

Schedule of Requirements

THERMODYNAMICS LABORATORY- CHEMICAL ENGINEERING DEPARTMENT

S. No	Description	Quantity	Unit Price C&F	Total Price C&F
1	<p>Calorimeter The Unit should be designed for the accurate determination of the calorific value of liquid and solid hydrocarbons and other fuels.</p> <ul style="list-style-type: none"> • Specifications: • A temperature-controlled water jacket with a built-in circulating system and an electric heater. • Oxygen bomb with an oval bucket which fits into the insulating water jacket. • A built-in automatic system for charging the bomb with oxygen. • A high precision electronic thermometer. • A bright, color, touch screen display for data entry and operation control. • Special communication ports for printer, computer and network (LAN) connections. • SD memory card slots for simple program updates and test report archiving. • Removable Oxygen Vessel and Bucket • 4-7 tests per hour • Operator time per test is approximately 6-10 minutes • 0.05 – 0.1% precision class instrument <ul style="list-style-type: none"> ○ °C Temperature Resolution • 52 – 12000 calorie sample range • 0.05% Linearity across operating range • SD memory and TCP/IP network communications • USB Port for balance and printer connections • Updates via the Internet <p>Supplied with</p> <ul style="list-style-type: none"> • oxygen combustion vessel & installation kit • Oval Calorimeter Bucket • A high precision electronic thermometer • Water Handling System with Cooler <ul style="list-style-type: none"> • Gas Regulator (for Oxygen) • Installation and Service Manuals • Printer with cable • Built in Ethernet for data transfer to PC <p>Software The equipment must be accompanied educational Software, PC and all standard accessories necessary for computerized data acquisition/upgrade. It should also allow all relevant system parameters to be automatically recorded on a PC.</p> <p>Manual: The equipment must be accompanied by manual containing information regarding Services requirements, Assembly and Installation, Starting-up, Safety,</p>	01		

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	<p>Maintenance & Practices Manuals.</p> <p>Services and parts Agreement All standard accessories and spares for three years normal operation together with a full three year warranty should be the part of standard agreement.</p>			
2	<p>Boyle's Law Demonstrator The service unit should be capable to (a) Demonstration of Boyle's Law $pV = \text{Constant}$ for air and Other safe gases. (b) Investigation of the characteristic equation of a gas $pV = mRT$ at Ambient temperature.</p> <p>The Boyle's Law Demonstrator should be a bench mounted cylinder containing test gas and bourdon tube pressure gauge as well as a Pressure relief valve. All necessary valve, pressure gauge, measuring scale and thermometer for air pressure, temperature and volume Measurement.</p> <p>Technical Specification :- Pressuring glass cylinder with pressure relief valve. Diameter 10mm. Height 220mm approx. Compressor 230V, 50Hz, 500W Compressor should be used as vacuum pump.</p> <p>Software The equipment must be accompanied educational Software, PC and all standard accessories necessary for computerized data acquisition/upgrade. It should also allow all relevant system parameters to be automatically recorded on a PC.</p> <p>Manual: The equipment must be accompanied by manual containing information regarding Services requirements, Assembly and Installation, Starting-up, Safety, Maintenance & Practices Manuals.</p> <p>Services and parts Agreement All standard accessories and spares for three years normal operation together with a full three year warranty should be the part of standard agreement.</p>	01		
3	<p>Compressible Flow Base unit The main unit consists of an instrumentation and control console that supplies a variable flow of compressed air to the range of optional modules. The unit provides common instrumentation for all of the options. Specialised instruments are included as required with the modules. Unit should accompany air Compressor to supply compressed air at 900kN/m² (9 Bar Gauge) at up to</p>	02		

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	<p>8g/s (400 litre/min free air)</p> <p>Software The equipment must be accompanied educational Software, PC and all standard accessories necessary for computerized data acquisition/upgrade. It should also allow all relevant system parameters to be automatically recorded on a PC.</p> <p>Manual: The equipment must be accompanied by manual containing information regarding Services requirements, Assembly and Installation, Starting-up, Safety, Maintenance & Practices Manuals.</p> <p>Services and parts Agreement All standard accessories and spares for three years normal operation together with a full three year warranty should be the part of standard agreement.</p>			
<p>4</p>	<p>Impulse Turbine Module The unit should be capable to (a) Visual examination of a small impulse turbine. (b) Production of torque / speed and power / speed curves from a no Load speed of approx. 40,000 rev/min to stall and at a range of inlet pressure. (c) Comparison of turbine performance including specific air consumption when using throttle control or nozzle (4) control. (d) Application of the First Law of Thermodynamics to a simple open system undergoing a steady flow process. (e) Determination of the isentropic efficiency of a turbine and plotting the end state on a temperature / entropy diagram. (f) Determination of resisting torque due to bearing friction and disc aerodynamic friction at various speeds.</p> <p>An impulse turbine should be supplied with 4 separate nozzles and Control valves, a throttle valve and belt brake dynamometer. Inlet and outlet air temperatures should be recorded allowing the temperature drop due to work output should be measured.</p> <p>Inlet and outlet air pressures, temperatures and air flow rate, turbine Torque and speed should be recorded by a combination of instrumentation on the compressible base unit with the module.</p> <p>Software The equipment must be accompanied educational Software, PC and all standard accessories necessary for computerized data acquisition/upgrade. It should also allow all relevant system parameters to be automatically recorded on a PC.</p>	<p>01</p>		

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	<p>Manual: The equipment must be accompanied by manual containing information regarding Services requirements, Assembly and Installation, Starting-up, Safety, Maintenance & Practices Manuals.</p> <p>Services and parts Agreement All standard accessories and spares for three years normal operation together with a full three year warranty should be the part of standard agreement.</p>			
5	<p>Vortex Tube Refrigeration Module The unit should be capable to</p> <ul style="list-style-type: none"> • Demonstration of the ability to produce hot and cold air streams from a device with no moving parts • Production of performance curves for a vortex tube with:- • Variation of inlet pressure • Variation of hot and cold gas ratios • Variation of gas used(locally sourced) • Determination of the refrigerating effect and comparison of this with the estimated power required to drive the compressed air source <p>A compressed air vortex tube has two outlet ports that can be adjusted to vary the proportion of flow that leaves from the hot and cold exit points. Using a common compressed air source at ambient temperature, the cold stream can reach temperatures below -30°C and the hot stream temperatures above 50°C.</p> <p>The effect of air supply pressure on the performance can be investigated together with the overall refrigerating effect. The pressures, temperatures and air flow rate are recorded by a combination of instrumentation on the Compressible Flow Range</p> <p>Software The equipment must be accompanied educational Software, PC and all standard accessories necessary for computerized data acquisition/upgrade. It should also allow all relevant system parameters to be automatically recorded on a PC.</p> <p>Manual: The equipment must be accompanied by manual containing information regarding Services requirements, Assembly and Installation, Starting-up, Safety, Maintenance & Practices Manuals.</p> <p>Services and parts Agreement All standard accessories and spares for three years normal operation together with a full three year warranty should be the part of standard agreement.</p>	01		

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6	<p>Single Stage Compressor Test Unit The unit should be capable to</p> <ul style="list-style-type: none"> • Measurement of intake and delivery pressure • Measurement of air flow rate. • Measurement of all relevant system temperatures • Determination of the volumetric and isothermal efficiency. • Measurement of drive power and electric motor shaft power. <p>A bench mounted, belt driven, single stage reciprocating air compressor with a motor dynamometer allowing measurement of the motor shaft power. An intake vessel reduces intake air pulsations and a high pressure air receiver is connected to the compressor discharge. Intake and discharge air pressures are measured together with the air flow rate, motor drive speed and torque.</p> <p>Integral duplex thermocouples record all relevant system temperatures and are connected to a multi-way selector switch and digital temperature indicator.</p> <p>Software The equipment must be accompanied educational Software, PC and all standard accessories necessary for computerized data acquisition/upgrade. It should also allow all relevant system parameters to be automatically recorded on a PC.</p> <p>Manual: The equipment must be accompanied by manual containing information regarding Services requirements, Assembly and Installation, Starting-up, Safety, Maintenance & Practices Manuals.</p> <p>Services and parts Agreement All standard accessories and spares for three years normal operation together with a full three year warranty should be the part of standard agreement.</p>	01		
	Total Cost C&F			

Note:

- If a bidder submits bids on behalf of more than one Manufacturer, unless each such bid is accompanied by a separate Bid Form for each bid, and a bid security 2% of total quoted amount, when required, for each bid, and authorization from the respective Manufacturer, all such bids will be rejected as nonresponsive. in case of discrepancy between unit price and total price, the unit price shall prevail.
- Installation CDs and lab manual must be provided by bidder/supplier/authorize manufacturer at free of cost.

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- Free of cost training shall be provided by the supplier/bidder.

According to SPP rules 2010 (amended in 2013) of Rule 42:

For the purpose of comparison of bids quoted in different currencies, price shall be converted into a PKR. The rate of exchange shall be the selling rate prevailing seven working days before the date of opening of the bids, as notified by the State Bank of Pakistan;