WASTE WATER HEAT RECOVERY SYSTEMS

Technical Manual

For the:

POWER-PIPE® Waste Water Heat Recovery

Heat Exchanger for Single-Family and Multi-Family Residential Buildings

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Leave these instructions with the user for the Home User Pack

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1.0 Introduction

Waste water is one of the largest and most overlooked energy resources. For this reason waste water heat recovery (WWHR) represents potential energy savings in many building types including single residential, multi-unit residential, commercial and institutional as well as with industrial processes. Power-Pipe® WWHR systems harness the energy of warm waste water to heat cold mains water, delivering water heating cost savings cost-effectivly.

The Power-Pipe® WWHR unit is an energy efficient technology that is recognized internationally by a large number of organisations, including retailers, utilities and government authorities in the UK, France, Canada and the USA.

Although the Power-Pipe® Waste Water Heat Recovery System (WWHRS) technology has been tested and approved to the UK water regulations and is inherently simple and maintenance-free, there are a few important plumbing design and installation considerations. The successful operation of the Power-Pipe®, which serves as an Instantaneous Shower Heat Recovery Device in single and multi-unit residential buildings, depends upon the adherence to these instructions. Additionally, for new-build dwellings within the UK, recognition of the system's energy saving performance within the National Calculation Methodology (NCM) for the energy rating of dwellings, known as the Standard Assessment Procedure (SAP), requires compliance with these instructions in conjunction with a system design checklist. The Design and Installation Checklists and certificate of installation are available as one single docuement at: www.ncm-pcdb.org.uk/sap

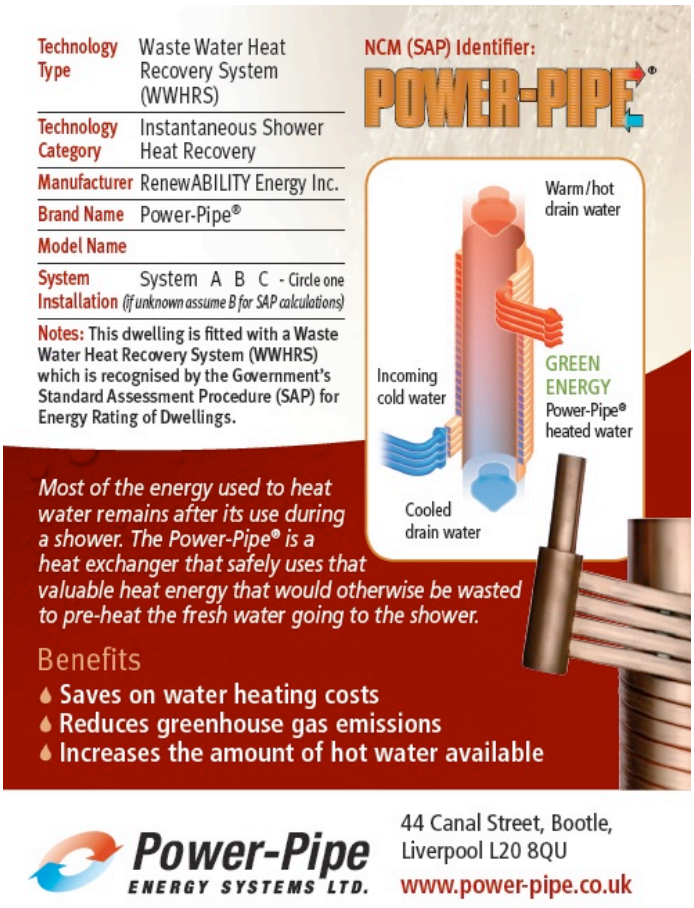
The unit must be installed in accordance with:

- The Building Regulations
- The Water Regulations (England and Wales), the Water Byelaws (Scotland) or the Water Supply Regualtions (Northern Ireland)
- Health and Safety at Work Act 1974
- Approved Code of Practive and Guidance L8 and HSG274 Part 2 (not applicable to privately owned homes)

This technical manual never takes preceidence over statutory obligations.

Power-Pipes® should be installed by a qualified plumber, with system design consideration being equally important to a correct installation. For recognition of the Power-Pipe® WWHRS within SAP, the Design and Installation Checklist (available at www.ncm-pcdb.org.uk/sap) must be used. Copies must be kept for the home user pack (homeowner), the installer, and mailed or emailed to Power-Pipe Energy Systems at the addresses noted on the front cover of this manual for both SAP recognition. Building Control Officers may also request a copy. If completed and signed copies of these documents are not sent to Power-Pipe Energy Systems the warranty may be invalid.

For the purposes of system identification for inclusion of product data within SAP, the Power-Pipe® will be supplied with a factory fixed NCM (SAP) Identifier label. The installer must circle which of the "Installation Systems" have been installed : 'System A, System B or System C'. If no system is installed then for SAP purposes it will be assumed that the Power-Pipe® has been installed in accordance with System B. A sample label is shown:



An identical second NCM (SAP) indetifier label is also supplierd and the installer is to fix this to a nearby service cupboard during instaltion. Again the installer must circle which of the "Installation Systems" have been installed : 'System A, System B or System C'. If no system is installed then for SAP purposes it will be assumed that the Power-Pipe® has been installed in accordance with System B.

2.0 Technology Description

The patented and patent pending Power-Pipe® design incorporates multiple copper coils wrapped in a helical fashion around an inner copper waste pipe. As warm to hot waste water flows down the inner waste pipe, its heat is readily transferred to incoming colder mains water which is flowing up through the coils. The key advantage to the Power-Pipe's design is that it imposes very low pressure losses while having very high efficiency.

The Power-Pipe's high heat transfer efficiency is due to the surface tension between the waste water and the inner wall of the waste pipe, causing the waste water to cling to the inner pipe wall. The waste water falls quickly down the inner wall in a thin, turbulent film. This phenomenon produces a very high heat transfer rate between the warmer waste water and the cooler waste pipe wall. The heat is then transferred to the coils that are wrapped around the waste pipe through which the cold water supply circulates (See Figure).

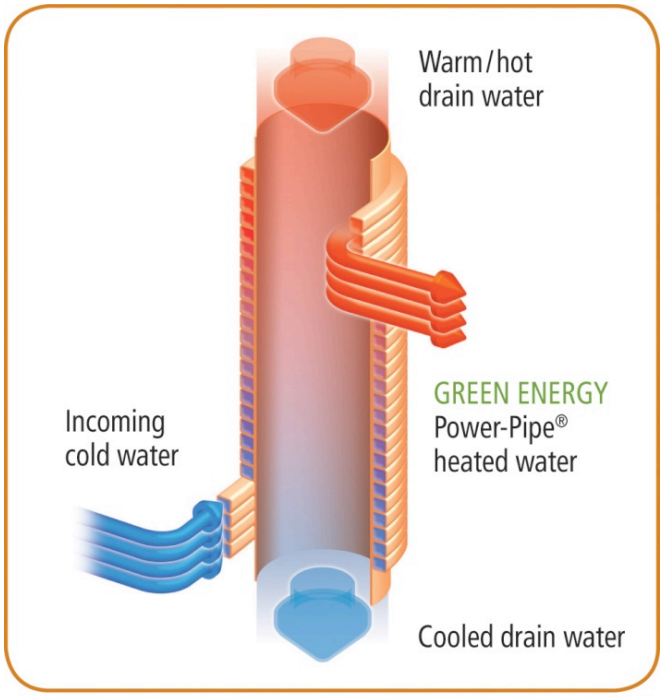


Figure 1 - Power-Pipe Heat Transfer

The result is that it takes up significantly less energy to heat water. Other benefits include a substantial increase in effective hot water capacity, extended life of the primary water heater and reduced greenhouse gas emissions. The Power-Pipe® WWHR system is a safe, cost-effective, reliable and maintenance-free energy saving solution.

The Power-Pipe ® WWHR system is primarily composed of:

-An inner section copper soil-stack (DWV) pipe, conforming to ASTM B306
-2, 4 or 6 coils wrapped in parallel, of Type L or Type K tube, conforming to ASTM B88

As there are no moving parts, the great benefit is zero maintenance and a very long system life of 50+ years.

3.0 Residential Application Overview

3.1 Dimensions for the different models of the Power-Pipe®

The size of a WWHR system must take into account the following parameters:

-The vertical height available in the waste pipe that is fed by the warm waste water source
-The nominal diameter of the waste stack
-The flow rate at the point of installation

Power-Pipe® models are available for equivalent standard waste pipe sizes of 50mm, 80mm, 110mm OD (2, 3 or 4 inch nominal). They are also available in different lengths ranging from 610mm to 3050mm in approximately 150mm increments.

Single-pipe Power-Pipe® WWHR units are also divided in three series. The R-series which is designed for residential applications, while the C-series is designed for multi-unit residential, commercial or industrial applications. The table below summarizes key differences between the three series. Please note that not all products are recognised in SAP.

	R-series	**C-series**
Nominal diameter available	50mm, 75mm, and 100mm (2, 3 and 4 inch)	80mm, 75mm and 150mm (3, 4 and 6 inch)
Mains water configuration	Coils consisting of 4 pipes in parallel	Coils consisting of 6 pipes in parallel
Equivalent mains water connection (mm)	22	28
Pressure loss at 9 lpm (kPa/m length of Power-Pipe®)	50mm: 4.9 75mm: 8.4 100mm: 8.6	75mm: 2.7 100mm: 1.9
Efficiency for a 2050mm length Power-Pipe®	50mm: 56.5% 75mm: 61.5% 100mm: 67.0%	75mm: 56.3% 100mm: 63.1%
Maximum mains water flow rate* (lpm)	19	30

*The Power-Pipe® R and C-series designs allows for the highest efficiency with very low pressure loss on the mains waterside of the unit. However, very high flow could induce noticeable pressure loss. For this reason these Power-Pipes® has been designed to limit pressure loss to 0.55bar under the maximum reasonable flow rates in single residential and multi-residential buildings. Where pressure loss is less of an issue the E-series gives improved performance. Please note that 1 bar = 100kPa.

3.2 Residential Applications

The implementation of the Power-Pipe® WWHR system can be done in any residential building so long as there is at least 530mm of vertical soil stack in which to install a unit. Simultaneous flow is necessary on both sides of the Power-Pipe® if it is to effectively recover heat; that is, there must be flow through the coils during the discharge of the warm waste-water down the Power-Pipe®.

It should be noted that there are many commercial and industrial applications where there may or may not be simultaneous flow and there may or may not be falling waste water, so there are many ways to adapt Power-Pipe® systems for different applications. For example, if the simultaneous flow does not exist naturally, it can be created by implementing a system consisting of pre-heated water storage and/or re-circulating pumps, often for a reasonable incremental cost.

3.3 Residential plumbing water configurations for the Power-Pipe®

This section provides for an overview of the different plumbing options for the Power-Pipe® for residential installations.

NOTE: The hot water source should be set to at least 60^{O}C for any hot water system.

A-1. Equal flow System A configuration (Option 1 – Hot Water supply up to shower mixing valve) – Highest Energy Savings & Recognized by SAP - *preferred method*

In the "Equal Flow" configuration, also known as 'System A', all of the preheated water from the Power-Pipe® should be plumbed up to the thermostatic mixing valve of the shower within the length of a tee fitting, which then branches to feed both the cold side of the shower and the inlet of the water heater (see Figure to the right). By doing this the pre-heated water will not be in stagnation conditions, even when the shower is not in operation for an extended period of time. In reality, when the shower is not used the Power-Pipe® would not pre-heat the mains water.

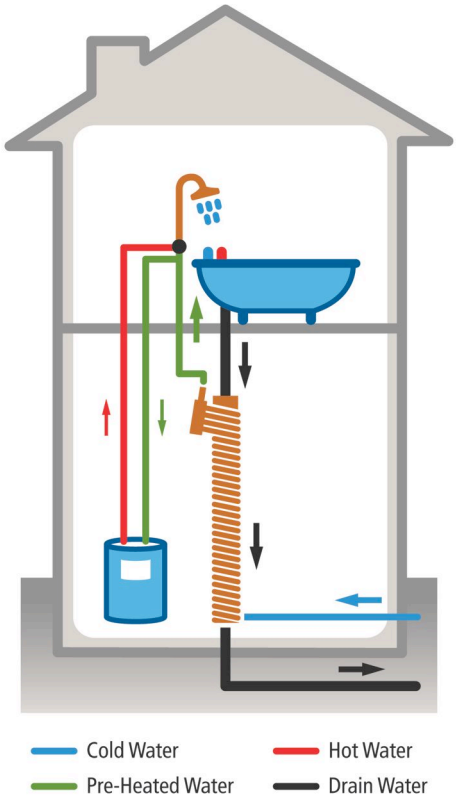


Figure 2 - Equal Flow System A - Option 1

In the case of two or more showers in the home sharing the same Power-Pipe®' there should still be a tee junction return to the water heater at each showerhead; these return lines would then come together again at any position before the water heater. Drawings are available upon request.

In this configuration (A-1) and the next configuration (A-2), both the hot water and cooler water that ultimately passes through the showerhead have been pre-heated by the Power-Pipe®. The reason that this configuration provides the highest energy savings is that it maximises the "carrying capacity" of the mains water flowing through the Power-Pipe®'s coils. In other words the cold mains water has the greatest ability to extract heat from the waste water because it is at the highest flow rate. The thermostatic shower mixing valve that is also required as part of SAP will also draw less hot water and will adjust itself automatically in order to achieve the same comfortable shower water temperature.

A-2. Equal flow System A configuration (Option 2 – Venturi Tee Assembly) – Also Highest Energy Savings & Recognized by SAP

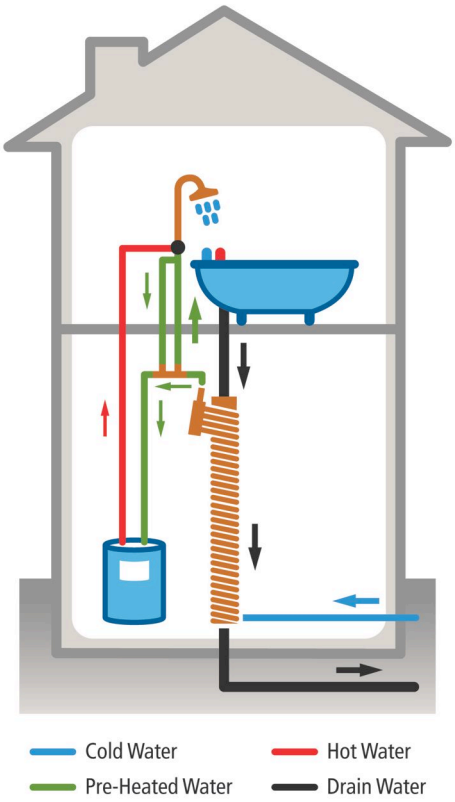


Figure 3 - Equal Flow System A - Option 2

In the "Equal Flow" configuration, also known as 'System A', under Option 2 the preheated water from the Power-Pipe® must flow through a Venturi Tee Assembly (see examples below), which then feeds thermostatic mixing valve of the shower as well as the inlet of the water heater (see Figure to the left). By doing this the pre-heated water line will also not be in stagnation conditions, even when the shower is not in operation for an extended period of time. In reality, when the shower is not used the Power-Pipe® would not pre-heat the mains water.

For this option, some possible examples of acceptable Venturi Tee Assembly configurations are shown in the figures below. One of these examples, or an accepted alternative may be used. This option may be preferred if it can result in a smaller line size to the water heater or in homes with two or more showers because only one return line is needed, which is from the furthest shower mixing valve. Drawings are available upon request.

NOTE FOR BOTH SYSTEM A OPTIONS: In some cases the "equal flow" configuration (System A) is not possible, consideration can then be used to using System B or C. An example of this is where there is a need for mulitple Power-Pipes® in a dwelling, where it will be necessary to plumb the other Power-Pipes in accordance with System B in order to comply with the SAP checklist.

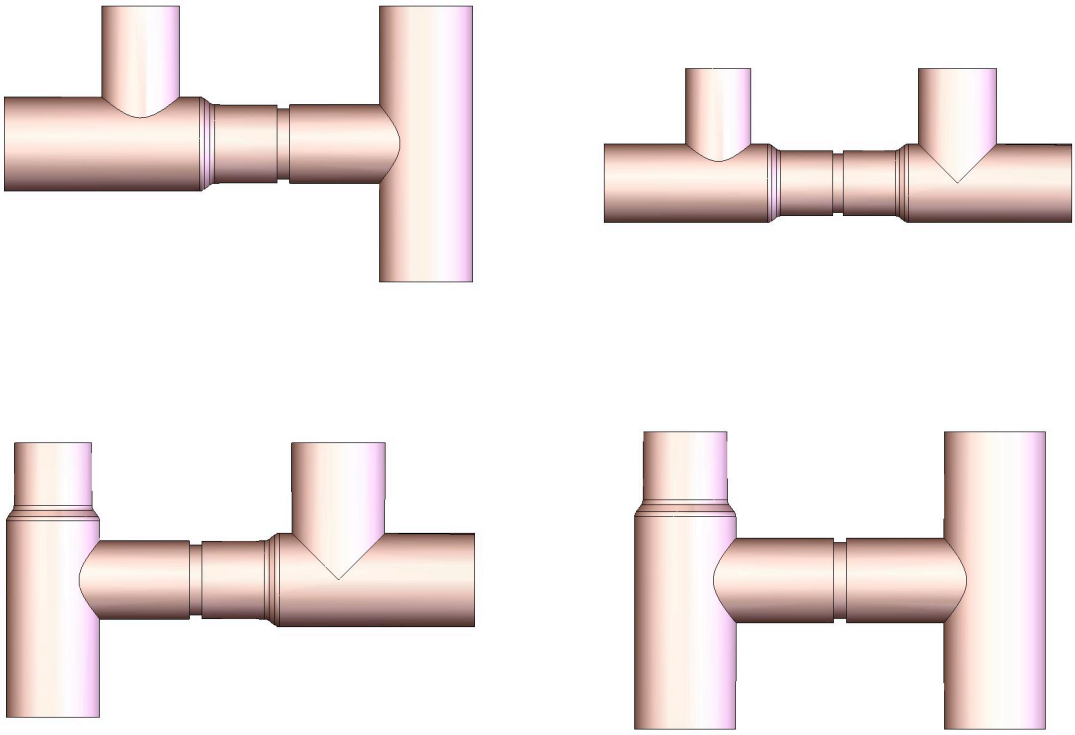
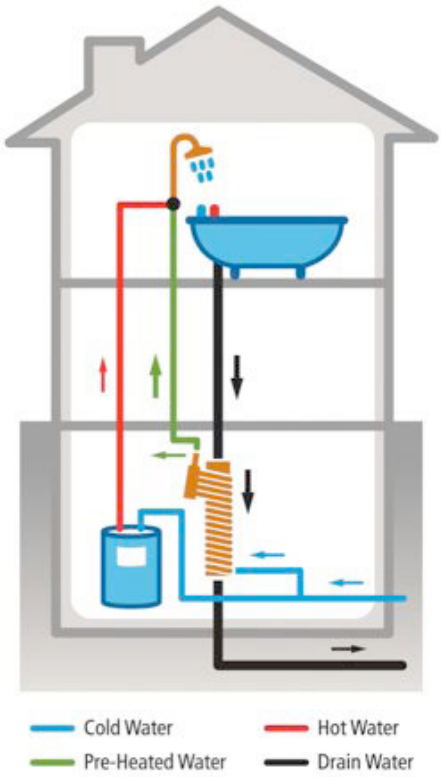


Figure 4 - Venturi Tee Assembly Samples for System A - Option 2

B. System B - Shower Cold Water feed only – Recognised by SAP

In some cases where the “equal flow” configuration is not possible, it may be necessary to connect the pipe run preheated by the Power-Pipe to just the shower (see figure), however, this results in reduced heat recovery performance.



In the “Shower Cold Water feed only” (CW only) configuration, known as ‘System B’; only the pipe run supplying the cold side of the showers thermostaic valve is preheated by the Power-Pipe® unit. This connection method is used mainly when the plumbing system of a home does not allow for the “equal flow” configuration.

An example of this is where there are multiple Power-Pipes® in the same system. To comply with the SAP Design and Installation Checklist only one of these can be System A or System C (see next section), the others must be System B.

C. System C - Hot water only (Power-Pipes® are not recognised for this in SAP)

In some cases where the “equal flow” configuration is not possible, it may be necessary to connect the pipe run preheated by the Power-Pipe to just the water heating system, however, product performance for that configuration is not recognised within SAP.

In the “Hot water only” (HW only) configuration, known as ‘System C’; only the pipe run supplying the domestic water heating system is preheated by the Power-Pipe® WWHR unit (see Figure on the right). This connection method is used mainly when the plumbing system of a home does not allow for the “equal flow” configuration.

The “HW only” configuration typically has a heat recovery efficiency that is about 75% of that obtained in the same conditions with the “equal flow” configuration.

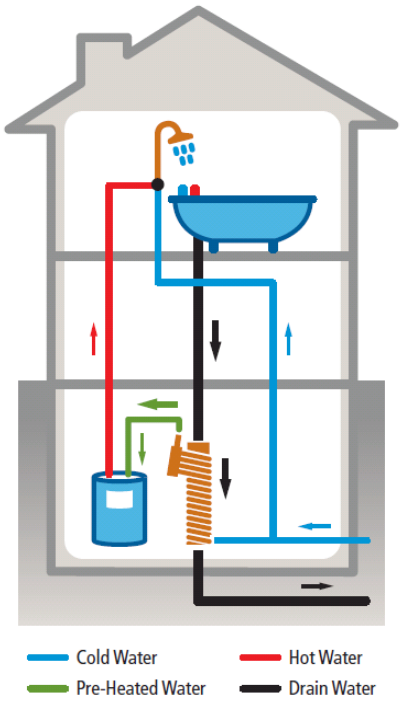


Figure 5 - Unequal Flow - System C

4.0 Implementation

4.1 Site evaluation

4.1.1 Vertical Orientation

A Power-Pipe® WWHR unit must be installed in a VERTICAL orientation. If the waste pipe is not vertical, additional plumbing based upon on-site conditions and/or special connectors will be necessary to provide a vertical orientation that deviates no more than 20mm from vertical.

4.1.2 Clearance Requirement

A Power-Pipe® WWHR unit and the drain connectors require approximately 10mm clearance between the waste pipe and any adjacent structure or wall. If the clearance is less than 10mm the Power-Pipe® may not fit. Rerouting of the waste pipe may be necessary.

4.1.3 Waste pipe Support

If installing a Power-Pipe® WWHR unit into a cast iron or copper waste pipe system, install structural supports for the waste pipe above where the Power-Pipe® is to be installed, and below if necessary. Cutting an unsupported cast iron or copper waste pipe may damage the drain system. It is recommended that all waste pipe types be supported near the ceiling level of the room in which the Power-Pipe® is to be installed.

4.1.4 Condensate pipes

Condensate pipes from boilers should never be allowed to discharge above a Power-Pipe. The condensate is acidic and if allowed to travel down the pipe will shorten its lifespan.

4.1.5 Legionella Health and Safety Concerns

The Power-Pipe® WWHR unit is constructed from copper. Copper suppresses the colonization and growth of micro-organisms, such as Legionella pnumophila.

Even so, a Power-Pipe® WWHR system should not be installed in an environment where the ambient temperature is naturally above 25°C to minimise the risk of legionella growth.

The Health and Safety Executive has issued guidance for dutyholders on the control of legionella bacteria in hot and cold water systems; HSG374 Part 2. The areas of particular relevance to systems where Power-Pipes are installed are:

1. Section 2.36: Cold Water Systems (relevant to System A and C installations):

- All pipe branches to individual outlets should be capable of delivering cold water at a temperature that is as close to the incoming water temperature within two minutes of running.
- The volume of stored cold water should be minimised and should not normally exceed that required for one day's water use although in healthcare premises, a nominal 12 hours total onsite storage capacity is recommended.
- There should be a regular water flow throughout the system and all outlets

- Water fittings should only be chosen where they are compliant with The Water Supply (Water Fittings) Regulations 1999 and Scottish Water Byelaws 2004. In the case of non-metallic materials, this will also include conformity with BS 6920. The best method to ensure compliance is to select products from the Water Regulations Advisory Scheme Water Fittings and Materials Directory.

2. Section 2.37: Hot Water Systems (relevant for System A and B installations)

- Maintains a supply temperature of at least 60^{O}C from the heat source and/or storage vessel (calorifier)

If the system is left to stand for 3 days or more without being used (for example if the dwelling is unoccupied) , the system should be flushed to drain, slowly, to avoid an aerosol spray. This can be achieved by turning on a hot water tap slowly, so as not to create splashing in the sink, the tap should be allowed to run for, say 3 minutes to allow enough fresh water to be introduced unto the system. This should be done for any domestic system left for any period, whether a Power-Pipe® system is present or not.

4.1.6 WRAS installation requirement

An 'Approved' single check valve or some other no less effective backflow prevention device providing backflow prevention protection to at least fluid category two shall be fitted at the point of connection(s) between the water supply and the fitting or appliance. Such a valve is required in all unvented systems, whether a Power-Pipe® system is present or not, and is not an additional item.

4.1.7 Other Points to Consider for Recognition in SAP

- Has consideration been given to domestic hot water delivery performance (water pressure and flow rate)?
- Is the dwelling domestic hot water system a mains pressure system?
- Does the water heater accept inlet water at temperatures up to 30°C?
- Is the length of drainpipe between shower and Power-Pipe® WWHRS less than 3 meters as far as practicable?
- Will there be access to the Power-Pipe® after installation?
- In accordance with Approved Document – Part H (2002) of the Building Regulations and the installation manual, the installation has implemented an appropriate method for preventing the ingress of foul sewer gases as a result of the WWHRS installation?
- Do installation drawings indicate the requirement to label pipe work between the WWHRS preheated water outlet and water heater and shower cold-water inlet(s) to prevent the future connection of any other service points, such as taps?
- Do installation drawings indicate the requirement to insulate pipe work between the WWHRS preheated water outlet and the water heater and shower cold-water inlet(s) in accordance with the specification for DHW primary circulation pipes defined in 'Domestic Building Services Compliance Guide - 2010 Edition'?
- If shut-off valves are specified for Power-Pipe® inlet and/or outlet, are they 'full flow' (non-restricting) shut-off valves?

4.1.8 SAP Design Checklist

In order for the Power-Pipe® WWHRS have its performance recognized within the Standard Assessment Procedure calculation, ensure that the design-stage checklist is completed. Note: Power-Pipe® products are listed within SAP under the Technology Category: Instantaneous Shower Heat Recovery Devices, which is within the Technology Type: Waste Water Heat Recovery Systems.

4.1 Power-Pipe® WWHR model selection guide

The determination of the model size of a Power-Pipe® required for the project is primarily dependent on two factors.

First, the nominal diameter of the waste pipe and Power-Pipe® ***must be the same***. Typical residential waste pipes are 2, 3, or 4 inch in diameter (50mm, 75mm, 100mm). SAP recognizes 63 Power-Pipe® models.

The second factor is the length. It is critical to measure your available ***vertical length*** of continuous waste pipe. The Power-Pipe® size that is recommended would be this length less 75mm and round down to the closest model. The longest Power-Pipe unit that can fit is always recommended. For example, a 1500mm long Power-Pipe® requires a minimum 1575mm section of waste pipe for proper installation and connection. The Power-Pipe® is also available in shorter and longer lengths in 6" increments (48", 54", 66", 72", etc.).

Nomenclature (model code) for Power-Pipe WWHR units is “YB-ZZ”, where:

-“Y” is the selected the model series (“R” for R-series or “C” for C-series)
-“B” is the diameter of the waste pipe (inches)
-“ZZ” is the length of the Power-Pipe ® that can fit (inches)

4.2 Installation

Please Note:

- Only qualified persons should perform a Power-Pipe® installation.
- A Power-Pipe® must be installed in a VERTICAL orientation with a deviation of less than 20mm from vertical.
- A Power-Pipe® must be the same nominal size as the waste pipe to which it is connecting.
- A Power-Pipe® may be installed on any level where there is access to a sufficiently long section of vertical waste pipe that carries waste-water.
- If the mains water connections are not plumbed correctly, performance and energy savings will be substantially lower. Plumbing the Power-Pipe® WWHR unit for counter-flow operation (waste water flowing down, mains water flowing up) is critical for maximum performance. INCOMING mains water must be connected to the BOTTOM Power-Pipe® manifold.
- If using PEX mains water tube to connect to the Power-Pipe® and connecting into an existing copper mains water line, it may be necessary to “bond” the pipe, i.e. re-establish grounding across the pre-existing copper line.
- If the cold water lines in the home are to be insulated, then it is recommended to also insulate at least the bottom section of the Power-Pipe® (at least up to 1m from the bottom of the Power-Pipe unit). A “Spiral Wrap” type of insulation is often the simplest to install.

- Insulate mains water lines to and from the Power-Pipe® as desired to minimise heat loss and/or eliminate condensation.
- Ensure that all modifications are completed according to Part H of the Building Regulations
- After installation all domestic water pipework should be flushed and cleaned.

Note: In new construction, it is recommended that the Power-Pipe® is not installed until the house is secured.

4.2.6 Power-Pipe® Installation Instructions for New Residential Construction

1. When laying out the plumbing for the home, it is imperative that the inlet to the water heater and the cold supply to the shower(s) be in close proximity to one another as these two branches must be fed by the pre-heated water from the Power-Pipe® WWHR system.
2. When laying out soil stacks in the home, if possible connect waste-water from all bathrooms together to one vertical pipe.
3. In an effort to reduce the chance of Power-Pipe® theft, it is recommended to first install the soil stack as usual and then cut a section of the stack when the building has been secured (that section of soil stack can be reused elsewhere). This is outlined in steps 4-6 below. Otherwise the Power-Pipe® can be installed at the same time that the soil stack is installed by simply including the Power-Pipe® in the soil stack. If this is the case, proceed to step 7.
4. On the vertical soil stack (must be less than 20mm from vertical), measure and mark 1.5" (38mm) up from the bottom of the waste pipe. This will be the BOTTOM CUT.
5. Starting from the BOTTOM CUT, measure up and mark the length of the Power-Pipe®. This will be the TOP CUT.
6. At the BOTTOM CUT and TOP CUT markings cut and remove the waste pipe section.
7. De-burr waste pipe openings.
8. Remove the steel bands, and wet the inside of the rubber “hubless” coupling (e.g. Fernco Proflex™).
9. Slide the large side of one of the hubless couplings onto the TOP CUT section of waste pipe.
10. Slide the small side of the other coupling over the bottom end of the Power-Pipe.
11. Push the Power-Pipe® up into the top hubless coupling.
12. Move the bottom hubless coupling down onto the BOTTOM CUT section of the waste pipe until the middle section of the coupling is up against the waste pipe, which is approximately 1.25” (32mm) from the end).
13. Loosen the steel bands and put them back onto the ProFlex™ couplings. Tighten all connections.
14. Connect the INCOMING cold-water to the BOTTOM Power-Pipe coil manifold.
15. Connect the TOP Power-Pipe® coil header to supply the water heater and the cold side of the shower according to System A (Options 1 or 2) as explained in section 3.3 – Only ‘System A’ configurations are recognized within SAP calculations.
16. Label this supply line from the Power-Pipe® to the rest of the home to ensure that no future take-off points are inserted into this line.
17. Check and tighten all connections.
18. If using PEX mains water tube to connect to the Power-Pipe and connecting into an existing copper mains water line, it may be necessary to “bond” the mains water piping, i.e. re-establish grounding across the pre-existing copper line.
19. Complete the installation checklist and certificate for the Standard Assessment Procedure Waste Water Heat Recovery Systems Standard Instantaneous Shower Heat Recovery Devices.

Power-Pipe® Installation Instructions for Retrofit Residential Applications

1. Determine which vertical soil stack (must be less than 20mm from vertical) is fed by the primary shower(s).
2. Measure and mark 1.5" (38mm) up from the bottom of the waste pipe. This will be the BOTTOM CUT.
3. Starting from the BOTTOM CUT, measure up and mark the length of the Power-Pipe®. This will be the TOP CUT.
4. At the BOTTOM CUT and TOP CUT markings cut and remove the waste pipe section.
5. De-burr waste pipe openings.
6. Remove the steel bands, and wet the inside of the rubber “hubless” (e.g. Fernco Proflex™).
7. Slide the large side of one of the hubless couplings onto the TOP CUT section of waste pipe.
8. Slide the small side of the other coupling over the bottom end of the Power-Pipe.
9. Push the Power-Pipe® up into the top hubless coupling.
10. Move the bottom hubless coupling down onto the BOTTOM CUT section of the waste pipe until the middle section of the coupling is up against the waste pipe, which is approximately 1.25” (32mm) from the end).
11. Loosen the steel bands and put them back onto the ProFlex™ couplings. Tighten all connections.
12. Connect the INCOMING cold water to the BOTTOM Power-Pipe® coil header.
13. Connect the TOP Power-Pipe® coil header to supply the water heater and the cold side of the shower according to System A (Options 1 or 2) as explained in section 3.3 – Only ‘System A’ configurations are recognized within SAP calculations.
14. Label this supply line from the Power-Pipe® to the rest of the home to ensure that no future take-off points are inserted into this line.
15. Check and tighten all connections.
16. If using PEX mains water tube to connect to the Power-Pipe® and connecting into an existing copper mains water line, it may be necessary to “bond” the pipe, i.e. re-establish grounding across the pre-existing copper line.
17. Complete the installation checklist and certificate for the Standard Assessment Procedure Waste Water Heat Recovery Systems Standard Instantaneous Shower Heat Recovery Devices

If you have any questions with regards to this installation, please contact Power-Pipe Energy Systems Ltd.

5 Power-Pipe WWHR performance testing summary

5.1 R-Series summary at standard test conditions of 9.0 L/min flow rate, 8°C mains water inlet temperature, and 36°C waste water inlet temperature

Model	Nominal Diameter (m / in)	Length (m / ft)	Effectiveness (%)	Pressure Loss (kPa / PSI)	Heat Recovery (kW / BTU/hr)
R2-12	0.05 / 2	0.30 / 1.0	9.4	1.16 / 0.17	1.68 / 5749.2
R2-18	0.05 / 2	0.46 / 1.5	14.9	2.27 / 0.33	2.55 / 8711.9
R2-24	0.05 / 2	0.61 / 2.0	21.8	3.07 / 0.44	3.86 / 13176.6
R2-30	0.05 / 2	0.76 / 2.5	28.9	3.97 / 0.58	5.23 / 17866.2
R2-36	0.05 / 2	0.91 / 3.0	32.6	4.27 / 0.62	5.72 / 19518.1
R2-42	0.05 / 2	1.07 / 3.5	37.7	5.41 / 0.78	6.59 / 22502.9
R2-48	0.05 / 2	1.22 / 4.0	37.8	6.00 / 0.87	6.54 / 22332.1
R2-54	0.05 / 2	1.37 / 4.5	42.1	8.02 / 1.16	7.40 / 25276.5
R2-60	0.05 / 2	1.52 / 5.0	47.4	7.40 / 1.07	7.77 / 26536.4
R2-66	0.05 / 2	1.68 / 5.5	48.9	9.08 / 1.32	8.59 / 29348.2
R2-72	0.05 / 2	1.83 / 6.0	53.8	10.44 / 1.51	9.41 / 32121.5
R2-84	0.05 / 2	2.13 / 7.0	56.5	9.60 / 1.39	9.89 / 33762.2
R2-96	0.05 / 2	2.44 / 8.0	61.3	12.24 / 1.78	10.67 / 36438.2
R2-108	0.05 / 2	2.74 / 9.0	63.7	14.10 / 2.05	10.63 / 36312.7
R2-120	0.05 / 2	3.05 / 10.0	64.4	14.39 / 2.09	10.81 / 36905.1
R3-12	0.08 / 3	0.30 / 1.0	7.2	1.85 / 0.27	1.22 / 4174.9
R3-18	0.08 / 3	0.46 / 1.5	19.0	3.11 / 0.45	3.35 / 11450.3
R3-24	0.08 / 3	0.61 / 2.0	27.9	4.97 / 0.72	4.71 / 16072.6
R3-30	0.08 / 3	0.76 / 2.5	33.6	6.03 / 0.87	5.79 / 19768.2
R3-36	0.08 / 3	0.91 / 3.0	38.7	6.98 / 1.01	6.79 / 23197.8
R3-42	0.08 / 3	1.07 / 3.5	43.1	7.43 / 1.08	7.50 / 25614.3
R3-48	0.08 / 3	1.22 / 4.0	48.1	9.91 / 1.44	8.31 / 28370.5
R3-54	0.08 / 3	1.37 / 4.5	50.0	11.15 / 1.62	8.71 / 29745.3
R3-60	0.08 / 3	1.52 / 5.0	54.6	11.77 / 1.71	9.46 / 32312.9
R3-66	0.08 / 3	1.68 / 5.5	55.9	13.25 / 1.92	9.71 / 33173.2
R3-72	0.08 / 3	1.83 / 6.0	59.4	15.19 / 2.20	10.33 / 35264.7
R3-84	0.08 / 3	2.13 / 7.0	61.5	15.56 / 2.26	10.61 / 36227.2
R3-96	0.08 / 3	2.44 / 8.0	66.4	18.10 / 2.63	11.55 / 39458.2
R3-108	0.08 / 3	2.74 / 9.0	67.9	20.29 / 2.94	11.92 / 40701.2
R3-120	0.08 / 3	3.05 / 10.0	67.8	25.41 / 3.69	12.06 / 41197.7
R4-12	0.10 / 4	0.30 / 1.0	7.1	1.34 / 0.19	1.22 / 4182.6
R4-18	0.10 / 4	0.46 / 1.5	21.7	2.25 / 0.33	3.81 / 13018.8
R4-24	0.10 / 4	0.61 / 2.0	32.0	6.46 / 0.94	5.64 / 19254.3
R4-30	0.10 / 4	0.76 / 2.5	41.3	6.21 / 0.90	7.09 / 24205.6
R4-36	0.10 / 4	0.91 / 3.0	43.0	8.08 / 1.17	7.58 / 25870.1
R4-42	0.10 / 4	1.07 / 3.5	46.6	6.96 / 1.01	8.12 / 27719.3
R4-48	0.10 / 4	1.22 / 4.0	53.5	10.30 / 1.49	9.31 / 31795.3
R4-54	0.10 / 4	1.37 / 4.5	55.8	11.96 / 1.73	9.57 / 32671.7
R4-60	0.10 / 4	1.52 / 5.0	59.1	12.68 / 1.84	10.31 / 35195.2
R4-66	0.10 / 4	1.68 / 5.5	60.5	14.91 / 2.16	10.55 / 36030.5
R4-72	0.10 / 4	1.83 / 6.0	63.5	15.50 / 2.25	11.07 / 37812,9
R4-84	0.10 / 4	2.13 / 7.0	67.0	15.17 / 2.20	11.50 / 39275.6
R4-96	0.10 / 4	2.44 / 8.0	69.0	17.54 / 2.54	12.30 / 41999.6
R4-108	0.10 / 4	2.74 / 9.0	69.6	20.90 / 3.03	12.12 / 41403.4
R4-120	0.10 / 4	3.05 / 10.0	72.4	25.30 / 3.67	12.76 / 43572.3

5.2 C-series summary at standard test conditions of 9.0 L/min flow rate, 8°C mains water inlet temperature, and 36°C waste water inlet temperature

Model	Nominal Diameter (m / in)	Length (m / ft)	Effectiveness (%)	Pressure Loss (kPa / PSI)	Heat Recovery (kW / BTU/hr)
C3-30	0.08 / 3	0.76 / 2.5	24.5	1.12 / 0.16	4.40 / 15020.3
C3-36	0.08 / 3	0.91 / 3.0	31.3	2.07 / 0.30	5.41 / 18481.9
C3-48	0.08 / 3	1.22 / 4.0	41.6	2.57 / 0.37	7.33 / 25047.1
C3-60	0.08 / 3	1.52 / 5.0	46.9	3.14 / 0.46	8.28 / 28262.2
C3-72	0.08 / 3	1.83 / 6.0	48.7	3.07 / 0.45	8.60 / 29373.8
C3-84	0.08 / 3	2.13 / 7.0	56.3	4.19 / 0.61	9.72 / 33257.1
C3-96	0.08 / 3	2.44 / 8.0	60.7	4.70 / 0.68	10.52 / 35911.3
C3-108	0.08 / 3	2.74 / 9.0	62.9	5.46 / 0.79	11.13 / 38022.2
C3-120	0.08 / 3	3.05 / 10.0	66.4	5.88 / 0.85	11.57 / 39523.6
C4-30	0.10 / 4	0.76 / 2.5	28.2	1.60 / 0.23	4.95 / 16888.1
C4-36	0.10 / 4	0.91 / 3.0	34.8	2.68 / 0.39	6.12 / 20905.8
C4-42	0.10 / 4	1.07 / 3.5	40.8	2.78 / 0.40	7.11 / 24291.1
C4-48	0.10 / 4	1.22 / 4.0	43.5	3.57 / 0.52	7.51 / 25661.6
C4-54	0.10 / 4	1.37 / 4.5	47.9	3.41 / 0.49	8.32 / 28408.6
C4-60	0.10 / 4	1.52 / 5.0	50.4	4.18 / 0.61	8.83 / 30139.0
C4-66	0.10 / 4	1.68 / 5.5	52.6	4.51 / 0.65	9.12 / 31159.9
C4-72	0.10 / 4	1.83 / 6.0	57.1	5.24 / 0.76	9.98 / 34075.7
C4-78	0.10 / 4	1.98 / 6.5	59.1	5.47 / 0.79	10.12 / 34075.7
C4-84	0.10 / 4	2.13 / 7.0	63.1	5.61 / 0.81	10.89 / 37194.0
C4-90	0.10 / 4	2.29 / 7.5	60.5	6.12 / 0.89	10.70 / 36546.1
C4-96	0.10 / 4	2.44 / 8.0	65.8	6.40 / 0.93	11.35 / 38753.1
C4-108	0.10 / 4	2.74 / 9.0	68.9	7.00 / 1.02	12.01 / 41001.1
C4-120	0.10 / 4	3.05 / 10.0	70.8	7.85 / 1.14	11.94 / 40760.9

6 Integration into plans and specifications

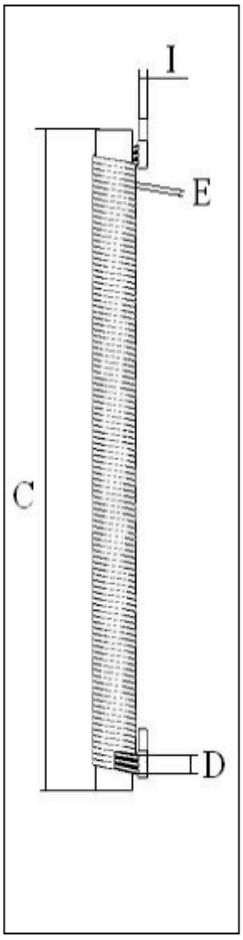
To facilitate the integration of the Power-Pipe® into plans and specifications, here's a description that could be used, complete with the specific model or system chosen:

> Waste Water Heat Recovery, vertical orientation, inlet and outlet for domestic water with a diameter of “A” inches. Power-Pipe ® model YB-ZZ with “B” inch diameter waste pipe connections, “ZZ" inches long, made of 4x 3/8 inch type L copper tubes (or 6x 3/8 inch type L copper tubes) wrapped around an inner copper soil pipe with a diameter of “B” inches, and a nominal effectiveness of XX% at 9.2LPM. WRAS listed.

In addition, an example of shop drawing is provided below. It should be noted that RenewABILITY Energy Inc. can provide shop drawings or specifications needed for integration into projects.

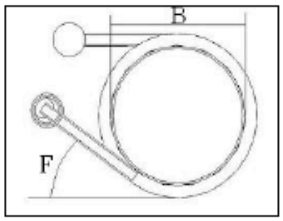
Effectiveness data for the Power-Pipe WWHR units can be found in the Performance Testing reports that were independently create. Summary tables from these reports can be found in sections 5.1 & 5.2 of this document.

Power-Pipe Specification Sheet for R2-84(UK) AND R4-84(UK)



Profile View of Unit

Power-Pipe Full Model Numbering System														
Model Number	A	B	-	C	-	D	T	E	L	F	-	G	H	I	L
R2-84 (for UK)	R	2	-	84	-	4	T	3	L	10	-	U	U	6	L
R4-84 (for UK)	R	4	-	84	-	4	T	3	K	10	-	U	U	6	L



Plan View of Unit

Nomenclature	
A	Application: Commercial / Residential (C/R)
B	Nominal Pipe Diameter [inches]
C	Drainage Pipe Length [inches]
D	# of tubes
E	Coil - Nominal Size - See List
F	% Wrap
G	Inlet Stubbie Orientation (U/D/B - Up/Down/Both)
H	Outlet Stubbie Orientation (U/D/B - Up/Down/Both)
I	Stubbie - Nominal Size - See List

Fresh Water Connection and Coil Sizes		
Code (E, J, I)	Nominal Size (inches)	UK Size*
2	1/4	N/A
3	3/8	N/A
4	1/2	15mm
6	3/4	22mm
8	1	28mm

*NOTE: For the UK the Stubbie is UK Size Copper Tube to ensure an easy fit for plumbers

Spec Sheet Provided by:
Ryan Brueckner Date: 101025 yymmdd

Approved by
Gerald Van Decker Date: 101028 yymmdd

NOTE:
For 4" units the minimum wall cavity width is: 4.75" or 121mm
For 3" units the minimum wall cavity width is: 3.75" or 95mm
For 2" units the minimum wall cavity width is: 2.75" or 70mm