



Department of  
Building and Housing  
*Te Tari Kaupapa Whare*

# Guidelines for energy efficient HVAC plant

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## **This document's status**

This document is issued as guidance under section 175 of the Building Act 2004. While the Department has taken care in preparing the document it should not be relied upon in all cases that may arise. The Document may be updated from time to time and the latest version is available from the Department's website at [www.dbh.govt.nz](http://www.dbh.govt.nz).

# Introduction

Heating, ventilation and air conditioning (HVAC) systems are no longer excluded from NZBC Clause H1 as at 31 January 2009, and a new performance (H1.3.6) is added as follows,

- H1.3.6** HVAC systems must be located, constructed, and installed to –
- (a) limit energy use, consistent with the intended use of space; and
  - (b) enable them to be maintained to ensure their use of energy remains limited, consistent with the intended use of space.

H1.3.6 will apply only to buildings that are classified as commercial (refer NZBC clause A1 for definitions).

There is currently no acceptable solution or verification method for the new NZBC clause H1.3.6.

This document provides guidance for designers and BCAs on the energy efficiency of HVAC systems in commercial buildings. This is not a compliance document and the decision of whether a design complies with clause H1.3.6 is for the BCA to make.

# 1 Controls

HVAC systems should be provided with appropriate controls to enable the achievement of reasonable standards of energy efficiency in use. In normal circumstances, the following features would be appropriate for mechanical heating, cooling, ventilation or air-conditioning system controls:

**1.1** The systems should be sub-divided into separate control zones to correspond to each area of the building that has a significantly different solar exposure, or pattern, or type of use.

**1.2** Each separate control zone should be capable of

- independent temperature control, and
- independent control of ventilation and recirculation rate

where the HVAC design provides the ability for such independent control without significant additional control hardware.

**1.3** The provision of the service should respond to the requirements of the space it serves. If both heating and cooling are provided to an individual control zone, they should be controlled so as not to operate simultaneously within that zone.

**1.4** Central plant should only operate as and when the zone systems require it, except that where non-communicating controls are used, central plant may be controlled by time schedule and outdoor air temperature such as to minimise plant operation when not needed to satisfy zone requirements. The default condition should be off.

**1.5** In addition to these general control provisions, the systems should meet specific control and efficiency standards as provided in the paragraphs below.

## 2 Air-conditioning and ventilation systems

An air-conditioning unit or system should—

- (i) be capable of, where the air-conditioning unit or system has motorised outside air and return dampers, closing the dampers when the air-conditioning unit or system is inactivated
- (ii) have all conditioned supply-air ductwork insulated in accordance with the suggested Specification 1 where;
  - it passes through an external area, unconditioned space, or zone which is not the final intended destination, and
  - the temperature difference between the ambient air and the supply air is greater than  $\pm 5$  degrees Celsius at any time
- (iii) have an outdoor air economy cycle when the unit capacity is over 50 kW
- (iv) when the air flow rate is greater than 1000 L/s, be designed so that the total motor shaft power of the fans in the system does not exceed—
  - (a)  $12 \text{ W/m}^2$  for a building of not more than 500  $\text{m}^2$  floor area adjusted by  $1.15 \text{ W/(L/s)}$  for each increase of 1 (L/s)/ $\text{m}^2$  in air flow rate above 10 (L/s)/ $\text{m}^2$ , and
  - (b)  $15 \text{ W/m}^2$  for a building of more than 500  $\text{m}^2$  floor area adjusted by  $1.7 \text{ W/(L/s)}$  for each increase of 1 (L/s)/ $\text{m}^2$  in air flow rate above 9 (L/s)/ $\text{m}^2$
- (v) the suggested requirements of (iv) should not apply to—
  - (a) fans in package air-conditioning plant complying with Paragraph 4.3, and
  - (b) the input power for an energy reclaiming system that preconditions outdoor air, and
  - (c) the input power for process-related components such as high efficiency particulate air filters
- (vi) when serving a conditioned space, not provide mechanical ventilation in excess of the minimum quantity required by NZBC G4 by more than 50% other than where there is—
  - (a) additional outside air supplied—
    - to provide free cooling, or
    - to balance required exhaust ventilation such as toilet exhaust, or
    - to balance process exhaust such as from a health-care building or laboratory; or
  - (b) additional exhaust ventilation needed to balance the required mechanical ventilation; or
  - (c) an energy reclaiming system that preconditions outside air.

## 3 Smoke and ventilation

The suggested requirements above in 1 and 2 should not inhibit—

- (i) the smoke hazard management operation of air-conditioning and mechanical ventilation systems; and
- (ii) essential ventilation (such as for a garbage room, lift motor room, gas meter enclosure or gas regulator enclosure or the like).

## 4 Heating and chilling systems

- 4.1** Systems that provide heating or chilling for air-conditioning systems should—
- (i) have any piping, vessels, heat exchangers or tanks containing heated or chilled fluid insulated in accordance with the suggested Specification 2, except those whose insulation levels are covered by Minimum Energy Performance Standards (MEPS), and
  - (ii) where water is circulated by pumping at greater than 2 L/s—
    - (a) be designed so that the total of the motor shaft power does not exceed—
      - 3 W/m<sup>2</sup> for a building of not more than 500 m<sup>2</sup> floor area adjusted by 330 W/(L/s) for each increase of 1 (L/s)/m<sup>2</sup> in water flow rate above 8.6 (L/s)/1,000m<sup>2</sup>; and
      - 4 W/m<sup>2</sup> for a building of more than 500 m<sup>2</sup> floor area adjusted by 470 W/(L/s) for each increase of 1 (L/s)/m<sup>2</sup> in water flow rate above 10 (L/s)/1,000m<sup>2</sup>; and
    - (b) except where the pump is required to run at full speed for safe or efficient operation, have the pump capable of varying its speed when it is—
      - operating for more than 3,500 hours per year; or
      - is more than 11 kW of motor shaft power; and
  - (iii) if the system contains more than one each of a water heater, chiller or coil used for heating or cooling the building, be capable of stopping the flow of water to non-operating heaters, chillers or coils.

**4.2** A water heater, such as a boiler in a heating system for a building, should achieve a minimum thermal efficiency of 80% when gas fired and 78% when oil fired when tested in accordance with BS 7190 or BS 845.

A boiler with capacity equal or greater than 500 kW should be fitted with a modulating burner.

**4.3** Package air-conditioning equipment, including a split unit and a heat pump, should have an energy efficiency ratio complying with Table 4.3 when tested in accordance with AS/NZS 3823.1.2:1998 at test condition T1.

**Table 4.3 Suggested minimum energy efficiency ratio for packaged air-conditioning equipment**

Equipment capacity	65 kW <sub>r</sub> to 95 kW <sub>r</sub>	More than 95 kW <sub>r</sub> to 125 kW <sub>r</sub>
	<b>Suggested minimum energy efficiency ratio</b>	
<b>Air-conditioner — cooling</b>	2.7	2.8
<b>Heat pump — cooling</b>	2.6	2.7

**4.4** A refrigerant chiller over 125 kW<sub>r</sub> capacity should have an energy efficiency ratio complying with Table 4.4 when determined in accordance with ARI 550/590.

**Table 4.4 Suggested minimum energy efficiency ratio for refrigerant chillers**

<b>Suggested minimum energy efficiency ratio</b>	<b>Full load</b>	<b>Part load</b>
<b>Water cooled chiller</b>		
More than 125 kW <sub>r</sub> but not more than 525 kW <sub>r</sub>	4.2	5.2
More than 525 kW <sub>r</sub> but not more than 1000 kW <sub>r</sub>	4.5	5.6
More than 1000 kW <sub>r</sub>	5.5	6.1
<b>Air cooled or evaporatively cooled chiller</b>		
More than 125 kW <sub>r</sub> but not more than 525 kW <sub>r</sub>	2.2	3.0
More than 525 kW <sub>r</sub>	2.5	3.1

**4.5** An air cooled condenser fan motor, other than one that is part of package air-conditioning equipment referred to in Paragraph 4.3, should not use more than 40 W of motor shaft power for each kW of heat rejected from the refrigerant when determined in accordance with ARI 460.

**4.6** The fan of a cooling tower should not use more than—

- (i) if a propeller or axial fan, 310 W of motor shaft power for each L/s of cooling water circulated, and
- (ii) if a centrifugal fan, 590 W of motor shaft power for each L/s of cooling water circulated.

**4.7** The fan of a closed circuit cooler should not use more than—

- (i) if a propeller or axial fan, 500 W of motor shaft power for each L/s of cooled fluid circulated; and
- (ii) if a centrifugal fan, 670 W of motor shaft power for each L/s of cooled fluid circulated.

**4.8** The fan of a evaporative condenser should not use more than—

- (i) if a propeller or axial fan, 18 W of motor shaft power for each kW of heat rejected, and
- (ii) if a centrifugal fan, 22 W of motor shaft power for each kW of heat rejected.

**4.9** The spray water pump of a closed circuit cooler or evaporative condenser should not use more than 150 W of pump motor shaft power for each L/s of spray water circulated.

## 5 Miscellaneous exhaust systems

**5.1** A miscellaneous exhaust system with an air flow rate of more than 1000 L/s, that is associated with equipment having a variable demand such as a stove in a commercial kitchen or a chemical bath in a factory, should—

- (i) have the means for the operator to—
  - (a) reduce the energy used, such as by a variable speed fan, and
  - (b) stop the motor when the system is not needed, and
- (ii) be designed to minimise the exhausting of conditioned air.

**5.2** The suggested requirements of Paragraph 5.1 above should not apply

- (i) where additional exhaust ventilation is needed to balance the required outside air for ventilation, or
- (ii) where air flow must be maintained for safe operation.

## 6 Access for maintenance

At the design and construction stages regard should be given to all requirements of space, position, access and repair (or replacement) in order to commission and maintain the equipment in an efficient operating condition, without undue difficulty, when using normally accepted maintenance procedures.

# Suggested specification 1

## Ductwork insulation and sealing

### 1.1 Scope

This Specification contains guidance for sealing and insulating supply and return ductwork used in a system that heats or cools a building.

### 1.2 Ductwork sealing

- (a) Heating or cooling ductwork and fittings should be sealed against air loss—
  - (i) by closing all openings in the surface, joints and seams of ductwork with adhesives, mastics, sealants or gaskets in accordance with the duct sealing requirements of AS 4254:2002 for the static pressure in the system, or
  - (ii) for flexible ductwork at an operating static pressure of less than 500 Pa, with a sealant and draw band encased with adhesive tape.

### 1.3 Ductwork insulation

- (a) Ductwork and fittings for heating or cooling should be thermally insulated with insulation complying with AS/NZS 4859.1:2002 to—
  - (i) achieve the Total R-Value specified in Tables 1.3a and 1.3b, or
  - (ii) achieve a minimum Total R-Value of 1.0 for flexible ductwork of not more than 3 m in length from an outlet or the like.
- (b) Insulation on ductwork conveying cold air should be protected by—
  - (i) a vapour barrier on the outside of the insulation, and
  - (ii) overlapping adjoining sheets of the membrane by 50 mm and bonding or taping the sheets together where the vapour barrier is a membrane.
- (c) Ductwork insulation should —
  - (i) be protected against the effects of weather and sunlight, and
  - (ii) abut adjoining insulation to form a continuous barrier, and
  - (iii) be installed so that it maintains its position and thickness, other than at flanges and supports.
- (d) The suggested requirements of Paragraph 1.3(a) should not apply to heating and cooling ductwork and fittings located within the last conditioned space served.

**Table 1.3a DUCTWORK – SUGGESTED MINIMUM TOTAL R-VALUE**  
**(For systems of no more than 65 kW<sub>r</sub> and 65 kW heating capacity)**

Ductwork element	Suggested minimum Total R-Value for ductwork and fittings		
	Evaporative cooling system	Heating-only system or refrigerated cooling system	Combined heating and refrigerated cooling system
Ductwork	0.6	1.0	1.5 (see note)
Fittings	0.4		
<p>Note:</p> <p>The suggested minimum Total R-Value may be reduced by R0.5 for combined heating and refrigerated cooling systems if the ducts are-</p> <p>(a) under a suspended floor with an enclosed perimeter; or</p> <p>(b) in a roof space that has insulation of not less than R0.5 directly beneath the roofing.</p>			

**Table 1.3b DUCTWORK - SUGGESTED MINIMUM TOTAL R-VALUE**  
**(For systems greater than 65 kW<sub>r</sub> and 65 kW heating capacity)**

Location of ductwork and fittings	Suggested minimum Total R-Value for ductwork and fittings	
	Evaporative cooling system	Heating system or refrigerated cooling system
Within a conditioned space other than where the space is the only or last space served.	Nil	1.3
All other locations	0.9	1.8

# Suggested specification 2

## Insulating piping, vessels, heat exchangers and tanks

### 2.1 Scope

This Specification contains guidance for insulating piping, vessels, heat exchangers and tanks containing heated or chilled fluid.

### 2.2 Insulation

- (a) Insulation should —
  - (i) be protected against the effects of weather and sunlight, and
  - (ii) be able to withstand the temperatures within the piping, and
  - (iii) for piping, achieve the Total R-Value in Table 2.2, and
  - (iv) for vessels, heat exchangers and tanks, achieve a suggested minimum Total R-Value of—
    - (A) 2.5 if the content is low temperature brine or glycol, or
    - (B) 1.8 if the content is chilled water, or
    - (C) 1.3 if the content is heated water, or
    - (D) 2.5 if the content is steam.
- (b) Insulation on piping, vessels, heat exchangers and tanks containing chilled fluid should be protected by a vapour barrier on the outside of the insulation.
- (c) The suggested requirements of Paragraph 2.2(a) should not apply to heating water piping—
  - (i) located within the space being heated where the piping is to provide the heating to that space, or
  - (ii) encased within a concrete floor slab which is part of a floor heating system.

**Table 2.2 PIPING - SUGGESTED MINIMUM TOTAL R-VALUE**

Location	Suggested minimum Total R-Value
<b>1. Heating water piping for systems of no more than 65 kW heating capacity</b>	
(a) Located internally	0.2
(b) Located within a wall space, an enclosed sub-floor area or an enclosed roof space	0.45
(c) Located outside the building or in an unenclosed sub-floor area or an unenclosed roof space	0.6
<b>2. Heating water piping for systems of more than 65 kW heating capacity</b>	
(a) Located internally	0.6
(b) Located within a wall space, an enclosed sub-floor area or an enclosed roof space	0.7
(c) Located outside the building or in an unenclosed sub-floor area or an unenclosed roof space	0.8
<b>3. Cooling water piping for systems of more than 65 kW capacity but less than 250 kW capacity</b>	
(a) Located internally	0.9
(b) Located within a wall space, an enclosed sub-floor area or an enclosed roof space	1.0
(c) Located outside the building or in an unenclosed sub-floor area or an unenclosed roof space	1.1
<b>4. Cooling water piping for systems of more than 250 kW capacity</b>	
(a) Located internally	1.2
(b) Located within a wall space, an enclosed sub-floor area or an enclosed roof space	1.3
(c) Located outside the building or in an unenclosed sub-floor area or an unenclosed roof space	1.4
<b>Note:</b> Piping should be insulated includes flow and return piping, cold water supply piping and pressure relief piping within 500 mm of the connection to the heating or cooling system.	

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