

NATIONAL INSTITUTE OF TECHNOLOGY TIRUCHIRAPPALLI – 15

Department of Chemical Engineering

Web : www.nitt.edu

Phone : 0431 - 2503631



TENDER DOCUMENT

Tender Notification No.: **NITT/F.NO: UG-MOD 001 TO 025 and 035 to 045/PLAN 2013-14/CHE**

Dated: 13.02.2014

Name of the component	: SCADA /Computerized laboratory set up
Quantity required	: One
EMD Amount	: Rs. 40,00,000
Cost of the Tender Document	: Rs.500/-
Delivery	: 8 Weeks
Last Date of submission of Tender	: 14.03.2014 up to 3.00 pm
Address for submission of Tender	: The Director, National Institute of Technology- Tiruchirappalli, Tiruchirappalli – 620015, Tamilnadu, India Kind ATTN to:Dr. J.Sarat Chandra Babu Professor & Head, Dept. of Chemical Engineering Phone: 9486001125 Email: sarat@nitt.edu
Date of opening of technical bid	: 14.03.2014 at 3.30pm



**NATIONAL INSTITUTE OF TECHNOLOGY
TIRUCHIRAPPALLI – 15**

DEPARTMENT OF CHEMICAL ENGINEERING

**Tender Notification No.: NITT/F.NO: UG-MOD 001 TO 025 and 035 to 045/PLAN 2013-14/CHE
Dated:13.02.2014**

NOTICE INVITING TENDER

The National Institute of Technology, Tiruchirappalli (NITT) is an autonomous body under MHRD, GOI, imparting Technical Education and engaged in Research Activities. It is proposed to procure the following component for the Departmental academic/research activities.

Sealed bids under *two bid system* are invited for the following component subject to the following terms and conditions, from the reputed manufacturers or their authorized dealers so as to reach this office on or before scheduled date and time. The technical cover will be opened on the same day in the presence of bidders or their authorized agents who may choose to be present.

Name of the component	: SCADA /Computerized laboratory set up
Quantity required	: One
EMD	: Rs.40,00,000
Cost of the Tender Document	: Rs.500/-
Time for completion of supply after placing purchase order	: 8 Weeks
Last Date of submission of Tender	: 14.03.2014 up to 3.00 pm

Address for submission of Tender :The Director,
National Institute of Technology- Tiruchirappalli,
Tiruchirappalli – 620015, Tamilnadu, India
Kind ATTN to:Dr. J.Sarat Chandra Babu
Professor & Head, Dept. of Chemical Engg
Phone: 9486001125
Email: sarat@nitt.edu

Place, Date and time of opening of bid :

Date:14.03.2014 Time:3.30 pm Venue:Central Stores, NITT

Note : The Institute shall not be responsible for any postal delay about non-receipt / non delivery of the bids or due to wrong addressee.

BIDDER'S COPY

INSTRUCTIONS TO BIDDERS

1. This document set contains the following:
 - a) Terms and conditions of the Tender
 - b) Details of the Firm offering this Quote
 - c) Technical Compliance Form
 - d) Quotation form (Price Bid)
 - e) Currency Form (quoted on behalf of the foreign suppliers)
 - f) NIT-T's check list copy
2. The bidder's copy is for your future records. Please fill in and return only NIT-T's copy.
3. The bidder should give details of their technical soundness and provide list of customers of previous supply of similar items to Universities, Institutes or Government Departments/Undertakings/public sectors with contact details. The details of the agency/profile should be furnished along with the copy of all related documents.
4. Read through the terms and conditions given and affix your signature and seal if you find them acceptable. Any deviations may be recorded. Read carefully list of specifications that we have enclosed.
5. Fill in the questionnaire regarding the Firm.
6. The downloaded documents 'Technical Compliance Form' and 'Quotation Form (Price Bid)' should be **TYPE WRITTEN USING CAPITAL LETTERS ONLY**. At the time of filling the "Quotation Form (Price Bid)" make sure that you have not missed anything. Specify the model number & specification for each item. The form should be filled item-wise. Do not leave blank fields. If you are not quoting for a specific item, you should specify "NOT QUOTING".
7. **Do not use** ambiguous terms like "yes", "complied" or "available". Specifically mention the matching specification of the product offered by you. Make sure that you have affixed your signature with date and seal on all the documents.

Please send the tenders in a sealed envelope superscribed as "QUOTATIONS AGAINST TENDER NOTIFICATION NO: NITT/F.NO: UG-MOD 001 TO 025 and 035 to 045/PLAN 2013-14/CHE" so as to reach "The Director, National Institute of Technology, Tiruchirappalli – 620 015, India" on or before - **14.03.2014 at 3.00 pm along with a Softcopy of the Technical Compliance form (along with cover-2) and Quotation Forms (along with cover-3) in MS-Excel file format in a CD/DVD or USB drive.**

8. For any further clarifications, contact by E-Mail: sarat@nitt.edu or by written request to "The Registrar, National Institute of Technology, Tiruchirappalli – 620 015, India"

9. Pre-bid conference will be held on **21.02.2014 at 9a.m**

Last Date for receipt of tender at NIT-T : 14.03.2014 up to 3.00 pm

Opening Date for technical bid : 14.03.2014 at 3.30 pm

CHECKLIST TO BE FILLED IN BY BIDDER	
List of documents to be enclosed	Completed & Signed
1. Terms and Conditions form	YES / NO
2. Details of the Firm offering this Quote	YES / NO
3. NIT-T's Quotation form (Technical & Price Bid)	YES / NO
4. Currency Form(quoted on behalf of the foreign suppliers)	YES / NO
5. Other technical specifications & pamphlets	YES / NO

Note: 1. "Cover" should contain the following:

- a. Form of "Acceptance of Terms and Conditions".
- b. Form of "Firm details"
- c. Pamphlets, if any (in a separate sealed cover)
- d. Quotation Form (Technical, Price Bid and Currency Form)

Please retain this page with you for your future reference.

SECTION : 1 – TWO BID TENDER**Cover 1: EMD and Tender cost**

(Should be superscribed as 'EMD and tender cost cover' duly indicating the tender reference No. and the due date of opening)

Earnest Money Deposit (EMD) and tender cost are to be submitted by way of Demand Draft/FDR drawn on any Nationalized bank in India in favor of "The Director, NIT, Trichy" payable at Trichy. The bids submitted without EMD or tender cost will be treated as non-responsive and will be rejected. EMD shall bear no interest. The EMD can be submitted in the form of bank guarantee as per the prescribed format given by NITT.

Cover 2: Technical Bid

(should be superscribed as 'Technical Bid' duly indicating the Tender reference No. and the due date of opening)

Should contain:

- a. Technical pamphlets
- b. Detailed technical specification
- c. Copy of license certificate for manufacture/supply of the item*
- d. Income Tax PAN number & TIN number.*
- e. Last three years balance sheet approved by the CA and the IT clearance certificate.*
- f. Warranty period offered for the tendered item to be specified. If the warranty period is not conforming with the schedule of requirements given in section 3 of the Tender document, the bid is liable to be treated as non-responsive and will be rejected.
- g. Duly filled up technical questionnaire, if any
- h. Duly filled up deviation schedules to technical specifications, if any
- i. Copy of supply orders completed during the last three years

* Appropriately pertaining to the country of origin.

Cover 3: Price Bid

(should be superscribed as 'Price Bid' duly indicating the Tender reference No. and the due date of opening)

Should contain:

- a. Price bid as per the format in Section-4 of the tender document
- b. Break-up price as per the format in Annexure-A

Note:

- a. If the prices are revealed in cover 1 or in cover 2, the offer will be summarily rejected.
- b. Each Cover shall be sent in a double sealed cover. The inner covers (Cover 1, Cover 2 and Cover 3) should be sealed individually with the Sellers's distinctive seal and superscribed with the tender reference No. and due date of opening. All inner covers shall be placed in a common outer cover which shall also be sealed with seller's distinctive seal and superscribed with the tender reference No. and due date of opening.
- c. Mention "Kind Attention: Dr. J.Sarat Chandra babu ,Prof & Head ,Dept of Chemical Engineering", and submit at the address given in the Notice Inviting Tender.
- d. Cover 1 & 2 will be opened on the scheduled date and time mentioned in the tender enquiry.
- e. Cover 3 of the technically and commercially suitable offers alone will be opened on a date which will be intimated to the qualified bidders.

SECTION : 2 – TERMS AND CONDITIONS FORM

IMPORTANT: READ THE FOLLOWING TERMS AND CONDITIONS AND SIGN THE ACCEPTANCE CLAUSE FOLLOWING IT

1. The offers should be addressed to “The Director, National Institute of Technology, Tiruchirappalli 620015, India” and should be sent in a sealed envelope superscribed **BID AGAINST TENDER NOTIFICATION No. NITT/F.NO: UG-MOD 001 TO 025 and 035 to 045/PLAN 2013-14/CHE**” so as to reach us **on or before 14.03.2014**.
2. Each offer should be sent in a sealed cover with the tender documents. Tenders received through email or FAX will not be considered. **Softcopy of the Technical Compliance form and Quotation Forms should be submitted along with the tender in MS-Excel file format in a CD/DVD or USB drive. However, if there is any dispute between Hard copy and Soft copy, Hard copy will be taken.**
3. The tenders will be opened **On 14.03.2014 at 3.30 pm** in the presence of the vendors present with authorization letter from the respective companies / firms. Suppliers intending to attend the tender opening should intimate us in advance.
4. Full technical specifications and pamphlets should be sent along with the tenders. **Offers without proper technical specifications will be rejected.**
5. The rate quoted should be on unit basis excluding Taxes. Taxes and other charges should be quoted separately, considering exemptions if any.
6. All offers should indicate unit price (excluding taxes and duties applicable), Taxes and other charges should be mentioned separately, if any. Additional charges for packing, forwarding, freight, insurance etc., if any, should be clearly mentioned. Clearance at Customs will be arranged by us.
7. NIT-T is paying concessional Customs & Excise duty under Government of India Notification No.51/96 for Central Customs and 10/97 for Central Excise Duty vide Certificate No.TU/V/RG-CDE(183)/2011 dt.10.10.11. Currently the purchaser is paying 5% Basic Customs Duty, 2% Educational Cess on Basic Customs Duty, 1% Higher Education Cess on Educational Cess, and 4% Import Additional Duty. **This institute is exempted from payment of service tax as per Sl.no. 9 of Government notification No25/2012-ST dated 20thJune, 2012.** The Institute is not authorized to issue C and D forms of Sales tax certificate.
8. In case the offered items are to be imported, the rates should be quoted in foreign currency on C.I.F. Chennai Airport basis, and it should include the Freight up to Chennai airport and the insurance cover should be up to National Institute of Technology, Tiruchirappalli. NIT-T shall pay Customs duty if any.
9. If the price quoted is in foreign currency and if the order value is more than US\$10,000 and requested by the bidder then 100% payment will be made through **Letter of Credit (LC) at sight on acceptance. The bank charges outside India should be borne by the Supplier / Beneficiary. Part shipment not allowed.**
10. If the price quoted is in Indian Rupees, then 100% payment will be made only after installation and commissioning. **No advance payment will be made.**
11. No revision of the price bid will be allowed once the price bids are opened. In case of foreign currency, the agency should mention the % of currency fluctuations they can bear.
12. No increase in price will be allowed after our firm orders are placed.
13. **Payment of excise duty and sales tax / VAT (on ultimate products)** as applicable on the closing date of tender will be to the supplier’s / contractor’s account. Any statutory variation (both plus and minus) in the rate of excise duty/sales tax/VAT after closing date of tender/revised price bid but before the expiry of the contractual delivery / completion period will be to the account of the office. The bidder(s) should indicate, in their bid, the amount with exact rate of the Excise and Sales tax/VAT on ultimate finished product, as applicable at tendering stage, separately in the bid. In case the above information subsequently proves wrong, incorrect or misleading (a) this Institute will have no liability to reimburse the excess in the difference in rates of the item under which the duty/tax assessed finally

(b) this Institute will have the right to recover the difference in case the rate of duty / tax finally assessed is on the lower side. Any increase in excise duty, sales tax / VAT during extended period of the contract / supply order will be to supplier's / contractor's account where such extension in delivery of the materials/completion of the project was on the request of supplier / contractor. However, any decrease in excise duty/sales tax/ VAT during extended period of the contract / supply order, will be to the account of this Institute.

14. **This institute is exempted from payment of service tax as per Sl.no. 9 of Government notification No25/2012-ST dated 20th June, 2012. The tenderer should verify the excise duty exemption certificates of this institution and service tax rules before submission of the Bid. It will be assumed on the submission of bid that excise duty exemption will be provided and no other conditions after the issue of purchase order will be accepted. No service tax will be paid by this institute.**
15. The warranty period should be clearly mentioned. The maintenance charges (AMC) under different schemes after the expiry of the warranty should also be mentioned.
16. Quote should come from authorized dealer or distributor or reseller for each of the product quoted. An authorization letter should accompany your quote for each product quoted; otherwise it may lead to rejection.
17. The delivery period and other terms should be clearly mentioned.
18. **Eligibility:** Quotation from registered firms/company's / manufacturer under TNGST/CST / other statutory bodies alone will be considered. Any Manufacturer / Supplier / Dealer who has been declared ineligible by World Bank/Government of India shall not be eligible to participate in this bid. Any fraudulent practices including concealing of facts at the time of submission of bid and there after shall lead to disqualification. List of beneficiaries especially from Educational Institutions / R & D Institutions should also be enclosed with the quotations.
19. For those instruments Cost exceeding Rs. 5,00,000/- the company should have (i) Three similar works, each of value not less than 40% of the estimated cost put to tender, or (ii) Two similar works, each of value not less than 50% of the estimated cost, or (iii) One similar work of value not less than 80% of the estimated cost, all amounts rounded off to a convenient full figure, in the last 7 years ending on the last day of the month previous to the one in which the tenders are invited.
20. Complete user, technical and service documentation and spare parts catalogue are to be provided along with the supply of the item.
21. The vendors are informed that they should not call us over phone or contact us in person. All clarifications can be obtained through E-Mail/FAX/Post. Vendors shall not make attempts to establish unsolicited and un-authorized contact with us after the opening of the offers and prior to the notification of the award. Any attempt by any vendor to bring to bear extraneous pressures on us shall be sufficient reason to disqualify the vendor.
22. Delay / loss in postal transit or due to other reasons will not be NIT-T's responsibility.
23. We are not responsible for accidental opening of the covers that are not properly superscribed and sealed before the time scheduled for opening.
24. The tender should be made only on the FORM which is available in our website, otherwise it shall lead to rejection. The FORM should be duly filled up (preferably **TYPE WRITTEN IN CAPITAL LETTERS**) and should clearly mention the features offered by the bidder against each specification.
25. Authorized signatory should sign on all the pages. Bids without authorized signatures or seal of the firm will be rejected.
26. The manufacturers of the quoted make of the product must be of National / International repute and having ISO /BIS certificate.
27. **Liquidated damages:** If the bidder/supplier, after accepting the Purchase Order, fails to deliver any or all of the Goods within the period specified in the Order, NIT-T shall, without prejudice to its other remedies under the Rules of Purchase, proceed to cancel the order or agree to accept a delayed delivery on the condition of payment of liquidated damages by the bidder / supplier a sum equivalent to 0.50% of the total cost as indicated in the Purchase Order (which will be deemed as agreed price) for each week or part thereof of delay until actual delivery or performance is completed and such penal charges shall be limited to a maximum of 5% of the total cost. Once the maximum is reached NIT-T may proceed on its own to consider the termination / cancellation of the order.

28. **The vendors are informed that they should sign a stamp paper agreement with us, for Warranty, AMC, etc. before placing the final purchase order as per our terms & conditions and 10% of purchase order value in the form of bank guarantee towards performance security. The bank guarantee will be returned to the supplier after the successful completion of supply, installation, and the warranty period.**
29. Failure to comply with all the terms and conditions mentioned herein would result in the tender being summarily rejected.
30. Vendors are informed that once the companies are shortlisted based on the technical specification, only then the price bids of the firms that meet NIT-T's Technical specification / requirements would be compared.
31. The order will be based on the actual requirement at the time of ordering, optional items may also be ordered based on the actual requirements at the time of ordering. Not quoting for this may result in disqualification.
32. NIT-T reserves the right to modify or alter the specifications after short listing of tenderers.
33. NIT-T reserves the right to change the order quantity or split the orders among multiple vendors without assigning any reason(s) whatsoever.
34. NIT-T reserves the right to reject any or all the tenders without assigning any reasons whatsoever.
35. NIT-T reserves the right to purchase decreased number of quantity of the item to be purchased.
36. The agencies should submit their rate as per the format given in Section 4 of the Notice Inviting Tender in this cover. All the pages of the bid should be signed affixing the seal. All corrections and overwriting should be initialed.
37. The tender will be acceptable only from the manufacturers or its authorized supplier.
38. The bid shall be in the format of price schedule given in Section 4. The contract form as per format given in section 5 shall be submitted. Incomplete or conditional tender will be rejected.
39. Details of quantity and the specifications are mentioned in Section 3 appended to this Notice Inviting Tender.
40. The item to be used is strictly according to the specification and subject to test by the Institute/concerned authorities. It must be delivered and installed in good working condition.
41. The Contractor/Supplier shall have no claim to any payment of compensation or otherwise whatsoever, on account of any profit or advantage which he might have derived from the execution of the work/supply in full but he did not derive in consequence of the foreclosure of the whole or part of the works.
42. In case of dispute, the matter will be subject to Tiruchirappalli, Tamil Nadu Jurisdiction only.

Release of EMD: The EMD will be released after receipt of performance security from successful bidder.

Validity of bids: The rate quote should be valid for a minimum of 120 days. No claim for escalation of rate will be considered after opening the Tender.

Imports: In case, goods are to be imported, the Indian agent should furnish authorization certificate by the principles abroad for submission of the bid in response to this Notice Inviting Tender.

Clarification of Tender Document: A prospective bidder requiring any clarification of the Tender document may communicate to the contact person given in this notice inviting tender.

Amendment of tender document: At any time prior to the last date of receipt of bids, Institute may for any reason, whether at its own initiative or in response to a clarification requested by prospective bidder, modify the Tender document by an amendment in the NIT-T website only.

The Institute may at its own discretion extend the last date for the receipt of bids.

The bids shall be written in English language and any information printed in other language shall be accompanied by an English translation, in which case for the purpose of interpretation of the bid, the English translation shall govern.

The Institute reserves the right of accepting any bid other than the lowest or even rejecting all the bids without assigning any reasons therefor. The decision of the Institute Purchase Committee is final in all matters of tender and purchase.

The bidder should give the following declaration while submitting the Tender.

ACCEPTANCE

We accept the above terms and conditions and shall comply with them strictly.

NAME OF THE VENDOR:

ADDRESS:

Signature and seal

“DETAILS OF THE FIRM OFFERING THIS QUOTE”
(Write or print or type in block letters)

1. Name of the firm: _____ 2. Date of incorporation: _____
2. Nature of the company (tick one): Government / Public / Private Company / Partnership / Proprietorship
3. Specify the number of years in this line of activity by the Company: ..
4. Quantity of sales in the last three years for the “**SCADA/Computerized laboratory set up**” (same model that you have quoted):

2010-2011	2011-2012	2012-2013

5. Turnover in the last three years (Lakh Indian Rupees):

2010-2011	2011-2012	2012-2013

6. Provide the postal address, telephone & fax numbers, and email address of the nearest service center.
7. Number of service engineers in the above location trained on the product quoted along with their educational qualification, certification and designation (applicable only for instruments):
8. Assured response time for service calls in hours:
9. Delivery period from the date an official purchase order placed (in weeks):
10. Enclose the list of customers to whom you have supplied “**SCADA/Computerized laboratory set up**” during the last 3 years ending 31/03/2013 with full postal address and name of the contact person with phone, FAX numbers, and E-Mail id. Certificate regarding satisfactory performance of the “**SCADA/Computerized laboratory set up**” from the minimum three end users should be furnished.
11. Are you the authorized dealer or distributor or reseller for the products quoted?
12. Have you supplied “**SCADA/Computerized laboratory set up**” to National Institute of Technology, Tiruchirappalli in the last 3 years? If yes, specify the quantity supplied in the last 3 years and last PO reference:
13. Was there any elapse or delay in supplying the goods ordered or any service related issue during the warranty period for the products ordered by NIT-T with your firm? If yes, provide details.
14. On Manufacturer’s Side to whom NITT have to contact in case of delayed in supply and other issues committed by the authorized dealer / distributor / reseller :

Contact Person Name : Address : E-mail ID :	Telephone / Cell Phone :
---	--------------------------

DECLARATION

I/we have not tampered/modified the tender forms in any manner. In case, if the same is found to be tampered/modified, I/we understand that my/our tender will be summarily rejected and full Earnest Money Deposit (EMD) will be forfeited and I/we am/are liable to be banned from doing business with NIT, Trichy and /or prosecuted.

Signature of the Bidder :

Name and Designation :

Business Address :

.....

.....

Place :

Date :

Seal of the Bidder's Firm

SECTION : 3 – SCHEDULE OF REQUIREMENTS, SPECIFICATIONS AND ALLIED DETAILS

Name of the Component to be procured : **SCADA/Computerized laboratory set up** Specifications

:

Name of the Laboratory: SCADA/Computerized laboratory set up for CHEMICAL REACTIONS ENGINEERING LAB.

S.No	Name of the Unit	Key Specification
1	Chemical reactors type-I	<p>1 Base Service Unit: This unit is common for the Chemical Reactors and can work with one or several reactors. Installation and exchange system of the reactors, quick and easy to handle. It supplies all the services for the operation of each reactor. Anodized aluminium structure and panels in painted steel. Main metallic elements in stainless steel. This unit included wheels for its mobility. Diagram in the front panel with similar distribution to the elements in the real unit. 2 dosing pumps, computer controlled. 3 tanks of 10 litres made of Pyrex-glass: two of them for the reagents and the other one for the product. 2 flow meters to measure the flow of liquids. Flow range: 0.7-7 and 0.54-5.4 l/h. Flow meter to measure the flow of gas for a maximum flow of 1440N l/h and maximum pressure of 0.5 Kg cm⁻². Thermostatic bath of 9 litres that regulates the temperature between T_{environment}+ 5^o and 70^o C. Level switch. A pump, computer controlled, to impel the water that comes from the thermostatic bath and goes to the reactor. Type “J” temperature sensor to get the temperature of the reactor in a continuous way. Temperature control through the computer. 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. All elements of this unit are chemically resistant.</p> <p>2 Control Interface Box: This control interface is common for the Chemical Reactors and can work with one or several reactors. 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. All sensors, with their respective signals, are properly manipulated from -10V. to +10V computer output. Sensors connectors in the interface have different pins numbers (from 2 to 16), to avoid connection errors. Single cable between the control interface box and computer. 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.</p>

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.

Shield and filtered signals to avoid external interferences.

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.

Open control allowing modifications, at any time and in a real time, of 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).

Possibility of automatization of the actuators involved in the process.

Three safety levels, one mechanical in the unit, other electronic in control interface and the third one in the control software.

3 . Data Acquisition Board:

PCI EXPRESS Data acquisition board (National Instruments) 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.

Sampling rate up to: 250 KS/s (Kilo samples per second). Input range (V)= $\pm 10V$.

Data transfers=DMA, interrupts, programmed I/O. Number of DMA channels=6.

Analog output: Number of channels=2. Resolution=16 bits, 1 in 65536. Maximum output rate up to: 900 KS/s.

Output range(V)= ± 10 . Data transfers=DMA, interrupts, programmed I/O.

Digital Input/Output: Number of channels=24 inputs/outputs. D0 or DI Sample Clock frequency:0 to 100 MHz.

Timing:Counter/timers=4. Resolution: Counter/timers:32 bits.

4 Chemical Reactors

4.1 . Isothermal Reactor with Distillation: (File No. 014)

Anodized aluminium structure and panels in painted steel. Main metallic elements in stainless steel.

Diagram in the front panel with similar distribution to the elements in the real unit.

Reactor insulated made of Pyrex-glass, with a maximum volume of 2 litres.

Inlets of reagents. Outlet of products. Conductivity cell connection. Water outlet. Water inlet.

Temperature sensor connection. Gas inlet. Gas outlet.

Agitation system with agitation speed control and indication from 0 to 2000 rpm.

Distillation column. Balls coolant. Coil coolant. Vacuum pump. Vacuum tramp.

Graduated funnel.

Temperature sensors. Conductivity sensor.

Safety, easy and quick connections.

All elements of this unit are chemically resistant.

This unit is supplied with 8 manuals: Required Services, Assembly and Installation, Interface and Control Software, Starting-up, Safety, Maintenance, Calibration & Practices Manuals.

Computer Control Software:

Computer Control+DataAcquisition+Data Management Software for Isothermal Reactor with Distillation (QRIA/D).

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 multicontrolsoftware, developed with actual windows graphic systems, acting simultaneously on all process parameters.
 Analog and digital PID control. Menu for PID and set point selection required in the whole work range.
 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.
 It allows the registration of the alarms state and the graphic representation in real time.
 Comparative analysis of the obtained data, after the process and modification of the conditions during the process.
 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.
 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.

4.2 Tubular Flow Reactor: (File No. 015)
 Anodized aluminium structure and panels in painted steel. Main metallic elements in stainless steel.
 Diagram in the front panel with similar distribution to the elements in the real unit.
 Temperature controlled by a jacket of water, through a temperature sensor "J" type.
 Electrical preheater with power of 265 W for both feeding lines.
 Reactor with inner coil made of teflon of 6mm of interior diameter, length 14.5 m, volume: 0.393 litres.
 Temperature sensor "J" type, that controls the preheating temperature.
 Conductivity sensor.
 Safety, easy and quick connections.
 All elements of this unit are chemical resistant.
 This unit is supplied with 8 manuals: Required Services, Assembly and Installation, Interface and Control Software, Starting-up, Safety, Maintenance, Calibration & Practices Manuals.
 Computer Control Software:
 Computer Control+DataAcquisition+Data Management Software for Tubular Flow Reactor (QRFT).
 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 multicontrolsoftware, developed with actual windows graphic systems, acting simultaneously on all process parameters.
 Analog and digital PID control. Menu for PID and set point selection required in the whole work range.
 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.
 It allows the registration of the alarms state and the graphic representation in real time.
 Comparative analysis of the obtained data, after the process and modification of the conditions during the process.
 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.

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.

4.3 . Adiabatic and Isothermal Reactor: (File No. 016)

Anodized aluminium structure and panels in painted steel. Main metallic elements in stainless steel.

Diagram in the front panel with similar distribution to the elements in the real unit.

Reactor insulated made of Pyrex-glass, with a maximum volume of 2 litres.

Nickel-plated cooper coil of 2500mm long, outer diameter of 6.7mm and inner one of 4.1 mm.

Stirrer.

Water flow control of 0-6 l/min.

Outer jacket made of anodisedaluminium and inner jacket made of expanded polyurethane foam rubber.

3 Temperature sensors. Conductivity sensor.

Safety, easy and quick connections.

All elements of this unit are chemically resistant.

This unit is supplied with 8 manuals: Required Services, Assembly and Installation, Interface and Control Software, Starting-up, Safety, Maintenance, Calibration & Practices Manuals.

Computer Control Software:

Computer Control+ Data Acquisition+ Data Management Software for Adiabatic and Isothermal Reactor (QRAD).

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 multicontrolsoftware, developed with actual windows graphic systems, acting simultaneously on all process parameters.

Analog and digital PID control. Menu for PID and set point selection required in the whole work range.

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.

It allows the registration of the alarms state and the graphic representation in real time.

Comparative analysis of the obtained data, after the process and modification of the conditions during the process.

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.

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.

4.4 . Reactors with Stirrer in Series: (File No. 017)

Anodized aluminium structure and panels in painted steel.

Main metallic elements in stainless steel.

Diagram in the front panel with similar distribution to the elements in the real unit.

3 Reactors insulated made of Pyrex-glass, with a maximum volume of 1 litre each one.

Agitation system with agitation speed control and indication from 0 to 2000 rpm. for each reactor.

3 Temperature sensors.

Conductivity sensors.

Safety, easy and quick connections.

All elements of this unit are chemically resistant.

This unit is supplied with 8 manuals: Required Services, Assembly and Installation, Interface and Control Software, Starting-up, Safety, Maintenance, Calibration &

Practices Manuals.

Computer Control Software:
 Computer Control+DataAcquisition+Data Management Software for Reactors with Stirrer in Series (QRSA).
 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 multicontrolsoftware, developed with actual windows graphic systems, acting simultaneously on all process parameters.
 Analog and digital PID control. Menu for PID and set point selection required in the whole work range.
 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.
 It allows the registration of the alarms state and the graphic representation in real time.
 Comparative analysis of the obtained data, after the process and modification of the conditions during the process.
 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.
 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.

5 Cables and Accessories, for normal operation.

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.

7. Computer Aided Learning Software (Results Calculation and Analysis)
 This Computer Aided Learning Software is a Windows base software, simple and very easy to use,
 CAL is a class assistant that helps in making the necessary calculations to extract the right conclusions from data obtained during the experimental practices.
 CAL will perform the calculations.
 CAL computes the value of all the variables involved.
 It allows to plot and print the results. Between the plotting options, any variable can be represented against any other.
 Different plotting displays.
 It has a wide range of information, such as constant values, unit conversion factors and integral and derivative tables.

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.
 There are several kinds of faults that can be grouped in three sections:
 Faults affecting the sensors measure:
 - An incorrect calibration is applied to them.
 - Non-linearity.
 Faults affecting the actuators: (These do not admit solutions. The student must just realise it and notify it.)
 - Actuators canals interchange at any time during the program execution.
 - Response reduction of an actuator.
 Faults in the controls execution:
 - Inversion of the performance in ON/OFF controls.
 - Reduction or increase of the calculated total response.
 - The action of some controls is annulled.

2	Chemical reactors type-II	<p>1 . Service Unit: (File No. 018) This unit is common for the Chemical Reactors, and can work with one or several reactors. Accommodation and exchange system of the reactors, quick and easy to handle. It supplies all the services for the operation of each reactor. Anodized aluminium structure and panels in painted steel (epoxy paint). Main metallic elements in stainless steel. Diagram in the front panel with similar distribution to the elements in the real unit. 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. Thermostatic bath of 9 l. capacity, computer controlled. Temperature PID control of the thermostatic bath. 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. 2 Tanks for the reagents, of 1 liter capacity each one, made in Pyrex glass. The control of the reaction is carried out by a conductivity sensor, which allows the reaction evolution parametrization in real time. 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. All elements of this unit are chemically resistant.</p> <p>2 . Control Interface Box: This control interface is common for the Chemical Reactors and can work with one or several reactors. 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. 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. 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. 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. Shield and filtered signals to avoid external interferences. 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). Open control allowing modifications, at any time and in a real time, of parameters involved in the process simultaneously. Possibility of automatization of the actuators involved in the process. Three safety levels, one mechanical in the unit, other electronic in control interface and the third one in the control software.</p>
---	----------------------------------	--

3. Data Acquisition Board:

PCI EXPRESS Data acquisition board (National Instruments) 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.

Sampling rate up to: 250 KS/s (Kilo samples per second). Input range (V)= $\pm 10V$.

Data transfers=DMA, interrupts, programmed I/O. Number of DMA channels=6.

Analog output: Number of channels=2. Resolution=16 bits, 1 in 65536. Maximum output rate up to: 900 KS/s.

Output range(V)= ± 10 . Data transfers=DMA, interrupts, programmed I/O.

Digital Input/Output: Number of channels=24 inputs/outputs. D0 or DI Sample Clock frequency:0 to 100 MHz.

Timing: Counter/timers=4. Resolution: Counter/timers:32 bits

4 Chemical Reactors

4.1 . Continuous Stirred Tank Reactor: (File No. 019)

Small scale Continuous Stirred Tank Reactor, computer controlled, designed to demonstrate the behavior of a reactor used for homogeneous reactions liquid-liquid.

Anodized aluminum structure and panels in painted steel (epoxy paint).

Main metallic elements in stainless steel.

Diagram in the front panel with similar distribution to the elements in the real unit.

Reactor body made in borosilicate glass, with a maximum capacity of 2 liters, specially designed to work in continuous. It also allows batch operation.

Adjustable volume from 0.4 to 1.5 l.

Stainless steel heat transfer coil and a baffle (removable).

Stirring system with speed control and indication, computer controlled. Stirrer range: 0-220 rpm.

Reactor lip with connectors for the appropriate sensors.

Temperature sensor "J" type to control the temperature into the reactor.

Conductivity sensor to control the reaction. Measurement range up to 20 mS.

Easy and quick assembly on the Service Unit.

All elements of this unit are chemically resistant.

This unit is supplied with 8 manuals: Required Services, Assembly and Installation, Interface and Control Software, Starting-up, Safety, Maintenance, Calibration & Practices Manuals.

Computer Control Software:

Computer Control+DataAcquisition+Data Management Software for Continuous Stirred Tank Reactor (QRCAC).

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 multicontrolsoftware, developed with actual windows graphic systems, acting simultaneously on all process parameters.

Analog and digital PID control. Menu for PID and set point selection required in the whole work range.

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.

It allows the registration of the alarms state and the graphic representation in real time.

Comparative analysis of the obtained data, after the process and modification of the conditions during the process.

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.

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.

4.2. Batch Reactor: (File No. 020)

Small scale Bath Reactor, computer controlled, designed for the kinetic study of homogeneous reactions liquid-liquid, both in adiabatic conditions and in isothermal conditions.

Anodized aluminium structure and panels in painted steel (epoxy paint).

Main metallic elements in stainless steel.

Diagram in the front panel with similar distribution to the elements in the real unit.

The reactor body is an isolated vessel with a stainless steel external casing. The working volume is 1 liter.

Heat transfer coil made in stainless steel and reactor baffle, of 4.5 loops of 76 mm of diameter and 1250 mm length. The tube internal diameter is of 6 mm and the external one is of 8 mm.

Stirring system with speed control and indication, computer controlled. Stirrer range: 0-220 rpm.

Temperature sensor "J" type to control the temperature into the reactor.

Conductivity sensor to control the reaction. Measurement range up to 20 mS.

Reactor lip with connectors for the appropriate sensors.

Easy and quick assembly on the Service Unit.

All elements of this unit are chemically resistant.

This unit is supplied with 8 manuals: Required Services, Assembly and Installation, Interface and Control Software, Starting-up, Safety, Maintenance, Calibration & Practices Manuals.

Computer Control Software:

Computer Control + Data Acquisition + Data Management Software for Batch Reactor (QRDC).

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.

Analog and digital PID control. Menu for PID and set point selection required in the whole work range.

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.

It allows registration of the alarms state and the graphic representation in real time.

Comparative analysis of the obtained data, after the process and modification of the conditions during the process.

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.

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.

4.3. Laminar Flow Reactor: (File No. 021)

Small scale Laminar Flow Reactor, computer controlled, designed to demonstrate the flow pattern characterization and the steady state conversion in a tubular reactor.

Anodized aluminium structure and panels in painted steel (epoxy paint).

Main metallic elements in stainless steel.

Diagram in the front panel with similar distribution to the elements in the real unit.

Working volume: 400 ml.

The reactor column is 1300 mm long approx., including 2 diffusers packed with glass balls.

At the bottom of the column a premixer provides a complete mixing of the reagents entering the reactor and improves the flow distribution.

The reactor refrigeration jacket keeps its contents at constant temperature to keep the laminar flow conditions.

The reagents are fed to the reactor by the peristaltic dosing pumps of the Service Unit.

Temperature sensors.

Conductivity sensor to control the reaction.

Easy and quick connection with the Service Unit.

All elements of this unit are chemically resistant.

This unit is supplied with 8 manuals: Required Services, Assembly and Installation, Interface and Control Software, Starting-up, Safety, Maintenance, Calibration & Practices Manuals.

Computer Control Software:

Computer Control+DataAcquisition+Data Management Software for Laminar Flow Reactor (QRLC).

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 multicontrolsoftware, developed with actual windows graphic systems, acting simultaneously on all process parameters.

Analog and digital PID control. Menu for PID and set point selection required in the whole work range.

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.

It allows registration of the alarms state and the graphic representation in real time.

Comparative analysis of the obtained data, after the process and modification of the conditions during the process.

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.

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.

5 Cables and Accessories, for normal operation.

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.

7 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

CAL is a class assistant that helps in making the necessary calculations to extract the right conclusions from data obtained during the experimental practices.

CAL will perform the calculations.

CAL computes the value of all the variables involved.

It allows to plot and print the results. Between the plotting options, any variable can be represented against any other.

Different plotting displays.

It has a wide range of information, such as constant values, unit conversion factors and integral and derivative tables.

8. Faults Simulation System:

The "FAULTS" mode consists on provoking several faults in the unit normal operation.

<p>The student must find them and, if possible, solve them. There are several kinds of faults that can be grouped in three sections: Faults affecting the sensors measure: - An incorrect calibration is applied to them. - Non-linearity. Faults affecting the actuators: (These do not admit solutions. The student must just realise it and notify it.) - Actuators canals interchange at any time during the program execution. - Response reduction of an actuator. Faults in the controls execution: - Inversion of the performance in ON/OFF controls. - Reduction or increase of the calculated total response. - The action of some controls is annulled.</p>

Name of the Laboratory: SCADA/Computerized laboratory set up for PROCESS CONTROL LAB.

Specification

1. Temperature Process Control (File No. 036 & 037)

- This Set will be supplied and installed in the Base Unit and ready for working.
- Sensor and elements:
 - Temperature sensor “J type”, range: -40 to 750°C.
 - Electric resistor (0.5 KW), with thermostat (70°C).
 - Helix agitator, range: 0-300 r.p.m.
 - On/off level switch; safety element that permits the resistance to operate just when the level of water is sufficient.
- Computer Control Software:
 - Computer Control+DataAcquisition+Data Management Software for Temperature Process Control.
 - 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 and open software, developed with actual windows graphic systems, acting simultaneously on all process parameters.
 - Analog and digital PID control. Menu for PID and set point selection required in the whole work range.
 - Management, processing, comparison and storage of data.
 - Sampling velocity up to 250,000 data per second guaranteed.
 - Student calibration system for all sensors involved in the process.
 - It allows the registration of the alarms state and the graphic representation in real time.
 - Comparative analysis of the obtained data, after the process and modification of the conditions during the process.
 - 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.
- A Computer to be provided for this setup.
- A Separate Data acquisition system to be provided for this setup.
- A Separate Control Interface to run the experiment simultaneously with other processes.

2. Flow Process Control: (File No. 038)

- This Set will be supplied and installed in the Base Unit and ready for working.
- Sensor and elements:
 - Turbine type flow sensor, range: 0.25-6.5 l./min.
- Computer Control Software:
 - Computer Control+DataAcquisition+Data Management Software for Flow Process Control.
 - 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 and open software, developed with actual windows graphic systems, acting simultaneously on all process parameters.
 - Analog and digital PID control. Menu for PID and set point selection required in the whole work range.
 - Management, processing, comparison and storage of data.
 - Sampling velocity up to 250,000 data per second guaranteed.
 - Student calibration system for all sensors involved in the process.
 - It allows the registration of the alarms state and the graphic representation in real time.
 - Comparative analysis of the obtained data, after the process and modification of the conditions during the process.
 - 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.
- A Computer to be provided for this setup.
- A Separate Data acquisition system to be provided for this setup.
- A Separate Control Interface to run the experiment simultaneously with other processes.

3. Level Process Control: (File No. 0394)

- This Set will be supplied and installed in the Base Unit and ready for working.
- Sensor and elements:
 - 0-300mm level sensor (of capacitive immersion, 4-20mA), made with teflon to avoid any corrosion.
- Computer Control Software:
 - Computer Control+DataAcquisition+Data Management Software for Level Process Control.
 - 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 and open software, developed with actual windows graphic systems, acting simultaneously on all process parameters.
 - Analog and digital PID control. Menu for PID and set point selection required in the whole work range.
 - Management, processing, comparison and storage of data.
 - Sampling velocity up to 250,000 data per second guaranteed.
 - Student calibration system for all sensors involved in the process.
 - It allows the registration of the alarms state and the graphic representation in real time.
 - Comparative analysis of the obtained data, after the process and modification of the conditions during the process.

- 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.
- A Computer to be provided for this setup.
- A Separate Data acquisition system to be provided for this setup.
- A Separate Control Interface to run the experiment simultaneously with other processes.

4 Pressure Process Control: (File No. 040)

- This Set will be supplied and installed in the Base Unit and ready for working.
- Sensor and elements:
 - Pressure sensor, range: 0-1 psi.
- Computer Control Software:
 - Computer Control+DataAcquisition+Data Management Software for Pressure Process Control.
 - 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 and open software, developed with actual windows graphic systems, acting simultaneously on all process parameters.
 - Analog and digital PID control. Menu for PID and set point selection required in the whole work range.
 - Management, processing, comparison and storage of data. Sampling velocity up to 250,000 data per second guaranteed.
 - Student calibration system for all sensors involved in the process.
 - It allows the registration of the alarms state and the graphic representation in real time.
 - Comparative analysis of the obtained data, after the process and modification of the conditions during the process.
 - 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.
- A Computer to be provided for this setup.
- A Separate Data acquisition system to be provided for this setup.
- A Separate Control Interface to run the experiment simultaneously with other processes.

5 pH Process Control: (File No. 041)

- This Set will be supplied and installed in the Base Unit and ready for working.
- Sensor and elements:
 - pH sensor:
 - Simple electrode Ag/Agcl.
 - Accuracy: ± 0.2 pH.
 - Resolution: 0.1 pH.
 - Range: 0-14.
 - Helix agitator, range: 0-300 r.p.m.
- Computer Control Software:
 - Computer Control+DataAcquisition+Data Management Software for pH Process Control.
 - 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 and open software, developed with actual windows graphic systems, acting simultaneously on all process parameters.
- Analog and digital PID control. Menu for PID and set point selection required in the whole work range.
- Management, processing, comparison and storage of data. Sampling velocity up to 250,000 data per second guaranteed.
- Student calibration system for all sensors involved in the process.
- It allows the registration of the alarms state and the graphic representation in real time.
- Comparative analysis of the obtained data, after the process and modification of the conditions during the process.
- 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.
- A Computer to be provided for this setup.
- A Separate Data acquisition system to be provided for this setup.
- A Separate Control Interface to run the experiment simultaneously with other processes.

6 Conductivity and TDS (Total Dissolved Solids) Process Control: (File No. 042)

- This Set will be supplied and installed in the Base Unit and ready for working.
- Sensor and elements:
 - Conductivity and TDS (Total Dissolved Solids) sensor:
 - Conductivity range: 0-1999 ms/cm.
 - Accuracy: $\pm 2\%$ ms/cm.
 - Resolution: 10 ms/cm.
 - TDS range: 0-1999 ppm.
 - Accuracy: $\pm 2\%$ ppm.
 - Resolution: 10 ppm.
 - Helix agitator, range: 0-300 r.p.m.
- Computer Control Software:
 - Computer Control+DataAcquisition+Data Management Software for Conductivity and TDS (Total Dissolved Solids) Process Control.
 - 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 and open software, developed with actual windows graphic systems, acting simultaneously on all process parameters.
 - Analog and digital PID control. Menu for PID and set point selection required in the whole work range.
 - Management, processing, comparison and storage of data. Sampling velocity up to 250,000 data per second guaranteed.
 - Student calibration system for all sensors involved in the process.
 - It allows the registration of the alarms state and the graphic representation in real time.
 - Comparative analysis of the obtained data, after the process and modification of the conditions during the process.
 - 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.
- A Computer to be provided for this setup.
- A Separate Data acquisition system to be provided for this setup.
- A Separate Control Interface to run the experiment simultaneously with other processes.

7. Multivariable Four Tank System (File No. 044)

- 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.
- 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.
- Anodized aluminum structure and panels in painted steel.
- Main metallic elements in stainless steel.
- Diagram in the front panel with similar distribution to the elements in the real unit.
- Four transparent tanks with graduated scale, with configurable coupling.
- Four pressure sensors to measure the level.
- Manual valves to configure the coupling between tanks and introduce perturbations..
- Two independent computer controlled centrifugal pumps.
- Reservoir tank.
- The complete unit includes as well:
- Fully compatible with MATLAB and SIMULINK.
- Open Control + Multicontrol + Real-Time Control.
- Data Acquisition board (250 KS/s , kilo samples per second) from reputed suppliers.
- Capable of doing applied research, real industrial simulation, training courses, etc.
- Remote operation and control by the user and technical support to be included.
- Totally safe, utilizing 4 safety systems (Mechanical, Electrical, Electronic & Software).
- Designed and manufactured under several quality standards.
- Optional software to help the user perform calculations and comprehend the results.
- A Computer to be provided for this setup.
- A Separate Data acquisition system to be provided for this setup.
- A Separate Control Interface to run the experiment simultaneously with other processes.

All the above should be supplied with the following

8. Cables and Accessories,

- For normal operation

9. Manuals

- This system is to be supplied with manuals for each process control: Required Services, Assembl and Installation, Interface and Control Software, Starting-up, Safety, Maintenance, Calibration , Practices Manuals.

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.
- 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.
- It will perform the calculations.
- It computes the value of all the variables involved.
- It allows to plot and print the results. Between the plotting options, any variable can be represented against any other.
- Different plotting displays.
- It has a wide range of information, such as constant values, unit conversion factors and integral and derivative tables.

- A Computer to be provided for this setup.

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.
- There are several kinds of faults that can be grouped in three sections:
- Faults affecting the sensors measure:
 - An incorrect calibration is applied to them.
 - Non-linearity.
- Faults affecting the actuators: (These do not admit solutions. The student must just realise it and notify it.)
 - Actuators canals interchange at any time during the program execution.
 - Response reduction of an actuator.
- Faults in the controls execution:
 - Inversion of the performance in ON/OFF controls.
 - Reduction or increase of the calculated total response.
 - The action of some controls is annulled.
- A Computer to be provided for this setup.

12. Bench-top unit.

- This unit must be available for all Sets for Process Control and can work with one or several sets.
- Anodized aluminium structure and panels in painted steel.
- Main metallic elements in stainless steel.
- Diagram in the front panel with similar distribution to the elements in the real unit.
- A transparent main tank and collector with an orifice in the central dividing wall ($2 \times 25 \text{ dm}^3$), and drainage in both compartments.
- A transparent dual process tank ($2 \times 10 \text{ dm}^3$), 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.
- 2 Centrifugal pumps, range: 0-10 l./min.
- 2 Variable area flow meters (0.2-2 l/min, and 0.2-10 l/min), and with a manual valve.
- 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.
- Pneumatic control valve:
 - Pneumatic valve with positioner regulator.
 - Body in stainless steel connection G $\frac{1}{2}$ ", orifice 6 mm.
- The I/P converter transforms the electric signal sent from the computer into a proportional pressure that acts over the valve.
- Any Set for Process Control to be supplied and installed in the Base Unit and ready for working.
- A Data Acquisition System to be provided for this unit.

13. Control Interface Box

- This unit is common for all Sets for Process Control and can work with several sets.
- 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.
- 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.
- 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.
- 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.
- Shield and filtered signals to avoid external interferences.
- 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.
- Open control allowing modifications, at any time and in a real time, of 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).
- Possibility of automatization of the actuators involved in the process.
- Three safety levels, one mechanical in the unit, other electronic in control interface and the third one in the control software.

14. Computer to be provided for each set up.

15. DAB Data Acquisition Board

- Common for the modules.
- Data acquisition board to be placed in a computer slot.
- Analog input:
 - Number of channels= 16 single-ended or 8 differential.
 - Resolution=16 bits, 1 in 65536.
 - Sampling rate up to: 250 KS/s (Kilo samples per second).
 - Input range (V)= ± 10 V.
 - Data transfers=DMA, interrupts, programmed I/O. Number of DMA channels=6.
- Analog output:
 - Number of channels=2.
 - Resolution=16 bits, 1 in 65536.
 - Maximum output rate up to: 900 KS/s.
 - Output range(V)= ± 10 V.
 - Data transfers=DMA, interrupts, programmed I/O.
- Digital Input/Output:
 - Number of channels=24 inputs/outputs.
 - D0 or DI Sample Clock frequency: 0 to 100 MHz.
 - Timing: Counter/timers=4. Resolution: Counter/timers: 32 bits.
- Data Acquisition Boards to be provided separately for each Process set mentioned.

pH Process Control System

(File No. 045)

- **ABB make pH SENSOR plus pH Transmitter** (Standard Industrial Type).

Range : 0-14 pH; Supply : 24V DC; Output: 4-20mA

RTD (PT 100) to be used as a temperature sensor for temperature compensation to pH transmitter.

pH SENSOR

Resolution 0.01 pH, 1 mV, 1°C.

Reference Temp. 25°C

Accuracy ± 0.02 pH

- **PROCESS TANK:**

One no. of Process tank to be provided for mixing the Solution

Body Material : Corrosion resistive material like Acrylic

Volume: 2.5 Liters

The liquid level in the tank to be 1.5 times the tank diameter and length to diameter ratio is 1:1.5

- **ACID AND BASE TANK:**

Storage Tank : Three

Body Material : Corrosion resistive material like Acrylic

Acid Tank 40 Liters with maximum flow rate 1 l/min.

Type of Acid: HCl with 0.0012 mol/l

Base Tank 40 Liters with maximum flow rate 1 l/min.

Type of Base: NaOH-NaHCO₃ with NaOH with concentration of 0.002 mol/l and NaHCO₃ with concentration of 0.0025 mol/l

- **SOLENOID VALVE:**

A Solenoid valve to be provided with corrosion resistance material at the outlet of the water tank to give disturbance to the process

Supply: 230V AC/50Hz

- **STIRRER:**

A stirrer to be provided with corrosion resistance material to stir the solution present in the vessel.

Supply : 0-5V DC

Rod Material: Corrosion resistive type

- **USB BASED DATA ACQUISITION SYSTEM**

A Matlab, SciLab and Labview compatible USB Data Acquisition system has a base board with provision for Two pluggable add on ADC & DAC boards

- **12 bit ADC & 14 bit DAC**

- **V/I & I/V CONVERTER**

Two Channel Current to Voltage Converter [INPUT : 4-20mA, OUTPUT : 0-5V]

Two Channel Voltage to Current Converter [INPUT : 0-5V, OUTPUT : 4-20mA]

- **Branded Computer (DELL/HP/IBM) for Control algorithm implementation:**

PC Intel Core i7 Processor 2600 3.40GHz (vPro), 8 MB Cache, Intel Q67 Express Chipset, 19" LCD Monitor with a minimum resolution 1280x1024 required, 512MB Radeon Graphics Card, 8GB Memory DDR3 SDRAM 1333MHz, Hard disk 1 TB 7200 rpm (SATA II) 3.0 Gbps, 8x DVD +/- RW, USB Keyboard and USB Optical mouse, 10/100/1000 NIC, Intel 8259LM, VGA 15 pin Intel HD Graphics, 1920 x 1200 60Hz resolution, Small Form Factor (SFF), SMPS - 240, Energy Star 5.0, Integrated High Definition audio with Internal Speakers, Stereo/speakers line-out & line-in, Microphone in jacks, Headphone (front), Minimum 1 Serial Port (9-pin) and 1 Parallel port (25-hole), 8 USB ports, Hi-Speed USB 2.0 of which 2 should be in front, Number of PCI slots (120 pins), 32-bit / 33 MHz

(Minimum 1 required), PCI Express x16 graphics slot (164 pins), 80 Gbps (low-profile), minimum 4 memory slots on motherboard.

- **OTHER FEATURES:**

An Electronic level switch to be provided to maintain the liquid level.

Suitable Hand valves to be provided wherever necessary.

All the equipments are mounted in an attractive frame.

Acid and alkaline paths are connected by rust proof tubes.

Digital Panel meter to display the pH Transmitter O/P

Necessary pressure gauges & Short Circuit protection.

Mimic diagram in the panel. & All electrical connectors terminated in the panel.

LAB view and MATLAB compatible.

- Variable Speed Pump: 2 Numbers

Valve less metering pumps with ceramic piston, ceramic liner and kynar casing driven by variable speed motor, Pump controllers to accept 4-20 mA signal and feed back indicator to display pump speed

The maximum flow rate of pump to be 576ml/min. with resolution of 0.2ml/min.

- **Other General Requirements for all the sections:**

The liquid level in the tank to be 1.5 times the tank diameter and length to diameter ratio is 1:1.5

- **Demonstration**

The supplier has to demonstrate the following concepts:

- An acid stream (HCl solution) and an alkaline stream (NaOH and NaHCO₃ solution) are fed to a 2.5 l constant volume, well-mixed tank, where the pH is measured through a sensor located directly in the tank.
- The control objective is to drive the system to different pH conditions (tracking control) and also to maintain the tank pH at a specified value despite variations in acid stream flow rate (disturbance rejection) by manipulating the alkaline stream flow rate. The acid flow rate is considered a measured disturbance and the tank volume is maintained constant using an overflow weir.
- The computer interface for data acquisition and control uses the real time tool box and editor using MATLAB.

SCADA/Computerized laboratory set up for FLUID MECHANICS LAB

SPECIFICATIONS DETAILS

LAMINAR FLOW VISUALIZATION and ANALYSIS UNIT (File No. 001)

This unit should have the following:

Anodized aluminium and steel structure.

Main metallic elements in stainless steel.

Process diagram in the front panel with similar distribution to the elements in the real unit.

Autonomous unit that is placed on the floor, equipped with wheels for mobility and with brake to immobilize the unit during the practices.

Laminar flow visualisation table.

Flow visualisation area.

8 sources and 8 drains.

Sources control valves.

Drains control valves.

Input control valves.

Tank of ink. Manifold of ink. Draining valve.

Tank at the input and output of the work section.

Grid to facilitate the visualisation of the lines of flow.

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.

The central drain of the inferior badge, placed in the visualisation area, has a double-shape, that is to say, two orifices in vicinity.

The control systems allow that every, or some, of the drains and sources are fed at the same time. coloured liquid injection system, for a better visualization of the lines of flow.

Needles, placed among the glass sheets at the input.

The direction can be visualized with clarity.

Hydrodynamic models formed by:

3 circular models: 40, 60 and 80 mm diameter.

3 square models: 40, 60 and 80 mm of length.

1 wing-shape model.

The Unit can be completely purged, opening the emptying valves, placed in the base of the input and output tank.

Cables and Accessories, for normal operation.

Manuals: This unit should be supplied with the following manuals: Required Services, Assembly and Installation, Starting-up, Safety, Maintenance & Practices Manuals.

Give some other Practical Possibilities of the Unit like

Ideal flow around submerged bodies: Ideal flow associated to drains and sources:

1. Ideal flow around a cylinder.

2. Ideal flow around a surface.

Ideal flow in channels and edges:

3. Ideal flow in a convergent channel.
4. Ideal flow in a divergent channel.
5. Ideal flow through a curve of 90° .
6. Ideal flow through a sudden contraction.
7. Ideal flow through a sudden broadening.

FLOW METER DEMONSTRATION UNIT (File No. 002)

A self-contained unit to demonstrate the characteristics of flow meters used in measurement of water flow through pipes or open channels.

Anodized aluminium structure and panel in painted steel.

Diagram in the panel with similar distribution to the elements in the real unit.

This unit should have wheels for its mobility.

Pipe circuit, including: Flow regulation valve, Several pressure measurement tapings, Air entrainment device, Flexible pipe to connect to the Hydraulics Bench.

Additional pipes to change the pipe circuit configuration.

Water manometer of 1 m. length and 2 Bourdon type manometers from 0 to 2.5 bar, precision 1%., to measure the pressure drop.

Flow meters are mounted in pipes that can be fitted into the unit test zone quickly and easily.

Meters included:

Orifice plate:

Made of transparent methacrylate.

Pipe diameter D_1 : 35 mm. Orifice diameter D_2 : 20 mm.

Venturi:

Made of transparent methacrylate.

Diameter h_1 : 32 mm. Diameter h_2 : 20 mm. Diameter h_3 : 32 mm.

Distance between h_1 and h_2 : 67.5 mm. Distance between h_2 and h_3 : 87.5 mm.

Upstream narrowing: 14° .

Downstream narrowing: 21° .

Shunt gage:

Made of steel.

Range: 0 to 20 m³/h.

Pitot:

Made of transparent methacrylate.

Pipe diameter: 35 mm.

Electro-magnetic:

PVC pipe Dn32.

Range: 0.05 to 10 m/s.

Measure error: +/- 2%.

Linearity: +/- 1%.

Reproducibility: 0.25% of medium value.

Conductivity: minimum 20 mS/cm.

Operation temperature: 0 to 80°C.

Quick and easy removal of pipes with test flow meters for evaluation and inspection.

Meters can be used independently to support research or student project work.

Hydraulics Bench:

Mobile hydraulic bench, made in polyester reinforced with fibreglass, and mounted on wheels for mobility.

Centrifugal pump, 0.55 KW, 2.5 Bar, 150 l./min., single phase 220V./ 50Hz or 110V./ 60Hz. Pump breaker starting.

Sump tank capacity: 165 litres. Small channel: 8 litres.

Flow measurement: volumetric tank, gauged from 0 to 7 litres for low flow values and from 0 to 40 litres for high flow values.

Remote hand-operating dump valves in the base of the volumetric tank.

Level tube with a scale that shows the water level in the upper tank.

Flow stilling baffle for reducing the turbulence rate.

Manufactured with corrosion resistant materials ensuring a long life of the unit. Safety and contact light.

Cables and other Accessories required for normal operation.

Manuals: This unit is supplied with the following manuals: Required Services, Assembly and Installation, Starting-up, Safety, Maintenance & Practices Manuals.

Some Practical Possibilities of the Unit like

1. To demonstrate the important characteristics of fourteen types of flow meters used in the measurement of water flow through pipes or open channels.
2. Comparing the use, application and limitations of different types of flowmeters.
3. To study the application of Bernoulli's Theorem.
4. Understanding the principles on which various types of flow meters are based.
5. Implications of performance, convenience, accuracy, head loss, etc. on flow meters selection.
6. Effect of the air in the hydraulic stream on flow meter performance.
7. To use manometers to measure pressure drop.
8. Relating pressure drop across a flow meter to flow rate.
9. Measure error determination using the venturimeter.
10. Factor C determination in the venturi.
11. Strangulation determination in the venturi.
12. Measure error determination using the orifice plate.
13. Factor C determination in the orifice plate.
14. Effective area determination in the orifice plate.
15. Measure error determination using the Pitot tube.
16. Factor C determination in the Pitot tube.
17. Measure error using the shunt gapmeter.
18. Energy loss comparison in the different meters.
19. Measure error using the inferential multistream type flowmeter.
20. Broad crested weir.

(4 TYPES OF PUMPS)**1. Unit:**

Unit designed to demonstrate the operating characteristics of several types of pumps.

Anodized aluminium structure and panels in painted steel.

Main metallic elements in stainless steel.

Diagram in the front panel with similar distribution to the elements in the real unit.

Fully instrumented self-contained unit.

The unit is mounted on a structure with a work surface covered by a plastic sheet.

It is equipped with rubber wheels to provide mobility and with brake to immobilize the unit during the practices.

4 Pumps (computer controlled):**Centrifugal pump, Axial flow, pump, Gear pump & Peripheral pump:**

Centrifugal pump: pedestal or of free axis type, made of brass.

- Maximum flow: 80 l./min.
- Maximum height: 20 mwc (meters of water column).
- Efficiency: 35%.

Axial flow pump: with propeller, which works in an acrylic casing with thin interstices between the propeller and the casing.

- Maximum flow: 50 l./min.
- Maximum height: 2 mwc (meters of water column).
- Efficiency: 15%.

Gear pump: of positive displacement, with casing of a melted piece and two rotors in form of a straight cylindrical gear.

- Maximum flow: 35 l./min.
- Maximum height: 45 mwc (meters of water column).
- Efficiency: 75%.

Peripheral pump: also known as regenerator or turbine pump, with a runner of straight blades inside an

annular casing and an axis of activation on two lubricated ball bearings.

- Maximum flow: 40 l./min.
- Maximum height: 22 mwc (meters of water column).
- Efficiency: 30%.

Motor for each pump, with independent operating.

Variation of speed by frequency converter, located in the control interface box, computer controlled.

There should two pressure tapplings in each pump, one at the admission and other at the discharge of the pump.

Admission pressure sensor and discharge pressure sensor for each pump (8 sensors).

Reading of speed (r.p.m.) and torque (Nm) of the pump.

The software to determine the pump manometric height, the hydraulic and mechanic power and the efficiency.

Calibrated volumetric tank of 0-10 l. for low flows and of 0-45 l. for high flows.

a level sensor (capacitive, length: 300 mm.) to determine the water flow and the water level in the volumetric tank, an indicating transparent tube and a graduated scale.

Water storage tank, with capacity of 160 l. approx. with an indicating transparent tube.

2 “U” Shape weirs, 2 Stilling baffles.

Valves for centrifugal, peripheral and gear pumps. Control valve for axial pump.

The complete unit includes as well:

Advanced Real-Time SCADA.

Open Control + Multicontrol + Real-Time Control.

Specialized Control Software based on Labview.

National Instruments 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.

Projector and/or electronic whiteboard compatibility allows the unit to be explained and demonstrated to an entire class at one time.

Capable of doing applied research, real industrial simulation, training courses, etc.

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).

Designed and manufactured under several quality standards.

Software to help the user perform calculations and comprehend the results.

This unit has been designed for future expansion and integration. A common expansion is the Scada-Net System which enables multiple students to simultaneously operate many units in a network.

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.

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.

The unit control elements are permanently computer controlled, without necessity of changes or connections during the whole process test procedure.

Simultaneous visualization in the computer of all parameters involved in the process.

Calibration of all sensors involved in the process.

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 displayed on only one screen in the computer.

Shield and filtered signals to avoid external interferences.

Real time computer control with flexibility of modifications from the computer keyboard of the parameters, at any moment during the process.

Real time computer control for pumps, compressors, resistances, control valves, etc.

Real time computer control for parameters involved in the process simultaneously.

Open control allowing modifications, at any moment and in real time, of parameters 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.

Dimensions (approx): 490 x 330 x 310 mm. (19.29 x 13 x 12.2 inches). Weight: 10 Kg. (22 pounds)

3 DAB. Data Acquisition Board:

PCI EXPRESS Data acquisition board (National Instruments) 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.

Sampling rate up to: 250 KS/s (Kilo samples per second).

Input range (V)=± 10V.

Data transfers=DMA, interrupts, programmed I/O. Number of DMA channels=6.

Analog output: Number of channels=2. Resolution=16 bits, 1 in 65536. Maximum output rate up to: 900 KS/s.

Output range (V)=±10. Data transfers=DMA, interrupts, programmed I/O.

Digital Input/output: Number of channels=24 inputs/outputs. D0 or DI Sample Clock frequency to 100 MHz.

Timing: Counter/timers=4. Resolution: Counter/timers:32 bits.

4. Computer Control +Data Acquisition+ Data Management Software:

Compatible with the industry standards.

Flexible, open and multicontrolsoftware, developed with actual windows graphic systems, acting simultaneously on all process parameters.

Management, processing, comparison and storage of data.

Sampling velocity up to 250 KS/s (Kilo samples per second).

Calibration system for the sensors involved in the process.

It allows the registration of the alarms state and the graphic representation in real time.

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.

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 blackboard.

5. Cables and Accessories, (High-End Computer is to be provided for software installation and data acquisition) etc. for normal operation.

6 Manuals: This unit is supplied with 8 manuals: Required Services, Assembly and Installation, Interface and Control Software, Starting-up, Safety, Maintenance, Calibration & Practices Manuals.

7. Computer Aided Learning Software (Results Calculation and Analysis)

This Computer Aided Learning Software should be windows base software, simple and very easy to use.

To help in making the necessary calculations to extract the right conclusions from data obtained during the experimental practices.

To compute the value of all the variables involved.

It allows plotting and printing the results. Between the plotting options, any variable can be represented against any other.

Different plotting displays.

It has a wide range of information, such as constant values, unit conversion factors and integral and derivative tables.

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.

There are several kinds of faults that can be grouped in three sections:

Faults affecting the sensors measure:

- An incorrect calibration is applied to them.
- Non-linearity.

Faults affecting the actuators: (These do not admit solutions. The student must just realise it and notify it.)

- Actuators canals interchange at any time during the program execution.
- Response reduction of an actuator.

Faults in the controls execution:

- Inversion of the performance in ON/OFF controls.
- Reduction or increase of the calculated total response.
- The action of some controls is annulled.

Specification for the purchase of Computer controlled continuous Distillation Unit (File No. 035)

Anodized aluminium structure and panels in painted steel.

Main metallic elements in stainless steel.

Diagram in the front panel with similar distribution to the elements in the real unit.

Sieve Plates Column with 8 plates with temperature taking (sensor) and sample in every plate.

50mm. internal diameter and 1000 mm. length. Vacuumed, silver-plated and double transparent band for vision.

It should allow continuous operation and batch operation.

Column head with temperature taking, conical output for distilled product and ball refrigerator.

Column head with a valve for the steam distribution.

The valve should operate in an electromagnetic way.

2 l. Boiler (with sample outputs), with heating mantle (computer controlled) with adjustable power (max. power: 500 watt.)

2 l. Distillation collector of graduated glass.

Liebig-West coolant.

Feeding system in continuous with preheating (heating resistance, computer controlled) at the specified temperature and a pump (computer controlled), that provides a maximum flow of 3.81 l./min.

Feed vessel, 10 l. capacity.

Adjustable vacuum pump (computer controlled), that allows to decrease the atmospheric pressure to 0.8 bar.

Temperature measurement system. 15 temperature sensors ("J" type).

Flow sensor.

Differential pressure sensor.

Working temperature: Ambient temperature up to 125° C.

Solenoid valve, computer controlled.

The computer control system shall act directly on:

The temperature of the heating resistances.

The feeding temperature.

The solenoid valve (reflux ratio).

The vacuum pump.

The feeding pump.

The complete unit shall include as well:

Advanced Real-Time SCADA and PID Control.

Open Control + Multicontrol + Real-Time Control.

Specialized Control Software based on Labview.

National Instruments 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.

Projector and/or electronic whiteboard compatibility allows the unit to be explained and demonstrated to an entire class at one time.

Capable of doing applied research, real industrial simulation, training courses, etc.

Remote operation and control by the user and remote control for EDIBON technical support, are always included.

Totally safe, utilizing 4 safety systems (Mechanical, Electrical, Electronic & Software).
Designed and manufactured under several quality standards.

Control Interface Box:

The Control Interface Box is part of the SCADA system.

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.

All sensors, with their respective signals, are properly manipulated from -10V. to +10V. computer output.

Sensors connectors in the interface have different pins numbers (from 2 to 16), to avoid connection errors.

Single cable between the control interface box and computer.

The unit control elements are permanently computer controlled, without necessity of changes or connections during the whole process test procedure.

Simultaneous visualization in the computer of all parameters involved in the process.

Calibration of all sensors involved in the process.

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 displayed on only one screen in the computer.

Shield and filtered signals to avoid external interferences.

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).

Open control allowing modifications, at any moment and in real time, of parameters involved in the process simultaneously.

Possibility of automatization of the actuators involved in the process.

Three safety levels, one mechanical in the unit, another electronic in the control interface and the third one in the control software.

DAB. Data Acquisition Board:

The Data Acquisition board is part of the SCADA system.

PCI Data acquisition board (National Instruments) to be placed in a computer slot. Bus PCI.

Analog input: Number of channels= 16 single-ended or 8 differential.

Resolution=16 bits, 1 in 65536.

Sampling rate up to: 250 KS/s (kilo samples per second).

Input range (V)= 10 V. Data transfers=DMA, interrupts, programmed I/O. DMA channels=6.

Analog output: Number of channels=2

Resolution=16 bits, 1 in 65536. Maximum output rate up to: 833 KS/s.

Output range (V)= 10 V. Data transfers=DMA, interrupts, programmed I/O.

Digital Input/Output: Number of channels=24 inputs/outputs

DO or DI Sample Clock frequency: 0 to 1 MHz.

Timing: Number of Counter/timers=2.

Resolution: Counter/timers: 32 bits.

Compatible with actual Windows operating systems. Graphic and intuitive simulation of the process in screen.

Registration and visualization of all process variables in an automatic and simultaneous way.

Flexible, open and multicontrol software, developed with actual windows graphic systems, acting simultaneously on all process parameters.

Analog and digital PID control. PID menu and set point selection required in the whole work range.

Management, processing, comparison and storage of data. Sampling velocity up to 250 KS/s (kilo samples per second)

Calibration system for the sensors involved in the process.

It shall allow the registration of the alarms state and the graphic representation in real time.

Comparative analysis of the obtained data, after the process and modification of the conditions during the process.

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. 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.

Cables and Accessories, for normal operation. and necessary manuals.

SCADA/Computerized laboratory set up for HEAT TRANSFER LAB

Specification for the purchase of **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**

S.No	Name of the Unit	Specification
1	Computer Controlled basic Heat Transfer Modules	<p>1.1. Linear Heat Conduction Module: (File No. 004 & 005) 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. 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. Anodized aluminium structure and panel in painted steel. Diagram in the front panel with similar distribution to the elements in the real unit. Input heat section. Electric heater (heating resistance) with power regulation (150 W, temperature max.: 150°C), computer controlled. Refrigeration section with a surface cooled by water. Central section: With brass of 25 mm of diameter. With brass of 10 mm of diameter. With stainless steel of 25 mm of diameter.</p>

Water flow sensor.
Water flow regulation valve.
Thermal paste is supplied to demonstrate the difference between poor and good thermal contact between the sections.
13 Temperature sensors, “J” type:
 11 Temperature sensors distributed in the heating section, refrigeration section and central sections.
 1 Temperature sensor at the water inlet of the unit.
 1 Temperature sensor at the water outlet of the unit.
Power measurement from the computer (PC).
Cables and Accessories, for normal operation.
This unit is supplied with 8 manuals: Required Services, Assembly and Installation, Interface and Control Software, Starting-up, Safety, Maintenance, Calibration & Practices Manuals.
Computer Control Software:
Computer Control+ Data Acquisition+ Data Management Software for Linear Heat Conduction Module.
 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 multi control software, developed with actual windows graphic systems, acting simultaneously on all process parameters.
 Analog and digital PID control. Menu for PID and set point selection required in the whole work range.
 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.
 It allows the registration of the alarms state and the graphic representation in real time.
 Comparative analysis of the obtained data, after the process and modification of the conditions during the process.
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.
-This module requires Control Interface Box and Data Acquisition Board (DAB).
Control Interface Box:
This control interface is common for the modules and can work with one or several modules.
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.
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.
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.
 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.
 Shield and filtered signals to avoid external interferences.
 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.
 Open control allowing modifications, at any time and in a real time , of 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).
 Possibility of automatization of the actuators 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.

Data Acquisition Board:
 Common for the DAC modules.
 PCI EXPRESS Data acquisition board 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.
 Sampling rate up to: 250 KS/s (Kilo samples per second).
 Input range (V)= ± 10 V.
 Data transfers=DMA, interrupts, programmed I/O. Number of DMA channels=6.
 Analog output:
 Number of channels=2.
 Resolution=16 bits, 1 in 65536.
 Maximum output rate up to: 900 KS/s.
 Output range(V)= ± 10 V.
 Data transfers=DMA, interrupts, programmed I/O.

Digital Input/Output:
 Number of channels=24 inputs/outputs.
 D0 or DI Sample Clock frequency: 0 to 100MHz.
 Timing: Counter/timers=4. Resolution: 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.
 High-End Computer is to be provided for software installation and

data acquisition

Computer Aided Learning Software (Results Calculation and Analysis)

This Computer Aided Learning Software (CAL) is a Windows based software, simple and very easy to use.

CAL is a class assistant that helps in making the necessary calculations to extract the right conclusions from data obtained during the experimental practices.

CAL will perform the calculations.

CAL computes the value of all the variables involved.

It allows to plot and print the results. Between the plotting options, any variable can be represented against any other.

Different plotting displays.

It has a wide range of information, such as constant values, unit conversion factors and integral and derivative tables.

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.

There are several kinds of faults that can be grouped in three sections:

Faults affecting the sensors measure:

- An incorrect calibration is applied to them.
- Non-linearity.

Faults affecting the actuators: (These do not admit solutions. The student must just realize it and notify it.)

- Actuators canals interchange at any time during the program execution.

- Response reduction of an actuator.

Faults in the controls execution:

- Inversion of the performance in ON/OFF controls.
- Reduction or increase of the calculated total response.
- The action of some controls is annulled.

1.2 Combined Free and Forced Convection and Radiation Module: (File No. 006)

Bench-top unit to study the principles of combined free and forced convection with 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.

Anodized aluminum structure and panel in painted steel.

Diagram in the front panel with similar distribution to the elements in the real unit.

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.

Stainless steel conduct with interior cover, including:

Temperature sensor, "J" type, in order to measure the temperature of inlet air.

Flow sensor.

Temperature sensor, "J" type, in order to measure the temperature of outlet air.

Heater:

Copper cylinder with exterior cover: Interior resistance of 150W, temperature sensor "J" type for measuring the temperature of the cylinder.

Temperature sensor, "J" type.
 Power measurement from the computer (PC).
 Cables and Accessories, for normal operation.
 This unit is supplied with 8 manuals: Required Services, Assembly and Installation, Interface and Control Software, Starting-up, Safety, Maintenance, Calibration & Practices Manuals.

Computer Control Software:
 Computer Control+ Data Acquisition + Data Management Software for Combined Free and Forced Convection and Radiation Module.
 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.

Analog and digital PID control. Menu for PID and set point selection required in the whole work range.

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.
 It allows the registration of the alarms state and the graphic representation in real time.

Comparative analysis of the obtained data, after the process and modification of the conditions during the process.

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.

-This module requires Control Interface Box and Data Acquisition Board (DAB).

Control Interface Box:
 This control interface is common for the modules and can work with one or several modules.
 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.
 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.
 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.
 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.

Shield and filtered signals to avoid external interferences.

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.

Open control allowing modifications, at any time and in a real time , of 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).

Possibility of automatization of the actuators 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.

Data Acquisition Board:
Common for the DAC module
PCI EXPRESS Data acquisition board 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.
Sampling rate up to: 250 KS/s (Kilo samples per second).
Input range (V)= ± 10 V.
Data transfers=DMA, interrupts, programmed I/O. Number of DMA channels=6.

Analog output:
Number of channels=2.
Resolution=16 bits, 1 in 65536.
Maximum output rate up to: 900 KS/s.
Output range(V)= ± 10 V.
Data transfers=DMA, interrupts, programmed I/O.

Digital Input/Output:
Number of channels=24 inputs/outputs.
D0 or DI Sample Clock frequency: 0 to 100MHz.
Timing: Counter/timers=4. Resolution: 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.
High-End Computer is to be provided for software installation and data acquisition

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.
CAL is a class assistant that helps in making the necessary calculations to extract the right conclusions from data obtained during the experimental practices.

CAL will perform the calculations.
 CAL computes the value of all the variables involved.
 It allows to plot and print the results. Between the plotting options, any variable can be represented against any other.
 Different plotting displays.
 It has a wide range of information, such as constant values, unit conversion factors and integral and derivative tables.

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.
 There are several kinds of faults that can be grouped in three sections:
 Faults affecting the sensors measure:
 - An incorrect calibration is applied to them.
 - Non-linearity.
 Faults affecting the actuators: (These do not admit solutions. The student must just realize it and notify it.)
 - Actuators canals interchange at any time during the program execution.
 - Response reduction of an actuator.
 Faults in the controls execution:
 - Inversion of the performance in ON/OFF controls.
 - Reduction or increase of the calculated total response.
 - The action of some controls is annulled.

1.3 Unsteady State Heat Transfer Module: (File No. 007)
 Bench-top unit designed to allow practices and exercises to be performed in unsteady state heat transfer.
 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.
 Anodized aluminium structure and panel in painted steel.
 Diagram in the front panel with similar distribution to the elements in the real unit.
 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.
 Different shapes of different size and material are studied:
 Brass sphere (diameter: 40 mm).
 Brass sphere (diameter: 25 mm).
 Stainless steel sphere (diameter: 40 mm).
 Stainless steel sphere (diameter: 25 mm).
 Brass cylinder (diameter: 15 mm, length: 150 mm).
 Stainless steel cylinder (diameter: 15 mm, length: 150 mm).
 Aluminium rectangular slab (40 x 10 x 150 mm).
 Stainless steel rectangular slab (40 x 10 x 150 mm).
 Each shape is fitted with a temperature sensor at the center of the object.
 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.
 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.
 Water pump with variable speed. It allows to reach a maximum flow

of 4 l./min.

3 Temperature sensors “J” type allow controlling the stability of the temperature of the water bath.

Flow sensor.

2 Temperature sensors “J” type:

The first one permits to record the evolution of the temperature of the shape at its center.

The second one, works as a stopwatch, it will indicate the precise moment in which the shape is submerged.

Level switch.

Power measurement from the computer (PC).

Cables and Accessories, for normal operation.

This unit is supplied with 8 manuals: Required Services, Assembly and Installation, Interface and Control Software, Starting-up, Safety, Maintenance, Calibration & Practices Manuals.

Computer Control Software:

Computer Control+Data Acquisition+ Data Management Software for Unsteady State Heat Transfer Module.

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.

Analog and digital PID control.

Menu for PID and set point selection required in the whole work range.

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.

It allows the registration of the alarms state and the graphic representation in real time.

Comparative analysis of the obtained data, after the process and modification of the conditions during the process.

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.

-This module requires Control Interface Box and Data Acquisition Board (DAB).

Control Interface Box:

This control interface is common for the DAC modules and can work with one or several modules.

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.

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.

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.

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.

Shield and filtered signals to avoid external interferences.

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.

Open control allowing modifications, at any time and in a real time , of 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).

Possibility of automatization of the actuators 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.

Dimensions (approx.): 490 x 330 x 310 mm. Weight: 10Kg.

Data Acquisition Board:

Common for the DAC modules .

PCI EXPRESS Data acquisition board 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.

Sampling rate up to: 250 KS/s (Kilo samples per second).

Input range (V)= ± 10 V.

Data transfers=DMA, interrupts, programmed I/O. Number of DMA channels=6.

Analog output:

Number of channels=2.

Resolution=16 bits, 1 in 65536.

Maximum output rate up to: 900 KS/s.

Output range(V)= ± 10 V.

Data transfers=DMA, interrupts, programmed I/O.

Digital Input/Output:

Number of channels=24 inputs/outputs.

D0 or DI Sample Clock frequency: 0 to 100MHz.

Timing: Counter/timers=4. Resolution: Counter/timers: 32 bits.

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. High-End Computer is to be provided for software installation and data acquisition

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.

CAL is a class assistant that helps in making the necessary calculations to extract the right conclusions from data obtained during the experimental practices.

CAL will perform the calculations.

CAL computes the value of all the variables involved.

It allows to plot and print the results. Between the plotting options, any variable can be represented against any other.

Different plotting displays.

It has a wide range of information, such as constant values, unit conversion factors and integral and derivative tables.

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.

There are several kinds of faults that can be grouped in three sections:

Faults affecting the sensors measure:

- An incorrect calibration is applied to them.
- Non-linearity.

Faults affecting the actuators: (These do not admit solutions. The student must just realise it and notify it.)

- Actuators canals interchange at any time during the program execution.
- Response reduction of an actuator.

Faults in the controls execution:

- Inversion of the performance in ON/OFF controls.
- Reduction or increase of the calculated total response.
- The action of some controls is annulled.

1.4 Free and Forced Convection Heat Transfer Module: (File No. 008)

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.

Anodized aluminum structure and panels in painted steel.

Diagram in the front panel with similar distribution to the elements in the real unit.

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.

Stabilizers to guarantee an uniform air flux.

9 Temperature sensors, "J" type:

2 temperature sensors measure the air temperature at the inlet and outlet of the area 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.

1 temperature sensor for the heating resistance.

1 temperature sensor in the exchangers.

Maximum working temperature: 150°C.

Flow sensor, for measuring the air flow generated. Range: 0-5 l./min.

3 Aluminium exchangers:

Flat heat exchanger (100 x 100 mm).

Dowels heat exchanger. 17 dowels, each one of 10 mm diameter and 125 mm longitude.

Blade heat exchanger. 9 blades, each one of 100x125 mm.

Heating resistance of 150W for each exchanger, computer controlled.

Variable speed fan, computer controlled, which generates air flux through the tunnel. Range: 0-1200 l/min.

Cables and Accessories, for normal operation.

This unit is supplied with 8 manuals: Required Services, Assembly and Installation, Interface and Control Software, Starting-up, Safety, Maintenance, Calibration & Practices Manuals.

Computer Control Software:

Computer Control+Data Acquisition+ Data Management Software for Free and Forced Convection Heat Transfer Module.

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.

Analog and digital PID control. Menu for PID and set point selection required in the whole work range.

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.

It allows the registration of the alarms state and the graphic representation in real time.

Comparative analysis of the obtained data, after the process and modification of the conditions during the Process.

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.

-This module requires Control Interface Box and Data Acquisition Board (DAB)

Control Interface Box:

This control interface is common for the DAC modules and can work with one or several modules.

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.

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.

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.
 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.
 Shield and filtered signals to avoid external interferences.
 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.
 Open control allowing modifications, at any time and in a real time , of 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).
 Possibility of automatization of the actuators 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.

DAB. Data Acquisition Board:
 Common for the DAC module.
 PCI EXPRESS Data acquisition board 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.
 Sampling rate up to: 250 KS/s (Kilo samples per second).
 Input range (V)= ± 10 V.
 Data transfers=DMA, interrupts, programmed I/O. Number of DMA channels=6.

Analog output:
 Number of channels=2.
 Resolution=16 bits, 1 in 65536.
 Maximum output rate up to: 900 KS/s.
 Output range(V)= ± 10 V.
 Data transfers=DMA, interrupts, programmed I/O.

Digital Input/Output:
 Number of channels=24 inputs/outputs.
 D0 or DI Sample Clock frequency: 0 to 100MHz.
 Timing: Counter/timers=4. Resolution: 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

	<p>Software, Starting-up, Safety, Maintenance, Calibration & Practices Manuals.</p> <p>High-End Computer is to be provided for software installation and data acquisition</p> <p>Computer Aided Learning Software (Results Calculation and Analysis)</p> <p>This Computer Aided Learning Software (CAL) is a windows base software, simple and very easy to use.</p> <p>CAL is a class assistant that helps in making the necessary calculations to extract the right conclusions from data obtained during the experimental practices.</p> <p>CAL will perform the calculations.</p> <p>CAL computes the value of all the variables involved.</p> <p>It allows to plot and print the results. Between the plotting options, any variable can be represented against any other.</p> <p>Different plotting displays.</p> <p>It has a wide range of information, such as constant values, unit conversion factors and integral and derivative tables.</p> <p>Faults Simulation System:</p> <p>The "FAULTS" mode consists on provoking several faults in the unit normal operation. The student must find them and, if possible, solve them.</p> <p>There are several kinds of faults that can be grouped in three sections:</p> <p>Faults affecting the sensors measure:</p> <ul style="list-style-type: none"> - An incorrect calibration is applied to them. - Non-linearity. <p>Faults affecting the actuators: (These do not admit solutions. The student must just realise it and notify it.)</p> <ul style="list-style-type: none"> - Actuators canals interchange at any time during the program execution. - Response reduction of an actuator. <p>Faults in the controls execution:</p> <ul style="list-style-type: none"> - Inversion of the performance in ON/OFF controls. - Reduction or increase of the calculated total response. - The action of some controls is annulled.
	<p>1.5.Computer controlled Film and Drop wise Condensation Unit. (File No. 009)</p> <p>1.5.1 Base Unit:</p> <p>Bench-top unit, which has its own generator and air extraction system, as well as condensers to provide drop wise and film wise condensation.</p> <p>Anodized aluminum structure and panels in painted steel (epoxy paint).</p> <p>Main metallic elements in stainless steel.</p> <p>Diagram in the front panel with similar distribution to the elements in the real unit.</p> <p>Steam chamber: thick-walled glass cylinder with aluminum ends and P.T.F.E. seals. Capacity: approximately 0.5 – 1 Kg. of distilled water.</p> <p>2 Water cooled condensers, mounted in the upper cylinder cover.</p> <p>Dimensions: 12.7 mm. external diameter and 90 mm. effective length. They are specially designed and manufactured of cooper, incorporating a heat exchanger in order to reduce the surface temperature variation to a minimum:</p> <p>Drop wise condenser-gold plated.</p> <p>Film wise condenser-natural finish.</p>

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, respectively.

Electric heating element (3 KW. resistance) with thermal protection. Power of the resistance computer controlled.

Air extraction system, composed by air cooler, separator and water jet vacuum pump with the necessary valves.

Pressure sensor, to measure the chamber pressure. Range: 0-6 bar.

2 Water flow sensors (0-6.5 l./min.), to measure the water flow rate through the condensers.

Safety: Pressure relief valve fitted to upper cylinder cover. Pressure switch (fix to 2 bar). Heater thermal protection (120°C thermostat).

All electrical elements/components are earthed and fused.

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.

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.

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.

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.

Shield and filtered signals to avoid external interferences.

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).

Possibility of automatization of the actuators involved in the process. Open control allowing modifications, at any time and in a real time, of parameters involved in the process simultaneously.

Three safety levels, one mechanical in the unit, other electronic in control interface and the third one in the control software.

1.5.3. Data Acquisition Board:

PCI EXPRESS Data acquisition board 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.

Sampling rate up to: 250 KS/s (Kilo samples per second). Input range

(V)=± 10V.

Data transfers=DMA, interrupts, programmed I/O. Number of DMA channels=6.

Analog output: Number of channels=2. Resolution=16 bits, 1 in 65536. Maximum output rate up to: 900 KS/s.

Output range(V)=±10. Data transfers=DMA, interrupts, programmed I/O.

Digital Input/Output: Number of channels=24 inputs/outputs. D0 or DI Sample Clock frequency:0 to 100 MHz.

Timing: Counter/timers=4. Resolution: Counter/timers:32 bits.

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.

Analog and digital PID control. Menu for PID and set point selection required in the whole work range.

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.

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.

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.

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.

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.

High-End Computer is to be provided for software installation and data acquisition

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.

CAL is a class assistant that helps in making the necessary calculations to extract the right conclusions from data obtained during the experimental practices.

CAL will perform the calculations.

CAL computes the value of all the variables involved.

It allows to plot and print the results. Between the plotting options, any variable can be represented against any other.

Different plotting displays.

It has a wide range of information, such as constant values, unit conversion factors and integral and derivative tables.

1.5.8. Faults Simulation System:

	<p>The "FAULTS" mode consists on provoking several faults in the unit normal operation. The student must find them and, if possible, solve them.</p> <p>There are several kinds of faults that can be grouped in three sections:</p> <p>Faults affecting the sensors measure:</p> <ul style="list-style-type: none"> - An incorrect calibration is applied to them. - Non-linearity. <p>Faults affecting the actuators: (These do not admit solutions. The student must just realise it and notify it.)</p> <ul style="list-style-type: none"> - Actuators canals interchange at any time during the program execution. - Response reduction of an actuator. <p>Faults in the controls execution:</p> <ul style="list-style-type: none"> - Inversion of the performance in ON/OFF controls. - Reduction or increase of the calculated total response. - The action of some controls is annulled.
	<p>1.6. Computer Controlled Heat Exchangers</p> <p>1.6.1. Plate Heat Exchanger: (File No. 010)</p> <p>This Plate Heat Exchanger allows the study of heat transfer between hot and cold water through alternate channels formed between parallel plates.</p> <p>The exchanger allows measuring cold and hot temperatures at the inlet and outlet of the exchanger.</p> <p>Anodized aluminium structure and panel in painted steel.</p> <p>Main metallic elements in stainless steel.</p> <p>Diagram in the front panel with similar distribution to the elements in the real unit.</p> <p>Formed by corrugated stainless steel plates. It can be dismantled to observe its structure.</p> <p>4 Ports or connections of hot and cold water input and output.</p> <p>Maximum flow: 12m³/h.</p> <p>Maximum work pressure: 10 bar.</p> <p>Maximum work temperature: 100° C.</p> <p>Minimum work temperature: 0° C.</p> <p>Maximum number of plates: 20.</p> <p>Internal circuit capacity: 0.176 l.</p> <p>External circuit capacity: 0.22 l.</p> <p>Area: 0.32m².</p> <p>4 Temperature sensors ("J" type):</p> <ul style="list-style-type: none"> 2 Temperature sensors for measuring cold water temperature (inlet and outlet). 2 Temperature sensors for measuring hot water temperature (inlet and outlet). <p>Easy connection to the Base Service Unit.</p> <p>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.</p> <p>Computer Control Software:</p> <p>Computer Control+Data Acquisition+Data Management Software for Plate Heat Exchanger.</p> <p>Compatible with the industry standards.</p> <p>Flexible, open and multicontrolsoftware, developed with actual windows graphic systems, acting simultaneously on all process parameters.</p> <p>Analog and digital PID control.</p>

PID menu and set point selection required in the whole work range. Management, processing, comparison and storage of data. Sampling velocity up to 250 KS/s (kilo samples per second). Calibration system for the sensors involved in the process. It allows the registration of the alarms state and the graphic representation in real time.

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.

Base Service Unit:
This unit is common for Heat Exchangers type "TI" and can work with one or several exchangers.
This unit performs the following tasks:
Heating the water.
Pumping of hot water.
Change in the direction of cold water flows.
Cold and hot water measures.
Anodized aluminium structure and panel in painted steel.
Main metallic elements in stainless steel.
Diagram in the front panel with similar distribution to the elements in the real unit.
Stainless steel tank (30 l.), equipped with:
Electric heating resistance (3000W) with thermostat (70° C), to heat the water, computer controlled. PID temperature control.
Temperature sensor ("J" type) to measure the water temperature.
Level switch to control the water level in the tank.
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.
Draining water valve.
Centrifugal pump with speed control from computer, range: 0 - 3 l./min.
2 Flow sensors, one for hot water and the other for cold water, range: 0 - 6.5 l./min.
Control valve for the cold water.
4 Ball valves that, depending on how we 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.
4 Flexible tubes to connect with the different exchangers.
Cables and accessories, for normal operation.
Dimensions (approx): 1100 x 630 x 500 mm. (43.30 x 24.80 x 19.68 inches). Weight: 50 Kg. (110.2 pounds).

Control Interface Box:
This control interface is common for Heat Exchangers and can work with one or several exchangers.
Control interface box with process diagram in the front panel. The unit control elements are permanently computer controlled.
Simultaneous visualization in the computer of all parameters involved in the process.
Calibration of all sensors involved in the process. Real time curves representation about 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.

Shield and filtered signals to avoid external interferences.

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 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).

Open control allowing modifications, at any moment and in real time, of parameters 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.

Data Acquisition Board:
 PCI EXPRESS Data acquisition board 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.
 Sampling rate up to: 250 KS/s (Kilo samples per second). Input range (V)=± 10V.
 Data transfers=DMA, interrupts, programmed I/O. Number of DMA channels=6.

Analog output: Number of channels=2. Resolution=16 bits, 1 in 65536. Maximum output rate up to: 900 KS/s.
 Output range(V)=±10. Data transfers=DMA, interrupts, programmed I/O.

Digital Input/Output: Number of channels=24 inputs/outputs. D0 or DI Sample Clock frequency:0 to 100 MHz.
 Timing:Counter/timers=4. Resolution: Counter/timers:32 bits.

High-End Computer is to be provided for software installation and data acquisition

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

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.

There are several kinds of faults that can be grouped in three sections:
 Faults affecting the sensors measure:
 - An incorrect calibration is applied to them.
 - Non-linearity.

Faults affecting the actuators: (These do not admit solutions. The student must just realise it and notify it.)
 - Actuators canals interchange at any time during the program execution.
 - Response reduction of an actuator.

Faults in the controls execution:
 - Inversion of the performance in ON/OFF controls.
 - Reduction or increase of the calculated total response.
 - The action of some controls is annulled.

1.6.2. Shell & Tube Heat Exchanger: (File No. 011)

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. There are traverse baffles placed in the shell to guide the cold water to maximize the heat transfer.

Anodized aluminium structure and panel in painted steel.

Main metallic elements in stainless steel.

Diagram in the front panel with similar distribution to the elements in the real unit.

Formed by tubes of stainless steel with hot water circulating in the interior.

4 Segmented baffles located transversally in the shell.

Exchange length of the shell and each tube: $L = 0.5\text{m}$.

Interior tube (21 tubes):

Internal diameter: $D_{\text{int}} = 8 \cdot 10^{-3}\text{m}$.

External diameter: $D_{\text{ext}} = 10 \cdot 10^{-3}\text{m}$.

Thickness = 10^{-3}m .

Internal heat transfer area: $A_{\text{h}} = 0.0126\text{m}^2$.

External heat transfer area: $A_{\text{c}} = 0.0157\text{m}^2$.

Shell:

Internal diameter: $D_{\text{int,c}} = 0.148\text{m}$.

External diameter: $D_{\text{ext,c}} = 0.160\text{m}$.

Thickness = $6 \cdot 10^{-3}\text{m}$.

7 Temperature sensors ("J" type), for measuring cold and hot water temperatures at different points of the exchanger.

Easy connection to the Base Service Unit.

This unit is supplied with 8 manuals: Required Services, Assembly and Installation, Interface and Control Software, Starting-up, Safety, Maintenance, Calibration & Practices Manuals.

Computer Control Software:

Computer Control+DataAcquisition+Data Management Software for Shell & Tube Heat Exchanger.

Compatible with the industry standards.

Flexible, open and multicontrolsoftware, developed with actual windows graphic systems, acting simultaneously on all process parameters.

Analog and digital PID control.

PID menu and set point selection required in the whole work range.

Management, processing, comparison and storage of data.

Sampling velocity up to 250 KS/s (kilo samples per second).

Calibration system for the sensors involved in the process.

It allows the registration of the alarms state and the graphic representation in real time.

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.

Base Service Unit:

This unit is common for Heat Exchangers and can work with one or several exchangers.

This unit performs the following tasks:

Heating the water.

Pumping of hot water.

Change in the direction of cold water flows.

Cold and hot water measures.

Anodized aluminium structure and panel in painted steel.
 Main metallic elements in stainless steel.
 Diagram in the front panel with similar distribution to the elements in the real unit.
 Stainless steel tank (30 l.), equipped with:
 Electric heating resistance (3000W) with thermostat (70° C), to heat the water, computer controlled. PID temperature control.
 Temperature sensor (“J” type) to measure the water temperature.
 Level switch to control the water level in the tank.
 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.
 Draining water valve.
 Centrifugal pump with speed control from computer, range: 0 - 3 l./min.
 2 Flow sensors, one for hot water and the other for cold water, range: 0 - 6.5 l./min.
 Control valve for the cold water.
 4 Ball valves that, depending on how we 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.
 4 Flexible tubes to connect with the different exchangers.
 Cables and accessories, for normal operation.

Control Interface Box:
 This control interface is common for Heat Exchangers and can work with one or several exchangers.
 Control interface box with process diagram in the front panel. The unit control elements are permanently computer controlled.
 Simultaneous visualization in the computer of all parameters involved in the process.
 Calibration of all sensors involved in the process. Real time curves representation about 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.
 Shield and filtered signals to avoid external interferences.
 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 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).
 Open control allowing modifications, at any moment and in real time, of parameters 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.

Data Acquisition Board:
 PCI EXPRESS Data acquisition board 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.

Sampling rate up to: 250 KS/s (Kilo samples per second). Input range (V)=± 10V.

Data transfers=DMA, interrupts, programmed I/O. Number of DMA channels=6.

Analog output: Number of channels=2. Resolution=16 bits, 1 in 65536. Maximum output rate up to: 900 KS/s.

Output range(V)=±10. Data transfers=DMA, interrupts, programmed I/O.

Digital Input/Output: Number of channels=24 inputs/outputs. D0 or DI Sample Clock frequency:0 to 100 MHz.

Timing: Counter/timers=4. Resolution: Counter/timers:32 bits.

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

High-End Computer is to be provided for software installation and data acquisition

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.

There are several kinds of faults that can be grouped in three sections:

Faults affecting the sensors measure:

- An incorrect calibration is applied to them.
- Non-linearity.

Faults affecting the actuators: (These do not admit solutions. The student must just realize it and notify it.)

- Actuators canals interchange at any time during the program execution.

- Response reduction of an actuator.

Faults in the controls execution:

- Inversion of the performance in ON/OFF controls.
- Reduction or increase of the calculated total response.
- The action of some controls is annulled.

1.6.3. Jacketed Vessel Heat Exchanger: (File No. 012)

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.

It can work in continuous supply or in a batch process (heating of a constant mass of water containing in a vessel).

The exchanger allows measuring temperatures at the inlet and outlet of the exchanger in cold as well as in hot water.

Anodized aluminium structure and panel in painted steel.

Main metallic elements in stainless steel.

Diagram in the front panel with similar distribution to the elements in the real unit.

Constituted of a vessel.

Vessel total volume: 14 l.

Interior vessel volume: 7 l. approx.

Jacket volume: 7 l. approx.

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.

A jacket surrounds the vessel through where hot water flows.

An electric stirrer with a stirring rod of propeller shape and a turn range between 50 and 300 rpm.

5 Temperature sensors (“J” type):

3 Temperature sensors for measuring cold water temperature.

2 Temperature sensors for measuring hot water temperature.

Easy connection to the Base Service Unit.

This unit is supplied with 8 manuals: Required Services, Assembly and Installation, Interface and Control Software, Starting-up, Safety, Maintenance, Calibration & Practices Manuals.

Computer Control Software:

Computer Control +Data Acquisition+ Data Management Software for Jacketed Vessel Heat Exchanger.

Compatible with the industry standards.

Flexible, open and multi control software, developed with actual windows graphic systems, acting simultaneously on all process parameters.

Analog and digital PID control.

PID menu and set point selection required in the whole work range.

Management, processing, comparison and storage of data.

Sampling velocity up to 250 KS/s (Kilo samples per second).

Calibration system for the sensors involved in the process.

It allows the registration of the alarms state and the graphic representation in real time.

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.

Base Service Unit:

This unit is common for Heat Exchangers and can work with one or several exchangers.

This unit performs the following tasks:

Heating the water.

Pumping of hot water.

Change in the direction of cold water flows.

Cold and hot water measures.

Anodized aluminum structure and panel in painted steel.

Main metallic elements in stainless steel.

Diagram in the front panel with similar distribution to the elements in the real unit.

Stainless steel tank (30 l.), equipped with:

Electric heating resistance (3000W) with thermostat (70° C), to heat the water, computer controlled. PID temperature control.

Temperature sensor (“J” type) to measure the water temperature.

Level switch to control the water level in the tank.

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.

Draining water valve.

Centrifugal pump with speed control from computer, range: 0 - 3 l./min.

2 Flow sensors, one for hot water and the other for cold water, range: 0 - 6.5 l./min.

Control valve for the cold water.

4 Ball valves that, depending on how we 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.
 4 Flexible tubes to connect with the different exchangers.
 Cables and accessories, for normal operation.

Control Interface Box:
 This control interface is common for Heat Exchangers and can work with one or several exchangers.
 Control interface box with process diagram in the front panel. The unit control elements are permanently computer controlled.
 Simultaneous visualization in the computer of all parameters involved in the process.
 Calibration of all sensors involved in the process. Real time curves representation about 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.
 Shield and filtered signals to avoid external interferences.
 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 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).
 Open control allowing modifications, at any moment and in real time, of parameters 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.

Data Acquisition Board:
 PCI EXPRESS Data acquisition board 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.
 Sampling rate up to: 250 KS/s (Kilo samples per second). Input range (V)= $\pm 10V$.
 Data transfers=DMA, interrupts, programmed I/O. Number of DMA channels=6.
 Analog output: Number of channels=2. Resolution=16 bits, 1 in 65536. Maximum output rate up to: 900 KS/s.
 Output range(V)= ± 10 . Data transfers=DMA, interrupts, programmed I/O.
 Digital Input/Output: Number of channels=24 inputs/outputs. D0 or DI Sample Clock frequency:0 to 100 MHz.
 Timing: Counter/timers=4. Resolution: Counter/timers:32 bits.
 High-End Computer is to be provided for software installation and data acquisition

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

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.

There are several kinds of faults that can be grouped in three sections:

Faults affecting the sensors measure:

- An incorrect calibration is applied to them.
- Non-linearity.

Faults affecting the actuators: (These do not admit solutions. The student must just realize it and notify it.)

- Actuators canals interchange at any time during the program execution.
- Response reduction of an actuator.

Faults in the controls execution:

- Inversion of the performance in ON/OFF controls.
- Reduction or increase of the calculated total response.
- The action of some controls is annulled.

1.6.4. Coil Vessel Heat Exchanger: (File No. 013)

This heat exchanger allows the study of heat transfer between hot water flowing through a coil and cold water contained in the vessel. It can work in continuous supply or in a batch process.

Anodized aluminum structure and panel in painted steel.

Main metallic elements in stainless steel.

Diagram in the front panel with similar distribution to the elements in the real unit.

Formed by a pvc-glass vessel, volume: 14 l.

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.

A copper coil where the water circulates:

Dint = 4.35 mm.

Dext = 6.35 mm.

Total length of the tube that forms the coil: 1.5 m.

An electric stirrer using a stirring rod forming a propeller and with a turn range between 50 and 300 rpm.

5 Temperature sensors ("J" type):

3 Temperature sensors for measuring cold water temperature.

2 Temperature sensors for measuring hot water temperature.

Easy connection to the Base Service Unit.

This unit is supplied with 8 manuals: Required Services, Assembly and Installation, Interface and Control Software, Starting-up, Safety, Maintenance, Calibration & Practices Manuals.

Computer Control Software:

Computer Control+ Data Acquisition +Data Management Software for Coil Vessel Heat Exchanger.

Compatible with the industry standards.

Flexible, open and multicontrol software, developed with actual windows graphic systems, acting simultaneously on all process parameters.

Analog and digital PID control.

PID menu and set point selection required in the whole work range.

Management, processing, comparison and storage of data.

Sampling velocity up to 250 KS/s (Kilo samples per second).

Calibration system for the sensors involved in the process.

It allows the registration of the alarms state and the graphic representation in real time.

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.

Base Service Unit:

This unit is common for Heat Exchangers type “TI” and can work with one or several exchangers.

This unit performs the following tasks:

Heating the water.

Pumping of hot water.

Change in the direction of cold water flows.

Cold and hot water measures.

Anodized aluminium structure and panel in painted steel.

Main metallic elements in stainless steel.

Diagram in the front panel with similar distribution to the elements in the real unit.

Stainless steel tank (30 l.), equipped with:

Electric heating resistance (3000W) with thermostat (70° C), to heat the water, computer controlled. PID temperature control.

Temperature sensor (“J” type) to measure the water temperature.

Level switch to control the water level in the tank.

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.

Draining water valve.

Centrifugal pump with speed control from computer, range: 0 - 3 l./min.

2 Flow sensors, one for hot water and the other for cold water, range: 0 - 6.5 l./min.

Control valve for the cold water.

4 Ball valves that, depending on how we 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.

4 Flexible tubes to connect with the different exchangers.

Cables and accessories, for normal operation.

Control Interface Box:

This control interface is common for Heat Exchangers type “TI” and can work with one or several exchangers.

Control interface box with process diagram in the front panel. The unit control elements are permanently computer controlled.

Simultaneous visualization in the computer of all parameters involved in the process.

Calibration of all sensors involved in the process. Real time curves representation about 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.

Shield and filtered signals to avoid external interferences.

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 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).

Open control allowing modifications, at any moment and in real time, of parameters 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.

Data Acquisition Board:

PCI EXPRESS Data acquisition board 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.

Sampling rate up to: 250 KS/s (Kilo samples per second). Input range (V)=± 10V.

Data transfers=DMA, interrupts, programmed I/O. Number of DMA channels=6.

Analog output: Number of channels=2. Resolution=16 bits, 1 in 65536. Maximum output rate up to: 900 KS/s.

Output range(V)=±10. Data transfers=DMA, interrupts, programmed I/O.

Digital Input/Output: Number of channels=24 inputs/outputs. D0 or DI Sample Clock frequency:0 to 100 MHz.

Timing: Counter/timers=4. Resolution: Counter/timers:32 bits.

High-End Computer is to be provided for software installation and data acquisition

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

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.

There are several kinds of faults that can be grouped in three sections: Faults affecting the sensors measure:

- An incorrect calibration is applied to them.
- Non-linearity.

Faults affecting the actuators: (These do not admit solutions. The student must just realize it and notify it.)

- Actuators canals interchange at any time during the program execution.
- Response reduction of an actuator.

Faults in the controls execution:

- Inversion of the performance in ON/OFF controls.
- Reduction or increase of the calculated total response.
- The action of some controls is annulled.

SECTION : 4 – PRICE SCHEDULE

To be used by the bidder for submission of the price bid

1. Component Name :
2. Specifications (confirming to Section 3 of Tender document-enclose additional sheets if necessary) :
3. Currency and Unit cost (excluding Taxes) :
4. Quantity :
5. Item cost (Sl.No.3 * Sl.No.4) (in Indian Rupee):
6. Taxes and other charges :
 - (i) Specify the type of taxes and duties in percentages and also in figures
 - (ii) Specify other charges in figures
7. Total cost (Inclusive of all taxes) :

(Both in figures and words)
8. Warranty period (confirming to the Section 3 of Tender document. This should be mentioned in Technical bid also in order to get qualified for price bid) :
9. Delivery Schedule (confirming to the Section 3 of Tender document) :
10. Name and address of the firm for placing purchase order :
11. Name and address of Indian authorized agent (in case of imports only):

Signature of the Bidder :

Name and Designation :

Business Address :

Place :

Date :

Seal of the Bidder's Firm

(Note: All column should be filled. No column should be left blank. If any column is not filled-in properly or left empty then the bid will be rejected.)

SECTION : 5 – CONTRACT FORM

To be provided by the bidder in their business letter head

[Name of the Supplier’s Firm] hereby abide to deliver the **SCADA/Computerized laboratory set up** by the delivery schedule mentioned in the Section 3 of the Tender document for supply of the items if the purchase order is awarded.

The item will be supplied conforming to the specifications stated in the tender document without any defect and deviations.

Warranty will be given for the period mentioned in the tender document and service will be rendered to the satisfaction of NIT, Trichy during this period.

Signature of the Bidder :

Name and Designation :

Business Address :

Place :

Date :

Seal of the Bidder’s Firm

NATIONAL INSTITUTE OF TECHNOLOGY, TIRUCHIRAPALLI

Annexure-A

MODEL PRICE BID FORMAT FOR INDIAN BIDDERS

Tender No. & Date: **NITT/F.NO: RES - 012/PLAN 2013-14/CHE Dt: --.01.2014**

Bidder's Offer No. & Date:

S. No.	Description of item	Unit (SET /No)	QTY	Rate /Qty in Rs. (excluding of all taxes)	ED in %	VAT /CST In %	Service Tax in %	Total Value in Rs. (inclusive of all taxes)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1	Supply portion (The price indicated shall be exclusive of all accessories, spares etc. as given in the scope of supply)							
2	Other accessories /spares etc as given in scope of supply (Individual item-wise break-up price shall be attached as an annexure to this price bid format.)							
3	Installation & Commissioning (extra, if any)							
4	Packing & Forwarding charges (extra, if any)							
5	FOR Dispatching station value in Rs.							
6	Freight & Transit insurance charges, extra, if any							
7	Total all inclusive price delivered, installed and commissioned at NITT							
8	Value of Annual Maintenance Contract for 5 years							
9	Net cost to be paid by NITT							

Signature & Seal of Vendor

Note: The price bid should be submitted only as per the above format. No row shall be left blank. Please indicate NA, in case the item is "Not Applicable". If this format is not used or any column is left blank, then the bid will be rejected.