P A HILTON LTD

EXPERIMENTAL OPERATING

AND

MAINTENANCE MANUAL

HILTON HEAT EXCHANGER SERVICE MODULE
H100

H100M/E/1/001
MAR 00

POLICY STATEMENT

After Sales Service

We, P.A. Hilton Ltd., attach considerable importance in being able to retain the confidence and goodwill of our clients in offering an effective after sales service. Every effort is made to answer clients correspondence promptly and to provide a rapid follow up of spares and replacement parts by maintaining comprehensive stocks of components usually available ex-stock.

Should our clients encounter any difficulty in operating or maintaining a Hilton product we would ask that as a first step they contact the Hilton representative in their country or, in the absence of a local representative, write direct to P.A. Hilton Ltd.

In the extreme case a problem may arise in the operation of equipment which could seriously disrupt a teaching or research schedule. In such circumstances rapid advice from the manufacturers is desirable and we wish our clients to know that Hiltons' will accept from them a transfer charge telephone call from anywhere in the world.

We ask our clients to treat this service as an emergency service only and to use it sparingly and wisely. Please do be aware of the time differences that may exist and, before making a telephone call, make notes of the problem you wish to describe. English is a preferred language. Our telephone number is "Romsey (01794) 388382" and the telephone is normally manned between 0800 and 1700 hrs GMT every day. Advance notice of an impending telephone call by Fax would be appreciated.

Each product manufactured by P.A. Hilton Ltd., is tested under operating conditions in our permanent installations before despatch. Visitors to Horsebridge Mill are encouraged to operate and evaluate our equipment with initial guidance from a Hilton engineer.

CE

EDUCATION AND TRAINING EQUIPMENT

Declaration of Conformity:

Directives (where applicable) **89/392/CEE as amended by 91/368/EEC**
89/336/CEE
72/23/CEE

We declare that the following unit complies with the above EEC directives:

H100 Heat Exchanger Service Module
and Optional Extras

The use of the apparatus outside the classroom, laboratory, study area or similar such place invalidates conformity with the protection requirements of the Electromagnetic Compatibility Directive (89/336/EEC) and could lead to local prosecution.

For and on behalf of
P.A. HILTON LIMITED

Technical Director

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INTRODUCTION

The transfer of heat from one medium to another is an essential process in almost all industrial and commercial processes. From heavy engineering such as power generation and oil refineries, to small domestic heating systems; heat exchangers carry out an important process that should be understood by all engineers.

Heat exchangers can take many forms. However several common aspects are shared between the various designs. In order to maximise the heat transfer rate or reduce the volume of the heat exchanger, artificially increasing the turbulence of the two fluid streams is beneficial. This can be achieved by a combination of increasing the stream velocity and having flow diverters or baffles that cause rapid changes in flow direction.

Increasing the effective surface area of contact between the two streams will also increase the heat transfer rate. If this can be achieved by the use of corrugations or fins that do not result in an increase in volume then this will result in a more efficient design.

In industrial applications design for ease of maintenance is also important. Fouling of the heat transfer surfaces due to deposits from the heat transfer media will result in reductions in efficiency with time. If this cannot be easily removed then replacement of the heat exchanger is a costly solution.

The Hilton Heat Exchanger Service Module H100 and its four optional heat exchangers have been purpose designed to both visually and practically demonstrate heat exchangers in action.
The four optional heat exchangers are:

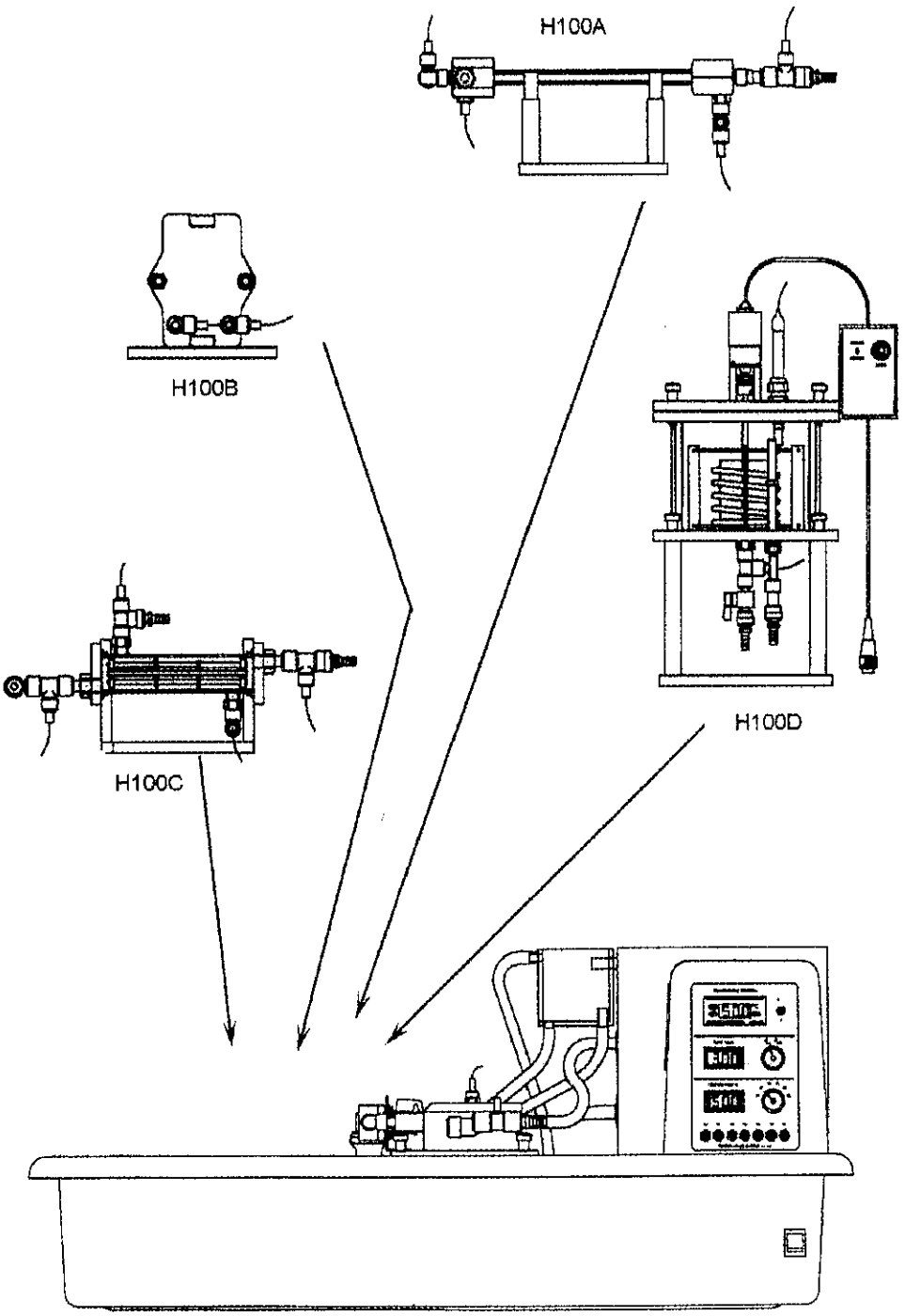
Concentric Tube Heat Exchanger H100A
Plate Heat Exchanger H100B
Shell and Tube Heat Exchanger H100C
Jacketed Vessel H100D

The heat exchangers are where possible fabricated in clear materials so that the heat transfer surfaces and general design can be studied by the students. Surfaces involved in heat transfer however use metal components as plastics introduce a non-representative thermal resistance.

Instrumentation is provided that allows basic evaluation of the factors that control the heat transfer processes occurring in each heat exchanger.

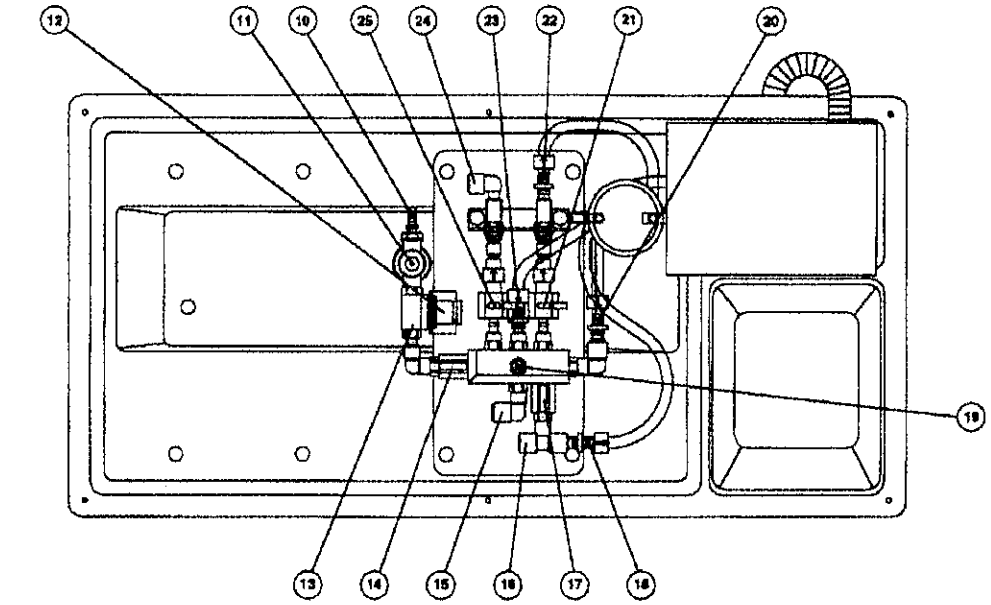
An optional Computer Interface HC100 complete with menu driven software allows the demonstration and evaluation procedure to be undertaken rapidly and often with greater understanding than by conventional means.

Figure 1



HEAT EXCHANGER SERVICE MODULE H100

Figure 2



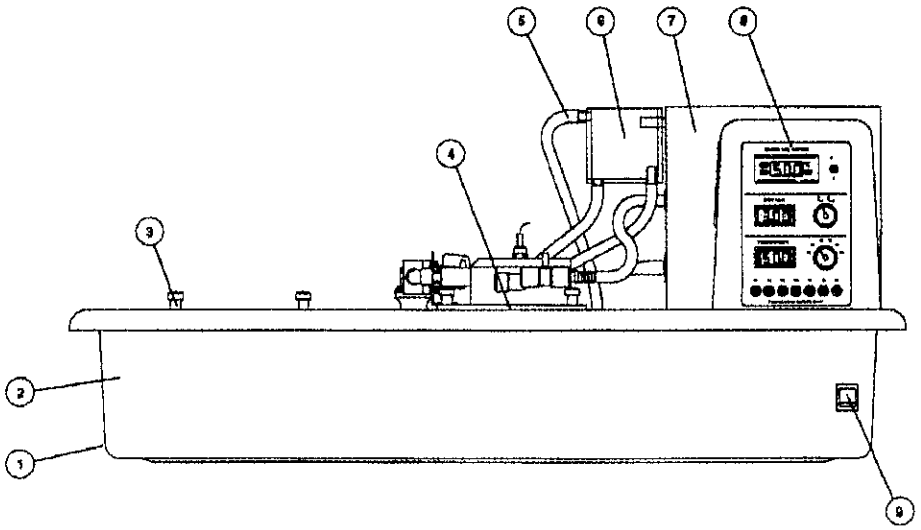
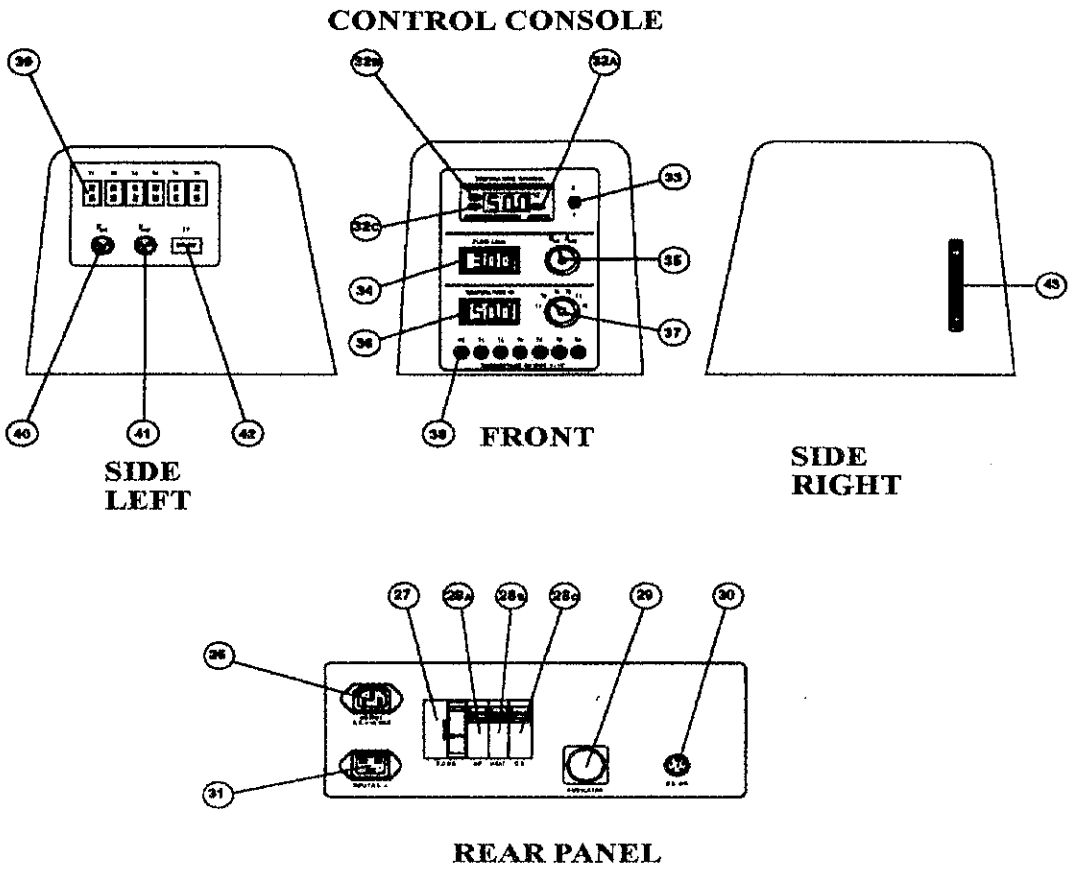


Figure 3



INSTALLATION AND COMMISSIONING
HILTON HEAT EXCHANGER SERVICE MODULE H100

Schematic Diagrams

To assist in identifying all of the components there are many schematic diagrams referenced in this manual. Each relevant component on the diagrams is numbered and in order to simplify identification of the numbered items the Figure number is placed in the text alongside the reference. For example in Figure 2 on page 3 the instrumentation console 8 will be referenced as **1(8)**. The Figure number being denoted by 2( ) and the item by **8**. This convention will be followed throughout the manual.

Remove the unit from its packing case and carefully examine it for damage. If any is found, notify the insurers immediately. Note that the optional heat exchangers are packed in separate cardboard boxes.

Refer to the schematic diagram Figure 1 on page 2 to assist in identifying the optional heat exchangers that have been ordered.

Check the Heat Exchanger Service Module H100 against the PACKING LIST supplied and ensure that all of the components are identified. Refer to the schematic diagrams **Figure 1 on page 2, Figure 2 on page 3, and Figure 3 on page 4.**

Pipe Push Fittings

The fittings used to connect the heat exchangers to the hot and cold water supply points on the valve plate **2(4)** are all of a similar type. The grey tube pushes easily into the light coloured sockets to make the connection. Leakage is prevented by rubber O rings inside each socket and these are the resistance that is felt when inserting the tubes into the sockets.

The tubes once inserted are restrained by small stainless steel teeth on the loose small grey rings on each socket. If an attempt is made to simply pull the tube from the socket these teeth will be forced into the tube and should prevent removal. It is recommended that a socket e.g. **2(24) or 2(15)** is closely examined before inserting the tube to understand this operation.

In order to remove the tube from a socket it is essential to push the loose grey ring into the socket while at the same time pulling the tube out of the socket. Failure to do this will result in damage to the tube and/or the socket.

The unit is shipped with the hot water circulator/heater **2(7)** packed separately to minimise the possibility of transit damage. The circulator/heater **2(7)** connects to its controlled power supply via a flexible conduit and multi pin plug and socket **3(29)** at the rear of the unit. The clear plastic priming vessel **2(6)** should be visible at the left hand side of the control console **2(8)** as shown in the side view of Figure 2 on page 3 when correctly positioned.

Connect the four flexible hoses between the circulator/heater **2(7)**, the priming vessel **2(6)** and the couplings on the valve plate **2(4)** as follows:

Flexible tube fitted to the right hand connection on the manifold block **2(20)** to the metal stub pipe on the left hand side of the circulator/heater **2(7).**
Flexible tube leaving the left hand side of the circulator/heater to the front hot water connection **2(18)** of the manifold block.
Flexible tube fitted to the base of the clear plastic priming vessel (tapping with no stub pipe inside the vessel) **2(6)** to the connection at the rear of the manifold block **2(23).**
Flexible tube fitted to the rear connection **2(22)** of the base plate to the tapping on the base of the clear plastic priming vessel **2(6)** (TAPPING WITH STUB INSIDE THE VESSEL).

All of the above connections are semi-permanent unless the unit is to be stripped for long term storage or shipping to another location. Therefore ensure that all of the above tubes are secured using the clips supplied.

The bottom drain connection on the left hand side of the circulator/heater has no connection to it under normal operating conditions.

220/240V Units

The unit requires connection to a **220/240V 50/60Hz single phase supply capable of supplying up to 10 Amps.** Check that the voltage and frequency of the locally available electrical supply correspond to the label on the rear of the unit.

The power supply cable should be plugged into the matching socket **3(31)** at the rear of the unit. Before connecting the power supply lead to the local supply ensure that the main switch **2(9)** at the front of the unit ,the three circuit breakers **3(28a), 3(28b), 3(28c) and the RCCB 3(27)** at the rear of the unit are all switched OFF(down).

The free end of the power supply cable should be connected to a suitable fixed power supply that complies with the local regulations. The cable colour code is as follows:

BROWN	LIVE or LINE
BLUE	NEUTRAL
GREEN/YELLOW	EARTH or ground

Note that for safe operation the green/yellow cable should be connected to a low impedance earthing point that complies with the local regulations.

Do not turn on the main switch or any of the circuit breakers until the following installation and commissioning stages have been completed.

110/120V Units

The unit requires connection to a **220/240V 50/60Hz single phase supply capable of supplying up to 20 Amps.** Check that the voltage and frequency of the locally available electrical supply correspond to the label on the rear of the unit.

The power supply cable should be plugged into the matching socket **3(31)** at the rear of the unit. Before connecting the power supply lead to the local supply ensure that the main switch **2(9)** at the front of the unit, the three circuit breakers **3(28a), 3(28b), 3(28c) and the RCCB 3(27)** at the rear of the unit are all switched OFF (down) .

The free end of the power supply cable should be connected to a suitable fixed power supply that complies with the local regulations. The cable colour code is as follows:

BROWN	LIVE or LINE
BLUE	NEUTRAL
GREEN/YELLOW	EARTH or ground

Note that for safe operation the green/yellow cable should be connected to a low impedance earthing point that complies with the local regulations.

Do not turn on the main switch or any of the circuit breakers until the following installation and commissioning stages have been completed.

Cooling Water Supply

Before connecting the water supply to the unit ensure that the cold water pressure regulator **2(13)** is adjusted to its minimum supply pressure as follows.

Locate the adjusting knob **2(12)** pull this away from the valve until it clicks and then turn the knob **fully anti-clockwise.** This reduces the pressure allowed into the unit to the minimum possible.

The unit requires connection to a source of clean cold water with a minimum flow rate of 3 litres/minute at 15m head.

Connect the supply to the cold water inlet point **2(10)** using the diagonal reinforced tubing supplied.

Cooling Water Drain

Each of the optional heat exchangers that may be used in conjunction with the service unit has a flexible drain tube that should be directed to a suitable drain at low level. Note that the tube should flow in a downward direction to the drain without loops to avoid air locks and flooding. A long drain tube is supplied with an adaptor that may be connected to the short stub drain on each heat exchanger as it is used.

The sump drain valve **2(1)** at the left hand side of the unit may be connected to a suitable drain and the valve left open. In this way any water that drops into the sump when the heat exchangers are changed is automatically collected and removed.

Alternatively if a permanent drain is not available the valve may be closed as the sump is of sufficient capacity to contain the entire contents of the circulator/heater.

The Hot Water Circuit

It will be necessary to fill the hot water circuit and adjust the cold water pressure reducing valve for maximum flow condition once the required heat exchanger has been fitted in position on the four mounting studs **2(3)** on the Service Module H100.

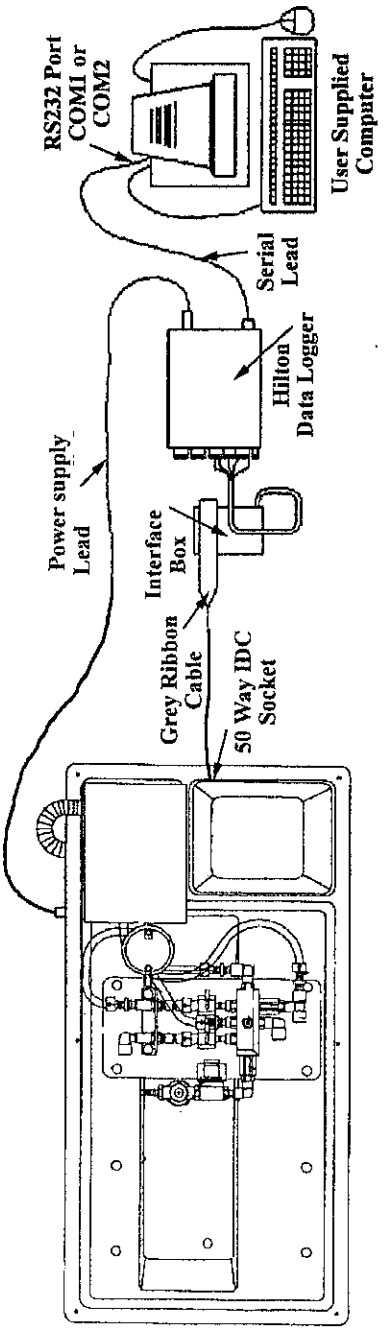
As each of the heat exchangers has different connection requirements these and the hot water filling procedure is dealt with in the OPERATING PROCEDURE on page 16 and in the separate sections dealing with each heat exchanger.

INSTALLATION AND COMMISSIONING
OPTIONAL COMPUTER INTERFACE HC100

Hardware Installation

The optional Computer Interface HC100 consists of a Hilton data logger and link cable with interface plus software. Refer to Figure 4.

Figure 4.



It will be necessary to have the user-supplied computer adjacent to the Heat Exchanger Service Unit H100 in order to allow convenient connection and operation.

The Hilton data logger connects to the user supplied computer using the serial cable provided. Note that the serial cable has a single 9 way D **socket** at one end and three, interconnected 9 way D **plugs** at the other. Connect any one of the D **plugs** to the corresponding socket on the rear of the Hilton data logger.

Connect the other end of the serial lead to either (RS232) COM1 or COM2 of the user-supplied computer. Note that though most modern computers use the 9 way standard D connectors for serial interfacing some have 25 way D connector ports. A 9 to 25 way adapter is supplied if required.

Note that if the COM port to be used had been connected to a mouse or other device be sure to disable the software that was being used for this purpose before installing the HC100 operating software.

The Hilton data logger and the interface sit adjacent to the Heat Exchanger Service Unit H100. Long cables allow flexibility depending upon the available space.

The grey ribbon cable from the interface box connects to the 50 way IDC socket **3(43)** on the side of the control console. Note that the plug and socket have raised lines and slots that are intended to prevent the plug being inserted in the wrong way. **Do not use excessive force to insert the plug. Check that it is in the correct way up.**

The Hilton data logger is supplied with power from the power output **3(26)** at the rear of the Heat Exchanger Service Unit H100. The lead links supplied between the power output **3(26)** and the power input at the rear of the Hilton data logger is supplied.

This completes installation of the optional Computer Interface HC100 hardware.

Software Installation

The software for operation of the optional Computer Interface HC100 is supplied on a number of 3½" floppy discs or a CD. The software supplied contains procedures for operation of all of the four optional heat exchangers.

The software operates in Windows 95 or 98.

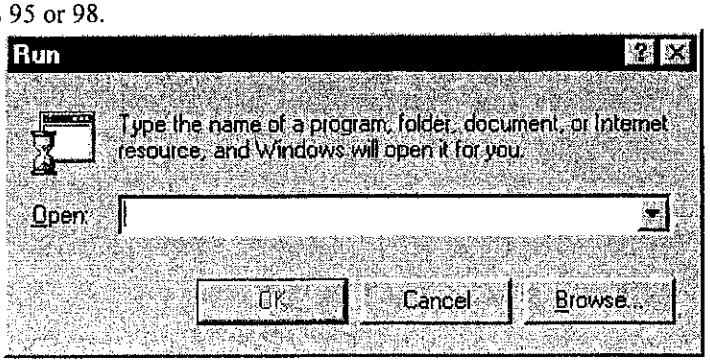


Figure 5

Insert disc 1 into the floppy disc drive or the CD in the CD drive and select the Start and Run option.

Using the Browse option select the floppy drive or CD drive, the disc (disc 1 if floppy discs) and select **Setup.exe** Then click OK.

The installation software contains instructions which should be followed to complete the procedure.

Note that the default file location patch should always be used.

Running the Software for the First Time

If running the Windows 95 or Windows 98 operating systems it is necessary to run the programmes dcom98.exe and Mdac_typ.exe, which are also on the disc(s) provided in a separate folder.

Insert the last disc provided into the floppy disc drive (or the CD into the CD drive) and select the Start, Run option as before. Browse to locate the dcom98.exe file on the disc and then click OK. The software will automatically load.

Repeat the procedure for the Mdac_typ.exe file.

Note that if operating Windows 2000 or Windows NT it is not necessary to run dcom98.exe or Mdac_typ.exe.

Click the Start button, then Programs, then P A Hilton **H100**. The start screen will appear.

The first screen shows the optional languages. If these have been ordered then clicking on the desired language button will convert the subsequent screens to text in that language. The default language is English.

Once the language has been selected and the copyright notice accepted the main menu appears. This allows the user to record data from any of the four optional heat exchangers assuming that they have been ordered.

The software is self explanatory and easy to use. However where relevant prompts are contained in this manual to indicate procedures that should be followed to assist the user in obtaining data easily and simply. These prompts appear in *italics* and are headed **If the Optional HC100 is In Use.**

It is of course necessary to ensure that the correct software option is run with the appropriate heat exchanger hardware.

SPECIFICATION

Heat Exchanger Service Unit H100

The Heat Exchanger Service Unit H100 is a bench top unit designed to accommodate four optional heat exchangers:

Concentric Tube Heat Exchanger H100A
Plate Heat Exchanger H100B
Shell and Tube Heat Exchanger H100C
Jacketed Vessel H100D

Base Unit

The base unit is formed in robust ABS plastic, contains the main power input point and power conditioning for the supported optional items. The base unit also contains or supports the following components:

Water Circulator/Heater

An immersion heater with 2x 1kW electric elements, a circulating pump, internal high temperature cut out and clear plastic header tank. The heater is controlled by a digital PID control to maintain constant temperature. The water circulator/heater is coupled electrically to the base unit

Valve plate

A white plastic plate onto which are mounted the cold water inlet pressure regulator, the hot and cold water flow measuring transducers, the hot water temperature control sensor and the hot and cold water flow control valves. All connections to the optional heat exchangers are made via push fit couplings attached to the heat exchangers and the valve plate.

Control console

This is formed into the top of the base unit and contains a digital PID temperature controller, two digital displays, two rotary selector switches and connections for the thermocouple sensors and flow transducers. It also contains the electronic signal conditioning and the digital /analogue input/output for the optional Computer Interface HC100.
Six analogue (voltage) output sockets and a common ground socket allow the six measured temperatures to be recorded on a chart recorder or equivalent if required.

Instruments

Thermocouples - 6 Type K input sockets and one digital display with 6 way rotary selector switch. The internal electronic conditioning also makes the temperatures available for the optional Computer Interface HC100. The optional heat exchangers each contain the necessary number of type K thermocouples, leads and plugs designed to fit the corresponding sockets. Range is suitable for the temperatures expected on the heat exchanger service unit e.g. +4 to 100•C

Flow Transducers – 2 turbine flow transducers are fixed onto the valve plate and record the hot and cold water flow rates. A rotary selector switch allows the flow rate to be displayed on a digital display. Range 0.2 to 3 Litres/minute.

Water Temperature Control - 1 Digital display PID(Proportional Integral derivative) burst firing heater control with permanent temperature sensor mounted on the Valve plate. Controls the hot water temperature, within the limits of the available 2 kW heaters.

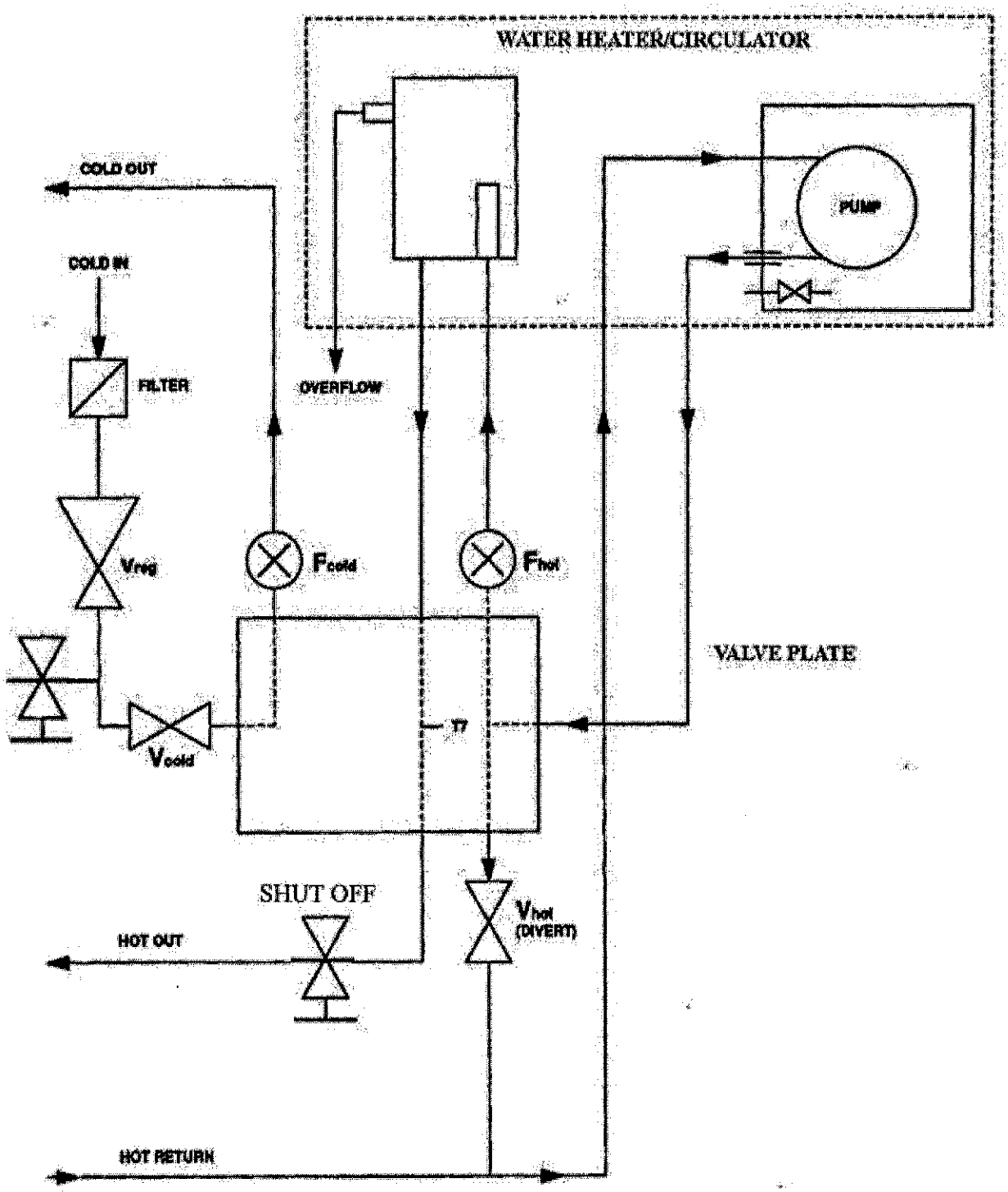
Safety

All metallic components connected to a common earthing point.
A 30 mA residual current circuit breaker disconnects the unit from the mains power in the event of a current leakage to earth.
3 mains overload circuit breakers, One protects the mains output socket. One the heating circuit in the hot water circulator and One the internal low voltage DC supplies.
An internal mechanical thermostat prevents the hot water temperature exceeding approximately 85•C. The PID controller is preset to limit the accepted set point as 80•C
A flow switch turns off the heaters in the event that water is not being circulated by the pump.

Dimensions

Height 400mm
Width 1000mm
Depth 500mm
Weight

Figure 6 Schematic of hot and cold water circuit.



DESCRIPTION

Heat Exchanger Service Unit H100

Please Refer to Figure 1 on page 2, Figure 2 on page 3, Figure 3 on page 4 and Figure 6 on page 13.

The Heat Exchanger Service Unit H100 is a bench top unit designed to accommodate four optional heat exchangers:

Concentric Tube Heat Exchanger H100A
Plate Heat Exchanger H100B
Shell and Tube Heat Exchanger H100C
Jacketed Vessel H100D

The base unit **2(2)** is vacuum formed from ABS plastic and is designed for bench mounting. The base unit **2(2)** has four mounting studs **2(3)** with securing screws to accept any one of the four optional heat exchangers.

The base unit **2(2)** has an internal sump to collect water that spills from the heat exchangers during changeover. A drain valve **2(1)** allows any water collected to be drained when convenient.

A mains switch **2(9)** allows the whole unit to be turned off and on as required. When off this isolates all of the electrical circuits inside the base unit **2(2).**

A valve plate **2(4)** and water heater/circulator **2(7)** together with push fit plastic couplings and flexible hoses allow the optional heat exchangers to be supplied with controlled and measured hot and cold water streams.

A schematic representation of the hot and cold water circuits to and from the valve plate **2(4)** are shown in Figure 6 on page 13.

Hot water for the heat exchanger under test is provided by the water heater/circulator **2(7)** which rests upon the base unit. This contains 2 x 1 kW electric water heaters a circulating pump and mechanical over temperature protection. The water heater/circulator is provided with power via a flexible cable and multi pin socket **3(29)** on the rear of the base unit, a priming vessel **2(6)** on the side of the water heater/circulator **2(7)** allows for expansion , de-aeration and aids filling the hot water system.

A mechanical thermostat limits the hot water temperature to approximately 85 °C and a flow switch turns off power to the heaters in the event that water flow stops for any reason.

Mounted on the valve plate **2(4)** are the following push fit couplings:

The hot water outlet **2(15)** to the heat exchanger .
The hot water return **2(16)** from the heat exchanger.
The Cold water inlet **2(10)** from the mains.
The regulated cold water outlet **2(24)** to the heat exchanger.

The valve plate **2(4)** also contains, the cold water flow transducer **2(25)** the hot water flow transducer **2(21)** the cold water pressure reducer **2(12)** the cold water filter **2(11)** the hot water flow control valve **2(21)** the cold water flow control valve **2(14)** and the water temperature control system thermocouple **2(19)** . The thermocouple connects to a dedicated thermocouple socket **3(42) labelled T7** on the side of the control console **2(8).** The cold water pressure regulator reduces the available mains pressure to a safe level for use with the optional heat exchangers and also reduce fluctuations that would affect the flow rate. The hot and cold water flow control valves allow the hot and cold stream flows to be varied between approximately 0.2 and 3 litres/minute depending upon the heat exchanger under test.

Semi-permanent connections between the valve plate **2(4)** and the water heater/circulator **2(7)** are made during the **Installation and Commissioning** procedures to complete the hot water circuit.

The optional heat exchangers are coupled to the hot water circuit and cold water source using the push fit couplings and the flexible hoses attached to each heat exchanger. Details of the coupling procedures and filling of the hot water circuit is given in the sections dedicated to the optional heat exchangers.

The use of the hot water push fit couplings **2(15)** and **2(16)** allow the hot water flow direction to and from the heat exchangers to be simply and quickly reversed so that parallel and counter-current flow can easily be investigated.

The control console **2(8)** contains all of the instrumentation and control components. On the front of the control console is the PID Temperature Controller **3(32a,b,c)** that automatically maintains the inlet water temperature to the heat exchanger under test. This also displays the nominal inlet temperature to the heat exchanger continuously until the set point key **3(32a)** is pressed. The set point may be adjusted up or down by pressing the appropriate keys **3(32b)** or **3(32c)**. This is described in the **Operating Procedure**.

The on/off switch **3(33)** adjacent to the Temperature controller **3(32)** switches on or off both the circulating pump and the power to the heating elements in the water heater/circulator **2(7)**. The controller remains illuminated with the switch in either position to allow the set point to be changed or checked before switching on the circulation system.

Also on the front of the control console **2(8)** is the flow transducer selector switch **3(35)** and a digital panel meter **3(34)** that displays the selected flow (F_{hot} or F_{cold}) directly in litres / minute.
The flow transducers **2(25)** and **2(26)** are connected to identical sockets on the side of the control console **3(40)** and **3(41)**. Note that the sockets are labelled accordingly and connecting the wrong transducer to the sockets will result in errors.

Also on the front of the control console **2(8)** is the 6 way temperature selector switch **3(37)** and a digital panel meter **3(36)** that displays the selected thermocouple temperatures directly in °C. The thermocouples connect to identical numbered type K sockets **3(39)** mounted on the side of the control console **2(8)**.

Note that the thermocouples on each of the optional heat exchangers are also numbered and should be connected to the corresponding socket.

Below the digital temperature display are a row of 6 red numbered 3mm diameter electrical sockets and a single black socket. These give proportional output voltages (10mV/°C) to the temperatures sensed by the thermocouples and may be used to connect to a chart recorder or equivalent device.

The rear of the base unit **2(2)** houses the mains power input socket **3(31)** to which the incoming mains lead supplied is connected. Adjacent to the socket are the residual current circuit breaker **3(27)** and the three individual over load circuit breakers **3(28a,b,c)**. There is also an auxiliary mains output supply socket **3(26)** capable of providing up to 1 Amp. This is intended for use with the optional computer interface HC100. Finally a DIN socket **3(30)** provides low voltage DC power to drive the stirrer on the optional Jacketed Vessel H100D.

OPERATING PROCEDURE

Please refer to figure 2 on page 3 and figure 3 on page 4.
It is assumed that the initial general Installation and Commissioning procedures have been completed and the unit is connected to the mains cooling water and the mains electrical supply.

Pipe Push Fittings

The fittings used to connect the heat exchangers to the hot and cold water supply points on the valve plate **2(4)** are all of a similar type. The grey tube pushes easily into the light coloured sockets to make the connection. Leakage is prevented by rubber O rings inside each socket and these are the resistance that is felt when inserting the tubes into the sockets.

The tubes once inserted are restrained by small stainless steel teeth on the loose grey rings on each socket. If an attempt is made to simply pull the tube from the socket these teeth will be forced into the tube and should prevent removal. It is recommended that a socket e.g. **2(24)** or **2(15)** is closely examined before inserting the tube to understand this operation.

In order to remove the tube from a socket it is essential to push the loose grey ring into the socket while at the same time pulling the tube out of the socket. Failure to do this will result in damage to the tube an/or the socket.

Installation of the Optional Heat Exchanger

Before testing can commence one of the four optional heat exchangers must be fitted to the base unit **2(2)** on the mounting studs **2(3).** As the four heat exchangers are all of different form the procedure for mounting these on the base unit is given in the **Installation Heat Exchanger Installation** section of this manual on the following pages:

Concentric Tube Heat Exchanger H100A	Page A5
Plate Heat Exchanger H100B	Page B7
Shell and Tube Heat Exchanger H100C	Page C5
Jacketed Vessel H100D	page D4

However all heat exchangers connect to the Hot out and Hot return couplings shown schematically in Figure 6 on page 13. Note that to prevent all of the hot water circuit draining each time a heat exchanger is removed two valves exist on the manifold hot water circuit that can be closed. These are shown schematically on Figure 6 on the HOT OUT (**SHUT OFF**) and HOT RETURN (**Vhot Divert**). When a heat exchanger has been fitted the valves are both opened fully until the circuit is primed and filled. There after the hot water flow control is achieved with the **Vhot Divert** valve only

Install the required optional heat exchanger according to the above detailed procedures. Note that for the H100A, H100B and H100C the specified flow directions should be observed as instructed. The following general procedures for operation should then be followed.

Filling The Hot Water Circuit

Note that an auxiliary hose is provided from a Tee fitting after the cold water pressure regulator **2(13).** This has a shut off valve that allows it to be used for initially filling and subsequently topping up the hot water header tank **2(6).**

Before priming or refilling the hot water circuit ensure that the appropriate optional heat exchanger has been fitted to the base unit **2(2)** according to the above relevant procedure. Ensure that the hot water circuit has been completed by connecting the appropriate heat exchanger to the hot water outlet **2(15)** and hot water return **2(16)** on the valve plate **2(4).** Ensure that the SHUT OFF valve and Vhot Divert valve shown in Figure 6 on page 13 are both open.

Ensure that the cold water pressure regulator **2(13)** has been set to minimum pressure (Locate the adjusting knob **2(12)** pull this away from the valve until it clicks and then turn the knob **fully anti-clockwise**) and that the cold water flow control valve **2(14)** is in the closed position.

Turn on the cold water supply to the unit by opening the locally supplied stop valve.

If the hot water circuit is being filled for the first time the cold water supply may be used to prime the hot water pump as follows. Disconnect the circulator outlet pipe **2(20)** from the valve plate **2(4)** and connect it to the cold water outlet socket **2(24)** (having temporarily removed the heat exchanger cold water inlet pipe). Carefully open the cold water flow control valve **2(14)** until water is heard to flow into the unit. Note that depending upon local water pressure it may be necessary to screw the water pressure regulating knob **2(12)** clockwise slightly in order to get water to flow. Allow water to flow into the system until the priming vessel **2(6)** is full.

Close the cold water flow control valve **2(14)** and return the circulator outlet pipe to its original socket **2(20)** on the valve plate. Reconnect the heat exchanger cold water inlet pipe to the cold water outlet socket **2(24).**

Turn on the main switch **2(9)** and briefly switch on the circulating pump **3(33)** until water is seen to circulate around the system. The water level will drop in the priming vessel **2(6)** and this should be topped up until it remains full with the pump running continuously.

If the hot water circuit has already been filled or used previously then it should not be necessary to re-prime the system. Water will be lost when the heat exchangers are removed and this must be replaced when a new heat exchanger is fitted using the top up hose from the cold water supply.

Once the system has been primed for the first time via the mains as indicated above the life of the unit will be extended by using de-mineralised water in the hot water circuit from that time onwards. This is particularly relevant if the local water contains high mineral content.

Fill the priming vessel **2(6)** with water(preferably de-mineralised). Turn on the main switch **2(9)** and briefly switch on the circulating pump **3(33)** until water is seen to circulate around the system. The water level will drop in the priming vessel **2(6)** and this should be topped up until it remains full with the pump running continuously.

Note that when the water is heated for the first time it may contain a large amount of dissolved air and this will be released as the temperature rises.

The priming vessel **2(6)** can be filled at any time and will not affect the hot water temperature to the heat exchangers. The circulator is fitted with a flow switch will not allow electrical power to the heaters until the water is flowing due to the action of the pump.

Setting the Hot Water Temperature

The digital temperature controller **3(32)** has been pre-configured to give the optimum control of the hot water inlet temperature for all four optional heat exchangers. The controller automatically proportions electrical power to the 2 x 1kW immersion heaters in the water heater/circulator **2(7).**

Heater activity is indicated by the red point LED at the top of the display.

Ensure that the temperature sensor **2(19)** in the valve plate **2(4)** is correctly connected to the T7 socket **3(42)** on the side of the control console **2(8).** Without this connected the heaters will not operate.

The required hot water inlet temperature to the heat exchanger on test is set by pressing the set point key **3(32a)** on the right of the display. The display will then show the current set temperature.

To increase the set temperature press the up arrow key 3(32b).

To decrease the set temperature press the down arrow key 3(32c) .

After 4 seconds the display reverts to the actual temperature of the hot water at the temperature sensor.

Note that the maximum settable temperature is 80°C and temperatures above this value should not be admitted by the system.

Setting the Cold Water Pressure Regulator
As the internal pressure resistance of each of the optional heat exchangers is different due to the flow passages it will be necessary to adjust the pressure regulator **2(13)** when a heat exchanger is fitted.

Ensure that the cold water pressure regulator **2(13)** has been set to minimum pressure (Locate the adjusting knob **2(12)** pull this away from the valve until it clicks and then turn the knob **fully anti-clockwise**) and that the cold water flow control valve **2(14)** is in the closed position.

Turn on the main switch **2(9)** and set the flow selector switch **3(35)** to F_{cold}.
Open the cold water flow control valve **2(14)** fully (handle in line with the flow). Gradually increase the pressure regulator **2(13)** by pulling the turning the knob **2(12)** out and turning clockwise until the flow meter display **3(34)** indicates at least 3.0 litres/minute.

Setting and Measuring the Cooling water Flow rate
Turn on the main switch **2(9)** and set the flow selector switch **3(35)** to F_{cold}. Adjust the cooling water flow control valve 2(14) to give the required flow rate through the heat exchanger under test. Note that for low flow rates the valve will need very careful adjustment.

It is not recommended to use the pressure regulating valve to adjust the cold water flow rate.

Setting and Measuring the Hot Water Flow Rate
Turn on the main switch **2(9)** and set the flow selector switch **3(35)** to F_{hot}. Adjust the hot water bypass control valve 2(17) to vary the flow of hot water through the heat exchanger under evaluation. Note that as the valve is a bypass the flow rate through the heat exchanger will **increase** as the valve is **closed** (handle at 90° to the flow).

Note that the maximum achievable hot water flow rate will vary depending upon the hot water temperature and the heat exchanger under test.

Using a Chart Recorder or Equivalent
Each of the six temperature channels is available as an analogue voltage signal from the 6 red 3mm diameter sockets **3(38)** on the front of the control console **2(8).**

The signal conditioning is such that the voltage output is 10mV dc / °C.
Hence for example a temperature of 100°C will result in a voltage of 1V dc.
The voltage is maintained between the red terminals and the single black terminal which is a common 0 Volt terminal.

Using The Optional Computer Interface and Software HC100
It is recommended that familiarity with operation of the hardware in manual mode is obtained **BEFORE** attempting to operate the software and recording data automatically. This is particularly relevant to laboratory technicians and assistants who will have day to day responsibility for the equipment.

It is assumed that the hardware and software have been installed according to the INSTALLATION AND COMMISSIONING OPTIONAL COMPUTER INTERFACE HC100 on pages 9, 10 and that the heat exchanger to be tested has been installed and is filled and operational.

Click the Start button, then Programs, then P A Hilton **HC100**. The start screen will appear.
The first screen shows the optional languages. If these have been ordered then clicking on the desired language button will convert the subsequent screens to text in that language. The default language is English.

Once the language has been selected this will become the default language until changed again.

Once the language has been selected and the copyright notice accepted the main menu appears. This allows the user to record data from any of the four optional heat exchangers assuming that they have been ordered.

Select the heat exchanger in use according to the instructions on the screen.

The software is self explanatory and easy to use. However where relevant, prompts are contained in this manual to indicate procedures that should be followed to assist the user in obtaining data easily and simply. These prompts appear in *italics* and are headed ***If the Optional HC100 is In Use.***

It is of course necessary to ensure that the correct software option is run with the appropriate heat exchanger hardware.

The descriptions of software operation relevant to each heat exchanger are contained in the sub section of this manual that relate to the individual heat exchangers. It is assumed in each case that data is being captured on disc for later review. This is not essential and the option NOT to record data is given. However it should be noted that if this option is selected it is not possible to review the data at a later time.

If review is required then the option to record data on disc should be accepted.

Note that data is recorded with certain parts of the filename fixed. This ensures that only data relevant to the review program selected is accessed. The remaining part of the filenames allocated by the operator should be selected to have relevance to the user at a later date.

MAINTENANCE

Hot Water Filter

A filter is located inside the water heater/circulator **2(7)** to prevent debris from entering the flow switch or flow transducer. After prolonged use, or more likely if raw mains water with a high mineral content is used instead of demineralised water, it will be necessary to clean the filter.

Disconnect the unit from the mains electrical supply and cold water supply.

Remove the fixing screws securing the cover of the water heater/circulator.

Drain the circulator by opening the drain valve below the heater.

Remove the filter by releasing the securing clips on the flexible tubing (note the tubing may be tight).

Flush the filter by passing clean water through it in the opposite direction to normal flow. When clean re-install the filter and replace the lid of the water heater/circulator.

It will be necessary to prime the water circulator pump as described in the **Filling The Hot Water Circuit** section of the **OPERATING PROCEDURE** on page 16.

Miniature Circuit Breakers

The three miniature circuit breakers on the rear of the base unit **3(28a,b,c)** should under normal operating conditions remain in the ON position.

The miniature circuit breakers are designed to switch to the off condition in the event of an overload caused by a short circuit or short to earth.

If a circuit breaker should switch to the OFF position the cause should be investigated by a competent electrician.

Residual current Circuit Breaker (RCCB)

The Residual Current circuit Breaker **3(27)** is also located on the rear of the base unit. This will isolate the unit from the mains in the event that the incoming and outgoing currents differ by more than 30mA, as in a leakage to earth situation.

The RCCB should be tested by a competent person at regular intervals as dictated by local safety regulations. **Supply power to the unit.** To test, press the button marked **"T" or Test.** The RCCB should immediately switch to the OFF condition.

Note that if no power is supplied to the unit the test button will not cause the RCCB to trip to the off condition.

If the RCCB fails to trip under test the device may be faulty and requires repair/replacement by a competent electrician.

Panel

This may be cleaned with a mild detergent and then polished with a soft cloth. Abrasive cleaners should not be used.

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