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ENERGY SYSTEMS

Stokvis CONCEPT Solar

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IMPORTANT NOTE

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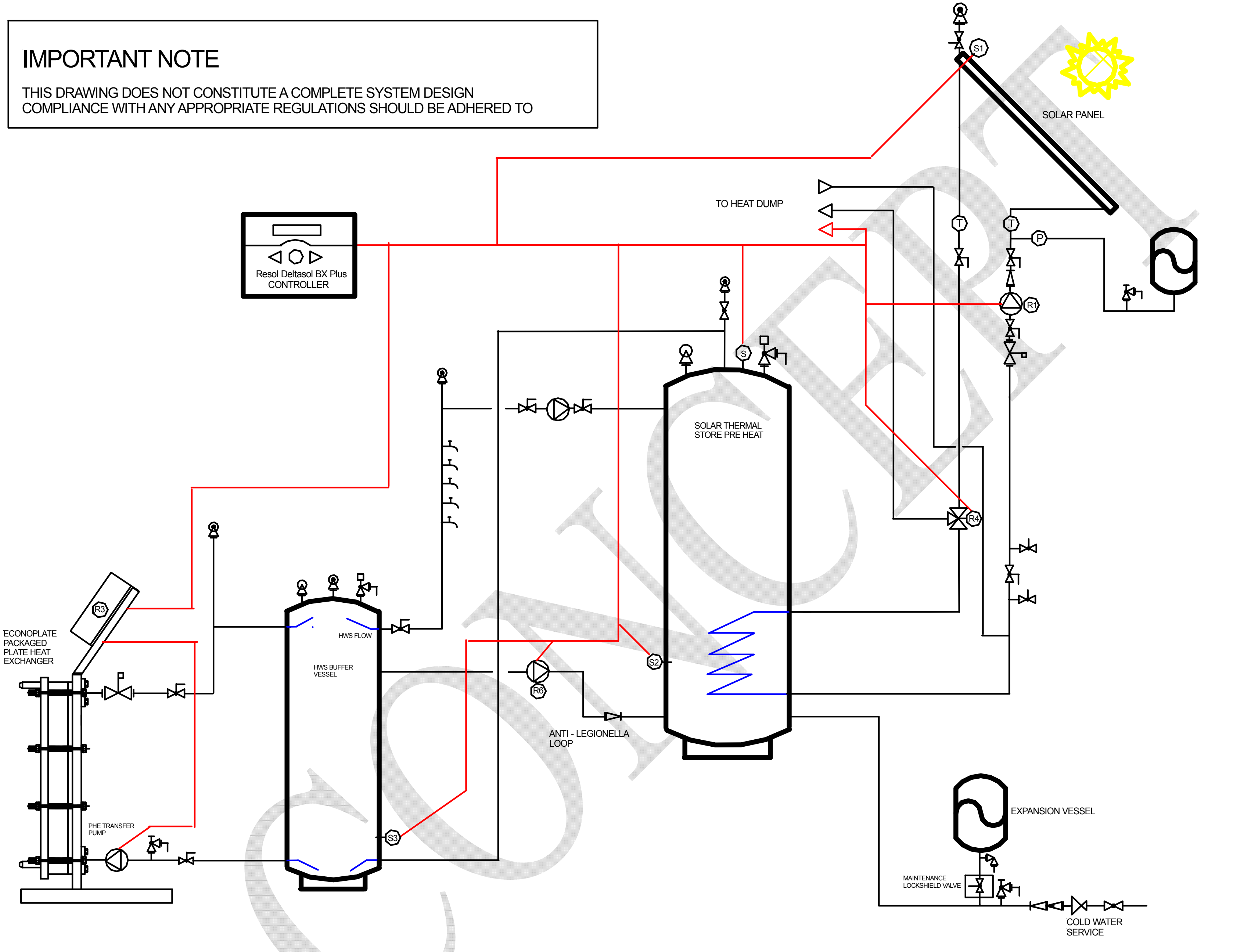

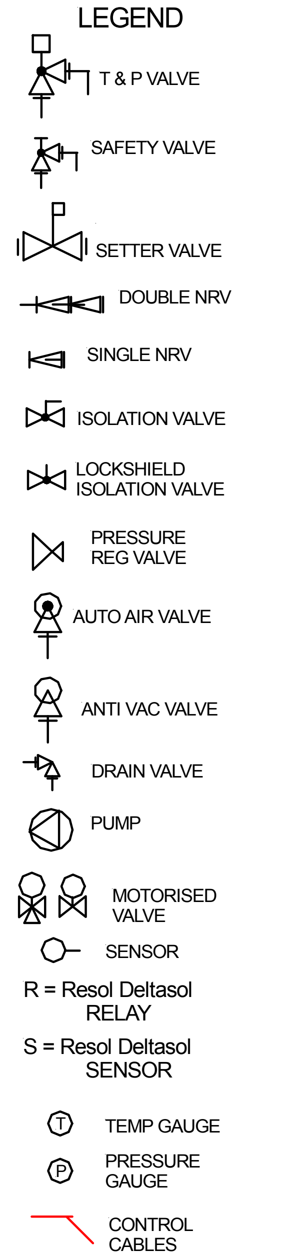

ISSUE	DATE	MODIFICATION

STOKVIS

Title

SCHEMATIC OF ECONOPLATE + BUFFER VESSEL WITH SOLAR PRE-HEAT

Drawn	R.S.
Date	APR 15
CAD ref	W-E-

Drawing No
SOLAR 1B.

STOKVIS ENERGY SYSTEMS, 96R WALTON ROAD, EAST MOLESEY, SURREY, KT8 0DL. Tel. 0208 783 3050

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

Here we are using a single coil solar preheat vessel to heat the cold water before it enters a buffer vessel which itself is heated by an Econoplate heat exchanger in lieu of an internal coil. The vessel must be sized to suit the number of solar panels being used. The Econoplate and Buffer vessel are sized for the full duty of the building. Also included are connections to a heat dump and an anti-legionella loop which may be requires to ensure safe and secure operation of the plant.
The Controller selected is a Resol Deltasol BX-plus.

Econoplate & Buffer Vessel:

The Econoplate and buffer vessel could be controlled by the DHW heating function, buffer vessel sensor (S3) and ensures that there is hot water readily available for immediate 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 required temperature, and if it is also less than the temperature of the solar panel sensor (S1), heat can be transferred. The solar controller will start the solar pump (R1) and solar fluid 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 the required temperature or the temperature measured by (S2) is greater than that measured by the solar panel sensor (S1).

Heat Dump:

Whilst the solar coil sensor (S1) remains greater than the collector maximum, the solar panel must supply the excess heat to a heat dump e.g. a fan coil unit or the heat may be used in a swimming pool heat exchanger. The solar controller using the Heat dump function will motor open the valve (R4) diverting fluid away from the solar coil to the heat dump. Once the heat dump valve (R4) reaches fully open, an end-switch, if present, on the valve can be utilised to close the enable circuit of the heat dump.

Heat transfer to the heat dump will occur until the solar coil sensor (S1) is less than the collector maximum in which case the solar controller will take power off the valve supplying the heat dump (R4) causing it to close. Once the heat dump valve (R4) starts to close, the end-switch, if present, on the valve will disable the heat dump.

Reverse Heat Exchange

Reverse heat exchange could possibly occur when the solar panel sensor (S1) is less than the solar coil sensor (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, when S1 is no longer greater than S2, 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.

Using the Thermal disinfection program and assuming that during a predetermined time the anti-legionella sensor (S2) (located at the bottom of the solar vessel) never reaches the required 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 Boiler plant operation and the Econoplate's enable (R3) times to ensure heat is available.

N.B. Relay (R*) and Sensor (S*) references are based on Resol DeltaSol BX plus. Actual relay and sensor numbers may vary due to pre-selection by the controller. The Econoplate requires an additional relay to allow 230V enable from the solar controller. Some 2/3 port valves are not spring closing and require a permanent live as well as a switched live to motor in both directions. An end-switch may not be a standard feature on all valves.

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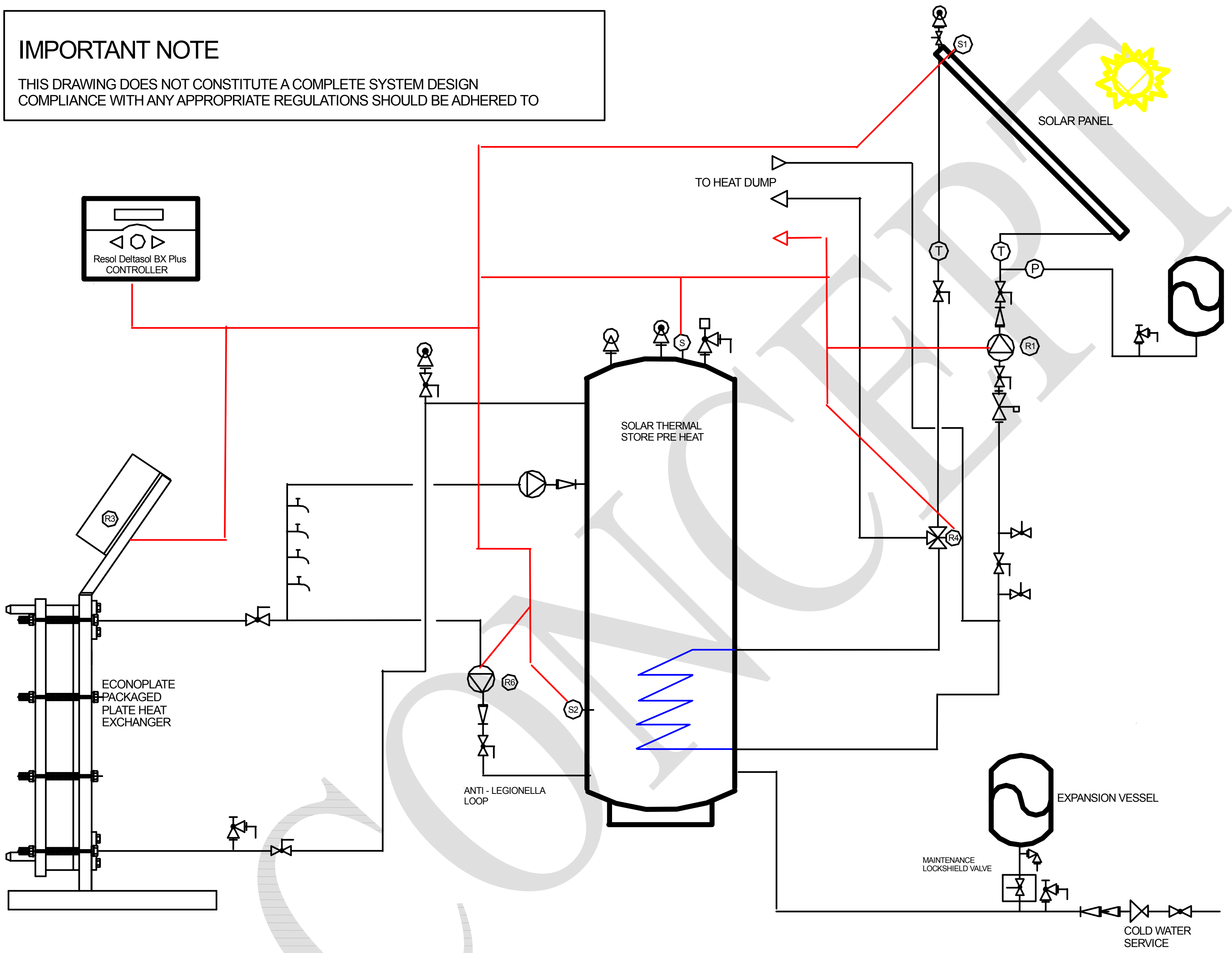

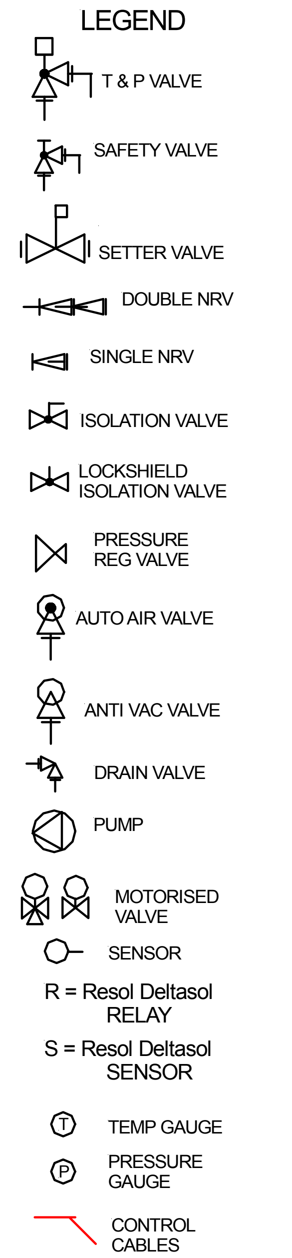

ISSUE	DATE	MODIFICATION

STOKVIS

Title

SCHEMATIC OF FULL DUTY ECONOPLATE WITH SOLAR PRE-HEAT

Drawn	R.S.
Date	APR 15
CAD ref	W-E-

Drawing No
SOLAR 2B

STOKVIS ENERGY SYSTEMS, 96R WALTON ROAD, EAST MOLESEY, SURREY, KT8 0DL. Tel. 0208 783 3050

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

Here we are using a single coil solar preheat vessel to heat the cold water before it enters an Econoplate Heat exchanger for final heating to the required temperature if higher. The vessel must be sized to suit the number of solar panels being used. The Econoplate is sized for the full instantaneous duty of the building. Also included are connections to a heat dump and an anti-legionella loop which may be requires to ensure safe and secure operation of the plant.
The Controller selected is a Resol Deltasol BX-plus.

Econoplate:

The Econoplate could be controlled by the DHW heating function but this is not essential. Sensor (S3) in the top of the preheat vessel will ensure that the Econoplate is enabled and there is hot water readily available for immediate draw-off. **On initial start-up** the sensor (S3) will be less than set-point. If programmed to do so, the solar controller will **enable** the Econoplate Econotrol 2100 (R3). When the sensor (S3) measures a temperature greater than set-point, the solar controller will **disable** the Econoplate Econotrol 2100 (R3).

Solar Vessel Pre-Heat:

The solar vessel is controlled by the solar coil sensor (S2). When the solar coil sensor (S2) is less than required temperature, and if it is also less than the temperature of the solar panel sensor (S1), heat can be transferred. The solar controller will start the solar pump (R1) and solar fluid 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 the required temperature or the temperature measured by (S2) is greater than that measured by the solar panel sensor (S1).

Heat Dump:

Whilst the solar coil sensor (S1) remains greater than the collector maximum, the solar panel must supply the excess heat to a heat dump e.g. a fan coil unit or the heat may be used in a swimming pool heat exchanger. The solar controller using the Heat dump function will motor open the valve (R4) diverting fluid away from the solar coil to the heat dump. Once the heat dump valve (R4) reaches fully open, an end-switch, if present, on the valve can be utilised to close the enable circuit of the heat dump.

Heat transfer to the heat dump will occur until the solar coil sensor (S1) is less than the collector maximum in which case the solar controller will take power off the valve supplying the heat dump (R4) causing it to close. Once the heat dump valve (R4) starts to close, the end-switch, if present, on the valve will disable the heat dump.

Reverse Heat Exchange

Reverse heat exchange could possibly occur when the solar panel sensor (S1) is less than the solar coil sensor (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, when S1 is no longer greater than S2, 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.

Using the Thermal disinfection program and assuming that during a predetermined time the anti-legionella sensor (S2) (located at the bottom of the solar vessel) never reaches the required 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 Boiler plant operation and the Econoplate’s enable (R3) times to ensure heat is available.

N.B. Relay (R*) and Sensor (S*) references are based on Resol DeltaSol BX plus. Actual relay and sensor numbers may vary due to pre-selection by the controller. The Econoplate requires an additional relay to allow 230V enable from the solar controller. Some 2/3 port valves are not spring closing and require a permanent live as well as a switched live to motor in both directions. An end-switch may not be a standard feature on all valves.

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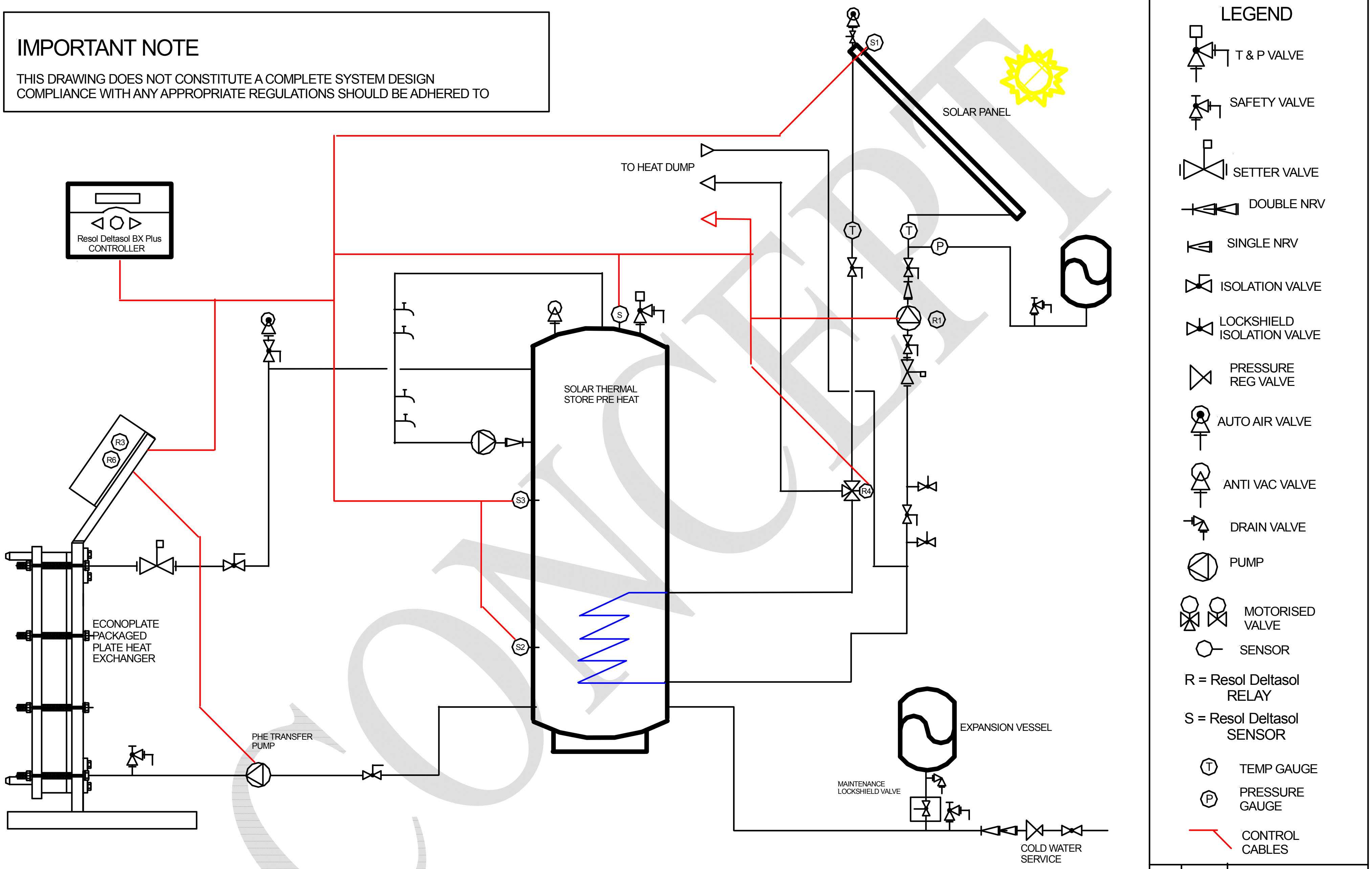

ISSUE	DATE	MODIFICATION

STOKVIS

Title

SCHEMATIC OF BACK UP ECONOPLATE WITH SOLAR PRE-HEAT

Drawn	R.S.
Date	APR 15
CAD ref	W-E-

Drawing No
SOLAR 3A

STOKVIS ENERGY SYSTEMS, 96R WALTON ROAD, EAST MOLESEY, SURREY, KT8 0DL. Tel. 0208 783 3050

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

Here we are using a single coil solar preheat vessel to heat the cold water and an Econoplate Heat exchanger as the backup heat source, rather like a twin coil vessel. The vessel must be sized such that the volume below S3 is suitable for the number of solar panels being used. The Econoplate ensures hot water is always available by heating the top half of the vessel when required. The Econoplate and the volume of the top half of the vessel are sized to meet the full duty of the building. Also included are connections to a heat dump and an anti-legionella loop which may be requires to ensure safe and secure operation of the plant.
The Controller selected is a Resol Deltasol BX-plus.

Econoplate:

The Econoplate can be controlled by the DHW heating function. Sensor (S3) in the top half of the vessel will ensure that the Econoplate is enabled and the top half of the vessel is hot and therefore hot water is readily available for immediate draw-off. **On initial start-up** the sensor (S3) will be less than set-point. If programmed to do so, the solar controller will **enable** the Econoplate Econotrol 2100 (R3) which will commence drawing cold water from the bottom of the vessel which it will heat up to the desired temperature and return back to the top of the vessel. When the sensor (S3) measures a temperature greater than set-point, the top half of the vessel will be full of hot water, the solar controller will **disable** the Econoplate Econotrol 2100 (R3).

Solar Vessel Pre-Heat:

The solar vessel is controlled by the solar coil sensor (S2). When the solar coil sensor (S2) is less than required temperature, and if it is also less than the temperature of the solar panel sensor (S1), heat can be transferred. The solar controller will start the solar pump (R1) and solar fluid 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 the required temperature or the temperature measured by (S2) is greater than that measured by the solar panel sensor (S1).

Heat Dump:

Whilst the solar coil sensor (S1) remains greater than the collector maximum, the solar panel must supply the excess heat to a heat dump e.g. a fan coil unit or the heat may be used in a swimming pool heat exchanger. The solar controller using the Heat dump function will motor open the valve (R4) diverting fluid away from the solar coil to the heat dump. Once the heat dump valve (R4) reaches fully open, an end-switch, if present, on the valve can be utilised to close the enable circuit of the heat dump.

Heat transfer to the heat dump will occur until the solar coil sensor (S1) is less than the collector maximum in which case the solar controller will take power off the valve supplying the heat dump (R4) causing it to close. Once the heat dump valve (R4) starts to close, the end-switch, if present, on the valve will disable the heat dump.

Reverse Heat Exchange

Reverse heat exchange could possibly occur when the solar panel sensor (S1) is less than the solar coil sensor (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, when S1 is no longer greater than S2, 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.

Using the Thermal disinfection program and assuming that during a predetermined time the anti-legionella sensor (S2) (located at the bottom of the solar vessel) never reaches the required set-point temperature, the solar controller will **start** the Econoplate (R6). The transfer pump will start and the whole 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 Econoplate (R6). The timing of this must coincide with the Boiler plant operation times to ensure heat is available.

N.B. Relay (R*) and Sensor (S*) references are based on Resol DeltaSol BX plus. Actual relay and sensor numbers may vary due to pre-selection by the controller. The Econoplate requires an additional relay to allow 230V enable from the solar controller. Some 2/3 port valves are not spring closing and require a permanent live as well as a switched live to motor in both directions. An end-switch may not be a standard feature on all valves.

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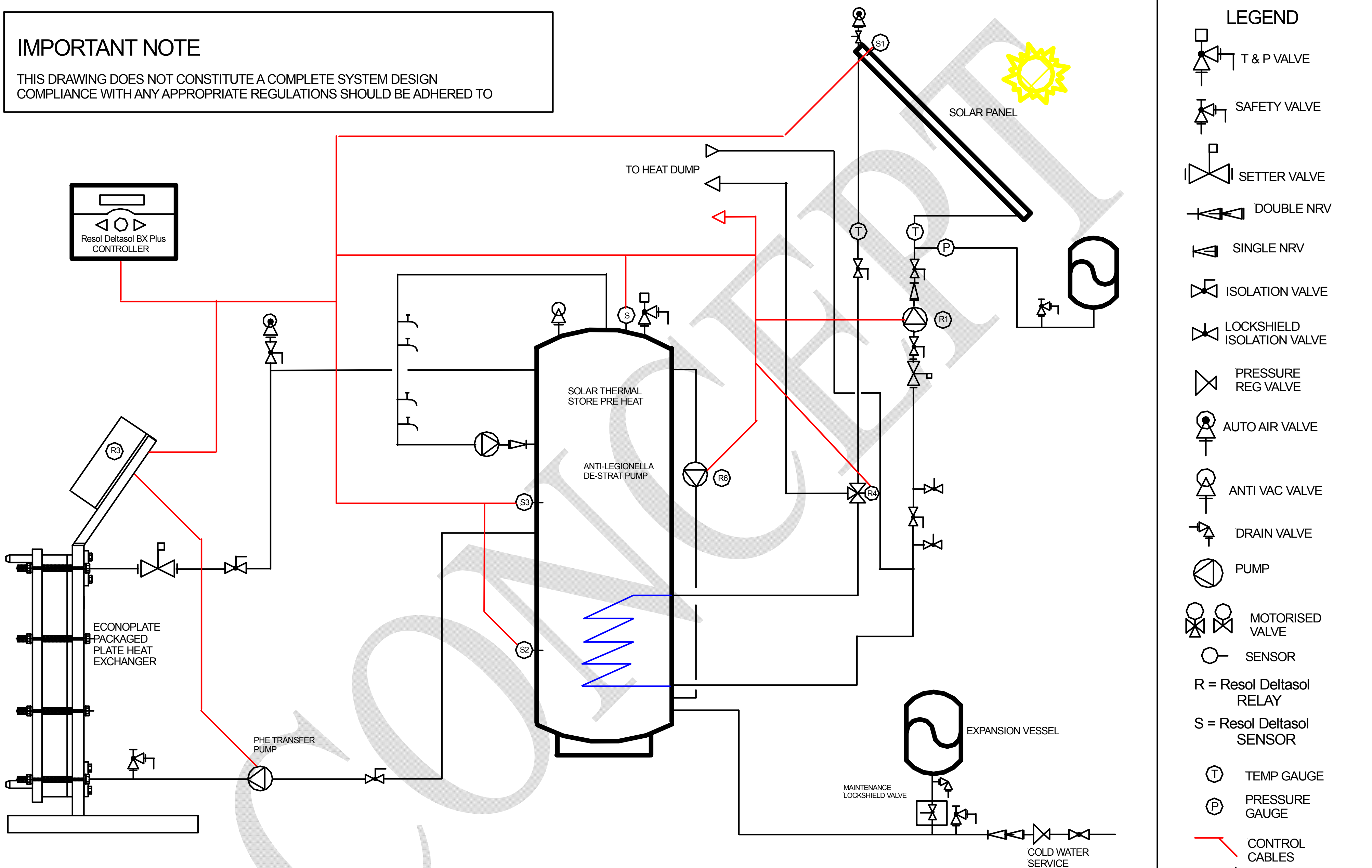

ISSUE	DATE	MODIFICATION

STOKVIS

Title

SCHEMATIC OF BACK UP ECONOPLATE WITH SOLAR PRE-HEAT

Drawn	R.S.
Date	APR 15
CAD ref	W-E-

Drawing No
SOLAR 4A

STOKVIS ENERGY SYSTEMS, 96R WALTON ROAD, EAST MOLESEY, SURREY, KT8 0DL. Tel. 0208 783 3050

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

Here we are using a single coil solar preheat vessel to heat the cold water and an Econoplate Heat exchanger as the backup heat source, rather like a twin coil vessel. The vessel must be sized such that the volume below S3 is suitable for the number of solar panels being used. The Econoplate ensures hot water is always available by heating the top half of the vessel when required. The Econoplate and the volume within the top half of the vessel are sized to meet the full duty of the building. Also included are connections to a heat dump and an anti-legionella loop which may be requires to ensure safe and secure operation of the plant.
The Controller selected is a Resol Deltasol BX-plus.

Econoplate:

The Econoplate can be controlled by the DHW heating function. Sensor (S3) in the top half of the vessel will ensure that the Econoplate is enabled and the top half of the vessel is hot and therefore hot water is readily available for immediate draw-off. **On initial start-up** the sensor (S3) will be less than set-point. If programmed to do so, the solar controller will **enable** the Econoplate Econotrol 2100 (R3) which will commence drawing cold water from themed point of the vessel which it will heat up to the desired temperature and return back to the top of the vessel. When the sensor (S3) measures a temperature greater than set-point, the top half of the vessel will be full of hot water, the solar controller will **disable** the Econoplate Econotrol 2100 (R3).

Solar Vessel Pre-Heat:

The solar vessel is controlled by the solar coil sensor (S2). When the solar coil sensor (S2) is less than required temperature, and if it is also less than the temperature of the solar panel sensor (S1), heat can be transferred. The solar controller will start the solar pump (R1) and solar fluid 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 the required temperature or the temperature measured by (S2) is greater than that measured by the solar panel sensor (S1).

Heat Dump:

Whilst the solar coil sensor (S1) remains greater than the collector maximum, the solar panel must supply the excess heat to a heat dump e.g. a fan coil unit or the heat may be used in a swimming pool heat exchanger. The solar controller using the Heat dump function will motor open the valve (R4) diverting fluid away from the solar coil to the heat dump. Once the heat dump valve (R4) reaches fully open, an end-switch, if present, on the valve can be utilised to close the enable circuit of the heat dump.

Heat transfer to the heat dump will occur until the solar coil sensor (S1) is less than the collector maximum in which case the solar controller will take power off the valve supplying the heat dump (R4) causing it to close. Once the heat dump valve (R4) starts to close, the end-switch, if present, on the valve will disable the heat dump.

Reverse Heat Exchange

Reverse heat exchange could possibly occur when the solar panel sensor (S1) is less than the solar coil sensor (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, when S1 is no longer greater than S2, 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.

Using the Thermal disinfection program and assuming that during a predetermined time the anti-legionella sensor (S2) (located at the bottom of the solar vessel) never reaches the required set-point temperature, the solar controller will **start** the anti-legionella de-stratification 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 Boiler plant operation and the Econoplate’s enable (R3) times to ensure heat is available.

N.B. Relay (R*) and Sensor (S*) references are based on Resol DeltaSol BX plus. Actual relay and sensor numbers may vary due to pre-selection by the controller. The Econoplate requires an additional relay to allow 230V enable from the solar controller. Some 2/3 port valves are not spring closing and require a permanent live as well as a switched live to motor in both directions. An end-switch may not be a standard feature on all valves.

General Notes on Performance and Cylinder 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 and Solar 2, 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.

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

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