shower under winter conditions.)

- Bring the answer to the nearest whole number and subtract 1 from the result.

The final answer is the maximum number of persons to be served by the water heater, counting each washing machine as one person and a second bathroom as an additional person. The number is a maximum and does not cover situations such as spa bath use. This empirical calculation automatically adjusts for various thermal inputs as the 1 hour availability varies in accordance with heat input.

Step 5 – Adjust For Lifestyle of Users

A final adjustment should be made for households that may use more hot water than the average for lifestyle reasons.

Example

Rheem 135 outdoor gas water heater using natural gas.

1 hour availability from table 3.3 = 254 L.

For QLD & NT, No. of people served = (254/40) -1 = 5

For NSW, SA, WA, No of people served = (254/45) – 1 = 4

Thus the Rheem 311135 will serve a maximum of 5 people in QLD & NT, and a maximum of 4 people in NSW, SA & WA.

Hot Water Usage Details

An adequate supply of hot water is such that in the worst season of the year, hot water is available at the temperature, flow rate and quantity to suit the normal need of a domestic dwelling.

Source of Usage	Temp.	Quantity of mixed water	User's requirement
Wash basin in bathroom	40°C	2.5 L	Minimum wait and minimum waste.
Normal bath	40°C	45-145 L	Minimum wait to fill bath to required level and ability to top up with hot water as bath water cools.
Spa bath	40°C	200-350 L	As above with emphasis on quick filling over increased volume. A spa bath holding 300 L of mixed water would take 20 min to fill at 15 L/min flow rate.
Shower	40°C	25-70 L or more	Ability to adjust flow rate from 7 to 30 L/min and to adjust temperature from 40°C down to 'chill off' temperature at will. Freedom from temperature fluctuations due to other draw-offs.
Kitchen	50°C to 60°C	about 4-5 L	Minimum waste to get hot water. Minimum time to fill saucepans, bowls, etc. Water hot enough to save cooking time and to clean greasy utensils.
Automatic washing machine	min. 60°C	65-85 L over 30 min. cycle	Good flow and temperature to ensure correct operation throughout cycle.
Dishwashing machine connected to hot water	min. 60°C	25-35 L over 1 h cycle	Good flow and temperature to ensure correct operation throughout cycle.

Table 7.1: Hot water requirements for typical domestic installations

QUICK SIZING GUIDE

Years of experience with Rheem storage water heaters have allowed us to provide an estimate of the number of people that a storage water heater will serve and number of bathrooms a continuous flow water heater will serve under a variety of conditions. These estimates are a guide only, and are no substitute for detailed use of the principles described in this chapter.

The information in the following tables is repeated from earlier chapters, and is included here for convenience only.

Rheem Gas Storage Water Heaters

	Outdoor Models					Indoor Models	
Rheemglas	311090	311135	-	311170	-	300135	300170
RheemPlus	-	314135	-	314170	-	-	-
Optima	-	811135	-	811170	-	-	-
Stellar	-	-	850330	-	850360	-	-
Storage Capacity (litres)	85	130	130	160	160	135	170
First hour capacity (litres)	210	280	330	335	360	260	295
No of people (moderate climate)	1-3	2-4	2-5	3-5	3-6	2-4	3-5
No of people (cool climate)	1-2	2-3	2-4	3-4	3-5	2-3	3-4

Table 7.2: Gas water heaters - Number of people served

Rheem Continuous Flow Gas Water Heaters

	Models			
60°C max temp	871018	871020	871024	871026
50°C max temp	875018	-	875024	875026
Input (MJ/hr)	157	157	188	199
No of bathrooms	1 + ensuite	2	2 + ensuite	3

Table 7.3: Continuous flow water heaters – Number of bathrooms served

Rheem Electric Water Heaters

Water heater delivery (L)	Continuous Tariff	Off Peak Tariff
25	-	-
50	1	-
80	1-2	-
125	2-3	-
160	2-4	-
250	3-5	1-3
315	4-6	3-4
400	5-9	4-6

Table 7.4: Electric water heaters – Number of people served

Rheem Solar Water Heaters

The number of people a solar water heater can supply depends on a number of factors, including location, number of collectors, size of storage tank and method of boost. It is not possible to display this information in a concise table here and the reader is directed to chapter 6.

OTHER CONSIDERATIONS

Multipoint Vs Single Point

The vast majority of water heaters will be required to supply a whole house. Multi point mains pressure water heaters or large capacity continuous flow water heaters are the appropriate choice.

A single point water heater may be more appropriate in some cases:

- ***Avoiding long pipe travel***: An example is where a house has been extended and an ensuite is well away from the existing hot water plumbing. In this case, it may be wise to install a 25L or 50L electric water heater or continuous flow gas water heater at the point of use. This method could overcome problems of excessive heat loss through long lengths of hot water piping.
- ***Minimal requirements***: Many commercial establishments need only small water heaters to provide hot water for hand washing. Often a small water heater supplying the one basin is sufficient.

Indoor Vs Outdoor

Some gas water heaters are available for outdoor installation only and others for indoor installation. Electric water heaters suit both locations.

The relocation of a replacement water heater from indoors to outdoors can provide the opportunity to rearrange a kitchen or laundry that was constrained by the water heater installation.

The points to consider are

- the availability of additional space inside the house;
- the reduced installation cost for outdoor gas water heaters, which do not require connection to a secondary flue;
- the possibility of a reduction in the length of hot water piping by relocating, which reduces running costs and water wastage.

The trend is to install the water heater outdoors close to the kitchen and bathroom.

Warranty Cover

The Rheem water heater range offers various warranty alternatives:

- Rheemglas offers a 5 year warranty. These water heaters feature a single coat of enamel and single anode.
- The Optima and Rheem Stellar range is usually recommended for its 10 year warranty, made possible by specially developed enamel formulation and twin or larger anode protection. Not all Rheem water heaters are available in the Optima range, but there is sufficient choice to satisfy most requirements.
- Rheem Integrity Instantaneous Gas water heaters offer 10 years on the heat exchanger and 3 years parts and labour on all other components.
- Premier Hiline has a stainless steel cylinder and is backed by a 6 year warranty.

Rheemglas and Optima models are suitable for use in most aggressive water supplies. Premier Hiline has limitations where Ph is low and high levels of chloride are present.

High Efficiency Alternatives

The consumer has four choices:

- Stellar storage water heaters, rated 5 star energy efficient
- Integrity electronic instantaneous water heaters, rated 5 star energy efficient
- Rheemglas and Optima models, rated 3 star

To be able to be classified as an energy efficient product, a gas water heater must save at least 20% of the running costs of a water heater that meets the minimum AGA standards.

- Rheem Heat Pump uses refrigeration technology to extract heat from the surrounding atmosphere. This provides an operating efficiency of approximately 300%.

Other Features

Thermostat

- Rheem Optima electric water heaters have user adjustable thermostats (60 to 75°C) which effectively provide the user with more hot water at useable temperatures.
- Rheemglas electric water heaters have a trade-adjustable thermostat (60 to 70°C).

- Optima, Stellar and Rheemglas gas water heaters have a user adjustable thermostat with a maximum temperature setting of 65°C.
- Integrity gas water heaters feature optional electronic temperature controllers which allow the user to set the temperature exactly as required. Alternatively the thermostat can be set by qualified trades people anywhere from 37 to 60°C.

Booster Heating Element

Off peak electric water heaters can be supplied with a booster heating element. This element is wired to a continuous electricity supply and provides a boost should the contents of the water heater approach depletion. Twin element water heaters provide assurance of hot water supply and account for unusual demands.

Temperature Limits

Rheem Integrity 875 series and RheemPlus water heaters are designed to deliver water at a temperature not exceeding 50°C in accordance with AS3498. These water heaters will protect vulnerable family members from the potential of a scalding injury.

There is no statutory requirement to fit a temperature limiting device to these water heaters if installed in any installation other than an early childhood centre, school, nursing home or a facility for young, aged, sick or disabled people. RheemPlus and Integrity 875 series water heaters save the cost of fitting this device to the water heater.

Protection Against Freezing

Rheem Premier Loline and Premier Hiline solar water heaters installed with S200 or T200 solar collectors offer protection against freeze damage for temperatures down to minus 17°C and 28°C. These water heaters utilise a heat exchange principle to protect the system against damage.

All Rheem Integrity models are supplied with frost protection as standard. As long as power is available to the unit, it is protected against damage due to frost to minus 20°C (including wind chill factor).

Chapter 8

Rheem Gas Water Heaters - Commercial

This Chapter Covers:

Design, operation and features of Rheem commercial gas water heaters

- Current models available in the Rheem commercial gas range
- An overview of their main features
- Tables of dimensions, performance, gas usage and other technical data

Overview of Models

Commercial Vs Domestic Gas Water Heaters

Commercial water heaters are used where large quantities of hot water are required, including: commercial kitchens, hospitals, laboratories, hotels, motels, apartments, ablution blocks, restaurants as well as a wide range of industrial applications.

As you can see from the table in the next section, commercial models differ mainly in hourly thermal input rather than storage capacity.

Rheem commercial water heaters are designed for either single or multiple installation, connected by either a single or multiple manifolds.

Range at a Glance

Rheem commercial gas water heaters come in three product ranges, with both an indoor and outdoor model available in each:

	620260	630260	621265	631265	621275	631275
	Indoor	Outdoor	Indoor	Outdoor	Indoor	Outdoor
Storage Capacity (litres)	260		265		275	
Hourly Thermal Input (MJ/hr)	50		110		200	
First hour delivery (litres)	380		620		970	

Table 8.1: Rheem commercial gas water heater range

260 Models

- For small heavy duty use, or large households or spa bath use
- Indoor – concentric draught diverter suits 100mm secondary flue
- Outdoor – balanced flue
- Max thermostat setting is 65°C
- Eurosit 630 Gas Control
- Piezo igniter

265 Models

- Indoor – concentric draught diverter suits 125mm secondary flue
- Outdoor – balanced flue
- Max thermostat setting is 82°C
- White Rodgers 36C90H-408 gas control
- Close temperature control with a digital thermostat
- Hot surface ignition
- 240 V 50 Hz electrical supply needs to be available for the water heater. A 3 pin 10A plug and lead is fitted

275 Models

- Indoor – concentric draught diverter suits 200mm secondary flue. Primary flue incorporates a flue damper which reduces energy consumption
- Outdoor – fan assisted balanced flue combustion system. Also suitable for room sealed flue applications
- Max thermostat setting is 82°C
- White Rodgers 36C90H-408 gas control.
- Close temperature control with a digital thermostat
- Hot surface ignition
- 240 V 50 Hz electrical supply needs to be available for the water heater. A 3 pin 10A plug and lead is fitted

Components

All of the features of a gas water heater discussed in chapter 3, as well as the cylinder design aspects in chapter 2, are relevant for the range of Rheem domestic gas water heaters. These include:

Colourbond Jacket that resists peeling and blistering, designed to withstand weather extremes.

Insulation – high-density CFC-free Polyurethane provides impact resistance as well as excellent thermal insulation.

Double Coat Vitreous Enamel Lining – suitable for operation at high temperature, providing the cylinder with a high level of protection from corrosion.

Multiple Sacrificial Anodes –For longer life in harsh conditions

Temperature and Pressure Relief Valve – with a thermal output capacity matched to the thermal capacity of the water heater.

Over-temperature Cut Out – to shut gas off to the system in case of an over-termperature situation.

Flue Baffle – located in the primary flue, to slow the exit of flue gases allowing more time for heat to pass from the gases to the water through the flue walls.

Multi-Fin flue (265 and 275 models) - provides increased heat exchange capacity to cope with greater heat output.

Draught Diverter (indoor models only) – sits on top of the water heater with a connection to accept a secondary flue. Prevents updraughts and downdraughts in the secondary flue from interfering with the safe operation of the burner system.

Balanced Flue Terminal (outdoor models only) – this design creates equal pressure at the flue inlet and outlet to ensure reliable flue operation even under extreme wind conditions.

Hot Surface Ignition: (265 and 275 models) – provides safe and reliable ignition of the burner without the need for a standing pilot.

FEATURE ENHANCEMENTS

Remote Control (265 and 275 models)

Both the 265 and 275 series water heaters can be controlled remotely by a time clock or remote isolating switch. Two common applications are:

- ***Long periods without use:*** Some installations such as sporting clubs may need their heating during the weekend only. Here an automatic time switch will turn the heater on and off at certain times of the week, saving unnecessary heating expense.
- ***Remote Operation:*** such as a building maintenance or process control room. These can be either manual or automatic.

Operation Above 70°C (265 and 275 models)

The 265 and 275 water heaters are designed to be used at temperatures up to 82°C for sanitising and other applications.

If water is consistently required at temperatures above 80°C, it is strongly recommended a pumped recirculating system be used.

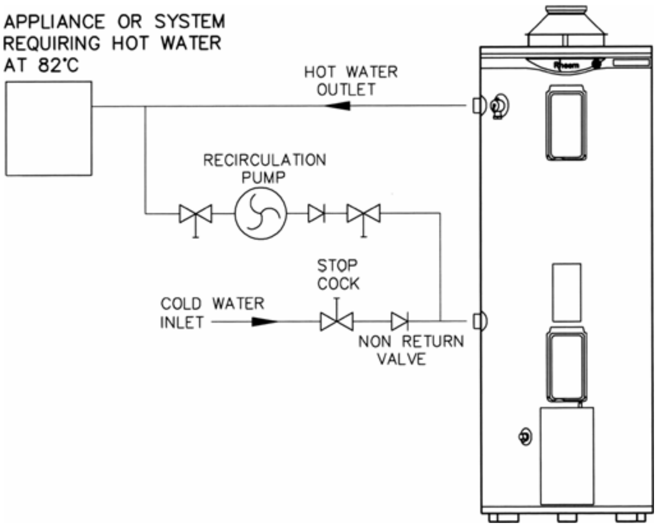


Fig 8.1: Typical installation for 265 and 275 model providing hot water at a constant 82°C

Fan Assisted Combustion (275 outdoor model)

The 631275 incorporates a fan situated in the front air duct to assist with the correct combustion of gases.

When the thermostat calls for heat, the fan is activated. A pressure switch signals the gas control to operate, allowing gas to the main burner for combustion.

To further enable correct operation of the fan, the front cover is fitted with an interlock switch. This switch prevents the gas valve from opening if the front cover is removed.

Room Sealed Flue Kit (631 275 outdoor model)

The Rheem 631275 outdoor water heater can be installed indoors using the Rheem Room Sealed Balanced Flue Kit. This kit relocates the balanced flue terminal to an external wall via a set of transition pieces which can accept plumber-supplied twin skin, single skin or flexible flue tubes.

Features

- ***3 metre total flue discharge length***: measured from the heater to the point of discharge. Allowed length can include up to three 90° bends.
- ***300 mm wall thickness:*** So the system can penetrate most walls likely to be encountered.
- ***150mm diameter flue required:*** Interconnecting nominal 150mm inlet air and flue ducting should be supplied by the installing plumber.

Advantages

- ***Ventilation may not be required***: The room does not need to be ventilated to ensure proper combustion because combustion air is provided by the balanced flue terminal and ducting direct from outside. Ventilation to prevent room temperature overheating may be required.
- ***No need for vertical discharge***: It is not necessary to run the flue to a suitable vertical discharge point, such as the top of a building. For large buildings, this can save significant installation costs.
- ***No need for fan to assist horizontal discharge***: Because the kit utilises the fan incorporated in the front air duct of the 631275, there is no need for additional fan assistance to carry the flue products over the horizontal distance.
- ***Easier installation***: Can be fully installed from within the plant room.

Room height of 2400mm is required, and the minimum clearances for balanced flue terminals according to AS5601 must be observed. Further information about flueing, including room sealed flueing is available in chapter 15.

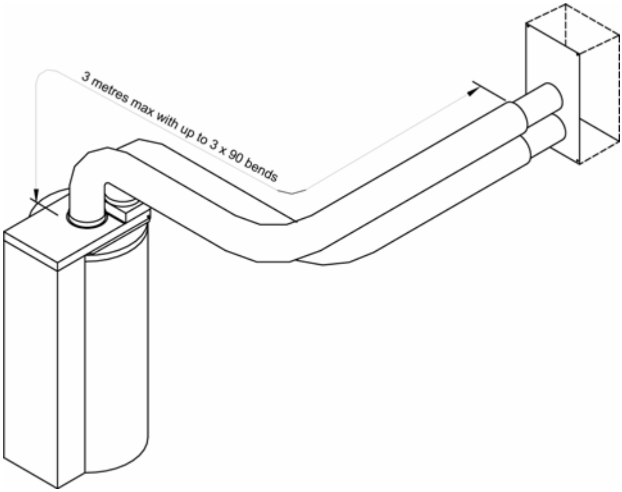


Fig 8.2: Room Sealed Flue model 631 275

Power Flue Considerations (621265 and 621275)

When water heaters are connected to a power flue system, it is essential to prove correct operation of the flue system before the main burner is allowed to operate as required by AS 5601.

A vane switch or a pressure differential switch, interconnected with a self proving relay will ensure that both air flow and control circuitry are operating correctly before the main burner can ignite.

Rheem indoor 265 and 275 models are supplied with terminals to allow interconnection with power flue or BMS control systems

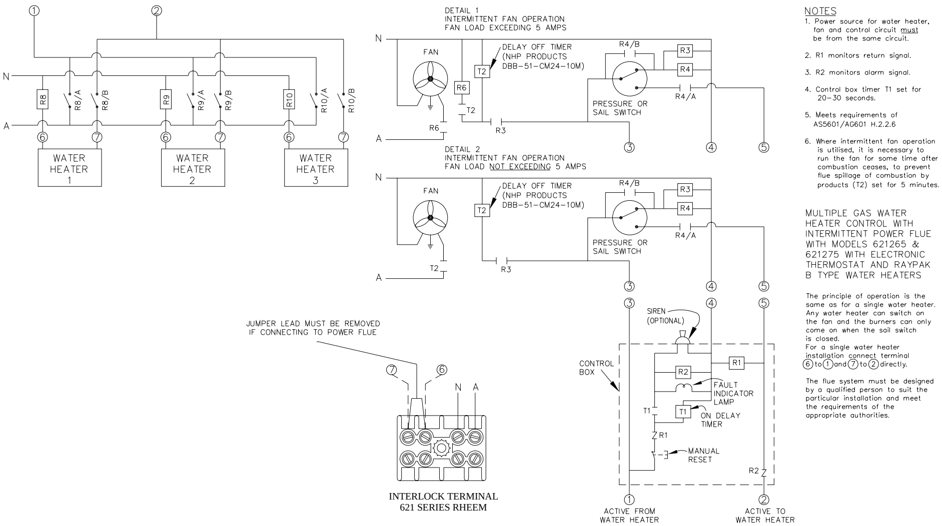


Fig 8.3: Powerflue interlocking of Rheem 621265 and 621275 models

DIMENSIONS

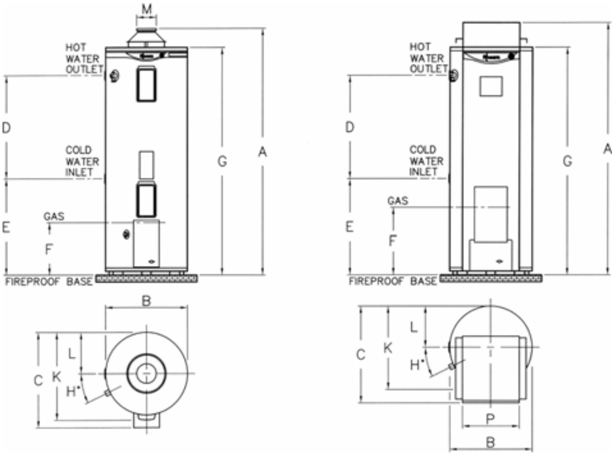


Fig 8.4: Dimensional diagrams of Rheem commercial gas water heaters

	620260	630260	621265	631265	621275	631275
	Indoor	Outdoor	Indoor	Outdoor	Indoor	Outdoor
Storage Capacity (l)	260	260	265	265	275	275
Dimensions mm						
A	1660	1640	1795	1835	1895	1865
B	595	595	610	610	640	640
C	670	680	750	710	780	780
D	990	990	750	750	760	760
E	330	330	700	700	700	700
F	297	295	380	380	340	340
G	1520	1520	1655	1655	1695	1695
H (degrees)	27	27	36	36	36	36
K	655	655	660	660	722	722
L	295	295	302	302	320	320
M	100	-	125	-	200	-
P	-	420	-	420	-	320
Approx Weight Empty kg	98	106	129	132	187	197

Table 8.2: Dimensions of the Rheem commercial gas water heater range

Gas, Water and Electrical Connections and Settings

	620260	630260	621265	631265	621275	631275
	Indoor	Outdoor	Indoor	Outdoor	Indoor	Outdoor
Water Connection LHS	RP1¼ / 32		RP1¼ / 32		RP1¼ / 32	
Gas Connection	RP½ / 15		RP¾ / 20		RP¾ / 20	
Electrical Connection			2m 10 A plug & lead		2m 10 A plug & lead	
T&PR Valve Connection	RP¾ / 20		RP¾ / 20		RP¾ / 20	
T&PR Valve Setting (kPa)	1000		1000		1000	
ECV* Setting (kPa)	850		850		850	
Maximum Water Supply Pressure without ECV (kPa)	800		800		800	
Maximum Water Supply Pressure with ECV (kPa)	680		680		680	
Factory Thermostat Setting (°C)	60		70		70	
Min Thermostat Setting (°C)	Off		60		60	
Max Thermostat Setting (°C)	65		82		82	
Electrical Rating 240V 50Hz			150 W 0.65 A		150 W 0.65 A	250 W 1.1 A

* Expansion control valve is not supplied with the water heater.

Table 8.3: Technical details of the Rheem commercial gas water heater range

Rheem gas water heaters are intended for connection to high or low pressure water supplies, subject to the following conditions:

- The maximum supply pressure does not exceed 80% of the relief valve setting. If it does, a pressure-limiting valve is to be fitted on the cold water supply.
- Mains pressure performance cannot be expected if the pressure of the cold water supply is less than 350 kPa.

PERFORMANCE

The gas consumption and hot water delivery of each of the commercial gas water heaters is listed on the following pages for each gas type.

Definitions

Storage Capacity is the actual volume of water which the heater can physically hold.

Effective delivery is equal to the storage capacity multiplied by the stratification as tested to AS 4552.

Notes:

Gas consumption and recovery rate details are based on gas compositions found in Australia. Gas compositions may differ from country to country resulting in different injector sizes, gas consumption and recovery rates to those shown in the following tables.

	No units in parallel	Initial storage capacity (L)	Thermal Input (MJ/hr)	Litres hot water at 50°C rise over peak period					
				1 hr	2 hr	3 hr	4 hr	6 hr	8 hr
260	1	260	50	370	560	750	940	1320	1690
	2	520	100	740	1120	1500	1880	2640	3390
	3	780	150	1110	1680	2250	2820	3960	5090
265	1	265	110	620	1030	1450	1860	2690	3510
	2	530	220	1250	2070	2900	3730	5380	7030
	3	795	330	1870	3110	4350	5590	8070	10550
275	1	275	200	960	1700	2440	3180	4670	6150
	2	550	400	1930	3410	4890	6370	9340	12300
	3	825	600	2900	5120	7340	9560	14010	18450
	4	1100	800	3860	6830	9790	12750	18680	24600
	5	1375	1000	4830	8530	12240	15940	23350	30750
	6	1650	1200	5800	10240	14690	19130	28020	36910

Table 8.4: Performance details of Rheem commercial gas water heaters at a 50°C temperature rise

	No units in parallel	Initial storage capacity (L)	Thermal Input (MJ/hr)	Litres hot water at 65°C rise over peak period					
				1 hr	2 hr	3 hr	4 hr	6 hr	8 hr
265	1	265	110	520	840	1160	1480	2110	2750
	2	530	220	1050	1690	2330	2960	4230	5510
	3	795	330	1580	2540	3490	4450	6350	8260
275	1	275	200	790	1360	1930	2500	3640	4780
	2	550	400	1590	2730	3870	5010	7280	9560
	3	825	600	2380	4090	5800	7510	10930	14350
	4	1100	800	3180	5460	7740	10020	14570	19130
	5	1375	1000	3980	6820	9670	12520	18220	23910
	6	1650	1200	4770	8190	11610	15030	21860	28700

Table 8.5: Performance details of Rheem commercial gas water heaters at a 65°C temperature rise

GAS CONSUMPTION

The following table gives the approximate daily gas consumption for each of the Rheem commercial gas water heaters for a range of daily water usages.

The table can be used to:

- Calculate the approximate fuel cost of a particular installation, if the average water usage is known.
- Determine the average daily hot water consumption, if the fuel consumption is known

Notes:

All calculations are based on water at a 50°C rise using natural gas.

Figures do not include an allowance for pipe losses. Where long pipe runs are involved an additional heat loss allowance should be added.

		620260	630260	621265	631265	621275	631275
		Indoor	Outdoor	Indoor	Outdoor	Indoor	Outdoor
Daily usage of hot water at 50°C rise (L)	**Energy Content of hot water (MJ)**	**Daily Gas Consumption in MJ (Natural Gas)**					
0	0.0	34	31	53	43	26	51
50	10.5	47	43	67	56	40	64
100	20.9	60	56	80	69	53	77
150	31.4	72	69	93	82	66	90
200	41.9	85	82	106	95	80	103
250	52.3	98	95	120	109	93	117
300	62.8	111	108	133	122	106	130
350	73.3	124	120	146	135	120	143
400	83.7	136	133	160	148	133	156
450	94.2	149	146	173	161	147	169
500	104.7	162	159	186	175	160	183
600	125.6	188	185	213	201	187	209
700	146.5	213	210	239	227	214	235
800	167.4	239	236	266	254	240	262
900	188.4	265	261	292	280	267	288
1000	209.3	290	287	319	307	294	314
1250	261.6	354	351	385	373	361	380
1500	314.0	419	415	452	438	428	446
1750	366.3	483	479	518	504	495	512
2000	418.6			584	570	562	578
2500	523.3			717	702	696	710
3000	627.9			850	834	829	842
3500	732.6			983	966	963	974
4000	837.2					1097	1105
5000	1046.5					1365	1369

To convert to kg of Propane, divide MJ by 49.5.
To convert to litres of Propane divide MJ by 25.3

Table 8.6: Daily gas consumption in MJ for a range of daily water usages

TECHNICAL SPECIFICATIONS

Gas Supply Pressures and Recovery Rates

		260			265			275		
		NG / SNG	Prop	But	NG / SNG	Prop	But	NG / SNG	Prop	But
Thermal Input	MJ/ hr	50	47	39	110	100	95	200	190	160
Power Output	kW	11	10	8.6	24	22	20	43	41	35
Min Gas Supply Pressure	kPa	1.13	2.75	2.75	1.13	2.75	2.75	1.13	2.75	2.75
Test Point Pressure	kPa	1.00	2.70	2.70	0.85	2.50	2.50	.90	2.65	2.65
Max Gas Supply Pressure	kPa	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Litres recovery per hour at rise of	20°C	480	430	370	1030	950	860	1850	1770	1510
	30°C	320	290	250	690	630	570	1230	1180	1000
	40°C	240	220	190	520	470	430	930	880	750
	50°C	190	170	150	410	380	340	740	710	600
	60°C	160	140	120	340	320	290	620	590	500
	65°C	150	130	110	320	290	270	570	540	460
	70°C	140	120	110	300	270	250	530	500	430
	75°C	130	110	100	280	250	230	490	470	400

Table 8.7: Gas supply pressures and recovery rates for Rheem commercial gas water heaters for various gases.

The minimum and maximum gas supply pressure to the water heater is shown above. The installer needs to ensure the installation will supply gas within this range to ensure correct operation of the water heater.

It should be noted all figures shown in Rheem literature and other printed performance data, is based on gas compositions found in Australia. As gas compositions can vary around the world, so too can the thermal inputs into Rheem gas water heaters and related performance data.

Chapter 9

Raypak Commercial Gas Water Heaters

This Chapter Covers:

Design, operation and energy usage of Raypak Commercial Water Heaters including

- Current models available in the Raypak range
- An overview of the main features, accessories and installation options
- Principles of operation
- Tables of dimensions, performance, power usage and other technical data

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RANGE OVERVIEW

Raypak commercial gas water heaters are a range of instantaneous water heaters designed for commercial and industrial applications, offering high recovery with low storage. Their compact design makes them ideally suited for low ceiling height installations and other applications where space is a premium.

The Raypak range achieves an impressive 80% or greater thermal efficiency. Inputs range from 147 MJ/hr to 4,224 MJ/hr. Models are available which allow for:

- Indoor or outdoor installation
- Natural gas or propane input (type B products are suitable for butane with individual certification.
- On –Off or modulating gas controls

Applications include:

- High temperature: up to 95°C with modulating models
- Low temperature: On/off models can operate as low as 44°C without any condensation or sooting, and a simple bypass arrangement allows even lower system temperatures.
- Low Load: With modulating gas controls, can match fuel input down to 20% of full load.
- Domestic Hot Water (DHW) applications
- Industrial process, mechanical and hydronic heating

Components

The Raypak water heater offers high thermal efficiency and relatively simple installation and ongoing maintenance by virtue of the following:

Major Components

All copper heat exchanger: the direct fired, pure copper finned heat exchanger maximises the transfer of heat energy to the circulating water.

Bronze headers: are compatible with the copper heat exchanger providing corrosion resistance.

Hot surface or electronic ignition: saves on operating costs

Refractory panels: Raypak's lightweight ceramic fibre insulating panels reduce heat loss resulting in further energy saving.

Free floating heat exchanger assembly: provides thermal shock resistance

Slide out burner tray: for ease of maintenance

Left or right hand configuration: All water connections, and gas connections on some models can be left hand (standard) or right hand configured to aid in plant room space allocation.

Digital display: temperature set point and actual temperature display

Flow switch: protects the heat exchanger from overheating should the pump flow be interrupted

Accessories

In addition to the major components, a number of accessories are available to make the Raypak heaters more suited to various applications. The table on the next page details which of these are standard or optional on each model.

Of particular note are the following:

High Wind Terminal (HWT): outdoor models can be supplied with outdoor hoods (standard) or high wind top terminals if the water heater is to be located in a position subject to adverse wind conditions.

Tankstat and Economaster: One tankstat per water heater is required to remotely control the pump. The tankstat overrides the water heaters' thermostat. The Economaster includes a run on timer to remove excess heat from the heat exchanger, improving efficiency and preventing a build up of excess heat.

Building Management System (BMS): models 538 – 4224 are supplied with run and fault status relays and can be specified with an audible alarm.

Ambient Air Sensor: provides fast automatic response to temperature changes, especially useful in mechanical heating applications.

Accessories	Standard	Optional
Pump run on timer	Modulating models	On-Off models
Hot surface ignition	147 to 430	-
Electronic ignition	507 to 4224	-
Water flow switch	538 to 4224	-
Relay run and fault status (BMS)	538 to 4224	-
Temperature &/or pressure gauge (modulating burner models only)	507 to 4224	200 to 4224
Temperature gauge (on/off models only)	-	147 to 4224
Rear water connections	147	-
Left hand water and gas connections	200 to 4224	-
Right hand water connections	-	200 to 507
Right hand water and gas connections	-	538 to 4224
Audible alarm	-	538 to 4224
High wind terminal	2004 to 4224	147 to 1852
Tankstat	-	147 to 4224
Ambient air sensor (modulating burner models only)	-	538 to 4224

Table 9.1: Accessories for Raypak Commercial Gas Water Heaters

OPERATION

Domestic Hot Water (DHW) Applications

DHW applications are those where potable water is required, including for large residential buildings, hospitals, commercial and industrial plants. Typical DHW temperature is 65 – 82°C.

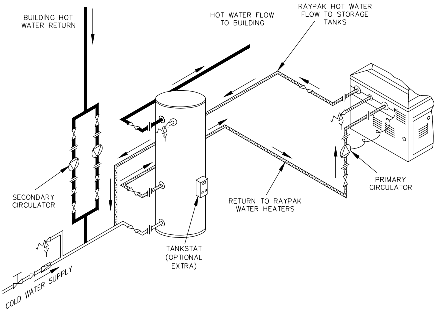


Fig 9.1: Typical installation of Raypak used in DHW applications

System Configuration

On-off gas control models are usually used for DHW applications and one or a number of storage cylinders are required to provide mains pressure operation to the building and act as buffer storage for peak demand usage. These storage cylinders have no independent heating capacity.

Mode Of Operation

A primary circulator transfers the water from the storage cylinder to the heat exchanger of the Raypak where heat is transferred to the water. This heated water then passes back to the storage cylinder.

The system is designed to raise the temperature of the water by approximately 10-15°C per pass. The process continues until the thermostat located in the outlet of the Raypak water heater senses the set point temperature and shuts down the gas supply to the water heater.

Tankstat option: In the default installation, the storage tank has no heating or thermostat of its own. Thus even during times of minimal draw-off when the water temperature remains close to set point and the gas supply is off, water still needs to circulate so that the temperature of the water can be constantly monitored.

If an optional thermostat is located remotely in the storage cylinder, the primary circulator can also be shut down while the water temperature remains near the set point, thus conserving energy. In this case, a delay timer (Economaster) allows the pump to run on briefly to remove excess heat from the heat exchanger.

Mechanical And Process Heating Applications

These applications do not require potable water. Rather, the hot water is used to transfer heat energy to industrial processes or to heat up buildings.

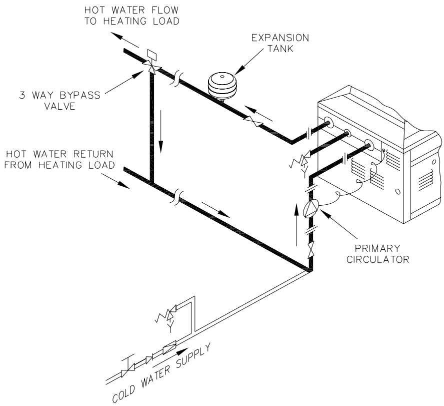


Fig 9.2: Typical installation Raypak used in mechanical heating applications

System Configuration

Modulating gas control models are used for mechanical/ hydronic heating or in applications where higher temperature is required. The modulating control allows the water heater to achieve higher temperatures without overshooting the Energy Cut-Out (ECO) Limit. A storage cylinder is generally not required if the system is designed as a closed loop.

Mode Of Operation

Most mechanical systems are designed to operate at lower pressures and therefore modulating water heaters are supplied with lower pressure setting relief valves. Higher working pressures (up to 1000kPa) can be achieved with the appropriate pressure relief valves fitted.

Modulation also allows closer control of fine temperature differentials usually encountered in mechanical heating systems preventing frequent on-off cycling of the gas control.

High Temperature Applications

Where delivery temperature greater than 90°C is required, an open vented system should be designed. This prevents the TPR valve temperature relief function from inadvertently operating.

INSTALLATION

Sizing

Sizing of Raypak water heaters is the same as for all Rheem commercial water heaters with the following additions:

Redundancy

With the largest input model able to provide up to 16,000 of hot water at a 50°C rise, careful consideration of the application is required to determine if two or more smaller units would provide a better solution with back up. This is highly recommended and even considered essential in buildings such as hospitals, hotels and nursing homes.

Storage Capacity

Rheem can supply vitreous enamel storage cylinders of nominal capacity 340 and 430 litre (1000kPa) or stainless steel cylinders with a capacity ranging from 650 – 1000L (700kPa). An assessment of the application peak demand needs to be carried out to determine the amount of storage vs recovery required. For most applications, allowing 10% of first hour peak consumption will provide a good balance between storage and recovery. More storage will be required for applications such as mining camps and sporting complexes where peak demand is large over a small time scale.

Pipe Size and Circulator Selection

Correct specification of primary flow/return and pump sizing is required to obtain optimum performance from the Raypak water heater. Table 9.2 shows the correct pipe size and pump/speed selections for combinations of Raypak water heaters up to 4 in a bank.

Commissioning

The Australian Gas Association operates a two tier approach to product certification.

- ***Type A Appliances*** – water heaters with a gas input less than or equal to 500MJ/hr are individually certified to AS 4552 (Gas Water heaters) and require no further regulatory certification after installation.
- ***Type B Appliances*** – All other appliances with a gas input greater than 500MJ/hr are designed to comply with AS 3814 (Industrial and commercial gas-fired appliances) and are required to be certified after installation by a Type B licensed gas fitter. The Rheem Service Department can arrange for type B inspection and Certification.

Pipe Sizing and Selection

Below is the Raypak pipe sizing and Selection Chart. In reading the chart, note the following:

- TP series circulator is recommended for hard water areas in lieu of UPS series circulator
- Manifold header sizes are minimum requirements for water heater performance

Model	Pump			Branch Size		Minimum Manifold Header Size Required (mm)			
	UPS Series	Speed	TP Series			1 Unit	2 Units	3 Units	4 Units
B0147	20-60B	3		1	25mm	20	32	32	40
	20-45N								
B0200	20-60B	3		1	25mm	25	32	40	50
	20-45N								
B0280	20-60B	3		1¼	32mm	32	32	50	50
	20-45N								
B0350	32-80B	2		1¼	32mm	32	40	50	50
B0430	32-80B	3		1¼	32mm	32	40	50	65
B0507	32-80B	3		1¼	32mm	32	50	65	65
B0538	32-80B	3		1¼	32mm	32	50	65	80
B0658	32-80B	3		1½	40mm	40	50	65	80
B0768	32-80B	3	50-30/4B	2	50mm	50	80	100	100
	40-60/2B	2		1½	40mm	40	50	80	80
B0868	32-80B	3		2½	65mm	65	100	125	150
	40-60/2B	1	50-30/4B	2	50mm	50	65	80	100
B0972/B0992	40-60/2B	3	50-60/FB	2	50mm	50	65	80	100
B1142/B1182	40-60/2B	3	50-60/FB	2½	65mm	65	80	100	100
B1242/B1292	40-60/2B	3	50-60/FB	2½	65mm	65	80	100	100
B1362/B1412	50-120B	1	50-60/FB	2½	65mm	65	80	100	100
B1492/B1552	50-120B	2	65-60/4FB	2½	65mm	65	80	100	125
B1662/B1722	50-120B	3	80-120FB	2½	65mm	65	80	100	125
B1852/B1922	50-120B	3	80-120FB	2½	65mm	65	80	100	125
B2004/B2214	50-120B	3	80-120FB	3	80mm	80	100	125	125
B2404/B2634	80-120B	2	80-120FB	3	80mm	80	100	125	150
B2804/B3164	80-120B	3	80-120FB	3	80mm	80	100	150	150
B3304/B3694	80-120B	3	80-120FB	4	100mm	100	125	150	150
B3804/B4224	80-120B	3	80-120FB	4	100mm	100	125	150	150

Table 9.2: Raypak pipe size and pump selection chart

model	back	front	left	right	ceiling
147	600	750	600	600	1200
200 to 430	600	750	600	600	1200
507 to 1922	600	750	600	600	1200
2004 to 4224	600	1200	600	600	1200

Table 9.3: Clearances from combustible materials – Indoor models

model	back	front	left	right	ceiling
147	300	750	300	300	1200
200 to 430	150	750	300	150	1200
507 to 1922	150	750	300	300	1200
2004 to 4224	300	1200	600	600	1200

Table 9.4: Clearances from non-combustible materials – Indoor models

		on / off	modulating	
Models		All	197-430	538-4224
Relief Valve Setting				
Potable Hot Water	kPa	850 (700)[2]	850 (700)[2,3]	850 (700)[2,3]
Mechanical Heating	kPa	-	310	415
Expansion Control Valve (ECV[1]) Setting	kPa		-	
Potable Hot Water	kPa	700 (550)[2]	700 (550)[2,3]	700 (550)[2,3]
Mechanical Heating	kPa	-	-	-
Minimum Supply Pressure (up to 65°C)	kPa	70	70	70
(greater than 65°C)	kPa	120	120	120
Maximum Supply Pressure				
without ECV[1] fitted		680 (550)		
Potable Hot Water	kPa	680 (550)[2]	680 (550)[2,3]	680 (550)[2,3]
Mechanical Heating	kPa	-	240	330
with ECV[1] fitted				
Potable Hot Water	kPa	550 (450)[2]	550 (450)[2,3]	550 (450)[2,3]
Mechanical Heating	kPa	-	-	-

[1]ECV is not supplied with the water heater
[2]Figures in brackets are to be used if a Raypak stainless steel storage tank is utilised in the system
[3]An 850kPa relief valve can be fitted to modulating water heaters used in potable hot water applications

Table 9.5: Water supply and relief valve settings

TECHNICAL SPECIFICATIONS

The following pages detail required settings, dimensions, and other performance data relevant to the Raypak range.

Modulating	Maximum	°C	95
	Factory set	°C	78
	Minimum	°C	44
On/Off	Maximum	°C	80
	Factory set	°C	50
	Minimum	°C	44

Table 9.6: Thermostat Settings

			147-430	507-4224
Natural Gas	minimum	kPa	0.95	1.10
	test point	kPa	0.77	0.92
	maximum	kPa	3.50	4.00
Propane	minimum	kPa	2.75	2.75
	test point	kPa	2.75	2.75
	maximum	kPa	3.50	4.00

Table 9.7: Gas pressures

Product Dimensions

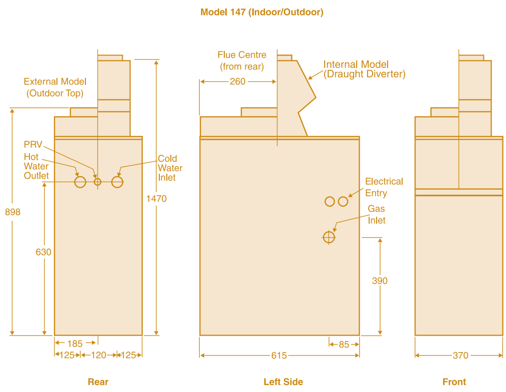


Fig 9.3: Model 147

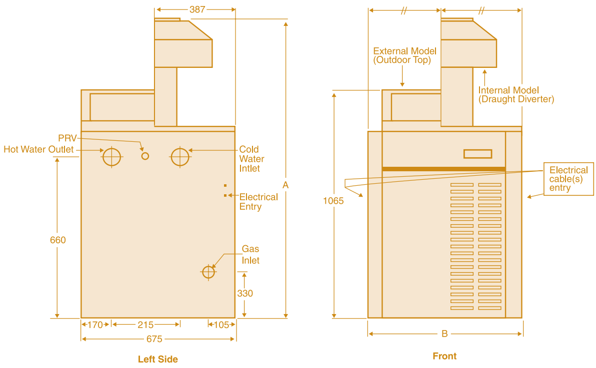


Fig 9.4:

Model 200 - 507

Models 538, 658, 768 & 868 (Indoor/Outdoor)

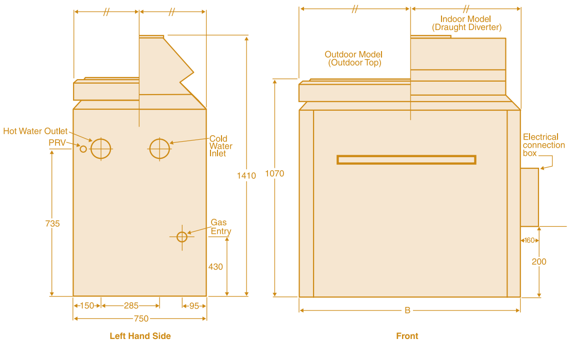


Fig 9.5:

Model 538 - 868

Models 972, 1142, 1242, 1362, 1492, 1662, 1852 (Outdoor)

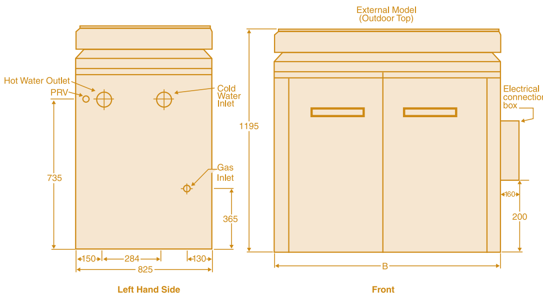


Fig 9.6:

Model 972 -1852 (outdoor)

Models 992, 1182, 1292, 1412, 1552, 1722, 1922 (Indoor)

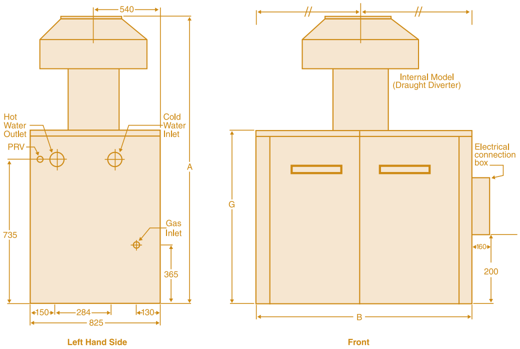


Fig 9.7:

Model 992 -1922 (indoor)

Models 2004, 2404, 2804, 3304, 3804 (Outdoor)

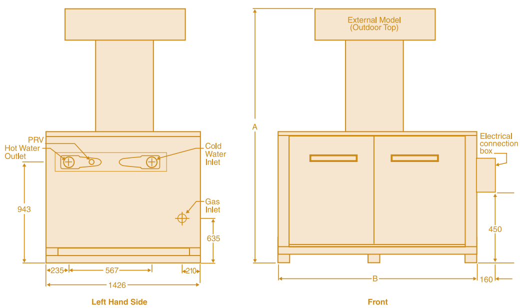


Fig 9.8:

Model 2004 – 3804 (outdoor)

Models 2214, 2634, 3164, 3694, 4224 (Indoor)

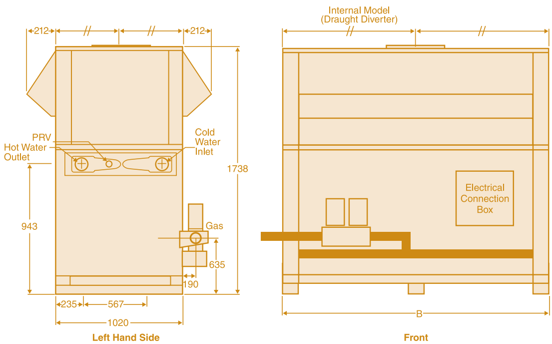


Fig 9.10:

Model 2214 – 4224 (indoor)

Table 9.6a:Technical data for Raypak models 147-430

model		147	200	280	350	430
natural - input	MJ/hr	144	196	278	343	420
- output	kW	32	44	62	76	94
propane - input	MJ/hr	135	185	261	323	396
- output	kW	30	41	58	72	88
dimensions						
a	mm	-	1625	1715	1715	1805
b	mm	-	465	570	655	745
C (HWT)	mm	-	1955	2240	2035	2145
flue connection	mm	150	175	205	225	255
weight	kg	71	91	93	103	107
inlet/outlet connections		RC11/4/32	RC11/2/40	RC11/2/40	RC11/2/40	RC11/2/40
gas connection - natural		RP3/4/20	RP3/4/20	RP3/4/20	RP3/4/20	RP1/25
gas connection - propane		RP3/4/20	RP3/4/20	RP3/4/20	RP3/4/20	RP3/4/20
relief valve connection						
on / off models		RC3/4/20	RC3/4/20	RC3/4/20	RC3/4/20	RC3/4/20
modulating models		N/A	RC3/4/20	RC3/4/20	RC3/4/20	RC3/4/20
electrical rating 240v 50hz	Watts Amps	50 0.21	50 0.21	50 0.21	50 0.21	50 0.21
min buffer tank capacity	litres	325	325	325	325	325
max storage capacity	litres	1,650	2000	3,000	4,000	4,800
recovery at 30°c rise (NG)	L/hr	917	1,250	1,769	2,187	2,683
recovery at 40°c rise (NG)	L/hr	688	937	1,327	1,640	2,012
recovery at 50°c rise (NG)	L/hr	550	750	1,061	1,312	1,610
recovery at 60°c rise (NG)	L/hr	459	625	884	1,094	1,342
recovery at 65°c rise (NG)	L/hr	423	577	816	1,010	1,238
recovery at 70°c rise (NG)	L/hr	393	536	758	937	1,150
recovery at 75°c rise (NG)	L/hr	-	500	708	875	1,073
recovery at 80°c rise (NG)	L/hr	-	469	663	820	1,006
recovery at 85°c rise (NG)	L/hr	-	441	624	772	947
maximum flow rate modulating (10°c rise)	L/s	0.76	1.04	1.47	1.82	2.24
pressure drop	kPa	5	3	8	13	17
maximum flow rate on/off (15°c rise)	L/s	0.51	0.69	0.98	1.22	1.49
pressure drop	kPa	3	3	4	6	8
minimum flow rate (20°c rise)	L/s	0.38	0.52	0.74	0.91	1.12
pressure drop	kPa	3	3	3	3	4

Table 9.6b: Technical data for Raypak models 507-868

model		507	538	658	768	868
natural - input	MJ/hr	515	539	661	765	870
- output	kW	115	120	150	170	195
propane - input	MJ/hr	485	505	620	720	820
- output	kW	108	115	140	160	180
dimensions						
a	mm	1805	-	-	-	-
b	mm	835	830	955	1055	1160
C (HWT)	mm	2145	2130	2255	2255	2355
flue connection	mm	255	255	305	305	355
weight	kg	115	195	200	250	260
inlet/outlet connections		RC11/2/40	RC21/2/65	RC21/2/65	RC21/2/65	RC21/2/65
gas connection - natural		RP1/25	RP1/25	RP11/4/32	RP11/4/32	RP11/2/40
gas connection - propane		RP1/25	RP1/25	RP1/25	RP1/25	RP1/25
relief valve connection						
on / off models		RC3/4/20	RC3/4/20	RC3/4/20	RC3/4/20	RC3/4/20
modulating models		not available	RC3/4/20	RC3/4/20	RC3/4/20	RC3/4/20
electrical rating 240v 50hz	Watts Amps	50 0.21	50 0.21	50 0.21	50 0.21	50 0.21
min buffer tank capacity	litres	325	325	325	325	325
max storage capacity	litres	5,700	6,000	7,500	8,500	10,000
recovery at 30°c rise (NG)	L/hr	3,297	3,440	4,300	4,873	5,590
recovery at 40°c rise (NG)	L/hr	2,473	2,580	3,225	3,655	4,193
recovery at 50°c rise (NG)	L/hr	1,978	2,064	2,580	2,924	3,354
recovery at 60°c rise (NG)	L/hr	1,648	1,720	2,150	2,437	2,795
recovery at 65°c rise (NG)	L/hr	1,522	1,588	1,985	2,249	2,580
recovery at 70°c rise (NG)	L/hr	1,413	1,474	1,843	2,089	2,396
recovery at 75°c rise (NG)	L/hr	-	1,376	1,720	1,949	2,236
recovery at 80°c rise (NG)	L/hr	-	1,290	1,613	1,828	2,096
recovery at 85°c rise (NG)	L/hr	-	1,214	1,518	1,720	1,973
maximum flow rate modulating (10°c rise)	L/s	2.75	2.87	3.58	4.06	4.66
pressure drop	kPa	18	6	10	14	22
maximum flow rate on/off (15°c rise)	L/s	1.83	1.91	2.39	2.71	3.11
pressure drop	kPa	9	3	4	6	8
minimum flow rate (20°c rise)	L/s	1.37	1.43	1.79	2.03	2.33
pressure drop	kPa	5	3	3	4	5

*Table 9.7a: Technical data for Raypak **indoor** models 992-1922*

model		992	1182	1412	1722	1922
natural - input	MJ/hr	999	1186	1412	1719	1926
- output	kW	225	265	315	380	430
propane - input	MJ/hr	933	1090	1296	1581	1772
- output	kW	205	240	290	350	395
dimensions						
A	mm	1810	1915	1990	2060	2130
B	mm	1330	1510	1740	2070	2270
G	mm	860	860	860	930	930
flue connection	mm	355	405	455	455	505
weight	kg	310	330	390	440	460
inlet/outlet connections		RC21/2/65	RC21/2/65	RC21/2/65	RC21/2/65	RC21/2/65
gas connection - natural		RL2/50	RL2/50	RL2/50	RL2/50	RL2/50
gas connection - propane		RL1/25	RL1/25	RL1/25	RL11/4/32	RL11/4/32
relief valve connection						
on / off models		RC3/4/20	RC3/4/20	RC3/4/20	RC3/4/20	RC3/4/20
modulating models		RC3/4/20	RC3/4/20	RC3/4/20	RC1/25	RC1/25
electrical rating 240v 50hz	Watts Amps	100 0.42	100 0.42	100 0.42	100 0.42	100 0.42
min buffer tank capacity	litres	410	650	650	650	820
max storage capacity	litres	11,000	13,000	16,000	19,500	22,000
recovery at 30°c rise (NG)	L/hr	6,450	7,597	9,030	10,893	12,327
recovery at 40°c rise (NG)	L/hr	4,838	5,698	6,773	8,170	9,245
recovery at 50°c rise (NG)	L/hr	3,870	4,558	5,418	6,536	7,396
recovery at 60°c rise (NG)	L/hr	3,225	3,798	4,515	5,447	6,163
recovery at 65°c rise (NG)	L/hr	2,977	3,506	4,168	5,028	5,689
recovery at 70°c rise (NG)	L/hr	2,764	3,256	3,870	4,669	5,283
recovery at 75°c rise (NG)	L/hr	2,580	3,039	3,612	4,357	4,931
recovery at 80°C rise (NG)	L/hr	2,419	2,849	3,386	4,085	4,623
recovery at 85°C rise (NG)	L/hr	2,276	2,681	3,187	3,845	4,351
maximum flow rate modulating (10°C rise)	L/s	5.38	6.31	6.31	6.31	6.31
pressure drop	kPa	29	44	49	55	58
maximum flow rate on/off (15°C rise)	L/s	3.58	4.22	5.02	5.68	5.68
pressure drop	kPa	12	18	30	50	58
minimum flow rate (20°C rise)	L/s	2.69	3.17	3.76	4.54	5.14
pressure drop	kPa	7	11	18	30	39

Table 9.7b: Technical data for Raypak **indoor** models 2214-4224

model		2214	3164	3694	4224
natural - input	MJ/hr	2215	3165	3692	4224
- output	kW	505	720	840	960
propane - input	MJ/hr	2150	3035	3540	4045
- output	kW	480	675	790	900
dimensions					
A	mm	-	-	-	-
B	mm	1550	2060	2350	2640
G	mm	-	-	-	-
flue connection	mm	610	710	760	815
weight	kg	625	780	860	940
inlet/outlet connections		R3/80	R3/80	R3/80	R3/80
gas connection - natural		RL2/50	RL21/2/65	RL3/80	RL3/80
gas connection - propane		RL11/4/32	RL11/2/40	RL2/50	RL2/50
relief valve connection					
on / off models		RC3/4/20	RC1/25	RC1/25	RC1/25
modulating models		RC11/4/32	RC11/2/40	RC11/2/40	RC11/2/40
electrical rating 240v 50hz	Watts Amps	100 0.42	100 0.42	100 0.42	100 0.42
min buffer tank capacity	litres	975	975	1230	1300
max storage capacity	litres	27,000	37,000	43,500	49,500
recovery at 30°C rise (NG)	L/hr	14,477	20,640	24,080	27,520
recovery at 40°C rise (NG)	L/hr	10,858	15,480	18,060	20,640
recovery at 50°C rise (NG)	L/hr	8,686	12,384	14,448	16,512
recovery at 60°C rise (NG)	L/hr	7,238	10,320	12,040	13,760
recovery at 65°C rise (NG)	L/hr	6,682	9,526	11,114	12,702
recovery at 70°C rise (NG)	L/hr	6,204	8,846	10,320	11,794
recovery at 75°C rise (NG)	L/hr	5,791	8,256	9,632	11,008
recovery at 80°C rise (NG)	L/hr	5,429	7,740	9,030	10,320
recovery at 85°C rise (NG)	L/hr	5,109	7,285	8,499	9,713
maximum flow rate modulating (10°C rise)	L/s	12.06	12.62	12.62	12.62
pressure drop	kPa	48	50	54	57
maximum flow rate on/off (15°C rise)	L/s	8.04	11.47	12.62	12.62
pressure drop	kPa	20	38	54	57
minimum flow rate (20°C rise)	L/s	6.03	8.60	10.03	11.47
pressure drop	kPa	12	23	30	42

Table 9.8a: Technical data for Raypak **outdoor** models 972-1852

model		972	1142	1362	1662	1852
natural - input	MJ/hr	976	1142	1357	1657	1854
- output	kW	220	255	300	370	410
propane - input	MJ/hr	933	1090	1296	1581	1772
- output	kW	205	240	290	350	395
dimensions						
A	mm	2500	2395	2570	2640	2920
B	mm	1330	1510	1740	2070	2270
weight	kg	360	385	440	510	520
inlet/outlet connections		RC21/2/65	RC21/2/65	RC21/2/65	RC21/2/65	RC21/2/65
gas connection - natural		RL2/50	RL2/50	RL2/50	RL2/50	RL2/50
gas connection - propane		RL1/25	RL1/25	RL1/25	RL11/4/32	RL11/4/32
relief valve connection						
on / off models		RC3/4/20	RC3/4/20	RC3/4/20	RC3/4/20	RC3/4/20
modulating models		RC3/4/20	RC3/4/20	RC3/4/20	RC1/25	RC1/25
electrical rating 240v 50hz	Watts Amps	100 0.42	100 0.42	100 0.42	100 0.42	100 0.42
min buffer tank capacity	litres	410	650	650	650	820
max storage capacity	litres	11,000	13,000	15,500	19,000	21,000
recovery at 30°C rise (NG)	L/hr	6,307	7,310	8,600	10,607	11,753
recovery at 40°C rise (NG)	L/hr	4,730	5,483	6,450	7,955	8,815
recovery at 50°C rise (NG)	L/hr	3,784	4,386	5,160	6,364	7,052
recovery at 60°C rise (NG)	L/hr	3,153	3,655	4,300	5,303	5,877
recovery at 65°C rise (NG)	L/hr	2,911	3,374	3,969	4,895	5,425
recovery at 70°C rise (NG)	L/hr	2,703	3,133	3,686	4,546	5,037
recovery at 75°C rise (NG)	L/hr	2,523	2,924	3,440	4,243	4,701
recovery at 80°C rise (NG)	L/hr	2,365	2,741	3,225	3,978	4,408
recovery at 85°C rise (NG)	L/hr	2,226	2,580	3,035	3,744	4,148
maximum flow rate modulating (10°C rise)	L/s	5.26	6.09	6.31	6.31	6.31
pressure drop	kPa	27	43	49	55	58
maximum flow rate on/off (15°C rise)	L/s	3.50	4.06	4.78	5.68	5.68
pressure drop	kPa	12	18	30	50	58
minimum flow rate (20°C rise)	L/s	2.63	3.05	3.58	4.42	4.90
pressure drop	kPa	7	10	16	27	21

Table 9.8b: Technical data for Raypak **outdoor** models 2004-3804

model		2004	2804	3304	3804
natural - input	MJ/hr	2004	2804	3304	3804
- output	kW	445	625	740	845
propane - input	MJ/hr	1595	2278	2659	3038
- output	kW	354	508	595	675
dimensions					
A	mm	3165	3185	2965	3165
B	mm	1550	2060	2350	2635
weight	kg	650	810	890	970
inlet/outlet connections		RC3/80	RC3/80	RC3/80	RC3/80
gas connection - natural		RL2/50	RL21/2/65	RL21/2/65	RL3/80
gas connection - propane		RL11/4/32	RL11/2/40	RL2/50	RL2/50
relief valve connection					
on / off models		RC3/4/20	RC1/25	RC1/25	RC1/25
modulating models		RC11/4/32	RC11/2/40	RC11/2/40	RC11/2/40
electrical rating 240v 50hz	Watts Amps	100 0.42	100 0.42	100 0.42	100 0.42
min buffer tank capacity	litres	975	975	1230	1230
max storage capacity	litres	23,000	32,000	39,000	43,000
recovery at 30°C rise (NG)	L/hr	12,757	17,917	21,214	24,224
recovery at 40°C rise (NG)	L/hr	9,568	13,438	15,910	18,168
recovery at 50°C rise (NG)	L/hr	7,654	10,750	12,728	14,534
recovery at 60°C rise (NG)	L/hr	6,378	8,958	10,607	12,112
recovery at 65°C rise (NG)	L/hr	5,888	8,269	9,791	11,180
recovery at 70°C rise (NG)	L/hr	5,467	7,679	9,092	10,382
recovery at 75°C rise (NG)	L/hr	5,103	7,167	8,485	9,689
recovery at 80°C rise (NG)	L/hr	4,784	6,719	7,955	9,084
recovery at 85°C rise (NG)	L/hr	4,502	6,324	7,487	8,550
maximum flow rate modulating (10°C rise)	L/s	10.63	12.62	12.62	12.62
pressure drop	kPa	45	53	57	60
maximum flow rate on/off (15°C rise)	L/s	7.09	9.95	11.79	12.62
pressure drop	kPa	18	35	53	57
minimum flow rate (20°C rise)	L/s	5.32	7.47	8.84	10.09
pressure drop	kPa	12	21	30	42

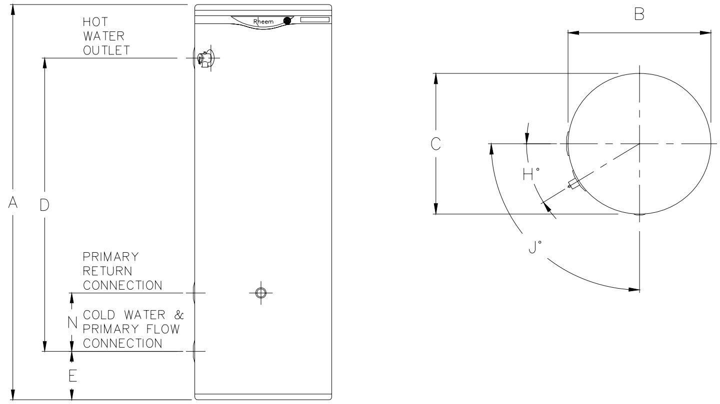


Fig 9.11: 610 series storage tanks dimensional drawing

Model			610 340	610 430
Storage Capacity		litres	325	410
Hot Water Delivery		litres	315	400
Maximum Storage Temperature		°C	82	82
Nominal Dimensions (mm)	A	mm	1640	1840
	B	mm	640	690
	C	mm	640	690
	D	mm	1298	1482
	E	mm	115	108
	H	degrees	32	30
	J	degrees	90	84
	N	mm	290	273
Weight empty		kg	87	111
Inlet / Outlet Connections		BSPF	RP 2 / 50	RP 2 / 50
TPR Valve Connection		BSPF	RP ¾ / 20	RP ¾ / 20
Remote Thermostat Connection		BSPF	RP ½ / 15	RP ½ / 15
TPR Valve Setting		kPa	1000	1000
ECV Setting		kPa	850	850
Maximum Water Supply Pressure Without ECV Fitted With ECV Fitted		 kPa kPa	 800 680	 800 680
Manifold - minimum centre to centre		mm	900	940

Table 9.9: Series 610 storage tank dimensions

Minimum Supply Pressure

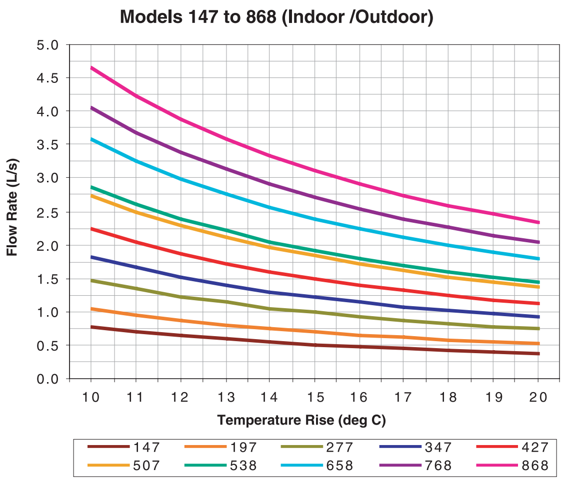
System design and pump selection is critical when water heaters are connected to a low pressure water supply. The table below shows minimum pressure requirements for Grundfos UPS series pumps. Minimum pressure requirements for TP series pumps depend on system characteristics and need to be calculated.

Pump	Raypak Model	75°C	80°C	85°C	90°C	95°C
UPS20-60B UP20-45N	147, 200, 280	0.5	0.5	0.5	3.0	5.0
UPS32-80B	350, 430, 507, 538, 658, 768, 868	0.5	0.5	0.5	3.0	5.0
UPS40-60/2B	768, 868, 972, 992, 1142, 1182, 1242, 1292	1.5	2.5	3.5	4.5	7.0
UPS50-120B	1362, 1412, 1492, 1552, 1662, 1722, 1852, 1922, 2004, 2214	4.0	5.0	6.0	7.0	9.0
UPS80-120B	2404, 2634, 2804, 3164, 3304, 3694, 3804, 4224	16.0	17.0	18.0	19.0	20.5

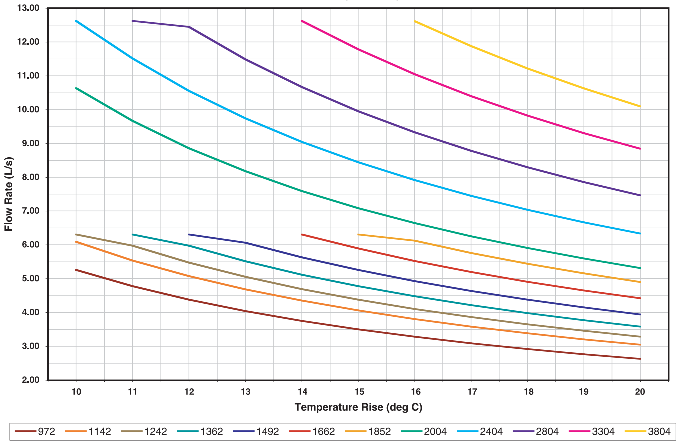
Table 9.10: Minimum supply pressures for Grundfos UPS series pumps when connected to Raypak water heating systems

Temperature Rise Vs Flow Rate

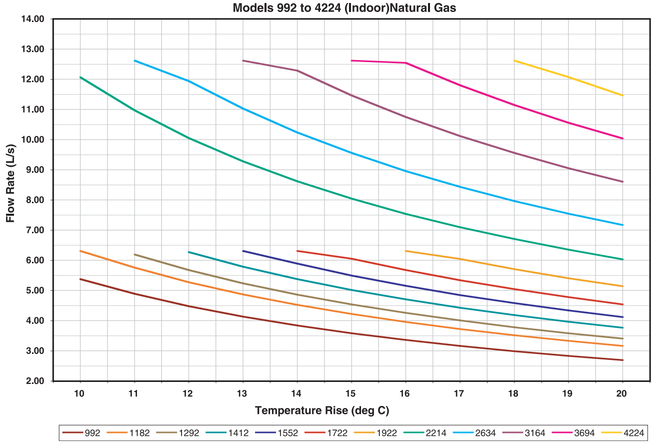
The following graphs give the maximum flow rates achievable for a range of temperature rises.



Temperature Rise V 's Flow Rate -Raypak Water Heaters
Models 972 to 3804 (Outdoor)Natural Gas



Temperature Rise V 's Flow Rate -Raypak Water Heaters
Models 992 to 4224 (Indoor)Natural Gas



Chapter 10

Rheem Electric Water Heaters – Commercial

This Chapter Covers:

Design, operation and energy usage of commercial electric water heaters

- Current models available in the Rheem Commercial electric range
- An overview of their main features and installation options
- Tables of dimensions, performance, power usage and other technical data

OVERVIEW OF MODELS

Commercial Vs Domestic Electric Water Heaters

Commercial electric water heaters are ideal for applications where large quantities of hot water are required and the provision of gas services and adequate fluing are difficult to achieve. Common applications include cafes, restaurants and hair dressing salons. These water heaters are also ideal for use in commercial kitchen and laundry applications as a high temperature (up to 82°C) sanitising boost to the normal domestic hot water supply.

Commercial electric water heaters differ from their domestic counterparts in many ways:

- Specially formulated heavy duty enamel
- Larger sacrificial anode to provide secondary cathodic protection
- Multiple electric heating elements provide greater recovery
- Higher temperature thermostats
- 32mm water connections

Rheem Commercial water heaters are designed for either single or multiple installation.

Model		613 050	613 315	616 315
Storage Capacity	Litres	60	325	325
Delivery Rating	Litres	50	315	315
Available Heating Element arrangements	kW	3 x 3.6 3 x 4.8	3 x 3.6 3 x 4.8 3 x 6.0	6 x 3.6 6 x 4.8 6 x 6.0
1st Hour Delivery	Litres	240 - 300	500 - 620	690 - 930

Table 10.1: Overview of Rheem commercial electric water heaters

COMPONENTS

All of the features of an electric water heater discussed at chapter 5, as well as the cylinder design aspects at chapter 2, are relevant for the range of Rheem commercial electric water heaters. These include:

Colourbond Jacket that resists peeling and blistering, designed to withstand weather extremes.

Insulation –High-density CFC-free Polyurethane insulation provides impact resistance as well as thermal insulation.

Specially Formulated Vitreous Enamel Lining – Providing the cylinder with a high level of protection from corrosion. The enamel has been specially formulated by Rheem to provide long life under the high water temperatures required for sanitising purposes.

Larger Sacrificial Anode – To provide added protection under adverse working conditions.

Temperature Pressure Relief Valve – To protect the water heater from extreme high pressures due to expanding effect of heating water.

3 or 6 Heating Elements: These water heaters are manufactured with either three or six single phase immersion heating units.

Energy Cut Out Thermostats: Each heating element is controlled by a contact thermostat incorporating a double pole over temperature cut out. Should the water temperature exceed the maximum limit due to malfunction of a thermostat, the element controlled by that thermostat is automatically shut off.

The thermostats operate on the active wire to the heating unit; the cut outs operate on both the active and neutral wires. The cut out requires resetting manually, and this should be done by a competent service operator as the cut out is located inside the unit behind the front cover.

Notes:

The outer jacket and heating unit enclosure are rated to IP 34 as tested against AS 1939, and as such these water heaters can be installed outdoors as well as indoors.

ELECTRICAL CONNECTIONS

The electrical supply to these water heaters should be a three phase 415V AC 4 wire (star connection), where one element per phase is connected on three element models or two elements per phase is connected on six element models.

It is possible to connect these water heaters to a single phase 240V AC supply or a 415V AC 3 wire (delta connection) supply however some restrictions apply (see below for details).

Model	613 050	613 315	616 315
Delivery Rating (litres)	50	315	315
No. Heating elements	3	3	6
No. elements /phase	1	1	2
Maximum element rating (kW)	4.8	6.0	6.0
Maximum input (kW)	3 x 4.8 = 14.4	3 x 6.0 = 18.0	6 x 6.0 = 36.0
Max current per phase (Amps)	20	25	50

Table 10.2:
Electric characteristics of Rheem commercial electric water heaters

Connection Options

There are a number of electrical connection options available for Rheem commercial electric storage water heaters. When planning an installation, two of the primary considerations are maximum current per phase, and total peak power load of the installation. In the following examples, keep in mind the following:

- Current = Power divided by Voltage or Voltage divided by Resistance.
- The table above gives the number of heating elements that need to be carried by each phase for each water heater.

In commercial or industrial situations, where high temperature water is required and the available energy is insufficient to support 3 x heating elements, one or two heating elements can be connected to the electricity supply.

3 phase connection with neutral

This is the recommended method of wiring, since the load is spread evenly over the three phases. The neutral takes the same load as any of the active wires.

613 050 with 3 x 4.8kW elements (rated at 240 volts)

With this heater, each phase carries the load from one element. Thus there is one 4800 Watt element per phase.

Max current per phase = 4800 Watts / 240V = 20 Amps

Max current in neutral = 20 Amps

Total power load = 3 x 4800 = 14400 Watts = 14.4 kW

616 315 with 6 x 6.0 kW elements (rated at 240 volts)

With this heater, each phase carries the load from two elements.

Max current per phase = 2 x 6000 Watts / 240V = 50 Amps

Max current in neutral = 50 Amps

Total power load = 6 x 6000 = 36000 Watts = 36 kW

Single phase supply

A single phase supply requires both the active and neutral wires to the water heater being able to carry the full power requirement of all heating units added together. This is not recommended for the 616 315 where the total current load would prove excessive.

613 050 with 3 x 4.8kW elements (rated at 240 volts)

With this heater, a single phase carries the total load

Total power load = 3 x 4800 = 14400 Watts

Max current per phase = 14400 Watts / 240V = 60 Amps

Max current in neutral = 60 Amps

3 phase connection with no neutral

This method utilises two elements in series, across two phases.

> 613 050 with 3 x 4.8kW elements (rated at 240 volts)
> Single element resistance = 11.4 ohms
> Resistance of two elements in series (phase to phase) = 22.8 ohms
> Max current phase to phase = 415V/22.8 ohms = 18.2 Amps
> Max wattage = 415V x 18.2 Amps = 7.553kW
> Reduced heating capacity = 7.553kW/9.6kW x 100 = 78.7%

Slower recovery performance: The recovery performance of a 3 phase, no neutral connection will be lower than a heater connected with a neutral, as follows:

- If only one thermostat calls for power, no electricity will flow as there is no return path to complete the circuit.
- Where a second thermostat calls for power, two elements will operate, but at a reduced power rating (approx 3.6kW each instead of 4.8kW). This is due to the reduced voltage (207.5 volts) when two elements are operated in series across 415 volts.
- When all thermostats call for power, all three elements will operate, but at a reduced power rating.

Unbalanced 2 phase connection

Only two phases are connected to the water heater with one phase carrying 2/3 of the load and the other phase carrying 1/3 the load.

> 613 050 with 3 x 4.8kW elements
> Total power load = 3 x 4800 = 14400 Watts
> Max current is carried by the phase that takes 2/3 load.
> Max current in high load phase = 2/3 x 14400 / 240V = 40 Amps
> Max current in neutral = 40 Amps

Note: this method of wiring is not advisable from a utility view point. The terminal block may need to be replaced to ensure the correct size cable can be terminated correctly.

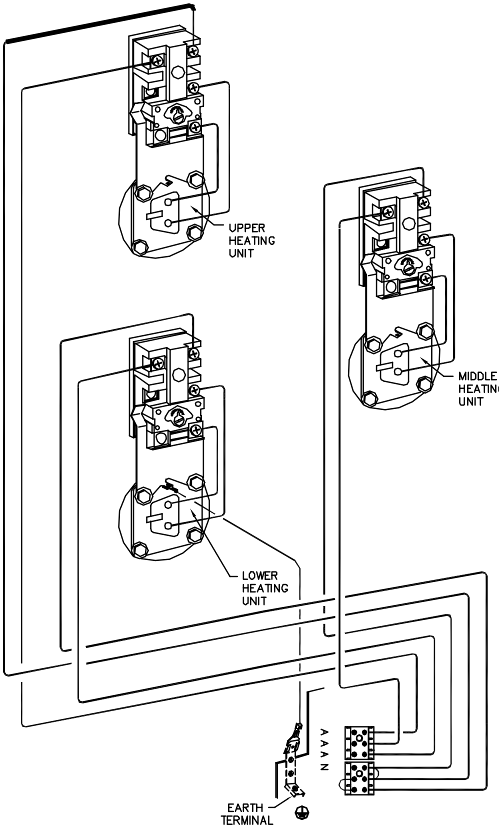
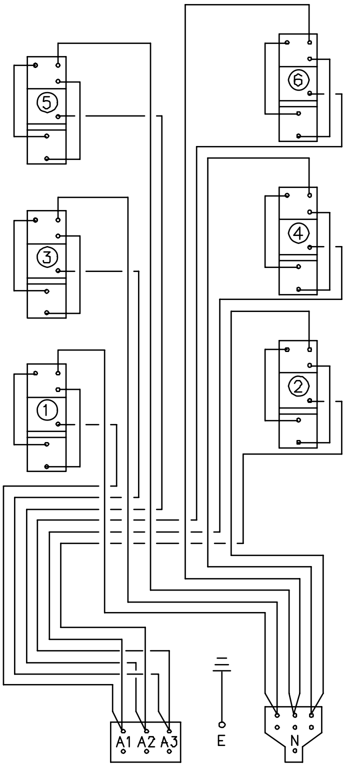


Fig 10.1: Electrical circuit for the 613 Series water heaters



NOTE
1. ACTIVES FROM A1 TO BE CONNECTED TO THERMOSTATS 1 & 4.
2. ACTIVES FROM A2 TO BE CONNECTED TO THERMOSTATS 2 & 5.
3. ACTIVES FROM A3 TO BE CONNECTED TO THERMOSTATS 3 & 6.
4. NEUTRAL CONNECTION FROM THERMOSTATS MAY BE CONNECTED TO ANY POINT ON THE NEUTRAL LINK

Fig 10.2: Electrical circuit for the 616315 model

TECHNICAL SPECIFICATIONS

Model		613 050	613 315	616 315
Delivery rating	litres	50	315	315
Water Connection Inlet and outlet		RP1¼ / 32	RP1¼ / 32	RP1¼ / 32
TPR Valve Connection		RP¾ / 20	RP¾ / 20	RP¾ / 20
TPR Valve Setting	kPa	1000	1000	1000
ECV Setting *	kPa	850	850	850
Maximum Water Supply Pressure without ECV	kPa	800	800	800
Maximum Water Supply Pressure with ECV	kPa	680	680	680
Factory Thermostat Setting	°C	75	75	75
Min Thermostat Setting	°C	60	60	60
Max Thermostat Setting	°C	82	82	82
Electrical Rating		240 v Single phase or 415 v 3 phase	240 v Single phase or 415 v 3 phase	415 v 3 phase
Manifold min. centre to centre	mm	685	890	890

* Expansion control valve is not supplied with the water heater.

Table 10.3: Technical specifications for Rheem commercial electric water heaters

Rheem electric water heaters are intended for connection to high or low pressure water supplies, subject to the following conditions:

- The maximum supply pressure does not exceed 80% of the relief valve setting. If it does, a pressure-limiting valve is to be fitted on the cold water supply.
- Mains pressure performance cannot be expected if the pressure of the cold water supply is less than 350 kPa.

DIMENSIONS

Model	613 050	613 315	616 315
Delivery Rating (litres)	50	315	315
Dimensions (mm) A	665	1640	1640
B	435	640	640
C	475	680	680
D	405	1294	1294
E	93	128	128
F	83	130	130
H (degrees)	30°	32°	32°
J (degrees)	90°	90°	90°
Approx Weight Empty (kg)	34	93	95

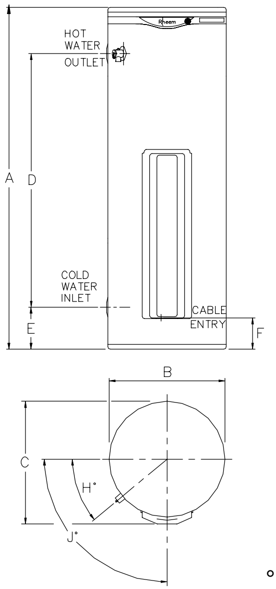


Table 10.4 and Fig 10.3: Dimensional details of Rheem commercial electric water heaters

PERFORMANCE

The electrical power consumption, efficiency and hot water delivery of each of the commercial electric water heaters is listed on the following pages.

Recovery

No. Heating Elements		3 x 3.6	3 x 4.8	3 x 6.0	6 x 3.6	6 x 4.8	6 x 6.0
Power Input	kW	10.8	14.4	18.0	21.6	28.8	36.0
Current per phase	Amps	15	20	25	30	40	50
Litres recovery per hour at rise of	20°C	460	620	770	930	1240	1550
	30°C	310	410	520	620	830	1030
	40°C	230	310	390	460	620	770
	50°C	190	250	310	370	500	620
	60°C	150	210	260	310	410	520
	65°C	140	190	240	290	380	480
	70°C	130	180	220	270	350	440
	75°C	120	170	210	250	330	410

Table 10.5: Recovery rates for various configurations of heating units and temperature rise requirements.

Volume of Hot Water Available

The next two tables give the approximate hot water availability at 50°C or 65°C temperature rise. The figures are based on the water heater delivery rating plus the recovery over the draw off period, i.e.

availability = (delivery rating) + (recovery rate x time).

For hot water availability at temperature rises other than 50°C or 65°C, refer to the recovery rates in table 10.5 and apply the above formula.

model	No of units	Initial delivery (litres)	Heating elements (kW)	Litres hot water at 50°C rise over peak period					
				1 hr	2 hr	3 hr	4 hr	6 hr	8 hr
613 050	1	50	3 x 3.6	240	420	610	790	1160	1540
			3 x 4.8	300	550	790	1040	1540	2030
613 315	1	315	3 x 3.6	500	690	870	1060	1430	1800
			3 x 4.8	560	810	1060	1310	1800	2300
			3 x 6.0	620	930	1240	1550	2170	2790
	2	630	3 x 3.6	1000	1370	1740	2120	2860	3600
			3 x 4.8	1130	1620	2120	2610	3600	4590
			3 x 6.0	1250	1870	2490	3110	4350	5580
	3	945	3 x 3.6	1500	2060	2620	3170	4290	5400
			3 x 4.8	1690	2430	3170	3920	5400	6890
			3 x 6.0	1870	2800	3730	4660	6520	8380
616 315	1	315	6 x 3.6	690	1060	1430	1800	2540	3290
			6 x 4.8	810	1310	1800	2300	3290	4280
			6 x 6.0	930	1550	2170	2790	4030	5270
	2	630	6 x 3.6	1370	2120	2860	3600	5090	6570
			6 x 4.8	1620	2610	3600	4590	6570	8560
			6 x 6.0	1870	3110	4350	5580	8060	10540
	3	945	6 x 3.6	2060	3170	4290	5400	7630	9860
			6 x 4.8	2430	3920	5400	6890	9860	12830
			6 x 6.0	2800	4660	6520	8380	12090	15810
	4	1260	6 x 3.6	2750	4230	5720	7200	10180	13150
			6 x 4.8	3240	5220	7200	9190	13150	17110
			6 x 6.0	3740	6210	8690	11170	16120	21070
	5	1575	6 x 3.6	3430	5290	7150	9010	12720	16440
			6 x 4.8	4050	6530	9010	11480	16440	21390
			6 x 6.0	4670	7770	10860	13960	20150	26340
	6	1890	6 x 3.6	4120	6350	8580	10810	15260	19720
			6 x 4.8	4860	7830	10810	13780	19720	25670
			6 x 6.0	5610	9320	13040	16750	24180	31610

Table 10.6: Volume of hot water available at 50°C rise

model	No of units	Initial delivery (litres)	Heating elements (kW)	Litres hot water at 65°C rise over peak period					
				1 hr	2 hr	3 hr	4 hr	6 hr	8 hr
613 050	1	50	3 x 3.6	190	340	480	620	910	1190
			3 x 4.8	240	430	620	810	1190	1570
613 315	1	315	3 x 3.6	460	600	740	890	1170	1460
			3 x 4.8	510	700	890	1080	1460	1840
			3 x 6.0	550	790	1030	1270	1740	2220
	2	630	3 x 3.6	920	1200	1490	1770	2340	2920
			3 x 4.8	1010	1390	1770	2150	2920	3680
			3 x 6.0	1110	1580	2060	2540	3490	4440
	3	945	3 x 3.6	1370	1800	2230	2660	3520	4370
			3 x 4.8	1520	2090	2660	3230	4370	5520
			3 x 6.0	1660	2370	3090	3800	5230	6660
616 315	1	315	6 x 3.6	600	890	1170	1460	2030	2600
			6 x 4.8	700	1080	1460	1840	2600	3360
			6 x 6.0	790	1270	1740	2220	3170	4130
	2	630	6 x 3.6	1200	1770	2340	2920	4060	5200
			6 x 4.8	1390	2150	2920	3680	5200	6730
			6 x 6.0	1580	2540	3490	4440	6350	8250
	3	945	6 x 3.6	1800	2660	3520	4370	6090	7800
			6 x 4.8	2090	3230	4370	5520	7800	10090
			6 x 6.0	2370	3800	5230	6660	9520	12380

Table 10.7: Volume of hot water available at 65°C rise

Approximate Daily Energy Consumption

The table which follows shows the approximate daily energy consumption for each Rheem Commercial electric water heater. The first daily usage line (0 litres) gives the maintenance rate of the heater. In other words, if no water is drawn off, the heater would use the quantity of electricity listed to maintain the water at the required temperature.

Each subsequent line gives the maintenance rate plus the amount of electrical energy needed to heat the quantity of water used.

Assumptions:

The figures are based on the following conditions:

- 3600 W heating elements. Although there are small differences in efficiency between different heating units, the figures in the table can be used with reasonable accuracy for all other heating element ratings.
- Water at a 50°C temperature rise.
- No allowance has been made for pipe losses. An allowance should be made for large manifold systems and installations that are designed with secondary flow and return circuits.
- Mains pressure operation only.

Other Uses for Table

Table 10.8 can be used:

- To calculate the approximate energy cost for a particular installation where the water usage is known.
- To determine the average daily hot water consumption knowing the energy consumption.

Daily usage of hot water (litres at 50°C rise)	Energy Content of hot water (kWh)	Energy used per day (kWh)		
		613 050	613 315	616 315
0	0.0	2.1	3.1	3.3
50	2.9	5.0	6.0	6.2
100	5.8	7.9	8.9	9.1
150	8.7	10.8	11.8	12.0
200	11.6	13.7	14.7	14.9
250	14.5	16.6	17.6	17.8
300	17.4	19.5	20.5	20.7
350	20.3	22.4	23.4	23.6
400	23.3	25.4	26.4	26.6
450	26.2	28.3	29.3	29.5
500	29.1	31.2	32.2	32.4
600	34.9	37.0	38.0	38.2
700	40.7	42.8	43.8	44.0
800	46.5	48.6	49.6	49.8
900	52.3	54.4	55.4	55.6
1000	58.1	60.2	61.2	61.4
1250	72.7	74.8	75.8	76.0
1500	87.2	89.3	90.3	90.5
1750	101.7	103.8	104.8	105.0
2000	116.3	118.4	119.4	119.6
2500	145.3		148.4	148.6
3000	174.4			177.7
3500	203.5			206.8
4000	232.6			235.9
5000	290.7			294.0

Table 10.8: Approximate daily energy consumption

Chapter 11

Rheem Solar Water Heaters - Commercial

This Chapter Covers:

Design and operation of commercial solar water heaters

- Current systems available in the Rheem range
- Sizing commercial solar systems
- Installation requirements

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OVERVIEW OF MODELS

In most states of Australia, it is now normal for design engineers in both private organisations and government to thoroughly investigate the feasibility of solar water heating for all new projects, and in some instances the inclusion of a solar design is a prerequisite for DA approval.

The feasibility of these systems is based on a comparison between capital cost and ongoing savings, relative to the cost of heating water using gas or electricity. With current tariffs and projected increases for gas and electricity in Australia, along with government incentives such as Renewable Energy Certificates or RECs (see later in this chapter), the return on investment for many projects can be attractive.

Types of Systems

For heavy duty or industrial applications, Rheem offers two basic types of systems that will meet the needs of most hot water demands.

The two systems available are:

- ***Rheem Premier Hiline*** close coupled system - the solar tanks and collectors are mounted directly on the roof. The units can be installed to supply hot water to various individual outlets, or can be manifolded in banks to provide total storage and supply of hot water to all outlets in the project.
- ***Rheem Loline*** split system - Banks of collectors are mounted on the roof, with the solar storage tanks manifolded and positioned in a convenient location at ground or floor level.

PREMIER HILINE

The Rheem Premier Hiline commercial solar water heating system is simply an extension of the Premier Hiline domestic system, incorporating a stainless steel storage cylinder utilising a heat exchange design. The Premier unit can either be installed as a single unit, with two collectors to meet requirements, or manifolded in banks up to eight units for larger applications. A multiple of banks, each consisting of up to eight units, can be employed where required.

The heat exchange fluid in the collectors resists freezing to temperatures as low as -28°C and the heat exchange design makes the Premier system an ideal choice in scaling water areas.

The booster backup system is generally electric, with an electric heating unit in each tank. This booster will heat approximately 150 L of the 300 L capacity.

In some applications it may be practical to combine a Premier installation with an in line electric or gas booster system. The advantage of this arrangement is the Premier storage tank is then available to store solar heated water only, thus providing maximum solar gains within the system. The installation of a Commercial Premier Hiline system utilising in line Rheem Commercial or Raypak boosting would be eligible for the creation of RECs.

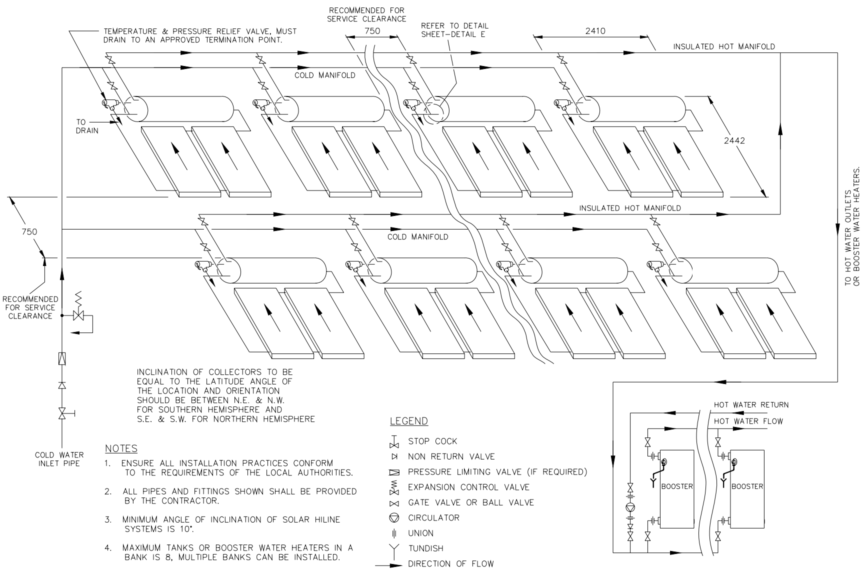

Fig 11.1: Rheem Premier Hiline commercial solar system

RHEEM LOLINE

The Rheem Loline commercial system consists of a bank of vitreous enamel mains pressure floor mounted storage tanks, nominal 325 or 410 litres, and an array of Rheem solar collectors sized to match the energy requirements to heat the water.

Frost protection is provided by recirculating stored hot water through the collectors. Should the water temperature fall below 4°C, the hot sensor will activate the circulating pump and bring a volume of hot water from the storage tanks into the collectors. When the hot sensor reaches 7°C, the pump is turned off.

This system offers significant flexibility in sizing selection of the solar storage and the booster backup system. For example, Figure 11.2 shows a bank of storage tanks coupled to an array of collectors. The number of storage tanks and the number of collectors are specified to suit each installation.

The Rheem Equa Flow manifold system is employed in this design, allowing for either the storage system or booster models to be increased in number to cope with increased demands. The Equa Flow manifold system ensures maximum hot water draw off from all units to meet load requirements.

Several design configurations can be used with this system, providing the designer with the opportunity to take advantage of local electric or gas tariffs best suited for economic reasons, as well as for project requirements. An appreciation of these alternatives can be seen by studying the various designs contained in this chapter.

Single panel array

Figure 11.2 shows a typical installation. An expansion pipe is required every eight collectors, however, up to twenty four collectors can be coupled together in this way using the collector internal header as shown.

Double panel array

Where the number of solar collectors exceeds 24, multiple arrays must be used (see fig 11.3). Each array is fed with water from a separate header and the arrays are plumbed using the Equa-Flow principle.

Multiple arrays can be placed side by side or behind / above each other as long as Equa-Flow principles are maintained.

Boosting Loline Commercial Solar

As previously stated, any solar system has to be designed to provide adequate backup for days of low solar energy. This is especially true with commercial installations that are providing hot water for industrial or commercial use.

A choice of gas or electrical boosting is available by installing the appropriate water heaters downstream of the solar storage tanks. These are connected in series with the solar storage so all the water passes through these boosting water heaters. Under good solar conditions, the thermostats on the boosting water heaters will recognise the preheated water and no heating will occur except for maintenance operation. If, however, cooler water enters the boosting water heaters, the thermostats will react and boosting will take place. Rheem recommends the thermostats on these units be set to 60°C in order to get the maximum solar contribution.

Figures 11.2 and 11.3 show the correct method of plumbing boosting water heaters into a Loline Commercial solar system.

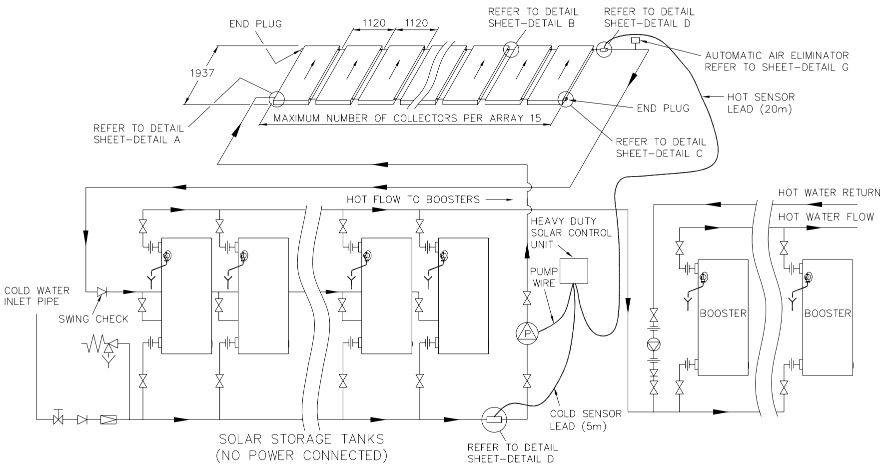

Fig 11.2: Single array Rheem Loline commercial solar system

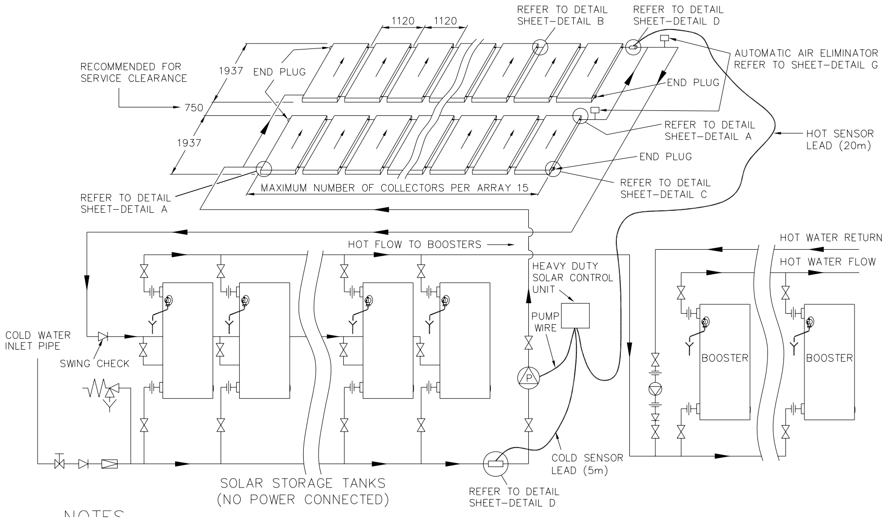

Fig 11.3: Double array Rheem Loline commercial solar system

SYSTEM SELECTION

Designing any hot water system requires you collect all relevant information regarding total hot water load, as well as budgetary and plant constraints.

The design of commercial solar water heating systems is more complex than for gas or electricity. Instead of looking at only the peak load over one or two hours, you must ensure you take into consideration both the peak period hot water demand factor *and* the total daily hot water requirements of the project.

Hiline Vs Loline

Since both Hiline and Loline systems can handle any size load, the choice of which system to use can be based on capital and plant considerations. The fundamental difference between the two systems is the Loline systems allow storage tanks at ground level, whereas Hiline systems require them to be positioned on the roof above the collectors.

The following tables summarise the major selection considerations for each system.

Advantages	Disadvantages
Gross weight loading on roof not critical	Requires electricity to operate energy circulation between collectors and storage tanks.
Solar storage tanks can be located internally or externally, near major draw-off points.	Requires planned area for positioning of solar storage tanks.
Minimum energy losses from secondary hot water lines.	
Backup system can be designed and located with solar storage tanks to ensure maximum efficiency.	
Greater flexibility in choice of backup system to meet varying peak loads.	

Table 11.1: Rheem Loline advantages and disadvantages

Advantages	*Disadvantages*
Total system can be positioned on roof.	Gross weight on roof structure must be taken into consideration.
Does not require electric circulator for energy circulation between collector and solar storage.	Roof area may limit number of solar storage tanks and panels.
Heat exchange design makes this unit suitable for frost prone areas and where hard water is present	In series gas or electric booster systems, positioning is critical.

Table 11.2: Rheem Premier Hiline advantages and disadvantages

Sizing A System

The objective of a solar hot water system is to provide energy savings, and a well designed system can save up to 90% of energy needed to heat the hot water required. Actual savings in dollars will depend entirely on the local tariff structure for gas and electricity. Where there are upfront capital restrictions, it is feasible to design systems with a smaller percentage of solar contribution. The payback period (the number of months for energy savings to “pay back” the original outlay) will be roughly the same for any level of solar contribution.

Design Rule: A solar system should be sized to provide sufficient energy and storage to heat a proportion of the total daily hot water load.

- ***Number of collectors***: based on the required solar energy contribution in megajoules per day, using performance for the best solar months. Sizing the collector area on data other than for the most favourable solar gain months will, in most cases, result in a system that is grossly overpowered during summer months and not cost effective.
- ***Size and number of storages tank***: sizing is done on the volume of hot water required for the installation, based on the solar contribution percentage.
- ***Plant area***: allowable plant space for both collectors and tanks may have an impact on the actual solar contribution. An assessment of the plant area requirements should be undertaken to complete the design.

Example – Sizing A Loline System

A squash court in Sydney with four courts operating between 10.00 am and 10.00 pm is sized for 100% contribution in the best month. (192 players use the showers each day.)

Step 1- Calculate Daily Energy Requirement

Hot water demand	= 3840 L/day (192 x 20L/person)
Solar contribution required (best month)	= 100 %
Solar radiation for best month in Sydney (December)	= 23.5 M J/m²/day from Table 6.11
Efficiency of solar collectors	= 60%
Cold water temperature in Sydney during same month	= 19°C
Hot water temperature required	= 65°C

$\text{Energy}_{\text{Daily}}$ = volume of water X heat capacity X temperature rise X contribution

Volume of Water	= 3840 litres/day
Heat Capacity	= 0.004186 (given in chapter 16)
Temperature rise	= (65 – 19) = 46°C
Contribution	= 100/100 = 1
Total daily energy requirement	= 3840 X 0.004186 X 46 X 1 = 739 MJ/day

Step 2 – Calculate Number of Collectors Required

The solar energy per collector is found from the formula

Heat Energy = Radiation/ m^2/day X area of collector X Efficiency

Radiation available per square metre for Sydney in December	= 23.5 MJ/ m^2/day
Area of NPT200 collectors	= 1.87 m^2
Efficiency	= 60%
Energy provided per collector per day	= 23.5 X 1.87 X 60% = 26.37MJ
Number of collectors required	= 739 / 26.37 = 28.02 collectors

Select 28 x NPT 200 collectors.

Step 3 – Calculate Number Of Rheem Storage Tanks

Calculating the number of Rheem storage tanks is straightforward. If we use the 610430 with a capacity of 410 litres, we will need 3840/410 = 9.4 tanks. For correct Equa-Flow operation it is customary to round the requirement to provide even banks. In this case select 10 storage tanks.

Step 4 – Other Considerations

The calculations above took into account the predictable efficiency of the solar collectors. However, there will be other losses and considerations which will vary from system to system, and location to location. These considerations include:

- flow rate of water through collectors
- flow and return pipe sizes
- pump size and speed
- frost protection method
- water quality
- collector mounting method and position
- collector connection method (i.e. single panel array or double panel array)

The Rheem Technical Advisory Service, available through any Rheem state office, will offer assistance in Commercial Solar designs.

INSTALLATION

Correct system design and installation is critical in achieving maximum performance from a commercial solar installation. In particular, the following should be observed:

- All installation directives listed in chapter 2 regarding orientation and positioning of collectors should be observed.
- For flat roof installations, Rheem can supply variable pitch frames with either 1 or 2 collectors with pre set pitch angles of 15°, 20° or 25°.
- A Rheem "with-pitch" bracket must be used for Premier Hiline systems for installations in extreme wind areas.
- Copper flow and return lines MUST be used between the solar storage tanks and the collectors.
- The copper pipe must be well insulated and sheathed if externally mounted. AS3500.4 has guidelines specific to each zone.

Pipe Sizing and Pump Selection

The table below gives correct specification for pipe sizing, pump selection and speed settings. In reading the table, note the following:

- The first column gives the total number of collectors in the installation. If the number of panels falls between two rows, use the next biggest array size.
- The second column is used in determining the total length of pipe interconnecting the tanks and interconnecting the collector arrays for selection purposes. The actual lengths of pipe have been pre-determined for both side by side and parallel collector arrays and appropriate tank configuration for a given number of collectors.
- Each subsequent column represents total lineal length (flow and return) between the storage tanks and the collector array. If the actual pipe length between tanks and collectors falls between the lengths shown, use the next longest length.
- Each entry in the body of the table gives the pipe size, pump model and speed that are appropriate for the number of collectors, collector configuration and total pipe length. For example DN20/20-60/2 refers to DN20mm nominal diameter pipe, with a Grundfos UPS20-60B model pump set to speed 2.
- Where an entry is blank, either the given pipe diameter in the row is not suitable for lengths greater than those shown, or it is unlikely that a pipe length this short is to be encountered for a project with the number of collectors requested.

<table>
<tr><th>No. Collectors</th><th>Configuration</th><th>10</th><th>20</th><th>30</th><th>40</th><th>50</th><th>60</th></tr>
<tr><td rowspan="2">15</td><td>Parallel</td><td colspan="2">DN20 20-60/1</td><td colspan="4">DN20 20-60/2</td></tr>
<tr><td>Parallel</td><td colspan="6">DN25 20-60/1</td></tr>
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<tr><td>Parallel</td><td colspan="2">DN25 20-60/2</td><td colspan="4">DN25 20-60/3</td></tr>
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<tr><td>Side by side</td><td colspan="2">DN25 20-60/2</td><td colspan="4">DN25 20-60/3</td></tr>
<tr><td rowspan="3">45</td><td>Parallel</td><td></td><td colspan="4">DN25 32-80/3</td><td></td></tr>
<tr><td>Parallel</td><td></td><td colspan="5">DN32 20-45</td></tr>
<tr><td>Side by side</td><td></td><td colspan="5">DN32 20-45</td></tr>
<tr><td rowspan="4">60</td><td>Parallel</td><td></td><td colspan="5">DN32 32-80/3</td></tr>
<tr><td>Parallel</td><td></td><td colspan="5">DN40 20-45</td></tr>
<tr><td>Side by side</td><td></td><td colspan="5">DN32 32-80/3</td></tr>
<tr><td>Side by side</td><td></td><td colspan="5">DN40 20-45</td></tr>
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<tr><td>Side by side</td><td></td><td></td><td colspan="4">DN40 32-80/3</td></tr>
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<tr><td>Parallel</td><td></td><td></td><td colspan="4">DN50 20-60/3</td></tr>
<tr><td>Side by side</td><td></td><td></td><td colspan="2">DN40 32-80/3</td><td></td><td></td></tr>
<tr><td>Side by side</td><td></td><td></td><td colspan="4">DN50 20-60/3</td></tr>
<tr><td rowspan="2">105</td><td>Parallel</td><td></td><td></td><td></td><td colspan="3">DN50 32-80/3</td></tr>
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<tr><td rowspan="2">120</td><td>Parallel</td><td></td><td></td><td></td><td colspan="3">DN50 32-80/3</td></tr>
<tr><td>Side by side</td><td></td><td></td><td></td><td colspan="3">DN50 32-80/3</td></tr>
</table>

Table 11.3: Commercial solar pipe size, pump selection and speed setting guide (this page and following)

<table>
<tr><th>No. Collectors</th><th>Configuration</th><th>70</th><th>80</th><th>90</th><th>100</th><th>150</th><th>200</th></tr>
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32-80/2</td><td>DN32
20-60/2</td></tr>
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<tr><td>Side by side</td><td>DN32
20-45</td><td colspan="4">DN32 20-60/3</td><td>DN32
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<tr><td rowspan="4">60</td><td>Parallel</td><td colspan="4">DN32 32-80/3</td><td></td><td></td></tr>
<tr><td>Parallel</td><td colspan="4">DN40 20-45</td><td>DN40
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32-80/3</td></tr>
<tr><td rowspan="4">75</td><td>Parallel</td><td colspan="6">DN40 32-80/3</td></tr>
<tr><td>Parallel</td><td colspan="6">DN50 20-45</td></tr>
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<tr><td rowspan="4">90</td><td>Parallel</td><td colspan="4">DN40 32-80/3</td><td></td><td></td></tr>
<tr><td>Parallel</td><td colspan="4">DN50 20-60/3</td><td>DN50
32-80/2</td><td>DN50
32-80/2</td></tr>
<tr><td>Side by side</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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32-80/2</td><td>DN50
32-80/3</td></tr>
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<tr><td>Side by side</td><td colspan="6">DN50 32-80/3</td></tr>
</table>

CALCULATING REC'S

To calculate the approximate number of REC's for which your installation may be eligible (details discussed in chapter 1):

1. Take the number of collectors in the installation
2. Look at table 11.4 to confirm the ratio of collectors to storage tanks for each zone and cylinder size is within the minimum and maximum. To qualify for REC's the ratio must fall within these limits.
3. Multiply the number of collectors in the installation by the REC's per collector for the relevant zone, as found in table 11.5.

City (zone)	Latitude	Solar Radiation (MJ/m²/day)					340 litre		430 litre	
		Ave		Best Month						
		Inclined @ 20°	*Inclined @ latitude*	Inclined @ 20°	*Inclined @ latitude*	Best Month	Min	Max	Min	Max
Darwin (1)	12°	21.9	*21.7*	24.7	*23.7*	Aug	2.0	3.0	2.5	4.0
Cairns/ Townsville (1)	17°/19°	20.8	*20.6*	24.0	*23.7*	Sept	2.3	3.5	2.8	4.0
Brisbane (3)	27°	20.0	*20.2*	23.2	*22.4*	Jan	2.0	3.0	2.5	4.0
Perth (3)	32°	21.1	*21.2*	28.9	*27.2*	Jan	2.0	3.0	2.3	3.5
Sydney (3)	34°	18.5	*18.9*	23.5	*21.9*	Dec	2.2	3.5	2.7	4.0
Adelaide (3)	35°	19.9	*20.3*	28.2	*26.4*	Jan	2.0	3.0	2.4	3.5
Canberra (3)	35°	19.9	*20.3*	27.0	*25.4*	Jan	2.0	3.0	2.5	4.0
Melbourne (4)	38°	16.7	*17.0*	24.4	*22.8*	Jan	2.0	3.1	2.5	4.0
Hobart (4)	42°	16.1	*16.9*	23.6	*22.0*	Jan	2.4	3.5	3.0	4.5

Table 11.4: Solar radiation data plus the minimum and maximum collector to cylinder ratio required to be eligible for REC's

Model	Zone 1	Zone 2	Zone 3	Zone 4
Hiline 52H 300 (4 to 64 x S200)	13.0	13.1	13.0	10.9
Loline				
610 340 (4 to 16 x NPT200)	13.7	13.7	13.7	11.6
610 430 (5 to 90 x NPT200)	14.5	14.2	14.5	12.5
1000 SS (15 to 90 x NPT200)	14.2	14.1	14.2	12.1

Table 11.5: Approximate Renewable Energy Certificates per collector for Rheem Commercial solar systems

Chapter 12

Selection Of Water Heaters For Commercial Use

This Chapter Covers:

Selection and design criteria for a range of commercial water heating applications including:

- Sizing data for various commercial uses such as snack bars, laundries, offices and factories
- Sizing and design guidelines for specific applications such as laundries, mechanical heating and multiple dwelling units
- Temperature zoning and storage options

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GENERAL PRINCIPLES

Hot water requirements can be divided into two broad classifications:

- ***Commercial and institutional***: This covers the same purpose as the domestic water heaters, but in larger quantities and associated with commercial gain. It refers to hotels, motels, guesthouses, schools, laundries, factory and office toilet amenities, canteens, etc.
- ***Industrial***: This covers more specialised applications where hot water is used for mixing, heating, sterilising, etc.

Rheem and Raypak Commercial water heaters are designed so the variety of storage capacities, thermal inputs, recovery rates and temperature settings is sufficient to provide a custom designed system for most hot water demands. If the recovery rate of one unit is not enough to meet a particular demand, more heaters can be included in the installation. The Rheem Equa Flow® manifolding system ensures each water heater shares the hot water demand so all water heaters operate as one system.

Modular Design

Rheem commercial water heating systems are custom designed by manifolding standard gas, electric or solar units to cope with any hot water demand. This method of custom designing to suit the particular installation has the advantage that all water heaters will fit through a standard doorway, obviating the need for structural alterations if water heaters need to be moved in or out. Once the water heaters are in the plant room, they are coupled together to form a large water heating system.

Advantage of Manifolding

Manifolded systems have the added advantage that water heaters can be isolated from the system without interrupting the hot water supply. Water heaters can be isolated for service or replacement and can also be bypassed during summer months when the demand on the total system is reduced.

Coping With Extreme Quantities of Hot Water

Where extreme quantities of hot water are required, it may be more desirable to utilise 2 or more large Raypak water heaters coupled with appropriate storage. This method will reduce the overall installation cost, however careful planning and design is required to ensure adequate back up is allowed for in the case of system maintenance, and access is available to install the larger water heaters.

Various models of water heaters can be used to design a system that most suits the daily demand of the project and to ensure a cost effective system with minimum running cost. Figure 12.1 shows a combination of off peak and continuous recovery water heaters suitable for a motel. The electric storage units are connected to the off peak tariff. The storage capacity of these off peak units is sufficient to cover the normal daily needs of the motel. The heating unit rating is enough to ensure the water heaters will fully recover during the heating period. If the motel occupancy is exceptionally high and the draw off exceeds the normal daily demand, the high recovery gas or electric unit will be able to provide the additional hot water.

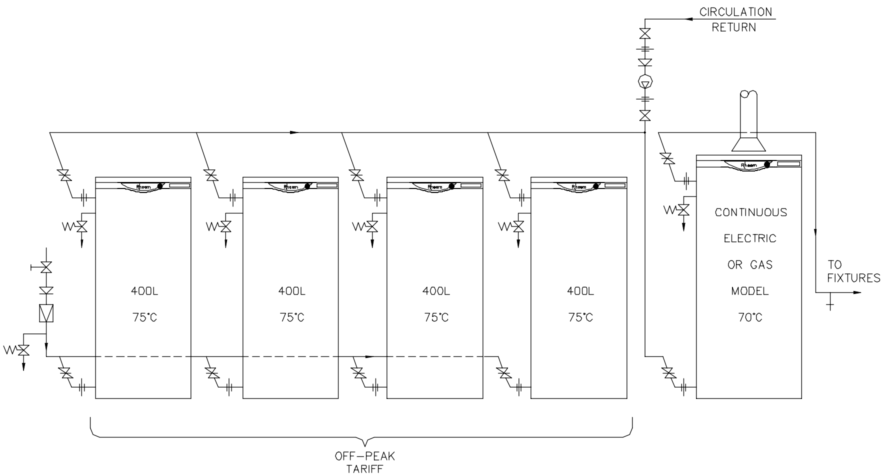


Fig. 12.1 Combined off peak and continuous recovery commercial system

Coping With Temperature Zones

Not all hot water used in commercial or industrial premises is required at the same temperature. It is possible however to design a Rheem commercial system to deliver water at the required temperature at different points in the building.

- ***Ablution hot water*** is normally used at approximately 40°C. It is delivered to specific outlets by blending cold water and 60-65°C water either manually, through a mixing valve or via a centralised warm water system such as Rheem Guardian.
- ***Laundry hot water*** is usually required at 60°C, which can most readily be achieved by setting the thermostat. All Rheem Commercial water heaters have adjustable thermostats, most of which have a maximum setting of 82°C, whilst Raypak water heaters have a maximum setting of 95°C.
- ***Sanitising hot water*** for use in commercial kitchens is required above 77°C. This is achieved by installing one or more water heaters

providing hot water at 65-70°C to the entire building, and to which is coupled another water heater that boosts the 65-70°C water to 82°C for the kitchen area. This design has the advantage of minimising heat loss by circulating the 65-70°C water and then boosting water at the point of use to 82°C. As the 82°C water heater is only boosting 17°C, the water heater can be a smaller capacity. Figure 12.2 shows such a system.

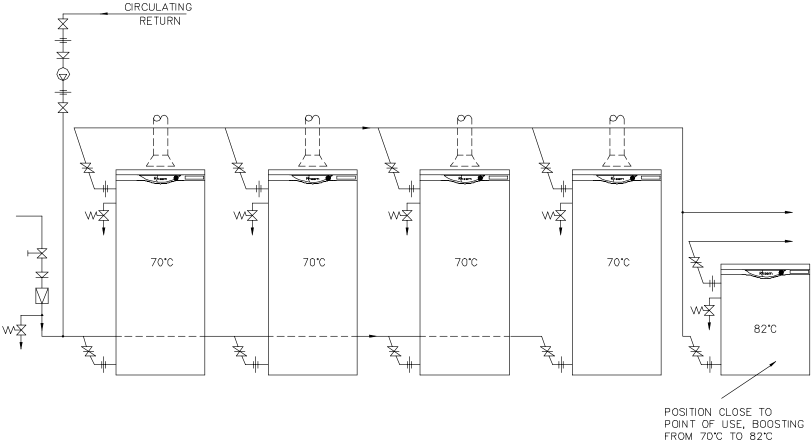


Fig. 12.2 Modular Heavy Duty design providing hot water for two temperature zones

Increased Storage Capacity

Some installations, such as shower facilities for shift workers in remote areas, are characterised by one or two high peaks per day of around 30 minutes each, with minimal draw off in between. These requirements are most cost effectively served by providing high storage capacity but slow recovery. Since there is often seven to eight hours between usages, a slow recovery is acceptable, with the advantage that smaller gas piping or electrical cabling can be used, thus saving installation costs. The system needs to be sized so that the system achieves full recovery in time for each peak.

This system can be used to increase the storage capacity of an existing installation that has had an increase in hot water demand. As long as there is sufficient time between peak demands, this design can save the additional cost of increasing the energy supply to the installation. Figure 12.3 shows a method of increasing the storage capacity of a low recovery water heater.

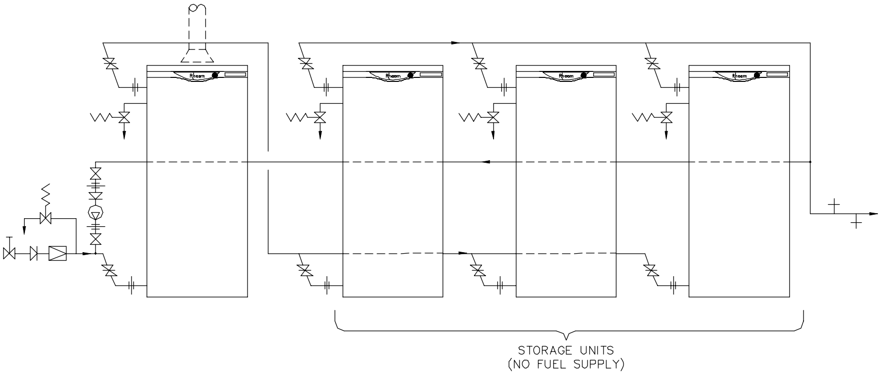


Fig. 12.3 Heavy Duty system with increased storage capacity

Selection Guidelines

System sizing is primarily determined by the pattern of energy supply to the heater.

- ***Off peak electric supply***, it is necessary to determine the *maximum daily demand* for hot water on the busiest day of the year and provide a unit or units large enough to meet this maximum daily requirement with some reserve for increased demand or emergency.
- Where the off peak supply provides ***additional daytime electrical supply***, *reduce the volume of stored hot water* to safely meet the major peak demand. Then the recovery characteristics are checked to ensure the daytime boost will meet the balance of the total daily demand.
- ***Gas water heaters and continuous electric supply***, it is not necessary to calculate the full day's demand, but to determine the *extent and duration of the peak hot water demand* during the day. A system that will meet the peak requirement will be more than adequate for the rest of the day.

Sizing Procedure

To decide what size of water heater to install, follow these steps:

1. Determine the ***peak demand period***. (This may be spread over one or more hours. Refer to Table 12.1)
2. Calculate the ***hot water requirements*** over the peak period. (see table 12.1)
3. ***Select the water heaters*** that will satisfy the peak demand requirements. (One, two, three or more water heaters can be connected in parallel. Refer to the relevant tables in Chapters 8-11). Note: Cold water temperature is needed to determine the appropriate temperature rise.
4. ***Ensure adequate space*** is available in the building for the installation. This is of extreme importance, particularly where a number of water heaters are connected in parallel. Electric water heaters and specific gas models can be installed outdoors. When allocating space, observe the installation regulations, particularly in respect of gas water heater fluing. In allocating space for the installation, consider the possible expansion of the system should the hot water demand increase, and allow room for possible service work.
5. For an efficient mains pressure commercial or industrial installation, ensure the ***correct pipe sizes are installed***.

Application	Suggested peak period	Hot water requirements, 60°C supply temperature (unless indicated otherwise)
Snack bars, take-away foods	1 to 2 h 12 to 1 pm or 12 to 2 pm	Allow 3.1 L for each meal. This covers cooking and washing, e.g. 200 meals over 2h=620 L. *Note:* Water is required greater than 77°C for sanitising.
Canteens, cafes, hotel kitchens, restaurants	1 to 2 h 12 to 1 pm or 12 to 2 pm	Allow 5.5 L for each 3 course meal. This covers cooking and washing, e.g. 200 meals over 2 h = 1100 L. *Note:* Water is required greater than 77°C for sanitising.
Holiday flats, hotels, motels, guest houses	1 h 7.30 am to 8.30 am	Allow 20 to 25 L per head over the peak hour, e.g. 40 guests = 1000 L over 1 h. For 4 and 5 star accommodation allow 35 to 50 L per head.
Apartments	1 h 7 am to 8 am	Allow for each type of apartment in the building. e.g. studio = 25 L, 1 bed apartment = 40 L, 2 bedroom = 70 L 3 bedroom = 90 L, 4 bedroom = 110 L, Penthouse = 150 L
Caravan parks, camping areas	Spread over 2 h	Allow 20 L per person; average 4 persons per van, e.g. 30 vans = 120 people = 2400 L over 2 h. In parks used mainly for long-term holiday or residential purposes, the peak period may extend over a much longer time. The actual usage pattern should be ascertained.
Hairdressing salons	3 to 4 h	Each installation to be individually evaluated, but as a guide allow 10 L per customer.
Squash courts	spread over 4 h	Allow 20 L per player; average 16 players per court over 4 h, e.g. 4 courts = 20 x 4 x 16 = 1280 L over 4 h.
Office amenities	spread over 8 h	Allow 3 to 4 L per person per day. Showers seldom used or 1.5L per person over a 1hour peak.
Factory change rooms (light industry)	1 h 4 pm to 5 pm	Average of 30% use showers. Allow 20 L per head. Average of 70% use hand basins. Allow 3 L per head. (This is equivalent to 8 to 9 L per person.)
Factory change rooms (heavy or dirty industry)	1 h 4 pm to 5 pm	Allow 30 L per head. In some industries, such as mining projects, up to 50 L may be required.
Coin-operated laundries	spread over 8 h	Allow 70 L per machine per hour. e.g. 6 machines = 70 x 6 x 8 = 3360 L over 8 h. For large commercial laundries allow 10 L per kilogram of dry washing.
Glass washing machines	usually over 2 h	Determine quantity of glasses to be washed over peak period Allow 3 glasses per litre of beverage sold. Most machines require 7 L of hot water per wash of 25 glasses and can handle one wash per minute, e.g. 1000 L of beverage over 2 hours requires 1000 x 3 x 7 / 25 = 840 L of hot water. Alternatively, allow 3 glasses per person (use licensed capacity as a guide). Notes: (1) Temperature required by regulations is 82°C (2) Where beverage consumption is known in gallons, multiply by 4.55 to convert to litres.

Table 12.1: Sizing Guide for Commercial Applications

DISHWASHING MACHINES

A common feature of all dishwashing and glass washing machines is they use hot water in quantity and an adequate supply must be available to ensure all the washing up is carried out effectively and without interruption.

Principle of operation

Commercial dishwashing machines are of two basic types:

- ***batch operation*** (basket of dishes placed in position, machine completes cycle of operation, basket withdrawn from same position)
- ***continuous operation*** (baskets of dishes fed by conveyer through one end of the machine and withdrawn after passing through the wash and rinse sections at the other end of the machine)

Domestic machines are of the batch type. In all cases there are two basic operations: detergent wash in hot water and hot water rinse.

The larger machines are provided with tanks to hold the detergent wash and the rinse water. These are filled prior to use, and are recirculated by pump during the wash and rinse operations. The final rinse is made using fresh hot water, which drains into the rinse tank, causing a similar amount to flow into the wash tank and in turn causing a similar overflow into the drain. This ensures the rinse and wash waters are replenished while the unit is in use.

The smaller machines operate on a "once through" basis, and wash and rinse waters are not recirculated at all.

Hot Water Requirements

Most machines have provision for keeping wash and rinse water hot by means of gas burners, electric elements or steam coils, but all benefit by the use of hot water supplied by an external hot water system.

To eliminate the need for subsequent drying of dishes, the final rinse should be hot enough to allow the utensils to dry off on removal. At the same time, the temperature should be adequate from the sanitary angle. A temperature in excess of 77°C is desirable and in fact can be a legal requirement of glass washing and dishwashing installations.

Most commercial dishwashing appliances have built in booster heating units to raise the temperature of the hot water from 60°C to 82°C, the recommended sanitising temperature. If a machine is not supplied with such a booster, water at sanitising temperature can be obtained in one of two ways:

- From a water heater certified for operation at 82°C
- From a booster water heater certified for operation at 82°C and fed with hot water at 60°C from the main hot water supply system (as shown in Fig. 12.2)

Whichever system is used, storage and recovery capacity must be available to meet the dishwashing needs throughout the period of peak demand.

In most cases water at temperature above 77°C will need to be supplied to the rinse sinks.

Calculation Of Hot Water Requirement

1. Determine the length of the period of peak demand (usually ½ to 1 h).
2. Determine the number of cycles to be allowed for during this period of peak demand.
3. Determine the amount of hot water required to meet these cycles. (The manufacturer's literature usually shows the water consumption per cycle.)
4. Add the amount of hot water required for the initial charge of wash and rinse tanks.
5. Determine the water heater or water heaters required.

Example 1

Brand X is a batch type machine with a 1 hour peak period and a maximum 60 racks. The literature for the machine shows:

- 60 cycles per hour
- 4.5 L per cycle
- 14 L rinse tank
- 32 L wash tank

Water required = (60 x 4.5) + 14 + 32 = 316 L

Solution using gas water heaters:

Refer to the hot water availability figures for 1 hour (Tables 8.4-8.5). The 260 L Heavy Duty (620 or 630260) shows 380 L, which is adequate.

Recommendation: 1 only 620260 or 630260.

Solution using electric water heaters:

Refer to the hot water availability figures for 1 hour (Table 10.6). 1 x 315 L with 3 x 3600 W heating unit will produce 500 L. Alternatively, the following domestic models would also suffice:

1 x 250 L with 1 x 4800 W heating unit 330 L

1 x 315 L with 1 x 3600 W heating unit 374 L

Each of these domestic units would be adequate, but only the Commercial model has reserve for future needs. It should be noted that if 82°C water is required, a commercial model should be selected.

Where power supply is limited, it is possible to use a three heating unit model with one or two units connected. Naturally, the resultant reduced recovery must be adequate for the needs of the application.

When specifying a two heating unit model, it is necessary to use a three heating unit model with one unit disconnected rather than a booster model where the second heating unit is only activated after substantial draw off of water.

Recommendation: 1 x 315 L with 3 x 3600 W heating units. If insufficient power is available, 1 x 613315 with 1 x 3600 W connected would meet both the temperature and peak needs.

Example 2

Brand Y is a conveyer type machine with a 1 hour peak period and an estimated 200 racks in use. The literature for the machine shows:

- 240 racks per hour
- 14 L per rack
- 60 L rinse tank
- 70 L wash tank

Note it would be unwise to supply a 240 rack machine with hot water for only 200 racks, and so we do two checks: one at 200 and one at 240.

Calculating the hot water requirement as in example 1:

For 200 racks: (200 x 14) + 60 + 70 = 2930 litres

For 240 racks: (240 x 14) + 60 +70 = 3490 litres

Solution using gas water heaters:

Reference to Tables 8.4 – 8.5 and 9.6 – 9.7 show:

3 only 621 275 or 631 275 can provide 3000 L

4 only 621 275 or 631 275 can provide 4000 L

2 only Raypak 427 with 1 only 340 L cylinder can provide 3470 L

Recommendation: 4 only 621 275 or 631 275.

Solution using electric water heaters:

Reference to Table 9.2 shows:

5 only 616315 with 6 x 3600 W each can provide 3425 L

5 only 616315 with 6 x 4800 W each can provide 4050 L

Recommendation: 5 only 616315 with 6 x 4800 W each.

COMMERCIAL LAUNDRIES

The selection of an adequate hot water supply is very important to ensure the installation can meet heavy and extended demand due to the effect of sudden or prolonged bad weather.

The hot water requirements vary with different equipment, and it is advisable to check with the manufacturer of the washing machine as to the quantity of hot water used per cycle time.

Hot water availability should cover continuous use of all machines over a *5 hour period*.

Basic hot water requirements are:

1. Mains pressure is needed to ensure adequate flow to all units simultaneously (as will happen at opening time on a wet Saturday morning).
2. The temperature at the washing machine must not be less than 60°C (recommend 65°C at the water heater).
3. The initial fill of hot water plus *additional* hot water during the cycle must be supplied. The initial fill uses approximately three quarters of the hot water used in the cycle.

Example

A coin operated laundry with six Brand Z washing machines has a 5 hour peak. Literature for the machines shows a 30 min cycle and 84 L of hot water per cycle.

Maximum usage = 6 x 5 x 2 x 84 = 5040 L over 5 h

Solution using gas water heaters:

Refer to Tables 8.4-8.5:

2 x 621 265 or 631 265 gives 4660 L

1 x 621 275 or 631 275 gives 4060 L

3 x 621 265 or 631 265 gives 6990 L

2 x 621 275 or 631 275 gives 8120 L

Prepare alternative recommendations based on:

1. 3 only 621 265 or 631 265
2. 2 only 621 275 or 631 275

Note: Refer to chapter 15 for special precautions with gas water heating in laundries.

Solution using electric heaters:

Refer to Table 10.6:

2 x 616315 with 6 x 3600 W gives 4340 L

2 x 616315 with 6 x 4800 W gives 5580 L

Alternative:

4 x 613315 with 3 x 3600 W gives 5000 L

4 x 613315 with 3 x 4800 W gives 6200 L

While 4 x 613315 with 3 x 3600 W would be close, it does not meet the specification.

Recommendation: Prepare a quotation based on 2 x 616315 with 6 x 4800 W each and an alternative quote on 4 x 613315 with 3 x 4800 W.

Other Applications

Coin Operated Dispensing Of Hot Water

Where it is necessary to recover costs for hot water consumed in communal laundries, caravan parks, camping grounds, sportsgrounds, etc., a prepayment device is recommended.

The desirable features of such a device are:

- It is adjustable to suit different tariffs or fuel supply.
- It can deliver a useful quantity of water at a charge big enough to recoup fuel cost and part of the capital costs of installation.
- It allows the user to control usage of hot water over a reasonable period of time.

Two types of units are currently available:

- electrically operated devices using coin operated time control switches, flow control valves and solenoid valves
- coin operated hot water meters

Controlled Temperature Water Supply

AS/NZ 3500.4.2 places temperature restrictions on all new hot water installations, where there are sanitary fixtures used primarily for personal hygiene purposes. The outlets of these fixtures shall deliver hot water not exceeding 45°C for early childhood centres, schools, and nursing homes or similar facilities for young, aged, sick or disabled persons and 50°C in all other buildings.

AS/NZS 3500.4.2 prescribes the type of temperature control device suitable for each of the above requirements and should be consulted to determine the correct method of meeting the above requirements.

Rheem Guardian warm water is suitable for applications requiring water at 45°C as stated above, whilst RheemPlus or 875 series Rheem Integrity meets the requirements for all other applications at 50°C.

Combined Mechanical Heating And Domestic Hot Water Systems

It is possible to use Rheem and Raypak Commercial water heaters for combined domestic water and mechanical heating systems. Sizing of such installations should be carried out by adding the space heating load (determined by reference to recognised texts) to the peak domestic hot water load.

Figure 12.4 shows a typical combined system, and the following rules should be adhered to.

1. All components within the system should be made from ***non corroding materials***, i.e. all pipe work (including the pipes within the different types of radiators, convectors or fan coils) should be made of copper. The circulating pump should have both housing and impellor of bronze or stainless steel, and other components (such as check valves, automatic air vents, gate valves, etc.) should also be made from non corroding materials.
2. ***Pressure limiters:*** Radiator components are mainly used in heating systems working on low pressure, so some makes will not be suitable for operation at the same pressure as the water heater, i.e. 1000 kPa. The maximum working pressure of each component must be taken into account and the operating pressure of the complete system cannot exceed that of the lowest rated component. Raypak modulating water heaters are supplied with lower operating pressure relief valves for this express purpose.

- ► Where the component is rated *below 1000 kPa*, a cold water relief valve rated at 15% below the component's value, and a pressure limiting valve rated at or below 80% of the cold water relief valve setting, must be fitted. It should be noted a pressure limiting valve alone will not protect the fan coil, as the pressure within the system can build up on expansion. The cold water relief valve is used to handle this expansion.
- ► If all components are rated at *1000 kPa* or above, normal procedures for fitting limiting valves to the water heater apply. In this, it should be noted the TPR valve on the water heater protects against expansion.

  Note: these pressures refer to Rheem storage water heaters. Raypak water heaters operate at 850kPa maximum pressure and maximum allowable pressures should be adjusted accordingly.

3. ***Optional Tempering Valves:*** The normal operating temperature for a mechanical heating system is 82°C, which may be considered too hot for domestic hot water. If the mechanical heating sizing is done using 75°C water, a temperature control valve is not necessary except where controlled warm water systems are mandatory. (See Controlled Temperature Water Supply on pg 13).
4. The use of ***expansion tanks*** (similar to Flexmatic or Filltrol) is not generally recommended. This is because the system is active, that is, water is being consumed directly for domestic hot water, and minor losses through expansion is generally not a concern.
5. If the water heater is installed in a ***heating only system***, without the possibility of needing domestic hot water supply in the future, it can be installed as shown in the diagrams or may be fed from a cistern at high level and an expansion pipe fitted at the water heater outlet. In either

case, it is not imperative (though still preferable) for all components in the system to be made from corrosion resistant materials.

6. ***During the summer*** the pump should be turned off and the thermostat on the water heater turned down to a lower setting.

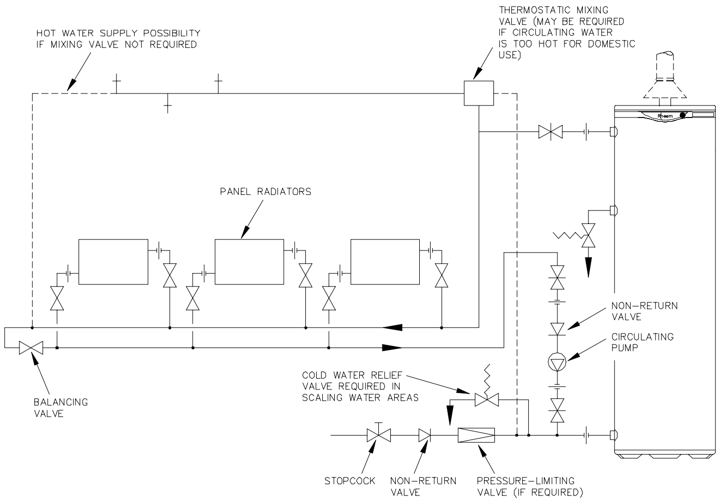


Fig.12.4: Commercial mechanical heating and hot water system

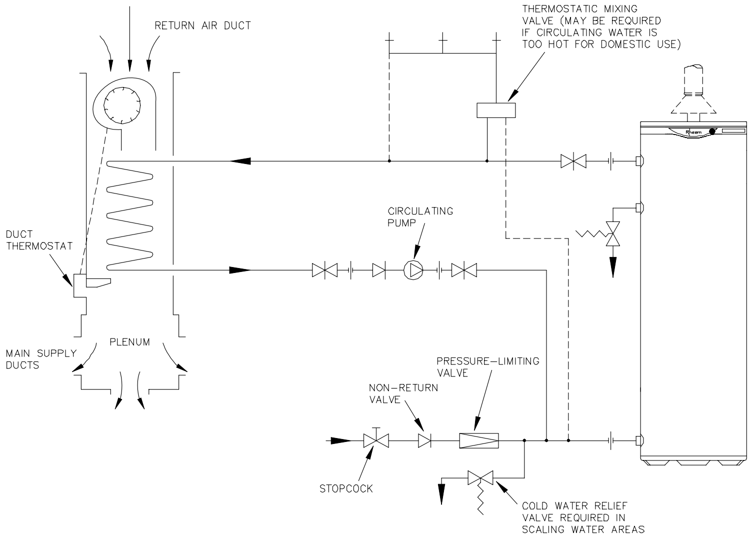


Fig.12.5: Heavy Duty warm air heating and hot water system

INDUSTRIAL APPLICATIONS

There are many industrial uses of hot water where both the initial cost and the operating cost of commercial water heaters are very much lower than for a small packaged boiler performing the same task.

Typical industrial applications include:

- hot water for photographic processing
- temperature control of industrial processes by hot water
- use of preheated water in blending and mixing for industrial processes
- industrial cleaning operations especially for food processing plants

Procedure For Estimating Industrial Installations

1. Determine whether the overall operation is within the working range of Rheem water heaters singly or in multiples up to say eight in a bank.
2. Determine whether Rheem storage water heaters are suited to the job, or whether the storage feature is of little advantage. For a continuous and constant demand over a long period, one or two Raypak water heaters may do a much better job than a number of storage water heaters.
3. Determine governing factors such as:
   (a) cold water temperature
   (b) quantity and temperature of hot water required
   (c) intervals of time at which hot water is needed
   (d) dead time available in each cycle of operation
   (e) accuracy of temperature required
4. Prepare a proposition based on facts and using such aids as:
   (a) flow control valves
   (b) thermostatic mixing valves
   (c) flow control by solenoid valves
   (d) use of auxiliary water heaters to raise the temperature of hot water to a higher level for specific purposes
   (e) circulating pump units.

MULTIPLE DWELLINGS

There are two basic techniques for supplying hot water to each living unit in a multiple dwelling or apartment building (such as a block of flats or home units):

- individual water heater for each living unit
- central installation supplying several units from a central bulk supply.

Individual Water Heaters

Advantages

1. Each living unit is self contained regarding usage and fuel bill.

Disadvantages

1. It is difficult to find space for an adequate size of water heater.
2. There is a tendency to install undersized storage water heaters.
3. Fluing of gas units is difficult and/or costly.
4. It is difficult to provide hot water for a communal laundry.
5. Larger supply lines (gas or electric) are required to each living unit.
6. Most states in Australia have legislation to reduce greenhouse gas emissions which has the effect of obsolescing individual electric water heaters.

Recommendations

- It is important that encouragement and assistance is given to builders in order to ensure an adequate hot water service.
- It is important to find locations where suitable storage units can be installed in a way that has provision for service.
- Sizing recommendations follow the domestic recommendations.

Central Installation

In some apartment buildings, hot water is supplied as a communal building service, just as water rates, gardening, maintenance, etc. In the more normal application the consumption of hot water can be metered to each living unit, and the water heating bill pro rated according to the measured consumption of hot water. The pro rating of the water heating bill is often done by the supply authority, but if not, by the body corporate.

Advantages

1. Centralised installation is cheaper than individual water heaters.
2. Full mains pressure is available in each unit.
3. Diversity enables each living unit to have access to more hot water.
4. Where meters are used, water is not wasted and each group of occupants pays for what they use.
5. Hot water meters assist in special tariff arrangements with the supplier

Disadvantages

1. More care is needed in determining a suitable layout for piping.
2. Hot water meters are relatively expensive.
3. The hot water meters must be located in an accessible location.
4. Running costs are higher when a proportion (say 60% or more) of units are unoccupied.

Recommendations

- Find a suitable space for water heaters in the basement, in breezeways or on landings where they have minimum distance to vertical risers.
- Ensure adequate provision for fluing.
- Make use of service ducts and cavities to take hot water pipes.
- Design the system so water held in the hot line between meters and the furthest living unit does not exceed 2.5 L.
- Where practical, the water in main vertical trunk lines can be kept hot using forced circulation by a small return line from the top of the vertical trunk via a check valve to the cold water inlet. The circulating pump used should be operated at regular intervals by a time switch, or by a line thermostat.
- Hot water pipes should not be buried directly in concrete. Not only are heat losses increased, but thermal expansion and contraction weakens the concrete and the pipe.
- All hot water pipes must be insulated as required by local authorities.
- Hot water meters must be ordered as such direct from reputable water meter manufacturers. The usual location is in the kitchen or hallway adjacent to each unit. The distance from the hot water meter to the furthest draw off point should preferably be less than 10 m.
- The storage capacity required depends on number and size of units served by the heaters. An allowance of 10% storage of the first hour hot water requirement will provide an adequate diversity buffer.
- A main water meter at the inlet to the central water heaters measures total throughput. The difference between this meter and the sum of individual meters may be charged as a communal cost or pro rated according to consumption in each unit.

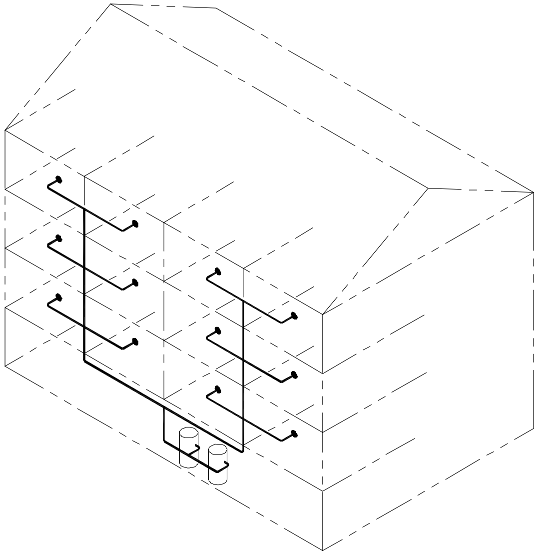


Fig. 12.6: Direct feed for multiple dwellings

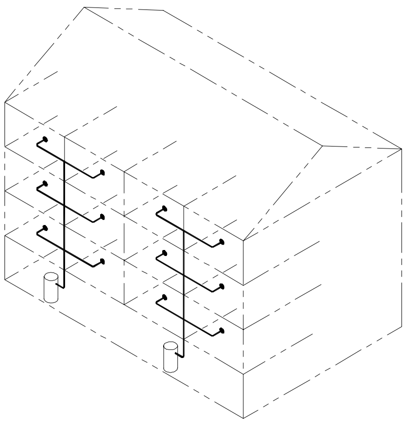


Fig. 12.7 Split system for multiple dwellings

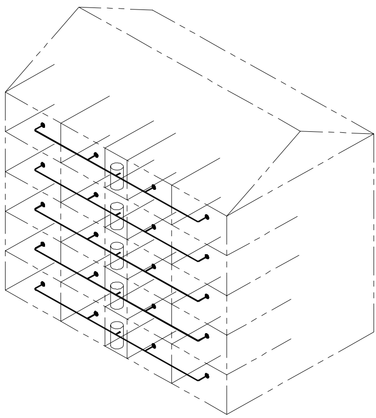
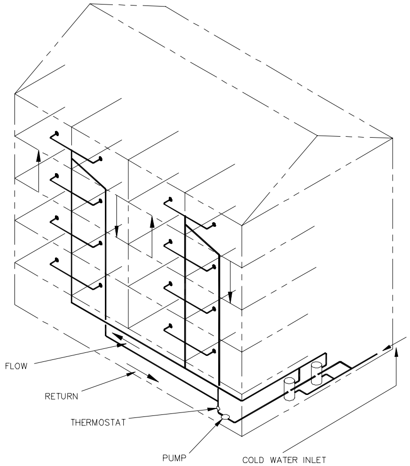
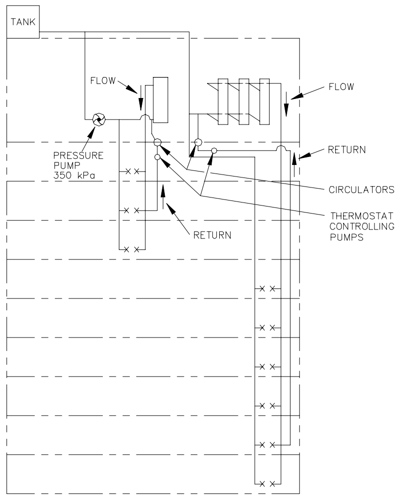


Fig. 12.8 Packaged system for multiple dwellings



PUMPED RECIRCULATION
FOR THE LARGER APARTMENT BUILDING OR WHERE GRAVITY CIRCULATION IS NOT PRACTICAL
A CIRCULATOR MAY BE USED TO CIRCULATE THE HOT WATER THROUGH THE HOT WATER LINES.

Fig. 12.9: Pumped recirculation for multiple dwellings



HIGH LEVEL INSTALLATION WITH 'DIVIDED' SYSTEM

Fig. 12.10: High level installation for multiple dwellings

Chapter 13

Rheem Lazer Boiling Water Units

This Chapter Covers:

Design, operation and features of Rheem Lazer Boiling Water Units

- Current models available in the Lazer range
- An overview of their main features and installation options
- Tables of dimensions, performance, and other technical data

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OVERVIEW OF MODELS

Boiling Water Units Vs Storage Heaters

Rheem Lazer provides boiling water for tea, coffee, soup, noodles and cooking continuously throughout the day and night efficiently and economically.

Rheem Lazer is designed for use in offices, clubs, commercial and domestic kitchens, factories, hospitals, hotels, motels, medical and dental surgeries, restaurants, shops and any where else boiling water is required for beverage making.

Range At A Glance

The Rheem Lazer boiling water units come in 3 ranges that are distinguished as follows:

	Designer	Classic White Enamel	Classic Stainless Steel
Finish	Sculptured ABS	White baked enamel coated steel	Stainless steel
Capacities Available (litres)	2.5 5.0 7.5	2.5 5.0 7.5 15 25 40	7.5 15 25 40
Tap	Push button tap	Spring loaded tap	Spring loaded tap
Warranty	7 years on storage tank, 2 years labour and parts	5 years on storage tank, 1 year labour and parts	5 years on storage tank, 1 year labour and parts
			

Table 13.1: Rheem Lazer model summary

FEATURES

Electronic Control and Constant Monitoring; The Rheem Lazer employs modern electronic technology ensuring superior performance and trouble free operation. This electronic control system governs the operation of the Rheem Lazer by constantly monitoring and coordinating the functions of the boiling water unit from its staged filling process to heating whilst maintaining fine temperature control of the boiling water.

Reliability: The electronic operation of the Rheem Lazer means it has fewer components. This makes for a simple operation and easier servicing.

Fully Automatic Staged Filling Process; The Rheem Lazer refills and reheats in cycles so boiling water is available straight away. The filling and heating processes are governed electronically, giving two benefits:

- There is no messy manual refilling required, leaving the tea room or kitchen clean and tidy.
- There is no waiting for a unit to fill completely before boiling water is obtained.

Delivers More Instant Boiling Water; The powerful heating element ensures rapid recovery so boiling water is always available.

Convenient and Productive, Water is dispensed at a moment's notice. Staff are not inconvenienced by having to fill a jug or kettle and having to wait for it to boil. This increases productivity as they are not kept away from their desk, work station or counter.

Energy Efficient; The water is heated and stored in the same tank. There are no cold water tanks nor make up or heating chambers. The Rheem Lazer's compact internal tank is fully insulated with CFC-Free polystyrene foam keeping the heat inside the tank. This reduces standing heat losses, saving energy and keeping running costs down.

Hygienic and Safe; The Rheem Lazer has a fully enclosed and sealed copper internal tank, with venting through a concealed overflow pipe and drain line. This prevents contaminants from entering the water, and eliminates the incidence of scalding due to spilled boiled water.

Concealed Plumbing; The 2.5 litre, 5 litre and 7.5 litre models of the Rheem Lazer are designed so both the cold water connection and vent connection can be completely concealed. There are no unsightly unions or joins to detract from the unit or the surrounding décor.

Fig 13.1: The Rheem Lazer Designer Series boiling water unit

COMPONENTS

Structural Components

The internal tank is made of copper and is fully sealed, with venting through an overflow pipe located under the jacket skirt.

The Electronic Control Box provides the logic to monitor and coordinates the functions of the boiling water unit from its staged filling process to heating whilst maintaining fine temperature control of the water.

The heating element and thermistor maintain water at near boiling. Fine changes in temperature cause the heating element to energize, thereby providing more boiling water when it is needed most.

The water level probe is a stainless steel probe monitoring:

- low water level to ensure the heating unit cannot operate unless it is covered by water.
- high water level to ensure the maximum water level is not exceeded.

The solenoid valve controls the flow of water into the unit. Activation depends on the level and temperature of water in the unit.

A separate relay is incorporated into the 25 and 40 litre units due to the higher heating element ratings.

Insulation is of rigid polystyrene foam.

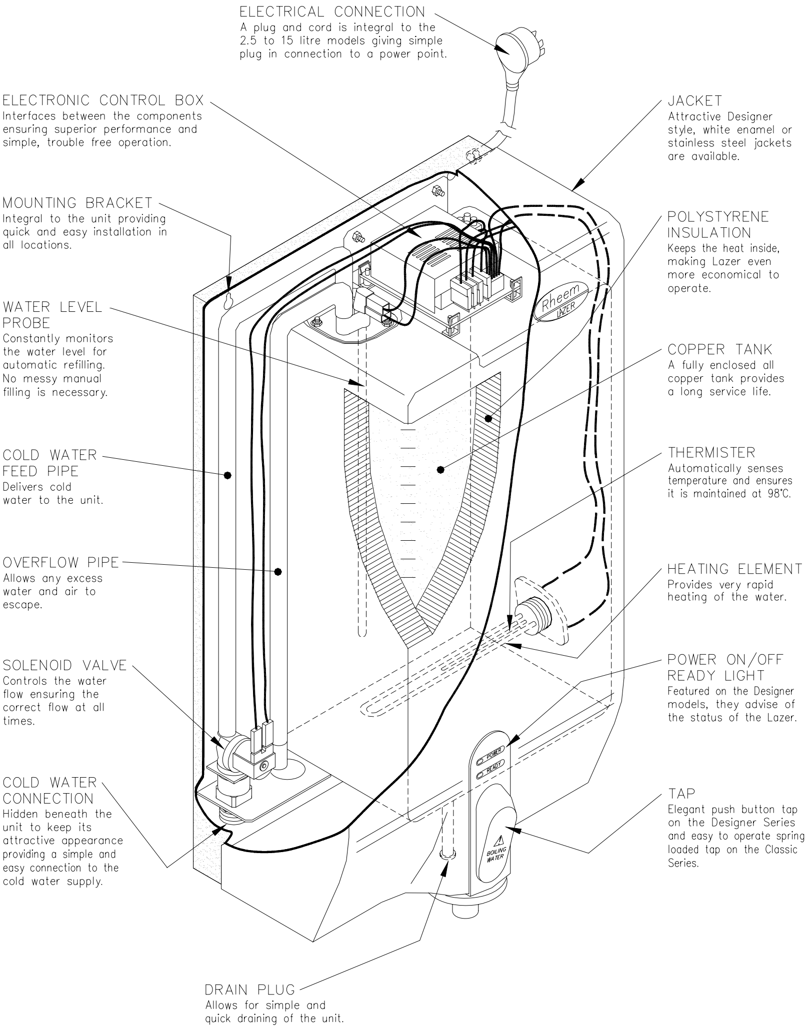


Fig 13.2: Cutaway view of a Designer series Rheem Lazer boiling water unit

How It Works

The Rheem Lazer boiling water unit has four operating modes.

Mode 1. Empty.

The unit enters mode 1 when the water level is below the low level sensor on the water level probe and the heating unit is exposed. During this mode, power to the heating unit is off. The solenoid valve will open to allow water to enter. When the water level reaches the low level sensor, a delay of 2 seconds will elapse before the solenoid closes and the unit enters mode 2.

Mode 2. Not Full.

The unit is in mode 2 when the water level is between the low level sensor and the high level sensor. The heating unit will have power on throughout this time. While it is heating, incremental filling takes place where small quantities of water are admitted through the solenoid valve each time the water temperature is sensed at 98°C. The solenoid valve will close when the water temperature is sensed at 96°C. In this way, even while the unit is filling, the water temperature never falls below 96°C.

The solenoid valve cycle time will depend on the delay between cold water entry and the sensing of the temperature at 98°C. The cycling time is directly related to:

- The temperature of inlet water,
- The pressure of inlet water,
- The capacity of the Rheem Lazer,
- The water level in the Rheem Lazer.

Each time the solenoid valve closes, the high level sensor on the water level probe is activated and, when it is covered with water the Rheem Lazer will change to Mode 3.

Mode 3. Full.

The unit enters mode 3 when water reaches the high level sensor. At this time, the solenoid valve will close and heating will continue until the water temperature reaches 98°C.

The solenoid will open momentarily at this time. The solenoid valve will then only open when water is drawn from the Lazer and the water level falls below the high level sensor.

Heating will continue to cycle on, when the water temperature falls to 96°C, and off, when the water temperature reaches 98°C.

- The drawing of water from the tap will return the Rheem Lazer boiling water unit to Mode 2.

- During continuous drawing of water the solenoid will close after being open for 30 seconds and the Rheem Lazer will enter Mode 4.
- Draining of all the water will return the Rheem Lazer to Mode 1.

Mode 4 Over temperature cut out (OTC)

The unit enters mode 4 when the solenoid valve remains open for more than 30 seconds during Mode 2. This causes the over temperature cut out function (OTC) to operate, which in turn closes the solenoid valve and turns off the heating unit. This is to ensure the water temperature is not reduced below 96°C and allows the Rheem Lazer to stabilise.

Once activated, the OTC will maintain the Rheem Lazer in this state until the water temperature falls below 93°C. At this temperature the Rheem Lazer will switch back to Mode 2. The OTC is not temperature activated and will not prevent continuous boiling of the Rheem Lazer. Continuous boiling of water may occur if the altitude adjustor has not been set correctly.

INSTALLATION

Positioning

The Rheem Lazer is simple to install. Each model has an integral mounting bracket allowing the unit to be easily mounted on the wall. The following must be observed:

- ***Weather protection***: The Rheem Lazer Boiling Water Unit is not weatherproof and external installations must be protected from the weather.
- ***Clearances***: The unit must also be installed with sufficient clearance for service access. A clearance of 150 mm for service access is required both above and to the left or right hand side of the unit depending on the model type.

Plumbing Requirements

The Rheem Lazer must be connected to a *cold* water supply. The cold water connection is located underneath the Rheem Lazer, ensuring the attractive appearance of the installation. The following must be observed:

- ***Cold Water Piping:*** The connection to the Rheem Lazer is R½/15 (½” BSP male) and the cold water supply pipe should be DN 15 (½” OD).
- ***Water supply pressure*** must be between a minimum 50 kPa for the 2.5 litre to 7.5 litre, 75 kPa for the 15 and 25 litre, and 100 kPa for the 40 litre and a maximum 1000 kPa.
- ***An isolation valve*** must be installed on the cold water supply line to the Rheem Lazer Boiling Water Unit. A non return valve is not required as a double non return valve is incorporated at the cold water connection prior to the solenoid valve and internal filler pipe.
- ***Cold water connection only***: The Rheem Lazer *must not* be connected to a hot water supply.

Vent Drain Line

The Rheem Lazer boiling water unit is not a pressurised unit. It incorporates an integral overflow pipe in its design. A vent drain line discharging to the atmosphere with a continuous fall is required to be connected to the Lazer. The primary functions of the overflow pipe and vent drain line are to:

- Allow air to escape whilst filling,
- Prevent the inner tank from collapsing when draining.

This vent drain line, connected to the overflow pipe at the bottom of the Rheem Lazer, should not exceed one metre in length and not have more than three bends in it. The drain line must not be sealed or blocked in any way. The secondary functions of the overflow pipe and vent drain line are to allow any excess water to drain away and to allow any steam to escape while heating. The point of discharge must be where it can be readily discernible but not cause nuisance if water or steam is discharged. The connection is R ½/15 (½" BSP male) and the drain pipe should be DN 15 (½" OD).

Drain Point

A drain point with a fitted screw plug is incorporated on the underside of the tank. This allows the entire contents to be drained from the tank, if required, making the servicing or removal of the unit simple and convenient.

Hot Water Outlet

This is situated at the front of the unit. The Classic white enamel and stainless steel models incorporate a tap which can be left open for continuous pouring or held open for intermittent use. The Designer series range has a unique push button tap at the front of the unit and the delivery spout is located at the bottom of the unit. The push button tap will only allow water to be drawn from the Rheem Lazer whilst it is manually depressed.

Concealed Plumbing

The 2.5 litre, 5 litre and 7.5 litre models of both the Designer and Classic series Lazer have a cut out at the rear of the unit to allow the installation of concealed plumbing.

Altitude Considerations

The boiling temperature of water decreases as altitude increases. To allow for this, a potentiometer is incorporated into the Electronic Control Box. This must be adjusted on Rheem Lazer Boiling Water Units installed at altitudes over 300 metres above sea level. This ensures the unit does not boil continuously. The potentiometer has an adjustment range of 92°C to 102°C and its adjustment must be made by a qualified person. The temperature of boiling water at various altitudes is:

- 300 - 600 metres - 97°C,
- 600 - 1200 metres - 96°C,
- 1200 meters and over - 95°C.

Electrical

The 2.5 litre, 5 litre, 7.5 litre and 15 litre models are supplied with an electrical cord and three pin plug. The electrical connection is as simple as plugging directly into a 10 Amp general power outlet. It couldn't be easier. The 25 litre and 40 litre models must be hard wired by a qualified electrician. The 25 litre models require a 15 Amp circuit and the 40 litre models require a 20 Amp circuit.

Servicing

Servicing of the Rheem Lazer is also very simple. The front jacket on the 2.5 litre, 5.0 litre and 7.5 litre models can be easily removed to enable complete and unencumbered access to all components for servicing, should it be required. Access to components on the 15 litre, 25 litre and 40 litre models is via a detachable panel on both the left hand side and the top of the unit. The side panel provides access to the heating element, thermistor, solenoid valve and the electronic control box, whilst the top panel provides access to the water level probe.

TECHNICAL SPECIFICATIONS

Performance

		2.5 litre	5.0 litre	7.5 litre	15 litre	25 litre	40 litre
Classic White Enamel		771 025	771 050	771 075	771 150	771 250	771 400
Classic Stainless Steel				781 075	781 150	781 250	781 400
Initial Draw Off	cups*	13	27	38	82	140	235
Initial Draw Off	litres	2.6	5	7	16	28	47
First Hour Delivery	cups*	135	150	165	200	300	410
Recovery Per Hour	cups*	120	120	120	120	182	232
Heating Element Input	kW	2.4	2.4	2.4	2.4	3.6	4.6
Electrical Load	Amps	10	10	10	10	15	20
Electrical Connection	supplied with 10 Amp 3 pin plug and flex					Hard wired by electrician	

		2.5 litre	5.0 litre	7.5 litre
Designer Series		791 025	791 050	791 075
Initial Draw Off	cups*	14	27	42
Initial Draw Off	litres	2.8	5.4	8.5
First Hour Delivery	cups*	141	152	166
Recovery Per Hour	cups*	120	120	120
Heating Element Input	kW	2.4	2.4	2.4
Electrical Load	Amps	10	10	10
Electrical Connection	supplied with 10 Amp 3 pin plug and flex			

* Note: cup size is 200ml.

Table 13.2: Performance characteristics of Rheem Lazer boiling water units

Dimensions

		2.5 litre	5.0 litre	7.5 litre	15 litre	25 litre	40 litre
Classic White Enamel		771 025	771 050	771 075	771 150	771 250	771 400
Classic Stainless Steel				781 075	781 150	781 250	781 400
Dimensions mm							
A	mm	430	515	615	615	615	615
B	mm	335	335	335	490	490	490
C	mm	180	180	180	180	235	235
D	mm	268	268	268	268	323	413
E	mm	77	77	77	6	6	6
F	mm	49	49	49	31	31	31
G	mm	55	55	55	90	90	90
Approx Weight Empty kg	kg	8	9	10	15	17	19

Table 13.3: Dimensions of Rheem Lazer Classic Series boiling water units

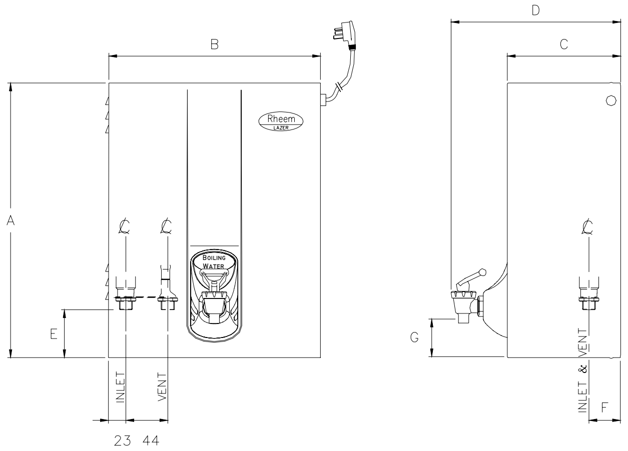


Fig 13.3: Dimensions of Rheem Lazer Classic Series boiling water units

		2.5 litre	5.0 litre	7.5 litre
Designer Series		791 025	791 050	791 075
Dimensions mm				
A	mm	440	525	625
B	mm	345	345	345
C	mm	192	192	192
D	mm	215	215	215
E	mm	74	74	74
F	mm	49	49	49
Approx Weight Empty kg	kg	6	7	8

Table 13.4: Dimensions of Rheem Lazer Designer Series boiling water units

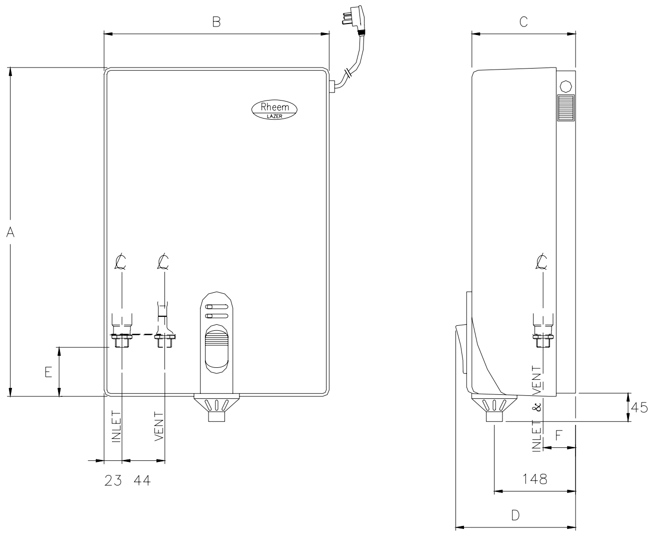


Fig 13.4: Dimensions of Rheem Lazer Designer Series boiling water units

RHEEM LAZER MODEL NUMBERS

The model numbers for Rheem Lazer boiling water units are designed to convey detailed information about each model

		7	7	1	0	7	5	A	U
7	Rheem Lazer, Fully Automatic operation								
7	Classic White Enamel								
8	Classic Stainless Steel								
9	Designer Series								
1	No. of elements								
###	Litres capacity								
AU	Australian Model								
NZ	New Zealand Model								

Table 13.5: The structure of Rheem Lazer model numbers

Chapter 14

Rheem Guardian Warm Water

This Chapter Covers:

Design, operation and installation of The Rheem Guardian Warm Water System

- ► Current models of both the warm water unit and the associated UV disinfection units available in the range
- ► Modes of operation
- ► An overview of the main features and installation options
- ► Details of dimensions and flow performance

Overview of Models

The Rheem Guardian warm water system provides tempered and warm water to ablution outlets from a central plant room location. This system can reduce capital and maintenance costs associated with multiple thermostatic mixing valves and whilst typically used in health care applications such as hospitals and nursing homes, Guardian is also suitable for delivery of temperature controlled water in hotels, apartments and institutional applications. The units work by precisely mixing hot water from a storage hot water system with cold water and recirculated warm water, to provide warm water at a set temperature.

A unique feature of Rheem Guardian is the ability to blend return system warm water with hot water to deliver warm water at the correct temperature. As long as the circulation flow rate is above the minimum required and a temperature drop of 2°C is provided between the outlet and the return, Guardian will maintain system temperature within close tolerances.

Guardian warm water and UV units are wall mounted, can be installed indoors or outdoors and can be coupled with gas, electric or solar water heaters as the primary hot water source. The ability to provide hot water as well as disinfected, controlled-temperature warm water from the one plant reduces capital outlay and saves plant space.

There are three models in the range which can also be manifolded together to provide warm water to meet any load requirements.

Range At A Glance

There are three models in the Rheem Guardian Warm Water range.

All are suitable for indoor and outdoor installation.

Guardian Model	940 080	940 160	940 240	2 x 940 160	2 x 940 240
Nominated flow rate (L/min)	80	160	240	320	480
UV disinfection model	940 001	940 002	940 002	940 002	2 x 940 002
Recommended maximum Flow rate (L/min)	120	240	360	480	720

Table 14.1: Summary of Rheem Guardian warm water models

Approvals

Rheem Guardian warm water is approved by NSW Health as complying with Policy Directive PD2005-34 - Requirements for the Provision of Cold and Heated Water.

NSW HEALTH
DEPARTMENT
www.health.nsw.gov.au

Mr David Micallef
Technical Marketing Manager
Rheem Australia Pty Ltd
1 Alan St
Rydalmere NSW 2116

Dear Sir

Approval of Warm Water System - Rheem Guardian Models 94008000; 94016000; and 94024000 Series

I refer to your application for the approval of the Rheem Guardian Models 94008000; 94016000; and 94024000 Series Warm Water Systems which was submitted to the Director-General of Health pursuant to clause 7 1(b), Public Health (Microbial Control) Regulation, 2000.

The Director-General has **approved** the warm water systems subject to the ongoing compliance with the Health Department Policy Directive PD2005_34 – Requirements for the Provision of Cold and Heated water. A copy is attached.

The applicant should advise the owner / occupier of the premises where this equipment is installed that this approval does not negate the requirement to obtain other necessary approvals. Information to support applications for such approvals should be supplied to the owner / occupier. Alterations to the product approved may affect the approval given and must be resubmitted to the Health Department for consideration.

You must complete the attached acknowledgement from and return it by mail to Mr Tony Burns, Legionella Consultant at PO Box 201 Wagga Wagga, 2650, NSW, within **14** days of the date of this letter.

Yours sincerely

Dr Jeremy McAnulty
A/ Director Health Protection and
Deputy Chief Health Officer

73 Miller Street North Sydney NSW 2060
Locked Mail Bag 961 North Sydney NSW 2059
Telephone (02) 9391 9000 Facsimile (02) 9391 9101
E-mail nswhealth@doh.health.nsw.gov.au

Fig 14.1: Rheem Guardian NSW Health Approval

Ultra Violet Disinfection Units

There are two models available, designed to match the flow rates of the warm water units.

The UV disinfection units comprise a stainless steel reactor chamber, quartz tube and ultra violet lamp. The UV lamp is housed within the quartz tube. Water passes through the stainless steel chamber and around the quartz tube for disinfection.

The reactor assembly can be mounted in any convenient orientation with the main criteria being water must flow from the bottom to the top.

An electrical cabinet suitable for installation indoors or outdoors is mounted on the wall.

The UV system has the following features:

- Suitable for operation up to 1000kPa
- 2” BSP male threaded connections
- Inbuilt filtered sight glass for visual observation of lamp operation.
- Hours run meter
- Audible alarm to indicate lamp failure
- Voltage-free contacts for BMS connection

OPERATION

Basic Operation

At the heart of Rheem Guardian is a series of high accuracy, large flow thermostatic mixing valves. Rheem Guardian works by mixing hot water and cold water to provide water at a controlled temperature between the hot and the cold. Exiting warm water then passes through an ultra violet chamber to provide disinfected warm water to the recirculation loop.

The detail of the operation differs depending on whether water is being consumed (draw off) or is recirculating.

During Draw Off

When warm water is being used, the quantity of warm water leaving the system is equal to the quantity of cold water entering the system.

A portion of this cold water passes directly into the cold water inlet of the Guardian mixing valve; the rest displaces whatever hot water is required for the hot water inlet of the Guardian valve.

The result is a steady supply of warm water at a given rate and temperature.

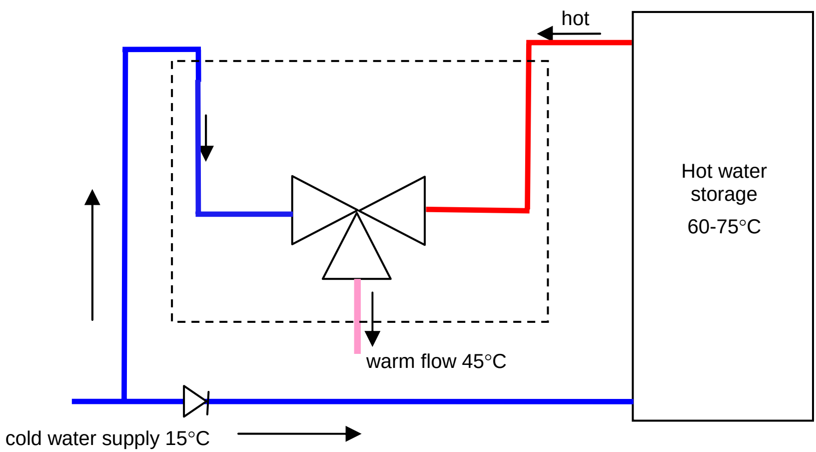


Fig 14.2 - Rheem Guardian operation during draw-off conditions (with typical temperatures)

No Draw Off Conditions

When water is not being drawn out of the system (ie recirculation mode), cold water cannot enter the system. However, the system needs to keep functioning to prevent the water in the pipes from cooling down unacceptably.

This is achieved by recirculating warm water and allowing part of that recirculated water to enter the cold inlet of the Guardian valve, and the rest directed to the hot water storage unit, thus allowing an equivalent quantity of hot water to enter the Guardian mixing valve.

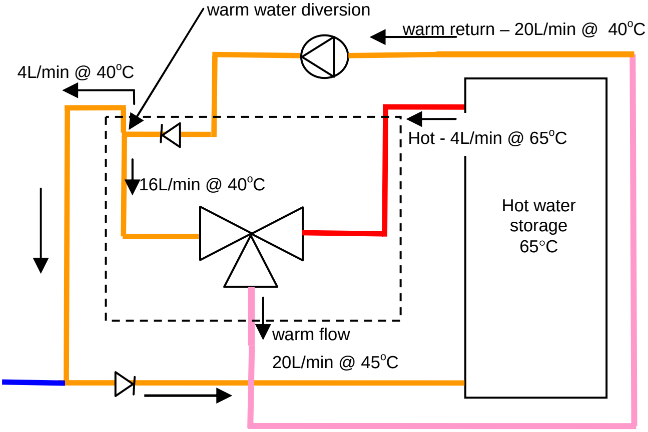


Fig 14.3 - Rheem Guardian operation during recirculation conditions (with typical flow rates and temperatures)

Example

Referring to fig 14.4, warm water is recirculating at a flow rate of 20L/min with negligible draw off. Assume the recirculated water loses 5°C (exaggerated for the sake of example) so that the returning water is at 40°C, down from 45°C delivery.

If the hot water temperature from the storage water heater is 65°C, how much hot water is required to maintain an outlet temperature of 45°C?

Using the mixing formula from chapter 16

$Q_h \times (T_h - T_c) = Q_m \times (T_m - T_c)$

$Q_h = Q_m \times (T_m - T_c) / (T_h - T_c)$

$Q_h = 20 \times (45-40) / (65-40)$

$Q_h = 4$ litres/min

Thus, of 20 litres of warm water that is recirculated, 16 litres enters the cold water inlet of the Guardian mixing valve, and 4 litres is diverted into the hot water storage unit via the common cold water supply. This in turn displaces 4 litres of hot water which enters the Guardian hot water inlet. Together these two quantities of water combine to provide 20 litres of mixed water at 45°C.

Why Recirculating Water Cannot Enter The Storage Unit Directly

If all the warm water entered the storage water heater, it would displace an equivalent amount of hot water, which would pass through the Guardian valve. The valve would try to mix this hot water with incoming cold water to produce the required warm water. Since no cold water is entering the system in recirculation mode, the warm water system would be forced to shut down, in effect, emulating a cold water failure.

For this reason, a portion of the warm water enters the cold water inlet of the valve and the mechanics of the valve regulate the balance.

The ability of the Guardian to precisely control water temperature in this way is a unique feature of the system.

GUARDIAN COMPONENTS

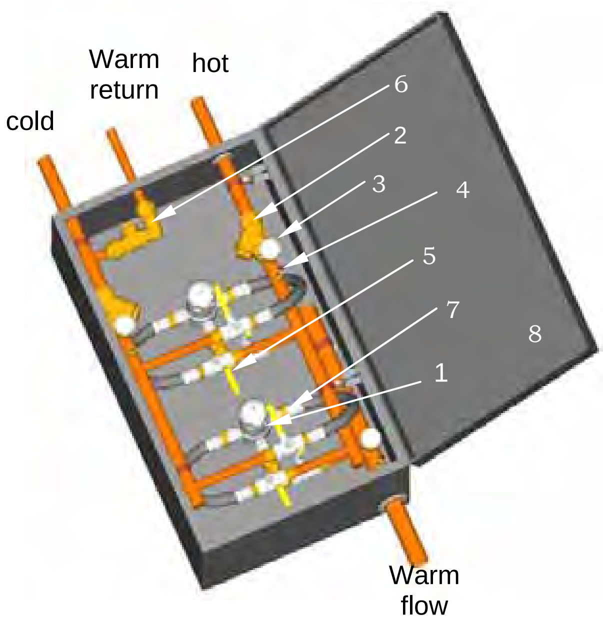


Fig 14.4: Components of the Rheem Guardian warm water unit.

Each system comprises the following components:

1 Thermostatic Mixing Valve/s
2 Line strainer on the cold and hot water headers
3 Pressure gauges on the cold, hot and warm headers
4 Binder temperature test points on the cold, hot and warm headers
5 Isolation valves on every cold, hot and warm water branch to the mixing valves
6 Warm water return check valve
7 Check valves on the cold and hot inlet to each mixing valve
8 Lockable cabinet

The system contains no electrical components, increasing reliability.

INSTALLATION

Hot water can be supplied from any source including gas, electric or solar as long as the hot and cold water supply pressure is balanced and the maximum temperature does not exceed 82°C. (85°C for sanitizing purposes is acceptable for short periods).

Standard installation configuration is shown at fig 14.6.

Installation Requirements

Common cold water connection: The key element of installation is that the cold water connection must be common to the inlet of the warm water unit and the hot water plant. This is essential for correct and safe operation of the warm water return function. This will also ensure hot and cold water supply pressures are balanced, providing further guarantee of hot water shut off in the event of cold water failure. Note that even without this feature, the Guardian passes all mandatory tests including system failure tests, required by Australian Standards and NSW Health.

Non-return valve: After the cold water branch to the warm water unit, a 50mm non-return valve must be fitted to prevent any possibility of hot water cross connecting with the cold water supply feeding the warm water unit. This special valve is certified for use with hot water and is supplied with the system.

Expansion Control Valve: If an ECV is employed, it must be installed after the 50mm non-return valve.

For installations utilising solar pre-heat refer to fig 14.5. The installation principles are the same, however separation of the pre-heat hot water, warm water return and cold water must be observed.

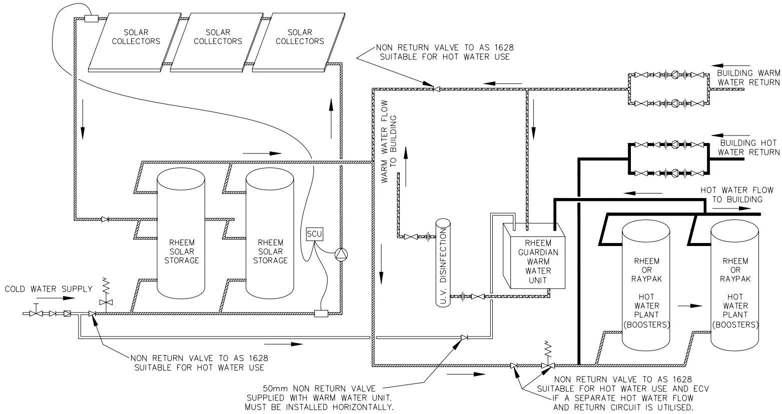


Fig 14.5: Rheem Guardian utilising Solar Lo-line Pre-heat

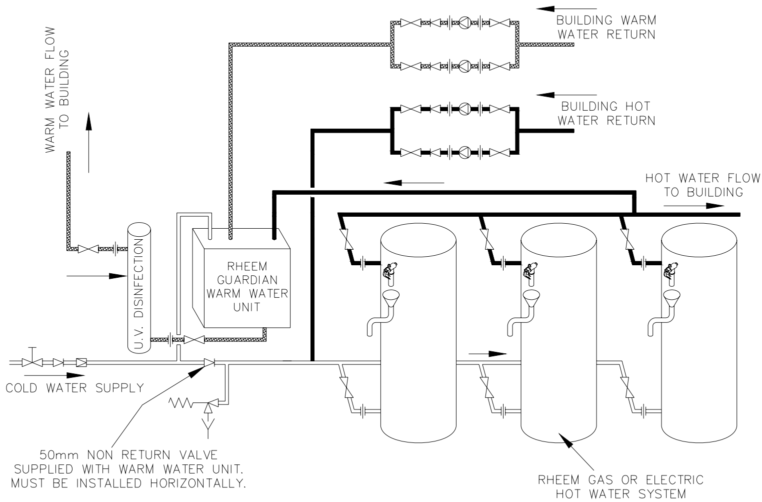


Fig 14.6:Rheem Guardian installation with Rheem commercial water heaters

TECHNICAL SPECIFICATIONS

Temperature and Flow Specifications

	All models
Maximum water supply pressure	1000 kPa static / 800 kPa dynamic
Thermostatic control range	25-60°C
Factory set outlet temperature	43°C
Maximum hot water supply temperature (temporary)	82°C (85°C)
Maximum outlet temperature (sanitizing)	85°C
Min temperature differential between *cold* supply and outlet (flow conditions)	15°C
Min temperature differential between *Hot* supply and outlet (flow conditions)	15°C
Minimum temperature drop in recirculation loop required for accurate temperature maintenance	2°C

Table 14.2: Temperature specifications for Rheem Guardian

	940 080	940 160	940 240
Nominated flow rate (l/min)	80	160	240
Recommended maximum Flow rate (l/min)	120	240	360
Recommended minimum recirculation flow rate (l/min)	8	16	24

Table 14.3: Flow specifications for Rheem Guardian

The minimum recirculation flow rates listed are those flow rates required for accurate temperature maintenance. In practice, larger flow rates are typically required to ensure minimum temperature loss in the recirculation loop.

During periods of very low water draw, say overnight when perhaps only one tap is turned on, as long as the required minimum recirculation flow rate is achieved, any other draw on the system will be seen as *additional* flow, and the valve will perform to specification.

DIMENSIONS

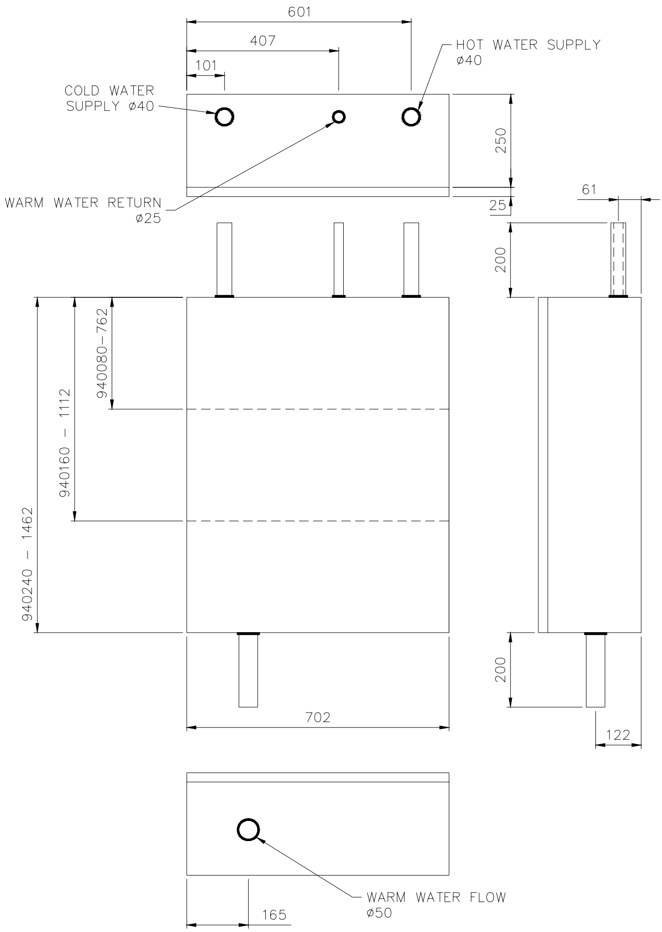
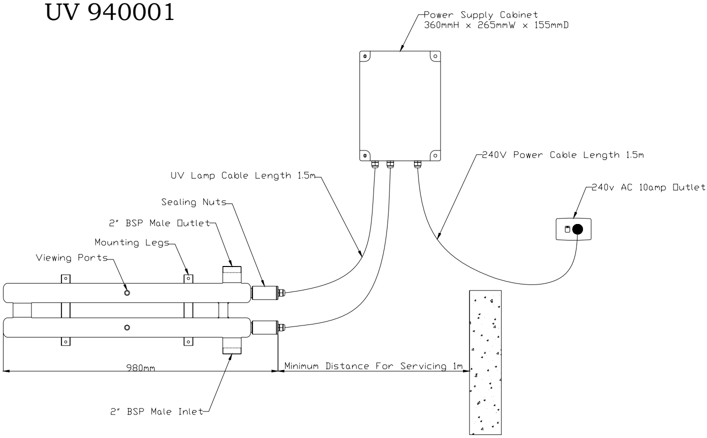


Fig 14.7: Dimensional drawing of Rheem Guardian warm water units

UV 940001



UV 940002

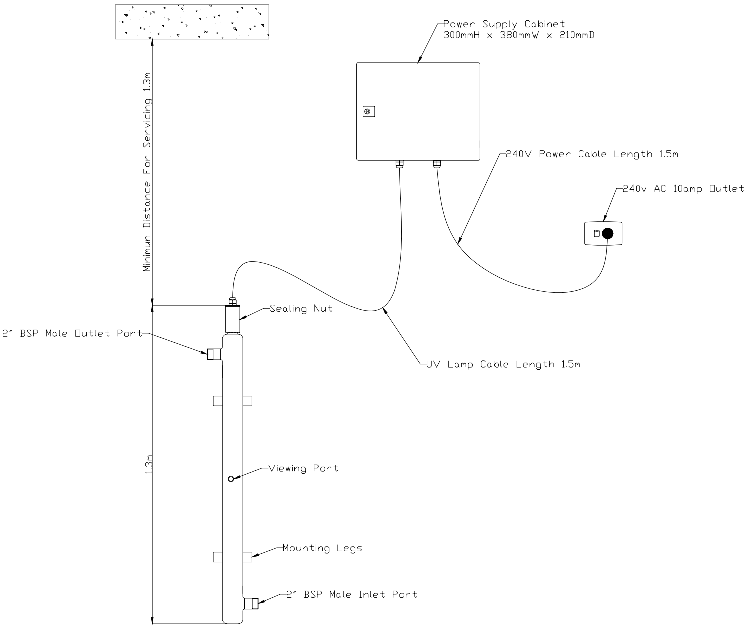
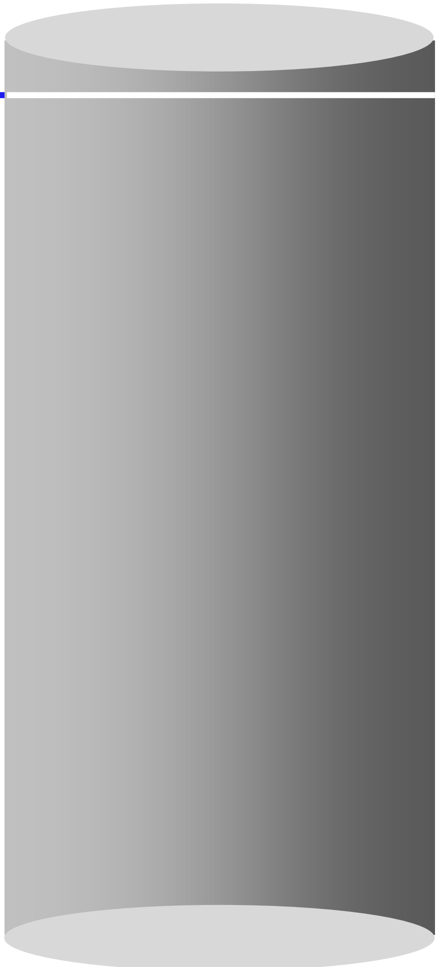


Fig 14.8: Dimensional drawings of Rheem Guardian UV units

Chapter 15

Installation Requirements And Accessories



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This Chapter Covers:

Installation requirements for water heaters and includes:

- ► Domestic and commercial water heaters
- ► Manifolding principles for multiple water heaters
- ► Accessories
- ► Fluing requirements for single and multiple water heaters

OVERVIEW

It is in the interests of everyone concerned, including the manufacturer, the plumber, the user and the fuel supply authority, that the water heater be installed in the correct manner and in the best position to minimise heat loss and fuel usage. This chapter will shed light on many of the intricacies of installing various water heaters. As a starting point, it is presumed the installing plumber knows the fundamentals of the trade.

Each water heater is supplied with a set of installation instructions that detail the installation requirements for that water heater. Additional copies of these instructions can be obtained by contacting the nearest office of Rheem or visiting www.rheem.com.au. It is important to be aware that installation in accordance with the Rheem installation instructions is a prerequisite for qualification for the Rheem warranty except where such changes are necessary to meet local authority regulations.

Installation of Rheem water heaters must be in accordance with:

1. Rheem installation instructions
2. AS/NZS 3500.4 - National Plumbing and Drainage Code
3. AS/NZS 3000 – Wiring Rules
4. AS 5601 – Installation Code for Gas Burning Appliances and Equipment (gas water heaters only)
5. Local gas fitting regulations (gas water heaters only)
6. Local plumbing regulations

The type of water heater/s most suitable for a particular situation can be determined using the criteria in the chapters on selection. This includes determining whether the water heater will be indoors or outdoors. Then the choice of the most suitable position must be made.

HEATER POSITION

There are a number of considerations to determine the exact location of a water heater, depending on the type.

General Considerations

Close to point of use: In order to minimise running costs, select a position close to the most often used tap. In a normal domestic dwelling, this position would be close to the kitchen primarily followed by the bathroom. A site midway between these rooms would be ideal. Consider also close proximity to the laundry.

If a suitable position can be found that has minimum hot water plumbing, the amount of hot water wasted in the pipe work each time a hot tap is closed will be reduced.

Single point appliances should be within 1 or 2 m of the outlet.

Service Access: Consider accessibility for periodic maintenance and servicing.

Position the water heater so the rating label can be read and parts can be removed for service. Typical parts requiring removal from time to time are electric elements, burners, anodes, flue baffles, TPR valves and gas controls.

Ease of Use: The water heater needs to be positioned so the controls can be easily operated. This requirement mainly concerns gas appliances. The user needs to be able to inspect the pilot light during the normal lighting procedure.

Keep flammable substances away: Water heaters must not be installed in any area where there is the likelihood of a build up of flammable gases or where flammable liquids or chemicals are stored.

Minimising space: Small electric water heaters are often wall mounted in order to conserve floor space. Rheem can provide wall brackets for this purpose. The kit contains three brackets and a marking off template to position the brackets (see Fig. 15.1).

Considerations for Outdoor Water Heaters

Water heaters installed outdoors need to be on a level plinth that is a minimum of 50 mm above the surrounding ground level. This requirement is necessary to prevent the water heater base being in contact with water for long periods.

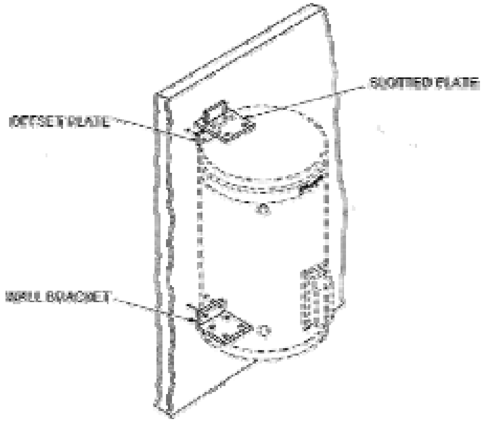

Fig. 15.1: Rheem wall bracket for small electric water heaters (P/No 299120)

Considerations for Indoor Water Heaters

Drainage: Indoor positions need to be evaluated for drainage from the TPR valve.

The National Plumbing and Drainage Code AS/NZS 3500.4 requires the fitting of a safe tray under a water heater installed indoors in a concealed position. This safe tray must be connected to a drain that falls continuously to an approved termination point.

N.B. Rheem recommends the installation of a safe tray under every water heater installed indoors where there is the possibility of damage being caused by leaking water. (See Fig. 15.2 for safe tray details.)

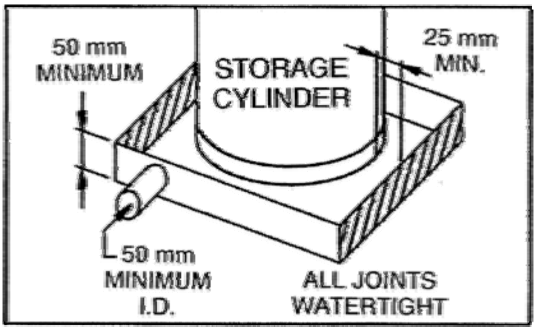

Fig. 15.2: Safe tray details

Gas Appliance Considerations

Need for adequate fresh air: Indoor gas water heaters must have an adequate supply of fresh air to provide oxygen for the combustion process. If the water heater is to be installed in a cupboard, an air supply must be provided in the form of two permanent openings, one near the top and one near the bottom of the cupboard. If the air is to be drawn from an adjoining room, each opening must have a minimum free ventilation area of 600 mm^2 per megajoule of hourly input of all appliances in the cupboard. If the air is to be drawn from outside the building, the openings need only be a minimum of 300 mm^2 per megajoule of hourly input of all appliances in the cupboard (refer AS 5601, Clause 5.4.3).

Avoid corrosive air: Gas water heaters (except for room sealed units) must not be installed near a corrosive or potentially corrosive air supply, which frequently exists in beauty salons, dry cleaning establishments, coin operated laundries and areas where pool chemicals are stored. The air may be safe to breathe, but passing it through a flame liberates corrosive elements that will shorten the life of any oil burning or gas burning appliance. Vapours from dry cleaning agents, some aerosol propellants and pool chemicals fall into this category.

Before recommending the installation of any gas burning appliance in areas where these chemicals or vapours exist, the following precautions should be taken:

- Draw to the attention of the customer the known hazards associated with these vapours and chemicals.
- Ensure the water heaters are screened off from these vapours and chemicals. Perchlorethylene vapour, used as a dry cleaning agent, is heavier than air, so ensure the lower parts of the screens are vapour-tight. Consider the possibility of the vapour being drawn up through drains.
- Ensure these chemicals are not stored in the same area as the water heaters and any spent dry cleaning fluids, filters or residues are not placed or handled near the water heaters.
- Ensure the water heaters are installed with an adequate and permanent supply of uncontaminated fresh air. The provision of a slight positive pressure in the water heater area by means of a fan bringing clean air from outside is recommended.
- Consider the installation of a room sealed water heater. The Rheem heavy duty gas model 631 275 (outdoor model) combined with the room sealed fluing kit (P/No 299135) is suitable for installations where the combustion air may be contaminated

Warranty is void when failure is due to corrosion from a contaminated atmosphere.

Clearance to combustibles: Gas water heaters and flue ways must be kept at least 25 mm clear from combustibles such as timber walls and cupboards and at least 500 mm clear of curtains and furnishings.

Flue terminal clearances:

Outdoor gas water heaters must have certain minimum clearances between the flue terminal and certain building features such as opening windows, ventilation bricks, doors, eaves, etc. Refer to figure, 15.3 and Table 15.1, which are extracted from AS5601, for these clearance details.

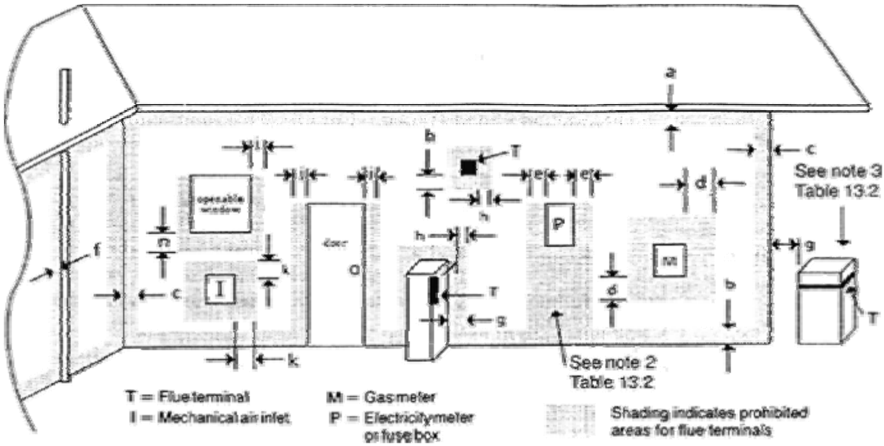

Fig. 15.3: Minimum clearances required for balanced flue terminals, fan-assisted flue terminals, room sealed appliance terminals or the terminals of outdoor appliances

Notes: to table 15.1

1. All distances shall be measured to the nearest part of the terminal.
2. The prohibited area below an electricity meter or fuse box extends to ground level.
3. A flue terminal of this type shall not be located under a roofed area unless the roofed area is fully open on at least two sides and a free flow of air at the appliance is achieved.
4. Refer to AS 5601, Appendix J for clearances required from a flue terminal to an LPG cylinder. A flue terminal is considered to be a source of ignition.
5. For appliances not addressed above, acceptance should be obtained from the technical regulator.

Building feature	**Minimum clearances (mm)**	
	Natural draft	**Fan assisted**
a. Below eaves, balconies and other projections:		
Appliances up to 50 MJ/h input	300	200
Appliances over 50 MJ/h input	500	300
b. From the ground, above a balcony or other surface†	300	300
c. From a return wall or external corner†	500	300
d. From a gas meter (M)	1000	1000
e. From an electricity meter or fuse box (P)	500	500
f. From a drain pipe or soil pipe	150	75
g. Horizontally from any building structure † or obstruction facing a terminal	500	500
h. From any other flue terminal, cowl or combustion air intake†	500	300
j. Horizontally from an openable window, door, non-mechanical air inlet, or any other opening into a building, with the exception of sub-floor ventilation:		
- Appliances up to 150 MJ/h input	500	300
- Appliances over 150 MJ/h input up to 200MJ/h input	1500	500
- Appliances over 200 MJ/h input up to 250MJ/h input	1500	500
- Appliances over 250 MJ/h input†	1500	1500
- All fan-assisted flue appliances, in the direction of discharge	-	1500
k. From a mechanical air inlet, including a spa blower	1500	1000
n. Vertically below an openable window, non-mechanical air inlet or any other opening into a building, with the exception of sub-floor ventilation		
- Space heaters up to 50 MJ/h input	150	150
- Other appliances up to 50 MJ/h input	500	500
- Appliances over 50 MJ/h input and up to 150 MJ/h input	1000	1000
- Appliances over 150 MJ/h input	1500	1500

† Unless appliance is certified for closer installation

Table 15.1: Clearance details for Figure 15.3

Cold Water Connection

All Rheem water heaters are designed for direct connection to the mains supply. They are also suitable for connection to cold cisterns or storage tanks, but for mains pressure operation a minimum of 350 kPa cold water pressure is required. Heat pump model 551310 requires a minimum supply pressure of 200kPa and continuous flow models require 140kPa.

The cold plumbing connection must include the following:

- Isolating valve
- Non return valve (storage water heaters only)
- A duo isolating non-return valve in lieu of two individual valves.
- Pressure limiting or pressure reduction valve (if supply pressure exceeds maximum rating)
- Expansion control valve (some areas only)
- Drain cock (some areas only)
- Disconnecting union
- Appropriate anode for local water conditions
- Correct pipe size

Each of these will now be discussed.

Isolating And Non-Return Valves

All Water Authorities have requirements for the fitment of both an isolating valve and a non return valve on the supply line to the inlet of pressurised storage water heaters. This can be achieved by using separate single purpose valves or a duo valve to cover both functions.

Isolating Valve

Also known as a stopcock. These are required in all cases and should be the first fitting on the water heater supply pipe. It is necessary to be able to isolate the hot water system for maintenance and servicing.

A separate isolating valve is not required if a duo valve is employed.

Non return valve

Also known as a check valve. All water supply authorities require the fitting of a non return valve on the supply to mains pressure storage water heaters and the fitting of such a valve is indicated in the Rheem installation instructions.

Non return valves are usually of simple design in which a loose valve rises to allow flow in one direction but falls back into the closed position when flow stops or back flow conditions arise.

Figure 15.4 shows the design of a spring loaded non return valve with a silent seat designed to overcome the objectionable metallic "hammer" noise that may occur with other valve designs.

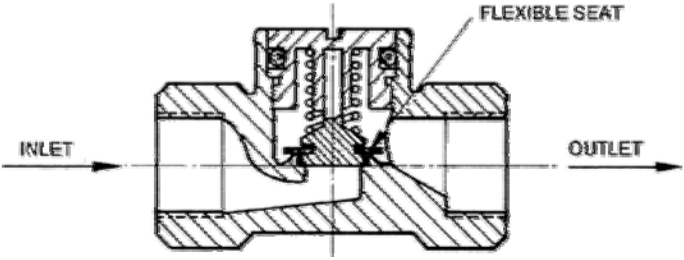

Fig. 15.4: Non-return valve

Installation of non return valve: The following must be noted:

- The valve must be of adequate size to suit the installation. A soft seat type is preferred.
- Swing check valves designed for horizontal use must be installed horizontally with the cap uppermost. If designed for vertical use, it must be installed vertically with the outlet uppermost.
- The non return valve is located between the stopcock and the water heater.
- A non-return valve must not be fitted to the inlet of a continuous flow water heater.

A separate non-return valve is not required if a duo valve is employed.

Combination isolating non return valve (duo valve)

Duo isolating valves are of a simple design, which embodies a specially engineered jumper valve which is spring loaded and performs the function of an isolating valve when in the closed position, and the function of a non return valve when in the open position. If replacement is ever necessary it must be made with a jumper supplied by the manufacturer, as the design is quite different from a standard tap jumper.

Pressure Limiting And Reducing Valves

Each Rheem mains pressure water heater is designed for the maximum working pressure indicated on the rating plate and this is the maximum TPR valve setting to be installed on the water heater. Maximum working pressures (and relief valve settings) vary on different models and will usually be 1400, 1000 or 850 kPa.

Although the water heaters are designed for direct connection to cold water mains, care should be taken to see the maximum water supply pressure does not exceed 80% of the relief valve setting otherwise excessive wastage of hot water through the relief valve is likely to occur. The following supply pressures should not be exceeded for the relief pressures indicated.

Relief valve setting (kPa)	Maximum supply pressure (kPa)
1400	1120
1000	800
850	680
700	560

Table 15.2: Relief valve settings and maximum supply pressures

Where supply pressures exceed the maximum indicated, a means of reducing line pressure is an essential part of the installation. This may be by means of either a pressure limiting valve or a pressure reduction valve.

Whichever valve is used, it should be placed on the cold water supply to the whole house in order to maintain equal cold and hot water pressures. This requirement is also necessary for the adequate performance of most tempering valves and thermostatic mixing valves. In such cases, however, a larger valve is needed than when connected only to the water heater cold supply connection.

A description of the two types of valves follows.

Limiting Valve

The pressure limiting valve remains open until the upstream pressure approaches the valve pressure setting. With inlet pressures above this, the valve acts as a reducing valve to keep the outlet pressure around this level.

Pressure limiting valves are made in a range of sizes, the most common being 15 mm, 20 mm and 25 mm.

For continuous flow water heaters, it is recommended to use an RMC PSL type pressure limiting valve, as this model valve does not display non-return characteristics typical in PS type valves

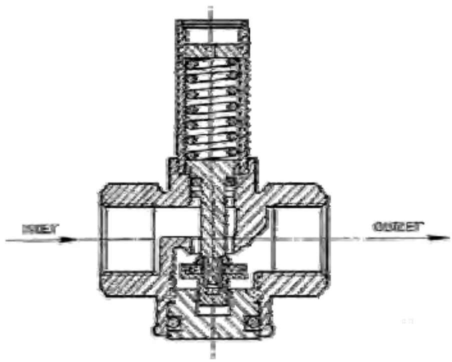

Fig. 15.5: Pressure-limiting valve (RMC PS type)

Installation of limiting valves: The following needs to be noted:

- Where approved by local water supply authorities, the pressure limiting valve may be placed on the cold water supply to the whole house and thus maintain balanced cold and hot water pressures. To provide adequate flow capacity, a 20 mm or 25 mm valve should be used.
- Where not approved for cold water supply, the limiting valve is connected to the inlet line to the water heater between the stopcock and the water heater. It can be placed before or after the non return valve.
- The valve should be accessible for service.

Reduction valve (water pressure reducing valve)

This type of valve may be used as a substitute for a pressure limiting valve where the line pressure exceeds the maximum line pressure for which the water heater is designed. However, pressure limiting valves are preferred because of their greater flow rate in proportion to size.

Reduction valves are usually spring loaded diaphragm valves of conventional design and are intended to control the downstream pressure to a predetermined level no matter what upstream pressure is experienced. In practice, there is usually some variation in static downstream pressure as upstream pressure increases, and there is always a drop in downstream pressure as flow increases.

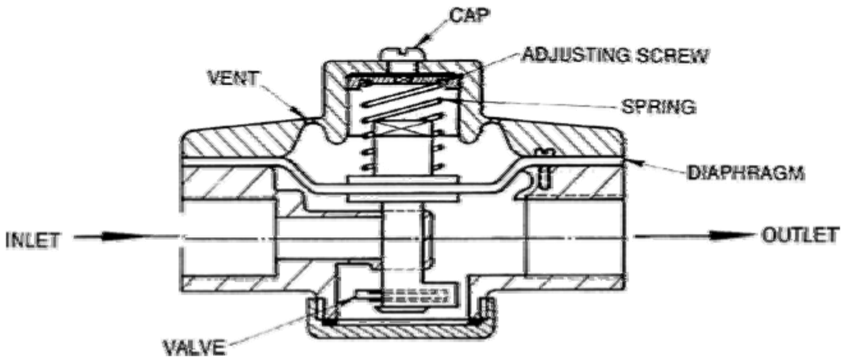

Fig. 15.6: Reduction valve

Installation of reduction valves: The following needs to be noted:

- Where approved by the local water authorities and where the flow capacities are large enough, the reduction valve may be placed on the cold water supply to the whole household and thus maintain equal cold and hot water pressures. A larger valve is needed

- Provision of unions on either side of the reduction valve will allow for easier servicing.
- When connected to the water heater only, the reduction valve should be connected between the stopcock and the water heater after the non return valve.

Expansion Control Valve (ECV)

Also known as a Cold Water Relief Valve. Some water supplies in Australia have high saturation indexes. As described in Chapter 2, the saturation index indicates the tendency of water to form or deposit scale. Water with a high saturation index is referred to as scaling water, because calcium carbonate is deposited out of the water and forms a type of scale onto any hot metallic surface.

In scaling water areas, it is possible the TPR valve fitted to the water heater can eventually become blocked with calcium carbonate deposits, as the scaling water passes through the hot valve body. If the TPR valve were to become totally blocked, the water heater cylinder would eventually distort due to expansion.

To prevent this occurrence, every water heater installed in a scaling water area must have an expansion control valve (ECV) fitted on the cold supply to the water heater. The valve should be fitted after the non return valve and must be the last valve before the water heater.

The pressure relief setting on the ECV is lower than the relief setting of the TPR valve, therefore pressure relief will occur through the ECV. As the water relieved is cold, the incidence of scale build up in the ECV is reduced dramatically. It follows that as the TPR valve is not relieving pressure, scale formation will not occur. The TPR valve must not be removed from the water heater as it performs a secondary safety function of relieving heat energy under high temperature conditions.

Every water heater installed in Western Australia and South Australia must have an expansion control valve fitted to comply with the local plumbing regulations. Any other water heater supply with a saturation index greater than +0.4 needs to be fitted with an expansion control valve to comply with the Rheem warranty.

Check the local plumbing regulations for details of the requirements for drainage from the expansion control valve.

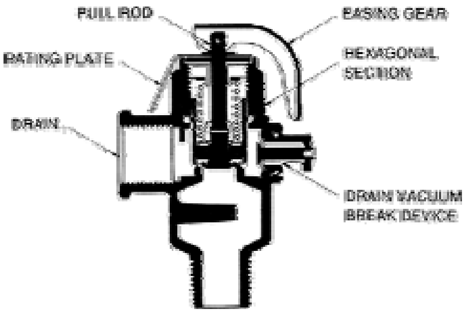

Fig. 15.7: Expansion-control valve

Other Fittings

Drain cock

Some areas of Australia require a drain cock to be fitted in the cold water supply. The provision of a drain cock can facilitate the draining of the water heater for sludge removal.

Disconnecting union

The final fitting on the cold water plumbing to a water heater should be a disconnection union. This is necessary so the water heater can easily be disconnected and removed for servicing or replacement.

Anodes

Rheem water heaters are manufactured to suit the water conditions of most Australian metropolitan supplies, but there are some known water supplies that can have detrimental effects on a water heater, its operation and life expectancy. Appropriate anodes for different water conditions are discussed at length in chapter 2.

Materials

Rheem recommends, and some water authorities demand, the use of dezincification resistant (DR) brass fittings for water plumbing.

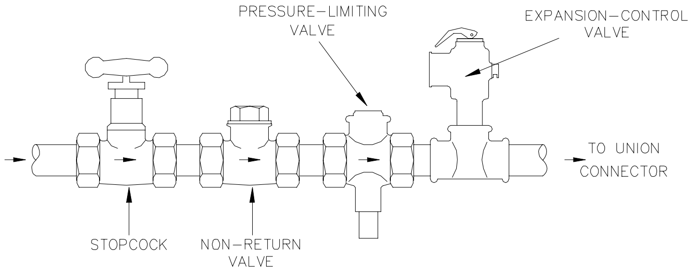

Fig. 15.8: Cold water connection detail

HOT WATER PLUMBING

Correct sizing, design and installation of the hot water plumbing leads to improved system performance. For full details of the correct procedures to be used, refer to AS/NZS 3500.4. This section details important points to be considered.

Pipe Sizing

Rheem water heaters for domestic use are manufactured with RP¾/20 outlet connections. The commercial range provides RP1¼/32 or RP2/50 outlet connections. It is up to the hydraulic consultant or the installing plumber to determine what size pipe should be used for the hot water plumbing to provide sufficient flow at the draw off points when the normal draw off pattern is applied. Factors affecting this decision are the number of branch joints, number of draw off points, length of runs and the type and usage of the hot water outlets.

AS/NZS 3500.4 recommends for domestic dwellings the hot water pipe should start at DN18 (18 mm diameter). As this size is not always available, the plumber may need to decide between DN20 (20 mm) and DN15 (15 mm) according to the installation. The determined size should be used to at least the first branch, after which the size may be reduced.

Pipe lengths longer than necessary or diameters larger than necessary increase running costs by retaining excessive amounts of hot water at the end of each draw off. This water eventually cools and the heat and subsequent dead water is wasted.

Example:

A 3 m length of DN20 (20 mm diameter) copper pipe that could have been adequately sized for flow rate at DN15 (15 mm diameter) wastes an additional 0.4 L of hot water each time hot water flows through and then is left to cool. If this length of pipe was the first length of the hot water plumbing, the pipe could fill with hot water and cool approximately 20 times each day leading to a hot water wastage of 2920 L per annum. (Refer to Table 16.6)

Pipe Insulation

Heat loss from hot water plumbing can be considerable, especially if a circulating loop is installed. To conserve fuel and minimise running costs, all hot water piping with circulating water should be insulated. AS/NZS 3500.4 provides minimum insulation requirements for various geographic zones.

Domestic installations should have at least the first 2m of the hot water plumbing insulated. This will reduce the heat lost from conduction through the water and the pipe material.

If a circulating pump is fitted, consideration should be given to time controlling the circulation pump to operate only during usage times.

Heat Traps

It is possible, on installations where no heat trap is fitted and the hot water plumbing rises from the water heater connection, for hot water from the water heater to circulate within the pipe. Hot water, during periods of no hot water usage, rises up the pipe until it cools and then it falls back to the water heater due to its increased density. This activity increases the heat loss of the system and increases running costs.

All current models of Rheem water heaters incorporate a dip tube, which conveys the hot water from the highest point inside the concave top of the storage cylinder to the outlet connection on the side of the cylinder. This dip tube acts as an integral heat trap by restricting the hot water in the cylinder from circulating within the hot water plumbing. AS / NZS 3500.4 states that for installations using water heaters with an integral heat trap, a further heat trap is not required to be installed.

Fittings

Disconnecting union

As with the cold water connection, the hot water connection to the water heater should include a disconnection union for ease of removing the water heater.

Vacuum break valve

All current Rheem storage water heaters are manufactured using mild steel cylinders and consequently vacuum break valves are not normally necessary. However, with any water heater with a light gauge cylinder, the occurrence of a partial vacuum or negative pressure can result in the collapse and failure of the water container. This can occur when hot water outlets are below the level of the bottom of the water heater and the cold water supply to the unit is turned off.

A vacuum break valve meeting the requirements of AS 1357 should be installed in the highest part of the hot water line to break the siphon action and relieve the vacuum. Figure 15.9 shows the principle of a typical vacuum break valve.

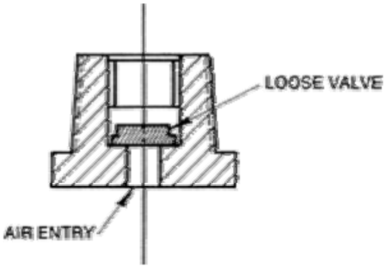

Fig. 15.9: Vacuum break valve

Flow control valves

The use of flow control valves is recommended, particularly in large scale installations, as a means of avoiding waste of water, especially hot water.

The use of flow control valves on showers and wash basins will often enable a small water heater to give much greater service, and has frequently been the answer where a water heater has appeared inadequate for the job.

There are many types of flow control devices on the market, ranging from valves suitable for retrofitting to existing tapware to units specifically designed to produce a set maximum flow rate. Regardless of the type, the principle of operation is similar. Low cost valves typically have a fixed orifice size to reduce the flow rate, however the flow rate can vary depending on the supply pressure. Higher quality valves also incorporate a self adjusting orifice that maintains the flow rate within close limits, whatever the pressure.

Close differential thermostats

In some cases, the differential (the range of degrees between cut in and cut out) of the thermostat on a water heater is not fine enough to maintain an accurate hot water temperature. Whenever hot water is required to be at a closely controlled temperature it can be obtained by using a close differential (say 1°C) thermostat installed at the outlet of the water heater.

The separate thermostat (set to the desired temperature) should be wired in series to control the water heater, and the water heater thermostat should be set at a higher temperature. In order to achieve fine control, it is necessary to use a pumped recirculating system.

Rheem commercial gas models 621265, 631265, 621275 and 631275 incorporate fine differential thermostats.

WARM WATER

There are two ways to provide warm water at a constant controlled temperature:

- By use of tempering and/or thermostatic mixing valves.
- Installing a centralised warm water system.

The primary consideration determining the choice is usually one of capital and installation cost and ongoing maintenance.

Legionella bacteria, which is not considered to be a health hazard at normal levels in cold water, flourishes in water between 20°C and 45°C. Certain categories of people (e.g. some patients in health care establishments) could, when bathing in this water, contract Legionnaires' disease under certain conditions. The propagation of Legionella bacteria needs to be considered for both centralised warm water systems and systems incorporating thermostatic mixing valves.

Tempering valve

A tempering valve is used to reduce the temperature of hot water to a preset level. By reducing the temperature to the safer range of 35-50°C the risk of scalding is minimised. The outlet from a tempering valve is adjustable within this temperature range and can be locked in position to prevent tampering or accidental change.

AS/NZS 3500.4 requires that all new hot water installations shall, at the outlet of all sanitary fittings used primarily for personal hygiene purposes, deliver hot water, not exceeding:

- (a) 45°C for early childhood centres, primary and secondary schools and nursing homes or similar facilities for aged, sick or people with disabilities; and
- (b) 50°C in all other buildings.

Note: Compliance with these temperature limits is optional for kitchen sinks and laundry tubs.

Compliance with the requirements of item (b) can be achieved using an adjustable tempering valve, a thermostatic mixing valve or a water heater complying with the temperature requirements of AS3498, set to deliver a maximum temperature of 50°C.

Some water heaters are designed to provide water at temperatures not exceeding 50°C in accordance with AS3498. This Standard specifies basic safety and public health related requirements for water heaters and hot-water storage tanks that are intended for connection to a potable water supply. Products certified to comply with the temperature requirements of AS3498 are marked accordingly.

RheemPlus gas and electric water heaters and 875 Series Rheem Integrity models comply with the temperature limit requirements of AS3498 and do not require further tempering in applications noted under (b) above.

The tempering valve may be fitted near the water heater to supply all outlets with water at a reduced temperature. The other option is to fit the tempering valve in the hot water line near the point of use (bathroom) so the water temperature to that area only is reduced. Water at the normal stored temperature can then be supplied to the laundry and kitchen. This second option normally provides better temperature control.

For applications listed under (a) above or for very accurate temperature control a thermostatic mixing valve is required.

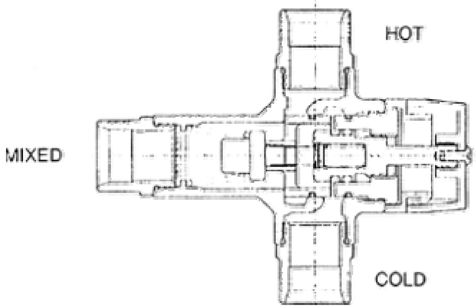

Fig. 15.10: Tempering valve

Thermostatic mixing valves

Wherever hot water is required to be at a constant temperature, it should be obtained by mixing hot and cold water through a thermostatically controlled mixing valve. Often, the differential (the range of degrees between cut in and cut out) of the thermostat on a water heater is not fine enough to maintain a consistent water temperature. There are very accurate temperature controlled mixing valves readily available.

Typical applications include:

- Controlled warm water temperature for ablutions in kindergartens, schools, hospitals, homes for the aged and institutions for disabled persons.
- Controlled water temperature for photographic processing, photo engraving or similar processes.

For correct operation of mixing valves the hot and cold water supply must be at similar pressures, preferably mains pressure. Check the specification requirements with the mixing valve manufacturer.

Warm Water Systems

Centralised warm water systems are an alternative to using thermostatic mixing valves installed at or near the point of use. Rheem Guardian is a centralised warm water system incorporating ultra violet disinfection. The system is approved by NSW Health. See the chapter on Rheem Guardian.

The detailing of recirculating warm water systems should be conducted by persons competent to do so. Some areas to consider are:

- ***Total system heat loss***: the flow and return piping system and insulation must be designed to limit the heat loss in the system to maintain the required temperatures for bathing purposes.
- ***Pump speed***: since warm water is produced at the plant room and recirculated at virtually user temperature, heat losses in the line between the first tap and last tap must be kept to a minimum (typically 2°C). The pump flow rate and subsequent pipe size must be carefully chosen.
- ***Pipe size***: for retro fit applications especially, bear in mind the warm water flow pipe has to carry approximately twice the volume of warm water as compared to hot water previously carried.
- ***Process of disinfection***: bacteria can grow at the temperatures used in warm water systems. There are many publications which deal with design criteria to minimise bacteria growth. The key to bacteria control is good design and continued monitoring and maintenance of the system.

TPR VALVES

Although this valve is strictly a part of the water heater, a discussion of it here is worthwhile. A typical Temperature and Pressure Relief (TPR) valve comprises the following:

- A fixed setting spring loaded pressure relief valve with the spring sealed from discharge water. The valve opens under normal operating conditions when the pressure in the water heater increases due to expansion caused by heating of the water.
- A fixed setting expansion type thermal element to open the same valve. The valve opens due to extremely high water temperature and is designed to release energy at a faster rate than can be input to the water heater.
- A means of lifting the valve manually off its seat (referred to as an easing lever) to facilitate clearing any foreign matter which may become lodged under the valve seat
- A vacuum relief device to relieve partial vacuum in the discharge line.
- A device to relieve excess pressure in the drain should the discharge line become blocked.

Thermal relief is provided under high temperature conditions by expansion of the polythene element, which causes the stainless steel push rod to lift the valve off its seat. The valve stays open until cooler water surrounds the thermal element, allowing the polythene to contract.

Note: The vacuum relief device does not relieve partial vacuum in the water heater, only partial vacuum in the drain line from the valve. It also prevents pressure build up in the cylinder if the drain line becomes blocked. In this circumstance, the vacuum break will blow out to relieve pressure.

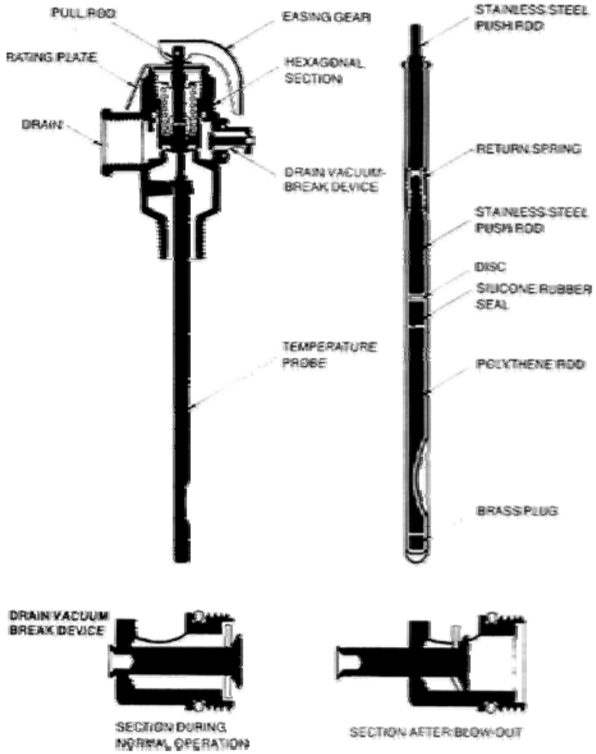

Fig. 15.11: Temperature and pressure relief valve

Causes of Flow

Four types of flow might be observed from the valve:

- A dribble of water caused by thermal expansion. The discharge occurs during the heating cycle and stops when heating stops or a hot tap is opened.
- A continuous dribble of water at all times. This is most likely caused by dirt under the valve seat. Operation of the easing lever should fix this.
- A flow of water in quantity discharging the full capacity of the unit then stopping, only to repeat itself at intervals. This indicates the thermal relief is working and service to the unit is necessary.
- A continuous flow of water in quantity without cycling. This indicates the cold water line pressure is excessive and a pressure limiting valve should be installed at the inlet to the water heater.

Combination TPR valves must meet the requirements of AS 1357 for such valves. They must also be of size 15 mm or 20 mm and setting 850, 1000 or 1400 kPa to suit the particular water heater. A TPR valve must never be replaced with one of a higher pressure rating.

Figure 15.11 shows the principle of operation of a particular type of TPR valve.

The valve must be installed in the fitting provided on the water heater, so the thermal element is immersed in the hot water in the storage cylinder and within the top 150 mm and the top 20% of the stored water.

Installation of drain pipe to TPR valve

The relief valve must be provided with a drain pipe, with the following requirements:

- The minimum diameter of the pipe is DN15 on 15 mm valves, and DN20 on 20 mm valves.
- The drain pipe must be of a minimum length and have a continuous fall to its outlet.
- The maximum length of the drain is 9 metres. Drain pipes longer than 9 metres must incorporate an air break.
- It must not have more than three right angle bends.

One function of the TPR valve is to discharge high temperature water under certain conditions. Therefore it is strongly recommended the pipe work downstream of the relief valve be capable of carrying water at temperatures exceeding 93°C. Failure to observe this precaution may result in damage to the pipe work and property.

The outlet of the drain pipe must be in a position so water flow out of the pipe can be easily discernible but arranged so hot water discharge will not cause injury, damage or nuisance. Final discharge from the TPR valve outside buildings should be in accordance with requirements of local authorities and AS/NZS 3500.4.

Recommendation for relief drain arrangements for up to 6 pipes when using a tundish is shown in Figure 15.12. For more than 6 pipes, it is usually more convenient to use more than one tundish.

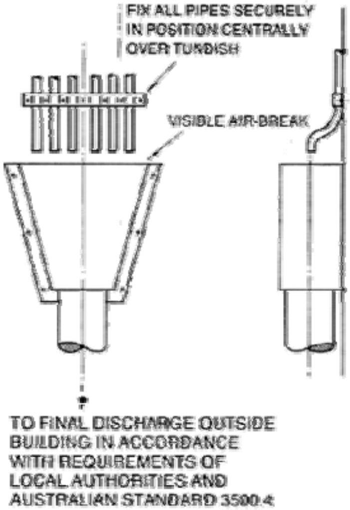

Fig. 15.12: Tundish installation

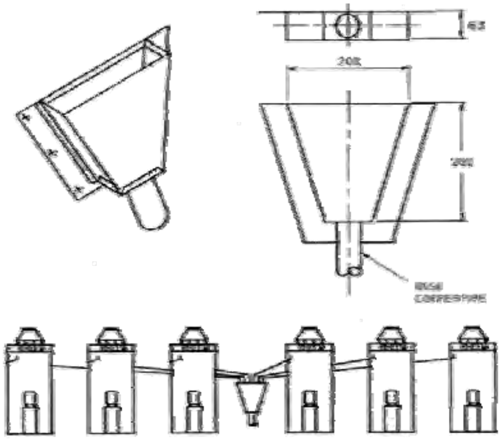

Fig. 15.13: Tundish for up to 6 pipe installations

For one pipe only, an air break, say by running one size pipe into a larger may be useful. Under the following two circumstances, an air break is mandatory:

- the drain exceeds 9m length
- the drain runs the risk of freezing outside a building

MULTIPLE INSTALLATIONS

Where large volumes of hot water are required over a short period at constant high temperature to several outlets all being used at the one time, 2, 3, 4, 5 or even more quick recovery mains pressure storage water heaters may be installed in parallel using the ***Rheem Equa Flow manifold system***.

Equa Flow Principles

The Equa Flow principle is designed to ensure that all water heaters in the bank are contributing an equal share of the work and there is an equal flow of hot water from each unit.

The essential principle of Equa Flow is that the demand on each water heater in the bank is the same as any other. Adherence to the following principles will lead to good design:

1. Sufficient space must be left to enable servicing or removal of any water heater.
2. The cold water supply to the inlet manifold must enter from the opposite end to that from which the hot water line leaves the outlet manifold.
3. The maximum number of water heaters in a bank should be 8, however several banks can be installed. These banks are also installed in Equa-Flow.
4. The hot water header, cold water header and cold water inlet pipe should be minimum DN32 pipe and be at least the next nominal diameter above the size of pipe required for the hot water outlet pipe to the system.
5. The hot water outlet pipe should be sized according to the requirements of the particular installation.
6. A non-return valve, isolation valve, and if required a pressure limiting valve and expansion control valve must be installed on the main cold water supply only as shown in Fig 15.8 and Fig 15.17.
7. A full flow gate or ball valve must be installed on both the cold and hot branch to each water heater.
8. Cold water supply branches to each water heater must be identical. Hot water outlet branches from each water heater must be identical.
9. Non-return valves, pressure limiting valves or loose jumper valves must not be installed in the branch assemblies to each water heater, since preferential flow through one water heater will result.
10. The water heaters must be of the same model.

The Equa Flow principle will function with water heaters in line along a wall, around a corner or in rows back to back. Adding more water heaters to the bank is simple, provided the plumbing is altered to keep the cold water inlet to the bank on the end opposite the hot water outlet.

"Series" Vs "Parallel" Installation

The Equa Flow principle requires the connection of units in parallel. Early thought sought to have multiple units in series, i.e. the outlet from the first water heater was connected to the inlet of the second and so on.

The pros and cons of the two principles are shown in Table 15.3.

Series	Parallel
Flow is limited to that obtainable from one water heater.	Flow is proportional to number in bank; i.e. 2 water heaters can give twice the flow of one water heater, 3 water heaters three times the flow etc.
Pressure loss increases as water passes through each water heater.	Pressure loss of the entire bank is equal to the pressure loss of one water heater.
First water heater in line does most work. Second water heater may not operate other than to maintain losses.	All units do equal share.
Full recovery only when last water heater in line is operating.	Full recovery when any water is used.
Breakdown of one unit and removal for service closes down whole operation	Any unit can be closed off at anytime, leaving rest in operation.

Table 15.3: Series Vs parallel connection

Flexibility of installation

The Equa Flow principle allows the best use of available space. Providing care is taken to ensure the cold water inlet and hot water outlet connections are at opposite ends of the bank, the units can be installed in a variety of positions.

The Equa Flow system facilitates the assembly of a large water heating plant using modules which will pass through standard doorways. Many large commercial water heaters have to be dismantled and then rebuilt within the plant romm as they are too large to pass through doorways.

Prefabricated Rheem Equa Flow hot and cold water manifold kits are available in the following sizes:

Small	Large
DN32 copper header pipes	DN40 copper header pipes
DN20 branch assemblies	DN25 branch assemblies

Each kit is suitable for the hot and cold connection of ONE water heater. Gate valves or ball valves are used to ensure balanced flow to and from each water heater in the bank.

Each kit consists of:

- header pipes 2 off
- branch assemblies 2 off
- flare nipples 2 off
- end caps 1 off

The header pipes supplied in the Rheem kits are sized to provide the required 500 mm clearance between adjacent balanced flue terminals. For electric or indoor gas water heaters, the header pipes may be shortened.

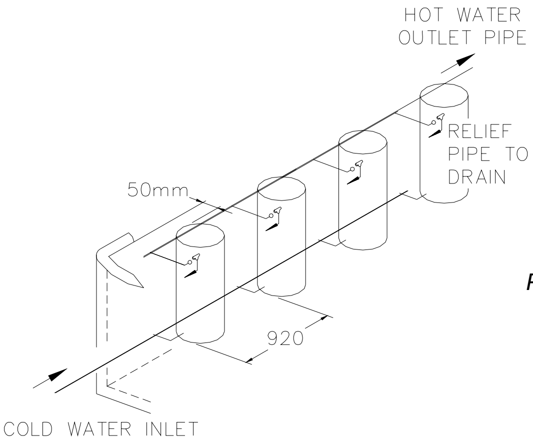

Fig.15.14: In-line manifolded bank

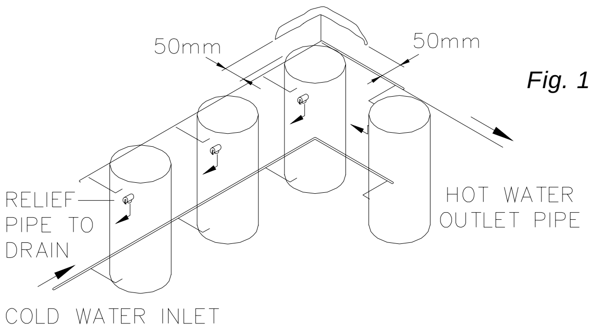

Fig. 15.15: Angle manifolded bank

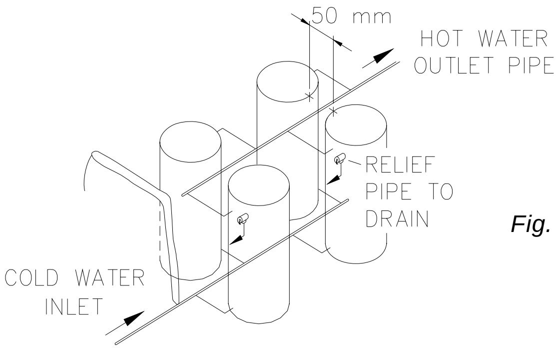

Fig. 15.16: Back-to-back manifolded

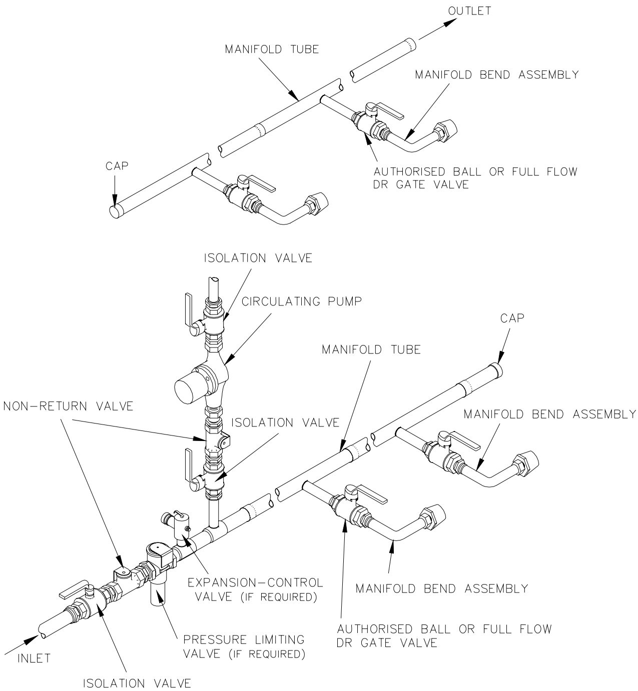

Fig. 15.17: Equa-Flow cold and hot header assembly

RECIRCULATION SYSTEMS

A recirculation system should be used wherever there is a risk of excessive water waste, caused by delays in hot water reaching the furthest outlet.

Gravity Recirculation (Thermosiphon)

With this system, the water heater is located at the lowest point. As the hot water in the pipe cools, the cooled water (being heavier than the hot water), slowly flows down the return pipes to the water heater while the hot water replaces it in the system.

Every Rheem water heater is fitted with one or more "dip" tubes in the water inlet and/or outlet of the water heater. These dip tubes act as integral heat traps, making gravity recirculation impossible. All recirculation systems using Rheem water heaters should be pumped.

Pumped Recirculation

A pumped recirculation system can be designed to operate between close temperature differentials and heat losses can be controlled.

For larger installations, an electric circulator pump may be used to circulate hot water through the main pipe system. Circumstances such as length of pipe system and expected usage pattern will dictate whether or not the pump should operate continuously or be controlled for intermittent operation.

Intermittent operation can be controlled either thermostatically or periodically by an electric time switch. Thermostatic control, for most installations, is preferable, and this should be located on the return line immediately upstream of the circulating pump.

In the pumped system, the return line from the recirculation system should be connected to the common cold supply to the water heaters after the main non return valve and pressure limiting valve and before the first branch. The pump should be isolated by a gate valve on either side and a non return valve installed adjacent to the pump. (See Fig.15.17) Installing the return branch up stream of the pressure limiting valve will cause recirculation to stop. This occurs because the hot water line and recirculation line operate at the lower setting of the pressure limiting valve and is trying to “push” water against the mains cold water supply pressure upstream of the pressure limiting valve.

Pump Sizing

The recirculation flow rate must be set to ensure an adequate temperature is maintained throughout the system. The required flow rate is obtained by calculating the total heat emission from the pipe work including both the flow and return lines.

Water flow is measured in litres per second in these cases. The hot water return flow is obtained from the following formula:

$$\text{water flow (L/sec)} = \frac{\text{heat loss}}{4.186 \times 1000 \times \Delta t}$$

where

- ***heat loss*** is the total rate of heat loss (in watts) emitted from the flow and return pipe work considering lengths of insulated and uninsulated pipe work, pipe diameters, temperature of water and temperature of surrounding air, referring to Table 16.1.
- ***Δt*** is the temperature difference (in degrees Celsius) between the hot water flow (leaving water heater) and the hot water return (entering water heater manifold). Normally, the hot water flow temperature is at 60°C and no more than 5°C is the desired temperature drop.

The calculated water flow and the resistance head of the circulation system are then used to select a suitable circulating pump.

Domestic Application Recirculation

There may be on occasion, a recirculation system installed in larger homes and small commercial premises. The practice of a recirculation system in domestic applications is increasing as more and more larger homes are being constructed. Changes to the recirculation system may be required depending on the water heating system design. In this section the following installations are discussed:

- Solar water heaters
- Off peak electric water heaters
- Tempering valves

Solar Water Heaters

Rheem do not recommend a solar water heater be connected directly to a recirculating ring main when either thermosiphon or pumped solar water heaters or banks of these products are installed. The solar water heater should be installed prior to the ring main. In a domestic or small commercial application, we recommend a secondary water heater, usually a small 25 or 50 litre electric water heater, be installed in the ring main to make up any heat losses. The thermostat on the electric water heater should be set at its minimum setting of 60°C.

It is recommended for a solar water heater system that utilises in-series storage booster water heater plant with a gas or continuous electricity supply (typical commercial solar system), for the recirculation system to return back into the booster water heater plant. The booster plant in this instance, in addition to providing boosting when required, will make up the pipe heat losses from the circulation system.

Solar with continuous boosting

Under normal solar heating, when a hot tap is opened and hot water is drawn off, cold water enters the bottom of the solar storage tank. This cold water is then either pumped or thermosiphoned through the solar collectors to be heated. The solar heated water is returned usually to the middle of the storage tank, near to where the booster thermostat is located. As more and more hot water is drawn off over the day, more and more cold water flows through the solar collectors to be heated.

If a solar water heater were directly connected to the recirculation system, the cold water which has entered the tank to replace the hot water would be circulated past the electric element or gas booster and its thermostat by the action of the circulation. The thermostat will register the temperature of the cold water and the contacts would close. For a water heater connected to a continuously available electricity or gas supply, the element or gas booster will then be activated.

The element or gas booster would remain activated until all of the cold water is heated to the thermostat setting. The electric or gas boosting usually recovers much faster than the solar collectors can heat water. Solar heating is a relatively slow process and it takes approximately about a solar day to heat an entire tank of water. Therefore the system would essentially be an electric or gas water heater connected to solar collectors, achieving minimal solar gain.

This same principle applies to a twin element electric water heater, where the bottom element is connected to Off Peak and the top element is connected to a continuous power supply.

Off-peak or time controlled boosting

The same principle applies to solar water heaters and electric Off Peak water heaters.

There are two considerations to be made for a solar water heater connected to either an Off-Peak electrical supply or a time controlled gas supply (i.e. Loline gas). The first is the stratification of the hot and cold water in the tank and the second is the heating capacity of the solar water heater system.

Stratification is the phenomena where hot water, being lighter than cold water, floats on top of cold water. This occurs in well designed water heaters, such as Rheem, when cold water enters the tank in a controlled manner with minimal mixing with, or disturbance of, the hot water in the tank. Effectively, the cold water remains below the layer of hot water.

The solar heated water from the collectors is delivered into the tank in a controlled manner. As the water moves relatively slowly, good stratification is achieved and the heated water sits on top of the cold water with minimal mixing. Therefore the hottest water can be drawn off from the top of the tank to the taps.

Pumped recirculation through a building flow and return system can interrupt the stratification inside a water heater. The recirculated hot water and cold water in the solar storage tank is mixed together, resulting in a tank of warm water. Therefore warm water would be drawn from the hot water outlet at the top of the tank and delivered to the taps. The delivery performance of the solar water heater is compromised.

System Heating Capacity the amount of heat loss in a building return system is dependant upon length of run of pipe, pipe size, type and quality of insulation and frequency of circulation. A water heater must have the capacity to provide both the useable hot water load and make up the heat loss load in the recirculation system.

A gas water heater or continuous tariff electric water heater can generally do this because they have the additional heating capacity to handle the recirculation system heat losses. There is the possibility a solar water heater does not have the additional capacity to cater for the recirculation system heat losses, particularly in times of poor solar gain. This would mean if the booster is connected to say an Off Peak electricity supply or the gas boost is on a timer (i.e. Loline gas), then a degree of the solar gain would be lost through the recirculation system and there may not be enough solar gain left over to provide adequate hot water for the domestic application.

Therefore, it is Rheem’s recommendation, the building recirculating hot water flow and return ring main has its own in line heating source, kept separate from the solar water heater, to make up for pipe heat losses in the ring main.

Tempering Valve

In many new homes, it is a common practice to install a single tempering valve at the water heater. The tempering valve is usually set at 50°C and the tempered water is supplied to the entire house.

A temperature limiting device cannot be installed in circulated hot water flow and return pipe work. The tempered water from a temperature limiting device cannot be circulated. Where a circulated hot water flow and return system is required in a building, a temperature limiting device can only be installed on a dead leg, branching off the circulated hot water flow and return pipe.

If circulated tempered water were to be returned back to the water heater, depending on the location of the return line connection on the water supply line to the water heater, then either:

- Water will be supplied to the cold water inlet of the temperature limiting device at a temperature exceeding the maximum recommended water supply temperature, or
- When the hot taps are closed no water will be supplied to the cold water inlet of the temperature limiting device whilst hot water will continue to be supplied to the hot water inlet of the temperature limiting device.

These conditions may result in either water at a temperature exceeding the requirements of AS/NZS 3500.4 being delivered to the hot water outlets in the ablution areas, or the device closing completely and not delivering water at all, or the device failing. Under either condition, the operation and performance of the device cannot be guaranteed.

FLUE SYSTEMS

The purpose of a flue system is to convey the products of combustion from the water heater draught diverter outlet to an approved point of discharge.

Statutory Requirements

AS 5601 (2004) Gas Installation Code, requires a flue system to be fitted to every appliance designed for connection to a flue, except where the Association considers that because of various factors a flue is not required.

All Rheem and Raypak indoor gas water heaters are designed for connection to a flue system. Rheem Outdoor gas water heaters have a balanced flue and Raypak Outdoor have a High Wind Top and therefore do not require additional fluing.

Information in this chapter has been prepared purely as a guide to assist the designer in determining the correct system and flue pipe diameters for various modes of installation of Rheem gas water heaters.

Types Of Flue Systems

Natural draught flues

The flow of combustion products in the natural draught flue system is created by the difference in density of the hot flue gases and the surrounding air. Since the hot flue gases are less dense, they tend to rise.

Flue performance is affected by many design factors.

- The higher the flue, the stronger is the upward draught.
- The wider the flue, the stronger is the upward draught, and the higher the volume of gases that can be carried.
- A draught diverter or barometric damper is employed to provide isolation of the combustion chamber from the secondary flue. Any excess flue “pull” draws air from the plant room rather than from the combustion chamber.
- Heat losses lower the difference in density between the flue gases and the outside air reducing natural draught.
- The more changes of direction (bends) and the greater the run of horizontal length, the greater the frictional losses which oppose the draught. In particular, changes of direction close to the draught diverter are more restrictive to flow than those more remote. It is for this reason height at this point in the system must be as much as possible. Where the initial rise in the system cannot be made sufficiently high to give satisfactory flue operation, this adverse condition can often be overcome by increasing the total vertical height of the system.

The appropriate gas authority should be consulted before any work is commenced on any flues other than single appliance flues.

Room Sealed Fluing

With room sealed fluing, a balanced flue terminal ducted to an outside wall provides both an exit for flue gases as well as the entry point for combustion air. Thus combustion air is not required from within the room where the water heater is installed.

The 631275 Outdoor commercial gas water heater can be configured as an indoor water heater and flued directly to an outside wall by utilising the Rheem Room Sealed Flue Kit (PN 299135). This kit is designed to connect to a 631275 water heater and re-use the existing balanced flue terminal at a remote horizontal location.

The room sealed flue kit utilises the fan in the 631275 to carry flue products up to 3 metres lineal length with up to 3 x 90° bends.

This kit, where suitable, eliminates the need for fan assistance when discharging flue products horizontally or the need to run a flue to a satisfactory vertical discharge point (usually at the top of the building). The kit is designed to fit 150mm nominal diameter twin skin flue (not supplied), and can be fully installed from within the plant room. The system is suitable to fit through walls up to 300mm thick and for plant rooms with a minimum ceiling height of 2400mm.

Specific plant room ventilation requirements are not necessary when a room sealed water heater is installed.

Power Fluing

A flue using a fan to remove or assist in removing combustion products from an appliance is known as a power flue. A power flue can be used for one or more appliances where any of the following conditions occur:

- It will be very difficult, expensive or undesirable to extend the flue above roof level.
- Spillage of flue products is occurring at the appliance due to insufficient flue draught. This may be due to unfavourable flue configuration or inadequate size.
- It is desirable to reduce the concentration of the flue gases to a maximum of 1% CO_2 (carbon dioxide) when they are discharged at a low level i.e., up to 4m from ground level.

Power flue systems must prove correct operation of the fan before the main burner is allowed to operate. A self proving relay interconnected with either a vane or pressure differential switch will prove both air flow and functionality of the control circuit before ignition of the main burner.

The sizing of power flue systems should be conducted by persons competent to do so in accordance with AS5601. Also, the siting of room sealed or balanced flues must be in accordance with AS5601.

Single Flue Systems

The entire flue system for a single appliance installation should be of the same diameter as the nominal size of the water heater draught diverter socket. For Rheem water heaters these are as given in Table 15.4.

Where a breeching piece is used, the vertical rise to a lateral is to be the maximum possible.

Series	Model	Hourly thermal input (MJ)	Flue pipe diameter (mm)
300	135	30	75
300	170	30	75
620	260	50	100
621	265	110	125
621	275	200	200

Table 15.4: Flue pipe diameters

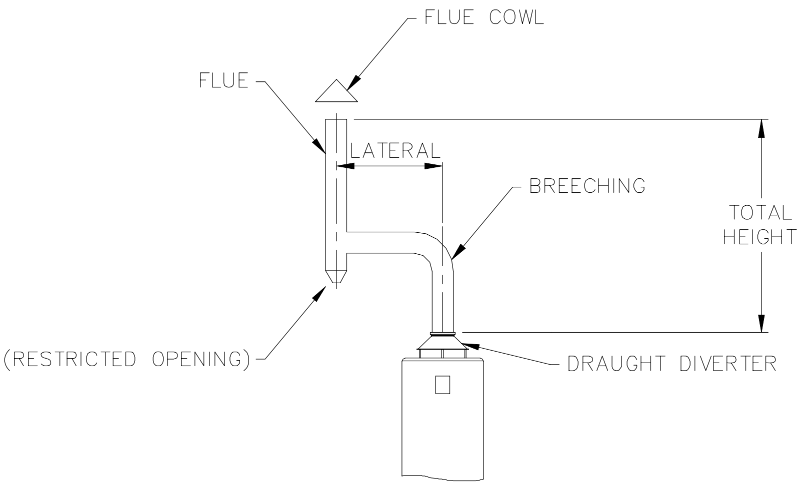

Fig. 15.19: Single appliance flue system

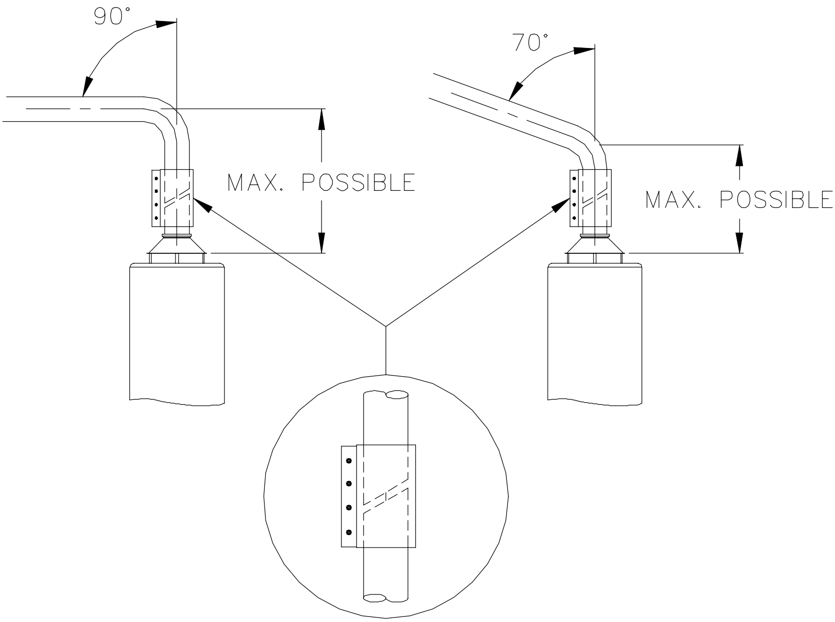

Fig. 15.20: Breeching piece and slip joint

Multiple Manifold Flue Systems

Where a number of Rheem water heaters are installed in parallel, each water heater can either be individually flued or connected to a single vertical flue via a common horizontal manifold.

Refer to Table 15.5 for flue sizing. The table is based on a natural draught system, with insulated type flue, or with flue installed indoors. The table is extracted from AS5601 and is meant as a quick guide only. Any variation should be referenced from AS5601.

The manifold may either be of constant diameter equal to the common flue or may be tapered to accommodate the increased volume of flue gas from each water heater. With a tapered manifold the section between the last water heater and the common flue must be the same diameter as the common flue.

For good flue operation, the manifold should be so located that the breeching from each water heater has not less than 1 m vertical rise. Should this be impractical, it may be necessary to increase the total height of the system.

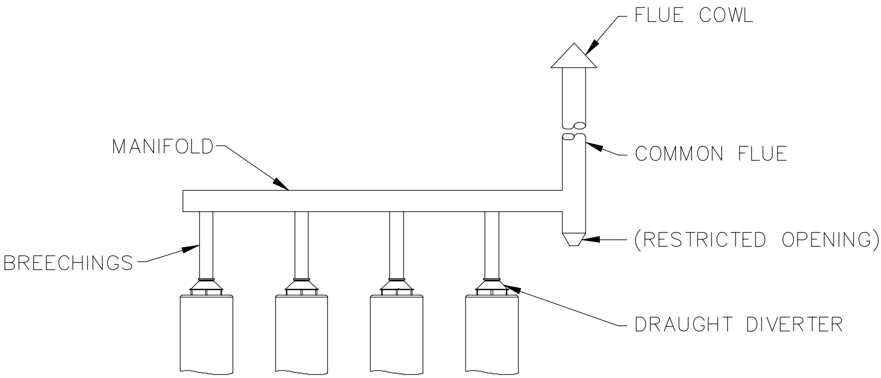

Fig. 15.21: Multiple manifold flue system

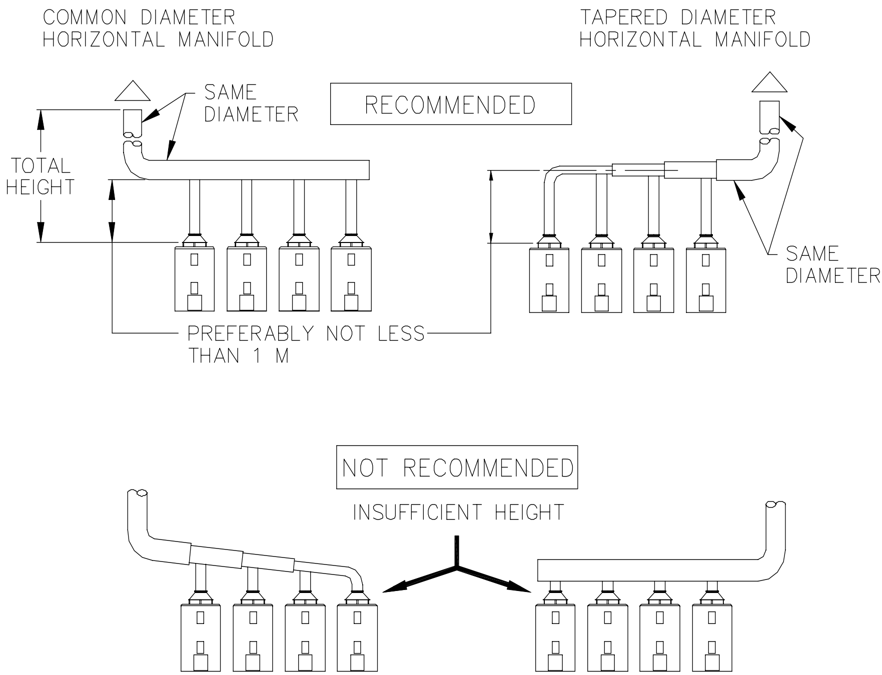

Fig. 15.22: Correct design of multiple manifold flues

Excessive manifold length may result in poor fluing. Therefore, manifold lengths should be as short as possible, and should not exceed 50% of the total flue height.

No. water heaters		**1**		**2**		**3**		**4**	
model	**Total flue height (m)**	**Max lateral (m)**	**Flue dia (mm)**	**Max manifold length (m)**	**Flue dia (mm)**	**Max manifold length (m)**	**Flue dia (mm)**	**Max manifold length (m)**	**Flue dia (mm)**
300 135 300 170 30 MJ/hr	**2.0**	1.00	*75*	1.00	*100*				
	2.5	1.25	*75*	1.25	*100*				
	3.0	1.50	*75*	1.50	*100*				
	4.5	2.25	*75*	2.25	*100*				
	6.0	3.00	*75*	3.00	*100*				
	9.0	4.50	*100*	4.50	*100*				
620 260 50 MJ/hr	**2.0**	1.00	*100*	1.00	*125*				
	3.0	1.50	*100*	1.50	*125*				
	6.0	3.00	*100*	3.00	*125*	3.00	*125*	3.00	*150*
	9.0	4.50	*100*	4.50	*100*	4.50	*125*	4.50	*150*
	12.0	6.00	*100*	6.00	*100*	6.00	*125*	6.00	*150*
	18.0	7.60	*125*	9.00	*125*	9.00	*125*	9.00	*150*
	24.0	7.60	*150*	12.00	*150*	12.00	*150*	12.00	*150*
621 265 110 MJ/hr	**2.0**	1.00	*125*	1.00	*200*				
	3.0	1.50	*125*	1.50	*175*				
	6.0	3.00	*125*	3.00	*150*	3.00	*175*	3.00	*200*
	9.0	4.50	*125*	4.50	*150*	4.50	*175*	4.50	*200*
	12.0	6.00	*125*	6.00	*150*	6.00	*175*	6.00	*200*
	18.0	7.60	*125*	9.00	*150*	9.00	*175*	9.00	*200*
	24.0	7.60	*150*	12.00	*150*	12.00	*175*	12.00	*175*
	30.0	9.10	*175*	15.00	*175*	15.00	*175*	15.00	*175*
621 275 200 MJ/hr	**2.0**	1.00	*175*	1.00	*250*				
	3.0	1.50	*175*	1.50	*250*				
	6.0	3.00	*175*	3.00	*200*	3.00	*250*	3.00	*300*
	9.0	4.50	*175*	4.50	*200*	4.50	*250*	4.50	*250*
	12.0	6.00	*175*	6.00	*200*	6.00	*250*	6.00	*250*
	18.0	7.60	*175*	9.00	*175*	9.00	*250*	9.00	*250*
	24.0	7.60	*175*	12.00	*200*	12.00	*250*	12.00	*250*
	30.0	9.10	*175*	15.00	*200*	15.00	*250*	15.00	*250*

Table 15.5: Appliance flue sizing –multiple installations

No. water heaters / model		5		6		7		8	
	Total flue height (m)	Max manifold length (m)	Flue dia (mm)	Max manifold length (m)	Flue dia (mm)	Max manifold length (m)	Flue dia (mm)	Max manifold length (m)	Flue dia (mm)
300 135 300 170 30 MJ/hr	**2.0**								
	2.5								
	3.0								
	4.5								
	6.0								
	9.0								
620 260 50 MJ/hr	**2.0**								
	3.0								
	6.0								
	9.0	4.50	*150*						
	12.0	6.00	*150*	6.00	*175*	6.00	*175*		
	18.0	9.00	*150*	9.00	*150*	9.00	*175*	9.00	*175*
	24.0	12.00	*150*	12.00	*150*	12.00	*175*	12.00	*175*
621 265 110 MJ/hr	**2.0**								
	3.0								
	6.0								
	9.0	4.50	*250*						
	12.0	6.00	*250*	6.00	*250*	6.00	*250*		
	18.0	9.00	*200*	9.00	*250*	9.00	*250*	9.00	*250*
	24.0	12.00	*200*	12.00	*250*	12.00	*250*	12.00	*250*
	30.0	15.00	*200*	15.00	*250*	15.00	*250*	15.00	*250*
621 275 200 MJ/hr	**2.0**								
	3.0								
	6.0								
	9.0	4.50	*300*						
	12.0	6.00	*300*	6.00	*300*	6.00	*350*		
	18.0	9.00	*250*	9.00	*300*	9.00	*300*	9.00	*350*
	24.0	12.00	*250*	12.00	*300*	12.00	*300*	12.00	*350*
	30.0	15.00	*250*	15.00	*300*	15.00	*300*	15.00	*300*

Table 15.5 (cont): Appliance flue sizing –multiple installations

Water Heaters At Different Levels

Where a number of Rheem water heaters are to be connected at different levels, the common flue should be tapered so as to provide for the increase in flue gas volume at each level.

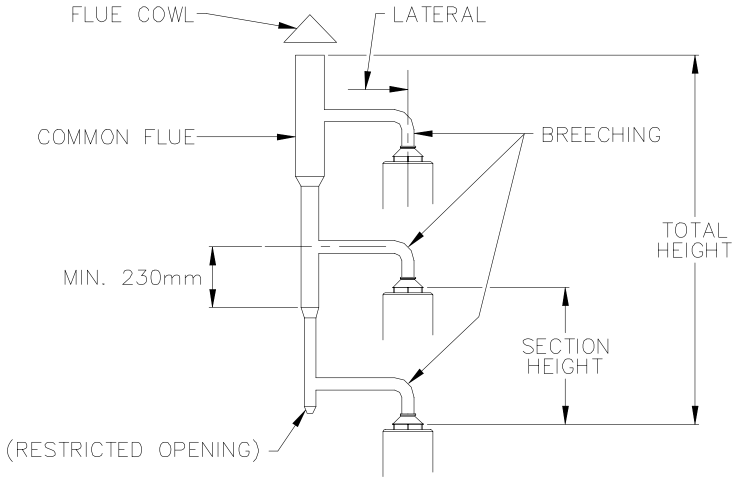

Fig. 15.23: Common flue system – water heaters at different levels

Unlike the multiple manifold system, where all water heaters normally operate simultaneously, water heaters installed on different levels on a common system will in most cases operate in random fashion. Under these circumstances simultaneous operation of all water heaters is most unlikely and it is also possible for one water heater to operate alone. Such conditions need special consideration and therefore it is recommended each such installation be carefully studied to determine, for each section of the common flue, the possible maximum number of water heaters that particular section may be required to flue simultaneously.

Using this information, the diameter of each section of the common flue may be obtained by reference to the tables in AS 5601 Appendix H.

The following rules should also be observed:

- The height from the draught diverter outlet of the highest water heater to the common flue terminal should not be less than 5 m.
- Each breeching should have a vertical rise of not less than 600 mm before a 90° change in direction and not less than 300 mm before a 70° change in direction.
- Laterals should not exceed 1 m.
- Each increase in flue diameter should occur at least 230 mm below the entry of the breeching from the water heater.

Ventilation

It is a requirement that indoor gas water heaters (non room sealed) are installed in a location with adequate ventilation.

Two permanent openings are required into the room housing the heaters.

The distance from the top of the upper opening to the ceiling and from the bottom of the lower opening to the floor, cannot each exceed 5% of the room height.

The two openings can be combined as long as the top and bottom of the opening are within the 5% distance requirement.

The minimum vertical dimension of any free ventilation opening is 6mm.

The minimum free ventilation area of each opening required for each Rheem commercial gas water heater installed is shown in tables 15.6 and 15.7. Refer to AS5601 for more details.

		Natural Ventilation (Area of each opening of water heater)			
		Plant room		Non plant room	
model no.	thermal input (MJ/hr)	direct to outside (cm^2)	via adjacent room (cm^2)	direct to outside (cm^2)	via adjacent room (cm^2)
620 260	50	75	150	150	300
621 265	110	165	330	330	660
621 275	200	300	600	600	1200

Table 15.6: Natural ventilation requirements for Rheem indoor water heaters

		Mechanical Ventilation (Requirements per water heater)		
		Low level	High level	
model no.	thermal input (MJ/hr)	Mechanical air supply (L/sec)	Mechanical exhaust* (L/sec)	Natural exhaust (cm^2)
620 260	50	25	8	75
621 265	110	55	16	165
621 275	200	100	29	300

* Note: natural air supply with a mechanical exhaust is not permitted

Table 15.7: Mechanical ventilation requirements for Rheem indoor water heaters.

Chapter 16

Formulas And Methods of Calculation

This Chapter Covers:

The basic theory and calculations required to understand

- ► The energy required to heat quantities of water
- ► Water heater efficiency
- ► Running costs of water heaters
- ► Mixing of hot and cold water
- ► Pipe sizing calculations

A1006

HEAT AND ENERGY

What is Temperature

Temperature measures the tendency of something to give off heat energy. If two objects come into contact, heat will flow from the hotter body to the colder body.

Example:

If you put your hands in hot water, heat will flow from the water to your hands. Your hands heat up. If you put your hands in cold water, even though it feels like coldness is flowing into your hands, in actual fact heat is being drawn out of your hands, which makes them cool down.

Heat and Specific Heat Capacity

Heat is a form of energy, and is measured in Joules.

Specific Heat Capacity (also called Heat Capacity) measures how much heat is required to increase the temperature of a body. It is measured in Joules/kg/°C.

The heat capacity of water is 4186 Joules/kg/°C. It takes 4186 Joules of energy to raise the temperature of 1 kg of water by 1°C. It is convenient to note that 1 litre of drinkable water weighs very close to 1 kg.

By comparison, the heat capacity of oil is 2000 Joules/kg/°C, which implies that far less energy is required to increase the temperature of oil compared to water. The heat capacity of copper used in piping is only 385 Joules/kg/°C, which explains why it heats up so easily.

Heat Energy = Mass X Specific Heat Capacity X Temperature Rise

Formula 16.1

The energy used to provide hot water is usually measured in Megajoules. For the formula to come out in Megajoules, ensure:

- Mass is measured in kilograms (for water, litres will be sufficiently accurate)
- Heat capacity is given in MJ/kg/°C. eg Water is 0.004186 MJ/kg/°C
- Temperature rise is in °C.

Quantities used must be converted to these units before they can be used. As a shortcut for most calculations, the heat capacity of water can be taken as 0.0042 MJ/kg/°C.

Example 1 - Heat Required

How much heat energy is required to heat 200 litres of room temperature water to 60°C. Assume room temperature is 25°C.

Solution: Derive all the quantities in the formula:

Mass	From the text above, 200 litres is the same as 200 kg
Specific Heat Capacity	0.0042 MJ/kg/°C
Temperature rise	(60-25) = 35°C

So the formula becomes:

Heat Energy = 200 X 0.0042 X 35
= 29.4 MJ

Example 2 – Resulting Temperature Rise

What would be the temperature rise of 200 litres of water at room temperature that was subject to 20 MJ of heat energy.

Solution: This time, it is the temperature rise that is unknown. Using basic mathematical techniques to isolate the unknown quantity, the formula becomes:

$$\text{Temperature Rise} = \frac{\text{Heat Energy}}{\text{Mass} \times \text{Specific Heat Capacity}}$$

Formula 16.1a – derived directly from formula 16.1

Deriving all the quantities in the formula:

Heat Energy	20 MJ
Mass	From the text above, 100 litres is the same as 100 kg
Specific Heat Capacity	0.0042MJ/kg/°C

So the formula becomes:

Temperature rise = 20 / (100 X .0042)
= 47.6°C

So 100 litres of water at room temperature, say 25°C, will be close to 73°C after the application of 20MJ.

WATER HEATERS

Efficiency Of A Water Heater

The previous section described how much heat energy is required to raise the temperature of a certain volume of water. But for a water heater to apply, say, 20MJ of heat energy to a volume of water, it must itself receive more than 20MJ of energy in the form of gas, electricity or solar power. The reason for this is that there are inefficiencies in any real world heating system. These inefficiencies come in two forms:

- *Appliance inefficiencies:* of the 20MJ of gas coming into a water heater, some of this heat will escape in the form of hot combustion products escaping up the flue. For electric water heaters, there are losses in the wires due to resistance. No heater can convert 100% of its input energy to useful heat.
- *System Losses:* including losses through the pipes, standby losses usually associated with storage water heaters and start up losses in the case of continuous flow units.

Thermal Efficiency

Thermal efficiency of an appliance is defined as the ratio of useful heat obtained from the heater, to the amount of heat energy supplied to the heater. This is expressed as a percentage. It takes into account appliance inefficiencies only. Unless otherwise stated, the thermal efficiency only refers to the immediate period of operation when conversion from fuel to useful heat is actually taking place. It is most relevant for heaters which are on for specified parts of the day.

Service Efficiency

Service efficiency is the ratio of useful heat carried by the water at the tap, to the amount of heat energy supplied to the water heater, usually over a 24 hour period. This is also expressed as a percentage. It takes into account appliance inefficiencies as well as system losses.

The efficiencies of Rheem water heaters are given in tables in their relevant chapters. The efficiency of Rheem solar collectors is approximately 60%.

Heat Energy Consumed By Water

From the first section, we know how much heat is *required* by a volume of water to raise its temperature. If we factor in the efficiency rating of a water heater, the actual energy *used* by the water heater in raising its temperature can be calculated. This is closer to the energy that the consumer will finally pay for and is also the energy requirement used in sizing water heaters for particular applications.

Appliances are rated by their power or the "time rate of doing the work" eg MJ/hr or kW. The hourly heat input to the water heater can be calculated from the following formula:

The formula used is:

$$\text{Hourly heat energy consumed by water (MJ)} = \text{Hourly energy input to water heater (MJ)} \times \frac{\text{Efficiency \%}}{100}$$

Formula 16.2

In this formula,

- The left hand side, the hourly heat energy consumed by water, is the heat given by formula 16.1. It is the energy necessary to raise the temperature of water.
- The hourly energy input to the water heater is simply the rated power of the heater, in kW or MJ/hr. If the water heater is rated in kW, convert to MJ by multiplying kW by 3.6.
- Although these two quantities are listed as "hourly" energy consumptions, any time period can be used, as long as it is the same for both quantities.

Example 3 - Heat Energy Consumed By Water

A Rheem Stellar gas water heater is rated at 42 MJ/hr. How much of this heat energy is actually consumed by the water to raise its temperature during this same time period.

Solution: We derive the quantities in the formula.

Hourly energy input to water heater	42 MJ
Efficiency	89%. Refer to chapter on Gas Domestic Heaters.

So the formula becomes:

Heat energy consumed = 42 X (89/100)

= 37.4 MJ

The rest of the heat is lost eg carried through the flue.

Example 4 – Heat Energy Used By A Water Heater

We calculated in example 1 that 200 litres of water requires 29.4 MJ to raise its temperature by 35°C. In the case of a Stellar gas domestic water heater, how much heat is actually used by the heater in the process.

Solution: Using basic mathematical techniques to isolate the unknown quantity, formula 16.2 becomes:

$$\text{Hourly energy input to water heater (MJ)} = \frac{\text{Hourly heat energy consumed by water (MJ)}}{\frac{\text{Efficiency \%}}{100}}$$

Formula 16.2a: derived directly from formula 16.2

Solution: So deriving the known quantities of the formula as before, the formula becomes

Heat energy consumed by water	29.4 MJ
Efficiency	From the chapter on Gas Domestic Heaters, the efficiency of Stellar heaters is 89%.

Energy input to water heater = 29.4 ÷ (89/100)

= 33 MJ

This is the energy input to the water heater to achieve the specified raise in temperature. Notice that in this example, no time period was specified; the time period for both sides of the formula was the same.

Heat Up Time

The time required to heat a quantity of water may be calculated as follows:

$$\text{Time to heat water (hrs)} = \frac{\text{Heat Energy required to heat water (MJ)}}{\text{Heat Energy consumed by water per hour (MJ/hr)}}$$

Formula 16.3

Notice the top line is an amount of heat energy, measured in MJ, and is given by formula 16.1. The bottom line is energy per hour, and is given by formula 16.2. We can thus use these previous two formulas to derive a version that uses numbers that are typically easy to find.

$$\text{Time to heat water (hrs)} = \frac{\text{Mass} \times .0042 \times \text{Temperature Rise}}{\text{Power rating of water heater (MJ/hr)} \times \dfrac{\text{Efficiency of heater \%}}{100}}$$

Formula 16.4

Example 5 – Heat up time of a gas water heater

How long does it take for a Rheem commercial gas storage water heater (rated 200MJ/hr) to heat 275 litres of water from 15°C to 65°C.

Solution: Derive the quantities in the formula:

Mass	275 litres, which weights 275 kg
Temperature rise	65 – 15 = 50°C
Power rating of water heater	200MJ/hr
Efficiency	78%

Top line: Heat energy required to heat water

= 275 X .0042 X 50

= 57.75 MJ

Bottom line: Heat energy consumed by water per hour

= 200 X (78 / 100)

= 160 MJ/hr

Thus time to heat water is

= 57.75 / 156

= 0.37 hours

In minutes, this equates to 0.37 X 60 = 22.2 minutes

The above formula is the most commonly used in determining the energy requirement in sizing water heaters for commercial applications. Any unknown can be found by isolating the unknown component of the formula.

The most commonly used variation is shown below in formula 16.4a.

$$\text{Power rating of water heater (MJ/hr)} = \frac{\text{Mass} \times .0042 \times \text{Temperature Rise}}{\text{Time to heat water (hrs)} \times \dfrac{\text{Efficiency of heater \%}}{100}}$$

Formula 16.4a

Recovery Rate

Recovery rate is the quantity of water that can be heated through a given temperature rise in a given time period, usually one hour. It is given by:

$$\text{Time to heat water (hrs)} = \frac{\text{Heat Energy consumed by water per hour (MJ/hr)}}{\text{Heat Energy required to heat 1 L of water (MJ/L)}}$$

Formula 16.5

Using formula 16.4a, which is based on formulas 16.1 and 16.2, we can derive a version that uses numbers that are easy to find.

$$\text{Recovery (L)} = \frac{\text{Power rating of water heater (MJ/hr)} \times \text{Time to heat water (hrs)} \times \frac{\text{Efficiency of heater \%}}{100}}{.0042 \times \text{Temperature rise}}$$

Formula 16.6

Example 5 – Recovery rate of an electric water heater

An electric water heater has an energy input of 4.8 kW and an efficiency of 95%. If the required temperature rise is from 20°C to 70°C, how many litres of water can be heated per hour, ie what is the recovery rate?

Solution: First we must convert kW to MJ/hr. This is straightforward using the conversion factor kW x 3.6 = MJ/hr.

Heater rating = 4.8 kW x 3.6

= 17.28 MJ/hr

Now derive the quantities in the formula:

Power rating of water heater	17.28 MJ/hr
Efficiency	95%
Time required to heat water	1 hour
Temperature rise	70 - 20 = 50°C

Top line: Heat energy consumed by water

= 17.28 X 1 X (95 / 100) = 16.416 MJ/hr

Bottom line: Heat energy required to heat water, per litre

= .0042 X 50 = 0.21 MJ

Recovery rate is

= 16.416 / 0.21 = 78.2 L/hr

PEAK DEMAND CAPACITY

We often need to calculate the amount of hot water that a heater can deliver during a period of peak demand. Typically there is little hot water demand for some time before and after the peak period. It can be assumed:

1. The heater is full of hot water at the start of the period.
2. Recovery starts at the beginning of the period and continues through to the end of the period.
3. There is no hot water left at the end of the period.

In other words, the deliverable storage and recovery capacity of the heater is available for the peak demand period. The maximum output of a storage water heater over a known period and a known temperature rise can then be calculated as:

Maximum Output in a period = Initial delivery capacity + Recovery during the period

Formula 16.7

Stratification

As hot water is drawn from the top of the water heater, cold water replaces it from the bottom. Although hot water will tend to float above the cold water, there will be some mixing, so the temperature of the hot water being delivered from the heater will drop as more and more water is being drawn off. The stratification level gives that draw off percentage, after which the temperature of the water has fallen to an unacceptable level.

Calculation Considerations

Water heater ratings: Electric water heaters are rated on their delivery performance; gas water heaters are rated on their storage capacity.

Stratification level: You should assume a stratification of 80% unless otherwise stated or known. This implies that 80% of the storage capacity will provide usable hot water.

Recovery rates: For Rheem storage water heaters, these are found in the tables in the relevant chapters of this book or can be calculated.

Usage pattern: The calculations depend on a certain usage pattern, whereby minimal demand occurs before and after the peak period. Before relying on these calculations in a real installation, you should ensure there is sufficient time between peak periods to reheat the water.

Example 6 – Using The Formula For Recovery Rate

A 275 litre storage gas water heater has an energy input of 200MJ/hr. The thermal efficiency of the water heater is 78% and has a stratification level of 86%. Temperature rise is 15°C to 82°C. How many litres of water can be delivered over a peak demand period of 4 hours?

We derive the quantities in formula 16.7, where recovery rate is calculated using formula 16.6

Initial delivery capacity	86% x 275 = 235 litres
Recovery rate/hr	554.3 litre/hr (using formula 16.6)

The formula then becomes

Maximum output for 4 hours = 235 + (4 x 554.3)

= 2452 litres

Example 7 – Using Recovery Rate Tables

Solve example 6 using the recovery tables instead of Formula 16.7.

Initial delivery capacity	86% x 275 = 235 litre
Recovery rate/hr for 65°C rise	580 litres/hr from table in chapter on commercial gas water heaters
recovery at 67°C	580 x (65/67) = 563 litres/hr

Formula becomes

Maximum output for 4 hours = 235 + (4 x 563)

= 2487 litres

Some tables may not exactly reflect the answers derived by calculation due to rounding to make the tables easier to read. Nonetheless, the methods agree to within 1-2% which is acceptable given the other uncertainties in real world installations.

FUEL COST

It is a common requirement to assess and compare the fuel cost of various proposed installations. This manual contains numerous tables showing the assessed fuel consumption of specific Rheem gas and electric water heaters under different daily draw off rates.

However, it is important to understand how fuel cost is estimated for a water heater under a variety of conditions.

Calculation Procedure

1. Assess the daily hot water requirement and the required temperature rise.
2. Calculate using Formula 16.1 the heat energy that would be consumed by this requirement, in MJ.

   For electrical calculations, convert this to kWhrs. For solid fuel or oil, convert this to kg.
3. Assess the service efficiency of each water heater.
4. Calculate the fuel usage per day.
5. Establish the cost of the fuel, and convert this pricing to the units which you have been using, with the assistance of the conversion table in chapter 17 if necessary. For instance, if the gas is charged by cubic metres, and your calculations are in MJ, use the relevant table to make the conversion.
6. Determine the total cost of the installation taking into account all water heaters and the number of days they will be used in a normal week, month, quarter or year.

Note: tables are also available for most Rheem water heaters in the relevant chapters, which provide daily energy consumption for a given temperature rise. This will prove to be sufficiently accurate for most applications.

Example 8 –Daily fuel cost of 2 electric water heaters

What is the approximate fuel cost of providing 1000 litres of hot water per day at 55°C rise, from two mains pressure storage water heaters at 7.15c/kWhr. Assume a service efficiency of 80%.

Step 1: Hot water requirement for each heater is 500 litres per day.

Step 2: Heat energy MJ = 500 x .0042 x 55 = 115.5 MJ

To convert to kWhrs, using standard conversions:

115.5MJ ÷ 3.6 = 32.08 kWhrs

Step 3: Assume 80%

Step 4: Fuel usage = 32.08 ÷ (80/100)

= 40.1 kWhrs

Step 5: cost of fuel = 40.1 kWhrs x 7.15c/kWhr

= $2.86 per heater

Sep 6: Total cost per day = 2 water heaters @ $2.86 per day = $5.72

Total Running Cost Considerations

Fuel cost is only one item to be considered in the running cost of a hot water service. Particularly in commercial and industrial work, the following must be considered:

- Rental value of space occupied by water heaters and ancillary equipment
- Auxiliary power for blowers and pumps
- Maintenance and repairs
- Depreciation
- Interest on investment

MIXING HOT & COLD WATER

As hot and cold water are blended, a temperature between the two results as follows:

$$\text{Mixed water temperature} = \frac{\left[\text{quantity at Temp 1} \times \text{Temp 1}\right] + \left[\text{quantity at Temp 2} \times \text{Temp 2}\right]}{\text{quantity at Temp 1} + \text{quantity at Temp 2}}$$

Formula 16.8

This formula extends easily to the mixing of three or more quantities of water.

Example 9 – Work out the final temperature

100 litres of water at 25°C is added to 75 litres at 85°C, then a further 50 litres at 60°C is added. What is the final temperature?

Solution: Here we will need to extend the formula to three quantities of water:

$$\text{Mixed temperature} = \frac{[100 \times 25] + [75 \times 85] + [50 \times 60]}{100 + 75 + 50}$$

$$= 52.8°\text{C}$$

Quantity of Hot Water Required

Often hot and cold water are mixed to achieve a required quantity of water at a required temperature. To calculate the required quantity of hot water required, or to determine the amount of mixed water that can be produced from a given quantity of hot water, use the following basic formula:

Quantity of hot water **X** Temperature rise from cold to hot **=** Quantity of mixed water **X** Temperature rise from cold to mixed

Fig 16.9

Example 10 – Quantity of hot water required

A specification calls for 1000 litres of water at 44°C. You have access to water at 70°C to mix with cold water at 15°C. Determine the quantity of hot water required.

Solution: Work out the quantities in the formula:

Quantity of mixed water	given as 1000 litres
Temperature rise from cold to mixed water	44 – 15 = 29
Temperature rise from cold to hot water	70 – 15 = 55

Using basic mathematical techniques, transpose the formula as follows:

$$Q_h = \frac{Q_m \text{ x } (T_m - T_c)}{(T_h - T_c)}$$

The quantity of hot water = 1000 x 29 / 55

= 527 litres

Which means the quantity of *cold* water required to make up the 1000 litres is 1000 – 527 = 473 litres.

You can use formula 16.8 to check that 527 litres at 70°C mixed with 473 litres at 15°C will give you a final quantity of water at 44°C.

Heat Loss From Pipes

For most purposes, an allowance for pipe losses of 5% of water heater losses is sufficiently accurate for calculating energy consumption. However, in large installations, and in special cases, Table 16.1 can be used.

Nominal diameter (mm)	Heat losses from uninsulated pipe (W/m)	Heat losses from well insulated pipe (10 mm of insulation) (W/m)
15	30	11
20	39	13
25	47	16
32	58	19
40	70	22
50	85	27

Table 16.1: Copper pipe heat losses for 45°C temperature difference

The effectiveness of insulation in reducing heat loss may vary with different materials but 10 mm is the minimum recommended thickness for insulating hot water circulation pipes.

PIPE SIZING

For most domestic situations, it is acceptable to base pipe sizing for hot water reticulation on known average requirements. For unusual domestic installations, or for commercial and industrial applications, it may be necessary to survey the installation and calculate the required pipe diameters.

The steps required are:

1. Establish the system supply pressure.
2. Assess the maximum required flow rate at each outlet and at each branch.
3. Calculate any pressure drop due to height.
4. Calculate the "corrected length" of the pipeline, to allow for pressure losses along the pipe line due to friction, bends etc. This is usually calculated by adding between 10% to 20% to the total pipe length.
5. Use this information to calculate the pressure gradient in the line.
6. Use the chart in Figure 16.1 to assess the recommended pipe diameter.

Flow Rates

The flow required should be determined at each junction point in the complete installation, allowing for the effects of *diversity*.

The following flow rates for hot water design purposes are recommended in AS 3500.4:

Application	Flow Rate (hot water)	
	(Litres/min)	(Litres/sec)
Domestic bath	18	0.3
Domestic shower	6	0.1
Hand basin	6	0.1
Kitchen sink and laundry tub	7	0.12
Washing machines and dishwashers	12	0.2

Table 16.2: Fixture flow rates

For many applications eg multiple dwellings, there will be a significant difference between the minimum, average and peak demand of a hot water system. This ***diversity factor*** must be allowed for.

For commercial and industrial applications (e.g. factory ablutions or change rooms), there will be very little diversity at all during the peak demand period.

Number of living units	MIN Diversified Flow		MAX Diversified Flow	
	L/min	L/sec	L/min	L/sec
1	14	0.25	23	0.38
2	22	0.37	33	0.50
3	28	0.47	40	0.67
4	32	0.53	45	0.75
5	35	0.58	47	0.78
6	36	0.60	48	0.80
7	37	0.62	49	0.82
8	38	0.63	50	0.84
9	39	0.65	51	0.86
10	40	0.67	52	0.88
11	41	0.69	53	0.90
12	42	0.71	54	0.92
Above 12	3.5 / unit	0.06 / unit	4.5 / unit	0.08 / unit

Table 16.3: Diversified flow rates for a block of home units

Calculating Pressure Gradient

The pressure at an outlet will almost always be less than at the heater. (The most common exception is when pressure builds in the pipeline due to the effects of gravity when the water heater is at the top of a multi storey building and the outlet is at the bottom of the building).

Pressure gradient is a measure of the available pressure drop per metre of pipe run. Pressure gradient is measured in kPa/metre. To calculate the pressure gradient between a water heater and an outlet, determine the available static pressure at the outlet, and divide by the total length of pipe between the water heater and the outlet.

In making these calculations, two factors must be used:

Rise: For each 1 metre rise of pipe, there will be almost a 10 kPa drop in pressure.

Friction: 10-20% should be added to the entire length of pipe to allow for loss in pressure due to friction, bends, unions, tees and valves.

Example 11 – Pressure Gradient

A hot water system has an outlet pressure of 410 kPa. Between the heater and the appliance is 15 metres of pipe, of which 3m is vertical rise. What is the pressure gradient along the pipe?

Solution:

Step 1: Allow for the loss due to the pipe rise. Because the rise is 3 metres, there will be a 3 x 10 = 30 kPa loss. The available pressure at the outlet is:

410 – 30 = 380 kPa.

Step 2: Calculate the total length of pipe, after correcting for friction losses. We know that we need to add 10-20% to the total length of pipe. To be conservative, we will add the full 20%. Since 20% x 15 = 3 metres, we can say:

Total corrected length of pipe is 15 + 3 = 18 metres

Step 3: Calculate the drop in pressure per metre of pipe length.

Pressure gradient = Available pressure / pipe length

= 380 / 18

= 21.1 kPa/metre

Pipe Diameter

Figure 16.1 can be used to determine pipe diameters once water flow and pressure gradient are known.

1. Along the bottom axis labelled Pressure Gradient, go to the vertical line that is immediately to the left of the calculated pressure gradient. This means you are working with a gradient that is slightly lower than you calculated. From the above example use 20kPa.
2. Follow this line up the chart until it crosses a sloping flow rate line that is close to the rate you calculated. If there is no line to match your calculations exactly, use the next line up. For example, if you calculated a flow rate of 13 litres per minute, use the 15 litre/min line.
3. Depending on where the vertical and sloping line meet, use the next highest horizontal pipe size line. Follow this horizontal line to the axis labelled Nominal OD, and read off the nominal pipe Outer Diameter. For a pressure gradient of 20kPa with a required flow rate of 15L/min, nominal 15mm copper pipe is recommended.

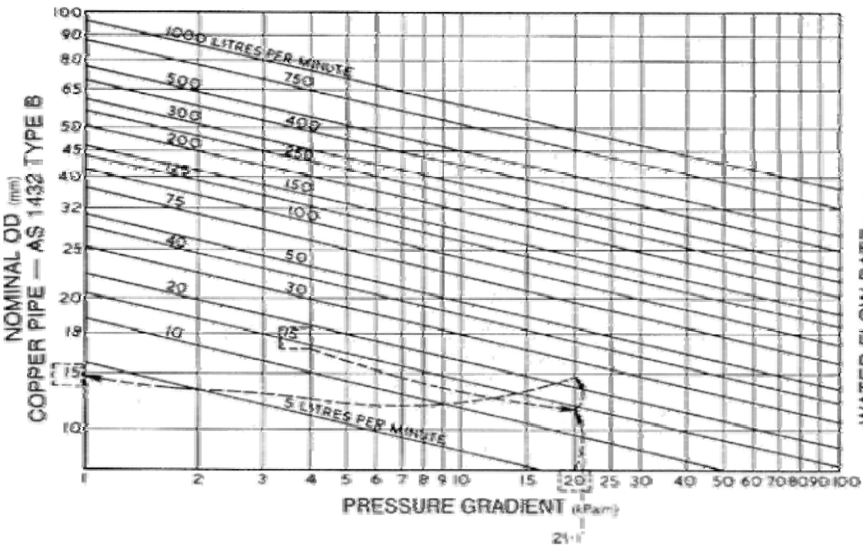

Fig 16.1: Pipe sizing as a function of pressure gradient and total flow.

Example 12 – Pipe Sizing

For the diagram below, calculate the pipe size along each run, where:

- A is a water heater
- D, E, F are bathrooms
- XYZ are kitchens

The pressure at the water heater is 350 kPa.

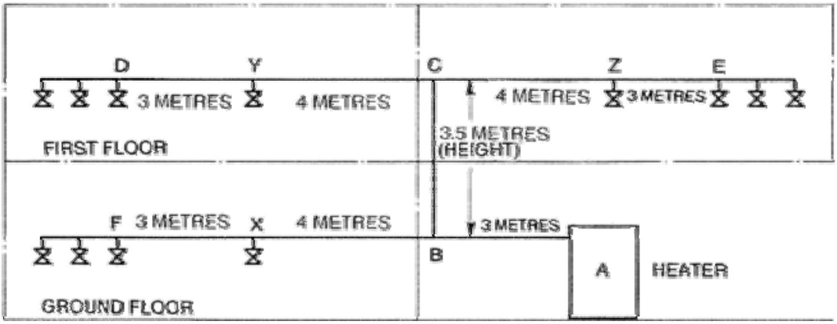

Fig 16.2: Example

Solution:

Step 1: Supply pressure of hot water heater is given as 350 kPa.

Step 2: Maximum flow rates at each branch, according to table 16.3 are:

AB	=	40 litre/min (servicing 3 dwellings)
BC	=	33 litre/min (servicing 2 dwellings)
BX, CY, CZ	=	23 litre/min (serving 1 dwelling)
XF, YD, ZE	=	15 litre/min (allowed for each bathroom, since not all fixtures likely to be on simultaneously)

The lines most likely to be starved are ABCD and ABCE, each with run lengths of 13.5 metres.

Step 3: Calculate the pressure drop in each line resulting from rises:

- For the ground floor units, the available pressure at outlets X and F is unaffected by the rise, and so is taken to be 350 kPa.
- For the top floor units, there is a rise of 3.5 metres. We can calculate the pressure drop as 3.5 x 10 = 35 kPa. Thus the available pressure at C, D, E, Y or Z is 350 – 35 = 315 kPa.

Step 4: Calculate the corrected pipe lengths. Assume a 10% loss due to friction.

- The corrected length for the ground floor unit (ie along the run ABXF) is 10 x 1.1 = 11 metres.
- The corrected length for the top floor units (along the run ABCYD or ABCZE) is 13.5 x 1.1 = 14.9 metres.

Step 5: Calculate the pressure gradient for each pipe run from the two previous steps.

- The pressure gradient for the ground floor unit (ie along the run ABXF) is 350/11 = 31.8 kPa/metre, which we can round down to say 30 kPa/metre.
- The pressure gradient for the top floor units (along the run ABCYD or ABCZE) is 315/14.9 = 21.1 kPa/metre, which we can round down to say 20 kPa/metre.

Step 6: Calculate the pressure drop in each line resulting from rises: This is read directly from figure 16.1. The results are summarised in table 16.4 below.

Pipe run	Pressure gradient (kPa/metre)	Flow rate (L/min)	Pipe diameter (mm)	Capacity of recommended pipe (L/min)
AB	30	40	18	45
BX	30	23	15	30
XF	30	15	10	13
BC	20	33	18	45
CY or CZ	20	23	15	25
YD or ZE	20	15	15	25

Table 16.4: Pipe sizes recommended for example 12.

PIPE CAPACITY

Two other problems arise from time to time:

- What is the volume of dead water in a hot water pipe line?
- How many smaller diameter pipes give the same area as one large pipe?

These problems can be answered using Tables 16.6 and 16.7.

Cross Sectional Area

To calculate the internal area of a grade of pipe, the following needs to be noted:

- Nominal outer diameter (as stated on a specification sheet) is usually different from actual outer diameter (as actually measured)
- Different grades of pipe have different wall thicknesses, as shown in table 16.5.
- The internal diameter is then calculated as

  actual outer diameter – 2 x wall thickness
- Internal area is given by

  $\pi d^2/4$,

  where d is the internal diameter, and π is taken to be 3.142.

Table 16.6 gives the cross sectional areas of different pipe diameters of Type B piping.

Volume Of Dead Water

The volume of dead water in a length of pipe of a given diameter is given by

length of pipe x litres per metre for that pipe diameter.

Table 16.6 gives the litres per meter of varying diameters of type B pipe.

It can easily be seen how litres per metre relates to internal diameter.

Example 13

What is the dead water in 20 m of DN15 copper pipe?

Solution: From table 16.6, DN15 pipe holds 0.0933 litres/meter of water.

Volume of dead water = 20 x 0.0933

= 1.866 L, say 1.9 L

Equivalent Number Of Smaller Pipes

Occasionally it may be necessary to estimate how many smaller pipes will carry the load of one larger pipe. Since a pipe's load carrying capacity is determined by its cross sectional area, this is essentially equivalent to finding the ratio of the internal areas of each pipe specification.

Table 16.7 provides for each pipe diameter, the number of other pipe diameters that are equivalent. For example, reading across from the 20mm OD row, we can see that a 20mm pipe has the same carrying capacity as either 4.88 x 10mm pipes, or 2.43 x 15 mm pipes.

Example 14

How many DN20 copper pipes can be supported by a DN32 copper pipe?

Solution:

Find the large pipe diameter (DN32) in left hand column of Table 16.7 and read across to the vertical column headed by the smaller pipe diameter (DN20). The answer is the number of small pipes equal in area to the single large pipe.

In this case, DN32 pipe = 2.97 x 20 mm, i.e. 3 x 20 mm pipes can be supported by a DN32 pipe.

Outside diameter (mm)		Outside diameter (inches)	Nominal wall thickness (mm)			
Nominal	Actual		Type A	Type B	Type C	Type D
10	9.5	⅜	-	0.9	0.7	-
15	12.7	½	1.2	0.9	0.7	-
18	15.8	⅝	1.2	1.0	0.9	-
20	19.0	¾	1.4	1.0	0.9	-
25	25.4	1	1.6	1.2	0.9	-
32	31.7	1¼	1.6	1.2	-	0.7
40	38.1	1½	1.6	1.2	-	0.9
45	44.4	1¾	-	1.2	-	0.9
50	50.8	2	-	1.2	-	0.9
65	63.4	2½	-	1.2	-	1.2
80	76.1	3	-	1.6	-	1.2
90	88.8	3½	-	1.6	-	1.2
100	102	4	-	1.6	-	1.2
125	127	5	-	1.6	-	1.4
150	152	6	-	2.0	-	1.6
175	178	7	-	2.0	-	-
200	203	8	-	2.0	-	-
225	228	9	-	2.6	-	-

Table 16.5: Wall thicknesses for different grades and diameters of pipe (AS 1432)

Nominal OD (mm)	Actual OD (mm)	Nominal thickness (mm)	Approx. internal area (mm^2)	Litres per metre	Metres per litre
10	9.5	0.9	46.5	0.0465	21.50
15	12.7	0.9	93.3	0.0933	10.72
18	15.8	1.0	150	0.150	6.67
20	19.0	1.0	227	0.227	4.41
25	25.4	1.2	415	0.416	2.40
32	31.7	1.2	674	0.674	1.48
40	38.1	1.2	1001	1.000	1.00
45	44.4	1.2	1385	1.385	0.722
50	50.8	1.2	1840	1.840	0.544
65	63.4	1.2	2922	2.923	0.342
80	76.1	1.6	4174	4.174	0.240
90	88.8	1.6	5755	5.755	0.174
100	101.5	1.6	7589	7.589	0.132

Table 16.6 Internal volume of copper pipe (AS 1432 - Type B)

Nominal OD (mm)	Approx internal area (mm^2)	Nominal OD (mm)						
		10	15	18	20	25	32	40
10	46.5	1.00	0.50	0.31				
15	93.3	2.00	1.00	0.63	0.41			
18	150	3.22	1.60	1.00	0.66	0.36		
20	227	4.88	2.43	1.52	1.00	0.55	0.34	
25	415	8.94	4.45	2.78	1.83	1.00	0.62	0.41
32	674	14.50	7.22	4.50	2.97	1.62	1.00	0.67
40	1001	21.50	10.70	6.69	4.41	2.41	1.49	1.00
45	1385	29.80	14.80	9.26	6.10	3.33	2.05	1.38
50	1840		19.70	12.30	8.10	4.43	2.73	1.84
65	2922		31.30	19.50	12.90	7.03	4.33	2.92
80	4174			27.90	18.40	10.00	6.19	4.17
90	5755				25.30	13.80	8.54	5.75
100	7589					18.30	11.20	7.58

Nominal OD (mm)	Approx internal area (mm^2)	Nominal OD (mm)					
		45	50	65	80	90	100
10	46.5						
15	93.3						
18	150						
20	227						
25	415						
32	674	0.48					
40	1001	0.72	0.54				
45	1385	1.00	0.75	0.47	0.33		
50	1840	1.33	1.00	0.63	0.44	0.32	
65	2922	2.11	1.59	1.00	0.70	0.51	0.38
80	4174	3.01	2.27	1.43	1.00	0.72	0.55
90	5755	4.15	3.13	1.97	1.38	1.00	0.76
100	7589	5.48	4.12	2.59	1.82	1.32	1.00

Table 16.7: Ratio of internal cross sectional area of copper pipe.

Chapter 17

Useful Data

This Chapter:

Contains tables of useful data and conversion factors.

A1006

Table 17.1: Imperial to metric conversions

A	B	C	D
25.4	millimetres	inches	0.03937
0.3048	metres	feet	3.2808
0.001	cubic metres	litres	1000
0.02832	cubic metres	cubic feet	35.3147
4.54609	litres	gallons (imperial)	0.21997
0.833	gallons (imperial)	US gallons	1.201
3.7853	litres	US gallons	0.264
0.0758	litres per second	gallons per minute (imp)	13.198
0.0631	litres per second	gallons per minute (US)	15.84
0.45359	kilograms	pounds	2.2046
28.353	grams	ounces	0.03527
6.8948	kilopascals	pounds per square inch	0.14504
0.2486	kilopascals	inches (water gauge)	4.0219
9.8173	kilopascals	metres (water gauge)	0.10186
9.8173	pascals	millimetres (water gauge)	0.10186
1.0551	kilojoules	Btu's	0.9478
0.0010551	megajoules	Btu's	947.8
3.6	megajoules	kilowatt hours	0.27778
0.03726	megajoules per cubic metre	Btu's per cubic foot	26.839
2.326	kilojoules per kilogram	Btu's per pound	0.42992
11.35653	megajoules per square metre	Btu's per square foot	0.08806
238.9	kilocalories	megajoules	0.004186
23.87915	calories per square centimetre (Langley)	megajoules per square metre	0.041846

To convert from B to C, multiply B by D.

To convert from C to B multiply C by A .

Table 17.2: Approximate conversions (for rough work only)

inches x 25	equals	millimetres
feet x 0.3	equals	metres
litres x 0.22	equals	gallons (imperial)
gallons x 4.5	equals	litres
kilograms x 2.2	equals	pounds
pounds per square inch x 7	equals	kilopascals
kilopascals x 4	equals	inches (water gauge)
Btu's x 1.06	equals	kilojoules
litres at 50°C rise x 0.25	equals	gallons at 80°F rise
gallons at 80°F rise x 4	equals	litres at 50°C rise

Table 17.3: Thermal expansion of water

Temperature	RD of water	Expansion of 1 L when heated from 20°C to temperature
20°C	0.998	-
40°C	0.992	0.006 L
60°C	0.983	0.015 L
80°C	0.972	0.027 L
100°C	0.958	0.042 L

Table 17.4: Temperature Conversion

°C	°F	°C	°F	°C	°F
0	32	35	95	70	158
5	41	40	104	75	167
10	50	45	113	80	176
15	59	50	122	85	185
20	68	55	131	90	194
25	77	60	140	95	203
30	86	65	149	100	212

To convert degrees Fahrenheit to degrees Celsius, deduct 32 and multiply by 5/9. To convert degrees Celsius to degrees Fahrenheit, multiply by 9/5 and add 32.

Table 17.5: Designation of pipe threads (AS 1722 parts 1 and 2)

Sealing pipe threads			Fastening pipe threads		
Type	**Series**	**Example**	**Type**	**Series**	**Example**
Internal taper	RC	RC½/15	Internal	G	G½
Internal parallel	RP	RP½/15	External Class A	GA	GA½
External taper	R	R½/15	External Class B	GB	GB½
External parallel longscrew	RL	RL½/15			

Table 17.6: Metal gauges

No.	BG (Birmingham gauge)		SWG (standard wire gauge)	
	Millimetres	**Inches**	**Millimetres**	**Inches**
1	8.97	0.353	7.62	0.300
2	7.99	0.315	7.01	0.276
3	7.12	0.280	6.40	0.252
4	6.35	0.250	5.89	0.232
5	5.65	0.223	5.39	0.212
6	5.03	0.198	4.88	0.192
7	4.48	0.176	4.47	0.176
8	3.99	0.157	4.06	0.160
9	3.55	0.140	3.66	0.144
10	3.175	0.125	3.251	0.128
12	2.517	0.099	2.642	0.104
14	1.994	0.0785	2.032	0.080
16	1.588	0.0625	1.626	0.064
18	1.257	0.0495	1.219	0.048
20	0.996	0.0392	0.914	0.036
22	0.794	0.0312	0.711	0.028
24	0.629	0.0247	0.559	0.022
26	0.498	0.0196	0.457	0.018
28	0.397	0.0156	0.376	0.0148
30	0.312	0.0123	0.315	0.0124

Table 17.7: Energy conversion

Megajoules	Kilowatt hours	BTU	Megajoules	Kilowatt hours	BTU
10	2.78	9480	65	18.06	61610
15	4.17	14220	70	19.44	66350
20	5.56	18960	75	20.83	71090
25	6.94	23700	80	22.22	75830
30	8.33	28440	85	23.61	80560
35	9.72	33170	90	25.00	85300
40	11.11	37910	95	26.39	90040
45	12.50	42650	100	27.78	94780
50	13.89	47390	110	30.56	104260
55	15.28	52130	120	33.33	113740
60	16.67	56870	130	36.11	123220

Table 17.8: Metre head to kilopascals

Metre head	Kilopascals	Metre head	Kilopascals
1	9.8	30	294
2	19.6	40	392
3	29.4	50	490
4	39.2	60	588
5	49	70	686
6	58.8	80	784
7	68.6	90	882
8	78.4	100	980
9	88.2	110	1 078
10	98	120	1 176
11	107.8	130	1 274
12	117.6	140	1 372
13	127.4	150	1 470
14	137.2	160	1 568
15	147	170	1 666
16	156.8	180	1 764
17	166.6	190	1 862
18	176.4	200	1 960
19	186.2	210	2 058
20	196	220	2 156

Table 17.9: Boiler horsepower to kilowatts

Boiler horsepower	Kilowatts	Boiler horsepower	Kilowatts
1	9.81		
2	19.6	20	196
3	29.41	30	294
4	39.22	40	392
5	49.03	50	490
6	58.84	60	589
7	68.65	70	687
8	78.46	80	785
9	88.27	90	883
10	98.08	100	981

Table 17.10: Comparison of fuels

		Gases						Oils		
		Town	*TLP*	*Natural*	*SNG*	*Propane*	*Butane*	*Fuel*	*Diesel*	*Heating*
HV	(MJ/m^3)	20	25	40	52	94	116	-	-	-
	(MJ/kg)	-	-	-	-	49.5	50.2	42.3	45.4	46.5
	(MJ/L)	-	-	-	-	25.3	29.1	39.8	38.1	37.7
SG:	Gas	0.60	1.14	0.65	1.28	1.52	1.90	-	-	-
	Liquid	-	-	-	-	0.51	0.58	0.94	0.94	0.81
Wobbe index		26.0	23.5	50.5	45.6	77.4	85.4	-	-	-
Nominal inlet gas pressure (kPa)		0.75	0.75	1.13	1.13	2.75	2.75	-	-	-
Cubic metres of air per cubic metre of gas		4.8	6.6	9.5	15.1	23.8	31.1	-	-	-

HV = Heating Value

SG = Specific Gravity

Table 17.11: Significant water temperatures

Temperature	Event
0°C	Freezing point of water at sea-level
4°C	Temperature below which water reduces its density (weight)
8°C	Approximate minimum ambient water temperature in Australia (Melbourne - winter, used in sizing water heaters for Victoria)
13°C	1. Approximate average water temperature in Melbourne 2. Approximate minimum water temperature in Sydney
20°C - 45°C	Temperature range in which Legionella bacteria flourish
24°C	Approximate maximum ambient water temperature in Australia
38°C - 40.5°C	Bathing temperature for children and infants
40°C - 43°C	Bathing temperature for adults
50°C	Maximum supply temperature to bathrooms and ensuites for new installations in Australia
55°C and above	Temperature range in which Legionella bacteria cannot survive
55°C - 60°C	Washing up temperature
60°C	Thermostat setting for booster elements in Solar, Heat Pump and Dual Element water heaters
60°C	Normal setting for domestic gas water heaters
65°C	Maximum setting for domestic gas thermostats
70°C	Maximum setting for Rheemglas electric thermostats
75°C	1. Factory setting for Heavy Duty electric water heater thermostats 2. Maximum setting for Optima electric thermostats
77°C	Temperature required in the sink for sanitising purposes
82°C	Maximum thermostat setting for thermostats in Heavy Duty water heaters
82°C - 92°C	Temperature at which the energy cut-off device will operate on fixed setting thermostats
87°C- 90°C	High limit thermostat setting on 621,631265 and 621,631275 water heaters
87°C - 95°C	Temperature at which the energy cut-off device will operate on adjustable thermostats
93°C - 95°C	Temperature at which a TPR valve subjected to normal working pressure will start to dribble
98.5°C	Nominal thermostat setting for Lazer boiling water units
100°C	Boiling point of water at sea-level

Table 17.12: Abbreviations

There are officially recognised ways of abbreviating the measurements we use and wherever possible the official way should always be used.

One should watch in particular:

1. The plural is the same as the singular and does not require the addition of an "s" (i.e. kg, not kgs).
2. There are no full stops between letters.
3. Some letters are in capitals and others are not.

Note that items marked with * are not used in SI.

ampere	A
*British thermal unit	Btu
*calorie	cal
centimetre	cm
cubic centimetre	cm^3
*cubic foot	cu ft or ft^3
*cubic inch	cu in or in^3
cubic metre	m^3
cubic millimetre	mm^3
degree Celsius	°C
*degree Fahrenheit	°F
*foot	ft
*gallon	gal
*US gallon	US gal
*gallons per minute	gpm or gal/min
*gallons per hour	gph or gal/h
*grain	gr
gram	g
hertz	Hz
hour	h
*hundredweight	cwt
*inch	in
joule	J
kelvin	K
*kilocalorie	kcal

kilogram	kg
kilojoule	kJ
kilometre	km
kilopascal	kPa
kilowatt	kW
kilowatt hour	kWh
litre	L
megajoule	MJ
megapascal	Mpa
metre	m
*mile per hour	mph
milligram	mg
milligram per litre	mg/L
millilitre	mL
millimetre	mm
newton	N
*ounce	oz
parts per million	ppm
pascal	Pa
*pint	pt
*pound	lb
*pound per square inch, (or, more correctly, pounds force per square inch)	psi or lbf/in^2
revolutions per minute	rpm or r/min
second	s
square centimetre	cm^2
*square foot	sq ft or ft^2
*square inch	sq in or in^2
square metre	m^2
square millimetre	mm^2
volt	V
watt	W
*yard	yd

Chapter 18

History of Models

This Chapter Covers:

A full history of Rheem water heaters from 1973 to the present, including:

- An explanation of how model numbers are constructed
- Chronology of Rheem water heaters, organised according to the chapters of this book.

MODEL IDENTIFICATION

This section is designed to provide ready identification of Rheem water heaters manufactured since 1973. Identification of a water heater in the field may help to ensure that a replacement water heater will at least match the performance of the old water heater. This guide should assist in establishing recovery performance, hourly thermal input and storage capacities of Rheem water heaters in the field.

There are two types of numbers associated with Rheem appliances, both having special significance. These are the model number and the serial number.

Serial Number / Date of Manufacture

The serial number, as used prior to 1982, identifies the date of manufacture of the water heater; e.g. serial no. 10/69 represents a unit made in October 1969. Since 1982, water heaters have had the month and year of manufacture also shown on the rating label.

Six digit serial numbers were implemented in 1981 with the introduction of the "Delta Project" water heaters. Seven digit serial numbers were implemented in December 1998, replacing the six digit format. The serial number is shown on the rating label.

Note: In any correspondence relating to a particular water heater, both the model and serial number or date of manufacture should be quoted to ensure the identity of the water heater under discussion.

Model Number

Each appliance has a model number consisting of two groups of two or three numbers each.

- The first part of the model number is the ***series*** to which the appliance belongs.
- The second part of the model number indicates the ***capacity*** in one form or another. This can take a number of forms:
  - capacity/delivery/first hour capacity (in litres or gallons),
  - flow rate (in litres/minute) or
  - input (in megajoules).
  - The input rating is used for the Raypak range of commercial water heaters (and the POWER-fin and Copper-fin water heaters).

When there are two digits in the second part of the model number, these represent the storage capacity in gallons on units produced before metrication. For example, model 14/15 represents a 15 gal gas water heater of the 14 series

When there are three digits, these represent the rating in litres. For example, model 70/135 represents a 135 L gas water heater of the 70 series; model 251/045 represents a 45 L electric water heater of the 251 series.

Series Number

A series of appliances represents a range of appliances of the same basic function and description, produced in the same broad period of time.

In general, the series number is changed at a time when redesign of the product makes the new product non interchangeable with the old, even though the basic function and description may be unaltered.

The series number is allocated according to the basic product description, and groups of numbers are reserved for different basic types (see Tables 18.1, 18.3, 18.4 and 18.5).

Fuel	Description	Series group
Gas	Galvanised steel	10-15
	Copper	20-21
	Silicon bronze	30-31
	Copper lined steel	40-49
	Vitreous enamel lined steel	50-69
	Copper lined steel	70-79
	Not allocated	80-99
Electricity	Not allocated	100-199
	Vitreous enamel lined steel	200-299
	Copper displacement	300-370
	Vitreous enamel lined steel (Weatherline)	300-350
	Copper falling level	400
	Copper side-fed cistern	451-499
	Galvanised steel	500-536
	Silicon bronze	600-699
	Copper lined steel	700-799
	Copper lined steel (Weatherline)	800-899

Table 18.1: Water heater series numbers before 1982

The model number may carry in addition one or more suffixes to denote special application, as shown in Table 18.2.

Suffix	Applicable to	Explanation
F	Gas	Unit supplied with additional connection. For use with gravity/pump circulation.
F	Electric	Unit supplied with additional flow and return connection(s) for supplementary heating by fuel stove, solar heating or circulator.
H	Electric	4.8 kW heating unit supplied.
L	Gas	Unit designed for LPG.
LB	Gas	Unit designed for butane only.
LP	Gas	Unit designed for propane only.
N	Gas	Unit designed for natural gas.
N	Electric	Unit wired for non simultaneous operation of upper and lower heating units.
R	Gas/electric	Unit designed for right-hand connection.
S	Electric	Unit designed for Sydney County Council.
T	Gas	Unit designed for town and TLP gas.
A (prefix)	Electric	281/135 designed for increased pressure rating up to 1400 kPa.

Table 18.2: Suffixes for special applications

Gas water heaters

Fuel	Description	Series group
Gas	Vitreous enamel lined steel - 1 coat	30-31
	Vitreous enamel lined steel - 1 coat, Sprint Superquick Recovery	33
	Vitreous enamel lined steel - 1 coat Energymiser, High Efficiency	38
	Vitreous enamel lined steel - 2 coats or Multiglaze	40-41
	Vitreous enamel lined steel - 2 coats or Multiglaze Energymiser, High Efficiency	48
	Vitreous enamel lined steel - Optima enamel	80-89
	Vitreous enamel lined steel - 1 coat- Heavy Duty	67/270
	Vitreous enamel lined steel - 2 coats - Heavy Duty	60-69
	Copper tube - instantaneous commercial	90-99

Table 18.3: Gas Water heater series numbers after 1982

The first part of the model number is the series number, which indicates whether the water heater has a single vitreous enamel coated cylinder (Rheemglas) or a double/Multiglaze vitreous enamel coated cylinder (Premier), whether it is an indoor or outdoor water heater, whether it is a conventional or a High Efficiency model and its gas type.

Examples

30N	3 –	indicates a gas Rheemglas model
	0 –	indicates a round indoor model
	N –	indicates a natural gas type
31T	3 –	indicates a gas Rheemglas model
	1 –	indicates a square outdoor model
	T –	indicates a town gas or TLP gas type
40P	4 –	indicates a gas Premier model
	0 –	indicates a round indoor model
	P –	indicates a propane gas type
41B	4 –	indicates a gas Premier model
	1 –	indicates a square outdoor model
	B –	indicates a butane gas type
38N	3 –	indicates a gas Rheemglas model
	8 –	indicates a square outdoor High Efficiency model
	N –	indicates a natural gas type
61N	6 –	indicates a Heavy Duty gas model
	1 –	indicates an outdoor model
	N –	indicates a natural gas type

Electric Water Heaters

Description	Series group
Vitreous enamel lined steel - 1 coat - indoor/outdoor	101-162
Vitreous enamel lined steel - 1 coat - DoublePlus	1B1-1D2
Vitreous enamel lined steel - 2 coats or Multiglaze - indoor/outdoor	201-242
Vitreous enamel lined steel - Optima	401-462
Vitreous enamel lined steel - 2 coats or Multiglaze - indoor/outdoor Double Plus	2B1-2D2
Vitreous enamel lined steel - 2 coats - Heavy Duty	603-616

Table 18.4: Water heater series numbers after 1982

The first part of the model number is the series number, which indicates whether the water heater has a single vitreous enamel lined cylinder (Rheemglas) or a double/Multiglaze vitreous enamel lined cylinder (Premier or Optima), whether it is a non-simultaneous wired water heater, or a simultaneous wired water heater, whether it is a right hand model and the number of heating units fitted. Note: All electric models are approved for either indoor or outdoor installation.

Examples

142	1 –	indicates an electric Rheemglas model
	4 –	indicates a non-simultaneous wired water heater
	2 –	indicates a two heating unit model
151	1 –	indicates an electric Rheemglas model
	5 –	indicates a right hand model
	1 –	indicates a single heating unit model
161	1 –	indicates an electric Rheemglas model
	6 –	indicates a "Right" water heater
	1 –	indicates a single heating unit model
202	2 –	indicates an electric Premier model
	0 –	does not indicate anything
	2 –	indicates a two heating unit model (simultaneous)
242	2 –	indicates an electric Premier model
	4 –	indicates a non-simultaneous wired heater
	2 –	indicates a two heating unit model
606	6 –	indicates an electric Heavy Duty model
	0 –	does not indicate anything
	6 –	indicates a six heating unit model
1B1	1 –	indicates an electric Rheemglas model
	B –	indicates a Double Plus cylinder design
	1 –	indicates a single heating unit model

Solar Water Heaters

Description	Series group
Vitreous enamel lined steel - 1 coat - Loline	501
Vitreous enamel lined steel - 1 coat - Loline	531
Vitreous enamel lined steel - 1 coat - Hiline	52R
Vitreous enamel lined steel - 2 coats or Multiglaze - Hiline	52T
Vitreous enamel lined steel - 2 coats or Multiglaze - Hiline frost protected	52F
Vitreous enamel lined steel multiglaze-sequential freeze protected	52S

Table 18.5: Water heater series numbers after 1982

DOMESTIC GAS HEATERS

Rheemglas Models

Indoor Units

Series No.	Description	Approx Production Period
56	Mains pressure gas water heater with vitreous enamel lined steel cylinder. Unit fitted with Unitrol 110RT control (Unitrol 400RT on 60 gallon), and includes a T&PR valve. Known as Rheemglas and replaces Standard. Interchangeable with 46 series.	July 1969 - July 1973
60	Metric Rheemglas mains pressure replacing series 56. Interchangeable with 70 series. Replaced by 67 series.	July 1973 - October 1974
67	Rheemglas mains pressure unit replacing series 60. Fittings for T&PR valves and gas thermostat altered from series 60. Interchangeable with series 77.	October 1974 - February 1982
30 and 300	Mains pressure gas water heater, single coat vitreous enamel lined steel cylinder, round in design, known as a Rheemglas, indoor installation.	April 1982 - current

Table 18.6a: Rheemglas gas models - indoor

Outdoor Units

Series No.	Description	Approx Production Period
53	Trimline mains pressure gas water heater with vitreous enamel lined steel cylinder. Balanced flue wall box unit for external in-wall or elevated in-ceiling installation. Replaced by series 63.	August 1972 – July 1973
63	Metric Trimline Rheemglas balanced flue unit replacing series 53. Replaced by 68 series.	July 1973 - October 1974
68	Trimline Rheemglas balanced flue unit replacing 63 series. Fittings for T&PR valves and gas thermostat altered for 68 series.	October 1974 - July 1976
69	Weatherline mains pressure with bonded vitreous-enamelled cylinder. Balanced flue unit for gas storage water heater.	July 1976 - September 1980
61	Weatherline mains pressure unit, replacing series 69, single coat enamel lined steel cylinder, balanced flue, outdoor installation.	September 1980 – May 1982
31 and 310	Weatherline mains pressure gas water heater, single coat vitreous enamel lined steel cylinder, branded Rheemglas, balanced flue, outdoor installation. Replaced by 311 series.	April 1982 - September 1999
311	Replaces 310 series but has an increased efficiency.	October 1999 – current
314	RheemPlus – Same as 311 but with 50°C maximum temperature delivery in accordance with AS3498. Has in built tempering valve.	September 2004 - current
330	Similar to 310 series but equipped with Multi-fin flue and Super Quick Recovery.	April 1997 - current
38 and 380	Weatherline High Efficiency mains pressure gas water heater, single coat vitreous enamel lined steel cylinder, known as an Energymiser or High Efficiency, balanced flue, outdoor installation.	April 1982 - September 1999

Table 18.6b: Rheemglas gas models - outdoor

Optima Models

Outdoor Units

Series No.	Description	Approx Production Period
810	Similar to 310 series but with Optima vitreous-enamel-lined steel cylinder and two anodes. Replaced by 811 series.	March 1993 - September 1999
811	Replaces 810 series but has an increased efficiency	October 1999 - current
880	High Efficiency model of 810 series water heater.	March 1993 - September 1999
850	Stellar super high efficiency gas water heater incorporating a SuperFlue, Optima enamel and two anodes.	September 1999 - current

Table 18.7: Optima gas models

Coppermatic or Premier Models

Indoor Units

Series No.	Description	Approx Production Period
46	As for series 45, except for addition of T&PR valve, interchangeable with series 56. Replaced by series 70	July 1969 - July 1973
70	Metric Coppermatic mains pressure replaced series 46. Interchangeable with 60 series. Replaced by 77 series.	July 1973 - October 1974
77	Coppermatic mains pressure unit replacing 70 series. Fittings for T&PR valves and gas thermostat altered for 77 series. Interchangeable with 67 series.	October 1974 - February 1982
40	Same as series 30 but has a double coated vitreous enamel lined steel cylinder and known as a Premier.	April 1982 - September 1985

Table 18.8a: Coppermatic and Premier models - indoor

Outdoor Units

Series No.	Description	Approx Production Period
79	Weatherline mains pressure Coppermatic heater, balanced flue, outdoor installation. Replaced by 71 series.	November 1979 - September 1980
71	Weatherline mains pressure unit, replaced series 79, Coppermatic water heater, balanced flue, outdoor installation.	July 1980 - May 1982
41	Same as series 31 but has a double coated vitreous enamel lined cylinder and known as a Premier. (Do not confuse this series with the Coppermatic series produced in the 1950s and 1960s.)	April 1982 - September 1985
	41/200. This water heater is a Premier outdoor model with 200 L water capacity	January 19991 - February 1994
48	Same as series 38 but has a double-coated or Multiglaze vitreous-enamel-lined cylinder and is known as an Energymiser or High Efficiency.	April 1982 - February 1994

Table 18.8b – Coppermatic and Premier models - outdoor

DOMESTIC ELECTRIC HEATERS

Rheemglas Models

Indoor

Series No.	Description	Approx Production Period
1 Heating Unit		
251	Metric Rheemglas mains pressure electric unit with single bolt on heating unit. Replaces series 235. Interchangeable with series 751. Replaced by 281 series.	July 1973 - October 1974
261	Metric Squat Rheemglas with one bolt on heating unit. Replaces series 238. Interchangeable with series 761.	July 1973 - October 1974
281	Similar to series 251, but with change to fittings for T&PR valves. Interchangeable with series 781.	October 1974 - February 1982
ENZ	Rheem New Zealand manufactured water heater branded Right. Available in 25, 40 and 50 L capacities. Rheemglas lined cylinder and 1400 kPa maximum operating pressure.	December 1978 - February 1982
2 Heating Units		
252	Metric Rheemglas mains pressure electric unit with two bolt on heating units. Replaces series 236. Interchangeable with series 752. Replaced by 282 series.	July 1973 - October 1974
282	Similar to series 252 but with change to fittings for T&PR valves. Interchangeable with series 782.	October 1974 – February 1982

Table 18.9a: Rheemglas electric models – indoor

Outdoor – 1 & 2 Heating Units

Series No.	Description	Approx Production Period
301 – 1 heating Unit	Weatherline mains pressure electric storage water heater with vitreous enamel lined cylinder for external installation. Galvanised steel outer casing.	March 1975 - February 1982
302 – 2 heating units	Similar to 301 series but with booster heating unit.	March 1975 - February 1982

Table 18.9b: Rheemglas electric models - outdoor

Indoor and Outdoor

Series No.	Description	Approx Production Period
1 Heating Unit		
101	Mains pressure electric water heater, single coat vitreous enamel lined steel cylinder, known as Rheemglas, single bolt on heating unit, polyurethane foam insulated, approved for indoor or outdoor installation. Replaced by 111 series.	April 1982 - September 1999
111	Replaces 101 series, has thicker insulation providing improved energy efficiency, meeting the requirements of the Minimum Energy Performance Standard (MEPS)	October 1999 - current
121	RheemPlus – Same as 111 but with 50°C maximum temperature delivery in accordance with AS3498. Has in built tempering valve.	September 2004 - current
151	Same as series 101 but is for right hand installation. Available in 50, 80 and 125 L Rheemglas only. Replaced by 171 series.	April 1982 - September 1999
161	Same as series 101 but known as a Right water heater. Outer jacket unpainted Galvabond. Available in 51 and 25 L only.	April 1982 - September 1985
	51, 125, 160 and 250 L models were reintroduced with Colorbond jacket.	June 1991 - May 1994
171	Same as for 161 series but for right hand installations.	March 1983 - July 1985
	Replaces 151 series. Same as 111 series but is for right hand installation, Available in 50, 80 and 125 L Rheemglas only. Meets the requirements of MEPS.	October 1999 - current
191	Dual handed 50L model. Replaced 111 and 171 series 50L for a short period.	July 2004 - January 2006
2 Heating Units		
102	Same as series 101 but has two simultaneously operated heating units.	April 1982 - August 1985
142	Same as series 101 but has two non simultaneously operated heating units. Replaced by 162 series.	April 1982 - August 1999
162	Replaces 142 series Same as 111 series but has two non-simultaneously operated heating units. Meets the requirements of MEPS.	October 1999 - current

Table 18.9c: Rheemglas electric models – indoor and outdoor

Optima Models

Indoor and Outdoor

Series No.	Description	Approx Production Period
1 Heating Unit		
401	Same as series 101 but with Optima vitreous enamel lined steel cylinder and larger anode. Replaced by 411 series	March 1994 - Septemebr 1999
411	Replaces 401 series, has thicker insulation providing superior heat loss characteristics and improved energy efficiency, meeting the requirement of the Minimum Energy Performance Standards (MEPS).	October 1999 – current
2 Heating Units		
442	Same as series 142 but with Optima vitreous enamel lined steel cylinder and larger anode.	March 1994 - Septemebr 1999
462	Replaced by 462 series. Replaces 442 series. Same as 411 series but has two non-simultaneous operated heating units. Meets the requirements of MEPS.	October 1999 – current

Table 18.10: Optima electric models

Coppermatic or Premier Models

Indoor and Outdoor – 1 & 2 Heating Units

Series No.	Description	Approx Production Period
201 – 1 Heating Unit	Mains pressure electric water heater, double coated vitreous enamel lined steel cylinder, known as a Premier, single bolt on heating unit, polyurethane foam insulated, approved for indoor or outdoor installation.	April 1982 - June 1994
202 – 2 Heating Units	Same as series 201 but has two simultaneously operated heating units.	April 1982 - August 1985
242 – 2 Heating Units	Same as series 201 but has two non-simultaneously operated heating units.	April 1982 - June 1994

Table 18.11a: Coppermatic or Premier electric models – indoor and outdoor

Indoor

Series No.	Description	Approx Production Period
1 Heating Unit		
751	Metric Coppermatic mains pressure electric unit with single bolt on heating unit. Replaces series 735. Interchangeable with series 251. Replaced by 781 series.	July 1973 - October 1974
761	Metric Squat Coppermatic with one bolt on heating unit. Replaces series 738. Interchangeable with series 261.	July 1973 - October 1974
781	Similar to 751 series but with change to fittings for T&PR valves. Interchangeable with series 281.	October 1974 - February 1982
722	340L model only. Similar to 783 series but with two heating units in lieu of three. Primarily a Heavy Duty heater but often used in domestic situations.	April 1978 - October 1980
2 Heating Units		
752	Metric Coppermatic mains pressure electric unit with two bolt on heating units. Replaces series 736. Interchangeable with series 252. Replaced by 782 series.	July 1973 - October 1974
782	Similar to 752 series but with change to fittings for T&PR valves. Interchangeable with series 282.	October 1974 – February 1982

Table 18.11b: Coppermatic or Premier electric models - indoor

Outdoor

Series No.	Description	Approx Production Period
1 Heating Unit		
801	Weatherline mains pressure with copper-lined cylinder. For electric storage water heater, external installation. Outer casing as for 301.	March 1975 - February 1982
2 Heating Units		
802	Similar to 801 series but with booster heating units.	March 1975 - February 1982
822	340 L model only. Similar to 803 series, but with two heating units in lieu of three.	April 1978 - October 1980

Table 18.11C: Coppermatic or Premier electric models - outdoor

Domestic Solar Heaters

Loline – Electric Boosting

Indoor Rheemglas Enamel

Series No.	Description	Approx Production Period
240	Similar to 281 series, but with heating unit openings blanked off. Storage cylinder only for solar water heating.	July 1978 - February 1982
241	Similar to 281 series, but with lower heating unit blanked off. Cranked heating unit fitted to top heating unit opening. For solar water heating.	July 1978 - February 1982

Outdoor Rheemglas Enamel

Series No.	Description	Approx Production Period
340	Similar to 301 series, but with heating unit openings blanked off. Storage cylinder only for solar water heating.	July 1978 - February 1982
341	Similar to 301 series, but with lower heating unit blanked off. Cranked heating unit fitted to top heating unit opening for solar water heating. Outer casing as for 301/801.	July 1978 - February 1982

Indoor/Outdoor

Series No.	Description	Approx Production Period
Rheemglas Enamel		
511	Mains pressure solar water heater, Rheemglas vitreous enamel lined steel cylinder, polyurethane foam insulation, with a raised heating unit for electric boosting.	June 2001 - current
591	Glycol filled closed circuit solar water heater suited for frost conditions and poor water quality. Rheemglas vitreous enamel lined steel cylinder.	October 2006 - current
Premier Enamel		
531	Indoor/outdoor polyurethane foamed Premier water heater with single element located in top of tank used for continuous boosting of solar storage.	April 1982 - May 1986

Table 18.12a: Loline electric boost models

Loline - Gas Boosting

Series No.	Description	Approx Production Period
531	Outdoor 260L gas fired storage water heater where the gas booster is controlled by an automatic timer to limit boosting.	December 2002 - current
596	Glycol filled closed circuit solar water heater suited for frost conditions and poor water quality. Integrated instantaneous gas water heater boosts solar pre-heated water in line. Rheemglas vitreous enamel lined steel cylinder.	August 2006 - current
590	Same as 596 series but tank only.	August 2006 - current

Table 18.12b: Loline gas boost models

Hiline

Series No.	Description	Approx Production Period
CCS-200 and 300	Close coupled Hiline mains pressure solar water heater. Vitreous enamel lined steel cylinder. Horizontally roof mounted. Electric boost.	August 1980 - August 1983
52R	Close coupled Hiline solar model replaces models CCS 300 and 200. Manufactured in 300 and 160 L capacity. Outer case in Colorbond on Zincalume or Galvabond.	May 1983 - June 1985
52T300 S (D) and 160	Replaced 52R series. 20 mm diameter flow and return pipes. Flow pipe connects to centre of right hand side of horizontal tank. Suffix S or D refers denotes a straight, providing 160 L boost capacity, or droopy element, providing 260 L boost capacity, on the 300 litre model. Droopy type element was introduced in 1991.	July 1985 - current
52F300 S (D)	Additional model to 52T series. Factory fitted with Rheem frost valves for use in all freezing areas. Suffix S or D refers to whether the element is straight, providing 160 L boost capacity, or droopy, providing 260 L boost capacity. Droopy type element was introduced in 1991.	August 1987 - current
52S160 and 300	Replaced 52T and 52F series. Designed to be installed with sequential freeze collectors (SCT 200, SBT 200) and suitable for areas which experience mild freeze conditions or NPT 200 collectors in non-frost areas.	May 2001 - current
52H180 and 300	Glycol filled closed circuit solar water heater suitable for frost conditions to minus 27^{o}C. Stainless steel cylinder. For use with S200 and T200 multiriser steel collectors.	May 2004 - current

Table 18.13: Hiline electric boost models

Heat Pump Water Heaters

Series No.	Description	Approx Production Period
550	Domestic heat pump water heater with central core condenser. 275 L capacity. No electric element back up for cold conditions.	June 2003 - December 2003
551	Replaces 550 series with electric element back up for cold conditions less than 7°C. 275L capacity.	December 2003 - March 2006
	310 L model with 2 piece heat pump / tank assembly. Central core condenser replaced by brazed plate heat exchanger and pump located in heat pump module.	May 2006 - current

Table 18.14: Heat pump models

Commercial Gas Heaters

Storage Indoor

Series No.	Description	Approx Production Period
74	Metric Coppermatic Heavy Duty mains pressure replacing 44 series. Discontinued and replaced by 75 series.	July 1973 - September 1974
75	Metric Coppermatic Heavy Duty mains pressure suitable for 82°C operation. Superseded 74 series.	September 1977 – September 1982
65	Heavy Duty enamelled version of the 75 series Heavy Duty water heater. 65/260	December 1979 - October 1986
	65/270	September 1982 – July 1989
60	Indoor Heavy Duty water heater with cylinder top concave to pressure using double-coated Heavy Duty enamel. Initial production was 260 L, replacing 67/260.	June 1984 - February 1994
	The 280 L model replaced the 65/260 using Honeywell gas control and polyurethane insulation.	October 1986 - June 1994
	The 290 L model replaced the 65/270 using a Honeywell gas control but retaining the minus cylinder top and rockwool insulation.	July 1989 - June 1994
Premier Enamel		
62	62/260- Indoor Heavy Duty water heater with 50 MJ/h input. Replacement for model 60/260.Now called 620 series.	February 1994 - current
	62/265 - Indoor Heavy Duty water heater with 110 MJ/h input. The central flue is the Multi-Fin type. Replacement for model 60/270.	June 1994 - October 1996
	62/275 - Indoor Heavy Duty water heater with 200 MJ/h input. The central flue is the Multi-Fin type and the insulation is polyurethane foam. Replacement for model 60/290.	June 1994 - October 1996
621	621265 - replaces 62/265. Incorporates Hot Surface Ignition.	October 1996 - current
	621275 - replaces 62/275. Incorporates Hot Surface Ignition.	October 1996 - current

Table 18.15a: Commercial gas models - indoor

Storage Outdoor

Series No.	Description	Approx Production Period
61	Similar design to the 60 series except fitted with a balanced flue assembly and front air duct. 260 litre model	
	61/260	June 1984 - February 1994
	61/280	Nov 1986 - June 1994
	61/290	Feb 1991 - June 1994
Premier Enamel		
63	63/260- Similar to 62/260 but with balanced flue terminal. Replaces model 61/260. Now called 630 series.	February 1994 - current
	63/265 - Similar to 62/265 but with balanced flue terminal. Replaces model 61/280.	June 1994 - October 1996
	63/275 - Similar to 62/275 but with balanced flue terminal. Replaces model 61/290.	June 1994 - October 1996
631	631265 - replaces 63/265. Incorporates Hot Surface Ignition.	October 1996 - current
	631275 - replaces 63/275. Incorporates Hot Surface Ignition.	October 1996 - current

Table 18.15b: Commercial gas models - outdoor

Copper-fin Indoor

Series No.	Description	Approx Production Period
90	Copper-fin - A copper tube gas fired instantaneous water heater designed for commercial applications. The tube for the heat exchanger is copper with fins extruded directly from the tube wall.	Jan 1992 - Dec 1999

Power-fin Indoor/Outdoor

Series No.	Description	Approx Production Period
91	Power-fin - A High Efficiency copper tube gas fired water heater designed for commercial applications. The tube for the heat exchanger is copper with fins extruded directly from the tube wall. Fluing options allow the unit to be installed outdoors or indoors with conventional or room sealed flue.	Jan 1992 - Dec 2003

Table 18.15c: Copper-fin and Power-fin models

COMMERCIAL ELECTRIC HEATERS

Indoor

Series No.	Description	Approx Production Period
Rheemglas 3 Heating Units		
253	Metric Rheemglas mains pressure electric unit with three bolt on heating units. Replaces series 237. Interchangeable with series 753. Replaced by 283 series.	July 1973 - October 1974
283	Similar to series 253, but with change to fittings for T&PR valves. Interchangeable with series 783.	October 1974 - December 1975
Coppermatic Models		
753	Metric Coppermatic mains pressure electric unit with three bolt on heating units. Replaces series 737. Interchangeable with series 253. Replaced by 783 series.	July 1973 - October 1974
783	Similar to 753 series but with change to fittings for T&PR valves. Interchangeable with series 283.	October 1974 - December 1975
2 Heating Units		
722	340 L model only. Similar to 783 series, but with two heating units in lieu of three.	April 1978 - October 1980
Coppermatic Models – 6 Heating Units		
756	Metric Coppermatic mains pressure electric unit with six bolt-on heating units. Interchangeable with series 256. Replaced by 786 series.	July 1973 - October 1974
786	Similar to 756 series but with change to fittings for T&PR valves. Replaced by 806 series.	October 1974 - January 1979

Table 18.16a: Commercial electric models - indoor

Outdoor

Series No.	Description	Approx Production Period
Rheemglas 3 Heating Units		
303	Similar to 301 series, but with three heating units. Interchangeable with 803 series.	March 1975 - February 1982
Coppermatic Models		
803	Similar to 801 series but with three heating units. Interchangeable with 303 series.	March 1975 - February 1982
6 Heating Units		
806	Weatherline mains pressure electric storage water heater for external installation. Cylinder interchangeable with 786 series.	November 1978 - February 1982

Table 18.16b: Commercial electric models - outdoor

Indoor/Outdoor

Series No.	Description	Approx Production Period
Heavy Duty Enamel – 6 Heating Units		
603	Mains pressure electric water heater, double coated vitreous enamel lined steel cylinder designed for commercial/industrial application, three bolt on heating units, polyurethane foam insulated, approved for indoor or outdoor installation. Replaced by 613 series.	April 1982 - September 1999
606	Same as series 603, but has six heating units. Replaced by 616 series.	April 1982 - September 1999
613	Replaces 603 series, has thicker insulation providing improved energy efficiency meeting the requirements of the Minimum Energy Performance Standard (MEPS)	October 1999 - current
616	Same as series 613 but has six heating units.	October 1999 - current

Table 18.16c: Commercial electric models – indoor /outdoor

Boiling Water Units

Series No.	Description	Approx Production Period
411	Boiling water heater, electric with automatic filling and thermostatic control of temperature, for wall mounting. Square, stainless steel jacket and one heating unit.	October 1979 - December 1981
412	Similar to 411, but with two heating units.	October 1979 - December 1981
421	Similar to 411, but with square white enamelled jacket.	October 1979 - December 1981
422	Similar to 421, but with two heating units.	October 1979 - December 1981
431	Similar to 411, but with circular jacket, and designed for use where large quantities of boiling water are required.	October 1979 - December 1981
432	Similar to 431, but with two heating units.	October 1979 - December 1981
433	Similar to 431, but with three heating units.	October 1979 - December 1981
741 A441*	Rheem Lazer boiling water heater. Rectangular copper tank. Microprocessor controls. White enamel jacket.	June 1985 - December 1998
751 A451*	Rheem Lazer boiling water heater. Same as model 441 but stainless steel jacket.	June 1985 - December 1998
742 A442*	Rheem Lazer boiling water heater. Same as A441 with two heating units. 50 L only, white enamel jacket.	June 1985 - June 1996
752 A452*	Rheem Lazer boiling water heater. Same as A442 but with stainless steel jacket.	June 1985 - June 1996
761	Rheem Lazer Silhouette boiling water heater. White plastic jacket. Push button tap. Indicator lights.	Septemebr 1995 - December 1998
771	Replaces 741 series, with new tank dimensions.	January 1999 - current
781	Replaces 751 series, with new tank dimensions.	January 1999 - current
791	Replaces 761 series, with new tank dimensions.	January 1999 - current

* series number A4 replaced with 7 series number from September 1996. eg A441 became 741.

Table 18.17: Boiling water units

ELECTRONIC INSTANTANEOUS GAS

Series No.	Description	Approx Production Period
871	Outdoor electronic instantaneous water heater with Flame Safe technology. Suitable for use with up to 3 x remote temperature controllers. 10 year heat exchanger domestic warranty.	January 2001 - current
875	Same as 871 series but with maximum delivery temperature limited to 48°C to comply with AS3498.	March 2003 - current
271	Same as 871 but branded Everhot.	March 2005 - current
275	Same as 875 but branded Everhot.	March 2005 - current
MPE	Tankless manifolded banks of 871 or 875 series water heaters with staging valves for use on light commercial applications.	May 2006 - current
CPE	Tankless manifolded banks of instantaneous water heaters (Comfort 400) with central controller and multi speed pump providing mains pressure performance for light commercial applications.	May 2006 - current

Table 18.18: Electronic instantaneous models

OTHER COMMERCIAL HEATERS

Raypak Commercial Heaters

Series No.	Description	Approx Production Period
BXXX7	Type A commercial copper tube water heaters available in indoor and outdoor configurations. Most models available with modulating gas controls. 144 – 515 MJ/hr input.	To December 2005
BXXX0	Same as BXXX7 series but with major changes to casing design. ZAM steel replaces powder coat. Available as outdoor model with conversion kit for indoor applications.	December 2005 - current
BXXX8	Type B commercial copper tube Series 8 water heaters available in indoor and outdoor configurations. Models available with on/off or modulating gas controls. 539 – 870 MJ/hr input.	Current
BXXX2	Type B commercial copper tube Series 2 water heaters available in indoor and outdoor configurations. Models available with on/off or modulating gas controls. 976 – 1926 MJ/hr input.	Current
BXXX4	Type B commercial copper tube Series 4 water heaters available in indoor and outdoor configurations. Models available with on/off or modulating gas controls. 2004 – 4224 MJ/hr input.	Current

Table 18.19: Raypak models

Guardian Warm Water

Series No.	Description	Approx Production Period
940	Centralised commercial warm water system using large capacity TMV's and UV disinfection.	November 2003 - current

Table 18.20: Guardian models

Chapter 19

A1006

Glossary of Terms

Definitions and explanations used in this section may not strictly agree with dictionary definitions, but are designed to give a specialised understanding of their meaning and application.

AC (alternating current) Electrical supply in which the polarity of the two wires (i.e. whether a wire is positive or negative) reverses rapidly; AC is the normal electrical supply in all parts of Australia. See also DC (direct current).

Active wire One of the two wires used in household electrical supply (not including the earth wire), is connected to the ground so its voltage is zero. This particular wire is called the neutral wire. The other wire, which will have full supply voltage between it and the earth, is called the active wire. Being the "live" or dangerous wire, an active wire should not be touched until it is isolated from main supply by opening the main switch. It is important the active wire is connected to the terminal marked "A" or "L" on the appliance.

Air The gases comprising the earth's atmosphere. Air has the following approximate constitution:

Nitrogen	78%
Oxygen	21%
Carbon dioxide	variable
Water vapour	variable to 2% - see "Humidity"

Inert gases (argon, neon, etc.) approximately 0.9%

Combustion of gas or liquid fuels requires the presence of oxygen in adequate supply. Normally this is supplied from the air.

Air used in combustion is of two types - primary air (air mixed with the gas or liquid fuel prior to combustion) and secondary air (air admitted to the flame without prior mixing with the fuel.)

The term "excess air" refers to the air passing up the flue and not actually used in combustion. A certain amount of excess air is required for proper combustion.

Ambient temperature The average temperature of the atmosphere in the vicinity of an appliance. Performance of water heaters is generally checked with reference to ambient temperature rather than a fixed temperature, to allow for a statement of performance that will hold true for summer and winter performance.

The generally accepted figure for discussion of performance is 15°C for air and water temperature. However, the Standards Association has adopted 20°C as a standard for electric water heater performance.

Ampere A measure of flow of electric current. An electrical circuit or electrical wiring is designed to take a certain maximum current load, and this should not be exceeded. The current (in amperes) flowing through an appliance is calculated by dividing the load (in watts) by the voltage.

Anode The positive electrode of an electrical cell, or the electrode with the higher potential. The negative electrode is called the cathode.

An anode may be in the form of an expendable electrode used to reduce or prevent corrosion (see "Galvanic action") or as a source of material in electroplating.

AS (Australian Standard) A published industry standard prepared by Standards Australia.

AS Mark The Australian Standards Mark, which can only be affixed to products that have been manufactured under a system of supervision, control and testing in accordance with the Certification Mark Scheme of Standards Australia.

Azimuth The angular distance between true north and the point on the horizon directly below the sun.

Baffle A component designed to control or deflect the flow of a gas or fluid (e.g. flue gases, water in a water heater) so as to obtain an improved or a consistent performance.

Bar The metric unit of pressure used in some European countries instead of Pascals (Pa). One bar equals 100kPa. Abbreviation b.

BG (Birmingham gauge) See "Gauge".

Billion As used in the gas industry this is the American billion of one thousand million (1 000 000 000) and not the British billion of one million million. It should be noted the British have now adopted the American billion.

Boiler AS1200 defines a boiler as follows ‘a vessel or an arrangement of vessels and interconnecting parts, wherein steam or other vapour is generated or other liquid is heated at a pressure above that of the atmosphere by the application of fire, the products of combustion, electrical power, or similar high temperature means. It also includes superheaters, re-heaters, economizers, boiler piping, supports, mountings, valves, gauges, fittings, controls, the boiler setting and directly associated equipment. It does not include a fully flooded or pressurized system where water or other liquid is heated to a temperature lower than the normal atmospheric boiling temperature of the liquid.’

As such, the term ‘boiler’ does not apply to Rheem and Raypak water heaters as these products have safety devices preventing heating above boiling point.

Boiling point The temperature at which a liquid changes to vapour by the addition of heat.

The boiling point depends on the pressure at which the liquid is held, and it increases as the pressure increases.

As the altitude increases atmospheric pressure reduces, so the boiling point of water in an open vessel decreases with rising altitude.

Boost control Used to control the boost function on some types of solar water heaters. The 531 series gas boosted solar water heater uses a remote timer which is set to automatically boost any unheated water at the end of the solar day. Electric boosted solar water heaters can be controlled by a simple on/off switch of suitable current capacity or by an automatic timer fitted in the meter board.

Boost water heater A system utilising a conventional energy source to supplement output energy requirements of a solar heating system, designed to provide backup for hot water requirements in periods of low solar gain.

Brass A wide range of alloys consisting of copper and zinc.

Brazing The action of joining two or more metal parts by the application of heat and using brass, bronze or copper alloy with a melting point below that of the metal parts being joined. In silver brazing the joining material contains a substantial proportion of silver.

British thermal unit (Btu) The unit by which heat energy was measured under the imperial system. It is the amount of heat energy required to raise the temperature of one pound of water through one degree Fahrenheit. Still used in the United States, 1,000Btu = approximately 1megajoule (MJ)

Bronze Originally, an alloy of copper and tin, but now the term covers copper alloys that may or may not have tin in them (e.g. silicon bronze, manganese bronze and aluminium bronze).

BS (British Standard) A published industry standard issued by the British Standards Institute.

BSP (British Standard Pipe) Formerly used to refer to steel pipes and the threads joining them. Now superseded by AS 1722 Parts 1 and 2. (See "Threads".)

Capillary action Derived from a word meaning "hair"; the action of liquids between close surfaces. A wick in kerosene operates because capillary action makes the kerosene climb up the wick above the level of the reservoir. Capillary plumbing fittings depend on the capillary action that makes molten solder flow into a narrow gap between a pipe and a fitting.

Cathode The negative electrode of an electrical cell - the opposite to anode. (See also "Galvanic action".)

Celsius The metric scale for measurement of temperature, formerly known as centigrade. (See also "Temperature", "Kelvin".) Abbreviation C.

Centi- The metric prefix meaning one-hundredth (0.01). Abbreviation c.

Check valve Also known as a non-return valve; a valve that allows a fluid to flow in only one direction in a pipe. Should conditions occur that might lead to flow in the reverse direction, the valve automatically closes.

Close-coupled solar water heater A solar water heater with the cylinder coupled directly to the top of the solar collectors and mounted horizontally, relying on the thermosiphon effect for circulation. It has the advantage of minimal plumbing connections between the collectors and the storage cylinder, but the advantages of superior stratification in the vertical cylinder cannot be obtained, and the weight of the cylinder full of water must be carried by the roof structure.

Collector efficiency The ratio of useful energy extracted from a collector to the solar energy totally available over the collector area.

Colorbond® (Trademark of Bluescope Steel Pty Ltd) A high-quality pre-painted steel sheet or coil that can be fabricated into an end product without further treatment. It is produced on modern high-speed continuous-coil coating lines and is available with a base of cold-rolled uncoated, zinc-coated or Zincalume® steel. The metal is then coated with a modified polyester paint. Colorbond is often used as a roofing material because of its ability to withstand many years of exposure to Australian weather conditions.

Combustion The reaction of gaseous, liquid or solid fuels at an elevated temperature with oxygen by burning, thus releasing heat.

For perfect combustion an adequate supply of oxygen must be available, all the carbon in the fuel will be converted to carbon dioxide and all the hydrogen to water vapour. The presence of carbon monoxide in the flue gases and/or sooting indicates imperfect combustion.

Conduction Two types are generally referred to: electrical conduction and thermal conduction. Electrical conduction is the ability of a material to transmit an electric current through a length of that material. Those materials that carry a current easily are called conductors, and those that do so with difficulty are called resistors or insulators. Materials that transmit heat easily are also good conductors. Materials that restrict the movement of heat are called insulators.

Controller A wall mounted device, which allows the consumer to select and adjust the hot water temperature, when connected to a Rheem Integrity electronic instantaneous gas water heater.

Convection The transfer of heat by means of a flow of fluid. The fluid (which may be a gas such as air or a liquid such as water) is heated in one place, then moved to a place where it can give up its heat.

Convection can be either natural or forced.

Natural convection is caused by the expansion of a fluid with heat, making it less dense than the surrounding fluid and allowing the heated fluid to rise. This principle is used in the heating of water by applying heat at the bottom of a vessel, and also in convection-type space heaters.

Forced convection refers to the transfer of heater fluid by pump or fan and is used where natural convection is either inadequate or unsuitable.

Copper A metallic element widely used in the electrical industry because of its high electrical conductivity, and in the sheet metal industry because of its ease of working, its high thermal conductivity and its resistance to corrosion. Various grades of copper are commercially available for specific applications, e.g. "commercial" or "tough pitch", "deoxidised" and "arsenical". These different grades cannot be identified by eye, only by analysis or metallurgical examination.

Cusilman A trade name for silicon bronze.

Cycle The number of times per second a conductor carrying ac returns to the same polarity. Generally 50 cycle ac is supplied in Australia, although 40 cycle may be experienced. The cycles do not affect heating elements, but may affect ancillary equipment such as solenoids or coils. Synchronous motors, as used in clocks and timing mechanisms, are directly affected by changes in cycle. 60 cycle is generally used in the USA. (See also "Hertz").

DC (direct current) Electrical supply in which the polarity of the two wires (whether the wire is positive or negative) does not change. Batteries produce DC, as do home lighting sets. dc supply is also found in tramway and railway use, on board some ships and in older types of generating equipment. While elements will operate equally on dc or ac, ancillary equipment such as thermostats, motors, etc. do not, and special arrangements have to be made to enable an appliance designed for AC to operate on DC.

Deca- The metric prefix meaning ten (10). Abbreviation D

Deci- The metric prefix meaning one-tenth (0.1). Abbreviation d.

Designer A range of Lazer Boiling water units designed with a sculptured white plastic jacket, push button control and indicator lights.

Dezincification The deterioration experienced by many brasses when exposed to hot water in which the zinc content is gradually removed, leaving a spongy copper structure. Components suffering dezincification may become porous and leak, or become brittle and break readily. Some waters produce this effect much more rapidly than others. Copper alloys for hot water use should be selected from those that do not dezincify. Brass fittings approved for use in Australia must be DR and stamped or indicated permanently on the component.

Differential See "Thermostat".

Displacement principle The principle that hot water is less dense than cold water is used in the operation of most storage water heaters. If cold water is fed into the bottom of a tank full of hot water it will displace an equal quantity of hot water out of the top of the tank, and if the water heater is correctly designed the hot water will float on the cold water for a considerable time without mixing. All Rheem water heaters in current production use the displacement principle.

Diversity The difference between the maximum possible load on an electrical wiring system or water supply piping if all outlets were in use at once and the likely load at any given time. For example, in a multistorey building, only a predictable percentage of the taps will be turned on at any one time. However, it can be expected all taps in a sportsground shower block will be turned on at once and require full water flow. In the first case the diversity factor will be low (perhaps 60%), while the shower block diversity factor must be 100%. Electrical diversity allowances are provided in the AS wiring rules section on cable sizes.

Drain down valves Valves used on solar water heaters to prevent freezing of the collectors. Valves fitted on each of the flow and return pipes isolate the collectors from the normal water supply as the ambient temperature falls towards freezing conditions. The valve fitted to the return pipe also opens to atmosphere, allowing the water in the collectors to drain out. The valve on the flow pipe allows air to replace the water as it drains and also purges the air during the refilling of the collectors. Once the ambient temperature rises above freezing conditions, the valves will revert to their normal operating positions. Heat exchange fluid systems have replaced drain down valves for freeze protection on current Rheem solar water heaters. See “glycol”.

Draught diverter A device fitted in the flue way of a gas appliance to prevent up-draught, down-draught or secondary flue blockage from obstructing the escape of products of combustion, or otherwise affecting the normal operation of the appliance.

Earth A safety device required in all major electrical appliances in Australia. There must be a separate connection between exposed metal surfaces of an appliance and the ground, so that in the event of failure of a "live" wire no part of an appliance likely to be touched can endanger life. All major appliances are provided with an "earth" connection clearly marked for this purpose.

Efficiency A measure of performance expressing the results obtained as a percentage of effort put in. On this basis, thermal efficiency is the percentage of the potential heat content of a fuel that becomes usefully available as hot water (or hot air in the case of a space heater).

Thermal efficiency is a measure of performance under stated conditions, and the efficiency will vary as the conditions are varied. Accordingly, official or test thermal efficiencies should not be quoted or used unless the circumstances are comparable to the method of test.

The differences between "thermal efficiency" and "service efficiency" are discussed in detail in Chapter 16 (See also "Pipe losses".)

Electrolyte Any water containing dissolved minerals that is capable of conducting electricity.

Element The element is the coil of resistance wire that produces heat by the passage of an electric current through it. Also used to generically refer to what is known as a heating unit or heating element.

Energy cut-out (ECO) A safety device fitted to a water heater and designed to cut off the energy supply to the water heater (i.e. gas or electricity) should the thermostat cease to function. The energy cut-out is intended to prevent the occurrence of excessive temperature in the water heater.

Energy input The rate at which energy is supplied to an appliance.

The hourly gas consumption (HGC) is the basic or nominal input at which a gas appliance was tested and to which published performance figures apply.

The HGC is the input for 1 hour in megajoules (MJ). Orifice size supplied and published gas pressure at the orifice give HGC on one particular gas only, and adjustment may be needed on other gas types. (See "Wobbe index".)

Electrical appliances are rated in kilowatts or watts (1 kilowatt equals 1000 watts). Again, this applies only to the voltage for which the element is designed, and the actual input will be affected as follows:

Heating unit design voltage (V)	***Watts produced by an element as a percentage of its watts rating***			
	220 V	230 V	240 V	250 V
220	100%	109%	119%	129%
230	92%	100%	109%	118%
240	84%	92%	100%	109%

Fahrenheit The imperial scale for measurement of temperature. See Table 16.10. Abbreviation °F.

Fatigue Just as the human body can break down if exposed too long to an adverse environment or repeated stress, so also can materials fail due to fatigue. A material can fail by repeated exposure to a stress well below its normal breaking point purely by cycling the stress on and off. Water heaters can be exposed to repeated pressure fluctuations during their life and must be designed to resist the effects of fatigue.

Five-way inlet connector A connector attached to the inlet fitting of Rheem water heaters in solar Loline systems which do not have a separate return connection. Typically used when converting an electric water heater to solar. The five connections are:

1. cold water inlet
2. cold water connection to pump and collectors
3. solar-heated water from collectors
4. water heater connection

5. temperature sensor well

This device ensures water can be efficiently circulated between the water heater and the collectors.

Flow-control valve A device limiting the flow of liquid in a pipe to a predetermined flow rate irrespective of the pressure conditions in the line.

Flux A material used in soldering or brazing to remove impurities from the surfaces to be joined and to promote wetting of these surfaces by the joining material. In welding, flux is used to remove impurities, to promote a sound weld joint and to protect the area from oxidation while it is still hot. In galvanising, flux is used to promote wetting of the steel surface by the molten zinc.

Free-outlet water heater See "Push-through water heater".

Gallon The imperial measure of liquid volume equal to the volume of 10 lbs of water. The US gallon contains 8.33 lbs of water.

Galvanic action The flow of electrical current that occurs when two dissimilar metals are immersed in an electrolyte. The metal that becomes the anode of this cell will corrode and dissolve, while the cathode will be protected from corrosion. The further the two metals are on the galvanic scale, the greater the current flow and the rate of dissipation of the anode.

Galvanising The process of coating steel with zinc. In hot-dip galvanising, the surface of the steel is pickled by acid to remove all oxide and scale, then dipped through flux into a bath of molten zinc. When withdrawn, the steel is completely coated with zinc. The zinc is anodic to steel and protects it by galvanic action.

Gas This definition is confined to the fuel gases for which our appliances are designed. There are five basic types of fuel gas:

1. natural gas
2. town gas and PNG
3. LPG
4. TLP gas
5. SNG

Natural gas: This is widely used throughout the world and is obtained from bores sunk into the earth either on land or under the sea. Although natural gas varies in different parts of the world, it is basically methane, but it may contain a number of other contaminants that may have to be removed before it can be distributed. A "wet gas" contains hydrocarbons that are liquid at normal temperatures (e.g. petrol fractions); a "sour gas" contains hydrogen sulphide. As finally distributed, natural gas is substantially methane, it has a high HV of around 40 MJ/m^3 and is not toxic.

Town gas: This is of very variable composition, depending on the plant and raw materials used in its production. Although it was originally based on coal gas, coal is becoming less significant as a raw material and reformed gas is becoming more important. Town gas has a HV around 20 MJ/m^3 and is generally toxic due to its carbon monoxide content, although at least one producer of town gas is detoxifying its gas by conversion of its carbon monoxide to harmless compounds. Town gas is made of one or more of the following gases:

Coal gas: Gas produced by heating black coal in sealed retorts, and removing tars, oils, ammonia, moisture, benzol and hydrogen sulphide from the gas produced. It comprises hydrogen (about 45%), carbon monoxide (6%), methane and similar saturated hydrocarbons (30%), unsaturated hydrocarbons (5%), carbon dioxide (2%), and a certain amount of oxygen and nitrogen.

Oil gas: A gas made from thermal cracking of waste refinery oils. This gas has a high HV and contains carbon monoxide, methane and unsaturated hydrocarbons

Blue water gas: A low HV gas made by blowing steam over incandescent coke. It contains carbon monoxide and hydrogen.

Carburetted water gas: A water gas in which refinery oils are introduced into the process, giving rise to methane and unsaturated hydrocarbons, as well as carbon monoxide and hydrogen.

Reformed gas: Gas with characteristics similar to those of conventional town gas produced by the catalytic processing of other fuels such as natural gas, LPG, refinery gases or refinery oil residues or fractions. Natural gas is catalytically processed to produce a town gas referred to as processed natural gas (PNG).

LPG (liquefied petroleum gas): This consists of commercial propane (C_3H_8) or butane (C_4H_{10}) or a mixture of both. These gases are obtained as by-products from the processing of raw natural gas or from oil refining. The gases can be distributed as a gas, or more frequently compressed to a liquid under pressure and transported in pressure vessels. LPG, when sold under a trade name such as Elgas, Heatane, etc., is usually commercial propane, but butane may be supplied in hotter regions. LPG has a high HV (95 MJ/m^3 for propane, 118 MJ/m^3 for butane) and a high relative density (1.5 propane, 1.9 butane). Being heavier than air, LPG does not disperse as readily as town gas, and this makes LPG more hazardous than town gas.

TLP gas (tempered liquefied petroleum gas): This is a mixture of propane (or butane) and air for distribution by piped supply from a central source, as with town gas. It is being used to replace town gas, particularly in country areas, due to the ease with which it can be produced by automatic plant operation.

SNG (simulated natural gas): A mixture of LPG and air for distribution by piped supply from a central source. As the name implies, it approximates the characteristics of natural gas and is used as a substitute for natural gas either before natural gas is used or as a peak load substitute.

In the USA the letters SNG stand for synthetic natural gas, which is methane produced from coal or raw material other than natural gas.

Gauge A means used under the imperial system to indicate the thickness of metal or the diameter of a wire. Two standard tables were used in Australia - BG (Birmingham gauge) for mild steel and low alloy steel, and SWG (Standard Wire Gauge) for nonferrous metals such as copper and aluminium, and for stainless steel. As metal thickness is reduced the gauge number is increased, for example:

10 BG	Nominal thickness 0.125	inch (3.175 mm)
24 BG	Nominal thickness 0.0247	inch (0.629 mm)
10 SWG	Nominal thickness 0.128	inch (3.251 mm)
24 SWG	Nominal thickness 0.022	inch (0.559 mm)

Glass lining See "Vitreous enamel".

Glass transmissivity The percentage of normal incident energy that is transmitted through glass; it varies according to glass composition and thickness

Glycol Propylene glycol (90%) in conjunction with di-potassium phosphate (corrosion inhibitor), distilled water and a trace amount of food grade blue (colour) is used in heat exchange solar systems to enable use in areas prone to sub zero frost or with poor water quality.

Gram The metric unit of mass. Abbreviation g.

Greenhouse effect The ability of a sheet of glass to trap solar energy. Incoming sun's rays, which are mainly in the visible and infra-red wave bands, will pass easily through a sheet of glass. However, after they strike and begin to heat an absorbing surface, some energy is re-radiated, but at a wavelength that will not pass through glass. Thus, heat energy can be trapped in a greenhouse, a motorcar parked in the sun, or in a solar collector with a glass plate in front of the absorber.

The term “greenhouse effect” can now also be applied to the heating of the earth’s atmosphere. This is caused by the release of gases, predominantly carbon dioxide (CO_2), into the atmosphere by industry and transportation. These gases, referred to as greenhouse gases, are changing the way energy from the sun interacts with and escapes from our planets atmosphere. The result is a slow increase in the average temperature of the earth’s atmosphere.

Greenhouse gases A term used to define a group of gases, including carbon dioxide (CO2), methane (CH4) and nitrous oxide (N2O), occurring in the earth’s atmosphere and have an insulating effect to keep the planet warm. Without these gases, at naturally occurring levels, earth would be up to 30°C colder than it is today. The increase in the levels of these gases in the atmosphere, due to industry and transportation, is having the effect of warming the earth’s atmosphere above naturally occurring levels.

Hardness (of water) Natural waters contain various amounts of dissolved impurities. Some of these impurities affect the lathering of soap, with the main offenders being the soluble salts of magnesium and calcium.

The hardness of water is defined as it’s difficulty in raising lather, and is measured in terms of the equivalent amount of calcium carbonate in a solution that would cause equal difficulty in lathering.

It is expressed in milligrams per litre (mg/L).

The hardness is generally determined by finding the quantity of a specially prepared soap solution that is necessary to add to a known quantity of the water in order to establish a permanent lather; however, it can also be determined using general chemical analysis techniques.

A general classification of waters would be as follows:

Type	*Hardness*
Soft	0- 49 mg/L
Fairly soft	50- 99 mg/L
Fairly hard	100-149 mg/L
Hard	150-249 mg/L
Very hard	250 mg/L plus

Head The pressure of water as measured at a stated point. It may be measured in kilopascals or in metres of water.

The head is the vertical distance from the point of measurement to the free level of water in the system.

A positive head occurs where the free water level is higher than the point of measurement.

A negative or "suction" head occurs where the free water level is lower than the point of measurement. A negative head may also be referred to as a "partial vacuum" or "negative pressure".

Heat A form of energy, when added to anything, makes it hotter, and when taken away makes it colder.

Heat cannot be destroyed, but can be changed in form. All heat present at the start of some action must be present in some form at the end.

Heat will flow naturally from a body at a higher temperature to one at a lower temperature, but not in the reverse direction without some mechanical or other aid, such as refrigeration.

Heat exchange water heater Also known as "indirect storage" or "coil-type" water heater; a water heater in which water is heated by passing through a heat exchanger (usually in the form of a coil of copper tubing) immersed in static heated water.

The term “heat exchange” can also be used to describe solar water heaters in which the solar energy collected is transferred to the consumable or potable water via a heat exchanger. The heat exchanger could be in the form of a coil inside the cylinder or a jacket wrapped around the cylinder.

Heat input See "Energy input".

Heat loss See "Maintenance rate".

Heating unit Refers to the complete electrical heating assembly comprising the heating element, insulation, sheath and supports. See “Element”.

Heating value (HV) Formerly referred to as calorific value; the amount of heat developed when a unit quantity of a fuel is burnt. The HV may be quoted as either "gross" or "net", the latter being the more realistic figure. The "gross" HV includes the heat content in the water vapour in the products of combustion, which can only be recovered if all water vapour in the flue gases were condensed.

The gas industry usually quotes gross HV and the oil industry uses net HV.

The HV is quoted in the following terms:

Natural, town and TLP gas	MJ/m^3
LPG	MJ/m^3 or MJ/kg
Liquid fuels	MJ/L or MJ/kg
Solid fuels	MJ/kg

Hertz A measure of frequency. One hertz equals one cycle per second. 50 cycle ac is 50 hertz ac (see "Cycle"). Abbreviation Hz.

Humidity Air normally contains a certain amount of water vapour. At any temperature, there is a limit as to how much water vapour the air can hold. The amount rises as the temperature rises, and falls as the temperature falls.

The humidity of the atmosphere is the ratio between the present water vapour content of the air and the maximum amount of water vapour the air could contain at that temperature. The ratio is expressed as a percentage.

An atmosphere of high humidity is a "muggy" atmosphere with little evaporation of water taking place. Low humidity indicates an ability to take up more moisture, and gives good evaporation of water.

The humidity is often measured by observing the difference between an ordinary "dry bulb" thermometer and a "wet bulb" thermometer, in which a wet cloth is wrapped round the bulb of a thermometer. Reference to appropriate psychrometric charts will indicate the humidity of the atmosphere.

Hydrostatic pressure Another name for "head" under static conditions, i.e. with no flow of water.

Insolation Radiation from the sun. Measured in MJ/m2

Instantaneous water heater A type of water heater in which heat energy is added only when water is flowing through the water heater (as a contrast to a storage water heater).

Insulation (electrical) Materials having such poor ability to conduct electricity they are used to prevent the escape of electricity from a "live" part.

Insulation resistance (IR) Even the best of electrical insulation is still capable of carrying some electricity. The IR is a measure of the insulating qualities of electrical insulation. It is measured by means of a "megger" instrument, which measures the current flowing when a relatively high dc voltage is applied.

Supply authorities may refuse to connect an appliance with an IR less than a certain value. For water heaters, the value is 1 megohm.

Insulation (thermal) Materials with such poor ability to conduct heat that they are used to prevent heat being lost from an appliance. Most insulating materials depend for their effect on the presence of numerous air cells, so held that convection is restricted or prevented.

Integrity A range of Rheem electronic instantaneous gas water heaters, which can be installed in conjunction with consumer adjustable temperature controllers

Joule The metric unit of energy, equal to one watt second. Abbreviation J.

Kelvin An alternative scale for temperature measurement often referred to as the "absolute temperature scale" because theoretically at 0 Kelvin all molecular and atomic particle activity ceases. Kelvin (K) = degrees Celsius (°C) + 273.15

Kilo- The metric prefix meaning one thousand (1000). Abbreviation k.

Kilowatt hour (kWh) A measure of the amount of energy used, equal to 1 kilowatt operating for 1 hour, 2 kilowatts for 1/2 hour, 1/2 kilowatt for 2 hours, 100 watts for 10 hours, etc. The kilowatt hour is the unit of energy by which electricity is sold to the consumer.

Legionnaires' disease An illness characterised by pneumonia, caused by infection of Legionella bacillus (Legionella pneumophila). Transmission is by inhalation of aerosols (minute particles suspended in air) from infected waters. There is no evidence of direct person-to-person transmission of the disease.

Legionella bacillus is widely distributed in nature and is commonly found in surface water and soil. Given the right conditions, it can establish itself in water systems in buildings, particularly cooling towers of air-conditioning systems or warm water systems where water is stored at temperatures up to 45°C. The organism is destroyed instantly at 60°C and cannot survive at temperatures exceeding 55°C.

Litre The metric unit of volume. Abbreviation L.

LPG Liquefied petroleum gas. See "Gas".

Mains pressure water heater A water heater connected directly to the cold water mains so that hot water is delivered at the same pressure as the cold water

Maintenance rate (standby losses) The rate at which heat or energy has to be supplied to an appliance to maintain its temperature at the required level without the unit being used. In the case of a storage water heater, it is the heat input required to hold the unit at the required temperature (generally 45°C above ambient on gas water heaters and 55°C above ambient on electric water heaters).

The maintenance rate may be measured in megajoules per hour for gas or kilowatt hours per 24 hours for electricity. The temperature above ambient must always be quoted. In reference to electric water heaters, the term "heat loss" is usually used.

Mega- The metric prefix meaning one million (1 000 000). Abbreviation M.

Metre The metric unit of length. Abbreviation m.

Metric system A decimal system of weights and measures originally based on the gram (weight), metre (length), second (time), etc. It was founded in the 1790s and is widely used in Europe and Asia. (See "SI units".)

Micro- The metric prefix meaning one-millionth (0.000 001). Abbreviation µ.

Milli- The metric prefix meaning one-thousandth (0.001). Abbreviation m

Milligrams per litre (mg/L) The SI unit for parts per million (ppm). All water analyses now use these units for the amount of dissolved minerals.

Natural gas See "Gas".

Neutral wire See "Active wire". The "neutral wire", although safe, should be checked before it is touched in case the installing electrician has made a mistake in its connection.

Newton The metric unit of force. Abbreviation N.

Non-return valve See "Check valve".

Ohm A measure of the resistance of a material to the flow of electricity.

1 megohm = 1 000 000 ohms. Abbreviation Ω.

Ohm's law The resistance of a conductor in ohms is equal to the voltage drop from one end of the conductor to the other, divided by the current flowing through the conductor, measured in amperes. R = V/I or V = IR.

Optima A range of Rheem domestic storage water heaters, both gas and electric, provided with the Optima vitreous enamel and increased anode mass and a 10 year full replacement warranty on the cylinder.

Over-temperature cut-out (OTC) See "Energy cut-out".

Pascal The metric unit of pressure, equal to a force of one Newton per square metre. Abbreviation Pa. The Pascal is a very small unit of measure and the kilopascal (KPa) is more commonly used.

Peak demand for hot water The amount of hot water used over the busiest period of the day in a building. For household and many commercial purposes, peak demand arises in two hours per day and occurs when people are bathing, showering, etc. To provide hot water for the peak demand period, an instantaneous water heater must have a very high input, and this reflects in a heavy demand on the gas or electricity supply authority's system. In a storage water heating system, sufficient hot water can be stored to provide for the demands of the peak period and recover over a longer period, hence load on the system is at a lower rate.

Phase For ease of production and distribution, AC is distributed in what is known as three-phase supply, using three active wires and one neutral wire. On 240/415 V supply, the voltage between any one active wire and the neutral is 240 V, but between any two active wires it is 415 V. The three-phase supply is used as follows:

1. Single-phase: One active and one neutral. Maximum loading depends on local supply authority's ruling.

2. Two-phase: Two active and one neutral. Maximum loading depends on local supply authority's ruling.

3. Three-phase: Three active and one neutral. No limit to loading, except loading should be balanced on each of the three phases. Three-phase may also be used with three active lines and no neutral, using the higher voltage between two active lines. Due to the fact the three phases are slightly out of step, the current loading per phase is less than would be expected. Given by the formula:

$$\text{current per line (A)} = \frac{\text{total power (W)}}{\sqrt{3} \times \text{voltage (V)}} = \frac{\text{total power (W)}}{1.732 \times \text{voltage (V)}}$$

For example, a 13 kW loading on 415 V supply gives:

$$\text{current per line} = \frac{13\ 000}{1.732 \times 415} = 18.1 \text{ A}$$

pH A measure of the acidity or alkalinity of an aqueous solution on a scale of 0 to 14. A pH value of 7.0 indicates a completely neutral solution. Below 7.0 the solution is acidic; the lower the pH the more acidic it is. Above 7.0 the solution is alkaline, and the higher the pH the more alkaline it is. The pH of a water supply is a critical factor in its analysis.

Piezo ignitor A device used to provide a high-voltage spark to ignite the pilot flame on a gas water heater. Pushing the ignitor button permits a spring-load plunger to strike and deform a piezo crystal. This generates a very high voltage, which causes a sharp spark to jump across the gap between the electrode and the pilot burner. The spark ignites the pilot flame.

Pipe losses Acceptance tests of a water heater are carried out on an isolated water heater (not connected to hot or cold water lines), so maintenance rates determined do not apply to the installed water heater.

Additional losses, called pipe losses, take place when the water heater is installed, and these are made up as follows:

Conduction of heat along the hot and cold water pipes. This effect is generally limited.

Convection of water in the hot water line above the water heater. This effect can be quite large, but can be reduced by introducing a heat trap in the hot water line at the water heater. Note: all Rheem storage water heaters have an integral heat trap.

Radiation from the hot water pipes and fittings. These are reduced by insulating with a suitable pipe insulation material, e.g. hair felt, Bradflex, polylag, etc.

Between uses, the water in the hot water line gets cold, and this has to be run off before hot water can be drawn from a tap.

The overall effect is reduced by the following means:

Fit a heat trap in the hot water line where one is not an integral part of the water heater. Use small-bore pipe. Use short runs of pipe. Insulate hot water pipes, particularly the section nearest the water heater.

In calculating the fuel used in an installation, first allow for the overall service efficiency (see "Efficiency"), then add an amount to cover pipe losses.

Polyurethane insulation An insulating material composed of two chemicals that when mixed expand to approximately 30 times their original volume. It is injected into the area between the cylinder and outer jacket of a storage water heater and sets within 5 minutes. It creates a rigid support to the outer jacket, and is 50% more insulation efficient than a fibre wool blanket of the same thickness. Polyurethane is used in Rheem electric, gas and solar water heaters. In 1993 Rheem became the first major manufacturer to introduce CFC-free polyurethane foam insulation in water heaters.

Power The rate at which energy is supplied. Usually reserved for electrical supply. Unit of measure is the watt. Abbreviation W.

PPM (parts per million) A measure of concentration of ingredients in water; older water analyses showed the ingredients being present, as so many "parts per million". Today the SI units of milligrams per litre (mg/L) are used.

Pressure For water pressure, see "Head".

For liquids other than water the same principles apply, but a correction should be made for the relative density of the liquid. For instance, a liquid (such as oil or kerosene) less dense than water will exert a lower pressure with the same vertical head. The pressure can be calculated by multiplying the measured head in metres by the relative density of the other liquid.

For gases in enclosed vessels, the static pressure of the gas is approximately equal at all points.

The pressure in a fuel gas supply line may be determined by measuring the vertical distance between water levels in both arms of a U tube manometer connected to the gas supply line and converting to kilopascals.

Pressure-limiting valve A form of pressure-reducing valve that automatically reduces inlet water pressure to within acceptable limits at the outlet under static cold water conditions, but only when supply pressure exceeds a set minimum.

Pressure-reducing valve (pressure-reduction valve) A valve that automatically reduces inlet water pressure to a specified value at its outlet under static cold water conditions.

Pressure-relief valve Also known as a "water-pressure-relief valve" or WPRV; a device that automatically opens a relief vent when the pressure rises to a predetermined value and closes when the pressure falls below a set value.

Primary flue The flue passage within an appliance that conducts the flue products from the combustion chamber to the draught diverter or a balanced flue terminal. The primary flue in a conventional storage water heater passes through the centre of the storage cylinder and provides heat transfer surface area.

Primary hot water circuit The circuit between a heating source and remotely located storage vessels. Commonly referred to as primary hot water flow and return, flow travels from the heating source and return travels to the heating source. This principle is used with Raypak water heaters and Loline solar systems both domestic and commercial.

Pumped circulation The method of circulating water around a large commercial hot water system or within a solar water heating system where the thermosiphon effect cannot be used. In a single-storey building, or where the water heater is not at the bottom of the building, a pump must be used to circulate hot water through the flow and return lines. Likewise, in solar water heating systems (such as a Rheem solar Loline system), where the water heater is normally at ground level, a small pump must be used to bring the heated water from the collectors down to the cylinder and circulate colder water back to the collectors for further heating.

When hot water is pumped around a building, it is also referred to as “secondary hot water flow and return”, “circulating”, “recirculating” or “flow and return”.

Push-through water heater Also called a free-outlet water heater; a small single-point storage water heater. It is connected to the mains water supply via the hot water tap. The water is stored at atmospheric pressure and it is pushed out of the outlet, which is open vented, by the incoming cold water.

Radiation (thermal) Invisible heat rays given off by a body that is at a higher temperature than its surroundings, causing it to lose heat. The amount depends on the shape, the size and, particularly, the difference between the body's temperature and the surrounding temperature - the higher the

Heat lost by radiation is in addition to that lost by conduction and convection.

A highly polished metal surface is a bad radiator but a good reflector, i.e. it reflects radiant heat falling on it, but is a poor radiator of its own heat. A dull surface is a better radiator and a poor reflector. Perfect radiators are good absorbers of heat; poor radiators are poor absorbers of heat.

Ratio valve (pressure-proportioning valve) A device that reduces the downstream pressure in a fixed ratio to the upstream pressure, e.g. on a 2 to 1 ratio valve an upstream pressure of 1000 kPa produces a downstream pressure of 500 kPa. These valves are only one-way valves, so downstream pressures do not affect upstream pressures.

REC See “Renewable Energy Certificate”.

Reduced pressure water heater A water heater in which the pressure is reduced below cold water mains pressure by means of a pressure-reducing valve pressure-limiting valve, ratio valve or open cold water feed tank.

Relative density (RD) Formerly referred to as "specific gravity"; is the ratio between the weight of a known volume of the material and the weight of a similar volume of a known standard. The usual standards are air (RD = 1) for gases, and water (RD = 1) for solids and liquids. In the case of solids and liquids, the RD indicates the kilograms per litre of the material.

If the RD of a solid or liquid is less than 1, it will float on water. If it is more than 1, it will sink. A gas of RD less than 1 will rise in air. If it is greater than 1 (as is LPG), it will fall in air.

Renewable Energy Certificate (REC) A certificate representing a unit of measure, equal to 1Mwh of electricity, produced from a renewable energy source such as hydro, wind, thermal and photo voltaics, or displaced from a non renewable source by a solar water heater.

An REC is a method of measuring the reduction of electricity production from non renewable sources. This method of measurement has been adopted by the Federal Government to assist in its goals to achieve a reduction in greenhouse gas emissions.

Resistance The difficulty with which an electric current will pass through a material. Even the best conductors have some resistance. The passage of an electric current through a resistance produces heat, and the amount produced is given by the following formula:

$$\text{power (in watts)} = \frac{(\text{voltage})^2}{\text{resistance (in ohms)}}$$

The resistance increases as temperature increases, so resistance in this case would refer to the hot element. (See also "Insulation resistance".)

Rilsan coating A trade name for a Nylon coating formulated to coat the inside of steel storage water heaters. It has been used in the past by some water heater manufacturers to provide corrosion protection of the steel cylinder instead of using vitreous enamel or a copper lining.

Ripple control A system of remote control of electrical loads by relay switches operated by an audio frequency signal superimposed on the electrical supply.

Safety shut-off valve A device on a gas appliance that shuts off the gas supply to the appliance to prevent a hazardous situation. A flame-failure safety shut-off (or safety pilot) operates when the actuating flame becomes extinguished. A "100%" shut-off valve cuts off all gas, including main and pilot burners. Other types may cut off only the supply to main burners.

Saturation index The solubility of minerals in water is dependent upon the chemical analysis and temperature of the water. In general, the higher the pH, total hardness and water temperature, the faster scale will form. The saturation index is a number that indicates the propensity of a water to form or deposit scale. If no scale forms, the water can be corrosive. A generalised list of the different effects occurring when referenced to the saturation index is as follows:

Saturation index	*Effect*
Less than -2	Highly corrosive
-2 to -1	Corrosive
-1 to -0.5	Slightly corrosive
-0.5 to 0	Corrosion not expected
0	No effect
0 to +0.5	Very slightly scaling
+0.5 to + 1	Light scaling
+ 1 to +2	Medium scaling
Greater than +2	Very heavy scaling

Scaling (liming) The term used to describe the formation of scale (or lime) on the inside of water heaters and associated pipe work or fittings. It is the result of minerals such as calcium carbonate being deposited out of the water when water is heated. The propensity of water to scale is defined by the saturation index.

Secondary flue The flue system, installed on site, that conducts the flue products from the exit of the draught diverter to the flue terminal, which must be located in an approved position.

Selective surface The special surface treatment of a solar absorber, designed to improve the efficiency of collection of solar energy. As any absorber heats up, it radiates some of the energy away again as infra-red rays, reducing the heat available for water heating or other purposes. A selective surface absorbs incident radiation, but is relatively poor at emitting infra-red rays. This ensures more of the solar energy is left in the absorber to heat water. Most selective surfaces are achieved by chemically dipping or coating the absorber plate.

SI units An international system of weights and measures adopted in 1966 as a replacement for the imperial system and based on a number of basic units, including the metre (length), kilogram (mass), second (time), ampere (electric current), kelvin (temperature) and candela (luminous intensity). The system also includes other units derived from the basic ones. (See "Metric system").

Silhouette A range of Lazer Boiling Water Units designed with a sculptured white plastic jacket, push button control and indicator lights. See also "Designer"

Silver solder Also known as "hard solder"; a range of brazing alloys with silver content. They have melting points lower than those of regular brazing alloys, but much higher than those of ordinary soft solders, which are tin and lead mixtures.

SNG (simulated natural gas) See "Gas".

Solar collector A device used to collect solar energy and convert it to a usable form, such as heat.

Solar energy The energy radiated from the sun. Outside the earth's atmosphere approximately 1350 W/m2 is received. The sun is a huge thermonuclear reactor and emits radiation over a number of different wave bands, including ultraviolet, visible light and infra-red radiation. A great deal of the ultraviolet energy is filtered out by the earth's atmosphere, so that the majority of solar energy received at the earth's surface is in the visible light range and some of the infra-red band. At the earth's surface the amount of energy received is reduced by atmospheric absorption and varies considerably.

Solenoid valve A valve actuated by electricity.

Specific gravity (of a material) See "Relative density".

Specific heat The amount of heat required to raise the temperature of 1 kg of a specific material through 1°C. In metric terms, the amount of energy required to raise 1 kg of water through 1°C is 0.004186 MJ or 0.00116 kWh.

Sprint A range of Rheem domestic gas outdoor water heaters with multi-fin flue technology allowing super quick recovery and high efficiency from a compact unit. No longer available.

Stacking The progressive rise in temperature of water in the top of a storage water heater caused by frequent draw-off of small quantities of hot water from the outlet. This situation can occur in gas water heaters where heat is absorbed into the water above the level of the thermostat. Precautions are built into the design of the water heater to prevent the water at the top of the cylinder from becoming excessively hot.

Stellar A high performance 5 star energy efficient Rheem domestic gas water heater providing super high efficiency and super quick recovery. Utilises SuperFlue technology creating high performance in domestic water heating.

Storage water heater A water heater incorporating a storage tank where water can be heated whether water is flowing through the water heater or not (as a contrast to an instantaneous water heater.)

Stratification A term used to describe the arrangement of a body of water into two or more layers of different densities.

Water expands as it is heated (see "Thermal expansion"); therefore, hot water has a lower density than cooler water.

In a storage water heater the less dense hot water "floats" above the cold water. This is a very stable arrangement and very little mixing can occur without mechanical agitation.

Sunstat valve A temperature-limiting valve developed by Rheem engineers and fitted to Hiline solar water heaters. It controls the water temperature in the system to around 70°C. This prevents the likelihood of extremely hot water being delivered at taps and other outlets at uncontrolled temperatures near boiling point. It also prevents premature operation of the T&PR valve and electrical energy cut-out.

SuperFlue The flue system utilised by the Stellar series of gas water heaters. It is external to and surrounding the storage cylinder providing increased efficiency and performance by removing more energy from the flue gases than a conventional primary flue.

SWG (standard wire gauge) See "Gauge".

Temperature A measure of heat energy that is analogous with water and heights. As water will flow naturally downhill, so heat flows from the higher temperature object to the lower. The flow in the reverse direction requires the application of energy in some way.

Temperature is measured in degrees Celsius (°C).

The fixed temperature points on the Celsius scale are:

1. Freezing point of water = 0°C

2. Boiling point of water at sea-level and at standard pressure of one atmosphere (101.3 kPa = 760mm Hg) = 100°C.

Temperature differential controller A device that senses difference in temperature between two parts of a system and switches an electrical circuit at preset temperature differences. For example, in the Rheem solar Loline system the temperatures at the cold inlet to the water heater and at the outlet at the solar collectors are sensed. When the temperature difference exceeds 8°C the pump is switched on, and when it falls to 4°C the pump is switched off.

Temperature relief valve (thermal relief valve) A device that automatically opens a relief vent when the temperature rises to a predetermined value. It may be incorporated in combination with a pressure relief valve as a combination temperature and pressure relief valve (TPR valve).

Tempering valve A device used to blend hot water and cold water to produce a pre-determined temperature somewhere between the two, within defined limits of temperature and pressure differentials. This device operates in a similar way to a thermostatic mixing valve however is approved to a less stringent standard. Water supply standards dictate limits of use for this type of product.

Thermal capacity The amount of heat energy held in a body or held in storage as measured above a fixed datum, usually ambient temperature.

In the case of water heaters, the thermal capacity approximates the volume in litres multiplied by temperature above ambient in degrees Celsius multiplied by 4.2 (an approximation of specific heat of water at normal temperature); the answer is in kilojoules.

In comparing water heaters, however, the true test should be thermal capacities above a usable level. Water below 40°C has very little application, so a practical consideration would be to measure all thermal capacities from a datum of 40°C, not ambient temperature.

Whichever datum is used, however, it is important we do not talk of "litres of hot water" in comparing water heaters, as a litre at 75°C will produce much more usable hot water than a litre at 60°C or a litre at 50°C.

Performance figures in Rheem literature are based on equivalent litres of water at 45°C, 50°C or 65°C rise above ambient depending on the type of application.

Thermal expansion On being heated, all solids and liquids expand; the exact amount of expansion varies with different materials.

The expansion of metals with heat is used to operate solid stem or bi-metallic thermostats where two materials of different expansion characteristics are involved. The different expansion of the two materials with heat is made to operate a valve or switching mechanism at an appropriate temperature.

The expansion of water on heating has three effects. First, there is an increase in volume for the same weight of water. This increase has to be allowed for by provision of an exhaust pipe or a relief valve that allows the extra volume of water to leave the storage cylinder.

The amount produced is proportional to the temperature rise. See table 17.3.

The second effect is expansion with heat makes the liquid less dense, making heated water lighter than cold water and causing it to rise by means of "convection currents". This effect is used in circulating water heaters, which are used with storage cylinders fitted with flow and return connections. In these installations the hot water rises from the heating unit up the "flow" pipe to the storage tank, and cold water flows from the tank down to the heating unit.

The third effect is hot water, being less dense than cold water, will float on top of cold water without mixing for some time. This principle is used in all displacement water heaters and allows cold water to enter the cylinder (while hot water is taken from the top) without mixing with the hot water.

Thermal relief See "Temperature relief valve".

Thermocouple When two dissimilar metals are joined to form a circuit and there is a temperature differential between the junctions, an electrical current is produced.

The current can be made to do useful work by exciting an electromagnet, which will hold a valve open while one junction between the two metals is hot. When the junction cools, current ceases to flow and the magnet allows the valve to close. This is the principle used in thermocouple type flame-failure valves.

A further application of the thermocouple is in testing of appliances. By measuring the current produced, the temperature of the hot junction can be determined. This is used as a means of recording temperatures of floors, appliance jackets, spot temperatures, etc., without the use of a thermometer.

Thermometer A device used for measuring temperature. When using a thermometer, check the following:

1. The stem should be immersed in the liquid being measured to the depth shown on the thermometer. This may be partial immersion or full immersion, and the incorrect use of either will give false readings.
2. Allow sufficient time for the reading to become steady.
3. Check whether divisions are 1°, 2° or 5° intervals.

Thermosiphon circulation Circulation of water taking advantage of the fact its density decreases as it is heated. Hot water will thus float to the top of cooler water. In flow and return systems for high-rise buildings, and in close coupled solar water heating systems, circulation of water can be achieved provided the system is arranged so that the water is heated at the lowest point of the circuit. Solar collectors, which rely on thermosiphon circulation to transfer the hot water from the absorber to the storage cylinder, must have the cylinder mounted above the absorber plates.

Thermostat A device that automatically maintains a predetermined temperature in an appliance.

Thermostats can be of the "immersion" pattern, where the actuating components are immersed in the fluid whose temperature is to be controlled, or of the "contact" pattern, where the actuating components sense the fluid's temperature through the wall of the container.

Thermostats can be "snap acting", i.e. operate from full-on to full-off and vice versa, or "modulating", operating gradually from full-on to a minimum bypass flow and vice versa. Some thermostats combine a modulating function from full-on to low-fire, then snap action to off.

The "differential" of a snap-action thermostat is the temperature difference between the opening and closing functions.

Thermostatic Mixing Valve A device used to blend hot water and cold water to produce a pre-determined temperature somewhere between the two, within defined limits of temperature and pressure differentials. Also known as a TMV, this device operates in a similar way to a tempering valve however is approved to a more stringent standard which also involves shut off of the hot water supply in the event of cold water supply failure.

Threads See also "BSP". Connecting threads on appliances and components may be "external" (ext.) as on the end of a bolt, or "internal" (int.) as on the inside of a nut. Threads may be "parallel" (Pl) with the same diameter at start and finish, or "taper" (Tr) with a smaller diameter at one end than at the other. Table 14.11 shows the metric expression for the most commonly used pipe threads.

TLP gas See "Gas".

Tonne A metric unit of mass. One tonne equals 1000 kg. Abbreviation t

Total dissolved solids (TDS) The sum of all the dissolved minerals in the water expressed in one unit.

Turboaire baffle An exclusive flue baffle specially developed to slow the flue gases and create greater turbulence in the flue way, resulting in superior heat transfer to the water content.

Unvented As applied specifically to water heaters, no exhaust or vent pipe in the hot water system open to atmosphere.

Vacuum-break valve A valve designed to admit atmospheric air to a system under partial vacuum or negative pressure conditions.

Vitreous enamel Referring to water heaters, fundamentally a coating of vitreous enamel bonded to a steel surface by firing at red heat. Due to the high content of silica it is also known as “glass”. The enamel is a special formulation resistant to hot water and is not the same type of glass as that used in windows and glassware. Glass lined water heaters may be referred to as "glass enamel lined", "glass enamelled", "vitreous enamelled", "bonded vitreous lined", “ceramic” or "porcelain enamelled".

Voltage A measure of the electrical potential between two conductors.

Open-circuit voltage is the voltage measured between two conductors when no appliance or other load is connected to them.

Closed-circuit voltage is the voltage as measured across the terminals of an appliance when the appliance is turned on and is operating. Generally the closed-circuit voltage will be lower than the open-circuit voltage.

Warm Water Typically referred to as water between the temperatures of 40°C and 50°C used primarily for bathing purposes. There are two types of warm water systems. Those which circulate hot water and reduce the temperature to a safe limit by an end of line device such as a thermostatic mixing valve and those which produce warm water in a central location and circulate it around the building for consumption. Rheem Guardian is a central warm water system.

Warranty A written statement of a manufacturer's obligations to the purchaser of a product. The warranty does not exclude any provision of the Trade Practices Act (1976), or relevant state legislation.

Watt The metric unit of energy rate that equals a rate of one joule per second. For single-phase electric appliances the energy rate is calculated by multiplying voltage (in volts) by current (in amperes). Abbreviation W.

Welding A process of joining two or more materials by the application of heat, resulting in the fusion of the components being joined (in comparison to "brazing", where components do not fuse). Heat may be applied electrically or by combustion of suitable fuel gases (e.g. acetylene). Welding may or may not incorporate the use of a suitable filler material, depending on the circumstances.

Wobbe index A figure obtained by dividing a gas's heating value (HV) by the square root of its relative density.

The thermal input obtained through a fixed orifice at the same gas pressure is proportional to the Wobbe index, so an appliance adjusted for a Wobbe index of 26 would have a higher input if 28 Wobbe gas were supplied and a lower input if 22 Wobbe gas were used.

Zincalume® (Trademark of Bluescope Steel Pty Ltd) A sheet steel with a corrosion-resistant aluminium/zinc alloy coating. It is produced by a continuous hot-dip coating process. The alloy coating provides significantly improved corrosion resistance when used under the same exposure conditions as traditional zinc-coated (galvanised) steel of similar coating thickness.