Stokvis CONCEPT Solar

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CONCEPT

Solar 1A – Schematic of Econoplate + Buffer Vessel with Solar Pre-Heat (Single Coil)

As the title suggests, the solar panel is the pre-heat for the solar vessel and effectively the buffer vessel (the buffer vessel draws pre-heated water from the top of the solar vessel). The Econoplate ensures the buffer vessel remains at desired set-point temperature for instantaneous HWS (Hot Water Service) draw-off.

The solar vessel should be portrayed as a pre-heat vessel only containing the following:

- Solar coil & solar coil sensor (S2).
- Flow to the buffer vessel.
- System HWS return.
- Anti-legionella loop connection & anti-legionella sensor (S7).
- Cold feed connection.

Assume on initial start-up that the solar controller is off, all motorised valves are closed, all pumps are off and that both the buffer and the solar vessel are cold.
The solar coil and Econoplate will act in unison to get both the buffer vessel and the solar vessel up to temperature.

Econoplate & Buffer Vessel:

The buffer vessel is controlled by the buffer vessel sensor (S3) and ensures that there is hot water readily available for instantaneous draw-off. **On initial start-up** the buffer vessel sensor (S3) will be less than set-point. If programmed to do so, the solar controller will **enable** the Econoplate Econotrol 2100 (R3), which in turn will **start** the Econoplate transfer pump. When the buffer vessel sensor (S3) measures a temperature greater than set-point, the solar controller will **disable** the Econoplate Econotrol 2100 (R3) which in turn will **stop** the Econoplate transfer pump.

Solar Vessel Pre-Heat:

The solar vessel is controlled by the solar coil sensor (S2). When the solar coil sensor (S2) is less than set-point, and if less than the temperature of the solar panel sensor (S1), heat can be transferred. The solar controller will **motor open** the valve supplying the solar coil (R5). Solar circuit flow is now able to pass through the solar coil where heat transfer occurs and the whole of the solar vessel (due to heat rising) will be “pre-heated”. This will occur until the solar coil sensor (S2) reaches a temperature greater than set-point.

Heat Dump:

Whilst the solar coil sensor (S2) remains greater than set-point, the solar panel must supply the excess heat to a heat dump e.g. a fan coil unit or a swimming pool heat exchanger. For this to occur the heat dump return sensor (S4) has to be less than the solar panel sensor (S1). If satisfied, the solar controller will **motor open** the valve supplying the heat dump (R4) and take power off the valve supplying the solar coil (R5) causing it to **spring close.** Once the heat dump valve (R4) reaches fully open, an end-switch on the valve can be utilised which will close to **enable** the heat dump.

Heat transfer to the heat dump will occur until the solar coil sensor (S2) is less than set-point in which case the solar controller will **motor open** the valve supplying the solar coil (R5) and take power off the valve supplying the heat dump (R4) causing it to **spring close.** Once the heat dump valve (R4) starts to close, an end-switch on the valve can be utilised which will open to **disable** the heat dump.

Reverse Heat Exchange

Reverse heat exchange could possibly occur when the solar panel sensor (S1) is less than any of the secondary fluid measuring sensors (S2). It would negate any previous solar gain due to dissipation of the solar vessel stored energy back to the atmosphere via the solar panel. To prevent reverse heat exchange, on presence of the aforementioned scenario for example when the sun goes down, the solar controller will **stop** the solar circuit pump (R1).

Anti-Legionella Cycle Solar Vessel:

To eliminate legionella bacteria contamination it is necessary to ensure that the total volume of water in the hot water system reaches a predetermined temperature, for a given period of time and with suitable frequency. These requirements should be decided based on current legislation, best practice and a risk assessing of the installation. The timing and frequency need to be carefully considered as poorly selected timing can negate a large proportion of any solar gain as the volume could already be up to temperature at times of thermal gain.

Assume that at a predetermined time the anti-legionella sensor (S7) (located at the bottom of the solar vessel) is below the set-point temperature, the solar controller will **start** the anti-legionella pump (R6). The whole solar vessel can then be heated to a predetermined set-point for a given period of time to ensure legionella build-up cannot take place. Once the time has elapsed, the solar controller will **stop** the anti-legionella pump (R6). The timing of this must coincide with the Econoplate’s enable time to ensure heat is available.

N.B. Relay (R*) and Sensor (S*) references based on Resol DeltaSol E control system 3 variant 3, function block 1 for PHE & function block 4 for anti-Legionella. The Econoplate requires an additional relay to allow 230V enable from the solar controller.

CONCEPT

IMPORTANT NOTE

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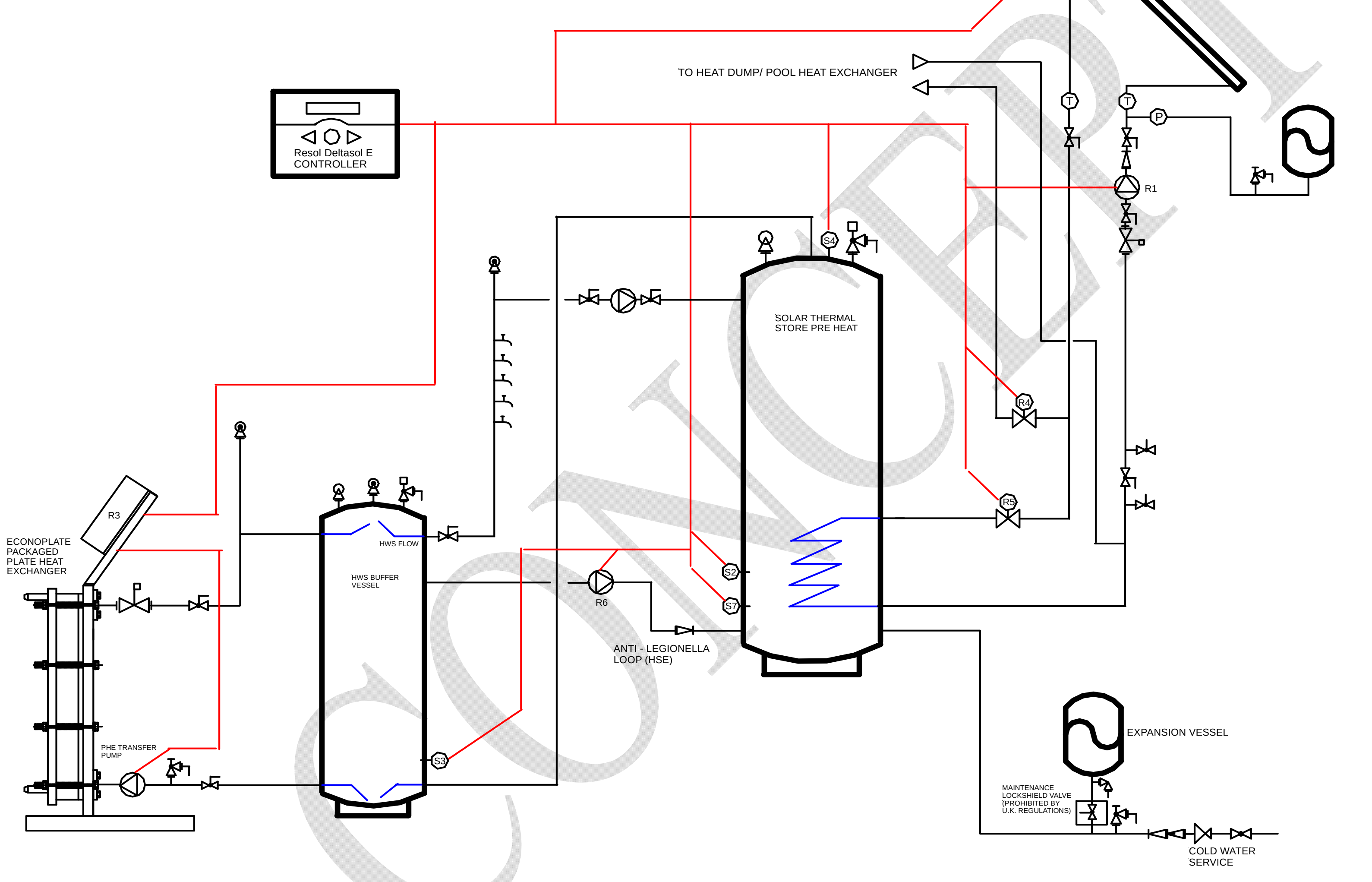
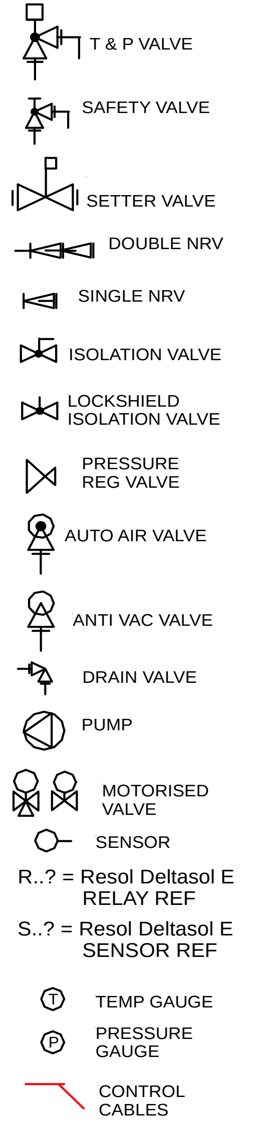
COMPLIANCE WITH ANY APPROPRIATE REGULATIONS SHOULD BE ADHERED TO



CONCEPT

LEGEND



ISSUE	DATE	MODIFICATION

STOKVIS

Title

SCHEMATIC OF ECONOPLATE + BUFFER VESSEL WITH SOLAR PRE-HEAT

Drawn	R.S.
Date	SEPT 11 REV A
CAD ref	W-E-

Drawing No
SOLAR 1A

STOKVIS ENERGY SYSTEMS, 96R WALTON ROAD, EAST MOLESEY, SURREY, KT8 0DL. Tel. 0870 770 7747

Solar 2A – Schematic of Full Duty Econoplate with Solar Pre-Heat (Single Coil)

As the title suggests, the solar panel is the pre-heat for the solar vessel. The Econoplate does the Hot Water Service (HWS) directly (full duty).

The solar vessel should be portrayed as a pre-heat vessel only containing the following:

- Solar coil & solar coil sensor (S2).
- Flow to the Econoplate.
- System HWS return.
- Anti-legionella loop connection & Anti-legionella sensor (S7).
- Cold feed connection.

Assume on initial start-up that the solar controller is off, all motorised valves are shut, all pumps are off and the solar vessel is cold.
The solar coil and Econoplate will act in unison to get the solar vessel up to temperature.

Econoplate:

The Econoplate is enabled by its internal time program and generates hot water at the set-point on demand.

Solar Vessel Pre-Heat:

The solar vessel is controlled by the solar coil sensor (S2). **On initial start-up** the solar coil sensor (S2) will be less than set-point, and if less than the temperature of the solar panel sensor (S1), heat can be transferred. The solar controller will **motor open** the valve supplying the solar coil (R5) and **start** the solar circuit pump (R1). Solar circuit flow is now able to pass through the solar coil where heat transfer occurs and the whole of the solar vessel (due to heat rising) will be “pre-heated”. This will occur until the solar coil sensor (S2) reaches a temperature greater than set-point.

Heat Dump:

Whilst the solar coil sensor (S2) remains greater than set-point, the solar panel must supply the excess heat to a heat dump e.g. a fan coil unit or a swimming pool heat exchanger. For this to occur the heat dump return sensor (S4) has to be less than the solar panel sensor (S1). If satisfied, the solar controller will **motor open** the valve supplying the heat dump (R4) and take power off the valve supplying the solar coil (R5) causing it to **spring close.** Once the heat dump valve (R4) reaches fully open, an end-switch on the valve can be utilised which will close to **enable** the heat dump.

Heat transfer to the heat dump will occur until the solar coil sensor (S2) is less than set-point in which case the solar controller will **motor open** the valve supplying the solar coil (R5) and take power off the valve supplying the heat dump (R4) causing it to **spring close.** Once the heat dump valve (R4) valve starts to close, an end-switch on the valve can be utilised which will open to **disable** the heat dump.

Reverse Heat Exchange

Reverse heat exchange could possibly occur when the solar panel sensor (S1) is less than any of the secondary fluid measuring sensors (S2). It would negate any previous solar gain due to dissipation of the solar vessel stored energy back to the atmosphere via the solar panel. To prevent reverse heat exchange, on presence of the aforementioned scenario for example when the sun goes down, the solar controller will **stop** the solar circuit pump (R1).

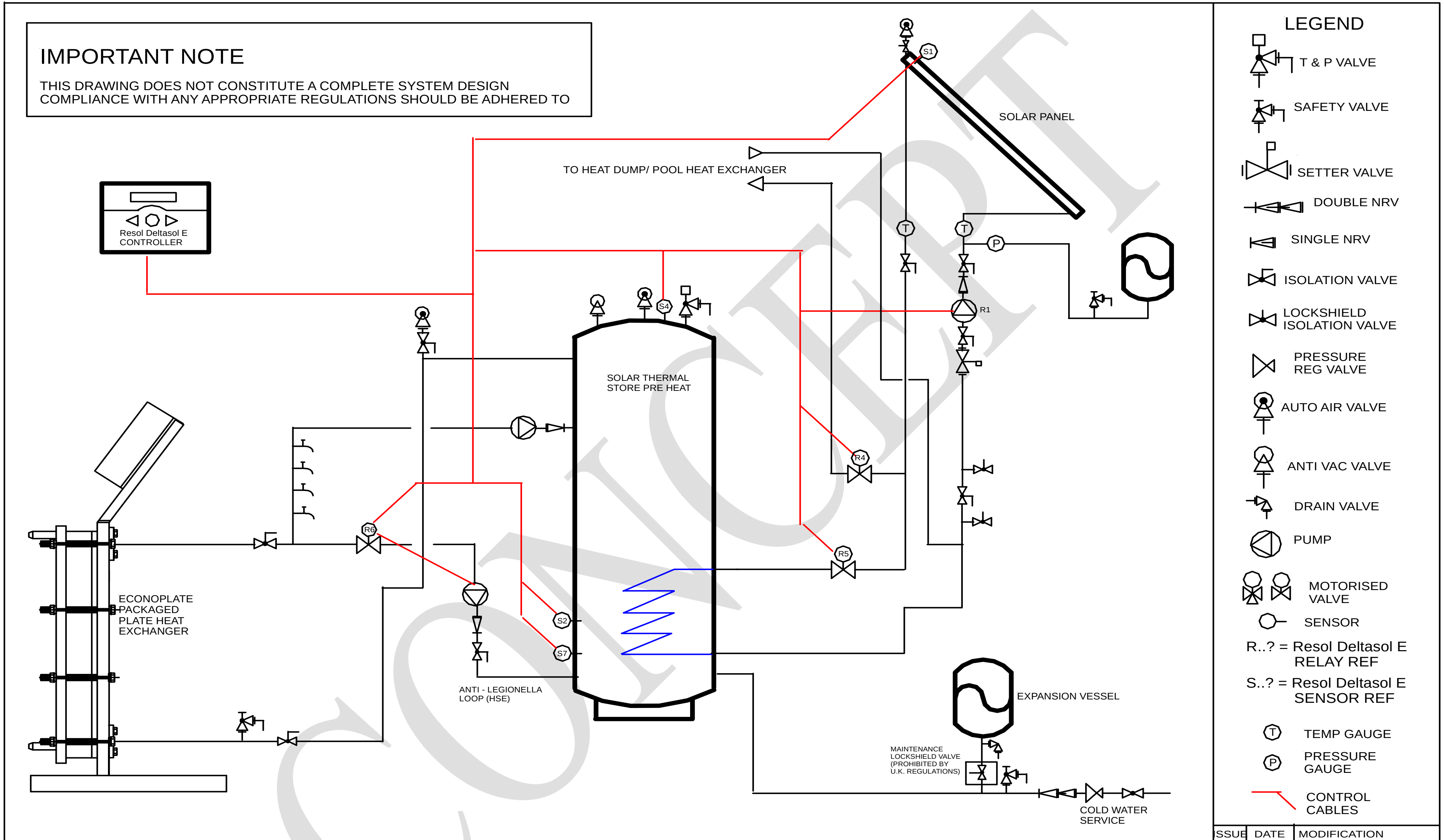
Anti-Legionella Cycle:

To eliminate legionella bacteria contamination it is necessary to ensure that the total volume of water in the hot water system reaches a predetermined temperature, for a given period of time and with suitable frequency. These requirements should be decided based on current legislation, best practice and a risk assessing of the installation. The timing and frequency need to be carefully considered as poorly selected timing can negate a large proportion of any solar gain as the volume could already be up to temperature at times of thermal gain.

Assume that at a predetermined time the anti-legionella sensor (S7) located at the bottom of the solar vessel is below set-point temperature, the solar controller will **motor open** the anti-legionella cycle valve (R6). Once the anti-legionella cycle valve (R6) reaches fully open, an end switch on the valve can be utilised which will close to **start** the anti-legionella pump. The whole solar vessel can then be heated to a predetermined set-point for a given period of time to ensure legionella build-up can not take place. When the time has elapsed, the solar controller will take power off the anti-legionella cycle valve (R6) causing it to **spring close.** Once the anti-legionella cycle valve (R6) starts to close, an end-switch on the valve can be utilised which will open to **stop** the anti-legionella pump. The timing of this must coincide with the Econoplate’s enable time to ensure heat is available.

N.B. Relay (R*) and Sensor (S*) references based on Resol DeltaSol E control system 3 variant 3, function block 4 for anti-Legionella.

CONCEPT



ISSUE	DATE	MODIFICATION

STOKVIS

Title

SCHEMATIC OF FULL DUTY ECONOPLATE WITH SOLAR PRE-HEAT

Drawn	R.S.
Date	AUG 12 REV B
CAD ref	W-E-

Drawing No
SOLAR 2A REV B

STOKVIS ENERGY SYSTEMS, 96R WALTON ROAD, EAST MOLESEY, SURREY, KT8 0DL. Tel. 0870 770 7747

Solar 3 – Schematic of Back-Up Econoplate with Solar Pre-Heat (Single Coil)

As the title suggests, the solar panel is the lead heat source for the solar vessel. The Econoplate is the back-up heat source for the solar vessel.

The solar vessel should be portrayed in layers:

- The top half – including the HWS flow, the HWS return, the flow from the Econoplate and the back-up heat source sensor (S3) (which marks the division between top and bottom of the vessel).
- The bottom half – including the solar coil, the solar coil sensor (S2), the flow to the Econoplate, the anti-legionella sensor (S7) and the cold feed connection.

Assume on initial start-up that the solar controller is off, all motorised valves are shut, all pumps are off and the solar vessel is cold.
The solar coil and Econoplate will act in unison to get the solar vessel up to temperature.

Solar Vessel Pre-Heat:

The solar vessel is controlled by the solar coil sensor (S2). **On initial start-up** the solar coil sensor (S2) will be less than set-point, and if less than the temperature of the solar panel sensor (S1), heat can be transferred. The solar controller will **motor open** the valve supplying the solar coil (R5) and **start** the solar circuit pump (R1). Solar circuit flow is now able to pass through the solar coil where heat transfer occurs and the whole of the solar vessel (due to heat rising) will be “pre-heated”. This will occur until the solar coil sensor (S2) reaches a temperature greater than set-point.

Back-Up:

The top half of the solar vessel is controlled by the back-up heat source sensor (S3) approximately half way up the solar vessel. The water in the top half of the vessel has to be kept up to temperature to allow for instantaneous HWS draw-off. If the back-up heat sensor (S3) measures a temperature less than set-point, the solar controller will **enable** the Econoplate Econotrol 2100 (R3) which in turn will **start** the Econoplate transfer pump. Water is drawn from the bottom of the vessel, heated by the Econoplate and injected into the top of the vessel. This will continue until the back-up heat source sensor (S3) reaches a temperature greater than set-point. Once this occurs, the solar controller will **disable** the Econoplate Econotrol 2100 (R3) which in turn will **stop** the Econoplate transfer pump.

Heat Dump:

Whilst the solar coil sensor (S2) remains greater than set-point, the solar panel must supply the excess heat to a heat dump e.g. a fan coil unit or a swimming pool heat exchanger. For this to occur the heat dump return sensor (S4) has to be less than the solar panel sensor (S1). If satisfied, the solar controller will **motor open** the valve supplying the heat dump (R4) and take power off the valve supplying the solar coil (R5) causing it to **spring close.** Once the heat dump valve (R4) reaches fully open, an end-switch on the valve can be utilised which will close to **enable** the heat dump.

Heat transfer to the heat dump will occur until the solar coil sensor (S2) is less than set-point in which case the solar controller will **motor open** the valve supplying the solar coil (R5) and take power off the valve supplying the heat dump (R4) causing it to **spring close.** Once the heat dump valve (R4) starts to close, an end-switch on the valve can be utilised which will open to **disable** the heat dump.

Reverse Heat Exchange

Reverse heat exchange could possibly occur when the solar panel sensor (S1) is less than any of the secondary fluid measuring sensors (S2). It would negate any previous solar gain due to dissipation of the solar vessel stored energy back to the atmosphere via the solar panel. To prevent reverse heat exchange, on presence of the aforementioned scenario for example when the sun goes down, the solar controller will **stop** the solar circuit pump (R1).

Anti-Legionella Cycle:

To eliminate legionella bacteria contamination it is necessary to ensure that the total volume of water in the hot water system reaches a predetermined temperature, for a given period of time and with suitable frequency. These requirements should be decided based on current legislation, best practice and a risk assessing of the installation. The timing and frequency need to be carefully considered as poorly selected timing can negate a large proportion of any solar gain as the volume could already be up to temperature at times of thermal gain.

Assume that at a predetermined time the anti-legionella sensor (S7) (located at the bottom of the solar vessel) is below set-point temperature, the solar controller will **enable** the Econoplate Econotrol 2100 (R6) which in turn will **start** the Econoplate transfer pump. The whole solar vessel can then be heated to a predetermined set-point for a given period of time to ensure legionella build-up can not take place. Once the time has elapsed, the solar controller will **disable** the Econoplate Econotrol 2100 (R6) which in turn will **stop** the Econoplate transfer pump.

N.B. Relay (R*) and Sensor (S*) references based on Resol DeltaSol E control system 3 variant 3, function block 1 for PHE & function block 4 for anti-Legionella. The Econoplate requires an additional relay to allow 230V enable from the solar controller.

CONCEPT

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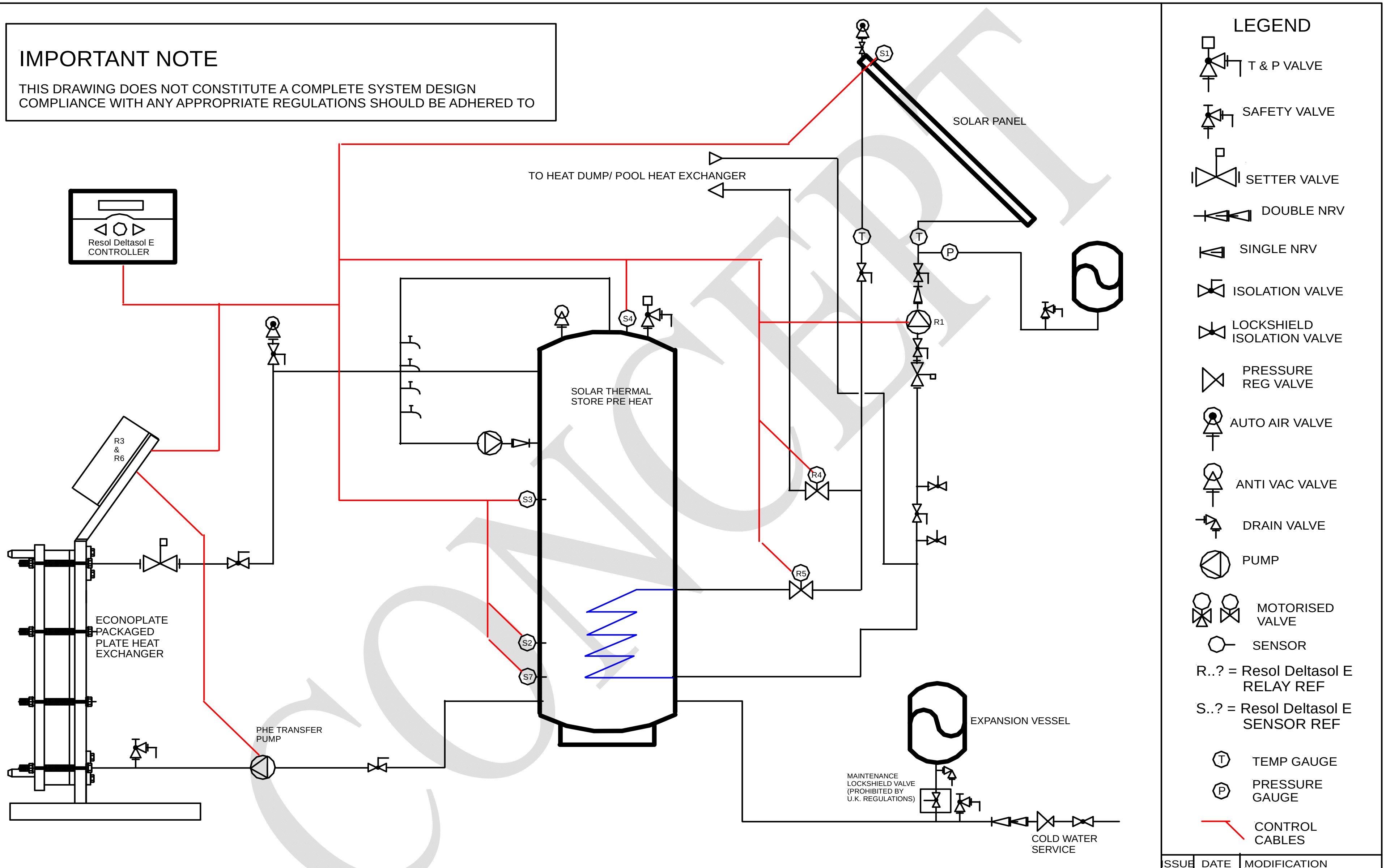

CONCEPT

ISSUE	DATE	MODIFICATION

STOKVIS

Title

SCHEMATIC OF BACK UP ECONOPLATE WITH SOLAR PRE-HEAT

Drawn	R.S.	Drawing No SOLAR 3
Date	SEPT 11 REV A	
CAD ref	W-E-	

STOKVIS ENERGY SYSTEMS, 96R WALTON ROAD, EAST MOLESEY, SURREY, KT8 0DL. Tel. 0870 770 7747

Solar 4 – Schematic of Back-Up Econoplate with Solar Pre-Heat (Single Coil)

As the title suggests, the solar panel is the lead heat source for the solar vessel. The Econoplate is the back-up heat source for the solar vessel.

The solar vessel should be portrayed in layers:

- The top half – including the HWS flow, the HWS return, the flow from the Econoplate, the flow to the Econoplate, the top de-strat pump connection and the back up heat source sensor (S3) (which marks the division between top and bottom of the vessel).
- The bottom half – including the solar coil, the solar coil sensor (S2), the bottom de-strat pump connection, the anti-legionella sensor (S7) and the cold feed connection.

Assume on initial start-up that the solar controller is off, all motorised valves are shut, all pumps are off and the solar vessel is cold.
The solar coil and Econoplate will act in unison to get the solar vessel up to temperature.

Solar Vessel Pre-Heat:

The solar vessel is controlled by the solar coil sensor (S2). **On initial start-up** the solar coil sensor (S2) will be less than set-point, and if less than the temperature of the solar panel sensor (S1), heat can be transferred. The solar controller will **motor open** the valve supplying the solar coil (R5) and **start** the solar circuit pump (R1). Solar circuit flow is now able to pass through the solar coil where heat transfer occurs and the whole of the solar vessel (due to heat rising) will be "pre-heated". This will occur until the solar coil sensor (S2) reaches a temperature greater than set-point.

Back-Up:

The top half of the solar vessel is controlled by the back-up heat source sensor (S3) approximately half way up the solar vessel. The water in the top half of the vessel has to be kept up to temperature to allow for instantaneous HWS draw-off. If the backup heat sensor (S3) measures a temperature less than set-point, the solar controller will **enable** the Econoplate Econotrol 2100 (R3) which in turn will **start** the Econoplate transfer pump. Water is drawn from the middle of the vessel, heated by the Econoplate and injected into the top of the vessel. This will continue until the back-up heat source sensor (S3) reaches a temperature greater than set-point. Once this occurs, the solar controller will **disable** the Econoplate Econotrol 2100 (R3) which in turn will **stop** the Econoplate transfer pump.

Heat Dump:

Whilst the solar coil sensor (S2) remains greater than set-point, the solar panel must supply the excess heat to a heat dump e.g. a fan coil unit or a swimming pool heat exchanger. For this to occur the heat dump return sensor (S4) has to be less than the solar panel sensor (S1). If satisfied, the solar controller will **motor open** the valve supplying the heat dump (R4) and take power off the valve supplying the solar coil (R5) causing it to **spring close.** Once the heat dump valve (R4) reaches fully open, an end-switch on the valve can be utilised which will close to **enable** the heat dump.

Heat transfer to the heat dump will occur until the solar coil sensor (S2) is less than set-point in which case the solar controller will **motor open** the valve supplying the solar coil (R5) and take power off the valve supplying the heat dump (R4) causing it to **spring close.** Once the heat dump valve (R4) starts to close, an end-switch on the valve can be utilised which will open to **disable** the heat dump.

Reverse Heat Exchange

Reverse heat exchange could possibly occur when the solar panel sensor (S1) is less than any of the secondary fluid measuring sensors (S2). It would negate any previous solar gain due to dissipation of the solar vessel stored energy back to the atmosphere via the solar panel. To prevent reverse heat exchange, on presence of the aforementioned scenario for example when the sun goes down, the solar controller will **stop** the solar circuit pump (R1).

Anti-Legionella Cycle:

To eliminate legionella bacteria contamination it is necessary to ensure that the total volume of water in the hot water system reaches a predetermined temperature, for a given period of time and with suitable frequency. These requirements should be decided based on current legislation, best practice and a risk assessing of the installation. The timing and frequency need to be carefully considered as poorly selected timing can negate a large proportion of any solar gain as the volume could already be up to temperature at times of thermal gain.

Assume that at a predetermined time the anti-legionella sensor (S7) (located at the bottom of the solar vessel) is below set-point temperature, the solar controller will **enable** the de-strat pump (R6). The whole solar vessel can then be heated to a predetermined set-point for a given period of time to ensure legionella build-up can not take place. Once the time has elapsed, the solar controller will **disable** the de-strat pump (R6). The timing of this must coincide with the Econoplate's enable time to ensure heat is available.

N.B. Relay (R*) and Sensor (S*) references based on Resol DeltaSol E control system 3 variant 3, function block 1 for PHE & function block 4 for anti-Legionella. The Econoplate requires an additional relay to allow 230V enable from the solar controller.

CONCEPT

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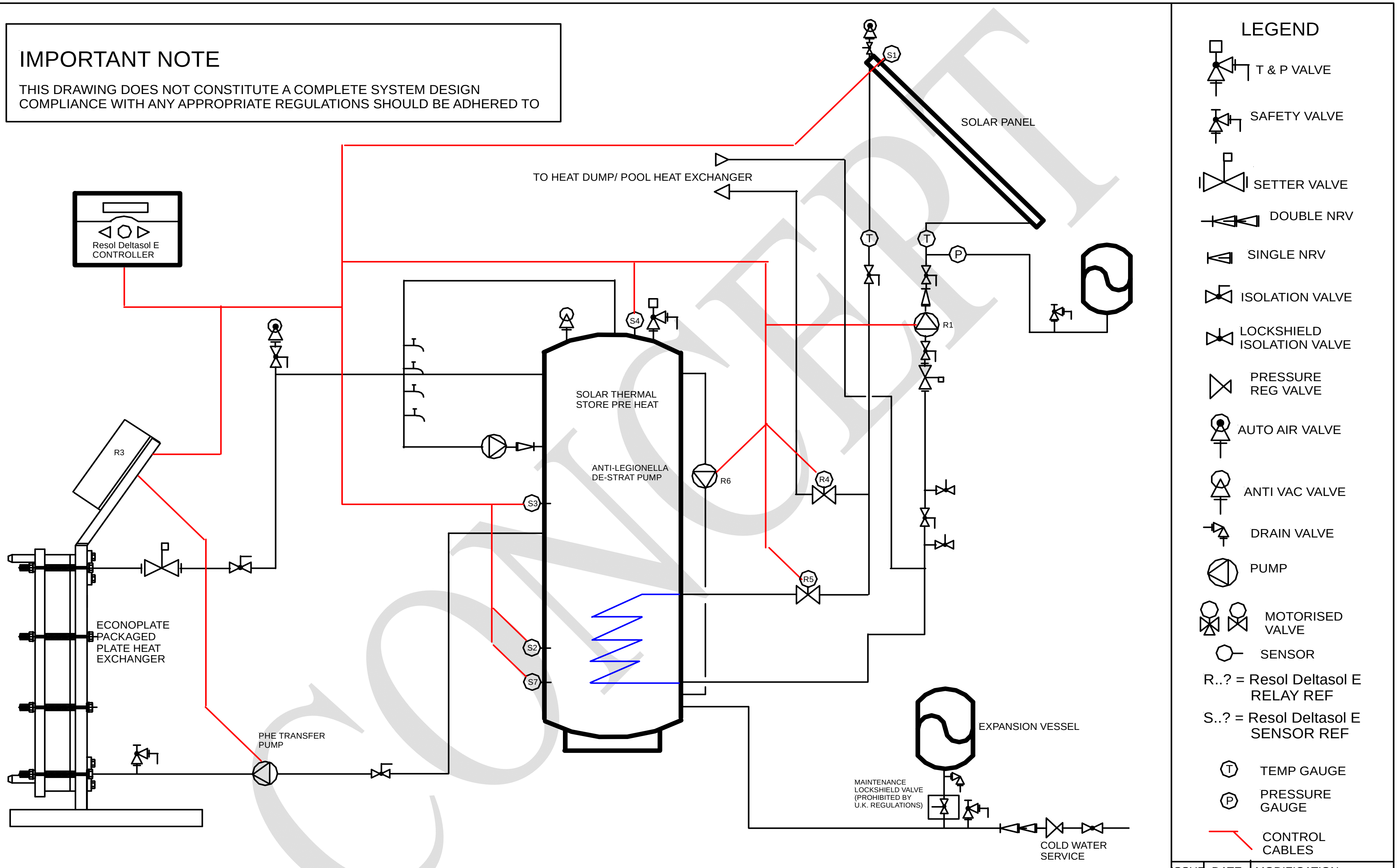

CONCEPT

ISSUE	DATE	MODIFICATION

STOKVIS

Title

SCHEMATIC OF BACK UP ECONOPLATE WITH SOLAR PRE-HEAT

Drawn	R.S.
Date	SEPT 11 REV A
CAD ref	W-E-

Drawing No
SOLAR 4

STOKVIS ENERGY SYSTEMS, 96R WALTON ROAD, EAST MOLESEY, SURREY, KT8 0DL. Tel. 0870 770 7747

General Notes on Vessel Sizing

- The total amount of stored water required is dictated by the number of solar panels being installed, the amount of hot water being used and the recovery rate that can be achieved by the back-up heat source during periods of low solar gain.
- When sizing solar vessels, a dedicated solar storage volume of approximately 60 litres per m^2 of evacuated tube collector aperture is recommended (source: Solar Heating Design & Installation Guide).
- The DF100 has an aperture area of 1.114m^2; it thus requires approximately 70 litres of dedicated solar storage per panel.
- The DF120 has an aperture area of 1.684m^2; it thus requires approximately 100 litres of dedicated solar storage per panel.
- The solar coil generally occupies the bottom half of the vessel, the back up heating coil is in the top half.
- This gives a vessel size of approximately 140 litres, per DF100, for a twin coil type of vessel.
- This gives a vessel size of approximately 200 litres, per DF120, for a twin coil type of vessel.
- At its peak, the output of a single DF100 is 0.882kW - based on a solar irradiation of 1kW/m^2, multiplied by the collector aperture area (1.114m^2) and collector efficiency (79.2%) – see DF100 SPF Test Results on following page.
- At its peak, the output of a single DF120 is 1.354kW - based on a solar irradiation of 1kW/m^2, multiplied by the collector aperture area (1.684m^2) and collector efficiency (80.4%) – see DF120 SPF Test Results on following page.
- The DF100 can generate around 106litres[*] of hot water (10-60ºC) on the “sunniest” summer’s day where the peak daily solar irradiation level can be as much as 7kWh/m^2.
- The DF100 can generate around 73litres[**] of hot water (10-60ºC) daily, during the peak month where the average solar irradiation level is around 4.8kWh/m^2.
- The DF100 can generate around 15211[***] litres of hot water (10-60ºC) per year where the yearly solar irradiation level is around 1000kWh/m^2.

- The DF120 can generate around 160litres[*] of hot water (10-60ºC) on the “sunniest” summer’s day where the peak daily solar irradiation level can be as much as 7kWh/m^2.
- The DF120 can generate around 110litres[**] of hot water (10-60ºC) daily, during the peak month where the average solar irradiation level is around 4.8kWh/m^2.
- The DF120 can generate around 23210[***] litres of hot water (10-60ºC) per year where the yearly solar irradiation level is around 1000kWh/m^2.
- The above statements ignore system losses however many of the losses associated with a solar pre-heat hot water system would also occur in a standard hot water system.
- Along with these system losses, the actual amount of hot water generated will vary dependent upon the level of solar irradiation and the position and orientation of the panel.
- Assuming that the back-up heat source is timed twice daily, (to prevent unnecessary heat input, during periods of solar gain), a proportion (30%) of the top half can be included in the volume designated as dedicated solar (source: Solar Heating Design & Installation Guide).
- In Solar 1/1A and Solar 2/2A, the solar vessel is purely dedicated solar storage requiring 100 litres per DF120 panel or 70 litres per DF100 panel to be provided below the HWS return connection.
- In Solar 3 and Solar 4, the volume below the back up heat source sensor is dedicated solar.
- With timed control of the Econoplate a proportion of the remaining volume could be viewed as dedicated solar based on the assumption above.

CONCEPT

DF120 Calculations.

$$^{*}7kWh/m^2 \times 1.684m^2 \times 0.804 = 9.477552\,kWh$$

$$Now, \quad kW = \Delta t \times flowrate\left(\frac{litres}{sec}\right) \times 4.2$$

$$However, \quad \left(\frac{litres}{hour}\right) = 60\left(\frac{litres}{\min}\right) = 3600\left(\frac{litres}{sec}\right)$$

$$\therefore kW = \Delta t \times flowrate\left(\frac{litres}{hour}\right) \times \frac{4.2}{3600}$$

$$\Rightarrow kWh = 50 \times volume(litres) \times 0.0011\dot{6}$$

$$\Rightarrow \frac{9.477552}{50 \times 0.0011\dot{6}} = Volume(litres)$$

$$\Rightarrow = 162.47\,litres$$

$$^{**}4.8kWh/m^2 \times 1.684m^2 \times 0.804 = 6.4988928\,kWh$$

$$Now, \quad kW = \Delta t \times flowrate\left(\frac{litres}{sec}\right) \times 4.2$$

$$However, \quad \left(\frac{litres}{hour}\right) = 60\left(\frac{litres}{\min}\right) = 3600\left(\frac{litres}{sec}\right)$$

$$\therefore kW = \Delta t \times flowrate\left(\frac{litres}{hour}\right) \times \frac{4.2}{3600}$$

$$\Rightarrow kWh = 50 \times volume(litres) \times 0.0011\dot{6}$$

$$\Rightarrow \frac{6.4988928}{50 \times 0.0011\dot{6}} = Volume(litres)$$

$$\Rightarrow = 111.41\,litres$$

$$^{***}1000\,kWh/m^2 \times 1.684m^2 \times 0.804 = 1353.936\,kWh$$

$$Now, \quad kW = \Delta t \times flowrate\left(\frac{litres}{sec}\right) \times 4.2$$

$$However, \quad \left(\frac{litres}{hour}\right) = 60\left(\frac{litres}{\min}\right) = 3600\left(\frac{litres}{sec}\right)$$

$$\therefore kW = \Delta t \times flowrate\left(\frac{litres}{hour}\right) \times \frac{4.2}{3600}$$

$$\Rightarrow kWh = 50 \times volume(litres) \times 0.0011\dot{6}$$

$$\Rightarrow \frac{1353.936}{50 \times 0.0011\dot{6}} = Volume(litres)$$

$$\Rightarrow = 23210.33\,litres$$

DF120 SPF Test Results:

- Efficiency 80.4% (relating to aperture area) – aperture area 1.684m².
- Flow Rate 1.72kg/min per panel

DF100 Calculations.

$$^{*}7kWh/m^2 \times 1.114m^2 \times 0.792 = 6.176016\,kWh$$

$$Now, \quad kW = \Delta t \times flowrate\left(\frac{litres}{sec}\right) \times 4.2$$

$$However, \quad \left(\frac{litres}{hour}\right) = 60\left(\frac{litres}{\min}\right) = 3600\left(\frac{litres}{sec}\right)$$

$$\therefore kW = \Delta t \times flowrate\left(\frac{litres}{hour}\right) \times \frac{4.2}{3600}$$

$$\Rightarrow kWh = 50 \times volume(litres) \times 0.0011\dot{6}$$

$$\Rightarrow \frac{6.176016}{50 \times 0.0011\dot{6}} = Volume(litres)$$

$$\Rightarrow = 106.48\,litres$$

$$^{**}4.8kWh/m^2 \times 1.114m^2 \times 0.792 = 4.2349824\,kWh$$

$$Now, \quad kW = \Delta t \times flowrate\left(\frac{litres}{sec}\right) \times 4.2$$

$$However, \quad \left(\frac{litres}{hour}\right) = 60\left(\frac{litres}{\min}\right) = 3600\left(\frac{litres}{sec}\right)$$

$$\therefore kW = \Delta t \times flowrate\left(\frac{litres}{hour}\right) \times \frac{4.2}{3600}$$

$$\Rightarrow kWh = 50 \times volume(litres) \times 0.0011\dot{6}$$

$$\Rightarrow \frac{4.2349824}{50 \times 0.0011\dot{6}} = Volume(litres)$$

$$\Rightarrow = 73.02\,litres$$

$$^{***}1000\,kWh/m^2 \times 1.114m^2 \times 0.792 = 882.288\,kWh$$

$$Now, \quad kW = \Delta t \times flowrate\left(\frac{litres}{sec}\right) \times 4.2$$

$$However, \quad \left(\frac{litres}{hour}\right) = 60\left(\frac{litres}{\min}\right) = 3600\left(\frac{litres}{sec}\right)$$

$$\therefore kW = \Delta t \times flowrate\left(\frac{litres}{hour}\right) \times \frac{4.2}{3600}$$

$$\Rightarrow kWh = 50 \times volume(litres) \times 0.0011\dot{6}$$

$$\Rightarrow \frac{882.288}{50 \times 0.0011\dot{6}} = Volume(litres)$$

$$\Rightarrow = 15211.86\,litres$$

DF100 SPF Test Results:

- Efficiency 79.2% (relating to aperture area) – aperture area 1.114m².
- Flow rate 1.74kg/min per panel

CONCEPT

Useful Information from Solar Heating Design & Installation Guide:

- Peak Irradiation falling horizontally on the ground: 1-1.2 kW/m^2 – occurs during sun bursts.
- Peak Power at solar collector: 0.7 kW/m^2 – occurs briefly during sun bursts in the plane of useful collecting surface.
- Peak Daily Average Radiation by month: 4.8 $kWh/m^2/day$ – occurs in June.
- Peak Daily Irradiation Energy: 5-7kWh/m^2 – summer peak measured horizontally.
- Annual Irradiation Energy UK: 800-1100kWh/m^2.
- Rule of thumb for Effective Solar Volume of cylinder : 60 l/m^2 of solar panel aperture.
- Solar coils in cylinders should have a surface area of: 0.2m^2 per m^2 of solar panel aperture, if made from plain tube and 0.4m^2 for finned tube.

Control of Legionella Bacteria

Below you will find an extract from:

Legionnaires' disease: The Control of Legionella bacteria in water systems. Approved Code of Practice and Guidance L8.

Paragraph 158: In a hot water system, cold water enters at the base of the calorifier with hot water being drawn off from the top for distribution to user points throughout the building. A control thermostat to regulate the supply of heat to the calorifier should be fitted to the calorifier near the top and adjusted so that the outlet water temperature is constant. The water temperature at the base of the calorifier (ie under the heating coil) will usually be much cooler than the water temperature at the top. **Arrangements should therefore be made to heat the whole water content of the calorifier, including that at the base, to a temperature of 60°C for one hour each day.** This period needs to coincide with the operation of the boiler plant (or other calorifier heat source) and is usually arranged during a period of low demand eg during the early hours of the morning. A shunt pump to move hot water from the top of the calorifier to the base is one way of achieving this; however, it should not be used continuously except for about one hour each day (see above). In all cases the operation of the pump should be controlled by a time clock.

The above information has been collated from various sources, to the best of our knowledge it was correct at the time of producing this document, however it should not be used in isolation for any purpose other than guidance and is not sufficient for a system design.

Please ensure compliance with any relevant standards or guidance documents which may be applicable for your design or installation.

If Carbon Emission based grants or loans are being applied for please refer to their methodology for calculation of solar performance.

NB the DF 100 panel has a Keymark Certificate of 011-7S1803R

NB the DF 120 panel has a Keymark Certificate of 011-7S684R

CONCEPT