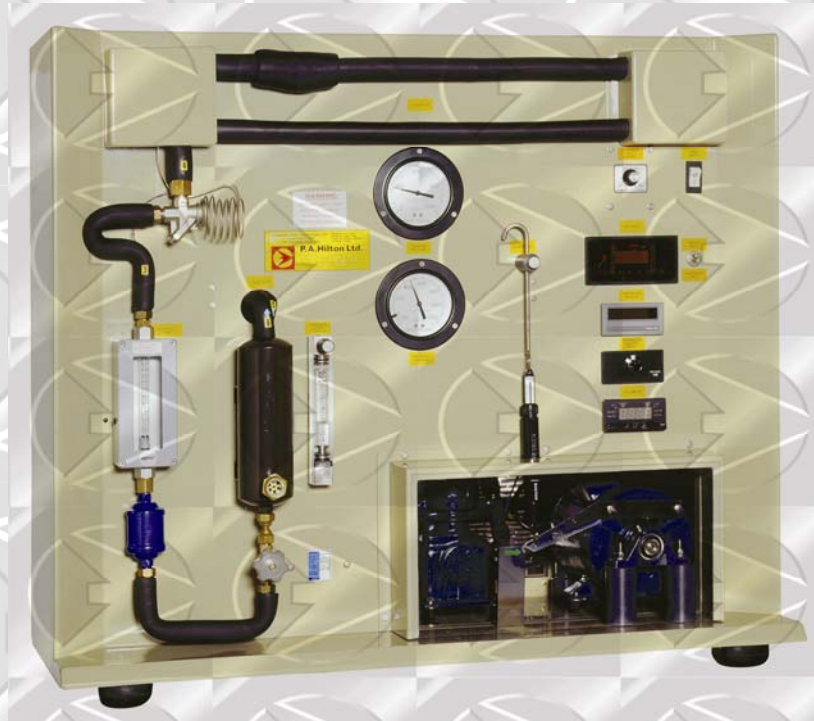




## ***Refrigeration Laboratory Unit R714***

Figure 1: R714



- ***Complete analysis of the Vapour-Compression Refrigeration/Heat Pump Cycle.***
- ***Adjustable evaporator load and condensing temperature.***
- ***Clear display of all parameters including Electrical Input, Refrigerant Flow, Water Flow, Motor Torque and Rotational Speed, Pressures & Temperatures.***
- ***Allows a complete refrigerant pressure-enthalpy cycle diagram to be drawn at all operating conditions.***
- ***Optional Computerised Data Acquisition Upgrade.***
- ***Two year warranty.***



## ***Introduction***

The vapour compression refrigeration cycle is used in many industrial, medical and domestic situations throughout the world. Air conditioning, food and medical preservation and transport all rely on the use of refrigeration plant. It is essential therefore that student engineers intending to design or utilise such plant are fully aware of the parameters affecting the performance of the vapour compression refrigeration cycle.

The Hilton Refrigeration Laboratory Unit R714 has been designed to allow students to fully investigate the performance of a vapour compression cycle under various conditions of evaporator load and condenser pressure. All of the relevant parameters are instrumented and the unit is completely safe for operation by students.

The unit forms an essential part of laboratory training for students studying:

- **Refrigeration**
- **Air Conditioning**
- **Building Services**
- **Mechanical Engineering**
- **Marine Engineering**
- **Plant and Process Engineering**
- **Food Processing**
- **Chemical Engineering.**

## ***Experimental Capabilities***

- Production of a vapour compression cycle diagram under various conditions.
- Production of an energy balance for the refrigerator.
- Investigation of the variation in refrigerator “duty” or cooling ability for various condensing temperatures.
- Investigation of the variation in refrigeration Coefficient of Performance for the various condensing temperatures.
- Investigation of the variation in Coefficient of Performance based on electrical, shaft and indicated power.
- Determination of the overall heat transfer coefficient for the condenser cooling coil.
- Investigation of the performance of the thermostatic expansion valve.
- Investigation of the heat delivered to the cooling water with variation in condensing temperature.
- Investigation of the Coefficient of Performance as a Heat Pump for various condensing temperatures.
- Investigation of power input based on electrical, shaft and indicated power.

## ***Description***

An attractive glass reinforced plastic panel houses a belt driven twin cylinder reciprocating compressor. This is driven by a trunnion-mounted electric motor connected to a spring balance. By measuring the motor torque and speed, the shaft power required to drive the compressor can be determined.

Refrigerant R134a vapour is drawn into the compressor from the evaporator mounted on the front of the panel. Work is done on the gas and its pressure and temperature are raised. This hot, high pressure gas discharges from the compressor and flows into the panel mounted water cooled condenser. A measured and controllable flow of cooling water passes through a coil sealed inside the condenser cylinder. The hot gas desuperheats and then condenses to a liquid on the surface of the cooling coil. The condensed liquid collects at the base of the cylinder where it is sub cooled and may be observed through a sight glass. This liquid then flows through a refrigerant filter/dryer and a variable area flowmeter to the thermostatic expansion valve. Here it passes through a controlled orifice, which allows its pressure to fall from that of the condenser to that of the evaporator. The liquid immediately starts to boil and takes in heat to accomplish this at low temperature. In order to allow control and measurement of the heat input at the evaporator, two electric heater elements are used. These are located inside the copper tube carrying the low temperatures liquid/vapour mixture from the expansion valve. The voltage across the



heater elements may be varied from zero to that of the mains supply voltage by adjustment of a voltage controller situated on the front panel. Measurement of the power is carried out by a panel mounted digital wattmeter. A change over switch allows the electrical power input to the motor to be measured.

The sensing bulb of the thermostatic expansion valve is mounted on the exit pipe from the evaporator and this detects the degree of superheat of the gas leaving the evaporator and entering the compressor. If the superheat is low the valve will close and reduce the flow and if too high the reverse will occur. By this means stability is maintained under all conditions of operation.

A panel mounted digital temperature indicator allows measurement of all the relevant system temperatures and a digital tachometer indicates the rotational speed of the compressor. Individual pressure gauges indicates the pressure in the condenser and evaporator.

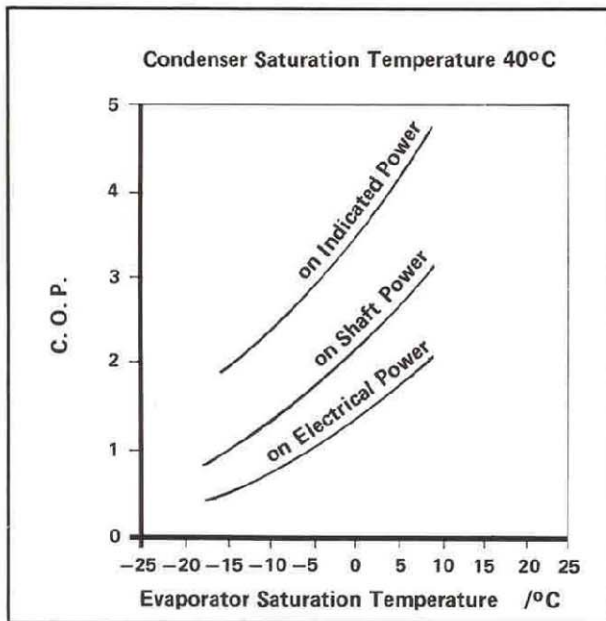
**Optional Data Acquisition Upgrade**

An optional computerised data acquisition upgrade RC714A is available to enable all relevant system parameters to be automatically recorded on a PC for further analysis and display. Data may also be transferred to spreadsheet format for complex analysis and calculation. This upgrade can be factory fitted prior to delivery or supplied later as a user installed upgrade.

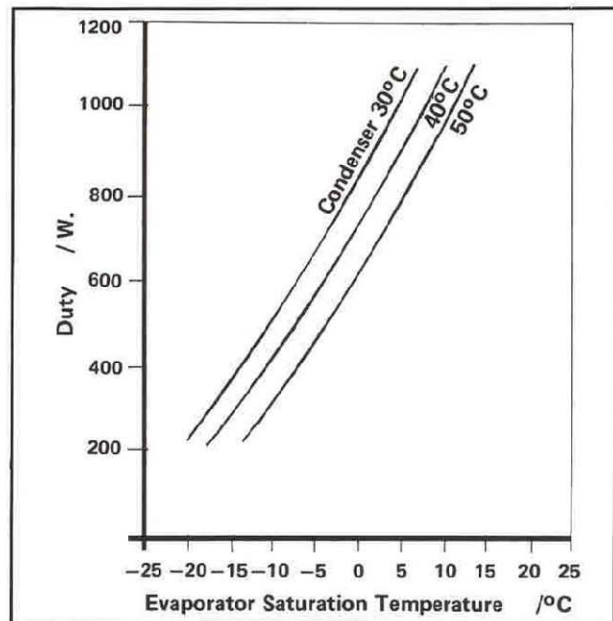
**Operation**

The Refrigeration Laboratory Unit has three controls. Firstly a combined miniature circuit breaker and switch turns on both the compressor motor and the supply to the electrically heated evaporator. A combined variable area water flowmeter and valve allow control of the condenser pressure. A panel mounted voltage controller allows control of the evaporator load from zero to full power of approximately 1500 Watts. Combined operation of the voltage controller and condenser cooling water flow allows control of the unit over a large range of conditions.

**Experimental Results**



**Coefficient of Performance as a Refrigerator  
(Based on Electrical, Shaft & Indicated Power)**



**Refrigerator "Duty"  
(i.e Cooling Ability)**



## Specification

### General

A fully instrumented refrigerant R134a vapour compression refrigerator with belt driven compressor, electrically heated evaporator, thermostatic expansion valve and water cooled condenser. Operating parameters can be varied by adjustment of condenser cooling water flow and electrically heated evaporator supply voltage.

Components have a low thermal mass resulting in immediate response to control variations and rapid stabilisation.

Instrumentation includes all relevant temperatures, condenser pressure, evaporator pressure, refrigerant and cooling water flow rates, evaporator and motor power, motor torque and compressor speed.

### Detailed

**Panel:** High quality glass reinforced plastic on which the following components are mounted.

**Refrigerant:** R134a

**Digital Thermometer:** 6 way type K indicator with 0.1°C resolution.

**Wattmeter:** Allows measurement of the power input to either evaporator or motor.

**Voltage Controller:** To vary evaporator load.

**Variable Area Flowmeters:** (2) Variable area types to indicator R134a and H<sub>2</sub>O flow rates.

**Pressure Gauges:** (2) to indicate R134a pressure in evaporator and condenser.

**Spring Balance and Tachometer:** Together allow measurement of power required to drive the compressor.

**Expansion Valve:** Thermostatically controlled type.

**Evaporator:** Electrically heated device.

**Compressor:** (Internally mounted) Twin cylinder belt driven unit.

**Safety:** Condenser pressure and evaporator heater temperature limited by automatic cutouts. All electrical components connected to common earth. Unit protected by miniature circuit breaker and residual current circuit breaker.

## Dimensions

Height: 92cm    Depth: 48.5cm  
Width: 106cm    Weight: 93kg

### Optional Data Acquisition Upgrade

An optional Data Acquisition Upgrade RC714A comprising of an electronic data logger, menu driven software and all necessary transducers, allows all relevant parameters to be simultaneously displayed and recorded on a suitable PC. The software allows review and printing of data and transfer to spreadsheets for complex analysis and calculation.

## Accessories and Spares

Unit supplied with:

One experimental operating and maintenance manual in English, Spanish or French.

Accessories and spares for 2 years normal operation. List available on request.

## Services Required

**Electrical: A:** 2.5Kw 220-240 Volts, Single Phase  
50Hz(With earth/ground).

**B:** 2.5kW 110-120 Volts, Single  
Phase, 60Hz(With earth/ground).

**C** 2.5kW 220 Volts, Two Phases,  
50/60Hz(With earth/ground).

**Water:** 3 litres/min at 24m head

## Ordering Information

**Order as:** R714 Refrigeration Laboratory Unit.

Optional : RC714A Data Acquisition Upgrade.

## Electrical Specification

Either: **A:** 2.5Kw 220-240 Volts, Single Phase  
50Hz(With earth/ground)

**B:** 2.5kW 110-120 Volts, Single Phase,  
60Hz(With earth/ground).

**C:** 2.5kW 220 Volts, Two Phases,  
50/60Hz(With earth/ground).

## Language

Either: English, Spanish or French.

## Shipping Specifications

**Net Weight:** 93kg. (approx.)

**Approximate Gross Weight:** 151kg. (approx.)

**Packing Case Dimensions:** 122 x 65 x 122 cm (approx.)

**Packing Case Volume:** 1.00 m<sup>3</sup> (approx.)

## Also Available On Request

Further detailed specification.

Additional copies of instruction manual.

Recommended list of spares for 5 years operation.



## Optional Data Acquisition Upgrade RC714A

### *Hardware details*

The optional Data Acquisition Upgrade RC714A consists of an internally located 35 channel Hilton Data logger (D102), together with dedicated software that will operate in the Windows™ environment.

The combined software and hardware package allows computer monitoring of all six relevant system temperatures, condenser and evaporator pressures, refrigerant flow rate, condenser cooling water flow rate, compressor electrical input power, compressor speed, motor speed and motor torque.

A duplex set of thermocouples provide the system temperatures. Pressure transducers and the water flow transducer connect to factory fitted internal couplings. The refrigerant flow transducer is a variable area type that may be fitted at any time with a signal transmitter.

A motor current transformer and internal voltage transducer provides motor V A, the wattmeter provides signal re-transmission for evaporator load. Motor torque is provided by a load cell and motor speed by an internal transducer.

The additional transducers allow the unit to be operated either with the computer or in the standard manual mode.

As all transducer coupling points are factory fitted the Data Acquisition Upgrade RC714A may be purchased and installed at any time.

### **Software Details**

The pre-configured menu driven Software supplied with the Data Acquisition Upgrade RC714A allows all recommended experiments detailed in the Refrigeration Laboratory Unit R714 manual to be carried out with the aid of computerised data acquisition and on screen data presentation.

This enhances student interest and speeds comprehension of the principles being demonstrated.

Students may be presented with numeric data or graphic data plotted against time.

Data may be printed, stored on disc for later analysis and transferred in ASCII form to most spreadsheets for further analysis and projects.

### **Additional Data Logging Facility Supplied As Standard**

The Hilton Data Logger D102 is an industrially proven 35 channel interface with 15 thermocouple/differential voltage inputs ( $\pm 80\text{mv dc}$ ), 8 single ended dc voltage inputs ( $\pm 8\text{v}$ ), 8 logic or frequency inputs, 3 ac current inputs one mains voltage input and 8 current sinking output channels. In addition there are on board 12v dc,  $\pm 5\text{V dc}$  and  $\pm 15\text{v dc}$  power supplies for most commercially available transducers.

The pre-configured Hilton Data Logging software, supplied as standard with the RC714A package, allows the D102 to be disconnected from the R714 transducers and used together with most standard transducers as a stand alone computer data logger and controller for the monitoring and control of existing laboratory equipment.

This further expands the student project capabilities of the RC714A package from teaching and demonstration into the field of research and postgraduate study.

### **Computer Hardware Requirements**

The menu driven Software supplied with the Data Acquisition Upgrade RC714A will operate on an IBM or IBM compatible PC having at least 32 Mb ram, VGA graphics, 1Gb hard drive and an available RS232 serial port. The software is Windows 2000 and XP compatible. Supplied on CD Rom.

### **Order as:**

Data Acquisition Upgrade RC714A

## **P A Hilton Ltd.**

Horsebridge Mill, King's Somborne,  
Stockbridge, Hampshire, SO20 6PX, England.

Telephone: **National (01794) 388382**

International **+44 1794 388382**

Fax: (01794) 388129

E-mail **sales@p-a-hilton.co.uk**