DEPARTMENT OF CHEMICAL ENGINEERING

NATIONAL INSTITUTE OF TECHNOLOGY: TIRUCHIRAPPALLI - 620 015

21.02.2014

NITT/F.NO: UG-MOD 001 TO 025 and 035 to 045/PLAN 2013-14/CHE: Tender for SCADA /Computerized laboratory set up, March 14, 2014

The pre-bid conference was held on 21.02.2014 at 09.00 AM in the committee room of Chemical Engineering department to discuss the specification published in the tender.

The correction on EMD value: Rs. 4,00,000/- instead of Rs. 40,00,000/-

Based on the discussion, the committee recommends the following amendments to the specification. In addition, the committee recommends the delivery date has to be mentioned as 16 weeks subject to Export License clearance.

Tender Notification No.: NITT/F.No: UG MOD 001, 002, 003 /PLAN 2013-14/CHE dt. 14.02.2014

Amendment for laminar flow visualization and analysis unit, flowmeter demonstration unit, and computer controlled multipump testing bench:

Original specification in tender	**Amended specification**
Fluid Mechanics Lab Specifications Details Laminar Flow Visualization And Analysis Unit	
This unit should have the following:	
Anodized aluminium and steel structure.	No Change
Main metallic elements in stainless steel.	No Change
Process diagram in the front panel with similar distribution to the elements in the real unit.	No Change
Autonomous unit that is placed on the floor, equipped with wheels for mobility and with brake to immobilize the unit during the practices.	No Change
Laminar flow visualisation table.	No Change
Flow visualisation area.	No Change
8 sources and 8 drains.	No Change
Sources control valves.	No Change
Drains control valves.	No Change
Input control valves.	No Change
Tank of ink. Manifold of ink. Draining valve.	No Change
Tank at the input and output of the work section.	No Change
Grid to facilitate the visualisation of the lines of flow.	No Change
The top glass sheet of the visualisation area has handles to be able to lift it with easiness for its correct operation or to install the different hydrodynamic models.	No Change
The central drain of the inferior badge, placed in the visualisation area, has a double-shape, that is to say,	No Change

two orifices in vicinity.	
The control systems allow that every, or some, of the drains and sources are fed at the same time.	No Change
coloured liquid injection system, for a better visualization of the lines of flow.	No Change
Needles, placed among the glass sheets at the input.	No Change
The direction can be visualized with clarity.	No Change
Hydrodynamic models formed by:	No Change
3 circular models: 40, 60 and 80 mm diameter.	No Change
3 square models: 40, 60 and 80 mm of length.	No Change
1 wing-shape model.	No Change
The Unit can be completely purged, opening the emptying valves, placed in the base of the input and output tank.	No Change
Cables and Accessories, for normal operation.	No Change
Manuals: This unit should be supplied with the following manuals: Required Services, Assembly and Installation, Starting-up, Safety, Maintenance & Practices Manuals.	No Change
Give some other Practical Possibilities of the Unit like	No Change
Ideal flow around submerged bodies: Ideal flow associated to drains and sources:	No Change
1. Ideal flow around a cylinder.	No Change
2. Ideal flow around a surface.	No Change
Ideal flow in channels and edges:	No Change
3. Ideal flow in a convergent channel.	No Change
4. Ideal flow in a divergent channel.	No Change
5. Ideal flow through a curve of 90□.	No Change
6. Ideal flow through a sudden contraction.	No Change
7. Ideal flow through a sudden broadening.	No Change
FLOW METER DEMONSTRATION UNIT	No Change
A self-contained unit to demonstrate the characteristics of flow meters used in measurement of water flow through pipes or open channels.	No Change
Anodized aluminium structure and panel in painted steel.	No Change
Diagram in the panel with similar distribution to the elements in the real unit.	No Change
This unit should have wheels for its mobility.	No Change
Pipe circuit, including: Flow regulation valve, Several pressure measurement tappings, Air entrainment device, Flexible pipe to connect to the Hydraulics Bench.	No Change
Additional pipes to change the pipe circuit configuration.	No Change
Water manometer of 1 m. length and 2 Bourdon type manometers from 0 to 2.5 bar, precision 1%., to measure the pressure drop.	No Change

Flow meters are mounted in pipes that can be fitted into the unit test zone quickly and easily.	No Change
Meters included:	No Change
Orifice plate:	No Change
Made of transparent methacrylate.	No Change
Pipe diameter D_1: 35 mm. Orifice diameter D_2: 20 mm.	No Change
Venturi:	No Change
Made of transparent methacrylate.	No Change
Diameter h_1: 32 mm. Diameter h_2: 20 mm. Diameter h_3: 32 mm.	No Change
Distance between h_1 and h_2: 67.5 mm. Distance between h_2 and h_3: 87.5 mm.	No Change
Upstream narrowing: 14º.	No Change
Downstream narrowing: 21º.	No Change
Shunt gapmeter:	No Change
Made of steel.	No Change
Range: 0 to 20 m^3/h.	No Change
Pitot:	No Change
Made of transparent methacrylate.	No Change
Pipe diameter: 35 mm.	No Change
Electro-magnetic:	No Change
PVC pipe Dn32.	No Change
Range: 0.05 to 10 m/s.	No Change
Measure error: +/- 2%.	No Change
Linearity: +/- 1%.	No Change
Reproducibility: 0.25% of medium value.	No Change
Conductivity: minimum 20 mS/cm.	No Change
Operation temperature: 0 to 80ºC.	No Change
Quick and easy removal of pipes with test flow meters for evaluation and inspection.	No Change
Meters can be used independently to support research or student project work.	No Change
Hydraulics Bench:	No Change
Mobile hydraulic bench, made in polyester reinforced with fibreglass, and mounted on wheels for mobility.	No Change
Centrifugal pump, 0.55 KW, 2.5 Bar, 150 l./min., single phase 220V./ 50Hz or110V./ 60Hz. Pump breaker starting.	No Change
Sump tank capacity: 165 litres. Small channel: 8 litres.	No Change
Flow measurement: volumetric tank, gauged from 0 to 7 litres for low flow values and from 0 to 40 litres for high flow values.	No Change
Remote hand-operating dump valves in the base of the volumetric tank.	No Change
Level tube with a scale that shows the water level in the upper tank.	No Change

Flow stilling baffle for reducing the turbulence rate.	No Change
Manufactured with corrosion resistant materials ensuring a long life of the unit. Safety and contact light.	No Change
Cables and other Accessories required for normal operation.	No Change
Manuals: This unit is supplied with the following manuals: Required Services, Assembly and Installation, Starting-up, Safety, Maintenance & Practices Manuals.	No Change
Some Practical Possibilities of the Unit like	No Change
1. To demonstrate the important characteristics of fourteen types of flow meters used in the measurement of water flow through pipes or open channels.	No Change
2. Comparing the use, application and limitations of different types of flowmeters.	No Change
3. To study the application of Bernoulli's Theorem.	No Change
4. Understanding the principles on which various types of flow meters are based.	No Change
5. Implications of performance, convenience, accuracy, head loss, etc. on flow meters selection.	No Change
6. Effect of the air in the hydraulic stream on flow meter performance.	No Change
7. To use manometers to measure pressure drop.	No Change
8. Relating pressure drop across a flow meter to flow rate.	No Change
9. Measure error determination using the venturimeter.	No Change
10. Factor C determination in the venturi.	No Change
11. Strangulation determination in the venturi.	No Change
12. Measure error determination using the orifice plate.	No Change
13. Factor C determination in the orifice plate.	No Change
14. Effective area determination in the orifice plate.	No Change
15. Measure error determination using the Pitot tube.	No Change
16. Factor C determination in the Pitot tube.	No Change
17. Measure error using the shunt gapmeter.	No Change
18. Energy loss comparison in the different meters.	No Change
19. Measure error using the inferential multistream type flowmeter.	No Change
20. Broad crested weir.	No Change
COMPUTER CONTROLLED MULTIPUMP TESTING BENCH	No Change
(4 TYPES OF PUMPS)	No Change
1. Unit:	No Change
Unit designed to demonstrate the operating characteristics of several types of pumps.	No Change
Anodized aluminium structure and panels in painted	No Change

steel.	
Main metallic elements in stainless steel.	No Change
Diagram in the front panel with similar distribution to the elements in the real unit.	No Change
Fully instrumented self-contained unit.	No Change
The unit is mounted on a structure with a work surface covered by a plastic sheet.	No Change
It is equipped with rubber wheels to provide mobility and with brake to immobilize the unit during the practices.	No Change
4 Pumps (computer controlled):	Real time PID and on/off control for pumps, resistances, control valves, etc.
Centrifugal pump, Axial flow, pump, Gear pump & Peripherical pump:	
	5% bank guarantee for 5 years towards the supply of spare components after the warranty period.

Tender Notification No.: NITT/F.No: UG MOD 005 – 013 /PLAN 2013-14/CHE
Amendment for Linear Heat Conduction Module, Combined Free and Forced Convection and Radiation Module, Unsteady State Heat Transfer Module, Free and Forced Convection Heat Transfer Module, Computer controlled Film and Drop wise Condensation Unit, Plate Heat Exchanger, Shell & Tube Heat Exchanger, Jacketed Vessel Heat Exchanger, Coil Vessel Heat Exchanger:

	Original specification in tender	**Amended specification**
Computer Controlled basic	**1.1. Linear Heat Conduction Module:**	
Heat Transfer Modules	Bench-top unit to study the principles of linear heat conduction and to allow the conductivity of various solid conductors and insulators to be measured.	No Change
	It is given with interchangeable samples of different materials, different diameters and different insulating materials that allow to demonstrate the area effects, the conductivity and the combinations in series in the heat transmission process.	No Change
	Anodized aluminium structure and panel in painted steel.	No Change
	Diagram in the front panel with similar distribution to the elements in the real unit.	No Change
	Input heat section.	No Change
	Electric heater (heating resistance) with power regulation (150 W, temperature max.: 150ºC), computer controlled.	No Change
	Refrigeration section with a surface cooled by water.	No Change
	Central section:	No Change
	With brass of 25 mm of diameter.	No Change
	With brass of 10 mm of diameter.	No Change
	With stainless steel of 25 mm of diameter.	No Change
	Water flow sensor.	No Change
	Water flow regulation valve.	No Change
	Thermal paste is supplied to demonstrate the difference between poor and good thermal	No Change

contact between the sections.	
13 Temperature sensors, “J” type:	No Change
11 Temperature sensors distributed in the heating section, refrigeration section and central sections.	No Change
1 Temperature sensor at the water inlet of the unit.	No Change
1 Temperature sensor at the water outlet of the unit.	No Change
Power measurement from the computer (PC).	No Change
Cables and Accessories, for normal operation.	No Change
This unit is supplied with 8 manuals: Required Services, Assembly and Installation, Interface and Control Software, Starting-up, Safety, Maintenance, Calibration & Practices Manuals.	No Change
Computer Control Software:	No Change
Computer Control+ Data Acquisition+ Data Management Software for Linear Heat Conduction Module.	No Change
Compatible with actual Windows operating systems.	No Change
Graphic and intuitive simulation of the process in screen.	No Change
Compatible with the industry standards.	No Change
Registration and visualization of all process variables in an automatic and simultaneously way.	No Change
Flexible, open and multi control software, developed with actual windows graphic systems, acting simultaneously on all process parameters.	No Change
Analog and digital PID control. Menu for PID and set point selection required in the whole work range.	No Change
Management, processing, comparison and storage of data.	No Change
Sampling velocity up to 250,000 data per second guaranteed.	No Change

Calibration system for the sensors involved in the process.	No Change
It allows the registration of the alarms state and the graphic representation in real time.	No Change
Comparative analysis of the obtained data, after the process and modification of the conditions during the process.	No Change
Open software, allowing to the teacher to modify texts, instructions.	No Change
Teacher's and student's passwords to facilitate the teacher's control on the student, and allowing the access at different work levels.	No Change
-This module requires Control Interface Box and Data Acquisition Board (DAB).	No Change
Control Interface Box:	
This control interface is common for the modules and can work with one or several modules.	No Change
Control interface box with process diagram in the front panel and with the same distribution that the different elements located in the unit, for an easy understanding by the student.	No Change
All sensors, with their respective signals, are properly manipulated from -10V. to +10V computer output.	No Change
Sensors connectors in the interface have different pines numbers (from 2 to 16), to avoid connection errors.	No Change
Single cable between the control interface box and computer.	No Change
The unit control elements are permanently computer controlled, without necessity of changes or connections during the whole process test procedure.	No Change
Simultaneously visualization in the computer of all parameters involved in the process.	No Change
Calibration of all sensors involved in the process.	No Change
Real time curves representation about system responses.	No Change
Storage of all the process data and results in a file.	No Change

Graphic representation, in real time, of all the process/system responses.	No Change
All the actuators' values can be changed at any time from the keyboard allowing the analysis about curves and responses of the whole process.	No Change
All the actuators and sensors values and their responses are placed in only one computer screen.	No Change
Shield and filtered signals to avoid external interferences.	No Change
Real time PID control with flexibility of modifications from the computer keyboard of the PID parameters, at any moment during the process.	No Change
Real time PID and on/off control for pumps, compressors, resistances, control valves, etc.	No Change
Real time PID control for parameters involved in the process simultaneously.	No Change
Open control allowing modifications, at any time and in a real time , of parameters involved in the process simultaneously.	No Change
Proportional control, integral control and derivative control, based on the real PID mathematical formula, by changing the values, at any time, of the three control constants (proportional, integral and derivative constants).	No Change
Possibility of automatization of the actuators involved in the process.	No Change
Three safety levels, one mechanical in the unit, other electronic in the control interface and the third one in the control software.	No Change
Data Acquisition Board:	
Common for the DAC modules.	No Change
PCI EXPRESS Data acquisition board to be placed in a computer slot. Bus PCI EXPRESS	No Change
Analog input:	No Change
Number of channels= 16 single-ended or 8 differential.	No Change
Resolution=16 bits, 1 in 65536.	No Change

Sampling rate up to: 250 KS/s (Kilo samples per second).	No Change
Input range (V)= ±10 V.	No Change
Data transfers=DMA, interrupts, programmed I/0. Number of DMA channels=6.	No Change
Analog output:	No Change
Number of channels=2.	No Change
Resolution=16 bits, 1 in 65536.	No Change
Maximum output rate up to: 900 KS/s.	No Change
Output range(V)= ±10 V.	No Change
Data transfers=DMA, interrupts, programmed I/0.	No Change
Digital Input/Output:	No Change
Number of channels=24 inputs/outputs.	No Change
D0 or DI Sample Clock frequency: 0 to 100MHz.	No Change
Timing: Counter/timers=4. Resolution: Counter/timers: 32 bits.	No Change
Cables and Accessories, for normal operation.	
Manuals:	
This system is to be supplied with 8 manuals for each module: Required Services, Assembly and Installation, Interface and Control Software, Starting-up, Safety, Maintenance, Calibration & Practices Manuals.	No Change
High-End Computer is to be provided for software installation and data acquisition	No Change
Computer Aided Learning Software (Results Calculation and Analysis)	
This Computer Aided Learning Software (CAL) is a Windows basesoftware, simple and very easy to use.	No Change
CAL is a class assistant that helps in making the necessary calculations to extract the right conclusions from data obtained during the	No Change

experimental practices.	
CAL will perform the calculations.	No Change
CAL computes the value of all the variables involved.	No Change
It allows to plot and print the results. Between the plotting options, any variable can be represented against any other.	No Change
Different plotting displays.	No Change
It has a wide range of information, such as constant values, unit conversion factors and integral and derivative tables.	No Change
Faults Simulation System:	
The "FAULTS" mode consists on provoking several faults in the unit normal operation. The student must find them and, if possible, solve them.	No Change
There are several kinds of faults that can be grouped in three sections:	No Change
Faults affecting the sensors measure:	No Change
- An incorrect calibration is applied to them.	No Change
- Non-linearity.	No Change
Faults affecting the actuators: (These do not admit solutions. The student must just realize it and notify it.)	No Change
- Actuators canals interchange at any time during the program execution.	No Change
- Response reduction of an actuator.	No Change
Faults in the controls execution:	No Change
- Inversion of the performance in ON/OFF controls.	No Change
- Reduction or increase of the calculated total response.	No Change
- The action of some controls is annulled.	No Change
1.2 Combined Free and Forced Convection and Radiation Module:	
Bench-top unit to study the principles of combined free and forced convection with	No Change

radiation from a horizontal heater cylinder.	
It studies the variation experimented by the local heat transfer coefficient around of a horizontal cylinder. It is subject to a forced and a free convection.	No Change
Anodized aluminum structure and panel in painted steel.	No Change
Diagram in the front panel with similar distribution to the elements in the real unit.	No Change
Centrifugal fan (computer controlled) of 2650 rpm, which provides a maximum flow of 1200l/min. and allows to the air to reach a maximum velocity around 5 m/s.	No Change
Stainless steel conduct with interior cover, including:	No Change
Temperature sensor, “J” type, in order to measure the temperature of inlet air.	No Change
Flow sensor.	No Change
Temperature sensor, “J” type, in order to measure the temperature of outlet air.	No Change
Heater:	No Change
Copper cylinder with exterior cover: Interior resistance of 150W, temperature sensor “J” type for measuring the temperature of the cylinder.	No Change
Temperature sensor, “J” type.	No Change
Power measurement from the computer (PC).	No Change
Cables and Accessories, for normal operation.	No Change
This unit is supplied with 8 manuals: Required Services, Assembly and Installation, Interface and Control Software, Starting-up, Safety, Maintenance, Calibration & Practices Manuals.	No Change
Computer Control Software:	No Change
Computer Control+ Data Acquisition + Data Management Software for Combined Free and Forced Convection and Radiation Module.	No Change

Compatible with actual Windows operating systems.	No Change
Graphic and intuitive simulation of the process in screen.	No Change
Compatible with the industry standards.	No Change
Registration and visualization of all process variables in an automatic and simultaneously way.	No Change
Flexible, open and multicontrol software, developed with actual windows graphic systems, acting simultaneously on all process parameters.	No Change
Analog and digital PID control. Menu for PID and set point selection required in the whole work range.	No Change
Management, processing, comparison and storage of data.	No Change
Sampling velocity up to 250,000 data per second guaranteed.	No Change
Calibration system for the sensors involved in the process.	No Change
It allows the registration of the alarms state and the graphic representation in real time.	No Change
Comparative analysis of the obtained data, after the process and modification of the conditions during the process.	No Change
Open software, allowing to the teacher to modify texts, instructions.	No Change
Teacher's and student's passwords to facilitate the teacher's control on the student, and allowing the access at different work levels.	No Change
-This module requires Control Interface Box and Data Acquisition Board (DAB).	No Change
Control Interface Box:	
This control interface is common for the modules and can work with one or several modules.	No Change
Control interface box with process diagram in the front panel and with the same distribution that the different elements located in the unit, for an easy understanding by the student.	No Change

All sensors, with their respective signals, are properly manipulated from -10V. to +10V computer output.	No Change
Sensors connectors in the interface have different pines numbers (from 2 to 16), to avoid connection errors.	No Change
Single cable between the control interface box and computer.	No Change
The unit control elements are permanently computer controlled, without necessity of changes or connections during the whole process test procedure.	No Change
Simultaneously visualization in the computer of all parameters involved in the process.	No Change
Calibration of all sensors involved in the process.	No Change
Real time curves representation about system responses.	No Change
Storage of all the process data and results in a file.	No Change
Graphic representation, in real time, of all the process/system responses.	No Change
All the actuators' values can be changed at any time from the keyboard allowing the analysis about curves and responses of the whole process.	No Change
All the actuators and sensors values and their responses are placed in only one computer screen.	No Change
Shield and filtered signals to avoid external interferences.	No Change
Real time PID control with flexibility of modifications from the computer keyboard of the PID parameters, at any moment during the process.	No Change
Real time PID and on/off control for pumps, compressors, resistances, control valves, etc.	No Change
Real time PID control for parameters involved in the process simultaneously.	No Change
Open control allowing modifications, at any time and in a real time , of parameters involved in the process simultaneously.	No Change

Proportional control, integral control and derivative control, based on the real PID mathematical formula, by changing the values, at any time, of the three control constants (proportional, integral and derivative constants).	No Change
Possibility of automatization of the actuators involved in the process.	No Change
Three safety levels, one mechanical in the unit, other electronic in the control interface and the third one in the control software.	No Change
Data Acquisition Board:	
Common for the DAC module	No Change
PCI EXPRESS Data acquisition board to be placed in a computer slot. Bus PCI EXPRESS	No Change
Analog input:	No Change
Number of channels= 16 single-ended or 8 differential.	No Change
Resolution=16 bits, 1 in 65536.	No Change
Sampling rate up to: 250 KS/s (Kilo samples per second).	No Change
Input range (V)= ±10 V.	No Change
Data transfers=DMA, interrupts, programmed I/0. Number of DMA channels=6.	No Change
Analog output:	No Change
Number of channels=2.	No Change
Resolution=16 bits, 1 in 65536.	No Change
Maximum output rate up to: 900 KS/s.	No Change
Output range(V)= ±10 V.	No Change
Data transfers=DMA, interrupts, programmed I/0.	No Change
Digital Input/Output:	No Change
Number of channels=24 inputs/outputs.	No Change
D0 or DI Sample Clock frequency: 0 to 100MHz.	No Change
Timing: Counter/timers=4. Resolution:	No Change

Counter/timers: 32 bits.	
Cables and Accessories, for normal operation.	
Manuals:	
This system is to be supplied with 8 manuals for each module: Required Services, Assembly and Installation, Interface and Control Software, Starting-up, Safety, Maintenance, Calibration & Practices Manuals.	No Change
High-End Computer is to be provided for software installation and data acquisition	No Change
Computer Aided Learning Software (Results Calculation and Analysis)	
This Computer Aided Learning Software (CAL) is a Windows base software, simple and very easy to use.	No Change
CAL is a class assistant that helps in making the necessary calculations to extract the right conclusions from data obtained during the experimental practices.	No Change
CAL will perform the calculations.	No Change
CAL computes the value of all the variables involved.	No Change
It allows to plot and print the results. Between the plotting options, any variable can be represented against any other.	No Change
Different plotting displays.	No Change
It has a wide range of information, such as constant values, unit conversion factors and integral and derivative tables.	No Change
Faults Simulation System:	
The "FAULTS" mode consists on provoking several faults in the unit normal operation. The student must find them and, if possible, solve them.	No Change
There are several kinds of faults that can be grouped in three sections:	No Change
Faults affecting the sensors measure:	No Change
- An incorrect calibration is applied to them.	No Change

- Non-linearity.	No Change
Faults affecting the actuators: (These do not admit solutions. The student must just realize it and notify it.)	No Change
- Actuators canals interchange at any time during the program execution.	No Change
- Response reduction of an actuator.	No Change
Faults in the controls execution:	No Change
- Inversion of the performance in ON/OFF controls.	No Change
- Reduction or increase of the calculated total response.	No Change
- The action of some controls is annulled.	No Change
1.3 Unsteady State Heat Transfer Module:	
Bench-top unit designed to allow practices and exercises to be performed in unsteady state heat transfer.	No Change
It studies the transient conduction with convection. Using different shapes (rectangular slabs, spheres and cylinders) of different materials, the temperature of other shapes and materials can be predicted.	No Change
Anodized aluminium structure and panel in painted steel.	No Change
Diagram in the front panel with similar distribution to the elements in the real unit.	No Change
Dual concentric open top tanks filled with water, total tank capacity: 40 litres, 300 x 350 x 400 mm. concentric tank: 1.2 l., diameter: 70 mm.	No Change
Different shapes of different size and material are studied:	No Change
Brass sphere (diameter: 40 mm).	No Change
Brass sphere (diameter: 25 mm).	No Change
Stainless steel sphere (diameter: 40 mm).	No Change
Stainless steel sphere (diameter: 25 mm).	No Change
Brass cylinder (diameter: 15 mm, length: 150 mm).	No Change

Stainless steel cylinder (diameter: 15 mm, length: 150 mm).	No Change
Aluminium rectangular slab (40 x 10 x 150 mm).	No Change
Stainless steel rectangular slab (40 x 10 x 150 mm).	No Change
Each shape is fitted with a temperature sensor at the center of the object.	No Change
The shapes are installed in special holder at the center of the top cover of the large tank. The holder also has a temperature sensor that enters in the water bath at the same time as the shape.	No Change
Heating element (immersion heater) with a power of 3000 W, the resistance is protected by a 16 A fuse. The high power allows reaching the steady state faster. It is computer controlled.	No Change
Water pump with variable speed. It allows to reach a maximum flow of 4 l./min.	No Change
3 Temperature sensors “J“ type allow controlling the stability of the temperature of the water bath.	No Change
Flow sensor.	No Change
2 Temperature sensors “J“ type:	No Change
The first one permits to record the evolution of the temperature of the shape at its center.	No Change
The second one, works as a stopwatch, it will indicate the precise moment in which the shape is submerged.	No Change
Level switch.	No Change
Power measurement from the computer (PC).	No Change
Cables and Accessories, for normal operation.	No Change
This unit is supplied with 8 manuals: Required Services, Assembly and Installation, Interface and Control Software, Starting-up, Safety, Maintenance, Calibration & Practices Manuals.	No Change
Computer Control Software:	No Change

Computer Control+Data Acquisition+ Data Management Software for Unsteady State Heat Transfer Module.	No Change
Compatible with actual Windows operating systems.	No Change
Graphic and intuitive simulation of the process in screen.	No Change
Compatible with the industry standards.	No Change
Registration and visualization of all process variables in an automatic and simultaneously way.	No Change
Flexible, open and multicontrol software, developed with actual windows graphic systems, acting simultaneously on all process parameters.	No Change
Analog and digital PID control.	No Change
Menu for PID and set point selection required in the whole work range.	No Change
Management, processing, comparison and storage of data.	No Change
Sampling velocity up to 250,000 data per second guaranteed.	No Change
Calibration system for the sensors involved in the process.	No Change
It allows the registration of the alarms state and the graphic representation in real time.	No Change
Comparative analysis of the obtained data, after the process and modification of the conditions during the process.	No Change
Open software, allowing to the teacher to modify texts, instructions.	No Change
Teacher's and student's passwords to facilitate the teacher's control on the student, and allowing the access at different work levels.	No Change
-This module requires Control Interface Box and Data Acquisition Board (DAB).	No Change
Control Interface Box:	
This control interface is common for the DAC modules and can work with one or several modules.	No Change

Control interface box with process diagram in the front panel and with the same distribution that the different elements located in the unit, for an easy understanding by the student.	No Change
All sensors, with their respective signals, are properly manipulated from -10V. to +10V computer output.	No Change
Sensors connectors in the interface have different pines numbers (from 2 to 16), to avoid connection errors.	No Change
Single cable between the control interface box and computer.	No Change
The unit control elements are permanently computer controlled, without necessity of changes or connections during the whole process test procedure.	No Change
Simultaneously visualization in the computer of all parameters involved in the process.	No Change
Calibration of all sensors involved in the process.	No Change
Real time curves representation about system responses.	No Change
Storage of all the process data and results in a file.	No Change
Graphic representation, in real time, of all the process/system responses.	No Change
All the actuators' values can be changed at any time from the keyboard allowing the analysis about curves and responses of the whole process.	No Change
All the actuators and sensors values and their responses are placed in only one computer screen.	No Change
Shield and filtered signals to avoid external interferences.	No Change
Real time PID control with flexibility of modifications from the computer keyboard of the PID parameters, at any moment during the process.	No Change
Real time PID and on/off control for pumps, compressors, resistances, control valves, etc.	No Change
Real time PID control for parameters involved in the process simultaneously.	No Change

Open control allowing modifications, at any time and in a real time , of parameters involved in the process simultaneously.	No Change
Proportional control, integral control and derivative control, based on the real PID mathematical formula, by changing the values, at any time, of the three control constants (proportional, integral and derivative constants).	No Change
Possibility of automatization of the actuators involved in the process.	No Change
Three safety levels, one mechanical in the unit, other electronic in the control interface and the third one in the control software.	No Change
Dimensions (approx.): 490 x 330 x 310 mm. Weight: 10Kg.	No Change
Data Acquisition Board:	
Common for the DAC modules .	No Change
PCI EXPRESS Data acquisition board to be placed in a computer slot. Bus PCI EXPRESS	No Change
Analog input:	No Change
Number of channels= 16 single-ended or 8 differential.	No Change
Resolution=16 bits, 1 in 65536.	No Change
Sampling rate up to: 250 KS/s (Kilo samples per second).	No Change
Input range (V)= ±10 V.	No Change
Data transfers=DMA, interrupts, programmed I/0. Number of DMA channels=6.	No Change
Analog output:	No Change
Number of channels=2.	No Change
Resolution=16 bits, 1 in 65536.	No Change
Maximum output rate up to: 900 KS/s.	No Change
Output range(V)= ±10 V.	No Change
Data transfers=DMA, interrupts, programmed I/0.	No Change
Digital Input/Output:	No Change

Number of channels=24 inputs/outputs.	No Change
D0 or DI Sample Clock frequency: 0 to 100MHz.	No Change
Timing: Counter/timers=4. Resolution: Counter/timers: 32 bits.	No Change
Cables and Accessories, for normal operation.	
Manuals:	
This system is supplied with 8 manuals for each module: Required Services, Assembly and Installation, Interface and Control Software, Starting-up, Safety, Maintenance, Calibration & Practices Manuals.	No Change
High-End Computer is to be provided for software installation and data acquisition	No Change
Computer Aided Learning Software (Results Calculation and Analysis)	
This Computer Aided Learning Software (CAL) is a Windows base software, simple and very easy to use.	No Change
CAL is a class assistant that helps in making the necessary calculations to extract the right conclusions from data obtained during the experimental practices.	No Change
CAL will perform the calculations.	No Change
CAL computes the value of all the variables involved.	No Change
It allows to plot and print the results. Between the plotting options, any variable can be represented against any other.	No Change
Different plotting displays.	No Change
It has a wide range of information, such as constant values, unit conversion factors and integral and derivative tables.	No Change
Faults Simulation System:	
The "FAULTS" mode consists on provoking several faults in the unit normal operation. The student must find them and, if possible, solve them.	No Change
There are several kinds of faults that can be grouped in three sections:	No Change

Faults affecting the sensors measure:	No Change
- An incorrect calibration is applied to them.	No Change
- Non-linearity.	No Change
Faults affecting the actuators: (These do not admit solutions. The student must just realise it and notify it.)	No Change
- Actuators canals interchange at any time during the program execution.	No Change
- Response reduction of an actuator.	No Change
Faults in the controls execution:	No Change
- Inversion of the performance in ON/OFF controls.	No Change
- Reduction or increase of the calculated total response.	No Change
- The action of some controls is annulled.	No Change
1.4 Free and Forced Convection Heat Transfer Module:	
This unit allows to study the efficiency of different exchangers, analyzing the heat transmission coefficients of each of the exchangers exposed to different airflows. A fan placed in the upper part of the tunnel allows controlling the airflow that goes through the tunnel.	No Change
Anodized aluminum structure and panels in painted steel.	No Change
Diagram in the front panel with similar distribution to the elements in the real unit.	No Change
Stainless steel tunnel of rectangular section, 700 mm long, painted and resistant to corrosion. In the tunnel three type of different heat exchangers can be set. Methacrylate viewer that allows a good visualization of the exchanger that is in use.	No Change
Stabilizers to guarantee an uniform air flux.	No Change
9 Temperature sensors,“J” type:	No Change
2 temperature sensors measure the air temperature at the inlet and outlet of the area	No Change

of heat exchange.	
Temperature measurements, at different distances of the base of the dowels and blade exchangers, are made by other five temperature sensors that are introduced by one side of the tunnel.	No Change
1 temperature sensor for the heating resistance.	No Change
1 temperature sensor in the exchangers.	No Change
Maximum working temperature: 150ºC.	No Change
Flow sensor, for measuring the air flow generated. Range: 0-5 l./min.	No Change
3 Aluminium exchangers:	No Change
Flat heat exchanger (100 x 100 mm).	No Change
Dowels heat exchanger. 17 dowels, each one of 10 mm diameter and 125 mm longitude.	No Change
Blade heat exchanger. 9 blades, each one of 100x125 mm.	No Change
Heating resistance of 150W for each exchanger, computer controlled.	No Change
Variable speed fan, computer controlled, which generates air flux through the tunnel. Range: 0-1200 l/min.	No Change
Cables and Accessories, for normal operation.	No Change
This unit is supplied with 8 manuals: Required Services, Assembly and Installation, Interface and Control Software, Starting-up, Safety, Maintenance, Calibration & Practices Manuals.	No Change
Computer Control Software:	No Change
Computer Control+Data Acquisition+ Data Management Software for Free and Forced Convection Heat Transfer Module.	No Change
Compatible with actual Windows operating systems.	No Change
Graphic and intuitive simulation of the process in screen.	No Change
Compatible with the industry standards.	No Change

Registration and visualization of all process variables in an automatic and simultaneously way.	No Change
Flexible, open and multicontrol software, developed with actual windows graphic systems, acting simultaneously on all process parameters.	No Change
Analog and digital PID control. Menu for PID and set point selection required in the whole work range.	No Change
Management, processing, comparison and storage of data.	No Change
Sampling velocity up to 250,000 data per second guaranteed.	No Change
Calibration system for the sensors involved in the process.	No Change
It allows the registration of the alarms state and the graphic representation in real time.	No Change
Comparative analysis of the obtained data, after the process and modification of the conditions during the Process.	No Change
Open software, allowing to the teacher to modify texts, instructions.	No Change
Teacher's and student's passwords to facilitate the teacher's control on the student, and allowing the access at different work levels.	No Change
-This module requires Control Interface Box and Data Acquisition Board (DAB)	No Change
Control Interface Box:	
This control interface is common for the DAC modules and can work with one or several modules.	No Change
Control interface box with process diagram in the front panel and with the same distribution that the different elements located in the unit, for an easy understanding by the student.	No Change
All sensors, with their respective signals, are properly manipulated from -10V. to +10V computer output.	No Change
Sensors connectors in the interface have different pines numbers (from 2 to 16), to avoid connection errors.	No Change

Single cable between the control interface box and computer.	No Change
The unit control elements are permanently computer controlled, without necessity of changes or connections during the whole process test procedure.	No Change
Simultaneously visualization in the computer of all parameters involved in the process.	No Change
Calibration of all sensors involved in the process.	No Change
Real time curves representation about system responses.	No Change
Storage of all the process data and results in a file.	No Change
Graphic representation, in real time, of all the process/system responses.	No Change
All the actuators' values can be changed at any time from the keyboard allowing the analysis about curves and responses of the whole process.	No Change
All the actuators and sensors values and their responses are placed in only one computer screen.	No Change
Shield and filtered signals to avoid external interferences.	No Change
Real time PID control with flexibility of modifications from the computer keyboard of the PID parameters, at any moment during the process.	No Change
Real time PID and on/off control for pumps, compressors, resistances, control valves, etc.	No Change
Real time PID control for parameters involved in the process simultaneously.	No Change
Open control allowing modifications, at any time and in a real time , of parameters involved in the process simultaneously.	No Change
Proportional control, integral control and derivative control, based on the real PID mathematical formula, by changing the values, at any time, of the three control constants (proportional, integral and derivative constants).	No Change
Possibility of automatization of the actuators	No Change

involved in the process.	
Three safety levels, one mechanical in the unit, other electronic in the control interface and the third one in the control software.	No Change
DAB. Data Acquisition Board:	
Common for the DAC module.	No Change
PCI EXPRESS Data acquisition board to be placed in a computer slot. Bus PCI EXPRESS	No Change
Analog input:	No Change
Number of channels= 16 single-ended or 8 differential.	No Change
Resolution=16 bits, 1 in 65536.	No Change
Sampling rate up to: 250 KS/s (Kilo samples per second).	No Change
Input range (V)= ±10 V.	No Change
Data transfers=DMA, interrupts, programmed I/0. Number of DMA channels=6.	No Change
Analog output:	No Change
Number of channels=2.	No Change
Resolution=16 bits, 1 in 65536.	No Change
Maximum output rate up to: 900 KS/s.	No Change
Output range(V)= ±10 V.	No Change
Data transfers=DMA, interrupts, programmed I/0.	No Change
Digital Input/Output:	No Change
Number of channels=24 inputs/outputs.	No Change
D0 or DI Sample Clock frequency: 0 to 100MHz.	No Change
Timing: Counter/timers=4. Resolution: Counter/timers: 32 bits.	No Change
Cables and Accessories, for normal operation.	
Manuals:	

This system is to be supplied with 8 manuals for each module: Required Services, Assembly and Installation, Interface and Control Software, Starting-up, Safety, Maintenance, Calibration & Practices Manuals.	No Change
High-End Computer is to be provided for software installation and data acquisition	No Change
Computer Aided Learning Software (Results Calculation and Analysis)	
This Computer Aided Learning Software (CAL) is a windows base software, simple and very easy to use.	No Change
CAL is a class assistant that helps in making the necessary calculations to extract the right conclusions from data obtained during the experimental practices.	No Change
CAL will perform the calculations.	No Change
CAL computes the value of all the variables involved.	No Change
It allows to plot and print the results. Between the plotting options, any variable can be represented against any other.	No Change
Different plotting displays.	No Change
It has a wide range of information, such as constant values, unit conversion factors and integral and derivative tables.	No Change
Faults Simulation System:	
The "FAULTS" mode consists on provoking several faults in the unit normal operation. The student must find them and, if possible, solve them.	No Change
There are several kinds of faults that can be grouped in three sections:	No Change
Faults affecting the sensors measure:	No Change
- An incorrect calibration is applied to them.	No Change
- Non-linearity.	No Change
Faults affecting the actuators: (These do not admit solutions. The student must just realise it and notify it.)	No Change

	- Actuators canals interchange at any time during the program execution.	No Change
	- Response reduction of an actuator.	No Change
	Faults in the controls execution:	No Change
	- Inversion of the performance in ON/OFF controls.	No Change
	- Reduction or increase of the calculated total response.	No Change
	- The action of some controls is annulled.	No Change
	1.5.Computer controlled Film and Drop wise Condensation Unit.	
	1.5.1 Base Unit:	
	Bench-top unit, which has its own generator and air extraction system, as well as condensers to provide drop wise and film wise condensation.	No Change
	Anodized aluminum structure and panels in painted steel (epoxy paint).	No Change
	Main metallic elements in stainless steel.	No Change
	Diagram in the front panel with similar distribution to the elements in the real unit.	No Change
	Steam chamber: thick-walled glass cylinder with aluminum ends and P.T.F.E. seals. Capacity: approximately 0.5 – 1 Kg. of distilled water.	No Change
	2 Water cooled condensers, mounted in the upper cylinder cover. Dimensions: 12.7 mm. external diameter and 90 mm. effective lenght. They are specially designed and manufactured of cooper, incorporating a heat exchanger in order to reduce the surface temperature variation to a minimum:	No Change
	Drop wise condenser-gold plated.	No Change
	Film wise condenser-natural finish.	No Change
	Each condenser is provided with three connected temperature sensors (”K” type) to measure the mean metal temperature, and two temperature sensors (”J” type) to measure the inlet and outlet water temperatures,	No Change

	respectively.	
	Electric heating element (3 KW. resistance) with thermal protection. Power of the resistance computer controlled.	No Change
	Air extraction system, composed by air cooler, separator and water jet vacuum pump with the necessary valves.	No Change
	Pressure sensor, to measure the chamber pressure. Range: 0-6 bar.	No Change
	2 Water flow sensors (0-6.5 l./min.), to measure the water flow rate through the condensers.	No Change
	Safety: Pressure relief valve fitted to upper cylinder cover. Pressure switch (fix to 2 bar). Heater thermal protection (120ºC thermostat).	No Change
	All electrical elements/components are earthed and fused.	No Change
	1.5.2. Control Interface Box :	
	Control interface box with process diagram in the front panel and with the same distribution that the different elements located in the unit, for an easy understanding by the student.	No Change
	All sensors, with their respective signals, are properly manipulated from -10V. to +10V. computer output. Sensors connectors in the interface have different pines numbers (from 2 to 16), to avoid connection errors. Single cable between the control interface box and computer.	No Change
	The unit control elements are permanently computer controlled, without necessity of changes or connections during the whole process test procedure.Simultaneously visualization in the computer of all parameters involved in the process. Calibration of all sensors involved in the process.	No Change

	Real time curves representation about system responses. Storage of all the process data and results in a file. Graphic representation, in real time, of all the process/system responses. All the actuators' values can be changed at any time from the keyboard allowing the analysis about curves and responses of the whole process. All the actuators and sensors values and their responses are placed in only one computer screen.	No Change
	Shield and filtered signals to avoid external interferences.	No Change
	Real time PID control with flexibility of modifications from the computer keyboard of the PID parameters, at any moment during the process. Real time PID and on/off control for pumps, compressors, resistances, control valves, etc. Real time PID control for parameters involved in the process simultaneously. Proportional control, integral control and derivative control, based on the real PID mathematical formula, by changing the values, at any time, of the three control constants (proportional, integral and derivative constants).	No Change
	Possibility of automatization of the actuators involved in the process.	No Change
	Open control allowing modifications, at any time and in a real time, of parameters involved in the process simultaneously.	No Change
	Three safety levels, one mechanical in the unit, other electronic in control interface and the third one in the control software.	No Change
	1.5.3. Data Acquisition Board:	
	PCI EXPRESS Data acquisition board to be placed in a computer slot. Bus PCI EXPRESS	No Change
	Analog input: Number of channels= 16 single-ended or 8 differential. Resolution=16 bits, 1 in 65536.	No Change
	Sampling rate up to: 250 KS/s (Kilo samples per second). Input range (V)=± 10V.	No Change
	Data transfers=DMA, interrupts, programmed I/0. Number of DMA	No Change

	channels=6.	
	Analog output: Number of channels=2. Resolution=16 bits, 1 in 65536. Maximum output rate up to: 900 KS/s.	No Change
	Output range(V)=±10. Data transfers=DMA, interrupts, programmed I/0.	No Change
	Digital Input/Output: Number of channels=24 inputs/outputs. D0 or DI Sample Clock frequency:0 to 100 MHz.	No Change
	Timing: Counter/timers=4. Resolution: Counter/timers:32 bits.	No Change
	1.5.4.. Computer Control+ Data Acquisition +Data Management Software:	
	Compatible with actual Windows operating systems. Graphic and intuitive simulation of the process in screen. Compatible with the industry standards. Registration and visualization of all process variables in an automatic and simultaneously way. Flexible, open and multicontrol software, developed with actual windows graphic systems, acting simultaneously on all process parameters.	No Change
	Analog and digital PID control. Menu for PID and set point selection required in the whole work range.	No Change
	Management, processing, comparison and storage of data. Sampling velocity up to 250,000 data per second guaranteed. Calibration system for the sensors involved in the process.	No Change
	It allows the registration of the alarms state and the graphic representation in real time. Comparative analysis of the obtained data, after to the process and modification of the conditions during the process.	No Change
	Open software, allowing to the teacher to modify texts, instructions. Teacher's and student's passwords to facilitate the teacher's control on the student, and allowing the access at different work levels.	No Change
	This unit allows that the 30 students of the classroom can visualize simultaneously all results and manipulation of the unit, during	No Change

	the process, by using a projector.	
	1.5.5 Cables and Accessories, for normal operation.	
	1.5.6. Manuals: This unit is to be supplied with 8 manuals:	
	Required Services, Assembly and Installation, Interface and Control Software, Starting-up, Safety, Maintenance, Calibration & Practices Manuals.	No Change
	High-End Computer is to be provided for software installation and data acquisition	No Change
	1.5.7.CAL Computer Aided Learning Software (Results Calculation and Analysis)	
	This Computer Aided Learning Software (CAL) is a Windows base software, simple and very easy to use.	No Change
	CAL is a class assistant that helps in making the necessary calculations to extract the right conclusions from data obtained during the experimental practices.	No Change
	CAL will perform the calculations.	No Change
	CAL computes the value of all the variables involved.	No Change
	It allows to plot and print the results. Between the plotting options, any variable can be represented against any other.	No Change
	Different plotting displays.	No Change
	It has a wide range of information, such as constant values, unit conversion factors and integral and derivative tables.	No Change
	1.5.8. Faults Simulation System:	
	The "FAULTS" mode consists on provoking several faults in the unit normal operation. The student must find them and, if possible, solve them.	No Change
	There are several kinds of faults that can be grouped in three sections:	No Change
	Faults affecting the sensors measure:	No Change

	- An incorrect calibration is applied to them.	No Change
	- Non-linearity.	No Change
	Faults affecting the actuators: (These do not admit solutions. The student must just realise it and notify it.)	No Change
	- Actuators canals interchange at any time during the program execution.	No Change
	- Response reduction of an actuator.	No Change
	Faults in the controls execution:	No Change
	- Inversion of the performance in ON/OFF controls.	No Change
	- Reduction or increase of the calculated total response.	No Change
	- The action of some controls is annulled.	No Change
	1.6. Computer Controlled Heat Excahngers	No Change
	1.6.1. Plate Heat Exchanger:	
	This Plate Heat Exchanger allows the study of heat transfer between hot and cold water through alternate channels formed between parallel plates.	No Change
	The exchanger allows measuring cold and hot temperatures at the inlet and outlet of the exchanger.	No Change
	Anodized aluminium structure and panel in painted steel.	No Change
	Main metallic elements in stainless steel.	No Change
	Diagram in the front panel with similar distribution to the elements in the real unit.	No Change
	Formed by corrugated stainless steel plates. It can be dismantled to observe its structure.	No Change
	4 Ports or connections of hot and cold water input and output.	No Change
	Maximum flow: $12m^3/h$.	No Change
	Maximum work pressure: 10 bar.	No Change
	Maximum work temperature: 100º C.	No Change
	Minimum work temperature: 0º C.	No Change

	Maximum number of plates: 20.	No Change
	Internal circuit capacity: 0.176 l.	No Change
	External circuit capacity: 0.22 l.	No Change
	Area: 0.32m^2.	No Change
	4 Temperature sensors (“J” type):	No Change
	2 Temperature sensors for measuring cold water temperature (inlet and outlet).	No Change
	2 Temperature sensors for measuring hot water temperature (inlet and outlet).	No Change
	Easy connection to the Base Service Unit.	No Change
	This unit is to be supplied with 8 manuals: Required Services, Assembly and Installation, Interface and Control Software, Starting-up, Safety, Maintenance, Calibration & Practices Manuals.	No Change
	Computer Control Software:	No Change
	Computer Control+Data Acquisition+Data Management Software for Plate Heat Exchanger.	No Change
	Compatible with the industry standards.	No Change
	Flexible, open and multicontrolsoftware, developed with actual windows graphic systems, acting simultaneously on all process parameters.	No Change
	Analog and digital PID control.	No Change
	PID menu and set point selection required in the whole work range.	No Change
	Management, processing, comparison and storage of data.	No Change
	Sampling velocity up to 250 KS/s (kilo samples per second).	No Change
	Calibration system for the sensors involved in the process.	No Change
	It allows the registration of the alarms state and the graphic representation in real time.	No Change
	Open software, allowing the teacher to modify texts, instructions. Teacher’s and	No Change

	student's passwords to facilitate the teacher's control on the student, and allowing the access to different work levels.	
	Base Service Unit:	
	This unit is common for Heat Exchangers type "TI" and can work with one or several exchangers.	No Change
	This unit performs the following tasks:	No Change
	Heating the water.	No Change
	Pumping of hot water.	No Change
	Change in the direction of cold water flows.	No Change
	Cold and hot water measures.	No Change
	Anodized aluminium structure and panel in painted steel.	No Change
	Main metallic elements in stainless steel.	No Change
	Diagram in the front panel with similar distribution to the elements in the real unit.	No Change
	Stainless steel tank (30 l.), equipped with:	No Change
	Electric heating resistance (3000W) with thermostat (70º C), to heat the water, computer controlled. PID temperature control.	No Change
	Temperature sensor ("J" type) to measure the water temperature.	No Change
	Level switch to control the water level in the tank.	No Change
	Stainless steel cover to avoid the contact with hot water. In this cover there is a hole that allows us to visualize the water level and also to stuff the tank.	No Change
	Draining water valve.	No Change
	Centrifugal pump with speed control from computer, range: 0 - 3 l./min.	No Change
	2 Flow sensors, one for hot water and the other for cold water, range: 0 - 6.5 l./min.	No Change
	Control valve for the cold water.	No Change
	4 Ball valves that, depending on how we manipulate them, give us parallel or	No Change

	crosscurrent flux in the exchanger.	
	Regulation pressure valve to avoid the introduction of too much pressure in the exchangers, tared at 0.6bar.	No Change
	4 Flexible tubes to connect with the different exchangers.	No Change
	Cables and accessories, for normal operation.	No Change
	Dimensions (approx): 1100 x 630 x 500 mm. (43.30 x 24.80 x 19.68 inches). Weight: 50 Kg. (110.2 pounds).	No Change
	Control Interface Box:	
	This control interface is common for Heat Exchangers and can work with one or several exchangers.	No Change
	Control interface box with process diagram in the front panel. The unit control elements are permanently computer controlled.	No Change
	Simultaneous visualization in the computer of all parameters involved in the process.	No Change
	Calibration of all sensors involved in the process. Real time curves representation about system responses.	No Change
	All the actuators' values can be changed at any time from the keyboard allowing the analysis about curves and responses of the whole process.	No Change
	Shield and filtered signals to avoid external interferences.	No Change
	Real time PID control with flexibility of modifications from the computer keyboard of the PID parameters, at any moment during the process.	No Change
	Real time PID control for parameters involved in the process simultaneously.	No Change
	Proportional control, integral control and derivative control, based on the real PID mathematical formula, by changing the values, at any time, of the three control constants (proportional, integral and derivative constants).	No Change
	Open control allowing modifications, at any moment and in real time, of parameters	No Change

	involved in the process simultaneously.	
	Three safety levels, one mechanical in the unit, another electronic in the control interface and the third one in the control software.	No Change
	Data Acquisition Board:	
	PCI EXPRESS Data acquisition board to be placed in a computer slot. Bus PCI EXPRESS	No Change
	Analog input: Number of channels= 16 single-ended or 8 differential. Resolution=16 bits, 1 in 65536.	No Change
	Sampling rate up to: 250 KS/s (Kilo samples per second). Input range (V)=± 10V.	No Change
	Data transfers=DMA, interrupts, programmed I/0. Number of DMA channels=6.	No Change
	Analog output: Number of channels=2. Resolution=16 bits, 1 in 65536. Maximum output rate up to: 900 KS/s.	No Change
	Output range(V)=±10. Data transfers=DMA, interrupts, programmed I/0.	No Change
	Digital Input/Output: Number of channels=24 inputs/outputs. D0 or DI Sample Clock frequency:0 to 100 MHz.	No Change
	Timing:Counter/timers=4. Resolution: Counter/timers:32 bits.	No Change
	High-End Computer is to be provided for software installation and data acquisition	No Change
	Cables and Accessories, for normal operation.	
	Manuals: This system is to be supplied with 8 manuals for each Heat Exchanger: Required service, Assembly and Installation, Interface and Control Software, Starting-up, Safety, Maintenance, Calibration & Practices Manuals	No Change
	Faults Simulation System:	
	The "FAULTS" mode consists on provoking several faults in the unit normal operation. The student must find them and, if possible, solve them.	No Change
	There are several kinds of faults that can be grouped in three sections:	No Change

	Faults affecting the sensors measure:	No Change
	- An incorrect calibration is applied to them.	No Change
	- Non-linearity.	No Change
	Faults affecting the actuators: (These do not admit solutions. The student must just realise it and notify it.)	No Change
	- Actuators canals interchange at any time during the program execution.	No Change
	- Response reduction of an actuator.	No Change
	Faults in the controls execution:	No Change
	- Inversion of the performance in ON/OFF controls.	No Change
	- Reduction or increase of the calculated total response.	No Change
	- The action of some controls is annulled.	No Change
	1.6.2. Shell & Tube Heat Exchanger:	
	It consists on a group of tubes inside the heat exchanger. The hot water flows through the internal tubes and the cooling water circulates through the space between the internal tubes and the shell.	No Change
	There are traverse baffles placed in the shell to guide the cold water to maximize the heat transfer.	No Change
	Anodized aluminium structure and panel in painted steel.	No Change
	Main metallic elements in stainless steel.	No Change
	Diagram in the front panel with similar distribution to the elements in the real unit.	No Change
	Formed by tubes of stainless steel with hot water circulating in the interior.	No Change
	4 Segmented baffles located transversally in the shell.	No Change
	Exchange length of the shell and each tube: L = 0.5m.	No Change
	Interior tube (21 tubes):	No Change
	Internal diameter: D int = $8 \bullet 10^{-3}$m.	No Change

	External diameter: Dext =10 • 10^{-3} m.	No Change
	Thickness =10^{-3}m.	No Change
	Internal heat transfer area: A_h= 0.0126 m^2.	No Change
	External heat transfer area: A_c= 0.0157m^2.	No Change
	Shell:	No Change
	Internal diameter: Dint,c = 0.148 m.	No Change
	External diameter: D ext,c= 0.160 m.	No Change
	Thickness = 6 • 10^{-3}m.	No Change
	7 Temperature sensors (“J” type), for measuring cold and hot water temperatures at different points of the exchanger.	No Change
	Easy connection to the Base Service Unit.	No Change
	This unit is supplied with 8 manuals: Required Services, Assembly and Installation, Interface and Control Software, Starting-up, Safety, Maintenance, Calibration & Practices Manuals.	No Change
	Computer Control Software:	No Change
	Computer Control+DataAcquisition+Data Management Software for Shell & Tube Heat Exchanger.	No Change
	Compatible with the industry standards.	No Change
	Flexible, open and multicontrolsoftware, developed with actual windows graphic systems, acting simultaneously on all process parameters.	No Change
	Analog and digital PID control.	No Change
	PID menu and set point selection required in the whole work range.	No Change
	Management, processing, comparison and storage of data.	No Change
	Sampling velocity up to 250 KS/s (kilo samples per second).	No Change
	Calibration system for the sensors involved in the process.	No Change

	It allows the registration of the alarms state and the graphic representation in real time.	No Change
	Open software, allowing the teacher to modify texts, instructions. Teacher's and student's passwords to facilitate the teacher's control on the student, and allowing the access to different work levels.	No Change
	Base Service Unit:	
	This unit is common for Heat Exchangers and can work with one or several exchangers.	No Change
	This unit performs the following tasks:	No Change
	Heating the water.	No Change
	Pumping of hot water.	No Change
	Change in the direction of cold water flows.	No Change
	Cold and hot water measures.	No Change
	Anodized aluminium structure and panel in painted steel.	No Change
	Main metallic elements in stainless steel.	No Change
	Diagram in the front panel with similar distribution to the elements in the real unit.	No Change
	Stainless steel tank (30 l.), equipped with:	No Change
	Electric heating resistance (3000W) with thermostat (70º C), to heat the water, computer controlled. PID temperature control.	No Change
	Temperature sensor ("J" type) to measure the water temperature.	No Change
	Level switch to control the water level in the tank.	No Change
	Stainless steel cover to avoid the contact with hot water. In this cover there is a hole that allows us to visualize the water level and also to stuff the tank.	No Change
	Draining water valve.	No Change
	Centrifugal pump with speed control from computer, range: 0 - 3 l./min.	No Change
	2 Flow sensors, one for hot water and the other for cold water, range: 0 - 6.5 l./min.	No Change

	Control valve for the cold water.	No Change
	4 Ball valves that, depending on how we manipulate them, give us parallel or crosscurrent flux in the exchanger.	No Change
	Regulation pressure valve to avoid the introduction of too much pressure in the exchangers, tared at 0.6bar.	No Change
	4 Flexible tubes to connect with the different exchangers.	No Change
	Cables and accessories, for normal operation.	No Change
	Control Interface Box:	
	This control interface is common for Heat Exchangers and can work with one or several exchangers.	No Change
	Control interface box with process diagram in the front panel. The unit control elements are permanently computer controlled.	No Change
	Simultaneous visualization in the computer of all parameters involved in the process.	No Change
	Calibration of all sensors involved in the process. Real time curves representation about system responses.	No Change
	All the actuators' values can be changed at any time from the keyboard allowing the analysis about curves and responses of the whole process.	No Change
	Shield and filtered signals to avoid external interferences.	No Change
	Real time PID control with flexibility of modifications from the computer keyboard of the PID parameters, at any moment during the process.	No Change
	Real time PID control for parameters involved in the process simultaneously.	No Change
	Proportional control, integral control and derivative control, based on the real PID mathematical formula, by changing the values, at any time, of the three control constants (proportional, integral and derivative constants).	No Change
	Open control allowing modifications, at any moment and in real time, of parameters	No Change

	involved in the process simultaneously.	
	Three safety levels, one mechanical in the unit, another electronic in the control interface and the third one in the control software.	No Change
	Data Acquisition Board:	
	PCI EXPRESS Data acquisition board to be placed in a computer slot. Bus PCI EXPRESS	No Change
	Analog input: Number of channels= 16 single-ended or 8 differential. Resolution=16 bits, 1 in 65536.	No Change
	Sampling rate up to: 250 KS/s (Kilo samples per second). Input range (V)=± 10V.	No Change
	Data transfers=DMA, interrupts, programmed I/0. Number of DMA channels=6.	No Change
	Analog output: Number of channels=2. Resolution=16 bits, 1 in 65536. Maximum output rate up to: 900 KS/s.	No Change
	Output range(V)=±10. Data transfers=DMA, interrupts, programmed I/0.	No Change
	Digital Input/Output: Number of channels=24 inputs/outputs. D0 or DI Sample Clock frequency:0 to 100 MHz.	No Change
	Timing: Counter/timers=4. Resolution: Counter/timers:32 bits.	No Change
	Cables and Accessories, for normal operation.	
	Manuals: This system is to be supplied with 8 manuals for each Heat Exchanger: Required service, Assembly and Installation, Interface and Control Software, Starting-up, Safety, Maintenance, Calibration & Practices Manuals	No Change
	High-End Computer is to be provided for software installation and data acquisition	No Change
	Faults Simulation System:	
	The "FAULTS" mode consists on provoking several faults in the unit normal operation. The student must find them and, if possible, solve them.	No Change
	There are several kinds of faults that can be grouped in three sections:	No Change

	Faults affecting the sensors measure:	No Change
	- An incorrect calibration is applied to them.	No Change
	- Non-linearity.	No Change
	Faults affecting the actuators: (These do not admit solutions. The student must just realize it and notify it.)	No Change
	- Actuators canals interchange at any time during the program execution.	No Change
	- Response reduction of an actuator.	No Change
	Faults in the controls execution:	No Change
	- Inversion of the performance in ON/OFF controls.	No Change
	- Reduction or increase of the calculated total response.	No Change
	- The action of some controls is annulled.	No Change
	1.6.3. Jacketed Vessel Heat Exchanger:	
	This Jacketed Vessel Heat Exchanger allows the study of heat transfer between hot water flowing through a jacket and the cold water contained in a vessel.	No Change
	It can work in continuous supply or in a batch process (heating of a constant mass of water containing in a vessel).	No Change
	The exchanger allows measuring temperatures at the inlet and outlet of the exchanger in cold as well as in hot water.	No Change
	Anodized aluminium structure and panel in painted steel.	No Change
	Main metallic elements in stainless steel.	No Change
	Diagram in the front panel with similar distribution to the elements in the real unit.	No Change
	Constituted of a vessel.	No Change
	Vessel total volume: 14 l.	No Change
	Interior vessel volume: 7 l. approx.	No Change
	Jacket volume: 7 l. approx.	No Change

	An overflow or a pipe that allows the exit of the water in the vessel through its upper part to maintain a constant flow during the process with a continuous supply.	No Change
	A jacket surrounds the vessel through where hot water flows.	No Change
	An electric stirrer with a stirring rod of propeller shape and a turn range between 50 and 300 rpm.	No Change
	5 Temperature sensors (“J” type):	No Change
	3 Temperature sensors for measuring cold water temperature.	No Change
	2 Temperature sensors for measuring hot water temperature.	No Change
	Easy connection to the Base Service Unit.	No Change
	This unit is supplied with 8 manuals: Required Services, Assembly and Installation, Interface and Control Software, Starting-up, Safety, Maintenance, Calibration & Practices Manuals.	No Change
	Computer Control Software:	No Change
	Computer Control +Data Acquisition+ Data Management Software for Jacketed Vessel Heat Exchanger.	No Change
	Compatible with the industry standards.	No Change
	Flexible, open and multi control software, developed with actual windows graphic systems, acting simultaneously on all process parameters.	No Change
	Analog and digital PID control.	No Change
	PID menu and set point selection required in the whole work range.	No Change
	Management, processing, comparison and storage of data.	No Change
	Sampling velocity up to 250 KS/s (Kilo samples per second).	No Change
	Calibration system for the sensors involved in the process.	No Change
	It allows the registration of the alarms state and the graphic representation in real time.	No Change

	Open software, allowing the teacher to modify texts, instructions. Teacher's and student's passwords to facilitate the teacher's control on the student, and allowing the access to different work levels.	No Change
	Base Service Unit:	
	This unit is common for Heat Exchangers and can work with one or several exchangers.	No Change
	This unit performs the following tasks:	No Change
	Heating the water.	No Change
	Pumping of hot water.	No Change
	Change in the direction of cold water flows.	No Change
	Cold and hot water measures.	No Change
	Anodized aluminum structure and panel in painted steel.	No Change
	Main metallic elements in stainless steel.	No Change
	Diagram in the front panel with similar distribution to the elements in the real unit.	No Change
	Stainless steel tank (30 l.), equipped with:	No Change
	Electric heating resistance (3000W) with thermostat (70º C), to heat the water, computer controlled. PID temperature control.	No Change
	Temperature sensor ("J" type) to measure the water temperature.	No Change
	Level switch to control the water level in the tank.	No Change
	Stainless steel cover to avoid the contact with hot water. In this cover there is a hole that allows us to visualize the water level and also to stuff the tank.	No Change
	Draining water valve.	No Change
	Centrifugal pump with speed control from computer, range: 0 - 3 l./min.	No Change
	2 Flow sensors, one for hot water and the other for cold water, range: 0 - 6.5 l./min.	No Change
	Control valve for the cold water.	No Change
	4 Ball valves that, depending on how we	No Change

	manipulate them, give us parallel or crosscurrent flux in the exchanger.	
	Regulation pressure valve to avoid the introduction of too much pressure in the exchangers, tared at 0.6bar.	No Change
	4 Flexible tubes to connect with the different exchangers.	No Change
	Cables and accessories, for normal operation.	No Change
	Control Interface Box:	
	This control interface is common for Heat Exchangers and can work with one or several exchangers.	No Change
	Control interface box with process diagram in the front panel. The unit control elements are permanently computer controlled.	No Change
	Simultaneous visualization in the computer of all parameters involved in the process.	No Change
	Calibration of all sensors involved in the process. Real time curves representation about system responses.	No Change
	All the actuators' values can be changed at any time from the keyboard allowing the analysis about curves and responses of the whole process.	No Change
	Shield and filtered signals to avoid external interferences.	No Change
	Real time PID control with flexibility of modifications from the computer keyboard of the PID parameters, at any moment during the process.	No Change
	Real time PID control for parameters involved in the process simultaneously.	No Change
	Proportional control, integral control and derivative control, based on the real PID mathematical formula, by changing the values, at any time, of the three control constants (proportional, integral and derivative constants).	No Change
	Open control allowing modifications, at any moment and in real time, of parameters involved in the process simultaneously.	No Change
	Three safety levels, one mechanical in the unit, another electronic in the control interface	No Change

	and the third one in the control software.	
	Data Acquisition Board:	
	PCI EXPRESS Data acquisition board to be placed in a computer slot. Bus PCI EXPRESS	No Change
	Analog input: Number of channels= 16 single-ended or 8 differential. Resolution=16 bits, 1 in 65536.	No Change
	Sampling rate up to: 250 KS/s (Kilo samples per second). Input range (V)=± 10V.	No Change
	Data transfers=DMA, interrupts, programmed I/0. Number of DMA channels=6.	No Change
	Analog output: Number of channels=2. Resolution=16 bits, 1 in 65536. Maximum output rate up to: 900 KS/s.	No Change
	Output range(V)=±10. Data transfers=DMA, interrupts, programmed I/0.	No Change
	Digital Input/Output: Number of channels=24 inputs/outputs. D0 or DI Sample Clock frequency:0 to 100 MHz.	No Change
	Timing: Counter/timers=4. Resolution: Counter/timers:32 bits.	No Change
	High-End Computer is to be provided for software installation and data acquisition	No Change
	Cables and Accessories, for normal operation.	
	Manuals: This system is to be supplied with 8 manuals for each Heat Exchanger: Required service, Assembly and Installation, Interface and Control Software, Starting-up, Safety, Maintenance, Calibration & Practices Manuals	No Change
	Faults Simulation System:	
	The "FAULTS" mode consists on provoking several faults in the unit normal operation. The student must find them and, if possible, solve them.	No Change
	There are several kinds of faults that can be grouped in three sections:	No Change
	Faults affecting the sensors measure:	No Change
	- An incorrect calibration is applied to them.	No Change

	- Non-linearity.	No Change
	Faults affecting the actuators: (These do not admit solutions. The student must just realize it and notify it.)	No Change
	- Actuators canals interchange at any time during the program execution.	No Change
	- Response reduction of an actuator.	No Change
	Faults in the controls execution:	No Change
	- Inversion of the performance in ON/OFF controls.	No Change
	- Reduction or increase of the calculated total response.	No Change
	- The action of some controls is annulled.	No Change
	1.6.4. Coil Vessel Heat Exchanger:	
	This heat exchanger allows the study of heat transfer between hot water flowing through a coil and cold water contained in the vessel.	No Change
	It can work in continuous supply or in a batch process.	No Change
	Anodized aluminum structure and panel in painted steel.	No Change
	Main metallic elements in stainless steel.	No Change
	Diagram in the front panel with similar distribution to the elements in the real unit.	No Change
	Formed by a pvc-glass vessel, volume: 14 l.	No Change
	An overflow or pvc-glass tube lets the output of water from the vessel in the upper part in order to maintain the flow constant for continue supply process.	No Change
	A copper coil where the water circulates:	No Change
	Dint = 4.35 mm.	No Change
	Dext = 6.35 mm.	No Change
	Total length of the tube that forms the coil: 1.5 m.	No Change
	An electric stirrer using a stirring rod forming a propeller and with a turn range between 50 and 300 rpm.	No Change

	5 Temperature sensors (“J” type):	No Change
	3 Temperature sensors for measuring cold water temperature.	No Change
	2 Temperature sensors for measuring hot water temperature.	No Change
	Easy connection to the Base Service Unit.	No Change
	This unit is supplied with 8 manuals: Required Services, Assembly and Installation, Interface and Control Software, Starting-up, Safety, Maintenance, Calibration & Practices Manuals.	No Change
	Computer Control Software:	No Change
	Computer Control+ Data Acquisition +Data Management Software for Coil Vessel Heat Exchanger.	No Change
	Compatible with the industry standards.	No Change
	Flexible, open and multicontrol software, developed with actual windows graphic systems, acting simultaneously on all process parameters.	No Change
	Analog and digital PID control.	No Change
	PID menu and set point selection required in the whole work range.	No Change
	Management, processing, comparison and storage of data.	No Change
	Sampling velocity up to 250 KS/s (Kilo samples per second).	No Change
	Calibration system for the sensors involved in the process.	No Change
	It allows the registration of the alarms state and the graphic representation in real time.	No Change
	Open software, allowing the teacher to modify texts, instructions. Teacher’s and student’s passwords to facilitate the teacher’s control on the student, and allowing the access to different work levels.	No Change
	Base Service Unit:	
	This unit is common for Heat Exchangers type “TI” and can work with one or several exchangers.	No Change

	This unit performs the following tasks:	No Change
	Heating the water.	No Change
	Pumping of hot water.	No Change
	Change in the direction of cold water flows.	No Change
	Cold and hot water measures.	No Change
	Anodized aluminium structure and panel in painted steel.	No Change
	Main metallic elements in stainless steel.	No Change
	Diagram in the front panel with similar distribution to the elements in the real unit.	No Change
	Stainless steel tank (30 l.), equipped with:	No Change
	Electric heating resistance (3000W) with thermostat (70º C), to heat the water, computer controlled. PID temperature control.	No Change
	Temperature sensor ("J" type) to measure the water temperature.	No Change
	Level switch to control the water level in the tank.	No Change
	Stainless steel cover to avoid the contact with hot water. In this cover there is a hole that allows us to visualize the water level and also to stuff the tank.	No Change
	Draining water valve.	No Change
	Centrifugal pump with speed control from computer, range: 0 - 3 l./min.	No Change
	2 Flow sensors, one for hot water and the other for cold water, range: 0 - 6.5 l./min.	No Change
	Control valve for the cold water.	No Change
	4 Ball valves that, depending on how we manipulate them, give us parallel or crosscurrent flux in the exchanger.	No Change
	Regulation pressure valve to avoid the introduction of too much pressure in the exchangers, tared at 0.6bar.	No Change
	4 Flexible tubes to connect with the different exchangers.	No Change
	Cables and accessories, for normal operation.	No Change

	Control Interface Box:	
	This control interface is common for Heat Exchangers type "TI" and can work with one or several exchangers.	No Change
	Control interface box with process diagram in the front panel. The unit control elements are permanently computer controlled.	No Change
	Simultaneous visualization in the computer of all parameters involved in the process.	No Change
	Calibration of all sensors involved in the process. Real time curves representation about system responses.	No Change
	All the actuators' values can be changed at any time from the keyboard allowing the analysis about curves and responses of the whole process.	No Change
	Shield and filtered signals to avoid external interferences.	No Change
	Real time PID control with flexibility of modifications from the computer keyboard of the PID parameters, at any moment during the process.	No Change
	Real time PID control for parameters involved in the process simultaneously.	No Change
	Proportional control, integral control and derivative control, based on the real PID mathematical formula, by changing the values, at any time, of the three control constants (proportional, integral and derivative constants).	No Change
	Open control allowing modifications, at any moment and in real time, of parameters involved in the process simultaneously.	No Change
	Three safety levels, one mechanical in the unit, another electronic in the control interface and the third one in the control software.	No Change
	Data Acquisition Board:	
	PCI EXPRESS Data acquisition board to be placed in a computer slot. Bus PCI EXPRESS	No Change
	Analog input: Number of channels= 16 single-ended or 8 differential. Resolution=16 bits, 1 in 65536.	No Change
	Sampling rate up to: 250 KS/s (Kilo samples	No Change

	per second). Input range (V)=± 10V.	
	Data transfers=DMA, interrupts, programmed I/0. Number of DMA channels=6.	No Change
	Analog output: Number of channels=2. Resolution=16 bits, 1 in 65536. Maximum output rate up to: 900 KS/s.	No Change
	Output range(V)=±10. Data transfers=DMA, interrupts, programmed I/0.	No Change
	Digital Input/Output: Number of channels=24 inputs/outputs. D0 or DI Sample Clock frequency:0 to 100 MHz.	No Change
	Timing: Counter/timers=4. Resolution: Counter/timers:32 bits.	No Change
	High-End Computer is to be provided for software installation and data acquisition	No Change
	Cables and Accessories, for normal operation.	
	Manuals: This system is to be supplied with 8 manuals for each Heat Exchanger: Required service, Assembly and Installation, Interface and Control Software, Starting-up, Safety, Maintenance, Calibration & Practices Manuals	No Change
	Faults Simulation System:	
	The "FAULTS" mode consists on provoking several faults in the unit normal operation. The student must find them and, if possible, solve them.	No Change
	There are several kinds of faults that can be grouped in three sections:	No Change
	Faults affecting the sensors measure:	No Change
	- An incorrect calibration is applied to them.	No Change
	- Non-linearity.	No Change
	Faults affecting the actuators: (These do not admit solutions. The student must just realize it and notify it.)	No Change
	- Actuators canals interchange at any time during the program execution.	No Change
	- Response reduction of an actuator.	No Change
	Faults in the controls execution:	No Change
	- Inversion of the performance in ON/OFF controls.	No Change

	- Reduction or increase of the calculated total response.	No Change
	- The action of some controls is annulled.	No Change
		5% Bank guarantee for 5 years towards the supply of spare components after warranty period

Tender Notification No.: NITT/F.No: UG MOD 014, 021 /PLAN 2013-14/CHE dt. 14.02.2014

Amendments for Isothermal Reactor with Distillation, Tubular Flow Reactor, Adiabatic and Isothermal Reactor, Reactor with Stirrer in Series, Service Unit, Continuous Stirred Tank Reactor, Batch Reactor and Laminar Flow Reactor

Particle description	Original specification in tender	Amended specification
CHEMICAL REACTIONS ENGINEERINGS LAB		
Chemical reactors type-I	**1 Base Service Unit:**	No Change
	This unit is common for the Chemical Reactors and can work with one or several reactors.	No Change
	Installation and exchange system of the reactors, quick and easy to handle.	No Change
	It supplies all the services for the operation of each reactor.	No Change
	Anodized aluminium structure and panels in painted steel.	No Change
	Main metallic elements in stainless steel.	No Change
	This unit included wheels for its mobility.	No Change
	Diagram in the front panel with similar distribution to the elements in the real unit.	No Change
	2 dosing pumps, computer controlled.	No Change
	3 tanks of 10 litres made of Pyrex-glass: two of them for the reagents and the other one for the product.	No Change
	2 flow meters to measure the flow of liquids. Flow range: 0.7-7 and 0.54-5.4 l/h.	No Change
	Flow meter to measure the flow of gas for a maximum flow of 1440N l/h and maximun pressure of 0.5 Kg cm^{-2}.	No Change
	Thermostatic bath of 9 litres that regulates the temperature between $T_{environment}+ 5^{O}$ and 70^{O} C.	No Change
	Level switch.	No Change
	A pump, computer controlled, to impel the water that comes from the thermostatic bath and goes to the reactor.	No Change
	Type "J" temperature sensor to get the temperature of the reactor in a continuos way.	No Change
	Temperature control through the computer.	No Change
	Control system of the reaction. The control of the reaction is carried out by means of a conductivity cell and conductimeter, connected to the control interface box.	No Change
	All elements of this unit are chemically resistants.	No Change
	2 Control Interface Box:	No Change
	This control interface is common for the Chemical Reactors and can work with one or several reactors.	No Change

	Control interface box with process diagram in the front panel and with the same distribution that the different elements located in the unit, for an easy understanding by the student.	No Change
	All sensors, with their respective signals, are properly manipulated from -10V. to +10V computer output. Sensors connectors in the interface have different pines numbers (from 2 to 16), to avoid connection errors. Single cable between the control interface box and computer.	No Change
	The unit control elements are permanently computer controlled, without necessity of changes or connections during the whole process test procedure.	No Change
	Simultaneously visualization in the computer of all parameters involved in the process.	No Change
	Calibration of all sensors involved in the process.	No Change
	Real time curves representation about system responses. Storage of all the process data and results in a file. Graphic representation, in real time, of all the process/system responses.	No Change
	All the actuators values can be changed at any time from the keyboard allowing the analysis about curves and responses of the whole process. All the actuators and sensors values and their responses are placed in only one computer screen.	No Change
	Shield and filtered signals to avoid external interferences.	No Change
	Real time PID control with flexibility of modifications from the computer keyboard of the PID parameters, at any moment during the process. Real time PID and on/off control for pumps, compressors, resistances, control valves, etc. Real time PID control for parameters involved in the process simultaneously.	No Change
	Open control allowing modifications, at any time and in a real time, of parameters involved in the process simultaneously.	No Change
	Proportional control, integral control and derivative control, based on the real PID mathematical formula, by changing the values, at any time, of the three control constants (proportional, integral and derivative constants).	No Change
	Possibility of automatization of the actuators involved in the process.	No Change
	Three safety levels, one mechanical in the unit, other electronic in control interface and the third one in the control software.	No Change
	3 . Data Acquisition Board:	No Change
		No Change
	PCI EXPRESS Data acquisition board (National Instruments) to be placed in a computer slot. Bus PCI EXPRESS	PCI EXPRESS Data acquisition board (National Instruments or equivalent) to be placed in a computer slot. Bus PCI EXPRESS
	Analog input: Number of channels= 16 single-ended or 8 differential. Resolution=16 bits, 1 in 65536.	No Change
	Sampling rate up to: 250 KS/s (Kilo samples per second). Input range (V)=± 10V.	No Change

	Data transfers=DMA, interrupts, programmed I/0. Number of DMA channels=6.	No Change
	Analog output: Number of channels=2. Resolution=16 bits, 1 in 65536. Maximum output rate up to: 900 KS/s.	No Change
	Output range(V)=±10. Data transfers=DMA, interrupts, programmed I/0.	No Change
	Digital Input/Output: Number of channels=24 inputs/outputs. D0 or DI Sample Clock frequency:0 to 100 MHz.	No Change
	Timing:Counter/timers=4. Resolution: Counter/timers:32 bits.	No Change
	4 <u>Chemical Reactors</u>	No Change
	4.1 . Isothermal Reactor with Distillation:	No Change
	Anodized aluminium structure and panels in painted steel. Main metallic elements in stainless steel.	No Change
	Diagram in the front panel with similar distribution to the elements in the real unit.	No Change
	Reactor insulated made of Pyrex-glass, with a maximum volume of 2 litres.	No Change
	Inlets of reagents. Outlet of products. Conductivity cell conecction. Water outlet. Water inlet.	No Change
	Temperature sensor connection. Gas inlet. Gas outlet.	No Change
	Agitation system with agitation speed control and indication from 0 to 2000 rpm.	No Change
	Distillation column. Balls coolant. Coil coolant. Vacuum pump. Vacuum tramp. Graduated funnel.	No Change
	Temperature sensors. Conductivity sensor.	No Change
	Safety, easy and quick connections.	No Change
	All elements of this unit are chemically resistants.	No Change
	This unit is supplied with 8 manuals: Required Services, Assembly and Installation, Interface and Control Software, Starting-up, Safety, Maintenance, Calibration & Practices Manuals.	No Change
	Computer Control Software:	No Change
	Computer Control+DataAcquisition+Data Management Software for Isothermal Reactor with Distillation (QRIA/D).	No Change
	Compatible with actual Windows operating systems. Graphic and intuitive simulation of the process in screen.	No Change
	Compatible with the industry standards.	No Change
	Registration and visualization of all process variables in an automatic and simultaneously way.	No Change
	Flexible, open and multicontrolsoftware, developed with actual windows graphic systems, acting simultaneously on all process parameters.	No Change
	Analog and digital PID control. Menu for PID and set point selection required in the whole work range.	No Change

	Management, processing, comparison and storage of data. Sampling velocity up to 250,000 data per second guaranteed.	No Change
	Calibration system for the sensors involved in the process.	No Change
	It allows the registration of the alarms state and the graphic representation in real time.	No Change
	Comparative analysis of the obtained data, after the process and modification of the conditions during the process.	No Change
	Open software, allowing to the teacher to modify texts, instructions. Teacher's and student's passwords to facilitate the teacher's control on the student, and allowing the access at different work levels.	No Change
	This unit allows that the 30 students of the classroom can visualize simultaneously all results and manipulation of the unit, during the process, by using a projector.	No Change
	4.2 Tubular Flow Reactor:	No Change
	Anodized aluminium structure and panels in painted steel. Main metallic elements in stainless steel.	No Change
	Diagram in the front panel with similar distribution to the elements in the real unit.	No Change
	Temperature controlled by a jacket of water, through a temperature sensor "J" type.	No Change
	Electrical preheater with power of 265 W for both feeding lines.	No Change
	Reactor with inner coil made of teflon of 6mm of interior diameter, length 14.5 m, volume: 0.393 litres.	No Change
	Temperature sensor "J" type, that controls the preheating temperature.	No Change
	Conductivity sensor.	No Change
	Safety, easy and quick connections.	No Change
	All elements of this unit are chemical resistant.	No Change
	This unit is supplied with 8 manuals: Required Services, Assembly and Installation, Interface and Control Software, Starting-up, Safety, Maintenance, Calibration & Practices Manuals.	No Change
	Computer Control Software:	No Change
	Computer Control+DataAcquisition+Data Management Software for Tubular Flow Reactor (QRFT).	No Change
	Compatible with actual Windows operating systems. Graphic and intuitive simulation of the process in screen.	No Change
	Compatible with the industry standards.	No Change
	Registration and visualization of all process variables in an automatic and simultaneously way.	No Change
	Flexible, open and multicontrolsoftware, developed with actual windows graphic systems, acting simultaneously on all process parameters.	No Change
	Analog and digital PID control. Menu for PID and set point selection required in the whole work range.	No Change

	Management, processing, comparison and storage of data. Sampling velocity up to 250,000 data per second guaranteed.	No Change
	Calibration system for the sensors involved in the process.	No Change
	It allows the registration of the alarms state and the graphic representation in real time.	No Change
	Comparative analysis of the obtained data, after the process and modification of the conditions during the process.	No Change
	Open software, allowing to the teacher to modify texts, instructions. Teacher's and student's passwords to facilitate the teacher's control on the student, and allowing the access at different work levels.	No Change
	This unit allows that the 30 students of the classroom can visualize simultaneously all results and manipulation of the unit, during the process, by using a projector.	No Change
	4.3 . Adiabatic and Isothermal Reactor:	No Change
	Anodized aluminium structure and panels in painted steel. Main metallic elements in stainless steel.	No Change
	Diagram in the front panel with similar distribution to the elements in the real unit.	No Change
	Reactor insulated made of Pyrex-glass, with a maximum volume of 2 litres.	No Change
	Nickel-plated cooper coil of 2500mm long, outer diameter of 6.7mm and inner one of 4.1 mm.	No Change
	Stirrer.	No Change
	Water flow control of 0-6 l/min.	No Change
	Outer jacket made of anodisedaluminium and inner jacket made of expanded polyurethane foam rubber.	No Change
	3 Temperature sensors. Conductivity sensor.	No Change
	Safety, easy and quick connections.	No Change
	All elements of this unit are chemically resistant.	No Change
	This unit is supplied with 8 manuals: Required Services, Assembly and Installation, Interface and Control Software, Starting-up, Safety, Maintenance, Calibration & Practices Manuals.	No Change
	Computer Control Software:	No Change
	Computer Control+ Data Acquisition+ Data Management Software for Adiabatic and Isothermal Reactor (QRAD).	No Change
	Compatible with actual Windows operating systems. Graphic and intuitive simulation of the process in screen.	No Change
	Compatible with the industry standards.	No Change
	Registration and visualization of all process variables in an automatic and simultaneously way.	No Change
	Flexible, open and multicontrolsoftware, developed with actual windows graphic systems, acting simultaneously on all process parameters.	No Change

	Analog and digital PID control. Menu for PID and set point selection required in the whole work range.	No Change
	Management, processing, comparison and storage of data. Sampling velocity up to 250,000 data per second guaranteed.	No Change
	Calibration system for the sensors involved in the process.	No Change
	It allows the registration of the alarms state and the graphic representation in real time.	No Change
	Comparative analysis of the obtained data, after the process and modification of the conditions during the process.	No Change
	Open software, allowing to the teacher to modify texts, instructions. Teacher's and student's passwords to facilitate the teacher's control on the student, and allowing the access at different work levels.	No Change
	This unit allows that the 30 students of the classroom can visualize simultaneously all results and manipulation of the unit, during the process, by using a projector.	No Change
	4.4 . Reactors with Stirrer in Series:	No Change
	Anodized aluminium structure and panels in painted steel.	No Change
	Main metallic elements in stainless steel.	No Change
	Diagram in the front panel with similar distribution to the elements in the real unit.	No Change
	3 Reactors insulated made of Pyrex-glass, with a maximum volume of 1 litre each one.	No Change
	Agitation system with agitation speed control and indication from 0 to 2000 rpm. for each reactor.	No Change
	3 Temperature sensors.	No Change
	Conductivity sensors.	No Change
	Safety, easy and quick connections.	No Change
	All elements of this unit are chemically resistant.	No Change
	This unit is supplied with 8 manuals: Required Services, Assembly and Installation, Interface and Control Software, Starting-up, Safety, Maintenance, Calibration & Practices Manuals.	No Change
	Computer Control Software:	No Change
	Computer Control+DataAcquisition+Data Management Software for Reactors with Stirrer in Series (QRSA).	No Change
	Compatible with actual Windows operating systems. Graphic and intuitive simulation of the process in screen.	No Change
	Compatible with the industry standards.	No Change
	Registration and visualization of all process variables in an automatic and simultaneously way.	No Change
	Flexible, open and multicontrolsoftware, developed with actual windows graphic systems, acting simultaneously on all process parameters.	No Change

	Analog and digital PID control. Menu for PID and set point selection required in the whole work range.	No Change
	Management, processing, comparison and storage of data. Sampling velocity up to 250,000 data per second guaranteed.	No Change
	Calibration system for the sensors involved in the process.	No Change
	It allows the registration of the alarms state and the graphic representation in real time.	No Change
	Comparative analysis of the obtained data, after the process and modification of the conditions during the process.	No Change
	Open software, allowing to the teacher to modify texts, instructions. Teacher's and student's passwords to facilitate the teacher's control on the student, and allowing the access at different work levels.	No Change
	This unit allows that the 30 students of the classroom can visualize simultaneously all results and manipulation of the unit, during the process, by using a projector.	No Change
	5 Cables and Accessories, for normal operation.	No Change
	6 Manuals: This system is supplied with 8 manuals for each Chemical Reactor: Required Services, Assembly and Installation, Interface and Control Software, Starting-up, Safety, Maintenance, Calibration & Practices Manuals.	No Change
	7. Computer Aided Learning Software (Results Calculation and Analysis)	No Change
	This Computer Aided Learning Software is a Windows base software, simple and very easy to use,	No Change
	CAL is a class assistant that helps in making the necessary calculations to extract the right conclusions from data obtained during the experimental practices.	No Change
	CAL will perform the calculations.	No Change
	CAL computes the value of all the variables involved.	No Change
	It allows to plot and print the results. Between the plotting options, any variable can be represented against any other.	No Change
	Different plotting displays.	No Change
	It has a wide range of information, such as constant values, unit conversion factors and integral and derivative tables.	No Change
	8. Faults Simulation System:	No Change
	The "FAULTS" mode consists on provoking several faults in the unit normal operation. The student must find them and, if possible, solve them.	No Change
	There are several kinds of faults that can be grouped in three sections:	No Change
	Faults affecting the sensors measure:	No Change
	- An incorrect calibration is applied to them.	No Change
	- Non-linearity.	No Change

	Faults affecting the actuators: (These do not admit solutions. The student must just realise it and notify it.)	No Change
	- Actuators canals interchange at any time during the program execution.	No Change
	- Response reduction of an actuator.	No Change
	Faults in the controls execution:	No Change
	- Inversion of the performance in ON/OFF controls.	No Change
	- Reduction or increase of the calculated total response.	No Change
	- The action of some controls is annulled.	No Change
Chemical reactors type-II	**1 . Service Unit:**	No Change
	This unit is common for the Chemical Reactors, and can work with one or several reactors.	No Change
	Accommodation and exchange system of the reactors, quick and easy to handle.	No Change
	It supplies all the services for the operation of each reactor.	No Change
	Anodized aluminium structure and panels in painted steel (epoxy paint).	No Change
	Main metallic elements in stainless steel.	No Change
	Diagram in the front panel with similar distribution to the elements in the real unit.	No Change
	2 Peristaltic dosing pumps, with variable speed, computer controlled. Flow rate up to 3 l./h. (unit standard disposition). With another disposition, they could reach a flow rate up to 10 l./h.	No Change
	Thermostatic bath of 9 l. capacity, computer controlled. Temperature PID control of the thermostatic bath.	No Change
	Pump of 3 l./min., with variable flow, to impel the thermostatization water from the bath to the reactor. Flow sensor, range: 0-6 l./min.	No Change
	2 Tanks for the reagents, of 1 liter capacity each one, made in Pyrex glass.	No Change
	The control of the reaction is carried out by a conductivity sensor, which allows the reaction evolution parametrization in real time.	No Change
	Three "J" type temperature sensors, one to know the thermostatic bath temperature in a continuous way and two sensors to know the water temperature at the thermostatic bath water inlet and outlet.	**J' Type or PI 100**
	All elements of this unit are chemically resistant.	No Change
	2 . Control Interface Box:	No Change
	This control interface is common for the Chemical Reactors and can work with one or several reactors.	No Change

	Control interface box with process diagram in the front panel and with the same distribution to the different elements located in the unit, for an easy understanding by the student.	No Change
	All sensors, with their respective signals, are properly manipulated from -10V. to +10V. computer output. Sensors connectors in the interface have different pines numbers (from 2 to 16), to avoid connection errors. Single cable between the control interface box and computer.	No Change
	The unit control elements are permanently computer controlled, without necessity of changes or connections during the whole process test procedure.	No Change
	Simultaneously visualization in the computer of all parameters involved in the process.	No Change
	Calibration of all sensors involved in the process.	No Change
	Real time curves representation about system responses.	No Change
	Storage of all the process data and results in a file. Graphic representation, in real time, of all the process/system responses.	No Change
	All the actuators values can be changed at any time from the keyboard allowing the analysis about curves and responses of the whole process. All the actuators and sensors values and their responses are placed in only one computer screen.	No Change
	Shield and filtered signals to avoid external interferences.	No Change
	Real time PID control with flexibility of modifications from the computer keyboard of the PID parameters, at any moment during the process. Real time PID and on/off control for pumps, compressors, resistances, control valves, etc. Real time PID control for parameters involved in the process simultaneously.Proportional control, integral control and derivative control, based on the real PID mathematical formula, by changing the values, at any time, of the three control constants (proportional, integral and derivative constants).	No Change
	Open control allowing modifications, at any time and in a real time, of parameters involved in the process simultaneously.	No Change
	Possibility of automatization of the actuators involved in the process.	No Change
	Three safety levels, one mechanical in the unit, other electronic in control interface and the third one in the control software.	No Change
	3. Data Acquisition Board:	No Change
	PCI EXPRESS Data acquisition board (National Instruments) to be placed in a computer slot. Bus PCI EXPRESS	PCI EXPRESS Data acquisition board (National Instruments or Equivalent) to be placed in a computer slot. Bus PCI EXPRESS
	Analog input: Number of channels= 16 single-ended or 8 differential. Resolution=16 bits, 1 in 65536.	No Change
	Sampling rate up to: 250 KS/s (Kilo samples per second). Input range (V)=± 10V.	No Change

	Data transfers=DMA, interrupts, programmed I/0. Number of DMA channels=6.	No Change
	Analog output: Number of channels=2. Resolution=16 bits, 1 in 65536. Maximum output rate up to: 900 KS/s.	No Change
	Output range(V)=±10. Data transfers=DMA, interrupts, programmed I/0.	No Change
	Digital Input/Output: Number of channels=24 inputs/outputs. D0 or DI Sample Clock frequency:0 to 100 MHz.	No Change
	Timing: Counter/timers=4. Resolution: Counter/timers:32 bits	No Change
		No Change
	4 <u>Chemical Reactors</u>	No Change
	4.1 . Continuous Stirred Tank Reactor:	No Change
	Small scale Continuous Stirred Tank Reactor, computer controlled, designed to demonstrate the behavior of a reactor used for homogeneous reactions liquid-liquid.	No Change
	Anodized aluminum structure and panels in painted steel (epoxy paint).	No Change
	Main metallic elements in stainless steel.	No Change
	Diagram in the front panel with similar distribution to the elements in the real unit.	No Change
	Reactor body made in borosilicate glass, with a maximum capacity of 2 liters, specially designed to work in continuous. It also allows batch operation.	No Change
	Adjustable volume from 0.4 to 1.5 l.	No Change
	Stainless steel heat transfer coil and a baffle (removable).	No Change
	Stirring system with speed control and indication, computer controlled. Stirrer range: 0-220 rpm.	No Change
	Reactor lip with connectors for the appropriate sensors.	No Change
	Temperature sensor “J“ type to control the temperature into the reactor.	No Change
	Conductivity sensor to control the reaction. Measurement range up to 20 mS.	No Change
	Easy and quick assembly on the Service Unit.	No Change
	All elements of this unit are chemically resistant.	No Change
	This unit is supplied with 8 manuals: Required Services, Assembly and Installation, Interface and Control Software, Starting-up, Safety, Maintenance, Calibration & Practices Manuals.	No Change
	Computer Control Software:	No Change
	Computer Control+DataAcquisition+Data Management Software for Continuous Stirred Tank Reactor (QRCAC).	No Change

	Compatible with actual Windows operating systems.	No Change
	Graphic and intuitive simulation of the process in screen.	No Change
	Compatible with the industry standards.	No Change
	Registration and visualization of all process variables in an automatic and simultaneously way.	No Change
	Flexible, open and multicontrolsoftware, developed with actual windows graphic systems, acting simultaneously on all process parameters.	No Change
	Analog and digital PID control. Menu for PID and set point selection required in the whole work range.	No Change
	Management, processing, comparison and storage of data.	No Change
	Sampling velocity up to 250,000 data per second guaranteed.	No Change
	Calibration system for the sensors involved in the process.	No Change
	It allows the registration of the alarms state and the graphic representation in real time.	No Change
	Comparative analysis of the obtained data, after the process and modification of the conditions during the process.	No Change
	Open software, allowing to the teacher to modify texts, instructions. Teacher's and student's passwords to facilitate the teacher's control on the student, and allowing the access at different work levels.	No Change
	This unit allows that the 30 students of the classroom can visualize simultaneously all results and manipulation of the unit, during the process, by using a projector.	No Change
		No Change
	4.2.Batch Reactor:	No Change
	Small scale Bath Reactor, computer controlled, designed for the kinetic study of homogeneous reactions liquid-liquid, both in adiabatic conditions and in isothermal conditions.	No Change
	Anodizedaluminiumstructureandpanelsinpaintedsteel(epoxypaint).	No Change
	Mainmetallicelementsinstainlesssteel.	No Change
	Diagraminthefrontpanelwithsimilardistributiontotheelementsintherealunit.	No Change
	Thereactorbodyisanisolatedvesselwithastainlesssteelexternalcasing.Theworking volumeis1liter.	No Change
	Heattransfercoilmadeinstainlesssteelandreactor baffle,of4.5loopsof76mmof diameterand1250mmlength.Thetubeinternaldiameterisof6mmandtheexternalone isof8mm.	No Change
	Stirringsystemwithspeedcontrolandindication,computercontrolled.Stirrerrange:0-220 rpm.	No Change
	Temperaturesensor"J"typetocontrolthetemperatureintothereactor.	No Change

	Conductivitysensortocontrolthereaction.Measurementrangeupto20mS.	No Change
	Reactorlipwithconnectorsfortheappropriatesensors.	No Change
	EasyandquickassemblyontheServiceUnit.	No Change
	Allelementsofthisunitarechemicallyresistant.	No Change
	Thisunitissuppliedwith8manuals:RequiredServices,AssemblyandInstallation,Interfaceand ControlSoftware,Starting-up,Safety,Maintenance,Calibration&PracticesManuals.	No Change
	ComputerControlSoftware:	No Change
	ComputerControl+DataAcquisition+DataManagementSoftwareforBatchReactor (QRDC).	No Change
	Compatible with actual Windows operating systems.	No Change
	Graphic and intuitive simulation of the process in screen.	No Change
	Compatible with the industry standards.	No Change
	Registration and visualization of all process variables in an automatic and simultaneously way.	No Change
	Flexible, open and multicontrolsoftware, developed with actual windows graphic systems, acting simultaneously on all process parameters.	No Change
	Analog and digital PID control. Menu for PID and set point selection required in the whole work range.	No Change
	Management, processing, comparison and storage of data.	No Change
	Sampling velocity up to 250,000 data per second guaranteed.	No Change
	Calibration system for the sensors involved in the process.	No Change
	It allows registration of the alarms state and the graphic representation in real time.	No Change
	Comparative analysis of the obtained data, after the process and modification of the conditions during the process.	No Change
	Open software, allowing to the teacher to modify texts, instructions. Teacher's and student's passwords to facilitate the teacher's control on the student, and allowing the access at different work levels.	No Change
	This unit allows that the 30 students of the classroom can visualize simultaneously all results and manipulation of the unit, during the process, by using a projector.	No Change
		No Change
		No Change
	4.3. Laminar Flow Reactor:	No Change
	Small scale Laminar Flow Reactor, computer controlled, designed to demonstrate the flow pattern characterization and the steady state conversion in a tubular reactor.	No Change

	Anodized aluminium structure and panels in painted steel (epoxy paint).	No Change
	Main metallic elements in stainless steel.	No Change
	Diagram in the front panel with similar distribution to the elements in the real unit.	No Change
	Working volume: 400 ml.	No Change
	The reactor column is 1300 mm long approx., including 2 diffusers packed with glass balls.	No Change
	At the bottom of the column a premixer provides a complete mixing of the reagents entering the reactor and improves the flow distribution.	No Change
	The reactor refrigeration jacket keeps its contents at constant temperature to keep the laminar flow conditions.	No Change
	The reagents are fed to the reactor by the peristaltic dosing pumps of the Service Unit.	No Change
	Temperature sensors.	No Change
	Conductivity sensor to control the reaction.	No Change
	Easy and quick connection with the Service Unit.	No Change
	All elements of this unit are chemically resistant.	No Change
	This unit is supplied with 8 manuals: Required Services, Assembly and Installation, Interface and Control Software, Starting-up, Safety, Maintenance, Calibration & Practices Manuals.	No Change
	Computer Control Software:	No Change
	Computer Control+DataAcquisition+Data Management Software for Laminar Flow Reactor (QRLC).	No Change
	Compatible with actual Windows operating systems. Graphic and intuitive simulation of the process in screen.	No Change
	Compatible with the industry standards.	No Change
	Registration and visualization of all process variables in an automatic and simultaneously way.	No Change
	Flexible, open and multicontrolsoftware, developed with actual windows graphic systems, acting simultaneously on all process parameters.	No Change
	Analog and digital PID control. Menu for PID and set point selection required in the whole work range.	No Change
	Management, processing, comparison and storage of data.	No Change
	Sampling velocity up to 250,000 data per second guaranteed.	No Change
	Calibration system for the sensors involved in the process.	No Change
	It allows registration of the alarms state and the graphic representation in real time.	No Change
	Comparative analysis of the obtained data, after the process and modification of the conditions during the process.	No Change

	Open software, allowing to the teacher to modify texts, instructions. Teacher's and student's passwords to facilitate the teacher's control on the student, and allowing the access at different work levels.	No Change
	This unit allows that the 30 students of the classroom can visualize simultaneously all results and manipulation of the unit, during the process, by using a projector.	No Change
	5 Cables and Accessories, for normal operation.	No Change
	6 Manuals:This trainer is supplied with 8 manuals for each Chemical Reactor: Required Services, Assembly and Installation, Interface and Control Software, Starting-up, Safety, Maintenance, Calibration & Practices Manuals.	No Change
	7 Computer Aided Learning Software (Results Calculation and Analysis)	No Change
	This Computer Aided Learning Software (CAL) is a Windows base software, simple and very easy to use	No Change
	CAL is a class assistant that helps in making the necessary calculations to extract the right conclusions from data obtained during the experimental practices.	No Change
	CAL will perform the calculations.	No Change
	CAL computes the value of all the variables involved.	No Change
	It allows to plot and print the results. Between the plotting options, any variable can be represented against any other.	No Change
	Different plotting displays.	No Change
	It has a wide range of information, such as constant values, unit conversion factors and integral and derivative tables.	No Change
	8. Faults Simulation System:	No Change
	The "FAULTS" mode consists on provoking several faults in the unit normal operation. The student must find them and, if possible, solve them.	No Change
	There are several kinds of faults that can be grouped in three sections:	No Change
	Faults affecting the sensors measure:	No Change
	- An incorrect calibration is applied to them.	No Change
	- Non-linearity.	No Change
	Faults affecting the actuators: (These do not admit solutions. The student must just realise it and notify it.)	No Change
	- Actuators canals interchange at any time during the program execution.	No Change
	- Response reduction of an actuator.	No Change
	Faults in the controls execution:	No Change
	- Inversion of the performance in ON/OFF controls.	No Change

	- Reduction or increase of the calculated total response.	No Change
	- The action of some controls is annulled.	No Change
		5% bank guarantee for 5 years towards the supply of spare components after the warranty period.

Tender Notification No.: NITT/F.No: UG MOD 035 /PLAN 2013-14/CHE

.**Amendments for Computer controlled continuous Distillation Unit:**

Original specification in tender	Amended specification
Anodized aluminium structure and panels in painted steel.	No Change
Main metallic elements in stainless steel.	No Change
Diagram in the front panel with similar distribution to the elements in the real unit.	No Change
Sieve Plates Column with 8 plates with temperature taking (sensor) and sample in every plate.	No Change
50mm. internal diameter and 1000 mm. length. Vacuumed, silver-plated and double transparent band for vision.	No Change
It should allow continuous operation and batch operation.	No Change
Column head with temperature taking, conical output for distilled product and ball refrigerator.	No Change
Column head with a valve for the steam distribution.	No Change
The valve should operate in an electromagnetic way.	No Change
2 l. Boiler (with sample outputs), with heating mantle (computer controlled) with adjustable power (max. power: 500 watt.)	No Change
2 l. Distillation collector of graduated glass.	No Change
Liebig-West coolant.	No Change
Feeding system in continuous with preheating (heating resistance, computer controlled) at the	No Change
specified temperature and a pump (computer controlled), that provides a maximum flow of 3.81 l./min.	No Change
Feed vessel, 10 l. capacity.	No Change
Adjustable vacuum pump (computer controlled) , that allows to decrease the atmospheric	No Change
pressure to 0.8 bar.	No Change
Temperature measurement system. 15 temperature sensors (”J” type).	‘J’ Type or PI 100
Flow sensor.	No Change
Differential pressure sensor.	No Change
Working temperature: Ambient temperature up to 125º C.	No Change
Solenoid valve, computer controlled.	No Change
The computer control system shall act directly on:	No Change
The temperature of the heating resistances.	No Change
The feeding temperature.	No Change
The solenoid valve (reflux ratio).	No Change

The vacuum pump.	No Change
The feeding pump.	No Change
The complete unit shall include as well:	No Change
Advanced Real-Time SCADA and PID Control.	No Change
Open Control + Multicontrol + Real-Time Control.	No Change
Specialized Control Software based on Labview.	No Change
National Instruments Data Acquisition board (250 KS/s , kilo samples per second).	NI or Equivalent Data Acquisition board (250 KS/s, kilo samples per second).
Calibration exercises, which are included, teach the user how to calibrate a sensor and the importance of checking the accuracy of the sensors before taking measurements.	No Change
Projector and/or electronic whiteboard compatibility allows the unit to be explained and demonstrated to an entire class at one time.	No Change
Capable of doing applied research, real industrial simulation, training courses, etc.	No Change
Remote operation and control by the user and remote control for EDIBON technical support, are always included.	Remote operation and control by the user and remote control for technical support, are always included.
Totally safe, utilizing 4 safety systems (Mechanical, Electrical, Electronic & Software).	No Change
Designed and manufactured under several quality standards.	No Change
Control Interface Box:	No Change
The Control Interface Box is part of the SCADA system.	No Change
Control interface box with process diagram in the front panel and with the same distribution that the different elements located in the unit, for an easy understanding by the student.	No Change
All sensors, with their respective signals, are properly manipulated from -10V to +10V. computer output.	No Change
Sensors connectors in the interface have different pines numbers (from 2 to 16), to avoid connection errors.	No Change
Single cable between the control interface box and computer.	No Change
The unit control elements are permanently computer controlled, without necessity of changes or connections during the whole process test procedure.	No Change
Simultaneous visualization in the computer of all parameters involved in the process.	No Change
Calibration of all sensors involved in the process.	No Change
Real time curves representation about system	No Change

responses.	
Storage of all the process data and results in a file.	No Change
Graphic representation, in real time, of all the process/system responses.	No Change
All the actuators' values can be changed at any time from the keyboard allowing the analysis about curves and responses of the whole process.	No Change
All the actuators and sensors values and their responses are displayed on only one screen in the computer.	No Change
Shield and filtered signals to avoid external interferences.	No Change
Real time PID control with flexibility of modifications from the computer keyboard of the PID parameters, at any moment during the process.	No Change
Real time PID and on/off control for pumps, compressors, resistances, control valves, etc.	Real time PID and on/off control for pumps, resistances, control valves, etc.
Real time PID control for parameters involved in the process simultaneously.	No Change
Proportional control, integral control and derivative control, based on the real PID mathematical formula, by changing the values, at any time, of the three control constants (proportional, integral and derivative constants).	No Change
Open control allowing modifications, at any moment and in real time, of parameters involved in the process simultaneously.	No Change
Possibility of automatization of the actuators involved in the process.	No Change
Three safety levels, one mechanical in the unit, another electronic in the control interface and the third one in the control software.	No Change
DAB. Data Acquisition Board:	No Change
The Data Acquisition board is part of the SCADA system.	No Change
PCI Data acquisition board (National Instruments) to be placed in a computer slot. Bus PCI.	PCI Data acquisition board (National Instruments/ Equivalent) to be placed in a computer slot. Bus PCI.
Analog input: Number of channels= 16 single-ended or 8 differential.	No Change
Resolution=16 bits, 1 in 65536.	No Change
Sampling rate up to: 250 KS/s (kilo samples per second).	No Change
Input range (V)= 10 V. Data transfers=DMA, interrupts, programmed I/0. DMA channels=6.	No Change
Analog output: Number of channels=2	No Change

Resolution=16 bits , 1 in 65536. Maximum output rate up to: 833 KS/s.	No Change
Output range(V)= 10 V. Data transfers=DMA, interrupts, programmed I/0.	No Change
Digital Input/Output: Number of channels=24 inputs/outputs	No Change
D0 or DI Sample Clock frequency: 0 to 1 MHz.	No Change
Timing: Number of Counter/timers=2.	No Change
Resolution: Counter/timers: 32 bits.	No Change
Compatible with actual Windows operating systems. Graphic and intuitive simulation of the process in screen.	No Change
Registration and visualization of all process variables in an automatic and simultaneous way.	No Change
Flexible, open and multicontrolsoftware, developed with actual windows graphic systems, acting simultaneously on all process parameters.	No Change
Analog and digital PID control. PID menu and set point selection required in the whole work range.	No Change
Management, processing, comparison and storage of data. Sampling velocity up to 250 KS/s (kilo samples per second)	No Change
Calibration system for the sensors involved in the process.	No Change
It shall allow the registration of the alarms state and the graphic representation in real time.	No Change
Comparative analysis of the obtained data, after the process and modification of the conditions during the process.	No Change
Open software, allowing the teacher to modify texts, instructions.	No Change
Teacher's and student's passwords to facilitate the teacher's control on the student, and allowing the access to different work levels. This unit allows the 30 students of the classroom to visualize simultaneously all the results and the manipulation of the unit, during the process, by using a projector or an electronic whiteboard.	Teacher's and student's passwords to facilitate the teacher's control on the student, and allowing the access to different work levels. This unit allows the 30 students and also 60 students of the classroom to visualize simultaneously all the results and the manipulation of the unit, during the process, by using a projector or an electronic whiteboard.
Cables and Accessories, for normal operation and necessary manuals.	No Change
	5% bank guarantee for 5 years towards the supply of spare components after the warranty period.

Tender Notification No.: NITT/F.No: UG MOD 036 – 042 and 044 /PLAN 2013-14/CHE

Amendments for Temperature Process Control, Flow Process Control, Level Process Control, Pressure Process Control, pH Process Control , Conductivity and TDS (Total Dissolved Solids) Process Control, Multivariable Four Tank System:

Original specification in tender	Amended specification
1. Temperature Process Control	
This Set will be supplied and installed in the Base Unit and ready for working.	No Change
Sensor and elements:	No Change
o Temperature sensor "J type", range: -40 to 750ºC.	No Change
o Electric resistor (0.5 KW), with thermostat (70ºC).	No Change
o Helix agitator, range: 0-300 r.p.m.	No Change
o On/off level switch; safety element that permits the resistance to operate just when the level of water is sufficient.	No Change
Computer Control Software:	No Change
o Computer Control+DataAcquisition+Data Management Software for Temperature Process Control.	No Change
o Compatible with actual Windows operating systems. Graphic and intuitive simulation of the process in screen.	No Change
o Compatible with the industry standards.	No Change
o Registration and visualization of all process variables in an automatic and simultaneously way.	No Change
o Flexible and open software, developed with actual windows graphic systems, acting simultaneously on all process parameters.	No Change
o Analog and digital PID control. Menu for PID and set point selection required in the whole work range.	No Change
o Management, processing, comparison and storage of data.	No Change
o Sampling velocity up to 250,000 data per second guaranteed.	No Change
o Student calibration system for all sensors involved in the process.	No Change
o It allows the registration of the alarms state and the graphic representation in real time.	No Change
o Comparative analysis of the obtained data, after the process and modification of the conditions during the process.	No Change

o Open software, allowing to the teacher to modify texts, instructions. Teacher's and student's passwords to facilitate the teacher's control on the student, and allowing the access at different work levels.	No Change
A Computer to be provided for this setup.	No Change
A Separate Data acquisition system to be provided for this setup.	No Change
A Separate Control Interface to run the experiment simultaneously with other processes.	No Change
2. Flow Process Control:	
This Set will be supplied and installed in the Base Unit and ready for working.	No Change
Sensor and elements:	No Change
o Turbine type flow sensor, range: 0.25-6.5 l./min.	No Change
Computer Control Software:	No Change
o Computer Control+DataAcquisition+Data Management Software for Flow Process Control.	No Change
o Compatible with actual Windows operating systems. Graphic and intuitive simulation of the process in screen.	No Change
o Compatible with the industry standards.	No Change
o Registration and visualization of all process variables in an automatic and simultaneously way.	No Change
o Flexible and open software, developed with actual windows graphic systems, acting simultaneously on all process parameters.	No Change
o Analog and digital PID control. Menu for PID and set point selection required in the whole work range.	No Change
o Management, processing, comparison and storage of data.	No Change
o Sampling velocity up to 250,000 data per second guaranteed.	No Change
o Student calibration system for all sensors involved in the process.	No Change
o It allows the registration of the alarms state and the graphic representation in real time.	No Change
o Comparative analysis of the obtained data, after the process and modification of the conditions during the process.	No Change

o Open software, allowing to the teacher to modify texts, instructions. Teacher's and student's passwords to facilitate the teacher's control on the student, and allowing the access at different work levels.	No Change
A Computer to be provided for this setup.	No Change
A Separate Data acquisition system to be provided for this setup.	No Change
A Separate Control Interface to run the experiment simultaneously with other processes.	No Change
3. Level Process Control:	
This Set will be supplied and installed in the Base Unit and ready for working.	No Change
Sensor and elements:	No Change
o 0-300mm level sensor (of capacitive immersion, 4-20mA), made with tephlon to avoid any corrosion.	No Change
Computer Control Software:	No Change
o Computer Control+DataAcquisition+Data Management Software for Level Process Control.	No Change
o Compatible with actual Windows operating systems. Graphic and intuitive simulation of the process in screen.	No Change
o Compatible with the industry standards.	No Change
o Registration and visualization of all process variables in an automatic and simultaneously way.	No Change
o Flexible and open software, developed with actual windows graphic systems, acting simultaneously on all process parameters.	No Change
o Analog and digital PID control. Menu for PID and set point selection required in the whole work range.	No Change
o Management, processing, comparison and storage of data.	No Change
o Sampling velocity up to 250,000 data per second guaranteed.	No Change
o Student calibration system for all sensors involved in the process.	No Change
o It allows the registration of the alarms state and the graphic representation in real time.	No Change
o Comparative analysis of the obtained data, after the process and modification of the conditions during the process.	No Change

o Open software, allowing to the teacher to modify texts, instructions. Teacher's and student's passwords to facilitate the teacher's control on the student, and allowing the access at different work levels.	No Change
A Computer to be provided for this setup.	No Change
A Separate Data acquisition system to be provided for this setup.	No Change
A Separate Control Interface to run the experiment simultaneously with other processes.	No Change
4 Pressure Process Control:	
This Set will be supplied and installed in the Base Unit and ready for working.	No Change
Sensor and elements:	No Change
o Pressure sensor, range: 0-1 psi.	No Change
Computer Control Software:	No Change
o Computer Control+DataAcquisition+Data Management Software for Pressure Process Control.	No Change
o Compatible with actual Windows operating systems. Graphic and intuitive simulation of the process in screen.	No Change
o Compatible with the industry standards. Registration and visualization of all process variables in an automatic and simultaneously way.	No Change
o Flexible and open software, developed with actual windows graphic systems, acting simultaneously on all process parameters.	No Change
o Analog and digital PID control. Menu for PID and set point selection required in the whole work range.	No Change
o Management, processing, comparison and storage of data. Sampling velocity up to 250,000 data per second guaranteed.	No Change
o Student calibration system for all sensors involved in the process.	No Change
o It allows the registration of the alarms state and the graphic representation in real time.	No Change
o Comparative analysis of the obtained data, after the process and modification of the conditions during the process.	No Change
o Open software, allowing to the teacher to modify texts, instructions. Teacher's and student's passwords to facilitate the teacher's control on the student, and allowing the access at different work levels.	No Change

A Computer to be provided for this setup.	No Change
A Separate Data acquisition system to be provided for this setup.	No Change
A Separate Control Interface to run the experiment simultaneously with other processes.	No Change
5. pH Process Control:	
This Set will be supplied and installed in the Base Unit and ready for working.	No Change
Sensor and elements:	No Change
o pH sensor:	No Change
o Simple electrode Ag/Agcl.	No Change
o Accuracy: ± 0.2 pH.	No Change
o Resolution: 0.1 pH.	No Change
o Range: 0-14.	No Change
o Helix agitator, range: 0-300 r.p.m.	No Change
Computer Control Software:	No Change
o Computer Control+DataAcquisition+Data Management Software for pH Process Control.	No Change
o Compatible with actual Windows operating systems. Graphic and intuitive simulation of the process in screen.	No Change
o Compatible with the industry standards. Registration and visualization of all process variables in an automatic and simultaneously way.	No Change
o Flexible and open software, developed with actual windows graphic systems, acting simultaneously on all process parameters.	No Change
o Analog and digital PID control. Menu for PID and set point selection required in the whole work range.	No Change
o Management, processing, comparison and storage of data. Sampling velocity up to 250,000 data per second guaranteed.	No Change
o Student calibration system for all sensors involved in the process.	No Change
o It allows the registration of the alarms state and the graphic representation in real time.	No Change
o Comparative analysis of the obtained data, after the process and modification of the conditions during the process.	No Change
o Open software, allowing to the teacher to modify texts, instructions. Teacher's and student's passwords to facilitate the teacher's control on the student, and allowing the access at	No Change

different work levels.	
A Computer to be provided for this setup.	No Change
A Separate Data acquisition system to be provided for this setup.	No Change
A Separate Control Interface to run the experiment simultaneously with other processes.	No Change
6 Conductivity and TDS (Total Dissolved Solids) Process Control:	
This Set will be supplied and installed in the Base Unit and ready for working.	No Change
Sensor and elements:	No Change
o Conductivity and TDS (Total Dissolved Solids) sensor:	No Change
o Conductivity range: 0-1999 ms/cm.	No Change
o Accuracy: ± 2% ms/cm.	No Change
o Resolution: 10 ms/cm.	No Change
o TDS range: 0-1999 ppm.	No Change
o Accuracy: ± 2% ppm.	No Change
o Resolution: 10 ppm.	No Change
o Helix agitator, range: 0-300 r.p.m.	No Change
Computer Control Software:	No Change
o Computer Control+DataAcquisition +Data Management Software for Conductivity and TDS (Total Dissolved Solids) Process Control.	No Change
o Compatible with actual Windows operating systems. Graphic and intuitive simulation of the process in screen.	No Change
o Compatible with the industry standards. Registration and visualization of all process variables in an automatic and simultaneously way.	No Change
o Flexible and open software, developed with actual windows graphic systems, acting simultaneously on all process parameters.	No Change
o Analog and digital PID control. Menu for PID and set point selection required in the whole work range.	No Change
o Management, processing, comparison and storage of data. Sampling velocity up to 250,000 data per second guaranteed.	No Change
o Student calibration system for all sensors involved in the process.	No Change
o It allows the registration of the alarms state and the graphic representation in real	No Change

time.	
o Comparative analysis of the obtained data, after the process and modification of the conditions during the process.	No Change
o Open software, allowing to the teacher to modify texts, instructions. Teacher's and student's passwords to facilitate the teacher's control on the student, and allowing the access at different work levels.	No Change
A Computer to be provided for this setup.	No Change
A Separate Data acquisition system to be provided for this setup.	No Change
A Separate Control Interface to run the experiment simultaneously with other processes.	No Change
7 .Multivariable Four Tank System	
This is a four coupled tanks computer-controlled coupled tanks system. The system has four transparent tanks each with a pressure sensor to measure the water level. The coupling configuration between tanks can be modified by the use of manual valves. Two independently controlled pumps drives the water from the bottom to the tanks and depending on how the valves are configured, the water flows from one tank to another.	No Change
The unit uses a data acquisition card for data acquisition, control and monitoring of the system. Dynamic models can be tested and validated using MATLAB/SIMULINK software. Also, different control algorithms can be also developed and tested in real time on the unit.	No Change
Anodized aluminum structure and panels in painted steel.	No Change
Main metallic elements in stainless steel.	No Change
Diagram in the front panel with similar distribution to the elements in the real unit.	No Change
Four transparent tanks with graduated scale, with configurable coupling.	No Change
Four pressure sensors to measure the level.	No Change
Manual valves to configure the coupling between tanks and introduce perturbations..	No Change
Two independent computer controlled centrifugal pumps.	No Change
Reservoir tank.	No Change
The complete unit includes as well:	No Change
Fully compatible with MATLAB and SIMULINK.	No Change
Open Control + Multicontrol + Real-Time Control.	No Change

□ Data Acquisition board (250 KS/s , kilo samples per second) from reputed suppliers.	No Change
□ Capable of doing applied research, real industrial simulation, training courses, etc.	No Change
□ Remote operation and control by the user and technical support to be included.	No Change
□ Totally safe, utilizing 4 safety systems (Mechanical, Electrical, Electronic & Software).	No Change
□ Designed and manufactured under several quality standards.	No Change
□ Optional software to help the user perform calculations and comprehend the results.	No Change
□ A Computer to be provided for this setup.	No Change
□ A Separate Data acquisition system to be provided for this setup.	No Change
□ A Separate Control Interface to run the experiment simultaneously with other processes.	No Change
All the above should be supplied with the following	
8. Cables and Accessories	
For normal operation	No Change
9. Manuals	
□ This system is to be supplied with manuals for each process control: Required Services, Assembly and Installation, Interface and Control Software, Starting-up, Safety, Maintenance, Calibration & Practices Manuals.	No Change
10. Computer Aided Learning Software (Results Calculation and Analysis)	
□ This Computer Aided Learning Software should be a Windows based software, simple and very easy to use.	No Change
□ It should be a class assistant that helps in making the necessary calculations to extract the right conclusions from data obtained during the experimental practices.	No Change
□ It will perform the calculations.	No Change
□ It computes the value of all the variables involved.	No Change
□ It allows to plot and print the results. Between the plotting options, any variable can be represented against any other.	No Change
□ Different plotting displays.	No Change
□ It has a wide range of information, such as constant values, unit conversion factors and integral and derivative tables.	No Change
□ A Computer to be provided for this setup.	No Change
11. Faults Simulation System	

□ The "FAULTS" mode consists on provoking several faults in the unit normal operation. The student must find them and, if possible, solve them.	No Change
□ There are several kinds of faults that can be grouped in three sections:	No Change
□ Faults affecting the sensors measure:	No Change
- An incorrect calibration is applied to them.	No Change
- Non-linearity.	No Change
□ Faults affecting the actuators: (These do not admit solutions. The student must just realise it and notify it.)	No Change
- Actuators canals interchange at any time during the program execution.	No Change
- Response reduction of an actuator.	No Change
□ Faults in the controls execution:	No Change
- Inversion of the performance in ON/OFF controls.	No Change
- Reduction or increase of the calculated total response.	No Change
- The action of some controls is annulled.	No Change
□ A Computer to be provided for this setup.	No Change
12. Bench-top unit.	
□ This unit must be available for all Sets for Process Control and can work with one or several sets.	No Change
□ Anodized aluminium structure and panels in painted steel.	No Change
□ Main metallic elements in stainless steel.	No Change
□ Diagram in the front panel with similar distribution to the elements in the real unit.	No Change
□ A transparent main tank and collector with an orifice in the central dividing wall (2 x 25 dm^3), and drainage in both compartments.	No Change
□ A transparent dual process tank (2x10 dm^3), interconnected through an orifice and a ball valve and an overflow in the dividing wall; a graduate scale and a threaded drain of adjustable level with bypass.	No Change
□ 2 Centrifugal pumps, range: 0-10 l./min.	No Change
□ 2 Variable area flow meters (0.2-2 l/min, and 0.2-10 l/min), and with a manual valve.	No Change
□ Line of on/off regulation valves (solenoid). Usually one is normally opened, and the other two are normally closed, and manual drainage valves of the upper tank.	No Change

□ Pneumatic control valve:	No Change
Pneumatic valve with positioner regulator.	No Change
Body in stainless steel connection G ½", orifice 6 mm.	No Change
□ The I/P converter transforms the electric signal sent from the computer into a proportional pressure that acts over the valve.	No Change
□ Any Set for Process Control to be supplied and installed in the Base Unit and ready for working.	No Change
□ A Data Acquisition System to be provided for this unit.	No Change
13. Control Interface Box	
□ This unit is common for all Sets for Process Control and can work with several sets.	No Change
□ Control interface box with process diagram in the front panel and with the same distribution that the different elements located in the unit, for an easy understanding by the student.	No Change
□ All sensors, with their respective signals, are properly manipulated from -10V. to +10V computer output. Sensors connectors in the interface have different pines numbers (from 2 to 16), to avoid connection errors.	No Change
□ Single cable between the control interface box and computer.	No Change
□ The unit control elements are permanently computer controlled, without necessity of changes or connections during the whole process test procedure.	No Change
□ Simultaneously visualization in the computer of all parameters involved in the process.	No Change
□ Calibration of all sensors involved in the process.	No Change
□ Real time curves representation about system responses. Storage of all the process data and results in a file. Graphic representation, in real time, of all the process/system responses.	No Change
□ All the actuators' values can be changed at any time from the keyboard allowing the analysis about curves and responses of the whole process. All the actuators and sensors values and their responses are placed in only one computer screen.	No Change
□ Shield and filtered signals to avoid external interferences.	No Change

□ Real time PID control with flexibility of modifications from the computer keyboard of the PID parameters, at any moment during the process. Real time PID and on/off control for pumps, compressors, resistances, control valves, etc. Real time PID control for parameters involved in the process simultaneously.	No Change
□ Open control allowing modifications, at any time and in a real time, of parameters involved in the process simultaneously.	No Change
□ Proportional control, integral control and derivative control, based on the real PID mathematical formula, by changing the values, at any time, of the three control constants (proportional, integral and derivative constants).	No Change
□ Possibility of automatization of the actuators involved in the process.	No Change
□ Three safety levels, one mechanical in the unit, other electronic in control interface and the third one in the control software.	No Change
14. Computer to be provided for each set up.	No Change
15. DAB Data Acquisition Board	
□ Common for the modules.	No Change
□ Data acquisition board to be placed in a computer slot.	No Change
□ Analog input:	No Change
o Number of channels= 16 single-ended or 8 differential.	No Change
o Resolution=16 bits, 1 in 65536.	No Change
o Sampling rate up to: 250 KS/s (Kilo samples per second).	No Change
o Input range (V)= ±10 V.	No Change
o Data transfers=DMA, interrupts, programmed I/0. Number of DMA channels=6.	No Change
□ Analog output:	No Change
o Number of channels=2.	No Change
o Resolution=16 bits, 1 in 65536.	No Change
o Maximum output rate up to: 900 KS/s.	No Change
o Output range(V)= ±10 V.	No Change
o Data transfers=DMA, interrupts, programmed I/0.	No Change
□ Digital Input/Output:	No Change
o Number of channels=24 inputs/outputs.	No Change
o D0 or DI Sample Clock frequency: 0 to 100 MHz.	No Change
o Timing: Counter/timers=4. Resolution: Counter/timers: 32 bits.	No Change

□ Data Acquisition Boards to be provided separately for each	No Change
Process set mentioned.	No Change
	5% bank guarantee for 5 years towards the supply of spare components after the warranty period.