P·A·Hilton Ltd



# ENERGY

Since the discovery of fire the efficient use of energy has been of importance to humankind. The Industrial Revolution in the 18th century made this even more important as heat energy in the form of coal was used to create motive power to drive machinery. This in turn created the need for the study of Thermodynamics and Combustion which investigated and quantified the efficiency and improvement of the then simple steam engines.

Today the study of Thermodynamics and Combustion is of even greater importance due to concerns about global warming and finite resources of increasingly expensive fossil fuels. Renewable Energy utilising wind, solar and tidal power has combined with thermodynamics and combustion to become possibly the most important subjects for scientific study if the world is to continue to operate in the way that has become accepted as normality.

The Hilton range of Energy related training units incorporating Combustion, Propulsion, Steam and Renewable will be of major importance to students of many disciplines not only those in engineering. Among the many new products are also the latest versions of machines that were first created in 1959 at the start of the company. Many of the original units are still in regular use around the world and are a testimony to the quality of the Hilton products.

**COMBUSTION**

**PROPULSION**

**RENEWABLE**

**STEAM**

# Combustion

Despite the contributions made by nuclear, hydro-electric, solar, wind and other renewable energy sources, the majority of energy is still derived from combustion of hydrocarbon fuels. These fuels are finite and it is vital that they are used efficiently to conserve resources and reduce pollution. A good knowledge of the factors which affect the efficient combustion of fuels is therefore essential for everyone involved in the study of energy use.

## **C100** Internal Combustion Engine Test Stand



A robust floor mounted modular internal combustion engine test stand with regenerative dynamometer allows students to investigate the performance of either a gasoline or a diesel internal combustion engine. A separate instrumentation console allows measurement and display of the engine torque, speed, air consumption, fuel consumption, inlet air temperature and exhaust gas temperature. An optional computerised data acquisition upgrade is available that allows all relevant system parameters to be automatically recorded on a PC. Operator safety is ensured by a range of interlocks and safety cut out devices.

**Optional Extras:**

**C100A -** Four Stroke Gasoline Engine
**C100B -** Four Stroke Diesel Engine
**Data Acquisition Upgrade**



## **C200** Bomb Calorimeter

A self-contained conventional bomb calorimeter complete with highly insulated and polished, stirred water vessel.

A stainless steel, hydraulically proof tested reaction vessel, together with all ignition equipment, pellet press, digital thermometer, oxygen charging couplings and pressure gauge allows students to investigate the calorific value of both conventional and potential alternative fuels in liquid and solid form.

## **C492** Combustion Laboratory Unit



A purpose designed unit, enabling studies into many aspects of combustion and burner operation using the optional burners or any suitable commercially available oil or gas burner up to 150 kW. The four large observation windows fitted in the frame mounted, water cooled, stainless steel combustion chamber provide an excellent flame demonstration facility. The full instrumentation and safety features allow supervised student operation over a wide range of air/fuel ratios and different fuels. An optional Flue Gas Analyser and Flue Installation Package mean that a complete combustion test facility can be installed in almost any laboratory.

**Optional Extras:**

**C492A -** Gas Burner
**C492B -** Oil Burner
**C492C -** Flue Installation Package
**C492D -** Flue Gas Analyser
**Data Acquisition Upgrade**

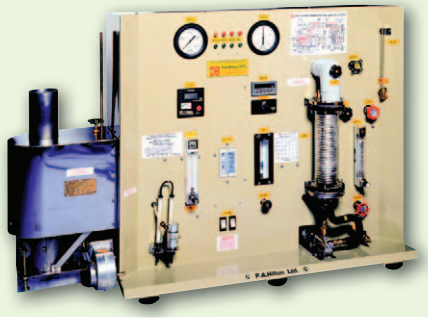


## **C552** Flame Propagation and Stability Unit

Specifically designed for studying the flame control techniques used in all gas combustion systems. This bench top unit allows supervised student operation and analysis over a very wide range of air/fuel ratios and gaseous fuel types. The observations and experiments that can be conducted include flame stability (lift off and light back), the plotting of stability diagrams, measurement of the air/fuel ratio, flame speed, arresting and quenching techniques as well as methods of expanding stability limits.

## Steam & The Rankine Cycle

Steam power plant for teaching purposes has traditionally been based on large industrial equipment adapted for educational use. Whilst enabling experimental work to be undertaken, this approach suffers from a number of disadvantages. These include a large fixed installation requiring extensive site preparation; high capital, running, maintenance and inspection costs and a slow response to a change in operating conditions. The complexity and scale of the system can also confuse student understanding of the basic principles of Rankine cycle steam generators and turbines.



## **S200** Steam Generator and Service Module

A bench top unit which includes a gas fired steam generator for wet or superheated steam, a condensing unit with air ejector and a closed feed water system. Instrumentation to allow the measurement of all important quantities including air/fuel ratio, generator efficiency, steam properties and heat transfer quantities. In addition, the module provides a supply of steam, condensate handling and air extraction facility for other bench top modules including the S210 Steam Turbine Module which may be simply connected to it in order to create a complete closed Rankine Cycle.

## **S220** Rankine Cycle Steam Turbine

A lower cost alternative to the S200 plus S210, the S220 is a self-contained two-part unit which demonstrates a fully closed Rankine Cycle and has sub-atmospheric condensing conditions. It is designed to facilitate student experiments in thermal efficiency, friction losses at various exhaust pressures, steam quality by throttling and turbine torque/speed and power/speed characteristics. It benefits from an externally certified electric boiler making it suitable for use in labs where bottled/piped gas is unavailable.

**Optional Extras:**

**S220A -** Generator Demonstrator Module
**Data Acquisition Upgrade**



## What is the Rankine Cycle?

The Rankine cycle is a closed power cycle that converts heat into work. The heat is supplied externally to a closed loop, which usually uses water or in some renewable power sourced applications an organic fluid. This cycle generates about 90% of all electric power used throughout the world, including virtually all thermal, biomass, coal and nuclear power plants. It is named after William John Macquorn Rankine, a Scottish polymath and Glasgow University professor.

## **F822** Solar/Heat Source Vapour Turbine

Incorporating all the major components and exhibiting all the performance characteristics for a fraction of the capital and running costs of a typical steam power plant, the unit operates on the classic Rankine cycle using a low pressure organic substance as the working fluid.

Instrumentation includes all relevant system pressures and temperatures, turbine torque and speed, working fluid and cooling water flow rates.

Supplied in standard form with an electric heat source, **an optional set of Solar Panels and Installation Package is available** (F820S) to demonstrate the generation of work from solar radiation.





## **R852** Vapour Jet Refrigerator/Heat Pump

A bench top example of a refrigerator/heat pump that is driven by a heat source. The unit operates on a combined Rankine and vapour compression refrigeration cycle using a low pressure using a low pressure organic substance as the working fluid. A simple ejector (or thermo-compressor) performs the expansion and compression processes involved in the combined cycles. A small electric motor drives the pump of the Rankine cycle. The heat source is electrically heated and produces high pressure vapour to drive the ejector.

**An optional set of Solar Panels and Installation Package (F820S) is also available** to demonstrate the generation of a refrigeration effect directly from solar radiation.

## Renewable Energy

The rapidly increasing cost of fossil fuels and the visible signs of global warming are concentrating interest in renewable energy. The continuously expanding range of Hilton Renewable Energy products allow students to increase their understanding of the limitations and practical applications of green technologies.

## **RE510** Educational PEM Fuel Cell



The RE510 Proton Exchange Membrane (PEM) fuel cell is one of the current leading contenders as a power source for use in motor vehicles. The fuel cell generates electrical power directly from hydrogen and air producing only pure water and heat as a by-product.

Unlike other educational units on the market the Hilton RE510 utilises an award winning module that is identical to those used in an actual vehicle power supply currently in production. This incorporates a unique membrane electrode assembly for the stack cells, each of which is internally reinforced and water cooled. This gives the cell a high watt density and allows students to investigate a practical fuel cell with a realistic output. The unit is provided with switchable internal electrical loads(up to 0.75kW) allowing immediate operation, evaluation and data collection. An integral computer control system and data acquisition software allows automatic start-up and shut down with full safety monitoring, hydrogen detection and alarm system.



## **RE540** Photovoltaic Trainer

A complete 80W solar panel system with instrumentation panel containing a battery charge controller, panel loading system, all relevant instrumentation and an external deep cycle 110Amp hour battery. Instrumentation includes high accuracy solarimeter, panel temperature, electrical charging and load power measurement.

**Optional extras:**

**RE540A -** Optional Water Pump
**RE540B -** Optional Single Phase Invertor
**RE540C -** Additional 80W Solar Panel
**RE540D -** Additional Deep Cycle Battery
**RE540E -** Solar Simulator
**Data Acquisition Upgrade**

## **RE550** Flat Plate Solar energy Collector



A flat plate solar collector similar to those used for heating swimming pools or domestic hot water is mounted on an adjustable frame. A system of recirculation and cooling water bleed flow control allows the unit to reach a wide range of stable operating conditions in a very short time period. This allows a wide range of system operating conditions to be investigated in a typical laboratory period. The unit is designed for internal or external operation.

For internal operation an artificial solar source is available on application as an optional extra.

**Optional Extras:**

**RE550A -** Flat Focussing Solar Collector
**RE550B -** Solar Simulator
**Data Acquisition Upgrade**



## **RE550A** Flat Focussing Solar Energy Collector

An optional flat evacuated tube "focussing type" solar collector RE550A is available that can be supplied to allow a comparison of performance of the two types of collector.

## **RE570** Horizontal Axis Wind Turbine

Allows students to easily investigate the basic principles behind power generation from wind. It is suitable for outdoor use only, in any unobstructed area, such as at the top of a tall building and comes complete with a three meter mast.

The bench mounted control console provides instrumentation for the wind turbine and displays air velocity before and after the turbine, turbine rotational speed and the current and voltage being produced by the wind generator.

An **optional computerised data acquisition upgrade** is available that allows all relevant system parameters to be automatically recorded on a PC. A wind up mast is available where flat roof mounting is not an option.





## **RE580** Combined Wind & Solar Generator Demonstrator

The use of combined wind and solar power generation has become increasingly common, not only from an energy conservation point of view but also for practical applications. A combined system involves the use of a charge controller that can allow for the daily steady and potentially small input from a solar panel and the potentially large but intermittent input from a wind generator.

The unit demonstrates the practical application of such a combined system as well as providing a cost-effective means for student investigation of wind and photovoltaic generation. It is supplied as standard with a high-powered axial fan to generate realistic wind-speeds and a 500W solar simulator to allow investigation of system performance inside the laboratory irrespective of outside conditions.

Both the solar panel and wind generator connect to a digital combined charge controller that allows the output from both the solar panel and the wind generator to be investigated. Optional hand held instrumentation includes, wind speed meter, tachometer and solarimeter for investigation of system efficiency.

## **R560** Water-Water Heat Pump

The R560 Water-Water Heat Pump allows investigation of the performance of a water sourced heat pump. This new addition to our Heat Pump range complements our R515 Mechanical Heat Pump and R832 Air-Water Heat Pumps (see our Refrigeration & Air Conditioning Brochure for full details). The R560 Water-Water Heat Pump allows students to investigate the performance aspects of a heat pump having a high efficiency plate evaporator and condenser that both operate on separately instrumented water supplies. Energy input to the compressor is recorded as are all relevant system temperatures, pressures and flow rates including that of the refrigerant. The unit allows construction of a cycle diagram on a pressure-enthalpy chart and the construction of performance curves at a wide range of evaporator and condenser pressures.

## **RE590** Ground Source Simulator

Where sufficient real-estate is available, ground sourced heat pumps give a large capture area with very little, if any visual impact. However the performance of the heat pump can be greatly affected by the materials used and the soil. The RE590 Ground Source Simulator is designed to be operated with either the R560 Water-Water Heat Pump or the R832 Air and water Heat Pump. The unit allows local soil, sands, gravel and water to be combined in a self contained unit to allow students to investigate how such a heat pump will perform in reality. The unit has its own circulating pump and temperatures and flow rates are recorded using the heat pump instrumentation.

## **P372** Jet Propulsion Test Stand

The Ramjet engine simulates the basic principles of all gas turbine engines but with no moving parts. The Pulsejet engine may be operated on the Jet Propulsion Test Stand P372 in place of the Ramjet engine. The Pulsejet, which operates over the entire range of the Ramjet simulated flight speeds, allows students to explore the characteristics of a device capable of generating static thrust.

For operation the ramjet requires incoming air to have a significant approach velocity in order to maintain combustion. The forward speed is simulated by a single stage blower delivering air through a nozzle mounted in front of the air intake. The use of gaseous fuel makes a low operating speed and therefore a moderate air supply requirement well within the reach of any engineering laboratory.



## OTHER EXPERIMENTS AVAILABLE

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| **S210** | Steam Turbine Module |
| **R515** | Mechanical Heat Pump |
| **R832** | Air and Water Heat Pump |


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