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ISSUE589 BULLETIN

HEAT PUMP WATER HEATING

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- Heat pump water heating systems have become more readily available and can provide an efficient means of heating water.
- A heat pump water heating system can supply hot water for regular household hot water supply or for space heating via underfloor or radiator hydronic heating.
- This bulletin outlines the basic parameters for the selection and installation of heat pump water heating systems for domestic hot water generation. It updates and replaces Bulletin 529 of the same name.

1.0 INTRODUCTION

1.0.1 A heat pump water heating system uses heat pump technology to provide a more efficient means of heating stored water than the more common electric storage heating.

1.0.2 A heat pump cycle transfers heat from one source to another. Heat pumps differ on the basis of where they source their heat and where they deliver it. Heat can be sourced from the outside air, water or the ground and transferred to heat water. This bulletin covers air-source heat pumps.

1.0.3 A heat pump water heating system can supply hot water for regular household hot water supply. Higher-capacity or specialised heat pump water heating systems can be used for applications such as underfloor hydronic heating systems or heating water for hot tubs, spas or swimming pools.

1.0.4 Heat pump water heating systems provide an alternative to solar water heating in many situations.

2.0 HEAT PUMP WATER HEATING SYSTEM OPERATION

2.0.1 Heat pump water heating systems operate by passing outdoor air over an evaporator (heat exchanger) to transfer heat to a low-pressure liquid refrigerant. This vapourises the refrigerant, which then enters the compressor. The compressor uses electrical energy to increase the refrigerant pressure (and temperature) and circulate it around to the condenser (heat exchanger) where the refrigerant cools as it heats a supply of water. The condensed liquid refrigerant is then returned to its initial low-pressure liquid state after passing through an expansion valve, allowing the heat pump cycle to continue (Figure 1).

2.0.2 Heat pump water heating systems in use in New Zealand use a range of refrigerants. Each of these will have different performance characteristics and design constraints.

3.0 SYSTEM CONFIGURATION

3.0.1 A heat pump water heating system can be:
- a split system, where the heat pump unit is located outside and is connected to a separate hot water tank via supply and return pipes
- an integral system, where the heat pump unit and hot water tank are provided together in a self-contained unit that is usually installed outside.

3.1 SPLIT SYSTEM

3.1.1 Split heat pump water heating systems allow the hot water tank to be installed within the thermal envelope, which reduces heat loss from the hot water tank (see 5.0).

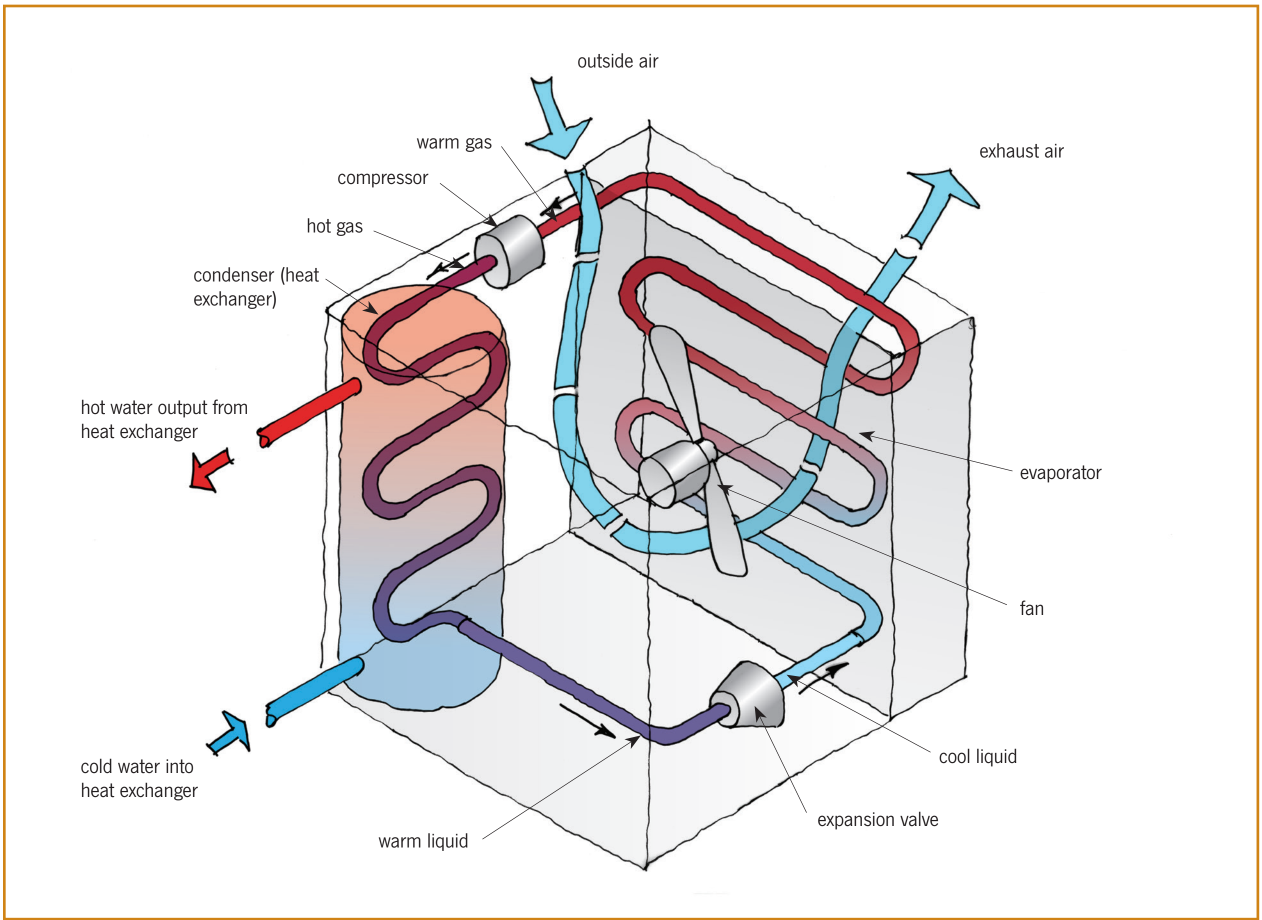

Figure 1. Air-source heat pump water heater cycle.

3.1.2 For a split system, there are several ways to split the heat pump cycle between the outdoor unit and the hot water tank, such as:

- including both the evaporator and condenser within the outdoor unit and circulating water between the condenser and the hot water tank
- splitting the heat pump between the evaporator and the condenser, circulating refrigerant between the outdoor unit and the combined condenser and hot water tank unit.

3.1.3 For split systems where the outdoor unit contains the condenser, there are two options to transfer heat between the condenser and the water in the hot water tank:

- A once-through process, where the inlet cold water to the hot water tank is heated by the condenser to the storage temperature of the system. The hot water is injected into the top of the hot water tank.
- A recirculating process, where water from the hot water tank is heated by the condenser repeatedly in multiple passes, raising the overall temperature of the stored hot water.

3.2 INTEGRAL SYSTEM

3.2.1 In an integral system, the heat pump unit and the hot water tank are in a self-contained unit. This often reduces the amount of plumbing required to install the system.

3.2.2 The integral unit is typically located outside. Follow the manufacturer's requirements to ensure sufficient airflow through the system is achieved. Tanks located outside are exposed to additional thermal losses.

4.0 OUTDOOR OPERATING TEMPERATURE RANGE

4.0.1 Heat pump water heating systems work more efficiently in warmer parts of the country and will be more efficient in summer rather than winter depending on the particular heat pump water heater.

4.0.2 Heat pump water heating systems are more efficient when operating during the day rather than at night.

4.0.3 AS/NZS 5125.1:2014 *Heat pump water heaters – Performance assessment – Part 1: Air source heat pump water heaters* specifies three low-temperature classes for heat pump water heaters:

- Class A – suitable for low-temperature operation without auxiliary heating.
- Class B – suitable for low-temperature operation by means of auxiliary heating or both heat pump operation and auxiliary heating.
- Class C – not suitable for low-temperature operation.

4.0.4 Auxiliary heating is often provided by electric resistance heating.

4.0.5 AS/NZS 4234:2008 *Heated water systems – Calculation of energy consumption* (with Amendment 3) defines two climate zones when considering heat pump water heating. Zone HP1-NZ covers the North Island excluding the Volcanic Plateau. It is equivalent to climate zone 1 and 2 in the thermal insulation standards (NZS 4218:2004 *Energy efficiency – Small building envelope* and NZS 4218:2009 *Thermal insulation – Housing and small buildings*). Zone HP2-NZ covers the South Island and the North Island's Volcanic Plateau and is equivalent to climate zone 3 in the thermal insulation standards.

4.0.6 Climate zones HP1-NZ and HP2-NZ differ from the climate zones defined in AS/NZS 4234:2008 (with Amendment 3) for solar water heating and other types of water heating.

5.0 ENERGY PERFORMANCE

5.0.1 Methods for determining the performance of a heat pump water heater are given in AS/NZS 5125.1:2014. This standard describes two methods of calculating the energy performance of a heat pump water heater:

- tank heat-up test method
- tapping cycle test method.

5.0.2 The tank heat-up test method records the energy use required to heat up a hot water tank from a number of initial test conditions. The standard defines a coefficient of performance (COP) as the ratio of the thermal capacity of the heat pump to the total electricity input. This COP assesses the heat pump water heater's ability to heat water and does not account for the standing losses within the system.

5.0.3 The tapping cycle test method is for heat pumps providing domestic hot water only. In this test, a system that has been preconditioned is subject to a series of water draw-offs over 12 hours and is then left for 12 hours. The performance measure for this test is the COP averaged over the 24-hour tapping cycle and is termed COP_{daily} to distinguish it from the COP determined from the tank heat-up method. COP_{daily} is defined as the ratio of the daily use energy output of the heat pump water heater to the daily energy consumption of the heat pump water heater.

5.0.4 The annual energy consumption of heat pump water heating systems is calculated using the methods outlined in AS/NZS 4234:2008 (with Amendment 3). This standard reports the energy savings of the heat pump water heater relative to a reference water heater.

6.0 COSTS

6.0.1 A heat pump water heating system is more efficient than an electric resistance or gas hot water system but is more expensive, costing around $4,000–8,000 including installation. To assess the economic viability of a particular heat pump water heating system, the higher cost of the system needs to be considered against its lower ongoing running costs.

6.0.2 When the amount of household hot water required is low, the energy losses from the standing losses of the system will become the dominant factor in the energy use of the system. In such cases, the savings of the system will be less in absolute terms than when the household hot water use is high.

6.0.3 Heat pump water heaters work by heating water that is stored in tanks. Having a larger storage capability provides greater flexibility as to when the heat pump needs to operate. The heat pump unit could be operated when:

- the price of electricity is lower (such as a night-rate tariff)
- surplus electricity is available from a photovoltaic (PV) system that would otherwise be exported back to the electricity grid
- outdoor temperatures are warmer (such as during the afternoon), which improves the energy performance of the system.

7.0 REGULATORY REQUIREMENTS

7.0.1 Suppliers of heat pump water heaters must have a Supplier Declaration of Conformity (SDoC) stating compliance with electrical safety standards and for electromagnetic compatibility (EMC) for their heat pump water heater. They must be able to produce evidence of the relevant testing upon demand.

7.0.2 The MBIE publication *Building work that does not require a building consent* (3rd edition, 2014) provides information on the consenting requirements for heat pump water heating systems.

7.0.3 A building consent is required when a new heat pump water heating system is installed. Adding a split heat pump (not a replacement split heat pump) to an existing water storage heater also requires a building consent. The exemption only covers replacement or repositioning of existing water heaters.

7.0.4 A building consent is not required provided the work is carried out by a certifying plumber when:

- an existing water storage heater is replaced with a heat pump water storage heater
- an existing internal water storage heater is replaced and repositioned with an external heat pump water storage heater
- an existing external water storage heater is replaced with an external heat pump water storage heater.

7.0.5 Regardless of whether a building consent is required, the installation of the heat pump water heater must comply with these Building Code clauses:

- B1 *Structure* – hot water tank gravity load and seismic restraint (see section 8.2).
- B2 *Durability* – not less than 5-year durability required for heat pump units and not less than 15-year durability required for hot water tanks, with normal maintenance.
- E2 *External moisture* – penetrations through the external envelope must be weathertight.
- G9 *Electricity* – covered by the electrical certificate of compliance issued by an electrician.
- G12 *Water supplies* – provisions include preventing contamination of drinkable water by refrigerants used in the heat pump, preventing the growth of *Legionella* bacteria and limiting the temperature and pressure within the hot water systems to safe limits.
- H1 *Energy efficiency* – adequate insulation required on hot water tank and pipes.

8.0 INSTALLATION

8.1 POSITIONING

8.1.1 The outdoor components of a heat pump water heating system must be positioned to ensure that airflow through the system is not impeded. They need to be clear of vegetation and other items that may obstruct the airflow.

8.1.2 Ideally, the location should be warm. As air-source heat pump water heating systems discharge cold air, this also needs to be taken into account to prevent the short-circuiting of the cold air back into the heat pump.

8.1.3 Heat pump water heating systems operate automatically, and the outdoor components of a heat pump water heating system may switch on at irregular times. This may create a noise nuisance at night if the outdoor components are located too close to bedrooms. Some heat pump water heating systems have hoods for the intake and extract air to suppress noise from the outdoor components. If the hot water tank storage is large relative to water demands, timers could be used to restrict the heat pump operating at certain times of day.

8.1.4 The location chosen should also limit the length of pipework required. The manufacturer's maximum lengths must be adhered to at all times. Insulating hot supply pipes will improve the performance of the system. Where external pipes are insulated, the insulation used should have a UV-rated, waterproof outer layer or standard insulation that is sleeved to prevent water ingress and UV breakdown.

8.2 FIXINGS AND SEISMIC RESTRAINTS

8.2.1 The outdoor components must be installed so that the heat pump unit is level and well supported to resist wind and earthquake loads or coming away from its connections.

8.2.2 The hot water tank should be restrained with straps to suitable anchoring points on the building for both internal and external tanks. The straps should not compromise the airflow through the heat pump unit. Where a heat pump unit or an integral unit is restrained to the outside of an external wall, suitable anti-vibration mounts should be used. This limits the transmission of noise to the inside of the house from the starting and stopping of the heat pump unit.

8.2.3 Acceptable Solution G12/AS1 gives restraint methods suitable for tanks up to 360 litres. Storage water heaters should be restrained with 25 × 1 mm galvanised steel straps tensioned when fixed in place. Straps at top and bottom should be no more than 100 mm from the end of the tank. For integral heat pump water heating units, the heat pump unit sits on top of the tank. Therefore, care is required to ensure that the top strap is aligned with the tank and not the external casing of the integral unit (Figure 2). Tanks over 200 litres should have a third strap in the centre.

8.3 WEATHERTIGHTNESS

8.3.1 Water pipes are required to connect the outdoor components with the pipework or hot water tank inside the house. Where possible, it is preferable to run water pipes under suspended floors or through eaves to avoid penetrations through the walls.

8.3.2 Penetrations need to be weathertight and meet the requirements of Building Code clause E2 *External moisture*.

8.4 ELECTRICAL CONNECTIONS

8.4.1 All hard wiring must be carried out by a registered electrician and have an electrical certificate of compliance.

8.4.2 Isolation switches need to be mounted on the exterior of the house, not on the outdoor components. If the cable between them breaks away, the electricity supply to the cable can be shut off from the isolation switch.

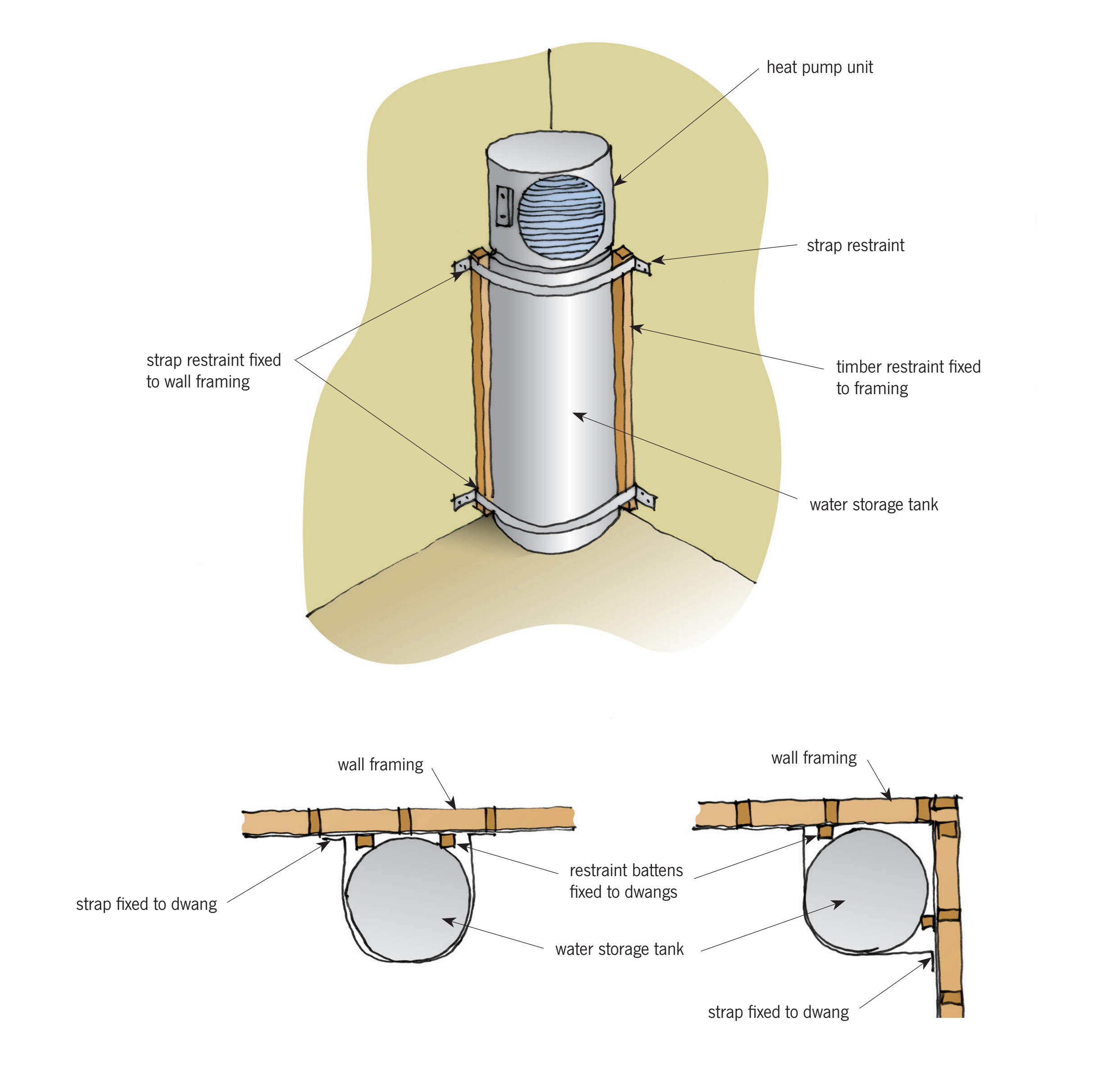

Figure 2. Recommended restraints from G12/AS1.

9.0 MAINTENANCE

9.0.1 The heat pump unit needs to be inspected periodically to ensure that airflow through the system is not compromised. Any vegetation should be cleared, and the grille and outdoor coils should be cleaned.

9.0.2 Condensate drains must be directed into drains and not be allowed to discharge onto the ground near the base of the tank where this may cause corrosion problems.

9.0.3 The valves on the hot water tank should be inspected to ensure that they are not discharging excessively and that the drainpipes are not blocked.

9.0.4 The restraints on the system should be tested to see if they are sufficiently tight.

9.0.5 The integrity of the pipe insulation on any outdoor hot water system should also be assessed and replaced or repaired where required.

10.0 FURTHER INFORMATION

Web resources
Level – www.level.org.nz
Smarter Homes – www.smarterhomes.org.nz
EECA – www.energywise.govt.nz
Consumer – www.consumer.org.nz

Consenting requirements
Building work that does not require a building consent (3rd edition, 2014) – www.building.govt.nz/bc-no-consent

Standards
AS/NZS 4234:2008 *Heated water systems – Calculation of energy consumption* (with Amendment 3)

AS/NZS 5125.1:2014 *Heat pump water heaters – Performance assessment – Part 1: Air source heat pump water heaters*

Other
Carrington, G. (2011). *Comparison of solar and heat pump water heaters in New Zealand*. Report prepared for the Parliamentary Commissioner for the Environment

Thompson, E., Ross, N., Howard, G., Duncan, J., Garrood, M. (2011). *Heat Pump Water Heating Pilot Report*. EECA Technical Report. www.eeca.govt.nz/node/11863

Pollard, A. (2010). *The energy performance of heat pump water heaters*. Study Report 237, BRANZ

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BRANZ. (2006). Bulletin 473 *Heat pumps*

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