

Good practice guide

Heat pump installation



Good practice guide to heat pump installation

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1.0 Introduction

Heat pumps have become increasingly popular in New Zealand homes over recent years as they are an energy efficient and convenient way of heating and cooling.

By using a relatively small amount of electricity, a heat pump can extract heat energy from one location – typically outdoor air – and transfer it to another location to provide heating. The reverse process can provide cooling.

Good design and installation are fundamental to a heat pump system's effectiveness and efficiency. It involves understanding the importance of correct sizing for the ambient conditions, selecting the right unit for the local environment and correctly installing the unit.

This guide provides good practice guidelines for designing and installing the most common type of residential heat pump system – air-to-air single-split heat pump systems (also known as reverse-cycle air conditioners), used primarily for heating.

The guide is aimed at experienced installers of heat pumps, and it gives the process to follow for system design and installation into both new and existing homes.

Note that this guide does not cover:

- multi-split or ducted heat pump systems
- ground-to-air, water-to-air or water heating systems
- DIY installations – EECA recommends heat pump systems are installed by experienced installers
- weathertightness and airtightness of the building envelope and structural integrity (though this must be maintained).

Before you begin

Insulate first

The first consideration when installing a heat pump system into any home is reducing heat loss as much as possible by:

- adding ceiling and underfloor insulation where practicable
- adding weather stripping to doors and windows
- eliminating draughts.

Ensure you are qualified and prepared

The installation of any heat pump system should be carried out by suitably qualified installers who:

- have the correct toolkit to allow them to carry out the work
- are licensed to carry out the electrical work
- hold a no-loss certification for the handling of refrigerants.

Know your standards and regulations

Standards and regulations applicable to a heat pump installation that must be complied with include the following:

- Building Code Clauses B1 Structure, E2 External moisture and G9 Electricity
- AS/NZS 3000:2007 Electrical installations (known as the Australian/New Zealand Wiring Rules)
- New Zealand electrical codes of practice
- Australia and New Zealand Refrigerant Handling Code of Practice 2007 and standards
- Consumer Guarantees Act 1993, which places a legal obligation on the installer to install a system that is suitable for the situation it is installed in
- Energy Performance – AS/NZS 3823 units must meet minimum energy performance requirements and have suitable labelling provided.

2.0 Heat pump systems

This section gives installers a general overview of heat pumps – the different types, system components and how heat pumps work.

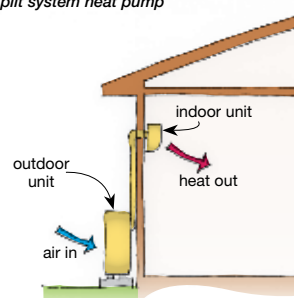
2.1 Types of heat pump systems

Air-to-air, reverse-cycle heat pump configurations are shown below.

The most commonly installed residential heat pump in New Zealand is an air-to-air, single-split system – it is this type of system that is covered in this installation guide.

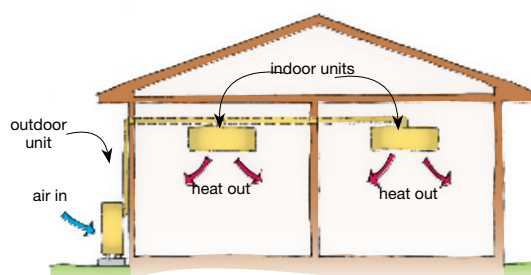
Single-split system – consisting of an outdoor unit and a single indoor unit connected to the coil or pipework containing the refrigerant (Figure 2.1). This guide covers design and installation of this type of system only.

Figure 2.1 Split system heat pump



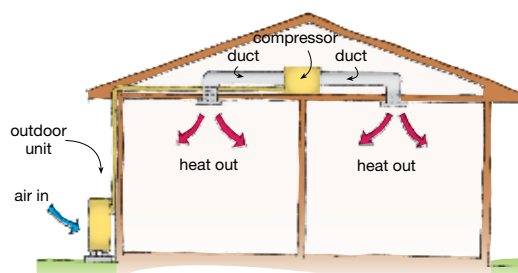
Multi-split system – consisting of an outdoor unit supplying a number of indoor units (Figure 2.2). The design and installation of this type of system are not included in this guide.

Figure 2.2 Multi-split system heat pump



Ducted system – consisting of an outdoor unit and a compressor, which may be located outside or in the roof space, and is connected to a number of air supply outlets to supply selected rooms or zones in the house. Zones can be controlled individually or by a centrally located controller (Figure 2.3). Ducted systems are not covered by this EECA guide as they are a specifically engineered installation. The design and installation of this type of system are not included in this guide.

Figure 2.3 Ducted heat pump system



Indoor units are defined according to positioning. They may be:

- high wall-mounted (Figure 2.4)

Figure 2.4 High wall-mounted unit



- ceiling cassette-mounted within the ceiling area (Figure 2.5)

Figure 2.5 Ceiling cassette



- floor console (Figure 2.6)

Figure 2.6 Floor console



More information on positioning of heat pumps can be found in **Section 4.0 Designing a heat pump system.**

2.2 Components of a heat pump

The principal components of an air-to-air heat pump and how they operate are described in Table 2.1 and shown in Figures 2.7, 2.8 and 2.9.

Table 2.1 Heat pump components

Component	Description
Evaporator	A heat exchanger that absorbs heat from the surroundings. <ul style="list-style-type: none"> For heating, it is the outdoor unit. For cooling, it is the indoor unit.
Condenser	A heat exchanger that releases heat to the surroundings. <ul style="list-style-type: none"> For heating, it is the indoor unit. For cooling, it is the outdoor unit.
Compressor	Reduces the refrigerant gas volume by compressing it, causing the gas temperature and pressure to rise, and pumps the refrigerant around the pipework/system. The compressor may operate as a fixed- or variable-speed system (see 2.4 Fixed speed and inverter compressors).
Metering device	Allows the refrigerant condensate (liquid) to expand, lowering the pressure and temperature.
Coil/pipework	Continuous, closed-circuit tubing through which refrigerant flows and heat transfer occurs. The pipes generally have fins to increase the surface area for the heat exchange process (see 6.0 Installing pipework).
Refrigerant	The compound that circulates through the heat pump system in both liquid and gas state, alternately absorbing and releasing heat (see 8.0 Refrigerants).
Reversing valve	Changes the direction of flow of the refrigerant to reverse the heat pump function from heating to cooling or vice versa. The reversing valve also allows the pump to switch into defrost mode (see 3.4 Impacts of defrost cycle on efficiency).
Fan	Draws air across the evaporator coil (for heat extraction) and moves air away from the condenser coil (for heat distribution/removal).

Figure 2.7 Schematic diagram of reverse-cycle, air-to-air, split system heat pump operation (heating mode)

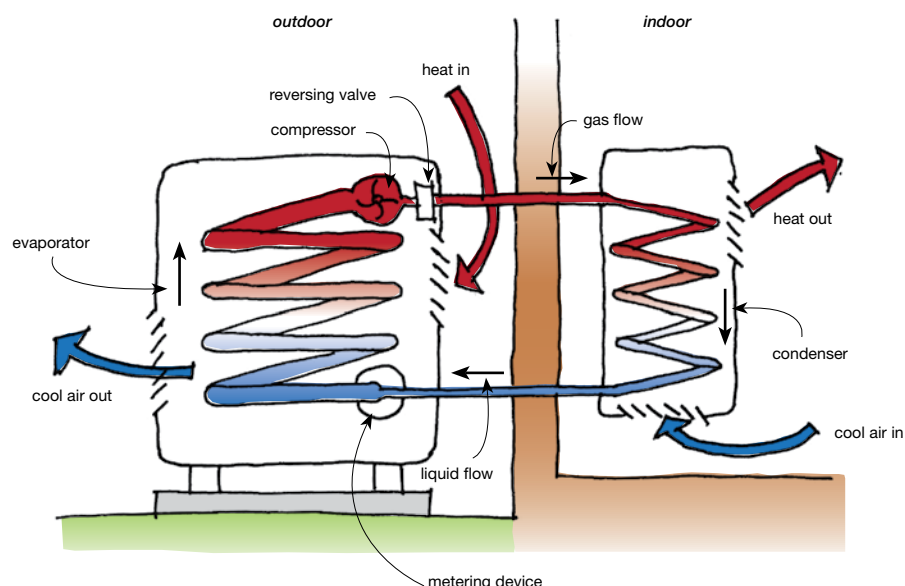


Figure 2.8 Schematic diagram of reverse-cycle, air-to-air, split system heat pump operation (cooling mode)

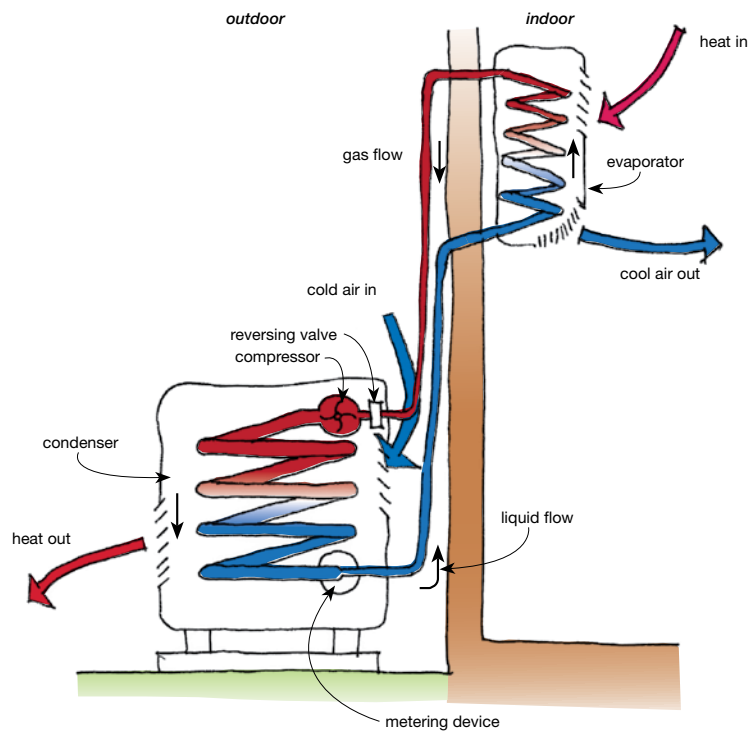
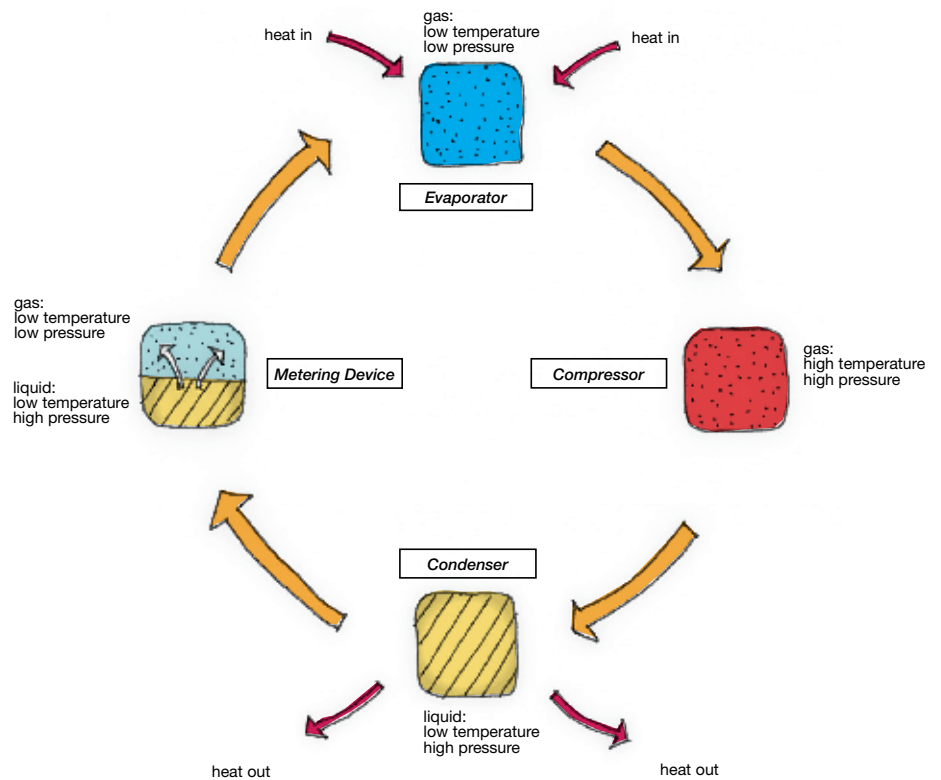


Figure 2.9 Schematic diagram of heat pump operation (heating)



2.3 How a heat pump works

In broad terms, air-to-air heat pumps work by using electrical energy to extract energy from the outside air and transfer it inside as heat, which makes it an efficient way of heating. Reversing the process enables indoor heat to be removed to provide cooling.

A more detailed illustration of how a heat pump operates in heating mode can be seen in Figure 2.9. There are five main processes in the cycle:

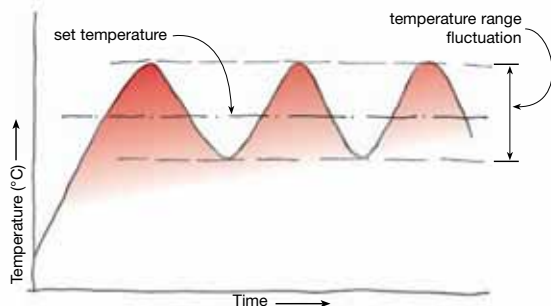
1. In the evaporator (outdoor unit), low-pressure, low-temperature liquid refrigerant absorbs heat from its surroundings and evaporates, converting to a gas state and absorbing energy as it does so (latent heat of evaporation).
2. It passes through the compressor where the low temperature gas is reduced in volume, resulting in a rise in both temperature and pressure.
3. As a heated and high-pressure gas, it passes through the condenser (indoor unit) where the gas condenses (latent heat of condensation) with a release of heat into the air surrounding the coil. A fan moves the warmed air away from the coil to distribute it throughout the indoor space.
4. Still under pressure, the cooled refrigerant, now in liquid state, passes through the metering device, where rapid expansion results in a reduction in pressure.
5. In the low-pressure, low-temperature state, the refrigerant flows back into the evaporator, and the cycle is repeated.

2.4 Fixed-speed and inverter compressors

As noted in Section 2.2, the compressor component of a heat pump can be either:

- a fixed- or single-speed compressor; or
- a variable-speed compressor – also known as an inverter.

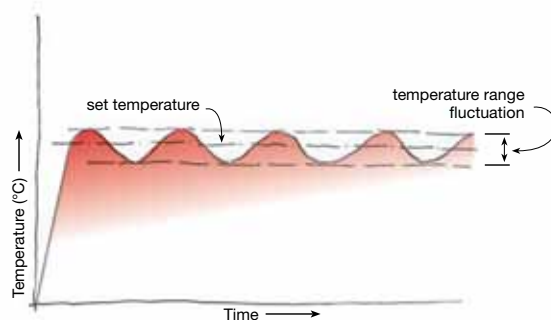
Figure 2.10 Fixed-speed compressor operation



A fixed-speed compressor operates at maximum refrigerant flow and capacity at start-up and during operation. It must continually stop and start to maintain the desired room temperature, switching off when the set point temperature is reached and switching on again when the temperature drops.

This can produce large fluctuations of temperature and reduce the system's energy efficiency as it switches on and off (Figure 2.10).

Figure 2.11 Inverter operation



An inverter or variable-speed compressor has a number of advantages over fixed-speed units.

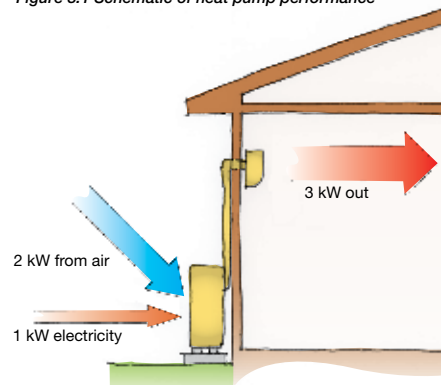
They have a 'soft start' and run at variable speed, decreasing as the temperature approaches set point and increasing as the temperature begins to fall. The varying speed delivers heating or cooling as required and maintains a more constant temperature that has smaller fluctuations (Figure 2.11). This results in improved efficiency, reduced vibration and a quieter operation when compared to fixed-speed compressors. Most heat pumps currently sold in New Zealand are inverter systems.

3.0 Heat pump performance

This section covers the performance of heat pumps and the different factors that impact on their efficiency. It includes how heat pump efficiencies are determined, where you can find that information, how temperature affects performance and the impacts of the defrost cycle on efficiency.

Understanding heat pump performance is essential when it comes to selecting a heat pump (which is covered in Section 4.0 of this guide).

Figure 3.1 Schematic of heat pump performance



In theory, the total heat that could be available for heating is the sum of the heat extracted from the source plus the energy required to drive the heat pump. Thus, if 1 kWh of electricity is required to drive a heat pump and 2 kWh of energy can be extracted from the heat source, the total energy delivered could theoretically be 3 kWh, giving an efficiency of 300% (Figure 3.1).

In practice, other factors that must be considered to determine the actual efficiency of a heat pump are:

- climate
- heating and cooling demands
- source and supply temperatures
- auxiliary energy consumption (pumps, fans)
- heat pump size to meet heating/cooling demand
- operating characteristics.

3.1 Heat pump efficiency

Heat pump efficiency is the ratio of the heating or cooling delivered to the electrical energy required to operate the system.

The ratios are given in two ways:

- coefficient of performance (COP) – the ratio of heating delivered to the electrical energy input
- energy efficiency ratio (EER) – the ratio of cooling delivered to the electrical energy input.

The higher the COP or EER, the greater is the efficiency of the heating or cooling system.

COP can be calculated by taking the heating output (in kW) and dividing it by the electrical input (in kW). These values can be found in the energy rating label (see Section 3.2) or manufacturer's information.

An acceptable level of COP should be at least 3, and better products may well have a COP of 4 or more.

3.2 Energy rating label

Figure 3.2 New energy rating label from October 2009 for heat pumps/air conditioners



The energy rating label (Figures 3.2) gives information on how much energy (at an ambient temperature of 7°C) a product uses so you can compare models. Every heat pump sold in New Zealand must display this label. The number of stars tells you how well the product performs – the more stars the better.

Figure 3.3 ENERGY STAR® mark



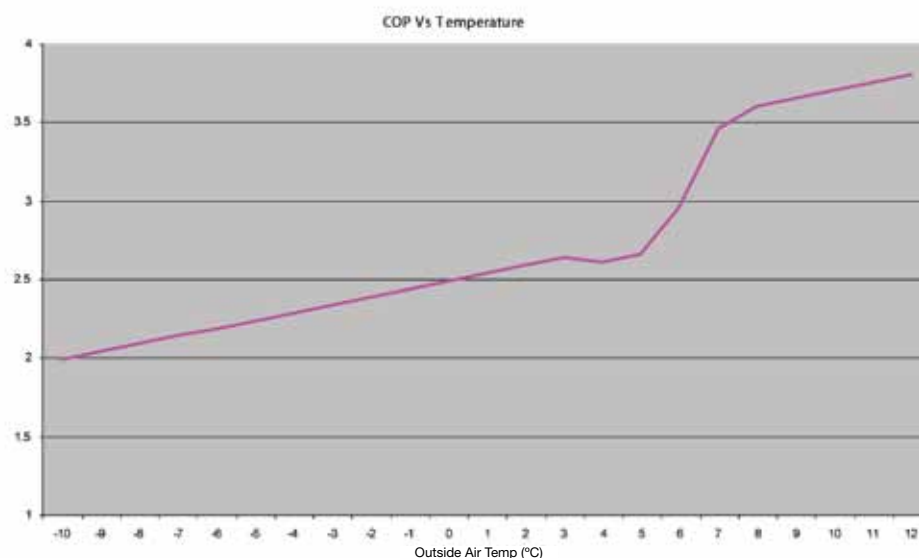
The blue ENERGY STAR® mark makes it easy to choose the most energy efficient appliances. It tells you at a glance which models are the very best. ENERGY STAR qualified heat pumps are, on average, 15% more efficient than non-qualified models. ENERGY STAR criteria cover cooling as well as heating performance. That is important if a heat pump is to be used for cooling in summer as well.

3.3 Effects of temperature on efficiency

Efficiency of a heat pump system is not constant – it varies along with the temperature differential between indoor and outdoor air. A heat pump's rated efficiency is for an outdoor temperature of 7°C, so when designing a system it is important to understand how it will perform at lower temperatures.

Whether a heat pump is in heating or cooling mode, as the difference between outdoor temperature and desired indoor temperature increases, the efficiency of a heat pump system decreases. This is illustrated in Figure 3.4, which shows the efficiency of a heat pump in heating mode reducing as the outdoor temperature decreases.

Figure 3.4 Graphic representation of heat pump efficiency



Different heat pumps will perform very differently at sub-zero temperatures – some may keep performing down to -20°C while others will struggle at temperatures below freezing.

Another temperature-related factor that can impact on efficiency is the extra energy that may be required for defrosting at low temperatures. At just a few degrees Celsius, any water vapour in the air will start to condense and freeze onto the evaporator (outdoor heat exchanger) coils. This will disrupt the heat flow, and the coils must be de-iced for heating to be able to continue (see **3.4 Impacts of defrost cycle on efficiency**).

While heat pumps have to be rated for efficiency under laboratory conditions at a 7°C ambient outdoor temperature (called H1), actual mid-winter temperatures in some parts of New Zealand, particularly in the central North Island and in the South Island, will give significantly different performance.

For this reason, standardised testing of heat pumps can also be rated at two additional levels of specific temperature and humidity. These are called H2 and H3 and are shown in Table 3.1.

Table 3.1 Outdoor ambient temperature rating conditions

Rating	Outdoor ambient temperature (°C) rating conditions
	Dry bulb (DB)
H1	7°C
H2	2°C
H3	-7°C

These ratings allow a wider range of design temperatures to be used to select heat pumps for areas where the temperature may often be below 0°C and ensure that, at low ambient temperatures, the heat pump will still provide the expected performance (see **4.5 Step 3: Calculate heat load requirement**).

Manufacturers will often test their product at other temperatures (e.g. -5, 0, 5, 10 etc).

3.4 Impacts of defrost cycle on efficiency

For optimal heat pump efficiency, a system must be correctly sized to minimise energy losses that occur during the defrost cycle.

The defrost cycle is necessary to remove ice build-up on evaporator coils. Ice build-up occurs at around at 0-4°C (especially in high humidity), when any water vapour in the air will start to condense and freeze onto the evaporator (outdoor heat exchanger) coils. This will disrupt the heat flow, and the coils must be de-iced for heating to be able to continue. To remove ice build-up on the coils, most heat pumps have a defrost cycle where the system switches into cooling mode (taking some heat from inside), which could effectively cool the room.

Some systems have a closed loop cycle to use waste heat from the motor/compressor to defrost the coils. While this is occurring, no heat is supplied to indoors.

The defrost frequency and performance are critical to heat pump efficiency. Undersized heat pumps will need to defrost frequently in low ambient temperatures, reducing the system's ability to reach and maintain set point. If the defrost cycle operates too frequently or if it does not operate often enough, it will not provide sufficient heating, and heat pump operation will be compromised.

The defrost cycle control is either:

- a time-temperature defrost starting and stopping at preset times (30-, 60- or 90-minute intervals); or
- on-demand defrost, which is generally more efficient because it operates only when it detects frost build-up on the outdoor coil by monitoring air and coil temperature, outdoor airflow, pressure differential across the coil and refrigerant pressure.

Systems that include a dry-coil defrost cycle briefly run the outdoor fan at maximum speed before the system starts to heat again, to remove any water that may still be on the coil fins and would immediately refreeze. This operation can be seen by water vapour blowing from the outdoor unit before the heating cycle resumes.

4.0 Designing a heat pump system

This section describes the steps for designing a heat pump system. A well-designed system will perform as efficiently as possible to meet the customer's needs.

4.1 Steps for designing a heat pump system

There are five steps to follow for a well-designed heat pump system – these are shown in Table 4.1. Each step is described in detail in Sections 4.3 to 4.7.

Table 4.1 Designing a heat pump system

Step	Action	Check
1	Determine requirements (Section 4.3): <ul style="list-style-type: none">• for heating/cooling• for the building• for the environment (e.g. protection for system components in coastal/geothermal regions)• for the type of unit suited to the room.	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
2	Determine seasonal design temperature (Section 4.4).	<input type="checkbox"/>
3	Calculate heat load (kW) requirement (Section 4.5).	<input type="checkbox"/>
4	Select the system/model to suit the design requirements and occupant preferences (Section 4.6).	<input type="checkbox"/>
5	Select the locations of the indoor and outdoor units (Section 4.7).	<input type="checkbox"/>

4.2 The importance of correct heat pump sizing

Correct heat pump sizing is critical to efficiency and performance. The unit should be selected for the heating load that is required. If the heat pump is too small or too large, the system will use more energy than necessary, increasing running costs and losing efficiency, and heating/cooling requirements may not be met (Table 4.2).

Table 4.2 Effects of incorrectly sized systems

If unit is:	Performance	Effects
Undersized	Operation may be in defrost mode too often (see 3.4 Impacts of defrost cycle on efficiency).	<ul style="list-style-type: none">• System is not delivering heat.• System may be blowing out cold air.
	Booster heating may be required.	<ul style="list-style-type: none">• Increased running costs.• Reduced efficiency.
	Operation may be at full capacity too often.	<ul style="list-style-type: none">• Increased running costs.• Reduced efficiency.• Undue wear and tear.
Oversized	Increased start-up power use.	<ul style="list-style-type: none">• Increased running costs.• Reduced efficiency.
	Short cycling because output exceeds demand.	<ul style="list-style-type: none">• Too much air movement (draught) even at low fan speed.• Increased noise.• Undue wear and tear.
	Runs at low load too often.	<ul style="list-style-type: none">• Reduced efficiency.

A correctly-sized heat pump system, when compared to a poorly-sized system, will have:

- shorter total compression run times
- lower frequency operation speeds
- reduced defrost mode running.

Installing an undersized heat pump unit will significantly increase running costs, to the extent that the extra annual running cost will be more than the cost of installing a unit that is the next size up.

Where a large-capacity heat pump is required or the space being heated is large, installing two smaller units or a multi-split system may give better heat distribution within the space and better control than the large single unit.

Heating loads tend to be larger than cooling loads where both are required (particularly in colder winter climates). Systems designed for heating are likely to be oversized for cooling, in which case, the system will run only intermittently in cooling, lowering cooling performance.

4.3 Step 1: Determine requirements

The first step in designing a system is gathering the information that you will use to determine what the most appropriate heat pump option is for a particular home. Use the checklists below to determine requirements for the system.

4.3.1 Checklist of heating/cooling requirements

- ☐ What is required? For example, is it mainly heating or cooling?
- ☐ What is the region and location of the building?
- ☐ Are there specific local conditions, such as microclimates within the climatic zones, which may influence selection?
- ☐ What are the seasonal high and low ambient temperatures?
- ☐ What type of home is the system for? For example, old, new, insulated.
- ☐ Is it for a typical single room or a large room (where more than one unit may be required)?
- ☐ What is the number of occupants?
- ☐ What is the owner preference for the type of indoor unit? For example, a floor-mounted unit may be better for an older user to give more direct heat flow and allow access for maintenance.
- ☐ What are the hours of occupation? For example, out at work all day, home all day, work from home, retired/elderly and so on.

4.3.2 Checklist of building conditions

- ☐ Building orientation.
- ☐ Window orientation.
- ☐ Solar gain.
- ☐ Areas of walls, ceilings, windows and floors.
- ☐ Building envelope; for example, air infiltration/heat loss around doors/windows.
- ☐ Insulation levels of walls, ceilings and floors.
- ☐ Single/double glazing.

4.3.3 Environmental requirements

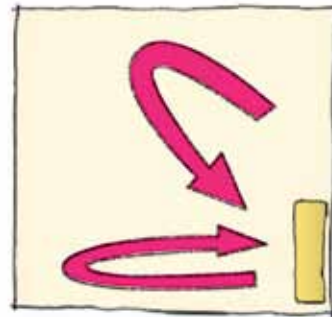
Check that the unit selected is **suitable for the environment** it is being installed in. For example, geothermal regions require the outdoor unit coil to be protected against atmospheric sulphides that will cause corrosion of the coil, and coastal regions also require protection against corrosion for both the outdoor cabinet and the coils.

4.3.4 Type of unit suited to room

Consider the options for airflow patterns in relation to room or space layout (Figures 4.1 – 4.4). All three types of unit can be used for heating or cooling. Different types may suit different people based on their own personal choice.

Floor console units are generally used for heating, as air circulation occurs from warm air rising and cold air falling (Figure 4.1). Consider the location of objects such as furniture that may block airflow.

Figure 4.1 Floor-mounted unit – horizontal and vertical air discharge (heating)



High wall- or ceiling-mounted units blow air down or out from the unit to circulate the warmed air within the room (Figures 4.2 and 4.3).

Figure 4.2 Ceiling-mounted unit – horizontal air discharge (heating)

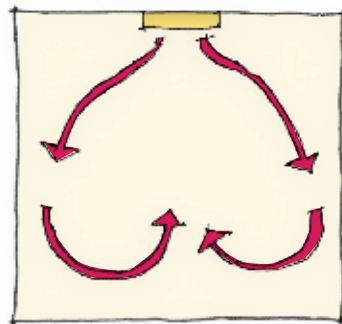
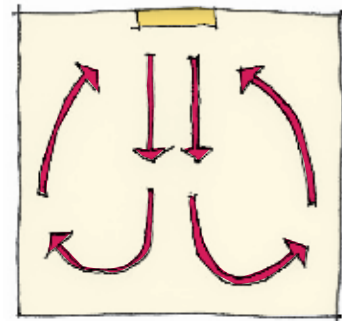
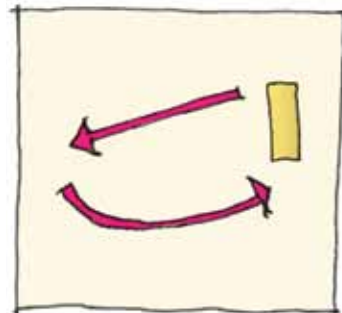


Figure 4.3 Ceiling-mounted unit – vertical air discharge (heating)



High wall-mounted units blow hot or cool air along the ceiling to mix with room air before dropping to the level of occupants (Figure 4.4).

Figure 4.4 Wall/high wall-mounted unit – horizontal air discharge (cooling)



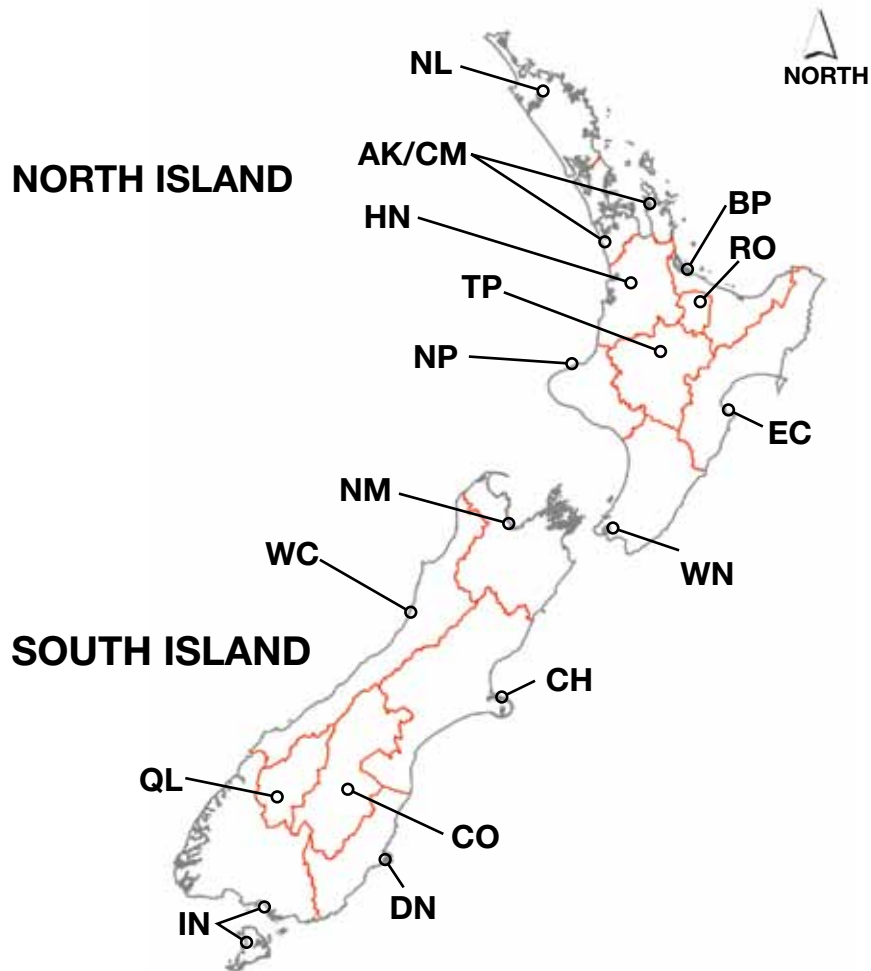
4.4 Step 2: Determine design temperature

The second step is to determine what the local climate is so you can design a system that meets the home's temperature needs.

You can determine the appropriate design temperature using the climate zones shown in Figure 4.5 as a starting point.

Because the temperatures in these areas are calculated from weather stations at the locations shown on the map, there may be some regional variation in this zone. If the location where the heat pump is being installed has a particularly severe climate or microclimate (for example, a sunless or damp valley), this needs to be taken into consideration. In this case, the design temperature may be one or two degrees lower.

Figure 4.5 New Zealand climate zones (design temperature in °C)



NORTH ISLAND

Climate zone codes	Regions	Climate index	Design temp (°C)
NL	Northland	0	5
AK/CM	Auckland and Coromandel	0	4
HN	Hamilton	1	-1
BP	Bay of Plenty	1	1
TP	Taupo	3	-3
RO	Rotorua	2	-2
EC	East Coast	2	-1
NP	New Plymouth	2	1
WN	Wellington	3	0

SOUTH ISLAND

Climate zone codes	Regions	Climate index	Design temp (°C)
NM	Nelson-Marlborough	3	-1
WC	West Coast	4	-1
CH	Christchurch	3	-4
QL	Queenstown-Lakes	5	-5
CO	Central Otago	5	-6
DN	Dunedin	5	-1
IN	Invercargill	5	-3

4.5 Step 3: Calculate heat load requirement

Using the information from Steps 1 and 2, you can now calculate the heat load requirement for the heat pump system.

There are three ways you can do this:

- a simple estimate
- a heater sizer worksheet (recommended method)
- a manual calculation.

Case studies for sizing heat pumps in three different locations are given in Section 12.

4.5.1 Simple estimate

A commonly used rule of thumb for estimating heat load requirements is based on Table 4.3.

Table 4.3 Simple guide to determine heat load requirement

Insulation	Method 1: Estimate by area (W/m ²)	Method 2: Estimate by volume (W/m ³ – based on 2.4 m ceiling height)
Non-insulated	150	65
Insulated	120	55

However, this method leaves no provision for any variables such as solar gain, increased levels of insulation, reduction of air leakage and so on.

4.5.2 Heater sizer worksheet (recommended method)

More accurate heating requirement calculations can be determined by using the heater sizer in Table 4.4. (This is reproduced as a worksheet at the back of this guide).

There are three stages:

- Insert the climate region and design temperature from Section 4.4 and use it to determine Step (A).
- Use the building information gathered in Section 4.3 and use it to determine Steps (B) to (E).
- Calculate the heater size by following Steps (F) to (H).

Table 4.4 Heater sizer

Climate		
Region:	<input type="text"/>	
Design Temperature:	<input type="text"/>	°C

Factor	Score	Room
(A) Climate index		
		+
(B) Room type		
Bed, Hall (16°C):	0	
Dining (18°C):	1	
Lounge (20°C):	2	
		+
(C) Insulation (select one)		
Very High:	0	
NZBC 2008 onwards:	1	
NZBC 1978–2007:	2	
Ceiling and/or floor insulation:	3	
Uninsulated:	4	
		+
(D) Number of external walls		
One:	1	
Two:	2	
Three:	3	
		+
(E) Window size in this room (% of exterior wall area)		
Small: ~ 25%:	1	
Medium: ~ 40%:	2	
Large: ~ 60%:	3	
Very Large: ~ 80%:	4	
		+
(F) Total score = (A) + (B) + (C) + (D) + (E) =		
(G) Multiply room area (<input type="text"/>) x 8 [m ²]		
(H) = (G) + (100) =		
Heater Size in Watts = (F) x (H) =		W

4.5.3 Manual calculation of heat loss and heating requirements for a building

Heating loads can also be calculated manually using a whole-house approach or performing room-by-room load calculations as follows.

To calculate the size of heating required, you need to know:

- the required indoor temperature
- the lowest likely ambient (outdoor) temperature that can be expected
- the direct heat loss from the building envelope
- how much natural or mechanical ventilation heat loss there is.

The difference between the ambient (outdoor) and internal temperatures is called the 'temperature lift':

$$\text{temperature lift (°C)} = \text{internal temperature (°C)} - \text{ambient temperature (°C)}$$

Calculate heat loss for each surface of the building envelope (walls, floor, ceiling) by calculating the area and multiplying this by the thermal transmittance coefficient or U-value ($U = W/m^2 \text{ °C}$) of the surface:

$$\text{surface heat loss (W/°C)} = \text{width (m)} \times \text{length (m)} \times \text{U-value (thermal conductivity)}$$

Deduct window and door areas from the wall area they are in and calculate their heat loss separately.

The total surface heat loss for the building is the sum of all surface heat losses:

$$\text{total surface heat loss (W/°C)} = \text{walls loss} + \text{roof loss} + \text{floor loss} + \text{windows and doors loss}$$

Allow for ventilation heat loss such as air leakage through badly fitting doors and windows and any damage to the surfaces, and so on. Estimating these losses can be difficult – figures may range from 20% to 70% depending on the type and condition of the structure:

$$\text{total heat loss (W/°C)} = \text{total surface heat loss} \times \text{ventilation heat loss}$$

Calculate the heating required by multiplying the total heat loss by the temperature lift:

$$\text{heating required (W)} = \text{total heat loss (W/°C)} \times \text{temperature lift (°C)}$$

4.6 Step 4: Select a system to meet requirements

You should now have all the information needed to select the right heat pump system for the home's needs. Things to keep in mind:

- Inverter type units are recommended in most cases for their increased efficiency.
- Consider suitability for the environment (i.e. seaspray, sulphur from geothermal activity).

Some manufacturers provide performance guide charts for selecting a heat pump system similar to Table 4.5. EECA recommends that particularly in colder climates, you should use products with this information available.

Table 4.5: Example of a heat pump performance guide chart

Model A: Capacity 4.0 kW rated output															
Indoor (°C)	Outdoor (°C)														
20	-10			-5			0			2			7		
	Output	Input	COP	Output	Input	COP	Output	Input	COP	Output	Input	COP	Output	Input	COP
	2.4	0.77	3.12	2.88	0.91	3.15	3.7	1.1	3.31	3.8	1.12	3.4	4.1	1.18	3.5
Model B: Capacity 6.0 kW rated output															
Indoor (°C)	Outdoor (°C)														
20	-10			-5			0			2			7		
	Output	Input	COP	Output	Input	COP	Output	Input	COP	Output	Input	COP	Output	Input	COP
	3.6	1.3	2.76	4.32	1.54	2.8	5.1	1.71	2.98	5.2	1.75	3.0	6.1	1.9	3.2
Model C: Capacity 8.0 kW rated output															
Indoor (°C)	Outdoor (°C)														
20	-10			-5			0			2			7		
	Output	Input	COP	Output	Input	COP	Output	Input	COP	Output	Input	COP	Output	Input	COP
	4.8	1.85	2.59	5.65	2.05	2.75	6.2	2.25	2.8	6.4	2.4	2.7	8.1	2.6	3.1

For a heat load design requirement of 5.6 kW and an ambient temperature of 0°C, by referring to the performance guide chart in Table 4.5, an 8 kW capacity heat pump is rated to deliver 6.2 kW at 0°C, which will meet the heat load design requirement.

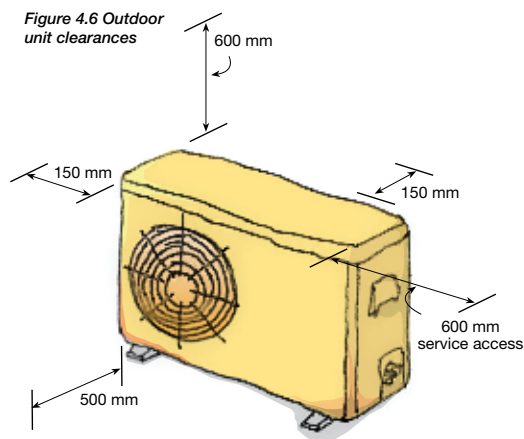
4.7 Step 5: Locate the units

Correct location of both outdoor and indoor units is essential for optimum performance, as many of the problems that are experienced with heat pumps are due to poor location of units.

4.7.1 Outdoor units

Locate outdoor units:

- to allow unimpeded air flow around the unit
- in a position that gets full sun in winter
- in accordance with the manufacturer's recommendations for distances to obstructions. If the manufacturer's recommendations are not given, provide the following minimum distances from obstructions:
 - 500 mm between air inlet and outlet faces
 - 600 mm above the unit
 - 150 mm to other faces (Figure 4.6).



Locate the units:

- to minimise refrigerant pipe run lengths and bends
- to give minimum pipe runs in accordance with the unit manufacturer's instructions
- where condensate can easily be drained away
- to allow access for service (minimum 600 mm) (Figure 4.7)
- where any blockage (such as from leaves or snow) is quickly seen.

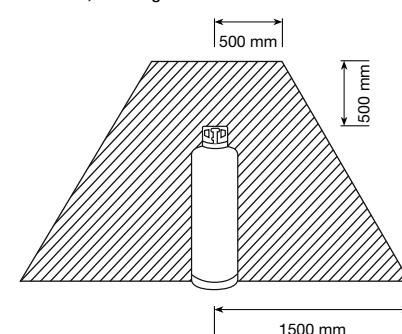
Figure 4.7 Service access




Locate the units:

- to be **protected from the sea spray in coastal areas**, sheltered from frost and strong wind (strong wind can cause the condenser fan to spin in reverse and burn out the motor, which is a particular problem when a unit is located on a roof)
- where condensation can be appropriately drained away (see **6.1.8 Condensate drainage pipe**) condensation will always be produced during heating and must be able to be drained safely
- for inverter systems, at least 6.0 m from television aerials to avoid signal interference
- in a well ventilated area, and at a safe distance from any gas sources or appliances.
 - e.g. 1.5 m from a LPG bottle.
 - 0.5 m from an instantaneous Gas water heater.

Figure 4.8 Exchange cylinders, adequately ventilated, in storage or in use.



Within space 0.5 m above and 0.5 m laterally from any cylinder valve, extending 1.5 m laterally at the base of the cylinder.

 = Zone 2

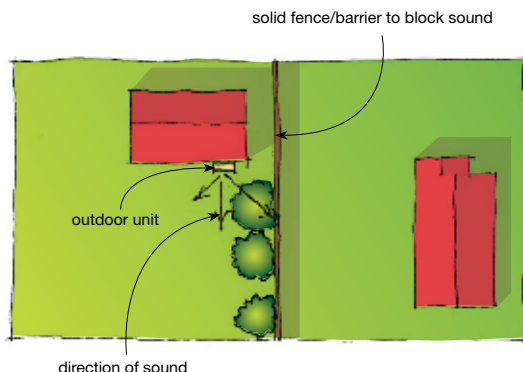
Do not locate the unit:

- where noise can cause a disturbance to home occupants or to adjacent properties (see Section 4.7.1.1 for more information)
- under the house or a deck, or any location that may impede airflow or create a microclimate that will reduce the ambient temperature around the unit
- below a window where the unit has a vertical discharge
- so that multiple units are competing against each other for air
- where the air outlet is directed to where people pass, such as across an accessway
- in a garage or enclosed space such as a roof space.

4.7.1.1 Avoid noise disturbance

Locate outdoor units where noise from the unit cannot transmit to and disturb the home occupant or adjacent properties. Do not install the outdoor unit under or close to bedroom windows. Council bylaws regarding permitted noise levels at the property boundary must be complied with.

Figure 4.9 Locate the outdoor unit where a solid barrier can block the sound



There are several ways to reduce sound transmission:

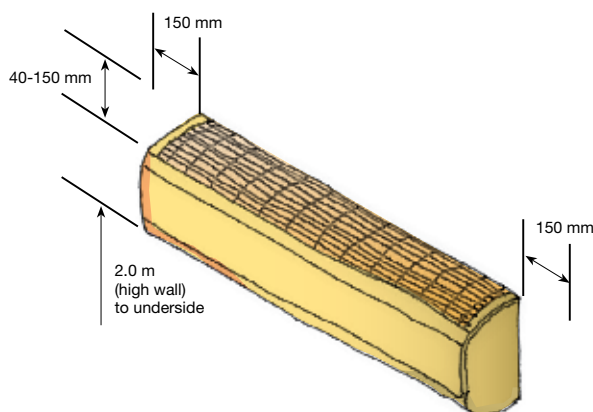
- Locate the unit where a fence or solid barrier can block sound so that the line of sight between source and receiver is blocked (Figure 4.9) but avoiding reflected sound transmission – consider the reverberation effects of lightweight materials such as corrugated iron fencing.
- Mount the unit on neoprene isolation mounting blocks or pads to absorb vibration.
- Ensure the owner is aware of the need to carry out regular maintenance to have worn bearings or other noisy parts replaced.

4.7.2 Indoor units

Locate indoor units:

- according to the type of unit, i.e. high wall, under-ceiling, floor-mounted
- on an external wall if possible
- to avoid directing airflow onto seating locations or electronic equipment
- to direct airflow to the coldest point in the room
- appropriately for room layout and airflow patterns

Figure 4.10 Wall-mounted indoor unit clearances



- in accordance with the manufacturer's recommendations for minimum clearances – otherwise allow:
 - 40-150 mm minimum above and 150 mm minimum on either side of a wall-mounted unit
 - 2.0 m minimum (measured to the bottom of the unit) above floor for a high wall or ceiling-mounted unit
 - 50 mm minimum to each side for a floor console (Figure 4.10)
- so that a clear airflow path is maintained
- to minimise refrigerant pipe run lengths and bends (for each 90° bend, deduct 1% from the heat pump performance data)
- so that the condensate drainage pipe can drain to outside without the need for a condensate pump.

Do not locate the indoor unit:

- in a tight corner
- behind a grille
- so it directs air to a primary source of heat gain or loss such as windows
- where there may be any steam
- within a kitchen or near an automatic insect repellent dispenser.

4.7.3 Building work

4.7.3.1 New building

Figure 4.11 Pre-install pipework before building claddings are installed



The best time to install pipework and cables in a new building is when it is still under construction. Co-ordinate with the other trades and plan the layout and location of the system early in the building design stage so that penetrations through the building envelope can be made before the cladding is installed (Figure 4.11 – note that the penetration through the wall underlay has not incorporated a sleeve and has not yet been taped off with flexible flashing tape).

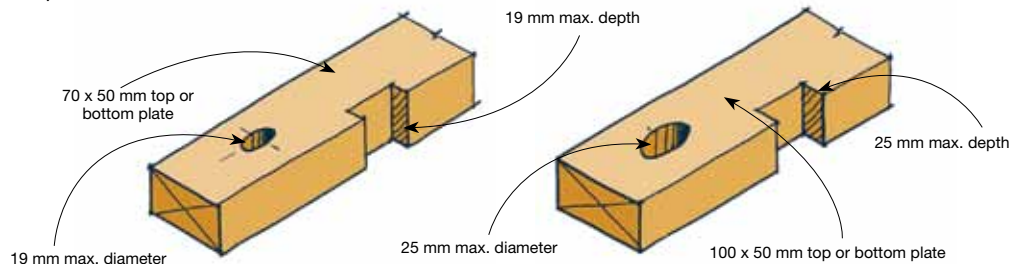
Building Code compliance document E2/AS1 gives guidance on making penetrations through the wall cladding and wall underlay – a copy is available for free download from the compliance documents section of the Department of Building and Housing website.

The installer making the penetration through the wall cladding system is responsible for the weathertight performance of the penetration made – they will be liable for any non-performance due to their work.

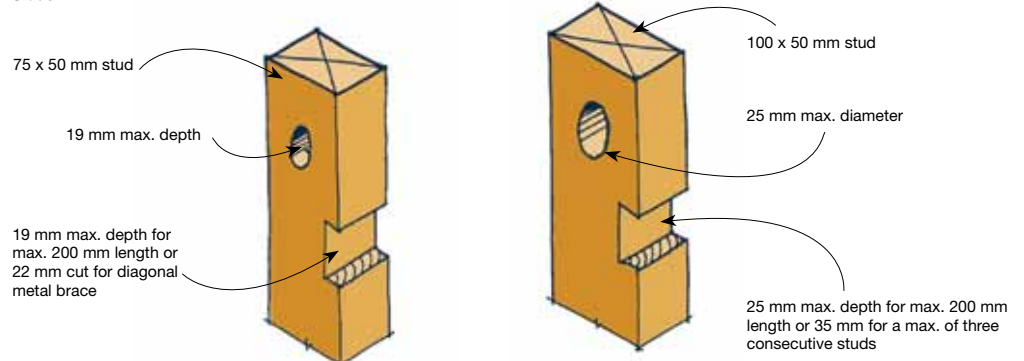
Any drilling, notching or cutting of load-bearing and support walls to fit pipes must be within the limits specified by NZS 3604 *Timber framed buildings*. Figure 4.12 outlines the maximum permitted allowances for drilling and notching.

Figure 4.12 Permitted notching and drilling of timber framing allowed under NZS 3604

Wall plates



Studs



Note: Notches in studs to be spaced at a min. of 600 mm apart.

4.7.3.2 Existing building

When installing units into an existing building:

- Identify the location of existing pipework, studs and cables before drilling holes or making penetrations in the building.
- Ensure any drilling, notching or cutting of load-bearing and support walls to fit pipes is within the limits specified by NZS 3604 *Timber framed buildings* (shown in Figure 4.12).

5.0 Toolkit

It is essential that heat pump installation is carried out by a trained installer using the correct array of tools and equipment. The following lists the essential tools and equipment that are needed to successfully carry out the installation work.

Equipment/materials

- ☐ Copper pipe:
 - hard/soft-drawn (using hard-drawn is considered best practice because it is less likely to deflect or sag over time when compared to soft-drawn)
 - twin-insulated dehydrated
- ☐ Pipe insulation
- ☐ Brazing equipment
- ☐ Set of standard hand tools
- ☐ Pipe benders for each size of pipe being used
- ☐ Electrical cable
- ☐ De-burring tool
- ☐ Swaging set
- ☐ Flaring tools – correct tool for pipe diameter and wall thickness is required
- ☐ Oil (for flared joints – must be compatible with refrigerant)
- ☐ Wrenches
- ☐ Torque wrenches
- ☐ 120 x 25 x 0.5 mm galvanised mild steel (gms) straps
- ☐ 65 mm gms diameter pipe brackets
- ☐ 30 mm gms nails
- ☐ Condensate drainage pipe:
 - smooth, hard, PVC (best practice option)
 - flexible, ribbed
- ☐ Vinyl tape
- ☐ Electrical conduit
- ☐ Pipe cutters
- ☐ Electronic scales
- ☐ Digital thermometer
- ☐ Oxygen free nitrogen gas cylinder with pressure gauge and manifold valve and flexible clear hose
- ☐ Leak testing solution
- ☐ Electronic leak tester (as back-up to leak testing solution)
- ☐ Vacuum pump with backflow prevention device
- ☐ Manifold set
- ☐ Hose adaptors
- ☐ Auto ignition gas torch
- ☐ Specific vacuum gauge
- ☐ Valve-core removal tool (8 mm (5/16") UNC for R-410A refrigerant)
- ☐ Tape measure
- ☐ Gas cylinder with refrigerant
- ☐ Charge hose and connector
- ☐ Charge valve (prevents gas from coming out of charge hose and unit when hose is removed)
- ☐ Compression or locked-ring jointing tool
- ☐ Recovery cylinder
- ☐ Safety glasses, gloves and ear protection

6.0 Installing pipework

Good pipework gives a safe, efficient and reliable installation that will help the heat pump system perform properly. Too many joints, bends and long lengths can reduce efficiency as it requires more energy for the compressor to pump the refrigerant around the system.

Many system failures occur due to poor workmanship of pipework installation. To reduce the likelihood of problems:

- pipes must be clean and moisture-free
- use pipe sizes recommended by the manufacturer
- design pipelines for the shortest runs and minimum number of bends to limit internal friction:
 - floor consoles may not have a minimum pipe run and can be installed back to back
 - high wall units have a minimum pipe run, typically 2.5-3.0 m – check the manufacturer's instructions for specific run lengths
- insulate and protect all pipework
- slope pipes towards the compressor to allow any oil that gets into the pipes to drain back to the compressor sump – some compressor oil will get into the pipeline in any system, and if it remains there it will de-rate the system's pressure and hence its efficiency
- install pipelines to allow for seismic, wind and thermal movement
- pipes must be rated for the refrigerant pressure being used in the system.

6.1 Pipework installation

Good-quality pipework involves the following steps:

1. Selecting suitable pipework and jointing (see Sections 6.1.1 and 6.1.2).
2. Ensuring pipework is clean (see Section 6.1.3).
3. Making bends properly (see Section 6.1.4).
4. Creating flared joints properly (see Section 6.1.5).
5. Ensuring pipework is well-supported (see Section 6.1.6).
6. Insulating refrigerant pipework (see Section 6.1.7).
7. Positioning and connecting the condensate drainage pipe properly (see Section 6.1.8).

6.1.1 Types of pipework

Figure 6.1 Twin-insulated and dehydrated pipe



Copper pipework forms the closed-coil system through which refrigerant flows. Copper may be hard-drawn or soft-drawn – while hard-drawn is recommended as best practice for pipe diameters of 20 mm and more, soft-drawn is commonly used because it is easier to work with.

Use twin-insulated and dehydrated pipe, which is easier to install in trunking and ceiling spaces (Figure 6.1).

6.1.2 Types of jointing

Pipes can be jointed by brazing, compression or lock-ring jointing.

Brazed joints are considered to provide the best resistance to pressure, temperature and stress vibrations, and using this type of jointing is recommended as good practice. Pipe joints behind the indoor unit and in wall spaces must be brazed as brazed pipe connections reduce the likelihood of leaks and take up less space. Carry out all brazing with oxygen-free nitrogen (OFN) circulating through the pipework – this will avoid a build-up of carbon in the pipe, which will cause oil sludging, filter blockage and eventual system failure.

Compression or lock-ring joints are a recent addition to the options for jointing copper pipe; however, space is needed to allow access to install and compress the jointer onto the pipe. Joints must be made with the supplier's recommended fittings and using the correct compression/locking tool. Fittings must be suitable for the pipe diameters and be rated for the refrigerant pressures present in the system.

Do not use screwed or flanged pipe connections.

6.1.3 Maintaining cleanliness of pipework

Ensure that all pipework is clean and suitable for the system by:

Figure 6.2 Pipe opening facing down when cutting



- Holding the pipe opening facing down when cutting (Figure 6.2).
- Removing metal filings from inside pipework after cutting.

Figure 6.3 Cover pipe ends



- Always keeping pipe ends covered with caps, by brazing or taping (Figure 6.3) – covering pipe ends prevents moisture, dirt or foreign matter getting into the pipes, particularly when pushing or pulling through wall cavities.

Do not let uncapped ends of pipe touch the ground.

6.1.4 Making bends

Bend all copper pipes over 9.5 mm or 3/8" diameter with the correct-sized pipe bender (Figure 6.4) – handmade bends may kink or have a reduced internal pipe dimension, which will reduce refrigerant flow.

Figure 6.4 Pipe bender



When pre-insulated pipe is used:

- Split the insulation and cut away from around the pipe.
- Bend the pipe using the correct-sized bender.
- Replace the insulation and tape together using vinyl tape or insert a copper bend using brazed connections, then insulate.

6.1.5 Creating flared joints

Flared joints are required where connecting the pipe to the units. Flared joints must be done by an experienced installer as the joints have a higher risk of the refrigerant leaking due to poor installation. They can also be easily modified by unqualified persons.

Flaring of joints is not a simple task and requires the correct tool to be used for the refrigerant gas being used and the pipe wall thickness. The correct steps must be followed to create a sound connection.

Units using R410A refrigerant require a specific flaring tool to cope with the pressure the refrigerant is installed at.

There are several steps for forming a flared joint.

Figure 6.5 Cut pipe with tube cutters



- Cut pipe with tube cutters to give a cut that is straight across (Figure 6.5)
 - use a sharp blade and cut slightly longer than measured length.

Figure 6.6 Remove all burrs



- Remove all burrs with a de-burr tool (Figure 6.6).
- Remove any metal filings that may have fallen into the pipe.

Figure 6.7 Place the flare nut over the pipe end



- Remember to remove the flare nut from the unit and put it over the pipe end (Figure 6.7) – it is not possible to put it on after flaring the pipe.

Figure 6.8 Flare the end of the tube (A)



- Flare the end of the tube using the correctly-sized flare tool and ensure that the correct amount of pipe protrudes (Figures 6.8 – 6.11).

Figure 6.9 Flare the end of the tube (B)



Figure 6.10 Flare the end of the tube (C)



Figure 6.11 Flare the end of the tube (D)



Figure 6.12 Apply oil to the back of the flared pipe and the flare joint



- Apply oil to the back of the flared pipe and the flare joint using oil compatible with the refrigerant before connecting pipes, i.e. use polyolester oil (POE) with R-410A refrigerant (Figure 6.12) – oil reduces the possibility of tearing the flare when the nut is tightened. Oil must not be allowed to contaminate the refrigerant.

Figure 6.13 Connect the pipes (A)



Figure 6.14 Connect the pipes (B)



- Hand-fasten the flare nut to connect the pipes (Figures 6.13 and 6.14).

Figure 6.15 Tighten connection (A)



Figure 6.16 Tighten connection (B)



- Tighten the connection using two spanners to the torque recommended by the manufacturer (Figures 6.15 and 6.16) – use a torque spanner to achieve the correct torque. Torque against the second spanner (to secure the load while tightening). Never tighten the connection against the joint.

Do not:

- mix polyolester oil and mineral-based oil
- use leak lock or PTFE tape – these are not plumbing joints.

6.1.6 Ensuring pipework is well-supported

Well-supported pipes help ensure the durability and performance of the system by:

- reducing the possibility of cracking or oil traps due to sagging
- eliminating vibration
- eliminating a liquid hammer effect or damage from fluid movement
- resulting in better fluid handling characteristics.

As good practice, copper tubing should be fixed at the spacings given in Table 6.1.

Table 6.1 Fixing spacings for copper tubing

Tubing diameter (mm)	Maximum fixing spacing (m)
<6.5	1.0
6.5–20	1.5
25	2.0
32–40	2.5
>50	3.0

Source: Australia and New Zealand Refrigerant Handling Code of Practice 2007 clause 5.18.

6.1.7 Insulating refrigerant pipework

Insulating all refrigerant pipework will help improve the efficiency of the heat pump system.

Use pre-split, polyurethane foam insulation that is a minimum of 12 mm thick (10 mm for 6 mm or ¼ inch pipe), and is heat-resistant up to 100°C.

To install:

- open insulation tube and wrap moulded section around pipe
- remove self-adhesive strip to seal-join long joint
- butt-join section lengths and tape seal around circumference.

6.1.8 Positioning and connecting the condensate drainage pipe

6.1.8.1 From the indoor unit

Position and connect the condensate drainage pipe from the indoor unit.

- Connect the drainage pipe to the drainage pipe outlet from the unit – if there are two drainage outlets in the condensate tray (indoor unit), connect the drainage pipe to the appropriate side, i.e. to suit the wall outlet location, and insert a rubber bung into the other outlet.
- Wrap the indoor and through wall section of the drainage pipe in polyurethane foam insulation (see **6.1.7 Insulating refrigerant pipework**).
- Use smooth, hard PVC-U drainage pipe if drainage pipe runs laterally – flexible, ribbed drainage pipe can be used for vertical drainage.
- Provide sufficient fall for condensate to drain away.
- Run the condensate hose beneath the refrigerant line when going through the wall, to ensure a free flow of condensate.
- Connect sections of pipe with pipe solvent – where pipe sizes must be stepped down, connect sections with silicone sealant internally, then tape around join with vinyl tape.
- Run the indoor drainage pipe:
 - to the outdoor unit to be drained away to the same location as the outdoor unit condensate
 - outdoors to drain onto lawn or garden – discharge into the stormwater system is permitted in some areas (do not discharge into a gully trap).
- Where pipe traps are recommended by the manufacturer to reduce negative pressure, install in accordance with the manufacturer's specifications.
- The condensate outlet pipe should never be allowed to be immersed in water as this can cause an air lock and prevent water drainage under gravity.

Do not:

- use flexible drainage piping in internal wall spaces
- use flexible ribbed drainage piping for lateral pipe runs, as water may sit in the ribs or low points may occur in the pipe
- use electrical conduit.

Internal units should be located to avoid the need to install a condensate pump. Where unavoidable, install in accordance with the manufacturer's specification and advise the owner of the maintenance requirements of the pump.

6.1.8.2 From the outdoor unit

Discharge condensate:

- onto a grassed or planted area
- into a stormwater gully trap
- through timber decking to ground below.

Do not discharge where it can run over a footpath as it may become slippery or freeze in the winter.

6.2 Pipework pre-installation in new buildings

When installing pipework in a new building, it is easiest to do it before wall linings and claddings are put on.

Procedure

- Unroll and lay out pipe and connection cable to connect indoor and outdoor units.
- Tape pipe and connection cable together with vinyl tape at 1-1.5 m spacings.
- Establish the location and centre of the indoor unit.
- Establish the location of the outdoor unit.
- Run taped pipe/cable across the top of the bottom truss chord/ceiling joist between the unit locations (Figure 6.17).
- Fix with galvanised mild steel pipe brackets.

Figure 6.17 Run pipe/cable across truss chord/ceiling joist



Indoor unit location

- Notch the top plate and studs (90 x 45 mm) to a maximum depth of 25 mm to insert pipe/cable (Figures 6.18 and 6.19).

Figure 6.18 Notch the top plate and studs (A)



Figure 6.19 Notch the top plate and studs (B)

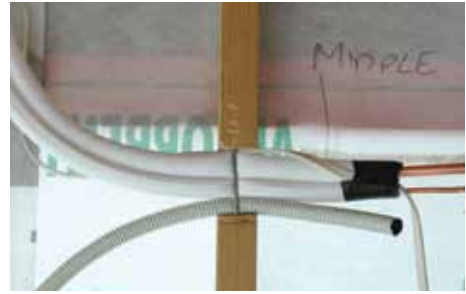


- Insert pipe/cable into notch and fix galvanised mild steel strap over to hold securely in position (Figure 6.20). Notching and drilling must not exceed the limits given in NZS 3604 – see Figure 4.11.

Figure 6.20 Fix galvanised mild steel strap to hold pipe/cable



Figure 6.21 Wedge the pipe cable end into the stud



- Wedge the pipe cable end into the stud in readiness for connection to the indoor unit (Figure 6.21) – use a lightly-fixed and wedged nail that can easily be removed to hold the pipe/cable flat for interior lining fixing.
- Braze pipe ends closed to keep moisture and debris out (Figure 6.22).

Figure 6.22 Braze pipe ends closed



- For floor-mounted units on internal walls:
 - fix pipe/cable in notched dwangs
 - drill holes and feed the drainage pipe through.
- Feed drainage pipe through a hole in the building wrap to outside and seal to weatherproof around pipe.

Do not cut out more timber than necessary.

Outdoor unit location

- Notch the top plate and studs sufficiently to insert pipe/cable. See Figure 4.12 (page 25) for limits on notching and drilling framing.
- Insert pipe/connection cable and power cable (run from meter board) into notches and fix galvanised mild steel strap over to hold securely in position (Figure 6.23).

Figure 6.23 Fix galvanised mild steel strap to hold pipe/connection cable



Figure 6.24 Feed pipe/cables through building wrap



Figure 6.25 Seal pipes or sleeve



- Feed pipe/cables for connection to outdoor unit through a hole cut in building wrap (Figure 6.24). Installing a sleeve is recommended as shown in Figure 7.4.
- Seal pipes or sleeve with flexible flashing tape to weatherproof around pipework and cables (Figure 6.25).
- Braze pipe ends closed to keep moisture and debris out.
- Leave pipe/cable neatly coiled and taped. Note that the taping off has not been completed in this figure nor has a sleeve been used as shown in Figure 7.4.

7.0 Heat pump installation

This section covers good-quality and safe installation of the indoor and outdoor heat pump units, connecting the units to pipework, testing the system for pressure/leaks and evacuation of the system (which must occur after pressure testing).

Some general rules for installing heat pump units are:

- Follow the manufacturer's instructions.
- Use tools and equipment appropriate to the task and in a well-maintained condition.
- Ensure components are compatible.
- Keep the entire system clean and dry.

7.1 Pre-installation checklist

There are a number of things to check before going ahead with installation of the heat pump units.

Unit components

- ☐ Check that the unit is what was specified and that model numbers match.
- ☐ Remove the unit from the packaging and check that all components are supplied.
- ☐ Check for any damaged components.
- ☐ Ensure that installation and owner manuals are supplied.

Trade co-ordination

- ☐ Confirm on-site trade co-ordination between the installer, builder (for new construction) and the electrician (only a registered electrician can hard wire the installation of the heat pump units).

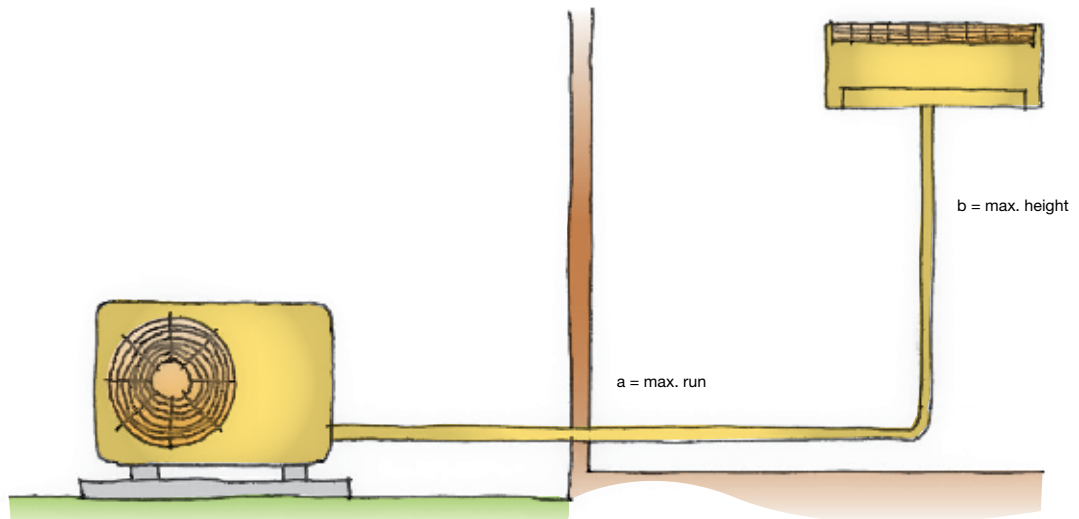
Site safety

- ☐ Follow the Health and Safety in Employment Act health and safety requirements for a building site. These should include:
 - the installer holding a Sitesafe passport and no-loss certification for refrigerant handling
 - using tools and equipment safely
 - securing and storing all materials, plant and equipment safely.
- ☐ Maintain safety procedures including electrical safety requirements when working on an existing building.

On-site checks

- ☐ Check and measure indoor and outdoor locations for available space, access and required clearances for installation and servicing (see 4.7 Step 5: Locate the units).
- ☐ Check the system pipe run does not exceed maximum length and differential height recommended by the manufacturer (Figure 7.1).
- ☐ Confirm the walls are able to provide fixing and support.
- ☐ Identify the location of a suitable power source (see 9.0 Electrical requirements).

Figure 7.1 Maximum pipe length and height



maximum length = a + b

If max. pipe lengths given as 20 m/12
max. run = 20 m
max. height = 12 m

7.2 Installing the indoor unit

Check the manufacturer's instructions for minimum clearances – otherwise allow clearances as given in **4.7 Step 5: Locate the units.**

- **New building:**

- Locate the pre-installed pipework.
- Have any required dwanging added.

- **Existing building:**

- Locate studs/framing on which to fix the installation plate. Plate should be located to span across two stud positions.
- Check the structural integrity of the wall.
- Insert dwanging between studs for fixing support if two studs in suitable positions are not available.

Figure 7.2 Screw-fix installation plate



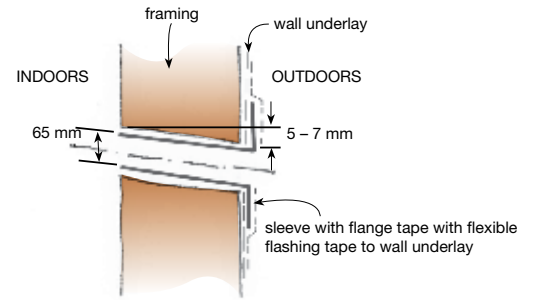
- Use a level to check that the installation plate is horizontal before fixing.
- Don't rack or twist the back plate during fixing – if necessary, pack behind.
- Seal the back of the installation plate with silicone before fixing to restore airtight barrier if dwanging has been installed. Screw-fix the installation plate through the wall into the framing behind for a framed wall (Figure 7.2).
- Bolt-fix the installation plate onto a concrete/concrete masonry wall using anchor or screw bolts.

Figure 7.3 Drill a hole through the wall



- Drill a hole in the wall: Using a 65 mm diameter core drill, drill a hole through the wall to the right or left of the installation plate (Figure 7.3). Drill the hole with a slight slope to the outside for drainage (Figure 7.4).

Figure 7.4 Slope of wall penetration



- Check that the wall space is free from electrical cables and cross bracings before drilling holes.

Figure 7.5 Release the tubing and drainage hose



- Attach the indoor unit: Release the tubing and drainage hose from the back of the indoor unit ready for connection to the pipework (Figure 7.5).

Figure 7.6 Feed the connecting cable through the wall



- Feed the connecting cable from the outdoor unit through the hole in the wall and connect to the indoor unit (Figure 7.6).

Figure 7.7 Tape tubing, drainage pipe and connecting cable together



- Tape the tubing, drainage pipe and the connecting cable together ensuring that the drainage hose is on the low side of the bundle (Figure 7.7). If the drainage hose is to be routed inside the room, it must be insulated to prevent condensation forming that may damage furniture or fittings.

Figure 7.8 Feed taped bundle through the hole



- Lift the unit into position and feed the taped bundle through the hole (Figure 7.8).

Figure 7.9 Attach unit to wall bracket (A)



Figure 7.10 Attach unit to wall bracket (B)



- Attach the unit to the wall bracket (Figures 7.9 and 7.10).

Figure 7.11 Ensure unit is securely seated



Figure 7.12 Taped pipes, drainage pipe and connection cable through hole



- Ensure that the unit is securely seated (Figure 7.11).
- Fill around the pipe work to seal the opening formed.
- Install cover and face plate to unit. Check that all holes through the wall lining are hidden by the installed unit.
- Taped pipes, drainage pipe and connection cable are through the hole to the outside (Figure 7.12). Ensure that the condensate drain is at the bottom of the grouped pipes and that there are no kinks in it.

Figure 7.13 Expose flared pipe ends



- Remove tape and expose flared pipe ends for connection to copper piping (Figure 7.13) – see **7.4 Connecting piping to indoor and outdoor units.**

Do not use flexible drainage hose inside existing walls unless fully accessible – if it becomes kinked, it may block and cause leakage inside the wall.

7.3 Installing the outdoor unit

Figure 7.14 Unobstructed gap under outdoor unit fixed on concrete pad cast in place



Install the outdoor unit so that:

- it sits level
- it cannot fall over
- the weight is fully supported
- it has an unobstructed gap under it (Figure 7.14)
- it creates no vibration
- there is a suitable clearance (about 100mm) underneath to allow for hosing and clearing of leaves and dirt
- fixings used are corrosion-resistant – typically requires stainless steel.

The outdoor unit can be fixed on:

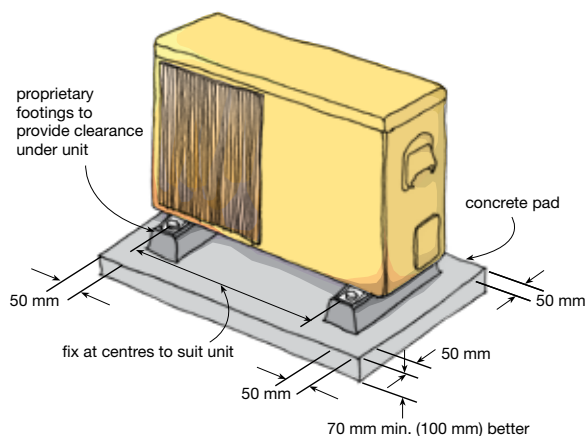
- a concrete pad cast in place or a single piece pre-cast slab at least 40 mm thick (see Section 7.3.1)
- a concrete patio or balcony (see Section 7.3.2)
- a timber slatted deck with anti-vibration mounts (see Section 7.3.3)
- brackets fixed to a foundation or wall (see Section 7.3.4)
- the roof where the installation has been specifically designed (engineered) to accommodate live loads and wind forces acting on the roof, and it incorporates anti-vibration mounts (see Section 7.3.5).

Proprietary mounting systems for roofs and walls are available and should be installed in accordance with the supplier's instructions.

Do not fix the unit onto a waterproof deck or a membrane roofing system as the fixings will penetrate and compromise the waterproofing.

7.3.1 Installing an outdoor unit on a concrete pad

Figure 7.15 Concrete pad construction



- Construct the pad as shown in Figure 7.15 (check construction if done by others) or place and level a single unit 950 x 450 x 50 mm thick pre-cast concrete slab.
- Fix proprietary mounting rails, where supplied, or hot-dip, galvanised mounting rails at centres to suit the unit.
- Securely fix the mounting rails to the concrete with 316 stainless steel masonry anchors or screw bolts using two fixings per rail.
- Check that rails are level before tightening – pack with plastic shims as necessary to level.
- Fix the unit to the rails and tighten fixing bolts/anchors.

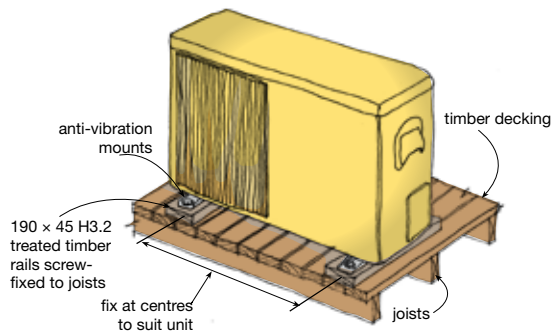
7.3.2 Installing an outdoor unit on a concrete balcony or patio

- Fix proprietary mounting rails (where supplied) or hot-dip galvanised mounting rails over anti-vibration mounts, at centres to suit the unit.
- Securely fix the mounting rails to the concrete with 316 stainless steel masonry anchors or screw bolts with two fixings per rail.
- Check that rails are level before tightening – pack with plastic shims as necessary to level.
- Fix the unit to the rails and tighten fixing bolts.

Note: Units must not be fixed to waterproof concrete or timber framed decks.

7.3.3 Installing an outdoor unit on a timber deck

Figure 7.16 Fixing unit to a timber deck



- Fix hot-dip galvanised mounting rails into the joists with 75 mm long stainless steel screws. Alternatively, fix the mounting rails to 140 x 45 H3.2 treated timber rails laid on flat that are screw-fixed to the decking joists with 115 mm long stainless steel screws (Figure 7.16). Provide anti-vibration mounts or pads. Fix hot-dip galvanised mounting rails through the rails and joists with 75 mm long stainless steel screws.

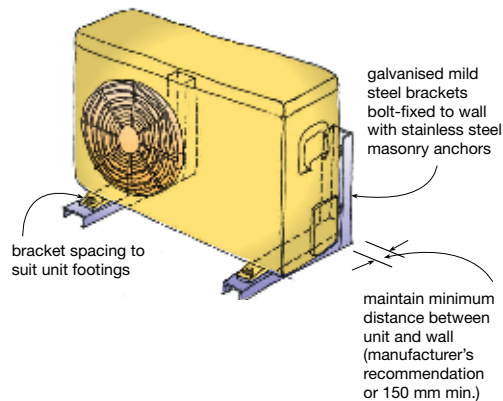
Figure 7.17 Pack with plastic shims to level



- Check that rails are level before tightening – pack with plastic shims as necessary to level (Figure 7.17).
- Fix the unit to the rails and tighten fixing bolts.

7.3.4 Installing an outdoor unit on a foundation or wall (concrete/concrete masonry only)

Figure 7.18 Wall-mounted unit on brackets – masonry wall



- Check the structural integrity of the wall or foundation.
- Bolt fix hot-dip, galvanised brackets or proprietary brackets to the wall or foundation using stainless steel masonry anchors or screw bolts (Figure 7.18).
- Check that the brackets are level before tightening.
- Waterproof around fixings according to the material.
- Fix the unit to the brackets.

Note: Outdoor units may be able to be wall-mounted to some lightweight claddings but the connections and weatherproofing details must be specifically designed to maintain the integrity of the weatherproofing.

7.3.5 Installing an outdoor unit onto the roof

- Roof installations must be specifically designed.
- Screw fix hot-dip, galvanised brackets or a proprietary mounting system into the roof framing to support painted timber base clear of roofing. If mounting on timber base, use painted H3.2 treated timber.
- Provide anti-vibration mounts.
- Insert ethylene propylene diene M-class (EPDM) rubber washers between the bracket and the roofing.
- Check that the brackets are level before tightening.
- Seal all fixings as for the rest of the roof fixing; for example, use EPDM or neoprene.
- Fix the unit to the timber.

Do not:

- **mount units on concrete or clay tile roofs (tiles are not strong enough to allow mounting and the weight of the installers working on the roof)**
- **mount directly onto metal roofing, as roofing can act as a sound amplifier and direct fixing may cause corrosion of the roofing**
- **let tanalised timber come into direct contact with galvanized steel roofing as it is not compatible.**

7.4 Connecting piping to indoor and outdoor units

Connection of piping to indoor and outdoor units must be done in the following order:

1. Connect the piping to the indoor unit (see Section 7.4.1).
2. Fix trunking (see Section 7.4.2).
3. Connect the piping to the outdoor unit (see Section 7.4.3).

7.4.1 Connect the piping to the indoor unit

Figure 7.19 Bind insulation with vinyl tape



- Use twin-insulated and dehydrated copper piping.
- Cut and flare the copper pipes for connection to the indoor unit (see **6.1.5 Creating flared joints**).
- Apply oil to both the flare and the indoor unit, ensuring that the oil is compatible with the refrigerant.
- Align and connect the pipes and tighten the flare nut by hand.
- Tighten the flare nut connections using two spanners to the correct torque.
- Overlap the connection pipe and indoor pipe insulation.
- Bind the insulation with vinyl tape (Figure 7.19).

Figure 7.20 Tape drainage hose to drainage outlet



- Connect and tape the drainage hose to the drainage outlet (Figure 7.20).

7.4.2 Fix trunking

Figure 7.21 Install trunking neatly



- Screw-fix proprietary trunking to the exterior wall from the outlet to the outdoor unit.
- Install trunking neatly in straight runs with 90° angles, tight weather seals and waterproof flashings (Figure 7.21).
- Run horizontal trunking with a slight downhill slope if it contains the condensate drainage pipe.

Figure 7.22 Fit refrigerant piping, drainage pipe and connecting cable into trunking



- Fit refrigerant piping, drainage pipe and connecting cable into trunking (Figure 7.22).
- Attach trunking cover.

Figure 7.23 Fill hole around piping with sealant



- Fill hole around piping with sealant compatible with the trunking and the cladding system (Figure 7.23).

Figure 7.24 Seal around cover



- Seal around and fit cover over opening (Figures 7.24 and 7.25).

Figure 7.25 Fit cover over opening



Do not use trunking indoors.

7.4.3 Connect the piping to the outdoor unit

Figure 7.26 Apply oil to the back of the flare and the outdoor unit



- Cut both pipes to the correct length.
- Flare the pipe ends for connection to the outdoor unit (see **6.1.5 Creating flared joints**).
- Purge the system by blowing oxygen-free nitrogen (OFN) into the pipes before making final flare connection. Note: Hard-drawn copper pipe must be annealed before bending and therefore also requires purging with nitrogen.
- Apply oil to the back of the flare and the outdoor unit, ensuring that the oil is compatible with the refrigerant (Figure 7.26).

Figure 7.27 Connect pipes and tighten flare nut



- Align and connect the pipes and tighten the flare nut by hand (Figure 7.27).

Figure 7.28 Tighten flare nut connections



- Tighten the flare nut connections using two spanners and to the correct torque (Figure 7.28).
- Check all mechanical joints for tightness on completion.
- Remove all rubbish from the installation.
- Clean any marks from the area around the units.

7.5 Leak/pressure test

Pressure test the system for leaks once pipework installation has been completed. Test in accordance with the methods specified in the Australia and New Zealand Refrigerant Handling Code of Practice 2007, Part 1: paragraphs. 3.2.1 and 3.2.2.

Procedure

- Remove the service port valve cap from the gas valve on the outdoor unit (the isolation valve must be kept closed).
- Use oxygen-free dry nitrogen (OFN). Any oxygen introduced into a system during pressure testing can be extremely dangerous and can cause a large explosion.
- Connect the nitrogen gas cylinder to the service port valve.
- Pressurise the system to maximum 200 psi/1.2 MPa and allow to hold for 5 minutes.
- Watch the pressure gauge for any drop-off in pressure.
- Test joints by using a bubble test solution. If using electronic testing, a trace gas must be added to the refrigerant. Electronic testing can be unreliable in windy conditions – if a leak is found with an electronic tester, it must be verified using a bubble test solution.
- Release the nitrogen pressure to discharge.
- Disconnect the cylinder when the pressure has returned to normal.
- Wipe the bubble test solution off the joints after testing.

7.6 Evacuation of the system

Evacuation removes air, moisture and any nitrogen remaining from the pressure testing that may be present in the system. Air, moisture and foreign matter must be removed from the system as it may cause:

- the pressure in the system to rise, resulting in compressor malfunction
- the operating current to rise, resulting in performance loss
- moisture to freeze and block pipework and valves
- oil sludge build-up
- corrosion of parts of the system.

If new twin-insulated piping is used, moisture removal is unlikely to be necessary.

Always use a specific vacuum gauge to monitor the test.

Ensure that the vacuum pump is in good working order, is serviced regularly and has clean oil. (Vacuum pump oil should be replaced after 25 uses or every 6 weeks.) Ensure the vacuum pump is equipped with a backflow prevention device to prevent the oil in the pump flowing backwards into the refrigerant pipes (should power fail during the test) as this could cause major damage to the system.

Procedure

Carry out the evacuation according to:

- the manufacturer's instructions, or
- the methods specified in the Australia and New Zealand Refrigerant Handling Code of Practice 2007, Section 6.

If the system under test holds the vacuum, then a leak is not present. Where the vacuum is not held, refer back to **7.5 Leak/pressure test**, then repeat the vacuum test.

Figure 7.29 Remove vacuum pump and gauges (A)



Figure 7.30 Remove vacuum pump and gauges (B)



- Connect the vacuum pump hose to the service port valve on the gas valve.
- Start the pump.
- Evacuate to 200 microns measure with a specific vacuum gauge. The evacuation time will vary according to the pump capacity and the length of the tubing. Moisture removal will occur in the evacuation process when the pressure is 0.5 Torr or less. Read the gauge for a pressure reading to check evacuation – do not time.
- When the required level of evacuation has been reached, close the manifold valve and stop the pump.
- Allow to hold for minimum 10 minutes – refer back to **7.5 Leak/pressure test** if pressure not held.
- Remove the vacuum pump and gauges (Figures 7.29 – 7.31).

Figure 7.31 Remove vacuum pump and gauges (C)



Figure 7.32 Progressively release the vacuum



- Progressively release the vacuum by opening both the liquid and gas side isolation valves using the valve core removal tool by turning it counter clockwise a ¼ turn (Figure 7.32) so that air is not introduced into the system.

Figure 7.33 Tighten valve caps



- Replace both liquid and gas valve caps and gas service port valve caps and tighten using an adjustable wrench (Figure 7.33). If a valve cap cannot be finger-tightened first, do not force-tighten it, as this may strip the thread – instead, remove and refit the cap. The caps must be securely fastened to prevent refrigerant leakage from the system.

Do not use refrigerant to purge air from pipes.

Evacuation methods specified in the Australia and New Zealand Refrigerant Handling Code of Practice 2007, Section 6 are set out in Tables 7.1 and 7.2. New installations may be evacuated using the single step evacuation procedure (Table 7.1).

These evacuation procedures apply only to the pipework installed on site – not manufacturing process pipework.

Table 7.1 Single step, deep vacuum method

Step	Process
1	Evacuate the system to 200 microns of mercury.
2	Isolate vacuum pump.
3	Allow system to stand for 60 minutes. Test for leaks in vacuum not maintained – if the gauge rises by 50 microns or more, then there is a leak or moisture in the system.
4	Ensure that vacuum is maintained at or below 250 microns of mercury.

Table 7.2 Triple evacuation method

Step	Process
1	Evacuate the system to at least 500 microns of mercury.
2	Break vacuum with oxygen-free nitrogen (OFN).
3	Allow system to stand.
4	Re-evacuate the system and repeat the process using OFN to break the vacuum.
5	Repeat procedure for a third time.

8.0 Refrigerants

A number of different refrigerants have been used over the years and all have some degree of impact to the environment. It is important to minimise refrigerant leaks because they can damage the ozone layer and increase greenhouse gases.

Early refrigerants used were chlorofluorocarbons (CFCs), but the ozone-depleting nature of these compounds has led to them being phased out and replaced with hydrochlorofluorocarbon (HCFC) compounds such as R-22. These have also been found to have global warming potential (GWP) and are now also being phased out and replaced with blended hydrofluorocarbon (HFC) compounds. Currently, the most commonly used refrigerant in residential heat pumps in New Zealand is a HFC blend called R-410A.

Compliance document

Since 1 January 2008, compliance with the Australia and New Zealand Refrigerant Handling Code of Practice 2007 is mandatory for the handling of fluorocarbon refrigerants by anyone holding a refrigerant handling licence or refrigerant trading authorisation. The Code of Practice is in two parts:

- Part 1 covers self-contained low charge systems that do not require any work on the refrigeration circuit to install and contain less than 2 kilograms of fluorocarbon refrigerant.
- Part 2 covers all other stationary and transport refrigeration and air conditioning systems.

Essential requirements of the code are that:

- heat pump systems must be able to be installed, operated, serviced and decommissioned without loss of refrigerant
- heat pump systems must be installed by an appropriately qualified person with no-loss refrigerant handling certification
- refrigerant must not be intentionally released into the atmosphere.

8.1 Refrigerant charging

The outdoor unit is factory-charged with sufficient refrigerant for the indoor unit and a specific pipe run. Refer to the manufacturer's installation instructions for the pre-charge pipe length. Refrigerant will need to be totally removed and recharged where the pipe run length is longer than that allowed for in the factory. Where shorter, some refrigerant will need to be released and captured. It is an offence to release refrigerant to the air.

Refrigerant charging must be carried out in accordance with AS/NZS 1677.2:1998, Section 6.1: Charging and discharging refrigerant.

Procedure

- Use on the specified refrigerant for charging.
- Measure the additional pipe run length.
- Accurately calculate the amount of refrigerant required according to the manufacturer's instructions.
- Measure the required amount of refrigerant (where additional charge is required) by mass, using electronic scales.
- Keep the charge lines as short as possible.
- Leak test the pipework before charging, by partially opening, then closing the cylinder valve to pressurise the connecting pipework.
- Charge using liquid refrigerant from the cylinder.
- Check for leaks using the bubble test solution.
- Ensure that the cylinder and unit are at the same height to prevent gravity transfer of the refrigerant.

Do not:

- **discharge refrigerant into the atmosphere – under AS/NZS 1677.2:1998, paragraph 6.1.2 Note 2, “it is an offence to deliberately discharge controlled ozone depleting substances into the atmosphere” with a \$5,000 fine**
- **use ultraviolet dye**
- **use reclaimed refrigerant to add additional charge.**

8.2 Labelling as record of service

When a system is charged with refrigerant or lubricant, it must be labelled. Compressors, systems and liquid refrigerant pumps must be labelled in accordance with AS/NZS 1677.2:1998, clause 5.4.2: Marking of compressors, unit systems, and liquid refrigerant pumps.

Place a permanent label on the unit that identifies:

- refrigerant type
- name of service person and organisation
- date of service
- lubricant type
- gas charge (total including any additional charge).

9.0 Electrical requirements

This section covers electrical requirements for heat pump installations. It is an essential element of the installation that all electrical work is carried out in an appropriate manner to ensure that the installation is safe and complies with legislation.

All electrical wiring must have a Certificate of Compliance (CoC) certificate issued by a registered tradesperson on completion and inspection of the installation. Electrical work must be carried out in accordance with the Electricity Act, electrical wiring regulations and AS/NZS 3000:1997.

Inverter units with a heat output of 5 kW or greater must be connected to a separate circuit. Those under 5 kW may be connected to a power circuit of at least 2.5 mm twin and Earth cabling with a 20 amp lockable RCD, and where sufficient load is safely available (i.e. not a kitchen, laundry or other heavy load circuit).

9.1 Installing electrical wiring

- Select a circuit for the main power supply.
- For new work, use a dedicated supply.
- Refer to the manufacturer's specifications for:
 - rated voltage
 - input capacity/fuse size
 - electrical cable size
 - wiring diagram for electrical installation.
- All hard wiring must be carried out by a registered electrician.

9.2 Outdoor unit connections

Figure 9.1 Connect power supply cable to terminal block



- Remove service cover from outdoor unit.
- Fix indoor/outdoor connecting cable correctly to the terminal block in the outdoor unit.
- Tighten terminal screws to ensure that wires are firmly secured.
- Connect power supply cable to terminal block in outdoor unit (Figure 9.1).

Figure 9.2 Install lockable isolating switch (A)



- Install a lockable isolating switch with a minimum 3 mm gap when open (Figures 9.2 – 9.4).

Figure 9.3 Install lockable isolating switch (B)



Figure 9.4 Install lockable isolating switch (C)



Figure 9.5 Replace service cover to outdoor unit



- Attach the isolating switch to the house
 - not to the outdoor unit.
- Provide waterproof protection to the connection as required, such as:
 - cable gland
 - flexible conduit.
- Replace service cover to outdoor unit when all connections are completed (Figure 9.5).

Do not:

- connect the isolating switch to the outdoor unit, which means that the unit cannot be isolated from the power
- allow contact between wiring and refrigerant pipework
- run the main power cable and heat pump system power cable together
- allow work to be carried out by an uncertified tradesperson or to be installed without a completion certificate for the electrical works, which may void future insurance loss claims.

9.3 Nameplate

Attach a nameplate in an accessible location displaying:

- manufacturer's name and/or trademark
- type or model designation and serial number
- rated voltage
- rated frequency
- cooling capacity
- heating capacity
- refrigerant type (designation) and charge.

10.0 Testing, commissioning and customer operating instructions

This section covers what to do once a heat pump system is installed. It includes what to check before it is commissioned, testing the system, briefing the homeowner on the new system and carrying out a quality assurance check once everything is completed.

Once the installation is complete, the system can be commissioned. If instructions are provided by the manufacturer, they must be followed; otherwise, testing and commissioning must comply with the Australia and New Zealand Refrigerant Handling Code of Practice 2007.

10.1 Pre-commissioning checks

Outdoor unit – check:

- ☐ The unit is secure and correctly mounted.
- ☐ There is a clear air movement path.
- ☐ Valve caps have been replaced and securely tightened.
- ☐ Wiring has been signed off.

Indoor unit – check:

- ☐ Unit mounting is level and secure.
- ☐ Remote control base is securely screwed to wall.

Pipework – check:

- ☐ Pipework has been correctly installed and secured.
- ☐ Pipework is correctly insulated.

Indoor unit drainage – check:

- ☐ Pour some water into the indoor unit drainage pan.
- ☐ Ensure that the water flows through the outlet and drainage hose without leaking.

10.2 Electrical checks

Wiring:

- ☐ Carry out tests required under the wiring regulations.
- ☐ Do a polarity test.
- ☐ Electrical code compliance certificate is obtained and a copy handed to the owner.

Labelling:

- ☐ Provide labels on indoor and outdoor units to identify:
 - fuse location
 - phase colour
 - size of protection device.

10.3 Prepare the remote control

- ☐ Remove the battery cover.
- ☐ Insert new batteries.
- ☐ Replace cover.

10.4 Testing the new system

- ☐ Switch the system on.
- ☐ Ensure that no LED lights are on. If LED lights are on or blinking, the installation is faulty. Disconnect the power supply and locate and fix the fault.
- ☐ Check the emergency operation by pressing the emergency operation on/off switch and holding down for 3-5 seconds. This will start a test run (continuous operation for a set period) during which the thermostat does not work.
- ☐ Press the emergency operation on/off switch again to turn off.
- ☐ Test unit in heating and cooling mode as described below.

Indoor unit – check:

- ☐ The fan operates at all speeds.
- ☐ There is no vibration of the unit.
- ☐ Vertical and horizontal air direction controls are operating.
- ☐ Air circulation mode (circulating air without heating/cooling) is operating.

The unit operates to the correct heat command – use a thermometer. With an indoor ambient air temperature of 21°C:

 - for heating, an air-off coil temperature of 45-50°C or better should be achieved
 - for cooling, an air-off coil temperature of 8-12°C or better should be achieved.
- ☐ The manual operation is functioning – for situations when the remote cannot be used.
- ☐ The auto start is functioning.
- ☐ An electronic sound can be heard by pressing the on/off button of the remote control.
- ☐ The condensate pump (if installed) works.

Note: Air-off coil (delivery air) temperature is dependent on the ambient internal temperature and the outdoor temperature. A good rule of thumb is to ensure a 10-15°C temperature difference between air-on coil (air coming back to the coil) and air-off coil (delivery air) for the indoor unit for both heating and cooling.

10.5 Instructions to the owner

Checklist of instructions to the owner on the use of the system:

- ☐ Demonstrate how to set the controls/different modes correctly.
- ☐ Demonstrate how to use the remote control.
- ☐ Demonstrate how to remove and clean air filters.

Advise:

 - on what to expect on very hot or very cold days
 - that the system will take a few minutes to warm up
 - consider turning the heat pump off late at night if the noise bothers the neighbours.
- ☐ Advise of service requirements.
- ☐ Recommend reading the operating instructions manual.
- ☐ Provide a service checklist.
- ☐ Provide the warranty.
- ☐ Provide an electrical code compliance certificate.
- ☐ Provide a record of the system commissioning data.
- ☐ Provide contact names and numbers in case of problems.

Understanding how to use a heat pump efficiently is important information for homeowners. The following information is taken from the EECA ENERGYWISE™ publication *How to choose a heat pump and use it wisely* – it can also be downloaded from www.energywise.govt.nz

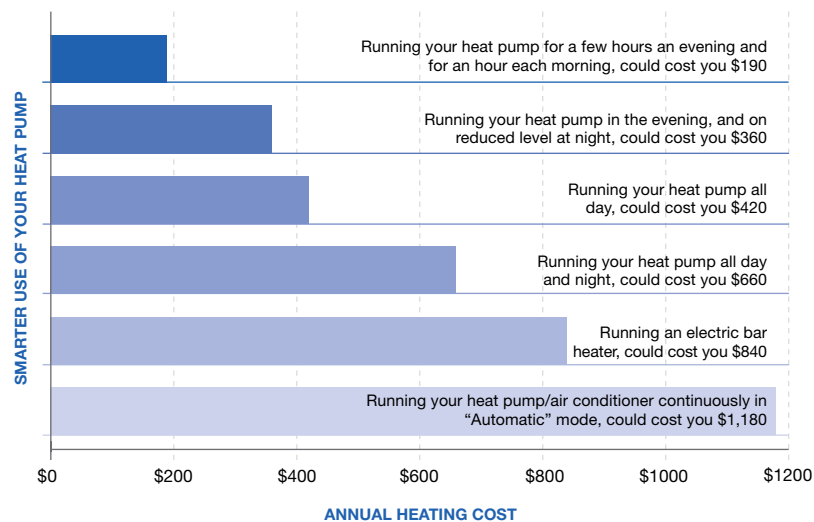
Heat pump running costs

Now you've chosen your heat pump, you'll get maximum energy efficiency gains and savings on your power bill by using it wisely.

If a heat pump/air conditioner is run all day and night, you can expect to double your power bill. But if you use your heat pump for a few hours in the evening, and an hour in the morning, you can expect to save about \$500 a year, as opposed to an electric heater.

Figure 10.1 shows how much the cost of running a heat pump can vary depending on how you use it. This chart illustrates the way that you run your heat pump can have a significant impact on overall running costs.

Figure 10.1 Annual heat pump running costs



Note: These figures are for information only. The values used are based on a number of assumptions (such as size of heat pump, ambient room and outside air temperature, levels of home insulation etc). Actual running costs will vary significantly depending on these assumptions as well as each particular product's characteristics and the individual installation.

Some heat pump installers suggest to consumers that they leave the heat pump on 24 hours a day. Heat pumps should only be used in this way if there are people in the house all day (especially if they are elderly, babies or have health problems) and if the householder wants to keep the house warm at night, otherwise they are wasting energy and increasing the potential for your heating bill to go up.

Heat pumps work harder on cold nights

Heat pumps work harder, and therefore use more energy, when the ambient air is colder. If you need to run your heat pump at night (for example for health reasons), turn down the thermostat setting to keep a minimum of background heat. Efficient home insulation will also make a big difference in keeping homes warm at night.

Extra load on energy supply

Dry winter months pose two problems: increased heating demand, and reduced energy resources in the hydro lakes. If all the heat pumps around the country were left running all day and night, this could equate to a demand equal to 5% of the total national production of electricity.

Use the remote

Remote controls come standard with most heat pumps. Users can set the timer so that their heat pump turns on an hour before they get home, and by using a temperature sensor to make it easy to achieve a constant, comfortable temperature.

It is also possible to get a 7-day timer which allows you to programme on/off times for each day of the week for maximum energy efficiency.

Summer cooling

Using a heat pump as an air conditioner in summer instead of opening the windows and doors will increase your power bill. Instead, try creating a cross-draft by leaving windows open on opposite sides of the house. You can also close blinds or curtains to keep the sun out in the heat of the day. If you do use the air conditioner to cool the space, close windows and doors otherwise the heat pump will have to work harder to keep the temperature down and end up costing you more.

Checklist for using a heat pump efficiently

Like any heating option, heat pumps give the best energy savings when they are used wisely.

- Heat the spaces that you are actually using and shut doors and curtains to keep the heat in.
- Don't have the temperature higher than you need it – aim for between 18-22°C while you are using a space, and 16°C overnight if required.
- Learn to use the timer features so your heat pump turns on an hour or so before you get home, instead of leaving it on all day.
- Make sure your house is well insulated, so that you keep the heat you are paying for in your house longer.
- Clean the filter (inside and outside) regularly, as per the manufacturer's instructions.
- Only use your heat pump as an air conditioner if you really need to. Try opening windows and doors on either side of the house to get a through breeze. Close curtains on hot, sunny days to keep your home cool and shady.

10.6 Quality assurance checklist for auditing

Carry out a quality assurance check on completion of installation of a heat pump system.

Outdoor unit

- ☐ Is the outdoor unit secure with no likelihood of falling over?
- ☐ Is there any vibration or noise disturbance to owners and/or adjacent properties?
- ☐ Is the area around the unit clear so there is no likelihood that the air supply routes will become blocked?
- ☐ Has the unit been installed to provide future servicing access?
- ☐ Is all the exterior ducting neat and tidy, with all flashing and waterproofing completed?
- ☐ Have all service covers been replaced?
- ☐ Is the unit clearly labelled?
- ☐ Have the installer's checklists been sighted?

Indoor unit

- ☐ Is the indoor unit secure and does not vibrate?
- ☐ Has the test run been carried out?
- ☐ Is the unit neatly installed with no pipework or ducting visible?
- ☐ Have the installer's checklists been sighted?

Pipework

- ☐ Is the pipework appropriate for the refrigerant used in the system?
- ☐ Has a leak test been carried out?
- ☐ Was the system evacuated?
- ☐ Is the system charged to a level appropriate for the pipe length?
- ☐ Are the stop valves fully open?
- ☐ Have the installer's checklists been sighted?

Drainage

- ☐ Is the drain hose from the indoor unit properly installed?
- ☐ Has the indoor unit drainage been tested by pouring water into the tray?
- ☐ Has the outdoor drainage pipe been directed away appropriately?

Electrical

- ☐ Does the electrical work have an electrical code compliance certificate?
- ☐ Has a copy of the Code of Compliance certificate been given to the owner?
- ☐ Is the unit connected to a separate circuit (if over 5 kW output), hard wired back to the mains distribution board?
- ☐ Is there a circuit breaker in the system and has the circuit been properly labelled on the distribution board?
- ☐ Is the energy rating label on the unit or available for viewing?

Instructions to the owner

- ☐ Has the operation of the system been explained to the owner?
- ☐ Does the owner have the operating manual?
- ☐ Has the owner been advised of maintenance and servicing requirements?
- ☐ Does the indoor unit have the energy rating label applied, or available?
- ☐ Has the owner been given a copy of the warranty?

11.0 Servicing and maintenance

In addition to regular maintenance by the owner, a routine maintenance agreement should be undertaken with a licensed service person or organisation. In addition, users should monitor their installation and call a service person immediately if any abnormal operation is found.

11.1 Owner maintenance

Indoor unit

- ☐ Check air filters after 3 months use then clean or replace as necessary (some units will identify when filters need cleaning or be self-cleaning). If they can be cleaned:
 - remove and vacuum clean using a brush attachment then replace, or
 - wash gently with a mild detergent and warm water, and dry before replacing.
- ☐ Check the indoor coils (if accessible) – dust gently to clean.
- ☐ Check and clean condensate pan, drain and trap.
- ☐ Clean the unit cover with a damp cloth and mild detergent as required.
- ☐ Recognise the operational sound of the heat pump – if the sound changes, have the system checked.
- ☐ Ensure that air vents are not blocked by furniture or objects.
- ☐ At 6 months, check operation of condensate pump if fitted.

Do not vacuum indoor coil fins as they are easily damaged.

Outdoor unit

- ☐ Keep the area around the outdoor unit clear of garden waste and dirt.
- ☐ Remove any growth around or into the unit.
- ☐ Make sure the unit is off when cleaning.
- ☐ Check and clean the outdoor coils when they are dirty.
- ☐ Contact a service person at any sign of unusual sounds or operation.
- ☐ Have an annual servicing agreement.
- ☐ Power may be switched off in line with the manufacturer's guidelines.

11.2 Service person maintenance

The system should be serviced by a qualified person every 12 months depending on use. Before servicing, establish the refrigerant that has been used in the system.

Indoor unit

- ☐ Inspect the filters, blower and indoor coil for dirt or obstructions.
- ☐ Check the airflow.
- ☐ Check the output temperature.

Outdoor unit

- ☐ Clean the condenser coils as follows:
 - Clear the outside of the coil of debris.
 - Vacuum the coil fins using a soft bristle brush attachment – take care to avoid bending the fins.
 - Spray water from the inside to the outside of the coils to remove stuck debris using a hose and spray gun.
 - Vacuum or remove by hand any debris remaining in the unit.
 - If there are no bent coil fins, replace grille covers.
- ☐ Check coil fins for damage – if coil fins are bent, straighten using a proprietary tool.
- ☐ Lubricate fan bearings if required – sealed bearing units do not require oiling.
- ☐ Inspect fan for damage and repair as required.
- ☐ Check that the condenser unit is secure and level in both directions. If necessary, adjust the levelling feet, or make level with timber/plastic shims. If the unit is seriously out of level, repair or replace the base the unit sits on.

Do not spray the fan motor or wires with water.

Refrigerant

- ☐ Check the operation of the air-on/air-off with a digital thermometer.
- ☐ Check pipe joints for refrigerant leakage with bubble solution.

Electrical

- ☐ Check terminals and connections – clean and tighten if necessary.
- ☐ Check fan motors for lubrication.
- ☐ Check that the electric control is operating correctly.
- ☐ Check that the thermostat is operating correctly.
- ☐ Check the voltage.

Service checklist

- ☐ Provide the owner with a service checklist after each service.

12.0 Case studies

The following house design has been used for three case studies in different locations around New Zealand.

Figure 12.1 House plan used in case studies



Figure 12.2 House elevations A and B as used in case studies



Figure 12.3 House elevations C and D as used in case studies



12.1 Case 1 – Auckland

12.1.1 Step 1: Determine requirements

Heating/cooling requirements

- ☐ Primarily for heating.
- ☐ Auckland region, open site.
- ☐ New home.
- ☐ Family room is to be heated by the heat pump.

Checklist of building conditions

- ☐ North facing.
- ☐ Good solar access.
- ☐ Areas of windows, floors and external walls calculated for the space.
- ☐ Complies with current Building Code (2008 onwards) – high levels of insulation and double glazing.

12.1.2 Steps 2 and 3: Determine design temperature and heat load requirement

Climate	
Region:	Auckland
Design Temperature: (PTO for table)	4°C

Factor	Score	Room
(A) Climate index (PTO for table)		0
(B) Room type		+
Bed, Hall (16°C):	0	2
Dining (18°C):	1	
Lounge (20°C):	②	
(C) Insulation (select one)		+
Very High:	0	1
NZBC 2008 onwards:	①	
NZBC 1978–2007:	2	
Ceiling and/or floor insulation:	3	
Uninsulated:	4	
(D) Number of external walls		+
One:	1	3
Two:	2	
Three:	③	
(E) Window size in this room (% of exterior wall area)		+
Small: ~ 25%:	1	2
Medium: ~ 40%:	②	
Large: ~ 60%:	3	
Very Large: ~ 80%:	4	
(F) Total score = (A) + (B) + (C) + (D) + (E)		8
(G) Multiply room area (45.1) x 8 [m ²]		360.8
(H) = (G) + (100) =		460.8
Heater Size in Watts = (F) x (H) =		3686.4 W

12.1.3 Step 4: Determine system requirements and options

- High wall inverter unit.
- Single-split.
- Non-ducted.
- High star rating for good energy efficiency performance.

12.1.4 Step 5: Select system/model to suit all requirements

In this case, a high wall indoor unit with low indoor and outdoor noise could be selected. The table below gives sample data for heat pumps – installers will need to use product-specific data. The design temperature is 4°C, and the heat required is 3.7 kW. Therefore Model A, which has an output of 3.8 kW at 2°C, is sufficient.

Always round down to the nearest design temperature there is performance data for.

Model A: Capacity 4.0 kW rated output															
Indoor (°C)	Outdoor (°C)														
20	-10			-5			0			2			7		
	Output	Input	COP	Output	Input	COP	Output	Input	COP	Output	Input	COP	Output	Input	COP
	2.4	0.77	3.12	2.88	0.91	3.15	3.7	1.1	3.31	3.8	1.12	3.4	4.1	1.18	3.5
Model B: Capacity 6.0 kW rated output															
Indoor (°C)	Outdoor (°C)														
20	-10			-5			0			2			7		
	Output	Input	COP	Output	Input	COP	Output	Input	COP	Output	Input	COP	Output	Input	COP
	3.6	1.3	2.76	4.32	1.54	2.8	5.1	1.71	2.98	5.2	1.75	3.0	6.1	1.9	3.2

12.1.5 Step 6: Locate the units

Outdoor unit

There are a few options for the outdoor unit. It would be best to avoid the area around the double doors as it is used for outdoor living. Outside the kitchen is appropriate as long as the occupants don't have an issue with it being close to their front door – see location on plan at A. Another option is on the bathroom or laundry wall. In this case, pipework needs to be planned at the design stage of building.

Indoor unit

The indoor unit can be placed on the external wall on the family side of the kitchen. It is important not to have steam from cooking underneath the unit – in this case, this is not likely, so will be OK.

12.2 Case 2 – Wellington

12.2.1 Step 1: Determine requirements

Heating/cooling requirements

- Primarily for heating.
- Wellington city, located in a valley with little sun.
- New home.
- Family room is to be heated by the heat pump.

Checklist of building conditions

- North facing.
- Poor solar access to the family room.
- Areas of windows, floors and external walls calculated for the space.
- Complies with current Building Code (2008 onwards) – high levels of insulation and double glazing.

12.2.2 Steps 2 and 3: Determine design temperature and heat load requirement

Climate		
Region:	Wellington	
Design Temperature: (PTO for table)	0°C	
Heater Sizer		
Factor	Score	Room
(A) Climate index (PTO for table)		3
(B) Room type		+
Bed, Hall (16°C):	0	2
Dining (18°C):	1	
Lounge (20°C):	②	
(C) Insulation (select one)		+
Very High:	0	1
NZBC 2008 onwards:	①	
NZBC 1978–2007:	2	
Ceiling and/or floor insulation:	3	
Uninsulated:	4	
(D) Number of external walls		+
One:	1	3
Two:	2	
Three:	③	
(E) Window size in this room (% of exterior wall area)		+
Small: ~ 25%:	①	2
Medium: ~ 40%:	2	
Large: ~ 60%:	3	
Very Large: ~ 80%:	4	
(F) Total score = (A) + (B) + (C) + (D) + (E)		11
(G) Multiply room area (45.1) x 8 [m ²]		360.8
(H) = (G) + (100) =		460.8
Heater Size in Watts = (F) x (H) =		5060 W

12.2.3 Step 4: Determine system requirements and options

- High wall inverter unit.
- Single-split.
- Non-ducted.
- High star rating for good energy efficiency performance.
- Low noise.

12.2.4 Step 5: Select system/model to suit all requirements

In this case, a high wall indoor unit with low indoor and outdoor noise could be selected. The table below gives sample data for heat pumps – installers will need to use product-specific data. The design temperature is 0°C and the heat required is 5.1 kW. Model B is sufficient in this case, as it provides a heating output of 5.1 kW.

Model A: Capacity 4.0 kW rated output															
Indoor (°C)	Outdoor (°C)														
20	-10			-5			0			2			7		
	Output	Input	COP	Output	Input	COP	Output	Input	COP	Output	Input	COP	Output	Input	COP
	2.4	0.77	3.12	2.88	0.91	3.15	3.7	1.1	3.31	3.8	1.12	3.4	4.1	1.18	3.5
Model B: Capacity 6.0 kW rated output															
Indoor (°C)	Outdoor (°C)														
20	-10			-5			0			2			7		
	Output	Input	COP	Output	Input	COP	Output	Input	COP	Output	Input	COP	Output	Input	COP
	3.6	1.3	2.76	4.32	1.54	2.8	5.1	1.71	2.98	5.2	1.75	3.0	6.1	1.9	3.2
Model C: Capacity 8.0 kW rated output															
Indoor (°C)	Outdoor (°C)														
20	-10			-5			0			2			7		
	Output	Input	COP	Output	Input	COP	Output	Input	COP	Output	Input	COP	Output	Input	COP
	4.8	1.85	2.59	5.65	2.05	2.75	6.2	2.25	2.8	6.4	2.4	2.7	8.1	2.6	3.1

12.2.5 Step 6: Locate the units

Outdoor unit

There are a few options for the outdoor unit. It would be best to avoid the area around the double doors as it is used for outdoor living. Outside the kitchen is appropriate as long as the occupants don't have an issue with it being close to their front door – see location on plan at A. Another option is on the bathroom or laundry wall. In this case, pipework needs to be planned at the design stage of building.

Indoor unit

The indoor unit can be placed on the external wall on the family side of the kitchen. It is important not to have steam from cooking underneath the unit – in this case, that is not likely.

12.3 Case 3 – Dunedin

12.3.1 Step 1: Determine requirements

Heating/cooling requirements

- Primarily for heating.
- Already have a wood burner that they are keeping and will use during the colder parts of winter in the family room – see location on plan at B.
- Dunedin, sloping site with good solar access.
- New home.
- Family room is to be heated by the heat pump.

Checklist of building conditions

- Good solar access to the family room.
- Areas of windows, floors and external walls calculated for the space.
- Complies with current Building Code (2008 onwards) – high levels of insulation and double glazing.

12.3.2 Steps 2 and 3: Determine design temperature and heat load requirement

Climate	
Region:	Dunedin
Design Temperature: (PTO for table)	-1°C

Heater Sizer		
Factor	Score	Room
(A) Climate index (PTO for table)		5
(B) Room type		+
Bed, Hall (16°C):	0	2
Dining (18°C):	1	
Lounge (20°C):	②	
(C) Insulation (select one)		+
Very High:	0	1
NZBC 2008 onwards:	①	
NZBC 1978–2007:	2	
Ceiling and/or floor insulation:	3	
Uninsulated:	4	
(D) Number of external walls		+
One:	1	3
Two:	2	
Three:	③	
(E) Window size in this room (% of exterior wall area)		+
Small: ~ 25%:	①	2
Medium: ~ 40%:	2	
Large: ~ 60%:	3	
Very Large: ~ 80%:	4	
(F) Total score = (A) + (B) + (C) + (D) + (E)		13
(G) Multiply room area (45.1) x 8 [m ²]		360.8
(H) = (G) + (100) =		460.8
Heater Size in Watts = (F) x (H) =		5990.4 W

12.3.3 Step 4: Determine system requirements and options

- High wall/floor-mounted unit.
- Single-split.
- Non-ducted.
- High star rating for good energy efficiency performance.
- Low noise.

12.3.4 Step 5: Select system/model to suit all requirements

In this case, a high wall or a floor-mounted indoor unit with low indoor and outdoor noise could be selected. The table below gives sample data for heat pumps – installers will need to use product-specific data. The design temperature is -1°C and the heat required is 6 kW. Model B has sufficient capacity for the heating required with an output of 6.2 kW at 5°C.

Model A: Capacity 8.0 kW rated output															
Indoor (°C)	Outdoor (°C)														
20	-10			-5			0			2			7		
	Output	Input	COP	Output	Input	COP	Output	Input	COP	Output	Input	COP	Output	Input	COP
	4.8	1.85	2.59	5.65	2.05	2.75	6.2	2.25	2.8	6.4	2.4	2.7	8.1	2.6	3.1
Model B: Capacity 10.0 kW rated output															
Indoor (°C)	Outdoor (°C)														
20	-10			-5			0			2			7		
	Output	Input	COP	Output	Input	COP	Output	Input	COP	Output	Input	COP	Output	Input	COP
	5.5	2.12	2.6	6.2	2.25	2.8	6.8	2.45	2.8	7	2.55	2.7	9.2	2.7	3.4

12.3.5 Step 6: Locate the units

Outdoor unit

There are a few options for the outdoor unit. It would be best to avoid the area around the double doors as it is used for outdoor living. Outside the kitchen is appropriate as long as the occupants don't have an issue with it being close to their front door – see location on plan at A. Another option is on the bathroom or laundry wall. In this case, pipework needs to be planned at the design stage of building.

Indoor unit

The indoor unit can be placed on the external wall on the family side of the kitchen. Alternatively, the unit could be on external wall elevation A between the windows. Both locations allow for easy drainage of the condensate drain to outside.



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