Australian Government

Office of the Renewable Energy Regulator

Renewable Energy (Electricity) Regulations

Regulation 19B

LEGISLATIVE INSTRUMENT

Determination of the method to be used to determine the number of certificates that may be created for a particular model of solar water heater

I, Andrew Livingston, Renewable Energy Regulator:

(1) make this determination for the purposes of regulation 19B of the *Renewable Energy (Electricity) Regulations 2001*; and

(2) revoke all previous determinations made for the purposes of regulation 19B of the *Renewable Energy (Electricity) Regulations 2001*.

In making this determination, I had regard to the method set out in the Australian Standards listed in Schedule 4 of the *Renewable Energy (Electricity) Regulations 2001,* as in force at the date of this determination.

Andrew Livingston
Date: 8 March 2012

Federal Register of Legislative Instruments F2012L00591

Contents:

Part 1: Definitions used in this instrument

In this Legislative Instrument, unless the contrary intention appears:

AS/NZS 2535.1: 2007 means Australian and New Zealand Standard *AS/NZS 2535.1: 2007 Test methods for solar collectors — Part1: Thermal performance of glazed liquid heating collectors including pressure drop*

AS/NZS 2712: 2007 means Australian and New Zealand Standard *AS/NZS 2712: 2007 Solar and heat pump water heaters – Design and construction*

AS 3498: 2009 means Australian Standard *AS 3498: 2009 Authorization requirements for plumbing products—Water heaters and hot-water storage tanks*

AS/NZS 4234: 2008 means Australian and New Zealand Standard *AS/NZS 4234: 2008 Heated water systems – Calculation of energy consumption*

AS/NZS4234: 2008 Amendment 1 means Australian and New Zealand Standard *AS/NZS 4234: 2008 Heated water systems – Calculation of energy consumption Amendment 1/ 2011*

AS/NZS4234: 2008 Amendment 2 means Australian and New Zealand Standard *AS/NZS 4234: 2008 Heated water systems – Calculation of energy consumption Amendment 2/ 2011*

AS/NZS 4552: 2005 means Australian and New Zealand Standard *AS/NZS 4552: 2005 Gas Water Heaters for hot water supply and/or central heating*

AS/NZS 4692.1: 2005 means Australian and New Zealand Standard *AS/NZS 4692.1: 2005 Electric water heaters. Part 1: Energy consumption performance and general requirements*

AS/NZS 5125.1: 2010 means Australian and New Zealand Standard *AS/NZS 5125.1: 2010 Heat pump water heaters – performance assessment*.

COP means coefficient of performance

extension package TRNAUS means the TRNSYS extension package for Australian Solar Products, see TRNAUS, *TRNSYS Extensions for Australian Solar Products*. Solar Thermal Energy Laboratory, School of Mechanical & Manufacturing Engineering, University of NSW. (http://www.solar1.mech.unsw.edu.au/glm/trnaus/trnaus.pdf)

ASHP means an air source heat pump water heater, or a solar water heater with an air sourced heat pump booster. This included combined heat pump and solar water heaters where the solar component provides less than or equal to 50% of the total energy savings.

large SWH means a SWH with a volumetric capacity over 700 litres which is not a ASHP

ORER means the Office of the Renewable Energy Regulator

PV means Photovoltaic

STC means small scale technology certificate

SWH means solar water heater

small SWH means a SWH with a volumetric capacity up to and including 700 litres which is not a ASHP. This includes combined heat pump and solar products where the solar component provides more than 50% of the total energy savings.

TRNSYS computer modelling package means the Transient Energy System Simulation Tool computer modelling package produced by the Solar Energy Laboratory at the University of Wisconsin-Madison, The Centre Scientifique et Technique du Batiment in Sophia Antipolis, France, Transsolar Energietechnik GmBH in Stuttgart, Germany and Thermal Energy Systems Specialists in Madison, Wisconsin. See *TRNSYS User Manual*, Klein, S.A. et al., The University of Wisconsin Solar Energy Laboratory.

Volumetric Capacity means the total volume of water in litres that can be held in the storage tank, as defined in AS/NZS2712: 2007 clause 1.5.24.

Part 2: STC Calculation Methodology for Solar Water Heaters with a volumetric capacity up to and including 700 Litres and Air Source Heat Pump Water Heaters with a volumetric capacity up to and including 425 Litres

A. Introduction

Part 2 contains the methodology for determining the number of STCs that may be created for SWHs with a volumetric water storage capacity up to and including 700 litres ('small SWHs') and ASHPs with a volumetric water storage capacity up to and including 425 litres.

B. Methodology

The methodology for determining the number of STCs that may be created for a small SWH or ASHP shall be based on AS/NZS 4234:2008 and AS/NZS 4234:2008 Amendments 1 & 2 with additional requirements specified in this document.

Small SWHs shall be rated for climate zones 1 to 4. Heat pump water heaters shall be rated for climate zones 1 to 5 based on the five heat pump climate zones HP1-Au to HP5-Au specified in AS/NZS 4234:2008 and AS/NZS 4234:2008 Amendments 1 & 2.

The methodology is as follows:

1. Using Versions 15 to 16 of the TRNSYS computer modelling package, format the ORER TRNSYS deck files (available at: www.orer.gov.au/forms/technical-swh.html) as set out in the TRNSYS Modelling Guidelines in Part 4 of this Instrument.

2. Calculate the **total annual auxiliary energy** (MWh/y) for the small SWH or ASHP using the TRNSYS computer modelling package with the following TRNSYS input parameters:

   a. Solar collector slope = 20°.

   b. Solar collector azimuth = 45°.

   c. For the climatic zones, use the weather data provided on the ORER website (www.orer.gov.au/forms/technical-swh.html).

   d. Select the appropriate hot water load for the small SWH or ASHP as detailed below. Please note a minimum delivery temperature of 45°C must be achieved in each zone for which STCs are to be claimed.

i. Select the hot water load (small, medium or large) for a SWH. A minimum energy savings of 60% is to be achieved in zone 3 for the SWH to be rated with medium or large load.

ii. Select the hot water load (small or medium) for a ASHP. A minimum energy saving of 60% is to be achieved in zone 3 for the ASHP to be rated as medium load.

e. The modelling of product shall show compliance with the legionella control requirements specified in AS 3498: 2009.

f. To rate thermosiphon solar water heaters and thermosiphon sidearm heat exchangers, use the extension package TRNAUS for TRNSYS.

g. ASHP COP and power consumption performance shall be determined from full system tests in a temperature and humidity control test chamber to the requirements of AS/NZS 5125.1:2010 including the Low Temperature Performance Penalty for Class A Low Temperature products. The performance shall be correlated using the method described in AS/NZS 5125.1: 2010. All ASHPs that operate in heat pump mode at ambient temperatures lower than the initial frosting temperature shall include the Low Temperature Operation Penalty specified in AS/NZS 5125.1:2010 and AS/NZS 4234:2008 Amendment 1.

h. The modelled lengths of piping shall be based on the following:

i. For a pumped circulation system, the length of pipe between the storage tank and the closest corner of the solar collector array shall be the manufacturer's specification or 10 m (each way), whichever is larger.

ii. For a pumped circulation solar preheat tank, the length of piping between the pre-heat tank and a separate series auxiliary booster shall be the manufacturer's specification or 5 m whichever is larger. If the auxiliary booster is integral with the pre-heat tank then the actual pipe lengths shall be used.

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

iv. The diameter of all connecting piping shall be equal to the manufacturer's specifications.

v. If manufacturer's specifications are not provided for the thermal conductivity of the pipe insulation then default values of 0.06 W/(m K) shall be used for closed cell foam insulation and 0.1 W/(m K) for rubberized insulation or polytube or fibre insulation.

i. All other input parameters and control strategies must be those used in the actual system, except where outlined in the Special Circumstances in Division C of Part 2 of this Instrument.

3. (a) For small SWHs (other than gas boosted SWHs) and ASHPs, subtract the **total annual auxiliary energy** used by the small SWH or ASHP from the energy use of the reference electric water heater in AS/NZS 4234:2008 supplying the same load (Table A10 AS/NZS 4234:2008) to determine the **displaced energy**.

   (b) For gas boosted SWHs use Appendix G of Amendment 1 to AS/NZS 4234:2008 to determine the **displaced energy**.

4. Convert the displaced energy to MWh/y.

5. Multiply the displaced energy in MWh/y by 10 to determine the **10 year MWh savings**.

6. Round down the ten year MWh savings to the nearest lower integer.

7. That number is the number of STCs that may be created for the small SWH or ASHP in the relevant zone.

8. The percent energy savings, for the purpose of defining load size, shall be calculated as per AS/NZS 4234:2008 Clause 3.14.1

C. Special Circumstances

The parameters used to calculate the total auxiliary energy for step 2 in the Methodology in Part 2 Division B are subject to modification in the following special circumstances.

(1) Dual Element Tanks

For systems where a bottom element is, or can be, fitted in the tank (e.g. a dual element tank) the bottom element is to be used. The minimum boost time for a bottom element shall be nominal off-peak times of 11 pm to 6 am.

Some tank designs may be modified by the installer to insert an element at the bottom of the tank even if this element has been blanked off. If a model uses a tank that can have the bottom element connected at the time of installation or at any later time, the bottom element is to be used.

(2) 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) Combined photovoltaic (PV) and water heating collectors

Combined PV and water heating collectors that do not incorporate a concentrator may obtain STCs for the water heating aspect of the mechanism if the following testing regime is documented.

(a) PV output

The PV output shall be assessed using a collector with the water heating part of the collector empty.

(b) Water heating output

The thermal efficiency of the collector shall be assessed to AS/NZS 2535: 2007 with the PV output set to maximum power conditions. The electrical output of the collector shall not be included in the thermal efficiency assessment.

Part 3: STC Calculation Methodology for Solar Water Heaters with a volumetric capacity greater than 700 Litres

A. Introduction

Part 3 contains the methodology for determining the number of STCs that may be created for SWHs with a volumetric water storage capacity over 700 litres (‘large SWHs’).

B. Methodology

The methodology for determining the number of STCs that may be created for a large SWH shall be based on AS/NZS 4234:2008 and AS/NZS 4234:2008 Amendments 1 & 2 with additional requirements specified in this document.

Large SWHs shall be rated for climate zones 1 to 4 specified in AS/NZS 4234:2008.

The methodology is as follows:

1. Using Versions 15 to 16 of the TRNSYS computer modelling package, format the ORER TRNSYS deck files (available at: www.orer.gov.au/forms/technical-swh.html) as set out in the TRNSYS Modelling Guidelines in Part 4 of this Instrument.

2. Calculate the **total annual auxiliary energy** (MWh) for the large SWH using the TRNSYS computer modelling package, using the following TRNSYS input parameters:

   a. Solar collector slope = 20°.

   b. Solar collector azimuth = 45°.

   c. For the climatic zones use the weather data provided on the ORER website (www.orer.gov.au/forms/technical-swh.html).

   d. The modelling of the product shall show compliance with the legionella control requirements specified in AS 3498:2009.

   e. To rate thermosiphon solar water heaters and thermosiphon sidearm heat exchangers, use the extension package TRNAUS for TRNSYS.

   f. To determine tank heat loss:

      i. For SWHs with a tank which is 630 Litres or larger is to be determined in accordance with the document titled *ORER Heat Loss Test Procedure for*

Solar Water Heaters with a Hot Water Storage Tank Greater than 630 Litres, 2003 (see http://www.orer.gov.au/publications/heatloss.html).

ii. For sub-element tanks smaller than 630 Litres the applicable tank heat loss assessment method specified in AS/NZS 4692: 2005 is to be used.

g. The modelled lengths of piping shall be based on the following:

i. For a pumped circulation system, the length of pipe between the storage tank and the closest corner of the solar collector array for shall be the manufacturer's specification or 25 m (each way), whichever is larger.

ii. For all systems the lengths of the supply and return pipes shall account for additional piping length associated with reverse return plumbing.

iii. For a pumped circulation solar preheat tank, the length of piping between the pre-heat tank and the series auxiliary booster shall be the manufacturers specification or 10 m whichever is larger. If the auxiliary booster is integral with the pre-heat tank then the actual pipe lengths shall be used.

iv. For a thermosiphon solar preheater, the length of piping between the preheater and the series auxiliary booster shall be the manufacturer's specification or 25 m whichever is larger. If the auxiliary booster is integral with the pre-heat tank then the actual pipe lengths shall be used.

v. The diameter of all connecting piping shall be equal to the manufacturer's specifications.

vi. If manufacturer's specifications are not provided for the thermal conductivity of the pipe insulation then default values of 0.06 W/(m K) shall be used for closed cell foam insulation and 0.1 W/(m K) for rubberized insulation or polytube or fibre insulation.

h. All other input parameters and control strategies must be those used in the actual system, except where outlined in the Special Circumstances in Division C of Part 3 of this instrument.

3. Select the **peak daily winter load** to suit the scale of the installation. The load shall be the same for all zones and set such that the solar water heater achieves at least 60% annual energy savings in zone 3. A minimum delivery temperature of 45°C must be achieved for each zone for which STCs are to be claimed.

4. Determine the **annual energy use** of an electric water heater ('the reference system') supplying the same hot water load, as follows:

   i. The heat loss from the reference system shall be 15% of the hot water load, therefore use a factor of 1.15.
   ii. The time weighted average seasonal load multiplier to be used is 0.905, see AS/NZS 4234:2008.
   iii. Multiply 365 by 0.905, by 1.15 by the **peak daily winter load**.

5. Determine the displaced energy as follows:
   i. For non-gas boosted systems subtract the **total annual auxiliary energy** used by the SWH, calculated in Step 2, from the **annual energy use,** calculated in Step 4, to determine the **displaced energy**.
   ii. For gas boosted systems, the equivalent displaced electric energy shall be determined using Appendix G of AS/NZS 4234:2008 except the annual electrical energy use of the reference electric heater shall be as calculated in Step 4.

6. Convert the displaced energy to MWh/y.

7. Multiply the displaced energy (MWh/y) by 10 to determine the **10 year MWh savings**.

8. Round down the ten year MWh savings to the nearest lower integer.

9. That number is the number of STCs that may be created for the large SWH in the relevant zone.

10. The percent energy savings, for the purpose of defining the peak daily winter load, shall be calculated by dividing the displaced energy (calculated in accordance with Part 3.B.5) by the annual energy use of the reference system (calculated in accordance with Part 3.B.4).

C. Special Circumstances

The parameters used to calculate the total auxiliary energy for step 2 in the Methodology in Part 3 Division B are subject to modification in the following special circumstances.

(1) Dual Element Tanks

For systems where a bottom element is, or can be, fitted in the tank (e.g. a dual element tank) the bottom element is to be used. The minimum boost time for a bottom element shall be nominal off-peak times of 11 pm to 6 am.

Some tank designs may be modified by the installer to insert an element at the bottom of the tank even if this element has been blanked off. If a model uses a tank that can have the bottom element connected at the time of installation or at any later time, the bottom element be used.

(2) 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) Combined photovoltaic (PV) and water heating collectors

Combined PV and water heating collectors that do not incorporate a concentrator may obtain STCs for the water heating aspect of the mechanism if the following testing regime is documented.

(a) PV output

The PV output shall be assessed using a collector with the water heating part of the collector empty.

(b) Water heating output

The thermal efficiency of the collector shall be assessed to AS/NZS 2535: 2007 with the PV output set to maximum power conditions. . The electrical output of the collector shall not be included in the thermal efficiency assessment.

(4) Family of Products

A ‘family of products’ is where a combination of tanks and collectors are used in a modular fashion to create a product range of different sizes.

Where a range of solar collector array sizes are used on the same storage tank or the product consists of an array of identical storage tanks with a constant ratio of collector area to tank volume, the performance of the family of products may be determined from detailed simulation of the performance of the largest, smallest and midpoint array sizes. The performance of other members of the family may be determined by interpolation.

For a solar system consisting of parallel sub-units, each having an identical solar collector array and storage tank configuration, the total annual auxiliary energy of the system may be calculated by multiplying the total annual auxiliary energy of one sub-system by the number of sub-systems. Note the volume of the sub-systems tanks can be less than 700 L, but the combined physical inner volume of the sub-systems tanks must add to more than 700 L to if this approach is to be used.

Part 4: TRNSYS Modelling Guidelines

A. Introduction

The TRNSYS modelling guidelines set out below describe the format and structure required for the TRNSYS deck files and the default values to be used in certain circumstances. These guidelines must be adhered to.

B . TRNSYS MODELLING GUIDELINES

TRNSYS DECKS

Deck layout

- All include files shall be at the top of the deck immediately after the SIMULATION statement and the timestep shall be 0.02 h or less
- The TOLERANCE statement shall be 0.005, 0.005 or less for relative tolerances
- Use the deck structure provided by ORER, *ORER template deck*, 2011 (see http://www.orer.gov.au/manufacturers/index.html) or another deck structure approved by the Regulator. Except for the product parameters, the example decks shall be used without modification unless the product has features not covered by the example decks.
- The include files shall be as provided by ORER and shall not be modified.
- All constants shall be towards the top of the deck.
- 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 unit shall be included in the deck. This shall output the following results: the zone, load size, percent energy savings, STC rating and 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. collector input + boosting + pump input – load – pipe losses – tank losses – energy dumped

- **Runtime graph:** A runtime graph (TYPE65) shall be included in each deck showing at least
  Hot water delivery temperature
  Solar collector flow rate

Solar collector inlet temperature
Solar collector outlet temperature
Load
Similar variables shall be plotted for heat pump water heaters.

Solar collector area

- The area specified for the solar collector (absorber, aperture or gross) shall be the same as the area used for the specification of the solar collector efficiency coefficients.

Controller default settings

- If the maximum tank temperature setting of the pump controller used for no-load system operation test (clause 7.4.3.2 in AS/NZS 2712: 2007) is not specified in the AS/NZS 2712: 2007 test report, then a maximum value of 65°C shall be used (Tmax = 65^{o}C and Tmax_reset = 60^{o}C shall be used in the modelling).
- For a simple temperature difference pump controller the minimum turn off temperature difference shall be 1 K.

Piping models

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

Gas heater defaults

- If an instantaneous gas booster has not been assessed for electrical power consumption during standby under AS 4552: 2005, then a value of 10 W shall be used. If the electrical power consumption during burner operation is not available, then a value of 50 W shall be used.
- If the startup heat loss has not been assessed under AS4552 then a default value of 0.5 MJ shall be used.

Stratification option for pumped circulation tanks

The default stratification specification for a pumped circulation storage tank shall be “Uncontrolled flow pumped circulation” (AS/NZS 4234: 2008 clause 3.7.4 or H3.4). For pump circulation water heaters satisfying the "Low flow criteria" (AS/NZS 4234: 2008 clause 3.7.2 or H3.2) the tank thermal stratification shall be modelled as per AS/NZS 4234: 2008 clause 3.8.2 or H4.2, if:

1) For solar preheat tanks the collector flow return to the tank is in the top 2/3 of the tank
2) For in-tank electrically boosted solar tanks the collector flow return to the tank is in the top 2/3 of the tank AND the solar return is below the electric element.

3) For tanks connected to stand alone heat pumps the heat pump flow return to the tank is in the top 2/3 of the tank.

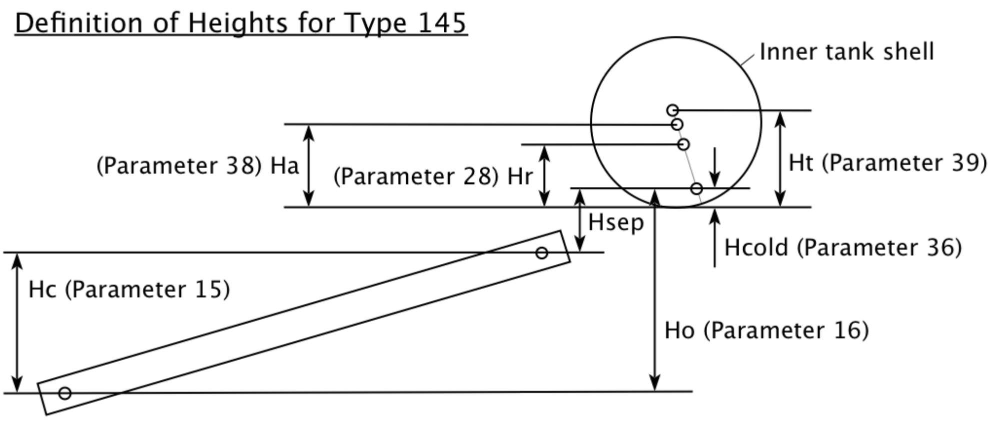
Effective air temperature

- The effective air temperature used to determine solar collector and piping heat loss during night time (horizontal irradiation < 1 kJ/h.m^2) shall be Taeff = Ta – (Ta –Tsky)/5, where Ta denotes the ground level air temperature and Tsky the sky temperature as defined by AS/NZS 4234: 2008.
- The effective air temperature used to determine solar collector and piping heat loss during day time (horizontal irradiation ≥ 1 kJ/h.m^2) shall be Taeff = Ta.

Dip tubes

- Note for a tank with dip (or snorkel) tube, the heat transfer between the stored tank water and the water flowing inside the dip tube usually is 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 collector inlet pipe (or the load) shall be the tank temperature at the dip (or snorkel) tube inlet. Evidence of any dip (or snorkel) tubes must be included in tank drawings supplied for system audits.

Height parameters for thermosyphon solar water heaters



Note: If a dip tube is used on the cold inlet port then the measurements Hsep and Hcold are relative to the level of the outlet of the dip tube.

Units

- The units system used in TRNSYS is metre, 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).

Rounding of numerical results

- The printing of STC and Energy Savings % outputs shall use the format F5.1 as specified in the example decks. This means that an STC rating of 20.94 will be rounded down to 20.9 in the printout and this will be taken as STC = 20. An STC rating of 20.96 will be rounded up to 21.0 in the print out and this will be taken as STC = 21.

C. MEASUREMENTS FOR TRNSYS MODELLING

Pump flow rate

Pumped circulation solar water heaters are classified as "controlled flow" or "uncontrolled flow" systems in AS/NZS4234:2008 section 3.7.2.
If a pumped product is claimed to be a "controlled flow" system then documentation demonstrating how the flow rate is controlled for every installation shall be provided. The alternative product configurations that shall be detailed in the installation manual are

i. **Flow meter in every installation**
If a flow meter is fitted in every installation with an adjusting valve that is not easily accessible by the user then provide a copy of the flow meter specification and the solar water heater installation manual detailing the flow setting procedure. The pump power use shall be measured as detailed below.

ii. **Flow meter used during commissioning**
If a flow meter is fitted in every installation and the flow rate set by an adjusting valve that is not easily accessible by the user and the flow meter is removed after commissioning, then provide a copy of the flow meter specification and the solar water heater installation manual detailing the flow setting procedure. The pump power use shall be measured as detailed below.

iii. **Flow rate set by controller**
If the pump flow rate is set by a controller based on a real time signal from a flow meter or the temperature rise in the collector circuit or by another real time signal then provide a copy of the controller logical functions and provided measured flow rate and pump electrical power results as detailed below.

iv. **Orifice restrictors**
If a set of orifice restrictors are used to set the flow rate for installations with different collector loop piping lengths and number of collectors then provide a copy of the installation manual detailing how the appropriate orifice is selected on the basis of the site specific piping lengths and number of solar collectors. The pump flow rate and power use shall be measured as detailed below

v. **Other site specific flow control method**
Provide details if applicable.

Measurement and documentation of pump flow rate and power

The collector loop flow rate and pump electrical power input to be used in the rating analysis shall be measured for a typical installation with 10 m (each way) of collector loop piping. The measurements shall be carried out for the specific collector array size that is specified for the product.
For products with variable flow rate the measurements shall cover the full range of operating conditions.

The test report shall include

i. Description of product configuration tested; including collector model, number of collectors, series or parallel connection, pump model, piping length and diameter.
ii. Test procedure used including schematic diagram or photograph of setup.
iii. Measuring equipment used
iv. Results for flow rate and pump electrical power input.

NOTES

Pump cycling and simulation stability

- For pumped solar systems the pump controller may cycle the pump on/off if the ratio Ton/Toff is too small. See Duffie & Beckman, "Solar Engineering of Thermal Processes", Section 10.4 Controls for more detail [1] and how to calculate the required Ton/Toff ratio to avoid pump cycling.

- Modelling an in-tank coil heat exchanger for the solar circulation loop using the Type 60 tank model can lead to convergence problems in TRNSYS 15, particularly for glycol-water mixtures. Using water as the HX fluid instead and/or artificially increasing the collector flow rate may overcome this problem. Changing the heat transfer fluid and/or flow rate will introduce an error, and the increase in flow rate should be kept as small as possible.

Batching multiple TRNSYS rating Calculations

- Running multiple TRNSYS decks can be automated by using a Windows batch file. For example, four decks (deckfilenameZ1 to deckfilenameZ4) can be run successively by writing the following lines into a Notepad file (note the spaces) and saving the file with .bat extension.

```
C:\Trnsys15\trnsys.exe deckfilenameZ1.dck /N
C:\Trnsys15\trnsys.exe deckfilenameZ2.dck /N
C:\Trnsys15\trnsys.exe deckfilenameZ3.dck /N
C:\Trnsys15\trnsys.exe deckfilenameZ4.dck /N
```

Right-clicking the batch file allows to one to edit it, left clicking or double clicking will run it.

References

[1] Duffie, J. A. and Beckman, W. A., Solar Engineering of thermal processes, 3rd ed., Wiley, New York, 2006.