

\* Minimum supply always includes: 1 + 2 + 3 + 4 + 5 + 6  
(Computer not included in the supply)

① Unit: TGFAC. Computer Controlled Axial Flow Gas Turbine/ Jet Engine

### Key features:

- **Advanced Real-Time SCADA.**
- **Open Control + Multicontrol + Real-Time Control.**
- **Specialized EDIBON 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.**
- **Optional ICAI software to create, edit and carry out practical exercises, tests, exams, calculations, etc. Apart from monitoring user's knowledge and progress reached.**
- **This unit has been designed for future expansion and integration. A common expansion is the EDIBON Scada-Net (ESN) System which enables multiple students to simultaneously operate many units in a network.**

**OPEN CONTROL  
+  
MULTICONTROL  
+  
REAL TIME CONTROL**



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PRODUCTS  
↳ 9. - THERMODYNAMICS  
& THERMOTECHNICS

For more information about Key Features, click here



ISO 9001: Quality Management (for Design, Manufacturing, Commercialization and After-sales service)



European Union Certificate (total safety)



Certificates ISO 14001 and ECO-Management and Audit Scheme (environmental management)



"Worlddidac Quality Charter" and Platinum Member of Worlddidac

## INTRODUCTION

A jet engine is a type of engine that discharges a jet of fluid at high speed to generate a thrust in accordance with Newton's law, although the term generally refers to a gas turbine used to generate a jet of gas for propulsion purposes. Reaction engines are used in planes for propulsion due to their reduced weight and high performance. The Computer Controlled Axial Flow Gas Turbine/ Jet Engine, "TGFAC", designed by EDIBON is a teaching unit that demonstrates the operation of a gas turbine as reaction engine.

## GENERAL DESCRIPTION

The main element of the Computer Controlled Axial Flow Gas Turbine/ Jet Engine, "TGFAC", is the gas turbine, which consists of:



TGFAC detail

- Axial compressor, supplied by atmospheric air that will be compressed afterwards.
- Annular combustion chamber, where fuel is added to the compressed air and that mixture is burnt. The combustion gases increase their temperature and velocity.
- Expansion axial turbine. The obtained combustion gases flow to the axial turbine, where they transfer part of their energy to the vanes. Since the compressor and the turbine are coupled on the same shaft, when the system is self-sustained, part of the energy of the combustion gases is used to move the compressor. Both the turbine and the compressor are made up of discs with vanes that rotate (rotor) and stationary ones (stator). The difference is that the compressor transforms kinetic energy into pressure while the turbine performs the opposite work. The gas expands when being expelled, its temperature drops and is accelerated. It is expanded till environmental pressure at the outlet of the nozzle and reaches great speed, generating the thrust.

The gas turbine works as open cycle process, air is taken from the environment and expelled to the environment.

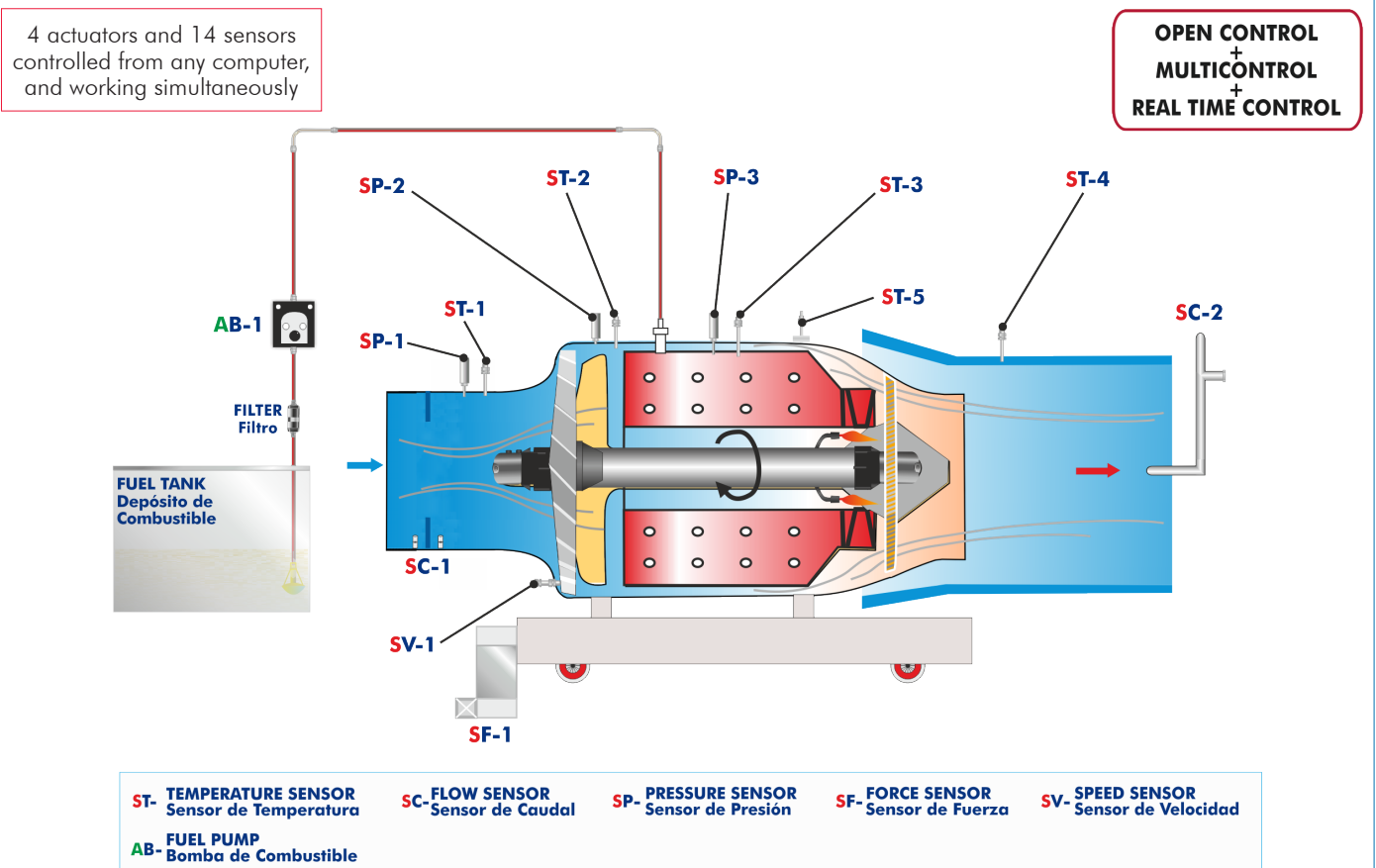
Besides, the unit includes a series of additional installations:

- Starting system: it is completely automatic; it is done with the aid of an electric starter motor that, coupled to the shaft of the compressor, generates the rotation of the shaft. There is a spark plug for the ignition.
- Fuel supply system: the fuel (kerosene/paraffin) passes through a filter and is supplied by a pump to the combustion chamber.
- Lubrication of the turbine: it is carried out with the oil mixed with the fuel (with a proportion of 5 % of special turbine oil).

The "TGFAC" unit includes the sensors required to measure all the important parameters of the process: pressure, temperature, air flow and fuel flow, speed and force (movable table with force sensor to measure thrust).

This Computer Controlled Unit is supplied with the EDIBON Computer Control System (SCADA), and includes: The unit itself + a Control Interface Box + a Data Acquisition Board + Computer Control, Data Acquisition and Data Management Software Packages, for controlling the process and all parameters involved in the process.

## PROCESS DIAGRAM AND UNIT ELEMENTS ALLOCATION



## COMPLETE TECHNICAL SPECIFICATIONS (for main items)

With this unit there are several options and possibilities:

- Main items: 1, 2, 3, 4, 5 and 6.
- Optional items: 7, 8 and 9.

Let us describe first the main items (1 to 6):

### ① TGFAC. Unit:

Bench-top unit.

Anodized aluminum frame and panels made of painted steel.

Main metallic elements made of stainless steel.

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

Axial flow gas turbine (reaction turbine) with a thrust of 180 N at 110000 rpm. It consists of:

- Axial compressor.
- Combustion chamber.
- Expansion axial turbine.

Computer controlled jet engine of the turbine with speed regulation. Quick response of the unit to speed changes.

Computer controlled starting system. It consists of:

- Electric motor.
- Spark plug for the ignition.

Computer controlled fuel supply system (kerosene with 5% approx. of jet oil, not included). It consists of:

- Fuel pump.
- Fuel tank of 5 l.

Intake gases manifold and exhaust gases pipe, 150 mm long, with sensors to measure flows, temperatures and pressures of the gases.

#### Instrumentation:

Five K type temperature sensors located in different stages of the process to measure:

- Inlet air temperature.
- Inlet air temperature in the compressor.
- Fuselage temperature.
- Combustion chamber temperature.
- Exhaust gases temperature.

Speed sensor to measure the speed (rpm) of the shaft of the turbine, range: 0 – 120000 rpm.

Force sensor to measure the thrust of the turbine, range: 0 – 300 N.

Three pressure sensors to measure:

- Pressure in the intake gases.
- Pressure in the compressor.
- Pressure in the combustion chamber.

Three flow sensors to measure:

- Inlet air flow.
- Exhaust gases flow (Pitot with two pressure sensors).
- Fuel flow.

Local control of the turbine through an electronic box installed in the unit, which includes:

- Switch to start and stop the turbine.
- Potentiometer to accelerate or decelerate the turbine.
- Display to show the speed of the turbine.

The unit includes all the required safety measures for a safe operation:

Transparent safety screens for a safe operation and observation of the practical exercises.

Two emergency stop buttons:

- One located in the unit, which stops it immediately.
- A remote one, located close to the computer.

Individual hearing protector.

The complete unit includes as well:

**Advanced Real-Time SCADA.**

**Open Control + Multicontrol + Real-Time Control.**

**Specialized EDIBON Control Software based on LabVIEW.**

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Unit: TGFAC

**② TGFAC/CIB. 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 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.**

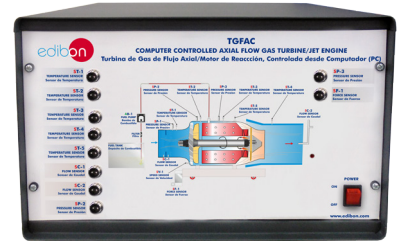
**Real time computer control with flexibility of modifications from the computer keyboard of the parameters, at any moment during the process.**

Real time computer control for pumps, compressors, heating elements, 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.**



TGFAC/CIB

**③ DAB. Data Acquisition Board:**

The Data Acquisition board is part of the SCADA system.

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)= ± 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: 900 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 100 MHz.

Timing: Number of **Counter/timers=4**. Resolution: Counter/timers: 32 bits.

**The Data Acquisition board model may change at any moment, providing the same or better features than those required for the unit.**



DAB

**④ TGFAC/CCSOF. Computer Control + Data Acquisition + Data Management Software:**

The three softwares are part of the SCADA system.

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 simultaneous way.

**Flexible, open and multicontrol software**, 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).**

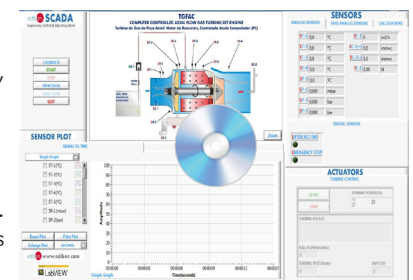
**Calibration system for the sensors involved in the process.**

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

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.**



TGFAC/CCSOF

**⑤ Cables and Accessories**, 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.

\*References 1 to 6 are the main items: TGFAC + TGFAC/CIB + DAB + TGFAC/CCSOF + Cables and Accessories + Manuals are included in the minimum supply for enabling normal and full operation.

## EXERCISES AND PRACTICAL POSSIBILITIES TO BE DONE WITH THE MAIN ITEMS

- 1.- Study of a gas turbine.
  - 2.- Function and operation of a gas turbine as jet engine.
  - 3.- Determination of fuel consumption.
  - 4.- Determination of air and fuel ratio.
  - 5.- Recording the relevant parameters of the turbine.
  - 6.- Determination of the efficiency of the compressor.
  - 7.- Determination of the turbine thrust.
  - 8.- Determination of the efficiency of the gas turbine.
  - 9.- Determination of the gas turbine characteristic curves.
  - 10.-Determination of the compression ratio of the compressor at different thrust regimes.
  - 11.-Determination of the gas turbine specific consumption.
  - 12.-Study of the safety systems in the operation of a gas turbine.
- Additional practical possibilities:
- 13.-Sensors calibration.
- Other possibilities to be done with this Unit:
- 14.-Many students view results simultaneously.  
To view all results in real time in the classroom by means of a projector or an electronic whiteboard.
  - 15.-Open Control, Multicontrol and Real Time Control.  
This unit allows intrinsically and/or extrinsically to change the span, gains; proportional, integral, derivative parameters; etc, in real time.
- 16.-The Computer Control System with SCADA allows a real industrial simulation.
  - 17.-This unit is totally safe as uses mechanical, electrical/electronic, and software safety devices.
  - 18.-This unit can be used for doing applied research.
  - 19.-This unit can be used for giving training courses to Industries even to other Technical Education Institutions.
  - 20.-Control of the TGFAC unit process through the control interface box without the computer.
  - 21.-Visualization of all the sensors values used in the TGFAC unit process.
- Several other exercises can be done and designed by the user.

### REQUIRED SERVICES

- Electrical supply: single-phase 200 VAC – 240 VAC/50 Hz or 110 VAC – 127 VAC/60 Hz.
- Exhaust gases extractor.
- Computer.

### REQUIRED CONSUMABLES (Not included)

- Fuel: kerosene or paraffin.
- Jet type oil to mix at 5 % with the fuel.

### DIMENSIONS AND WEIGHTS

#### TGFAC:

##### Unit:

- Dimensions: 700 x 500 x 800 mm approx.  
(27.55 x 19.68 x 31.49 inches approx.)
- Weight: 70 Kg approx.  
(154.32 pounds approx.)

##### Control-Interface Box:

- Dimensions: 490 x 330 x 310 mm approx.  
(19.29 x 12.99 x 12.2 inches approx.)
- Weight: 10 Kg approx.  
(22 pounds approx.)

# SOFTWARE MAIN SCREENS

**SCADA**  
Main screen

The screenshot displays the SCADA main screen for a TGFC (Turbine Gas Fuel Cell) system. It features a central diagram of the turbine engine with various sensors labeled (ST-1 to ST-5, SP-1 to SP-3, SC-1, SC-2, SF-1, AB-1, and FILTER). The interface is divided into several sections:

- Top Left:** A menu with buttons for CALIBRATE, START, STOP, VIEW DATA, SAVE DATA, and QUIT.
- Top Right:** A 'SENSORS' panel showing real-time values for analog sensors (ST-1 to ST-5, SP-1 to SP-3) and digital sensors (SC-1, SC-2(+), SC-2(-), SF-1).
- Bottom Left:** A 'SENSOR PLOT' section with a 'SIGNAL VS TIME' graph. It includes a channel selection list (IV) for ST-1 to ST-5 (°C) and SP-1 to SP-2 (bar), along with 'Reset Plot', 'Print Plot', and 'Enlarge Plot' options.
- Bottom Center:** A 'SIGNAL VS SIGNAL' graph (V) showing Amplitude vs. Time (seconds).
- Bottom Right:** An 'ACTUATORS' panel for 'TURBINE CONTROL' with 'START' and 'STOP' buttons, and a 'TURBINE POWER(%)' display showing 20.

- I Main software operation possibilities.
- II Sensors displays, real time values, and extra output parameters. Sensors: ST=Temperature sensor. SP=Pressure sensor. SC=Flow sensor. SF=Force sensor.
- III Actuators controls. Actuators: Turbine control= "STOP" for stop the turbine. "START" for start the turbine. "TURBINE POWER" for increase the turbine power.
- IV Channel selection and other plot parameters.
- V Real time graphics displays.

## Software for Sensors Calibration

Example of screen


The screenshot shows the 'Simple Calibrate' screen for sensors and actuators. It is divided into several sections:

- Analog Input Channel:** Fields for Sensor Name (ST-1), Calibration Units (°C), Current Gain (123,358343), Full Scale (100), and Current Offset (-2,16835). It also shows a Read Value (0,000719053) and Measurements Unit.
- Gain & Offset Setting:** Fields for New Gain (0) and New Offset (0), with buttons for 'Restore Factory Gains & Factory Offsets' and 'Set New Gain & New Offset'.
- Scaling Parameters:** A 'Least Square Fit' button.
- Actuators:** A 'TURBINE CONTROL' panel with 'START' and 'STOP' buttons, and a 'TURBINE POWER(%)' display showing 0.
- Sensors Table:** A table for sensor calibration with columns for Reference Value, Full Scale, Sensors, Volts, Calibrated, Err(%), Current Gain, Current Offset, and buttons for 'Back', 'Set', and 'Reset'.
- Buttons:** 'SAVE & EXIT', 'EXIT', 'Take Measurement', 'Get New Gain & New Offset', and 'Taken Data'.

The teacher and the students can calibrate the unit with a password provided by EDIBON. The teacher can restore the factory calibration any time.

## SOME REAL RESULTS OBTAINED FROM THIS UNIT

Real time representation of any measured or calculated variable.



Supervisory Control & Data Acquisition

CALIBRATE  
START  
STOP  
VIEW DATA  
SAVE DATA

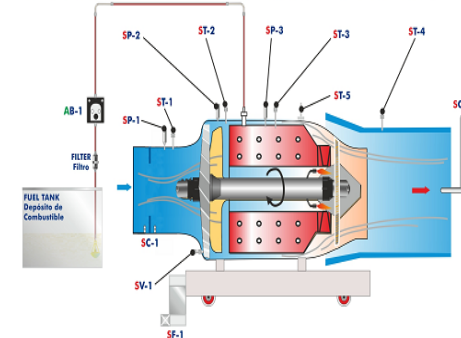
Periodic (sec)  
5      587 sec

Take Data      Taken Data

STOP SAVING

### TGFAC

COMPUTER CONTROLLED AXIAL FLOW GAS TURBINE/JET ENGINE  
Turbina de Gas de Flujo Axial/ Motor de Reacción, Controlada desde Computador (PC)



Zoom

### SENSORS

ANALOG SENSORS		TARE ANALOG SENSORS		CALCULATIONS	
ST-1	34,2 °C	SC-1	659	m3/h	
ST-2	99,7 °C	SC-2(+)	823,7	mmwc	
ST-3	118,0 °C	SC-2(-)	-53,2	mmwc	
ST-4	626,5 °C	SF-1	41,31	N	
ST-5	66,7 °C				
SP-1	-2,7 mbar				
SP-2	0,6 bar				
SP-3	0,6 bar				

DIGITAL SENSORS

INTERFACE ON? ●

EMERGENCY STOP ●

SIGNAL VS TIME

Graph B

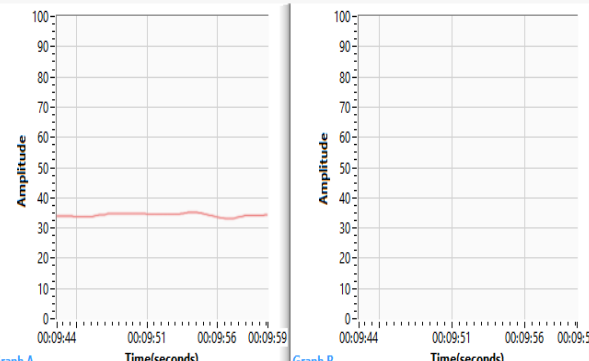
- ST-1(°C)
- ST-2(°C)
- ST-3(°C)
- ST-4(°C)
- ST-5(°C)
- SP-1(mbar)
- SP-2(bar)

Reset Plot      Print Plot

Enlarge Plot      seconds

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LabVIEW



Graph A      Graph B

### ACTUATORS

TURBINE CONTROL

START      TURBINE POWER(%)

STOP      **61**

TURBINE STATUS

Running T=518CRpm 75630 Pw 501


FUEL FLOW(ml/min)

223

TURBINE SPEED(rpm)      INPUT(V)

74500      7,5

Real time representation of any measured or calculated variable.



Supervisory Control & Data Acquisition

CALIBRATE  
START  
STOP  
VIEW DATA  
SAVE DATA

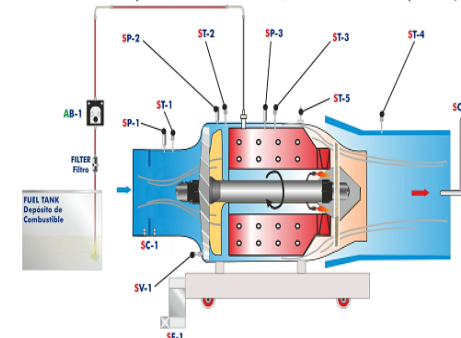
Periodic (sec)  
5      652,5 sec

Take Data      Taken Data

STOP SAVING

### TGFAC

COMPUTER CONTROLLED AXIAL FLOW GAS TURBINE/JET ENGINE  
Turbina de Gas de Flujo Axial/ Motor de Reacción, Controlada desde Computador (PC)



Zoom

### SENSORS

ANALOG SENSORS		TARE ANALOG SENSORS		CALCULATIONS	
ST-1	33,8 °C	SC-1	1214	m3/h	
ST-2	193,2 °C	SC-2(+)	2022,3	mmwc	
ST-3	189,0 °C	SC-2(-)	-480,7	mmwc	
ST-4	800,0 °C	SF-1	139,04	N	
ST-5	100,9 °C				
SP-1	-9,1 mbar				
SP-2	1,8 bar				
SP-3	2,0 bar				

DIGITAL SENSORS

INTERFACE ON? ●

EMERGENCY STOP ●

SIGNAL VS TIME

Single Graph

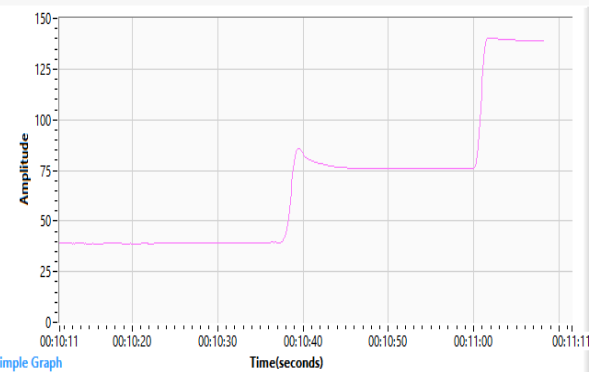
- SP-1(mbar)
- SP-2(bar)
- SP-3(bar)
- SC-1(m3/h)
- SC-2(+)
- SC-2(-)
- SF-1(N)

Reset Plot      Print Plot

Enlarge Plot      minutes

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LabVIEW



Simple Graph

### ACTUATORS

TURBINE CONTROL

START      TURBINE POWER(%)

STOP      **100**

TURBINE STATUS

Run-Max T=693CRpm 115230 Pw 1283

FUEL FLOW(ml/min)

585

TURBINE SPEED(rpm)      INPUT(V)

115200      7,5

Some **real** results obtained from this Unit

Calculation of the flow rate and velocity of the exhaust air and isentropic efficiency.

**edibon SCADA**  
Supervisory Control & Data Acquisition

Periodic (sec)  
1      825,1 sec

Take Data      Taken Data

**TGFAC**  
COMPUTER CONTROLLED AXIAL FLOW GAS TURBINE/JET ENGINE  
Turbina de Gas de Flujo Axial/ Motor de Reacción, Controlada desde Computador (PC)

Zoom

**SENSORS**

ANALOG SENSORS    TARE ANALOG SENSORS    CALCULATIONS

SC-2 (Air Speed)	78,6	m/s
SC-2 (Flow)	555	m3/h
Isentropic Efficiency	47,6	%

DIGITAL SENSORS

**ACTUATORS**  
TURBINE CONTROL

     TURBINE POWER(%)  
      40

TURBINE STATUS  
Run-Idle T=425CRpm 33390 Pw 187

FUEL FLOW(m/min)  
86

TURBINE SPEED(rpm)      INPUT(V)  
33100      7,5

SIGNAL VS TIME      SIGNAL VS SIGNAL

Single Graph

- SP-3(bar)
- SC-1(m3/h)
- SC-2(+)
- SC-2(-)
- SF-1(N)
- SC-2 (Air)
- SC-2

Reset Plot    Print Plot  
Enlarge Plot    minutes

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LabVIEW

Simple Graph

Visualization and representation of saved data.

FILE NAME

*saved\_data\_tgfac.xls*

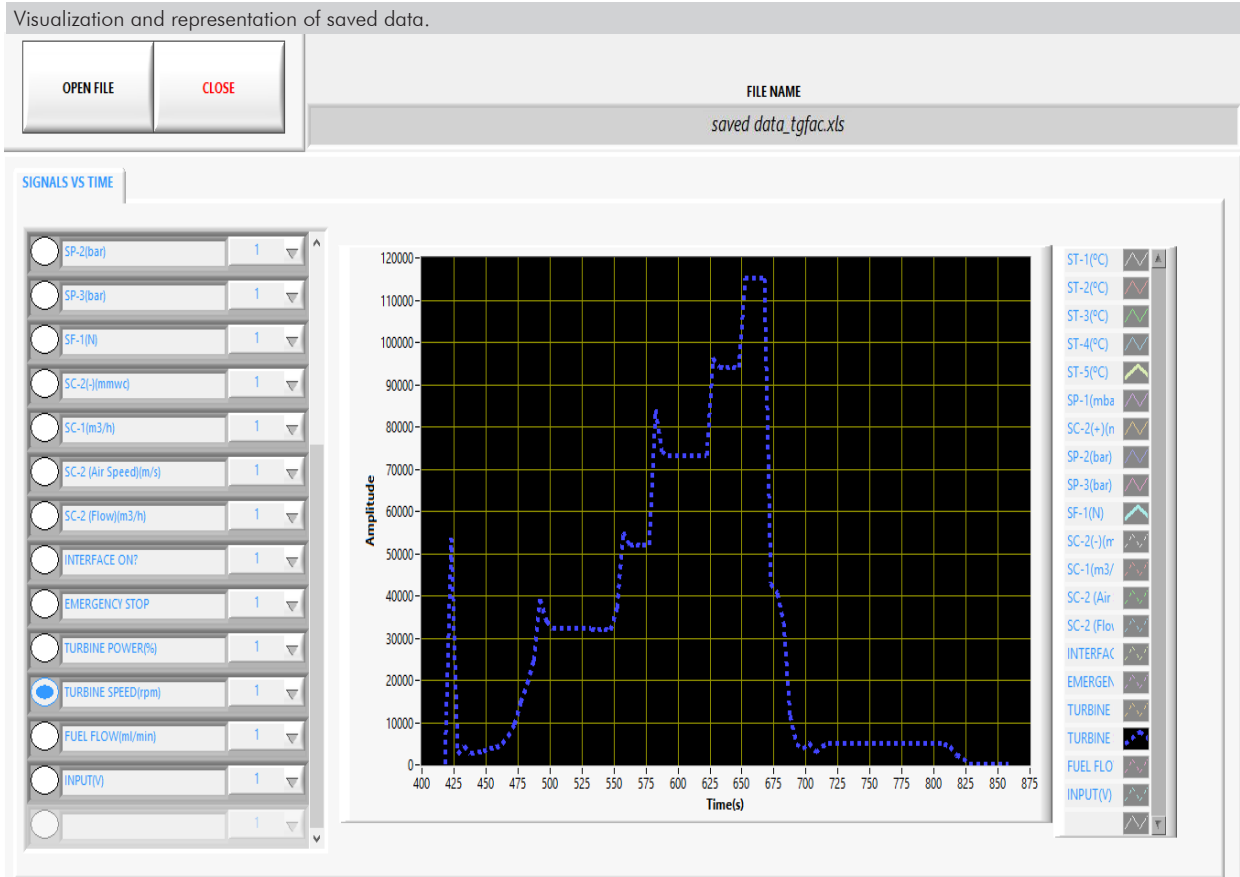
SIGNALS VS TIME    SIGNAL VS SIGNAL

- ST-1(°C)    1
- ST-2(°C)    1
- ST-3(°C)    1
- ST-4(°C)    1
- ST-5(°C)    1
- SP-1(mbar)    1
- SC-2(+)(mmwg)    1
- SP-2(bar)    1
- SP-3(bar)    1
- SF-1(N)    1
- SC-2(-)(mmwg)    1
- SC-1(m3/h)    1
- SC-2 (Air Speed)(m/s)    1
- SC-2 (Flow)(m3/h)    1

- ST-1(°C)
- ST-2(°C)
- ST-3(°C)
- ST-4(°C)
- ST-5(°C)
- SP-1(mbar)
- SC-2(+)(n)
- SP-2(bar)
- SP-3(bar)
- SF-1(N)
- SC-2(-)(rr)
- SC-1(m3/)
- SC-2 (Air)
- SC-2 (Flow)
- Isentropic
- INTERFAC
- EMERGEN
- TURBINE
- TURBINE
- FUEL FLO
- INPUT(V)



Some **real** results obtained from this Unit



## COMPLETE TECHNICAL SPECIFICATIONS (for optional items)

Additionally to the main items (1 to 6) described, we can offer, as optional, other items from 7 to 9.

All these items try to give more possibilities for:

- a) Technical and Vocational Education configuration. (ICAI)
- b) Multipost Expansions options. (MINI ESN and ESN)

### a) Technical and Vocational Education configuration

#### 7) TGFAC/ICAI. Interactive Computer Aided Instruction Software.

This complete software package consists of an Instructor Software (EDIBON Classroom Manager - ECM-SOF) totally integrated with the Student Software (EDIBON Student Labsoft - ESL-SOF). Both are interconnected so that the teacher knows at any moment what is the theoretical and practical knowledge of the students.

This software is optional and can be used additionally to items (1 to 6).

#### - ECM-SOF. EDIBON Classroom Manager (Instructor Software).

ECM-SOF is the application that allows the Instructor to register students, manage and assign tasks for workgroups, create own content to carry out Practical Exercises, choose one of the evaluation methods to check the Student knowledge and monitor the progression related to the planned tasks for individual students, workgroups, units, etc... so the teacher can know in real time the level of understanding of any student in the classroom.

Innovative features:

- User Data Base Management.
- Administration and assignment of Workgroup, Task and Training sessions.
- Creation and Integration of Practical Exercises and Multimedia Resources.
- Custom Design of Evaluation Methods.
- Creation and assignment of Formulas & Equations.
- Equation System Solver Engine.
- Updatable Contents.
- Report generation, User Progression Monitoring and Statistics.

#### - ESL-SOF. EDIBON Student Labsoft (Student Software).

ESL-SOF is the application addressed to the Students that helps them to understand theoretical concepts by means of practical exercises and to prove their knowledge and progression by performing tests and calculations in addition to Multimedia Resources. Default planned tasks and an Open workgroup are provided by EDIBON to allow the students start working from the first session. Reports and statistics are available to know their progression at any time, as well as explanations for every exercise to reinforce the theoretically acquired technical knowledge.

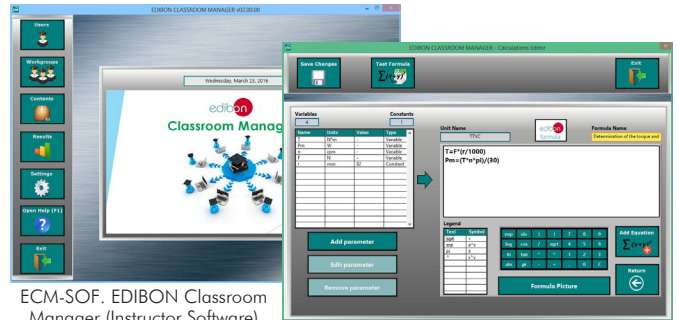
Innovative features:

- Student Log-In & Self-Registration.
- Existing Tasks checking & Monitoring.
- Default contents & scheduled tasks available to be used from the first session.
- Practical Exercises accomplishment by following the Manual provided by EDIBON.
- Evaluation Methods to prove your knowledge and progression.
- Test self-correction.
- Calculations computing and plotting.
- Equation System Solver Engine.
- User Monitoring Learning & Printable Reports.
- Multimedia-Supported auxiliary resources.

For more information see ICAI catalogue. Click on the following link:

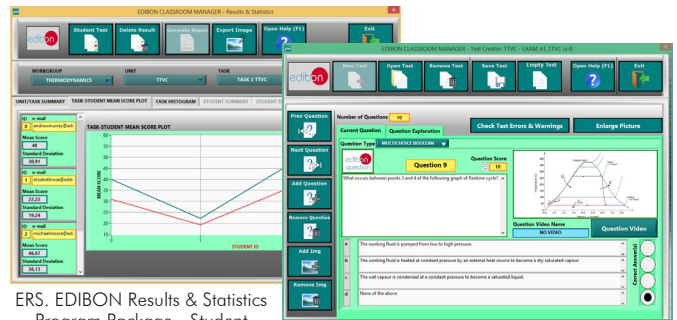
<https://www.edibon.com/en/interactive-computer-aided-instruction-software/catalog>

### Instructor Software



ECM-SOF. EDIBON Classroom Manager (Instructor Software) Application Main Screen

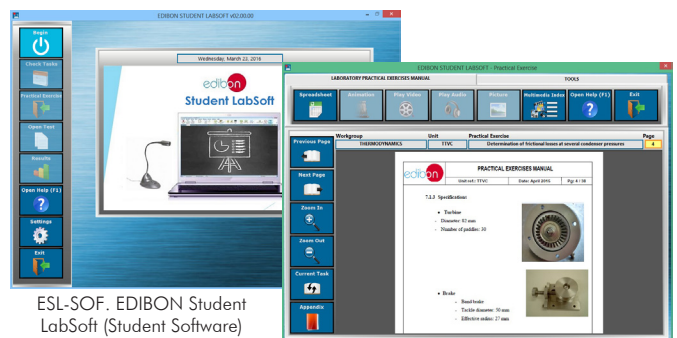
ECAL. EDIBON Calculations Program Package - Formula Editor Screen



ERS. EDIBON Results & Statistics Program Package - Student Scores Histogram

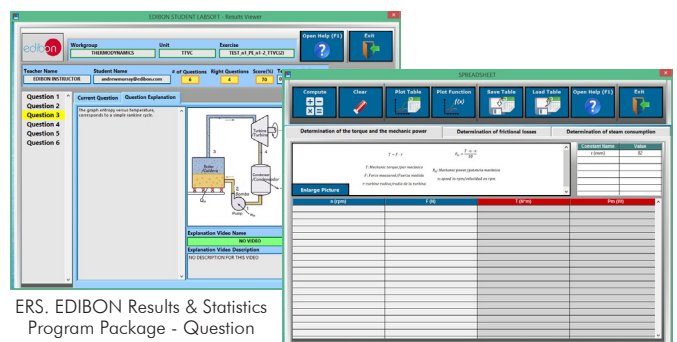
ETTE. EDIBON Training Test & Exam Program Package - Main Screen with Numeric Result Question

### Student Software



ESL-SOF. EDIBON Student LabSoft (Student Software) Application Main Screen

EPE. EDIBON Practical Exercise Program Package Main Screen



ERS. EDIBON Results & Statistics Program Package - Question Explanation

ECAL. EDIBON Calculations Program Package Main Screen

b) Multipost Expansions options

⑧ **MINI ESN. EDIBON Mini Scada-Net System for being used with EDIBON Teaching Units.**

MINI ESN. EDIBON Mini Scada-Net System allows up to 30 students to work with a Teaching Unit in any laboratory, simultaneously. It is useful for both, Higher Education and/or Technical and Vocational Education.

The MINI ESN system consists of the adaptation of any EDIBON Computer Controlled Unit with SCADA integrated in a local network.

This system allows to view/control the unit remotely, from any computer integrated in the local net (in the classroom), through the main computer connected to the unit. Then, the number of possible users who can work with the same unit is higher than in an usual way of working (usually only one).

Main characteristics:

- It allows up to 30 students to work simultaneously with the EDIBON Computer Controlled Unit with SCADA, connected in a local net.
- Open Control + Multicontrol + Real Time Control + Multi Student Post.
- Instructor controls and explains to all students at the same time.
- Any user/student can work doing "real time" control/multicontrol and visualisation.
- Instructor can see in the computer what any user/student is doing in the unit.
- Continuous communication between the instructor and all the users/students connected.

Main advantages:

- It allows an easier and quicker understanding.
- This system allows you can save time and cost.
- Future expansions with more EDIBON Units.

For more information see MINI ESN catalogue. Click on the following link:

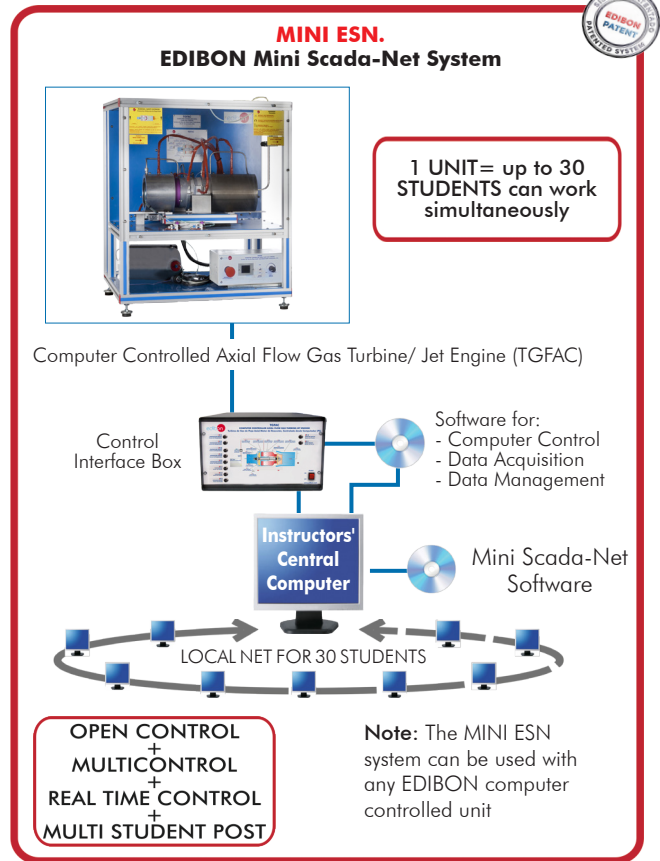
<https://www.edibon.com/en/edibon-scada-net/catalog>

⑨ **ESN. EDIBON Scada-Net Systems.**

This unit can be integrated, in the future, into a Complete Laboratory with many Units and many Students.

For more information see ESN catalogue. Click on the following link:

<https://www.edibon.com/en/edibon-scada-net/catalog>



## ORDER INFORMATION

### **Main items** (always included in the supply)

Minimum supply always includes:

- ① **Unit: TGFAC. Computer Controlled Axial Flow Gas Turbine/ Jet Engine.**
- ② **TGFAC/CIB. Control Interface Box.**
- ③ **DAB. Data Acquisition Board.**
- ④ **TGFAC/CCSOF. Computer Control + Data Acquisition + Data Management Software.**
- ⑤ **Cables and Accessories**, for normal operation.
- ⑥ **Manuals.**

**\*IMPORTANT:** Under TGFAC we always supply all the elements for immediate running as 1, 2, 3, 4, 5 and 6.

### **Optional items** (supplied under specific order)

a) Technical and Vocational Education configuration

- ⑦ TGFAC/ICAI. Interactive Computer Aided Instruction Software.

b) Multipost Expansions options

- ⑧ MINI ESN. EDIBON Mini Scada-Net System for being used with EDIBON Teaching Units.
- ⑨ ESN. EDIBON Scada-Net Systems.

**① TGFAC. Unit:**

Bench-top unit.  
 Anodized aluminum frame and panels made of painted steel.  
 Main metallic elements made of stainless steel.  
 Diagram in the front panel with distribution of the elements similar to the real one.  
 Axial flow gas turbine (reaction turbine) with a thrust of 180 N at 110000 rpm. It consists of:  
 Axial compressor.  
 Combustion chamber.  
 Expansion axial turbine.  
 Computer controlled jet engine of the turbine with speed regulation. Quick response of the unit to speed changes.  
 Computer controlled starting system. It consists of:  
 Electric motor.  
 Spark plug for the ignition.  
 Computer controlled fuel supply system (kerosene with 5% approx. of jet oil, not included). It consists of:  
 Fuel pump.  
 Fuel tank of 5 l.  
 Intake gases manifold and exhaust gases pipe, 150 mm long, with sensors to measure flows, temperatures and pressures of the gases.

**Instrumentation:**

Five K type temperature sensors located in different stages of the process to measure:  
 Inlet air temperature.  
 Inlet air temperature in the compressor.  
 Fuselage temperature.  
 Combustion chamber temperature.  
 Exhaust gases temperature.  
 Speed sensor to measure the speed (rpm) of the shaft of the turbine, range: 0 – 120000 rpm.  
 Force sensor to measure the thrust of the turbine, range: 0 – 300 N.  
 Three pressure sensors to measure:  
 Pressure in the intake gases.  
 Pressure in the compressor.  
 Pressure in the combustion chamber.  
 Three flow sensors to measure:  
 Inlet air flow.  
 Exhaust gases flow (Pitot with two pressure sensors).  
 Fuel flow.  
 Local control of the turbine through an electronic box installed in the unit, which includes:  
 Switch to start and stop the turbine.  
 Potentiometer to accelerate or decelerate the turbine.  
 Display to show the speed of the turbine.

The unit includes all the required safety measures for a safe operation:  
 Transparent safety screens for a safe operation and observation of the practical exercises.  
 Two emergency stop buttons:  
 One located in the unit, which stops it immediately.  
 A remote one, located close to the computer.  
 Individual hearing protector.  
 The complete unit includes as well:

Advanced Real-Time SCADA.  
 Open Control + Multicontrol + Real-Time Control.  
 Specialized EDIBON 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.  
 Optional ICAI software to create, edit and carry out practical exercises, tests, exams, calculations, etc. Apart from monitoring user's knowledge and progress reached.  
 This unit has been designed for future expansion and integration. A common expansion is the EDIBON Scada-Net (ESN) System which enables multiple students to simultaneously operate many units in a network.

**② TGFAC/CIB. Control Interface Box:**

The Control Interface Box is part of the SCADA system.  
 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 computer control with flexibility of modifications from the computer keyboard of the parameters, at any moment during the process.  
 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.

**③ DAB. Data Acquisition Board:**

The Data Acquisition board is part of the SCADA system.  
 PCI Express Data acquisition board (National Instruments) to be placed in a computer slot.  
 Analog input: Channels= 16 single-ended or 8 differential. Resolution=16 bits, 1 in 65536. Sampling rate up to: 250 KS/s (kilo samples per second).  
 Analog output: Channels=2. Resolution=16 bits, 1 in 65536.  
 Digital Input/Output: Channels=24 inputs/outputs.  
 The Data Acquisition board model may change at any moment, providing the same or better features than those required for the unit.

**④ TGFAC/CCSOF. Computer Control +Data Acquisition+Data Management Software:**

The three softwares are part of the SCADA system.  
 Compatible with the industry standards.  
 Flexible, open and multicontrol software, 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 whiteboard.

**⑤ Cables and Accessories, 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.

### Exercises and Practical Possibilities to be done with the Main Items

- 1.- Study of a gas turbine.
- 2.- Function and operation of a gas turbine as jet engine.
- 3.- Determination of fuel consumption.
- 4.- Determination of air and fuel ratio.
- 5.- Recording the relevant parameters of the turbine.
- 6.- Determination of the efficiency of the compressor.
- 7.- Determination of the turbine thrust.
- 8.- Determination of the efficiency of the gas turbine.
- 9.- Determination of the gas turbine characteristic curves.
- 10.-Determination of the compression ratio of the compressor at different thrust regimes.
- 11.-Determination of the gas turbine specific consumption.
- 12.-Study of the safety systems in the operation of a gas turbine.

Additional practical possibilities:

- 13.-Sensors calibration.

Other possibilities to be done with this Unit:

- 14.-Many students view results simultaneously.

To view all results in real time in the classroom by means of a projector or an electronic whiteboard.

- 15.-Open Control, Multicontrol and Real Time Control.

This unit allows intrinsically and/or extrinsically to change the span, gains; proportional, integral, derivative parameters; etc, in real time.

- 16.-The Computer Control System with SCADA allows a real industrial simulation.
  - 17.-This unit is totally safe as uses mechanical, electrical/electronic, and software safety devices.
  - 18.-This unit can be used for doing applied research.
  - 19.-This unit can be used for giving training courses to Industries even to other Technical Education Institutions.
  - 20.-Control of the TGFAC unit process through the control interface box without the computer.
  - 21.-Visualization of all the sensors values used in the TGFAC unit process.
- Several other exercises can be done and designed by the user.

## TENDER SPECIFICATIONS (for optional items)

### a) Technical and Vocational Education configuration

#### ⑦ **TGFAC/ICAI. Interactive Computer Aided Instruction Software.**

This complete software package consists of an Instructor Software (EDIBON Classroom Manager - ECM-SOF) totally integrated with the Student Software (EDIBON Student Labsoft - ESL-SOF). Both are interconnected so that the teacher knows at any moment what is the theoretical and practical knowledge of the students.

- ECM-SOF. EDIBON Classroom Manager (Instructor Software).

ECM-SOF is the application that allows the Instructor to register students, manage and assign tasks for workgroups, create own content to carry out Practical Exercises, choose one of the evaluation methods to check the Student knowledge and monitor the progression related to the planned tasks for individual students, workgroups, units, etc...so the teacher can know in real time the level of understanding of any student in the classroom.

Innovative features:

- User Data Base Management.
- Administration and assignment of Workgroup, Task and Training sessions.
- Creation and Integration of Practical Exercises and Multimedia Resources.
- Custom Design of Evaluation Methods.
- Creation and assignment of Formulas & Equations.
- Equation System Solver Engine.
- Updatable Contents.
- Report generation, User Progression Monitoring and Statistics.

- ESL-SOF. EDIBON Student Labsoft (Student Software).

ESL-SOF is the application addressed to the Students that helps them to understand theoretical concepts by means of practical exercises and to prove their knowledge and progression by performing tests and calculations in addition to Multimedia Resources. Default planned tasks and an Open workgroup are provided by EDIBON to allow the students start working from the first session. Reports and statistics are available to know their progression at any time, as well as explanations for every exercise to reinforce the theoretically acquired technical knowledge.

Innovative features:

- Student Log-In & Self-Registration.
- Existing Tasks checking & Monitoring.
- Default contents & scheduled tasks available to be used from the first session.
- Practical Exercises accomplishment by following the Manual provided by EDIBON.
- Evaluation Methods to prove your knowledge and progression.
- Test self-correction.
- Calculations computing and plotting.
- Equation System Solver Engine.
- User Monitoring Learning & Printable Reports.
- Multimedia-Supported auxiliary resources.

### b) Multipost Expansions options

#### ⑧ **MINI ESN. EDIBON Mini Scada-Net System for being used with EDIBON Teaching Units.**

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- Instructor can see in the computer what any user/student is doing in the unit.
- Continuous communication between the instructor and all the users/students connected.

Main advantages:

- It allows an easier and quicker understanding.
- This system allows you can save time and cost.
- Future expansions with more EDIBON Units.

The system basically will consist of:

This system is used with a Computer Controlled Unit.

- Instructor's computer.
- Students' computers.
- Local Network.
- Unit-Control Interface adaptation.
- Unit Software adaptation.
- Webcam.
- MINI ESN Software to control the whole system.
- Cables and accessories required for a normal operation.

\* Specifications subject to change without previous notice, due to the convenience of improvement of the product.



C/ Julio Cervera, 10-12-14. Móstoles Tecnológico.  
28935 MÓSTOLES. (Madrid). ESPAÑA - SPAIN.  
Tel.: 34-91-6199363 Fax: 34-91-6198647

E-mail: [edibon@edibon.com](mailto:edibon@edibon.com) Web: [www.edibon.com](http://www.edibon.com)

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