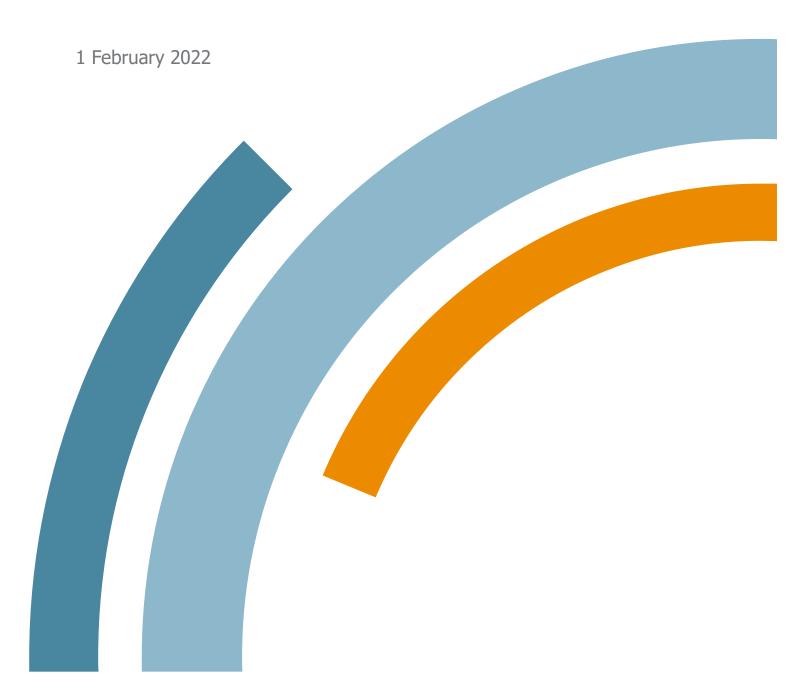# Commercial and Industrial Air Source Heat Pump Water Heater Product Application Guide

1 February 2022

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Contents

Introduction

This guide provides applicants with guidance on how to apply for commercial and industrial heat pump water heaters to be listed on the Register of Products, so that they are eligible to be installed and create Victorian energy efficiency certificates (VEECs) under the Victorian Energy Upgrades (VEU) program.

About this guide

This guide provides instructions on how to apply for a commercial and industrial air source heat pump water heater (commercial and industrial heat pump water heater) to be listed on the Register of Products.

The products covered by this guide are:

- Commercial and industrial heat pump water heaters (product category 44A-C) under the VEU program.

This guide is divided into two sections:

- The Introduction
- Section 1 provides general information on product applications
- Section 2 provides further detail on the performance criteria and documentary evidence required for commercial and industrial heat pump water heaters.

You should also read the Application Guide for Product Applicants which provides additional information on:

- The Register of Products
- The product application and assessment process, including things to bear in mind throughout the process
- Some product application functionality.

Who should use this guide

You should use this guide if you are:

- Applying for commercial and industrial heat pump water heaters to be listed on the Register of Products under the Victorian Energy Upgrades program.

- Interested in understanding the product application requirements for commercial and industrial heat pump water heaters under the VEU program.

You must hold a VEU account to apply for a product listing. You can create a VEU account by registering via this link.

Seeking assistance

If you encounter difficulties with your application that cannot be answered using this guide, contact us on (03) 90321310 or veu@esc.vic.gov.au

We appreciate the time and effort that businesses put into their applications, and product officers will endeavour to work with you during the assessment process.

If you have submitted a product application, please use the designated 'notes' field in the online product assessment tool to communicate directly with the product officer responsible for assessing your application.

Legal context for this guide

This guide is a general summary of the relevant parts of:

- Victorian Energy Efficiency Target Act 2007 (the VEET Act)
- Victorian Energy Efficiency Target Regulations 2018 (the VEET Regulations)
- Victorian Energy Upgrades Specifications 2018 (the VEU specifications)
- Victorian Energy Efficiency Target Guidelines (the VEET guidelines)

View these documents at www.esc.vic.gov.au/veu-legislation

This guide should not be relied upon as substitute for legal advice and should be read in conjunction with the above source documents. In the event of inconsistency between this guide and the source documents, the content in the source documents apply.

1. Product requirements

1.1.   Product criteria and documentation

Products must meet the specified requirements to be listed on the Register of Products and create VEECs No deviations from the listed standards will be accepted.

If you are unable to provide sufficient evidence that a product meets the minimum criteria, the product will not be approved.

Consult the relevant section of the VEET Regulations and VEU specifications when preparing evidence for your application.

2. Product performance and documentation requirements

2.1. Product category 44A-C: Commercial and industrial heat pump water heaters

Products are assessed to ensure that they meet the minimum eligibility requirements of the VEET Regulations and VEU Specifications.

Additional product performance data is also published on the commission's Register of Products, which are not relevant to the calculation of VEECs but which may assist licensed plumbers and builders to identify which products are capable of complying with the Plumbing Regulations 2018 (Vic).

Table 1 Activity 44 product criteria

Product category number	Product category	Product criteria

44A-C	Commercial and Industrial Heat Pump Water Heater	A heat pump water heater that:
		 • has an insulated storage volume:
		    − less than or equal to 700L and is certified to AS/NZS 2712, or
		    − more than 700L.
		
		 • achieves 60% annual energy savings and a minimum delivery temperature of 45°C, determined in accordance with the calculation method described in Appendix A, when modelled in climate zone HP4-Au for products installed in climate zone 4
		 • achieves 60% annual energy savings and a minimum delivery temperature of 45°C, determined in accordance with the calculation method described in Appendix A, when modelled in climate zone HP5-Au for products installed in climate zone 5

Note: A product does not need to achieve 60% annual energy savings across all three climate zones to apply for approval. However, it will only be able to claim certificates for installations in zones where it has met the 60% annual energy savings amount.

2.2. Supporting evidence and file naming conventions

You will need to complete and submit the [Commercial and industrial heat pump water heater product application form](#) as part of your product application via the VEU registry.

All supporting documents must specify the product brand and model number. All brands and models must reconcile precisely with the brands and the models on the supporting documents

Any supporting document with unexplained model variations will not be accepted. If supporting documents contain different brands and/or model numbers, the applicant must submit a manufacturer's declaration clearly reconciling the different product brands and/or model numbers used across supporting documents with the brands and model numbers proposed under the schedule.

Note: You do not need to submit modelling outputs for both climate zones for a product when applying for approval. However, a product will only be able to claim certificates for the zones with approved modelling outputs which meets the 60% annual energy savings threshold.[1]

Table 2 Supporting evidence and naming conventions

Product Category	Requirement	Documentary evidence	Naming convention and upload format
Commercial and Industrial Heat Pump Water Heater (44A-C)	Commercial and Industrial Heat Pump Water Heater Product Application Form (spreadsheet)	You can apply up to three products under the one application. Please provide one completed application spreadsheet listing specifications for each model being applied for as part of the current application. Guidelines for completing this spreadsheet are included in Appendix B.	Commercial and Industrial Heat Pump Water Heater Product Application Form File name needs to include the date and brand(s): BrandName_YYYYMMDD_ESC.xls. e.g. for a heat pump water heater from Brand ABC provided on 2 March 2022 the filename would be ABC_20220302_ESC.xls.
	TRNSYS model	TRNSYS model for the product, including deck files[2] and all input and output files.	TRNSYS Input (deck), including weather, output, and list files and, if applicable, file

---

[1] The product application form allows applicants to provide and submit product data relating to heat pump climate zones 3 (HP3-AU), 4 (HP4-AU) and 5 (HP5-AU). This is in preparation for the harmonisation of the product approval process for commercial and industrial heat pump water heaters with the [New South Wales Energy Savings Scheme](#). Applicants should note that only products approved with data for heat pump climate zones 4 and 5 are eligible to claim VEECS under the VEU program when installed in Victoria.

[2] Template files supplied by commission upon request. Please email: veu@esc.vic.gov.au

		Guidelines for TRNSYS Modelling are included in Appendix A.	describing heat pump performance map. Brandname_ModelNo_ESC_Z#.lst Brandname_ModelNo_ESC_Z#.DCK Brandname_ModelNo_ESC_Z#.out and if appropriate Brandname_ModelNo_HPMap.dat, where # = 3, 4 or 5. Plus a single copy of the unchanged 'include' file which include any weather files that were used to generate the results
	TRNSYS modelling reports (if available)	AS/NZS 4234 / SA/SNZ MP104 reports produced by TRNSYS modellers that include simulations as specified in this document.	PDF document Brandname_ModelNo.pdf
	TRNSYS variables list	List of all of the product variables used in the TRNSYS model.	[Commercial and Industrial Heat Pump Water Heater Specifications Sheet](#). Up to three products can be included in the excel spreadsheet. File name needs to include the date and brand(s): BrandName_YYYYMMDD_Specifications.xls.
	AS/NZS 2712 certification (only required for products with a storage volume less than or equal to 700L)	AS/NZS 2712 certificate	PDF document Brandname_ModelNo_2712.pdf
	Thermal performance of heat pump (COP and Power correlations or Performance map)	Test report: AS/NZS 5125.1 or EN 14511	PDF document Brandname_HPunitModelNo_HPPerformance.pdf
	Thermal performance of	Test report using:	PDF document

	all tanks including electric heated tanks	• AS/NZS 4692, AS/NZS 4552 or AS/NZS 5263.1.2 for tanks with a storage volume less than or equal to 700L, or • AS/NZS 4234 for tanks with a storage volume greater than 700L.	Brandname_TankModelNo_TankHeatLoss.pdf
	Thermal performance of gas fired booster systems	Test report: AS/NZS 5263.1.2 or AS/NZS 4552 including as appropriate; start up capacity, maintenance rate, pilot gas consumption, burner capacity, thermal efficiency and standby energy consumption.	PDF document Brandname_ModelNo_GasBoosterPerformance.pdf
	Pump specifications	Pump test report, including measured flow rate and power in standard configuration, if not included in AS/NZS 5125.1 test report. For variable flow systems include a description of the flow rate control algorithm.	PDF document Brandname_PumpModelNo_PumpPerformance.pdf
	Heat Exchanger specifications	Test report or technical data sheet.	PDF document Brandname_HXModelNo_HXPerformance.pdf
	Controller specifications	Description of the thermostat, heat pump and/or pump controller algorithm and set points. Must include explanation of legionella control method.	PDF document Brandname_ControllerModelNo_ControlLogic.pdf
	Schematic of the system and bill of materials	Schematic diagram including all relevant control valves and flow meter if appropriate, heat pump flow and return pipes and sensor locations. Parts list including insulation included or specified for piping etc.	PDF document Brandname_ModelNo_Schematic.pdf
	Dimensioned diagram of the tank	Dimensioned inner tank drawing including cold inlet and hot outlet positions, element position (*if fitted*), flow and return positions for all energy sources including heat pump and booster heater (if appropriate), and temperature	PDF document Brandname_TankModelNo_Dimension.pdf

		sensor location(s). It is preferable to provide the volume above each of these locations in a table within the drawing.	
	Photograph of relevant data plate(s)	Photo of the product data plate for integrated heat pumps. For split or separate heat pumps photo of the tank data plate and heat pump unit data plate. Any other component data plates, including but not limited to circulating pump, heat exchanger and booster heaters.	PDF document Brandname_TankModelNo_DataPlate.pdf Brandname_SystemModelNo_DataPlate.pdf Brandname_HPunitModelNo_DataPlate.pdf Brandname_PumpModelNo_DataPlate.pdf Brandname_HXModelNo_DataPlate.pdf Brandname_BoostHeaterModelNo_DataPlate.pdf

Appendix A: Annual Energy Use Calculation Method for Commercial and Industrial Heat Pump Water Heaters

1. Method Outline

Modelling must be conducted in accordance with AS/NZS 4234 and SA/SNZ MP 104 with the following variations:

1. Using the TRNSYS computer modelling package, format the TRNSYS deck files[3] as set out in [Section 3](#) of this appendix.

2. Calculate the annual electrical energy use (*HPElec*), and the annual gas energy use (*HPGas*), (if applicable, such as for gas boosted heat pump water heater systems), using the following TRNSYS input parameters:

   a) The following daily load profile, and weekend multiplier shall be used to define the daily energy delivery (dyengy) and load draw-offs (ldflw):

   > UNIT 14 TYPE 14 Daily Load Profile
   >
   > PARAMETERS 48
   >
   > 0, 0.025   2, 0.025
   >
   > 2, 0.025   4, 0.025
   >
   > 4, 0.05   6, 0.05
   >
   > 6, 0.08   8, 0.08
   >
   > 8, 0.08   10, 0.08
   >
   > 10, 0.04 12, 0.04
   >
   > 12, 0.04 14, 0.04

---

[3] Template files supplied by commission upon request. Please email: veu@esc.vic.gov.au

```
14, 0.04  16, 0.04

16, 0.03  18, 0.03

18, 0.03  20, 0.03

20, 0.03  22, 0.03

22, 0.025 24, 0.025


UNIT 11 TYPE 14 Weekend Multiplier

PARAMETERS 8

0, 1.17 120, 1.17

120, 0.575 168, 0.575

*Seasonal daily energy delivery - varies month to month

dyengy = [13,1] * [11,1] * ComPeakLoad

*Commercial systems mass flow rate for 1 h load flow period in kg/h

ldflw = dyengy*[14,1]/(TLOAD-Tcold)/0.00418
```

Note: [13,1] is the seasonal load pattern, TLOAD = 45°C, and Tcold is the cold water temperature, as defined in AS/NZS 4234. ComPeakLoad is the peak daily winter load as defined by the TRNSYS modeler (in the deck file), such that the system meets the performance requirements (see item 3. below).

b) Heat pump water heaters shall be rated for each climatic zone, HP4-Au or HP5-Au as specified in AS/NZS 4234, for which certificates are to be claimed. The weather data to be used for each climatic zone is supplied with the deck and include files.

c) If drinking water is to be supplied and a temperature control strategy is used to inhibit the growth of legionella, the modelling of the product shall show compliance with the legionella control requirements specified in AS 3498, or other applicable legislation.

d) Tank heat loss for a storage tank must be determined in accordance with:

- AS/NZS 4692, AS 4552 or AS/NZS 5263.1.2, for individual tanks with a capacity less than or equal to 700L; or
- AS/NZS 4234:2021 Appendix E for individual tanks with a capacity greater than 700L.

e) Heat pump performance must be determined in accordance with AS/NZS 4234, SA/SNZ MP 104 and AS/NZS 5125.1 with the following variations:

- *Power* and *COP* can be defined either via the AS/NZS 5125.1 *Power* and *COP* correlation functions, or via a set of EN 14511 (and EN 14825 for variable speed compressors) performance results which form performance maps of *Power*, *COP* and/or capacity (two out of three) as functions of air and water temperature. The remaining variable (capacity (*Q*), *COP* or *Power)* is then defined by the equation $Q = COP \times Power$ (kW).

- If the AS/NZS 5125.1 *Power* and *COP* correlation functions are used:

    - For test tanks with a capacity greater than or equal to 700L, a tank heat loss calculation in accordance with AS/NZS 4234 can be used for the AS/NZS 5125.1 calculations of heat pump capacity, rather than the tank heat loss tested to AS 4692.

    - Large stand-alone heat pumps with large storage tanks may be tested according to the modifications to AS/NZS 5125.1 specified in AS/NZS 4234 (Energy produced by the test unit may be measured with a flow meter and temperature sensors on the inlet and outlet of the unit).

    - For heat pumps containing variable speed compressors, the *COP* and *Power* functions must be modified as specified in AS/NZS 4234. A template TRNSYS deck implementing this for a PV powered heat pump water heater is provided with AS/NZS 4234.

- If EN 14511 (and EN 14825 for variable speed compressors) performance results are used to create performance maps of *Power*, *COP* and/or capacity (two out of three) as functions of water and air temperatures, they must include at least:

    - One water temperature greater than or equal to the maximum water temperature required during normal operation (typically the thermostat temperature, such as 60°C). This is to ensure that the TRNSYS model does not extrapolate thermal performance above the measured water temperature. It is recommended that additional water temperatures are also tested as defined by the manufacturer, such as the low (35°C), intermediate (45°C), medium (55°C) and high (65°C) water temperatures specified in EN 14511, in order to improve the accuracy of the heat pump performance map provided.

    - The outdoor air conditions specified in the rating condition (7°C DB, 6°C WB) and the low temperature test condition (2°C DB, 1°C WB). This is to ensure that

the frosting behaviour between these two test points is accurately captured. It is recommended that additional air temperatures are also tested as defined by the manufacturer, such as AS/NZS 5125.1 test conditions 2 (18-20°C, DP 11-14°C) and 3 (30-34°C, DP 14-18°C), in order to improve the accuracy of the heat pump performance map provided.

- For heat pumps containing variable speed compressors, the *COP* and *Power* performance maps evaluated in accordance with EN 14511 must be modified as a function of the compressor speed or heating capacity based on either additional testing in accordance with EN 14825, or a default table of *Power* and *COP* adjustments provided within AS/NZS 4234. A template TRNSYS deck implementing this for a PV powered heat pump water heater is provided with AS/NZS 4234.

- If using EN 14511 (and EN 14825 for variable speed compressors) results, a low temperature operation penalty is not required, however, an additional set of data points for the performance map must be calculated by linearly extrapolating the result for the rating condition and the low temperature test condition to the lowest air temperature required for the simulation. This is to prevent the performance values from the low temperature test condition being used directly for temperatures below this point.

- A performance map based on AS/NZS 5125.1 results is not suitable for use.

- Standby power consumption must be tested in accordance with either AS/NZS 5125.1 or EN 14511 and included in the TRNSYS model.

- Water pump performance must be separately included in the TRNSYS model if a water pump is used, unless it has clearly been included in the AS/NZS 5125.1 correlation functions. It must be evaluated to give power consumption (W) as a function of fluid flow rate (L/min), over the complete range of control parameters, in accordance with AS/NZS 4234.

- Where units are modular in design, the test data from one module may be applied to systems comprised of multiple identical modules.

f) The modelled lengths of piping shall be based on the following:

- For a stand-alone heat pump, the length of piping between the heat pump and the tank shall be the manufacturer's specification or 5m (each way), whichever is larger.

- For a pre-heat tank with series boosting, the length of piping between the pre-heat tank and the series auxiliary booster or finishing tank shall be the manufacturer's specification or 10m, whichever is the larger. If the auxiliary booster is integral with the pre-heat tank, then the actual pipe lengths shall be used.

- If the finishing tank is heated by a recirculating instantaneous auxiliary booster, the length of piping between the finishing tank and booster shall be the manufacturer's specification or 2m (each way), whichever is larger.
- The diameter of all connecting piping shall be equal to the manufacturer's specifications.
- If manufacturer's specifications for the thermal conductivity of the pipe insulation are provided, then those specified values are to be used. If no specifications are provided, then the default values of 0.06 W/mK shall be used for closed cell foam insulation and 0.1 W/mK for rubberised insulation or polytube or fibre insulation.

g) The heat pump must only be modelled as operating at air temperatures within its declared operating range, which must be evidenced by the manufacturer's documentation.

h) All other input parameters and control strategies must be those used in the actual heat pump water heater, subject to modification by [Section 2](#) of this appendix, and must be consistent with those supplied in the [Commercial and Industrial Heat Pump Water Heater Specifications Sheet](#).

3. Select the peak daily winter load, *ComPeakLoad*, for each climate zone in accordance with the scale of the installation. The load does not need to be the same for all zones but should be such that the heat pump water heater achieves at least 60% annual energy savings and a minimum delivery temperature of 45°C for each zone in which certificates are to be created.

4. The percentage energy savings for the purpose of defining the peak daily winter load shall be calculated using the following equation:

$$\text{Energy Savings (\%)} = \frac{\text{RefElec - HPElec - HPGas}}{\text{RefElec}} \times 100$$

where *RefElec* = the reference annual electrical energy use, as defined in item 5, (GJ/a).

HPElec = the annual electrical energy use of the heat pump water heater, as calculated in item 2, (GJ/a).

HPGas = the annual gas energy use of the heat pump water heater, as calculated in item 2 (GJ/a).

5. Determine the reference annual electrical energy use, *RefElec*, (GJ/a) of an electric reference water heater supplying the same hot water load, as follows:

a) The heat loss from the reference system shall be 5% of the hot water load, therefore use a factor of 1.05.

b) The average seasonal load multiplier to be used is 0.905.

c) Multiply number of a days in a year (365) by average seasonal load multiplier (0.905), by heat loss factor percentage (1.05) by the peak daily winter load, *ComPeakLoad.*

$$RefElec = 365 \times 0.905 \times 1.05 \times ComPeakLoad$$

6. Results must be presented in the current version of the Commercial and Industrial Heat Pump Water Heater Product Application Form available http://www.esc.vic.gov.au/veu-product-applicants. A separate row must be used for each system. Please enter only the required data marked by light blue cells.

Peak Daily Winter Load, *ComPeakLoad*, Annual Electrical Energy Use, *HPElec* and Annual Gas Energy Use, *HPGas*, should be entered with a precision of four significant figures. The final result of "annual purchased energy savings (%)" is published with a precision of two significant figures.

2. Special Circumstances

The input parameters and control strategies used to calculate the annual electrical energy use and annual gas energy use for step 2 in the method in Section 1 of this appendix are subject to modification in the following circumstances.

One-shot boosting

One-shot boosting is a manual control that allows a default boost mode (such as off-peak boosting) to be overridden so that the user can satisfy a short term high demand for hot water. Where the system automatically resets to the default boosting mode within 24 hours of the user changing the boost mode, the one-shot boosting can be ignored.

Where the system does not automatically reset to the default boosting mode within 24 hours of the user changing the boost mode, the boosting mode activated by the manual control must be considered to be active at all times.

3. TRNSYS Modelling Guidelines

These TRNSYS Modelling Guidelines specify the format and structure required for the TRNSYS deck files, and the default values to be used in certain circumstances. They must be adhered to in using the method specified above in Section 1 and Section 2 of this appendix.

Deck Layout

- All Include Files shall be at the top of the deck immediately after the SIMULATION statement and the timestep shall be 0.02h or less.

- The chosen time step shall be an exact divisor of the shortest load draw off period.
- The TOLERANCE statement shall be 0.005, 0.005 or less for relative tolerances.
- Each load draw-off event shall be applied over a period of 1h for commercial and industrial heat pump water heaters.
- Use the template deck structure supplied by the commission, unless the commission approves otherwise in writing. Except for the product parameters, the template decks shall be used without modification unless the product has features not covered by the example decks. There are different template decks for different types of heat pump water heaters.
- Files supplied with the deck files shall not be modified.
- All constants shall be towards the top of the deck.
- All product parameters used in the deck file shall be consistent with the values provided in the [Commercial and Industrial Heat Pump Water Heater Specifications Sheet](), test reports and documents.
- The output, list and other output file names shall be the same as the deck name except for the file type.
- The output printers in the example decks shall not be modified. Additional printers may be used if required.

Simulation Display

- Simulation output: A TYPE 25 printer shall be included in the deck. This shall output the following results: the zone, peak daily winter load, percent energy savings, heat pump water heater annual electrical energy use, heat pump water heater annual gas energy use, minimum delivery temperature, time at which minimum delivery temperature occurs, annual energy delivered below 45°C.
- Energy balance: A monthly energy balance in a TYPE 28 output unit shall be included in the deck. This shall include a full system energy balance i.e. heat pump input + boosting + pump input – load – pipe losses – tank losses – change in internal energy.
- Runtime graph: A runtime graph (TYPE65) shall be included in each deck showing at least: Hot water delivery temperature, heat pump inlet temperature, heat pump outlet temperature, load.

Controller Default Settings

For a simple temperature difference pump controller, the minimum turn off temperature difference shall be 1K.

Piping models

All piping shall be modelled using the TYPE 31 pipe routine.

Instantaneous gas heater defaults

- If an instantaneous gas booster has not been assessed for electric power consumption during standby under AS 4552 or AS/NZS 5263.1.2, then a value of 10W shall be used. If the electrical power consumption during burner operation is not available, then a value of 50W shall be used.
- If the startup heat loss has not been assessed under AS 4552 or AS/NZS 5263.1.2, then a default value of 0.5MJ shall be used.
- AS 3498 requires water heating to a minimum of 70°C for a preheat system with an inline instantaneous gas booster when the preheat tank temperature is less than 55°C. If a gas booster trigger temperature less than the gas booster set point temperature is used, then specifications for the gas booster control logic shall be provided. If specifications for the gas booster control logic are not provided, the trigger temperature used for rating purposes shall be equal to the gas booster set point temperature at all times.

Stratification option for pumped circulation tanks

- For finishing tanks where the water temperature is heated with a separate pumped recirculation loop, "Uncontrolled flow pumped circulation" shall be assumed unless:
  - the return from the recirculation booster loop to the tank is in the top 2/3 of the tank; and
  - the recirculation flow rate is below 1 L/min per kW thermal power added by the external booster; and
  - the booster tank recirculation water turnover rate is less than 1 tank volume per hour.
- For all other tanks and/or energy sources, thermal stratification of the storage tank must be modelled as per AS/NZS 4234. For storage tanks with more than one energy source, both must satisfy the stratification criteria in order for a controlled flow (stratified) model to be used.
- For a storage tank modelled with uncontrolled flow, set Mode60 = 2 in the TRNSYS deck, and set the number of tank derivatives to 10 as follows.

```
Mode60 = 2

…

derivatives 10

60 60 55 55 50 50 45 45 40 20
```

- For a storage tank modelled with controlled flow, set Mode60 = 1 in the TRNSYS deck, and set the number of tank derivatives to 20 as follows.

```
Mode60 = 1
```

```
…

derivatives 20

60 60 55 55 50 50 45 45 40 40

30 30 25 25 20 20 20 20 20 20
```

Dip tubes

For a tank with dip (or snorkel) tube, the heat transfer between the stored tank water and the water flowing inside the dip tube is usually small compared to the heat capacitance rate of the water flowing through the tube. In this case the temperature of the water supplied to the heat pump inlet pipe, or the load, shall be the tank temperature at the dip (or snorkel) tube inlet (not its connection to the tank). Evidence of any dip (or snorkel) tubes must be included in tank drawings supplied.

Units

The units system used in TRNSYS is m, kg, h and kJ. All energy transfer rate parameters must be converted from W to kJ/h (multiply Watts by 3.6 to get kJ/h).

Heat Pump sensor location

The tank is modelled as a stratified tank with 10 or 20 nodes of equal height dividing up the tank volume. The tank node corresponding with the position of the heat pump control sensor must be calculated and updated in the TRNSYS deck input file.

The top node is output number 22. The bottom node is number 23. For a 10-node tank, nodes i = 2 to 9 are output number = 22+i, where i = 1 is at the top and i = 10 is at the bottom.

For example, if there is 145L volume above heat pump temperature sensor in a 300L tank, then the fractional volume above = 145/300 = 0.48. Therefore, the node number = 0.48*10 = 4.8. This is rounded up to the next whole integer; i = 5. The output number = 22+5 = 27.

In the deck this would be written as:

```
Eqn 1

Tcontrol = [60,27]
```

Heat Pump Performance Data

- If the heat pump unit has been tested according to AS/NZS 5125.1, use either of the following templates:

    – HP_Integral_5125.dck (for integral heat pumps)

- HP_Standalone_5125.dck (for stand-alone heat pumps)

- Power and COP coefficients are to be taken from the AS/NZS 5125.1 test report.
- For stand-alone heat pumps, ensure that the temperature difference between the water and ambient ((Tin-Tamb) or (Tave-Tamb)) corresponds with the set of Power and COP coefficients used, and the equation in the "Heat pump" section of the TRNSYS input file is consistent with this.

> *heat pump average temperature
>
> Tave = ([12,1]+[22,1])/2
>
> Tin = [12,1]
>
> *Use (Tin-Tamb) OR (Tave -Tamb) for dT1 as per AS/NZS5125 test report
>
> dT1 = Tin - Tamb

- If the heat pump unit has been tested according to EN 14511, then use one of the TRNSYS templates utilising the Type 42 air-to-water heat pump component. This includes all templates except the "HP_integral_5125.dck" and "HP_standalone_5125.dck", which use testing from AS/NZS 5125.1.

Required heat pump performance data is heating capacity, and power consumption. Data can be provided for up to 10 ambient air temperature points, and up to 5 entering water temperature points. Performance data will be linearly interpolated between points during the simulation, but no extrapolation will occur. Conditions outside the range of provided data will be at the constant value of the outer limit.

If the lowest air temperature tested is above the minimum air temperature in the weather files, an additional set of data points must be provided manually, using linear extrapolation for each water temperature, based on the lowest two ambient temperature data points, to calculate the heat pumps performance at the minimum air temperature required for modelling, which is below the low temperature test point conditions.

In the tables below, an example for capacity ($C(T_{ambient}, T_{water})$) and power ($P(T_{ambient}, T_{water})$) and resulting data file format is shown. The ambient and water temperature points do not need to be equally spaced, but data must be provided for the ranges:

$$T_{w,min} \le \text{Entering water temperature} \le T_{w,max}$$

$$T_{a,min} \le \text{Ambient air temperature} \le T_{a,max}$$

where $T_{w,min}$ is the minimum tested water temperature; $T_{w,max}$ is the maximum tested water temperature; $T_{a,max}$ is the maximum tested air temperature; and $T_{a,min}$ is the minimum air temperature in the weather files for the zone(s) in which incentives are going to be claimed (the minimum across all weather files).

Table 3 Heat capacity data for a map of ambient and entering water temperatures

Entering Water Temp (°C)	Ambient air temperatures (°C)									
	-5	0	5	10	15	20	25	30	35	40
20	C(20,-5)	C(20,0)	C(20,5)	C(20,10)	C(20,15)	C(20,20)	C(20,25)	C(20,30)	C(20,35)	C(20,40)
30	C(30,-5)	C(30,0)	C(30,5)	C(30,10)	C(30,15)	C(30,20)	C(30,25)	C(30,30)	C(30,35)	C(30,40)
40	C(40,-5)	C(40,0)	C(40,5)	C(40,10)	C(40,15)	C(40,20)	C(40,25)	C(40,30)	C(40,35)	C(40,40)
50	C(50,-5)	C(50,0)	C(50,5)	C(50,10)	C(50,15)	C(50,20)	C(50,25)	C(50,30)	C(50,35)	C(50,40)
60	C(60,-5)	C(60,0)	C(60,5)	C(60,10)	C(60,15)	C(60,20)	C(60,25)	C(60,30)	C(60,35)	C(60,40)

Table 4 Power consumption data for a map of ambient and entering water temperatures

Entering Water Temp (°C)	Ambient air temperatures (°C)									
	-5	0	5	10	15	20	25	30	35	40
20	P(20,-5)	P(20,0)	P(20,5)	P(20,10)	P(20,15)	P(20,20)	P(20,25)	P(20,30)	P(20,35)	P(20,40)

30	P(30,-5)	P(30,0)	P(30,5)	P(30,10)	P(30,15)	P(30,20)	P(30,25)	P(30,30)	P(30,35)	P(30,40)
40	P(40,-5)	P(40,0)	P(40,5)	P(40,10)	P(40,15)	P(40,20)	P(40,25)	P(40,30)	P(40,35)	P(40,40)
50	P(50,-5)	P(50,0)	P(50,5)	P(50,10)	P(50,15)	P(50,20)	P(50,25)	P(50,30)	P(50,35)	P(50,40)
60	P(60,-5)	P(60,0)	P(60,5)	P(60,10)	P(60,15)	P(60,20)	P(60,25)	P(60,30)	P(60,35)	P(60,40)

The data from these tables must be normalised by the rated capacity and rated power at a selected rating ambient air temperature, T_{a_rate}, and rating entering water temperature, T_{w_rate}.

$$\bar{C}(T_{water}, T_{ambient}) = \frac{C(T_{water}, T_{ambient})}{C(T_{w\_rate}, T_{a\_rate})}$$

$$\bar{P}(T_{water}, T_{ambient}) = \frac{PT_{water}, T_{ambient}}{P(T_{w\_rate}, T_{a\_rate})}$$

Data file input format (example file "HP_Data.dat"):

20   30   40   50   60 !entering water temperatures

-5   0   5   10   15   20   25   30   35   40 !ambient temperatures

$\bar{C}(20,-5)$ $\bar{P}(20,-5)$! normalised capacity and power at 20C entering water, -5C ambient

$\bar{C}(20,0)$ $\bar{P}(20,0)$! normalised capacity and power at 20C entering water, 0C ambient

$\bar{C}(20,5)$ $\bar{P}(20,5)$! normalised capacity and power at 20C entering water, 5C ambient

…… (skipped lines)

$\bar{C}(20,40)$ $\bar{P}(20,40)$! normalised capacity and power at 20C entering water, 40C ambient

$\bar{C}(30,-5)$ $\bar{P}(30,-5)$! normalised capacity and power at 30C entering water, -5C ambient

$\bar{C}(30,0)$ $\bar{P}(30,0)$! normalised capacity and power at 30C entering water, 0C ambient

…… (skipped lines)

$\overline{C}(30,40)$ $\overline{P}(30,40)$! normalised capacity and power at 30C entering water, 40C ambient

…… (skipped lines)

$\overline{C}(60,40)$ $\overline{P}(60,40)$! normalised capacity and power at 60C entering water, 40C ambient

Save the performance data file as "Brandname_ModelNo_HPMap.dat".

In-direct systems

Choose the ExternalHX TRNSYS template deck file. The user must define the UA value of the external heat exchanger between the storage tanks and the load supply. The default overall heat transfer coefficient for water-water HX is 1000 W/m^2/K. The user may change this value with supporting evidence, and also provide the heat exchanger area.

Appendix B: Guidelines for completing application form

All values provided in the Application Form must be consistent with the modelling guidelines and documentation provided, and the following definitions.

- Refrigerant and refrigerant charge(kg): These must be as specified on the heat pump nameplate(s). For systems containing multiple heat pumps with different refrigerants, all of the refrigerants should be listed, and the refrigerant charge specified as the sum of the individual refrigerant charges (write the details into the application form as "=1 + 2 + 3 + 4"). The GWP should then be specified as the mass weighted average of the individual GWPs ("=(1 x GWP1 + 2 x GWP2 + 3 x GWP3 + 4 x GWP4)/(1 + 2 + 3 + 4)"). The values of GWP are listed in Appendix C.

- Pre-heat vs finishing tank: For systems with a clear separation of HP heating, then boost heating, the pre-heat tank(s) are those heated by the HP only, and the finishing tanks are those heated by booster heaters. For systems where boosting occurs in the primary tank, use the "Pre-heat" tank columns to specify data, and set the Finishing tank values to 0.

- Total heat pump thermal capacity (kW): The sum of the individual heat pumps' thermal capacities, where the thermal capacity of a heat pump is defined as the thermal output as determined for test condition 2 of AS/NZS 5125.1 at 20°C water temperature, or at the closest tested condition to 20°C air and 20°C water temperature using EN 14511. Where there are multiple heat pumps please write the details into the application form as "=1+2+3+4".

- Booster electric resistance heater(s) total input power (kW)must be as specified on the product's nameplate. If current only is specified on the nameplate, a nominal voltage of 230V must be used to calculate input power. Where there are multiple heaters please write the details into the application form as "=1+2+3+4".

- Booster gas heaters nominal gas consumption (MJ/h) must be as specified on the product's nameplate(s). Where there are multiple heaters please write the details into the application form as "=1+2+3+4".

- Total nameplate(s) rated electric power input: The sum of the rated power input provided on each component's nameplate, in accordance with AS/NZS 60335.1. If current only is specified on the nameplate, a nominal voltage of 230V may be used to calculating input power for single phase products.

- Total nameplate(s) maximum electrical power input (kW): The sum of the maximum power inputs provided on each component's nameplate. If maximum current only is specified on the

nameplate, a nominal voltage of 230V may be used to calculating input power for single phase products. If there is no maximum power or current provided, the rated value may be used.

- Heat pump minimum and maximum operating air temperatures (ºC) are the heat pump's operating range as declared in the manufacturer's documentation, such as the operating or installation manual, control logic or product packaging and labels.

Appendix C: List of Refrigerant GWPs

Table 3: List of refrigerant types with global warming potentials (GWP) values[4]

Refrigerant Type	Substance name/HFC Blend	GWP	Refrigerant Type	Substance name/HFC Blend	GWP
R-1234yf	HFO-1234yf	5	R-407A	HFC-407A	2107
R-1234ze(E)	HFO-1234ze	5	R-407B	HFC-407B	2804
R-125	HFC-125	3500	R-407C	HFC-407C	1774
R-1270	HC-1270	5	R-407D	HFC-407D	1627
R-12A	HC-12A	5	R-407E	HFC-407E	1552
R-134A	HFC-134A	1430	R-407F	HFC-407F	1825
R-143A	HFC-143a	4470	R-407G	HFC-407G	1463
R-152A	HFC-152a	124	R-41	HFC-41	92
R-170	HC-170	5	R-410A	HFC-410A	2088
R-227EA	HFC-227EA	3220	R-410B	HFC-410B	2229
R-22A	HC-22A	5	R-413A	HFC-413A	2053
R-23	HFC-23	14800	R-417A	HFC-417A	2346
R-236CB	HFC-236CB	1340	R-417B	HFC-417B	3027
R-236EA	HFC-236EA	1370	R-417C	HFC-417C	1809
R-236FA	HFC-236FA	9810	R-419A	HFC-419A	2967
R-245CA	HFC-245CA	693	R-419B	HFC-419B	2384
R-245FA	HFC-245FA	1030	R-421A	HFC-421A	2631
R-290	HC-290	3	R-421B	HFC-421B	3190
R-32	HFC-32	675	R-422A	HFC-422A	3143
R-365MFC	HFC-365MFC	794	R-422B	HFC-422B	2526
R-404A	HFC-404A	3922	R-422C	HFC-422C	3085
			R-422D	HFC-422D	2729

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[4] Sources: Intergovernmental Panel on Climate Change (IPCC) fourth assessment report, 2007 and the Department of Agriculture, Water, and the Environment website

Refrigerant Type	Substance name/HFC Blend	GWP	Refrigerant Type	Substance name/HFC Blend	GWP
R-422E	HFC-422E	2592	R-450A	HFC-450A	601
R-423A	HFC-423A	2280	R-451A	HFC-451A	146
R-424A	HFC-424A	2440	R-451B	HFC-451B	160
R-425A	HFC-425A	1505	R-452A	HFC-452A	2139
R-426A	HFC-426A	1508	R-452B	HFC-452B	697
R-427A	HFC-427A	2138	R-452C	HFC-452C	2219
R-428A	HFC-428A	3607	R-453A	HFC-453A	1765
R-429A	HFC-429A	13	R-454A	HFC-454A	236
R-430A	HFC-430A	94	R-454B	HFC-454B	465
R-43-10MEE	HFC-43-10MEE	1640	R-454C	HFC-454C	145
R-431A	HFC-431A	36	R-455A	HFC-455A	145
R-434A	HFC-434A	3245	R-456A	HFC-456A	684
R-435A	HFC-435A	26	R-457A	HFC-457A	136
R-437A	HFC-437A	1805	R-458A	HFC-458A	1650
R-438A	HFC-438A	2264	R-500	HFC-500	8077
R-439A	HFC-439A	1983	R-502A	HC-502A	5
R-440A	HFC-440A	144	R-503	HFC-503	14560
R-442A	HFC-442A	1888	R-507A	HFC-507A	3985
R-444A	HFC-444A	87	R-508A	HFC-508A	13214
R-444B	HFC-444B	293	R-508B	HFC-508B	13396
R-445A	HFC-445A	129	R-512A	HFC-512A	189
R-446A	HFC-446A	459	R-513A	HFC-513A	629
R-447A	HFC-447A	582	R-513B	HFC-513B	593
R-447B	HFC-447B	739	R-515A	HFC-515A	386
R-448A	HFC-448A	1386	R-600	HC-600	5
R-449A	HFC-449A	1396	R-600a	HC-600a	3
R-449B	HFC-449B	1411	R-601A	HC-601a	5
R-449C	HFC-449C	1250	R-717	HC-717	0

Refrigerant Type	Substance name/HFC Blend	GWP
R-744	HC-744	1

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