Technical Solutions

Practical Power & Energy Training Resources for Industry and Education Product Catalogue 2020

Practical Power & Energy Training Resources for Industry and Education

Contents of this catalogue:

The TSI Approach

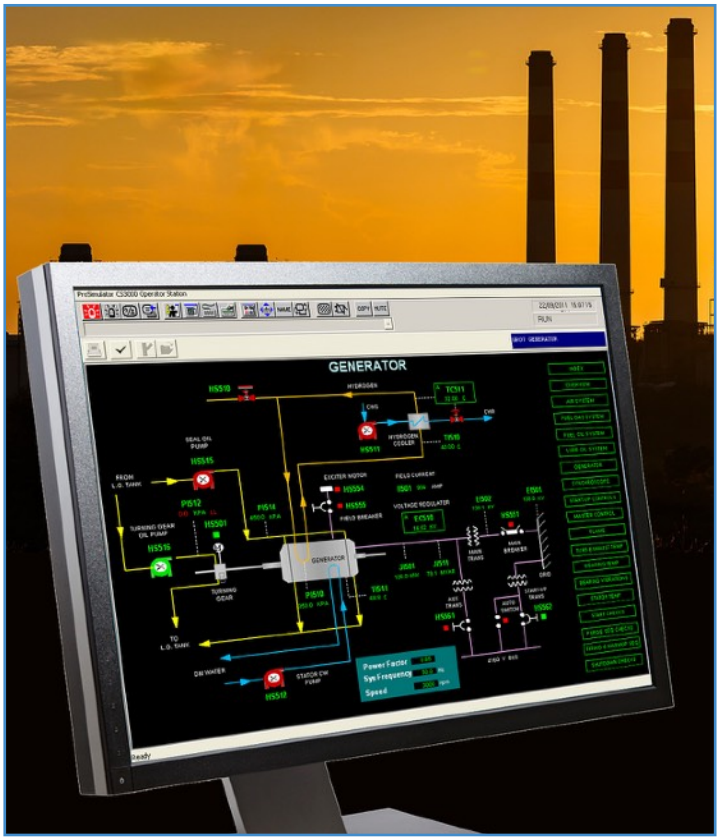
From the experience Technical Solutions International has gained over many years of working in the Power and Energy training sector, we know the importance of good, relevant and up to date training for engineers and technicians.

We are unique in being able to offer a comprehensive range of ready-made practical training solutions, as well as the professional staff development that will be required to support their use.

One of the key components of the range of TSI's solutions is the inclusion of real world or real life training in the form of OJT rigs and workshops (On The Job Training) and high fidelity Operator Training Simulations.

These can be used to deliver a wide range of technical courses matched to Internationally recognised vocational qualifications, as well as industrial certification courses such as AP (Authorised Person HV).

Our approach allows competent trainees to experience the use of professional tools and test equipment in a safe but realistic workplace environment. This enhances their skills and allows them to apply the theoretical knowledge that they have gained in an engaging and motivating environment.



Training Facilities Design Service

To support our clients in the Power Sector we offer a complete turnkey training facilities design service.

This includes:

- Initial consultation and planning with the client
- Advice on space planning based on our experience of providing
- complete practical labs and workshops
- Training needs analysis and job skills alignment
- Production of training program matrices
- Curriculum and qualifications alignment
- Design and production of eLearning and paper-based training materials where required
- Design and production of Operator Training Simulator Systems and Power Dispatcher Training Simulators
- Design of OJT workshops
- Design and specification of laboratories and workshop including the production of detailed overlay drawings
- Design and implementation of temporary training facilities using modular buildings
- Production of complete equipment lists for all classrooms, laboratories and practical workshops based on the requirements of the curricula and qualifications
- Production of implementation plans and timelines
- Production of tender ready specifications
- Design of instructor training programmes
- Supply of equipment to site
- Installation and commissioning using our trained engineers
- Delivery of a complete instructor and administrator training programme
- Supply of warranty support and local technical support for an agreed time period of up to 10 years

Designed for Training - Built for Realism

TSI offer a comprehensive range of training hardware and software that has been specifically designed for practical training for technicians and engineers. Emphasis is placed on industrial relevance and workplace realism.

As a result, we are unique in being able to offer complete training solutions that will meet your specific skills requirements be it in the area of generation, transmission, distribution or end user consumption.

Our hardware and curriculum designers ensure that the resources we produce meet both current and future training needs in the power industry and in related sectors such as oil and gas.

The competency-based materials they produce enable instructors to deliver focused training that meets real industry needs and allows trainees to quickly gain the valuable workplace skills they will need in the future.

Many of our training packages can be used to re-skill and up-skill an organisation's existing workforce.

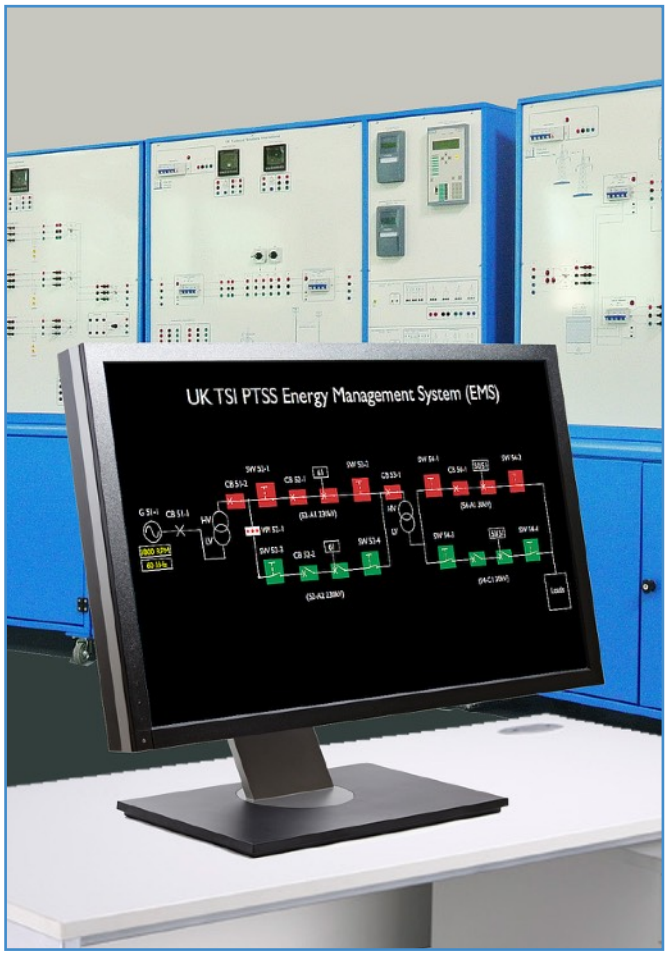
The TSI Product Range

Our resources can be used by:

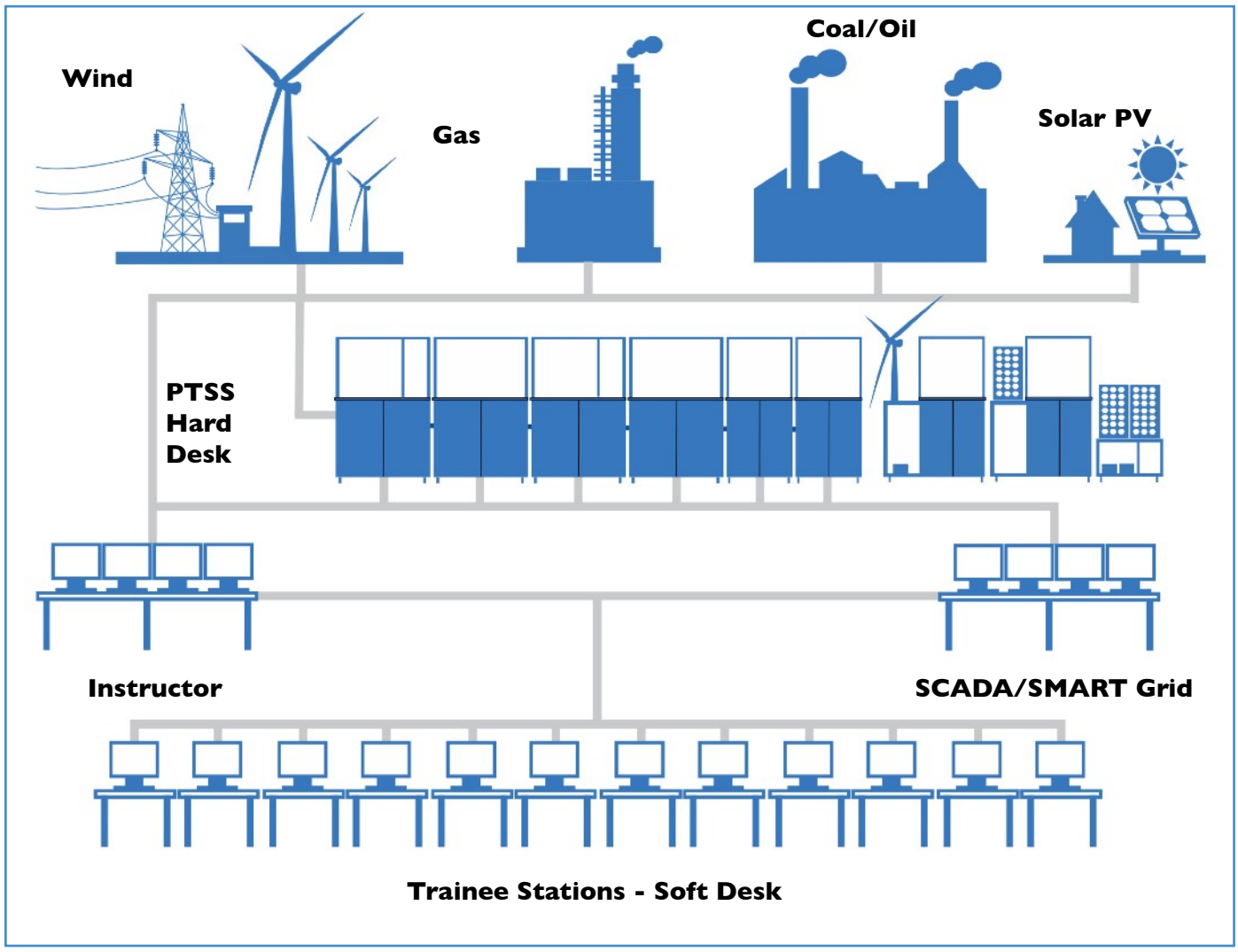
- **Vocational Training Schools**
- **Universities**
- **Power Utilities Technical Training Schools**
- **National Power Training Centres**
- **Military Training Schools**

We include professional test equipment and a large range of real power equipment where required as part of our standard labs and workshops. This allows you to deliver professional certification courses in addition to a wide range of practical courses that can meet international standards.

In this catalogue, our solutions are presented in the form of ready-made Labs and Workshops. Any of the items can be



Power Training Systems Simulator Lab



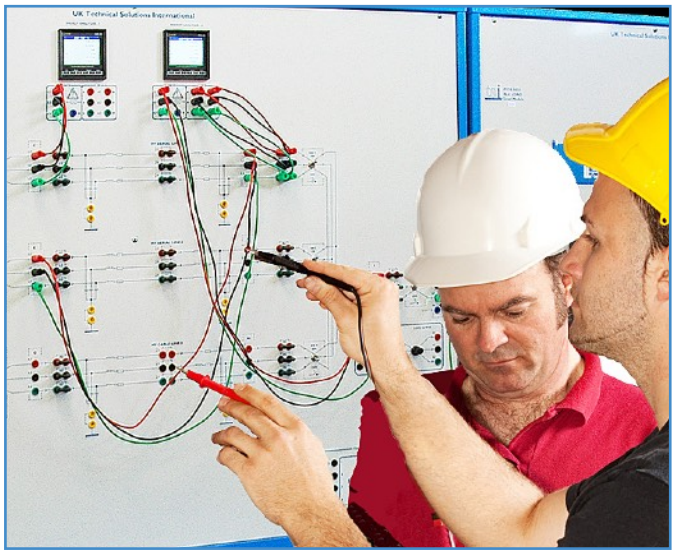
The TSI Power Training Systems Simulator (Generation and Distribution) is unique in its field. It is the only training package specifically designed to provide a completely integrated system that includes hard-desk and soft-desk power systems simulators, together with a SCADA Control System, SMART Grid System and an Instructor's Control Station.

All the elements are intended for practical hands-on training for operators, engineers and technicians. Many different levels of training can be carried out on the full system or on independent units if required.

This includes AP (Authorised Person) training and our unique Power Dispatchers Training Simulator.

By linking the Instructor Station with the SCADA System used with the hard-desk simulator this valuable facility enables the instructor to run a large number of different faulted and non-faulted operating scenarios.

Many of the faults that can be induced will guide the trainees on how to use professional test equipment such as automatic relay testers, high voltage test meters and hand-held system analysers.



TSI-PTSS 5010 Power Generation Module

This unit simulates a power plant with a substation and high-voltage line output. It includes different resistors/ reactors that can be used to simulate synchronous machines with different power outputs.

It also includes a programmable multifunction differential relay that can be used to protect both the generator and the transformer. A distance protection relay is also included to protect the HV output line.

The module is equipped with two digital multifunction 3-phase instruments for measuring voltage, current, active power, reactive power and harmonics.

The unit has four sections:

Section 1 - Static 50/60 Hz generator (this simulates an infinite power grid).

Section 2 - Rotating generator group

Section 3 - Generator control panel

Section 4 - Protection Relays

Section 1 - Static 50Hz or 60Hz generator

This simulates an infinite power grid where power generation is represented by a 3-phase variable autotransformer and a fixed 3-phase transformer. The transformer can be connected in delta/star and vice versa. A number of different taps are available to simulate different HV voltages. It has a rated power of 2kVA and an output voltage range of 0-230V/0-400V

Section 2 - Rotating generator group

This incorporates a synchronous machine that is mechanically coupled to an AC 3-phase motor. An electronic variable motor drive connected to the AC motor allows for changes in the speed and torque of the synchronous machine.

A DC excitation control allows for changes in the voltage and reactive power of the synchronous machine.

It has the following characteristics:

Rated power: 1kVA, Output voltage: 0-240V/0-420V, Field voltage: 200V, Nominal speed: 3600 RPM.

Section 3 – Generator control panel

The output from the generator can be connected to the power plant step-up transformer. This has an apparent power of 1,000 VA.

The primary voltage for DELTA connection is 150 V, for STAR connection it is 260 V. The secondary voltages for DELTA connection are 69 -127 V, for STAR connection they are 120 - 220 V.

This section provides two selectable modes of synchronisation operation:

Manual

This allows the manual selection of parallel synchronisation between the output of the rotating synchronous machine and the infinite power grid using voltmeters, zero-voltmeter and a synchroscope

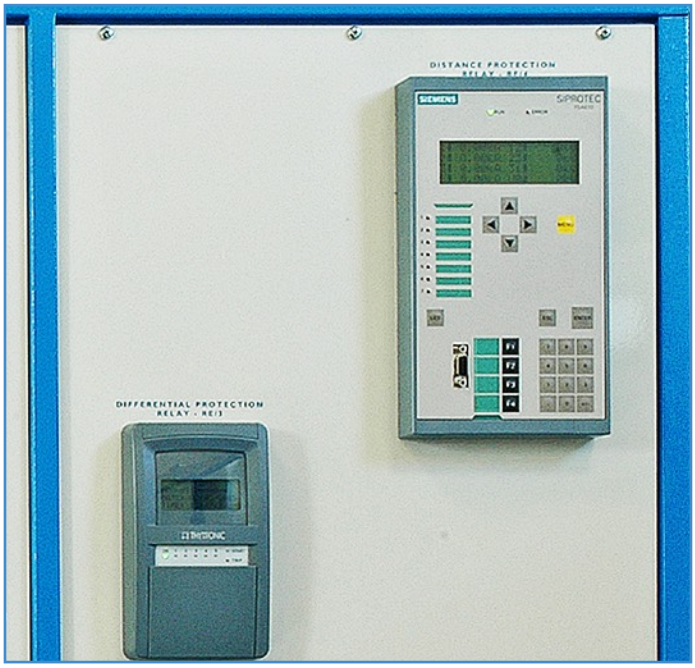
Automatic

This mode is designed to automatically adjust the speed, voltage and phase shifting of the rotating generator in order to automatically manage the synchronisation and paralleling between the generator and the mains supply.

The adjustment of the parameters of the PID control loops can be done experimentally by the trainee. After successful parallel synchronisation it is possible to share the load between the mains and the synchronous generator.

An outgoing bus system is used to connect the power generation module to the HV and or MV transmission line modules.

Section 4 - Protection Relays



A series of different protection relays are installed on the power generation module. These include:

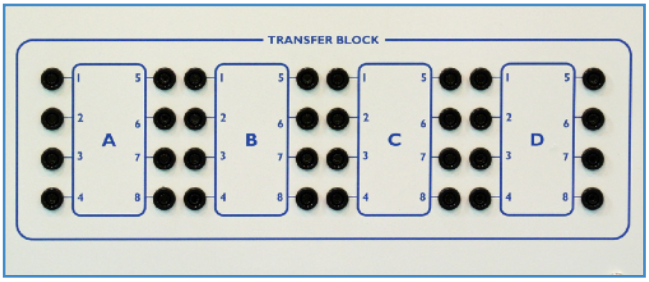
1 x Multifunction differential relay (87).
This protection relay provides the differential protection for the electrical machines (generators, motors and transformers) against internal faults.
It also provides the following additional protections:

- Undercurrent (37)
- Reverse-phase or phase-balance 46)
- Machine or transformer thermal relay (49)
- Instantaneous over-current relay (50)
- AC time over-current relay (51)
- Trip circuit supervision (74CT)

1 x Non-switched distance protection relay with 6 measuring systems (21/21N)
This provides:

- High resistance ground-fault protection for single and three-pole tripping (50N, 51N, 67N)
- Ground-fault detection in isolated and resonant-grounded networks
- Tele (pilot) protection (85)
- Fault locator (FL)
- Power-swing detection/tripping (68/68T)
- Phase over-current protection (50/51/67)
- Switch-onto-fault protection (50HS)
- STUB bus over-current protection (50STUB)
- Over-voltage/under-voltage protection (59/27)
- Over/under-frequency protection (81O/U)
- Auto-reclosure (79)
- Synchro-check (25)
- Breaker failure protection (50BF)
- Thermal overload protection (49)

This relay is suitable for selective protection of the outgoing HV lines.



A unique system of Transfer Blocks is also included on the unit to allow simple electrical connections with equipment located on the other modules.

The PTSS 5010 can be connected to any of the other modules in the system. It provides the power for a wide range of experiments in generation and transmission/ distribution.

TSI-PTSS 5015 Additional Power Generation Module

This unit has been specifically designed to extend the capability of the power training systems simulator. It provides an additional power generation plant that includes a step-up transformer and an HV output busbar system.

The workstation incorporates a machine mounting bed where different DC and AC motors can be connected to a fixed 3-Phase Generator.

An Automatic circuit breaker main switch provides overall power to the module. It also includes an emergency stop button that will remove all mains power to the module when pressed. All circuit interconnections can be made using 4mm safety leads and sockets.

The outputs from the electronic variable motor drive can be connected to the AC drive motor to allow for changes in the speed and torque of the fixed synchronous machine (Generator). This is a fully programmable control and it can be used with a range of AC motors.

The unit is supplied as standard with the following specification AC Motor:

- V = 220/380V
- F = 60Hz
- Nominal maximum speed: 3,600 RPM approx.
- Rated power: P = 1.5 KW
- I = 7/4 A approx.

A separate variable DC excitation control is provided to allow for changes in the voltage and reactive power of the 3-Phase Generator.

The generator has the following characteristics:

- Rated power: P = 1KW
- Nominal maximum speed: 3.600 RPM
- Vin = 220/380V
- f = 60 Hz when functioning as motor
- Vout = 220/380V
- f = 60 Hz when functioning as generator
- Iout = 2.8/1.6 A approx.

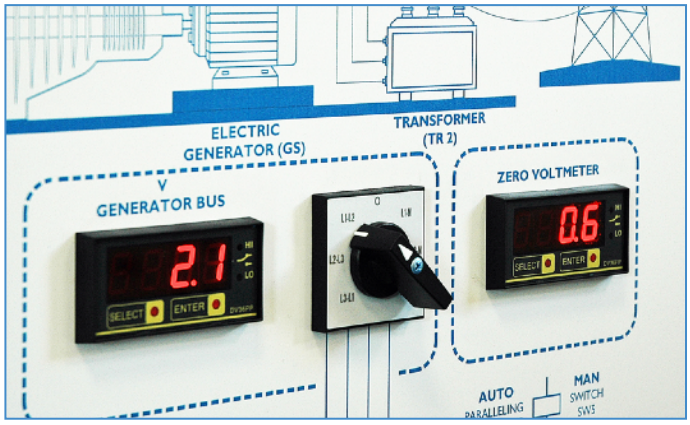
The output from the generator can be connected to a step-up transformer. This has an apparent power of 1,000 VA. The primary voltage for DELTA connection is 150 V, for STAR connection it is 260 V. The secondary voltages for DELTA connection are 69 -127 V, for STAR connection they are 120 - 220 V.

The additional generator unit has two types of parallel synchronisation: Manual and Automatic.

Manual

This will allow manual selection of parallel synchronisation between the output of the 3-phase generator and the power training systems simulator systems infinite power grid using a voltmeter, zero-voltmeter and a synchroscope.

This consists of three lamps that make up a synchroscope. The lamps flash with a frequency of a few Hz (the difference between the frequency of the network and that of the generator). When the lamps go dark it gives a positive indication that the generator is synchronised with the mains.

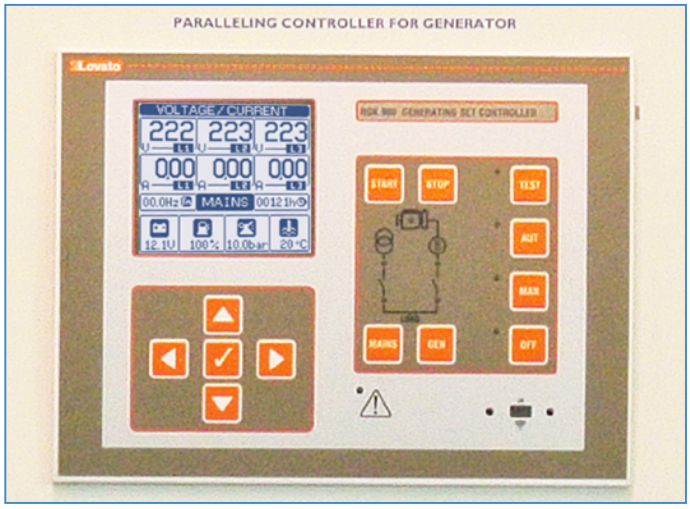


The voltmeter Zero Voltmeter also displays the voltage reading across the lamps and confirms the synchronised voltages before the user attempts manual closing of the paralleling switch. This system has a circuit that will automatically lock in and protect the synchronous generator.

Automatic

This mode is designed to automatically adjust the speed, voltage and phase shifting of the rotating generator in order to carryout automatic management of synchronisation and paralleling between the generator and the mains supply.

The user can make adjustment to the parameters of the controller's PID control loops, using the control panel interface.



After successful parallel synchronisation it will be possible to share the load between the mains and the synchronous generator.

An outgoing HV bus system is used to connect the additional power generation simulator module to the other simulator units. The unit has two circuit breakers, one for the protection of the medium-voltage windings of the transformer and one for the protection of the high-voltage windings of the transformer.

The module is equipped with two digital multifunction 3-phase instruments for measuring voltage, current,

TSI-PTSS 5015/MCL100 Add-on Pack for Electrical Machines

This optional package provides a series of additional motors and the associated curriculum materials that enable the PTSS 5015 to be used for the study of electrical machines and transformers. Motors have special connection boxes where all the required terminations are made available on 4mm safety sockets. A circuit mimic indicates the connections. Motors include:

- TSI-MCL/110 Shunt/Compound DC Machine
- TSI-MCL/120 Single phase AC Motor
- TSI-MCL/130 3 Phase AC Squirrel Cage Motor
- TSI-MCL/140 3 Phase AC Synchronous Machine
- TSI-MCL/150 3 Phase Slip Ring Asynchronous Machine

TSI-PTSS 5020 HV Transmission Lines Module

This unit includes two HV aerial lines that can be connected in series or parallel and an HV cable line.

The simulated lines include:
2 x Aerial line rated voltage 230 kV - Length 70 km - with automatic protection circuit breaker and manual isolator switch for connection in parallel or series with other lines on the module. The parameters of the simulated overhead power lines (length 70 km)are:

- R_l [Ω] = 0.226
- L_s [mH] = 70.7
- C_s [µF] = 0.66

1 x Cable line rated voltage 230 kV - Length 70 km - with automatic protection circuit breaker and manual isolator switch for connection in parallel or series with other lines on the module. The parameters of the simulated cable power line (length 70 km)) are:

- R_l [Ω] = 8.84
- L_s [mH] = 42.78
- C_s [µF] = 9.8

To enable fully independent "Stand-Alone" operation, the module has its own integrated 3-phase with neutral power supply that can provide 120 kV - 380 kV simulated voltages.

It also includes an integrated Power Factor Correction block that provides three 4.4 uF capacitors. With appropriate connections they can be inserted in star or delta to create different values and types of power factor correction of the load and the lines.

An integrated load of 160 VA that simulates a power equivalent to 16 MVA is also included.

The module is equipped with two digital multifunction 3-phase instruments for measuring voltage, current, active power, reactive power, power factor and

It also includes a separate 24 V a.c. output for feeding the auxiliary release circuits of the built-in circuit protection breakers on the lines.

Built-in facilities enable the creation of a range of faults located at different points in the system and of the following types:

- **Three-phase short circuit**
- **Two phase short circuit (with series arc resistance)**
- **Phase to earth fault (also with series arc resistance)**
- **Missing phase**

The Module can simulate the load flow between the HV lines using a PST (Phase Shifting Transformer) that is built into the PTSS 5030 Substation Module.

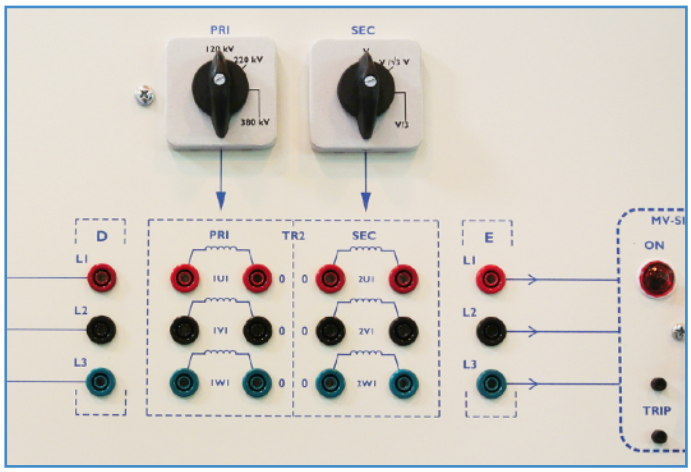
A unique system of Transfer Blocks is also included on the unit to allow simple electrical connections with equipment located on the other modules.

Special multi-pin connectors are provided on the rear panel of each module to enable quick and easy connection.

TSI-PTSS 5030 Substation Module

This module simulates a bus system with circuit breakers that allows connection between the high voltage lines and the medium voltage distribution network.

It comprises a substation transformer and a medium voltage output bus system.



The substation step-down transformer has three output voltages (V, V/1.73,V/3). This allows the user to investigate different voltage distribution systems. Two switches are used to select the voltages available on the primary and secondary windings.

The transformer has primary voltages (for Delta connection) of 120 - 220 - 380V and secondary voltages (for Star connection) of 69 - 127 - 220V.

It comprises three 1-phase 100VA power transformers. This solution allows you to simulate both 1-phase and 3-phase transformers.

The substation module is equipped with two digital multifunction 3-phase instruments for measuring voltage, current, active power, reactive power, power factor and harmonics. These units have both numerical and graphical display facilities.

It also includes a PST (Phase Shifting Transformer) for load flow problem simulation. This is based on a transformer with an angular displacement.

Circuit Protection Breakers

The Sub Station also includes two Automatic Circuit Breakers (Trips).

Protection Relays

A series of different protection relays are installed on the Substation Module. These include:

1 x Multifunction differential relay (87).

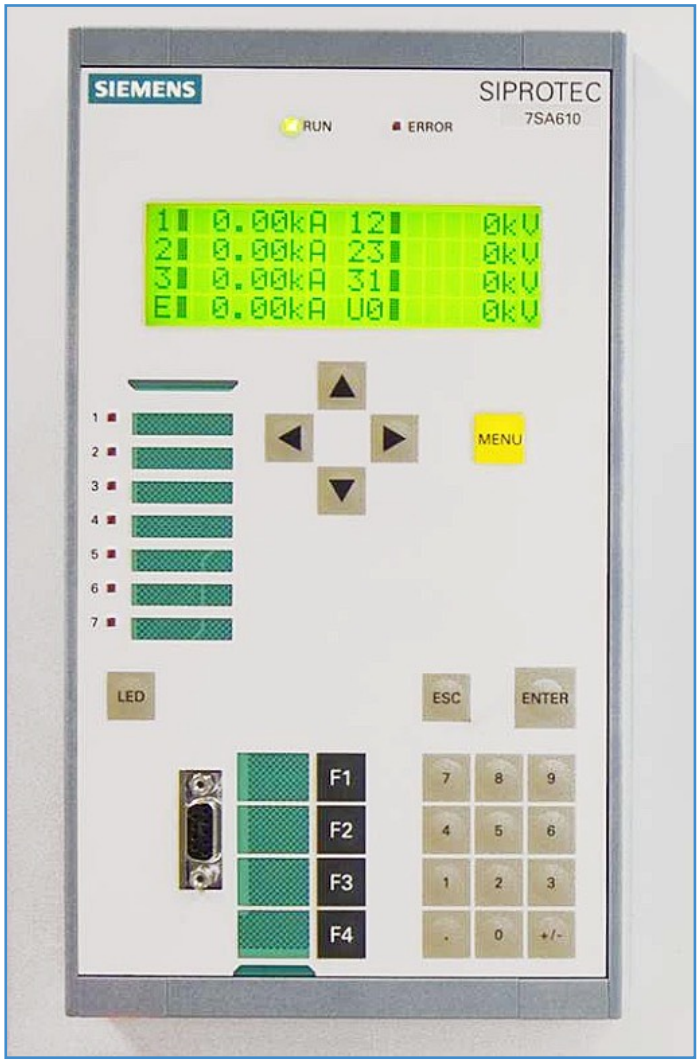
This protection relay provides differential protection for electrical machines (generators, motors and transformers) against internal faults. It also provides the following additional protections:

- Undercurrent (37)
- Reverse-phase or phase-balance (46)
- Machine or transformer thermal relay (49)
- Instantaneous over-current (50)
- AC time over-current relay (51)
- Trip Circuit Supervision (74)

1 x Multifunction current relay.

This provides the following protections:

- Max current (50/51)
- Max residual current (50N/51N)
- Monitoring of open circuit of the switch (74TCS)
- Setting the differential protection for substation transformer



1 x Non-switched distance protection relay with 6 measuring systems (21/21N).

This provides:

- High resistance ground-fault protection for single and three-pole tripping (50N, 51N, 67N)
- Ground-fault detection in isolated and resonant-grounded networks
- Tele (pilot) protection (85)
- Fault locator (FL)
- Power-swing detection/tripping (68/68T)
- Phase over-current protection (50/51/67)
- Switch-onto-fault protection (50HS)
- STUB bus over-current protection (50STUB)
- Over-voltage/under voltage protection (59/27)
- Over/under frequency protection (81O/U)
- Auto-reclosure (79)
- Synchro-check (25)
- Breaker failure protection (50BF)
- Thermal overload protection (49)

This relay also includes:

Distance Protection Zones.
All the distance protection zones can be set to forward, reverse or non- directional. Different curves and delays are programmable in order to allow selectivity in current and in time. All programming operations, modification, measurement display, are possible directly from the front panel or by using a personal computer with the included software connected to the relay.

Fault Locator
The integrated fault locator calculates the fault impedance and the distance-to-fault. The results are displayed in ohms/kilometres (miles) and in a percentage of the line length. Parallel line compensation and load current compensation for high resistance faults are also available.

A 24 V a.c. output for feeding the auxiliary release circuits of the line protection circuit breakers is also provided on the unit. The voltage is supplied by a 50 VA transformer that allows a maximum current draw of 2 A from the 2 mm safety sockets. The output is protected by a 2.5 A fuse.

A unique system of Transfer Blocks is also included on the unit to allow simple electrical connections with equipment located on the other modules.

TSI-PTSS 5035 Substation Busbar Systems Simulator

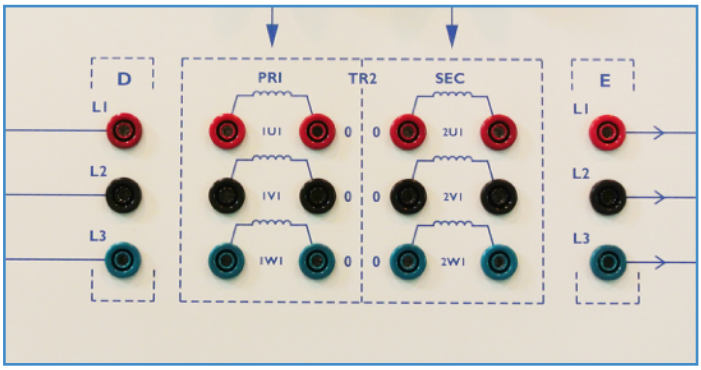
This unit has been specifically designed to extend the capability of the TSI PTSS System.

It provides a second substation module that includes a modular busbar system that allows the user to configure a range of commonly used substation bus bar systems.

The unit includes all the following elements:

- HV Busbar A (Sectionalised)
- HV Busbar B (Transfer Bus)
- 6 x HV Bus Side Manual Isolator Switches
- 4 x Circuit Breakers
- 6 x Manual Isolator Switches for Circuit Breakers
- 2 Stepdown Transformers

Both transformers have primary voltages (for Delta connection) of 120 - 220 - 380V and secondary voltages (for Star connection) of 69 - 127 - 220V.



They comprise three 1-phase 100 VA power transformers. This solution allows you to simulate both 1-phase and 3-phase transformers.

The use of 4mm safety interconnections allow the transformers to be connected in a variety of configurations.

The module is equipped with two digital multifunction 3-phase instruments for measuring voltage, current, active power, reactive power, power factor and harmonics. These units have both numerical and graphical display facilities.

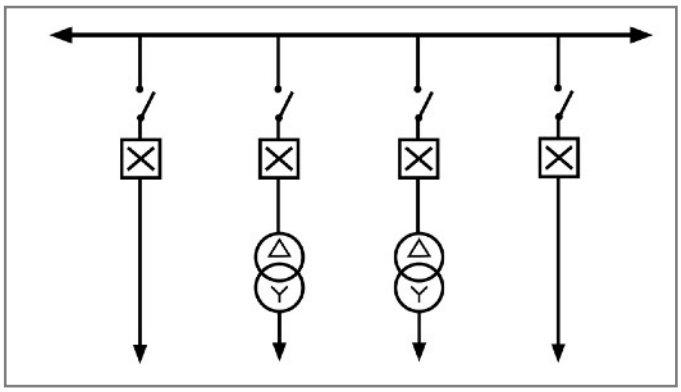
The unit has its own integral 3-phase power supply (120V, 220, 380V). This allows the unit to be used standalone or with other modules from the PTSS range such as the Power Plant Module and the HV Transmission lines module.

A protection relay is also installed on the Substation Module to protect the transformers and lines. This is a Multifunction differential relay (87).

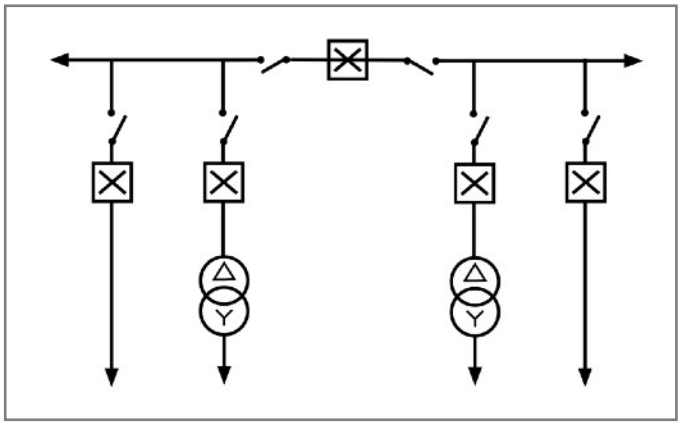
This relay provides differential protection for electrical machines (generators, motors and transformers) against internal faults. It also provides the following additional protections:

- Undercurrent (37)
- Reverse-phase or phase-balance (46)
- Machine or transformer thermal relay (49)
- Instantaneous over-current (50)
- AC time over-current relay (51)
- Trip Circuit Supervision (74)

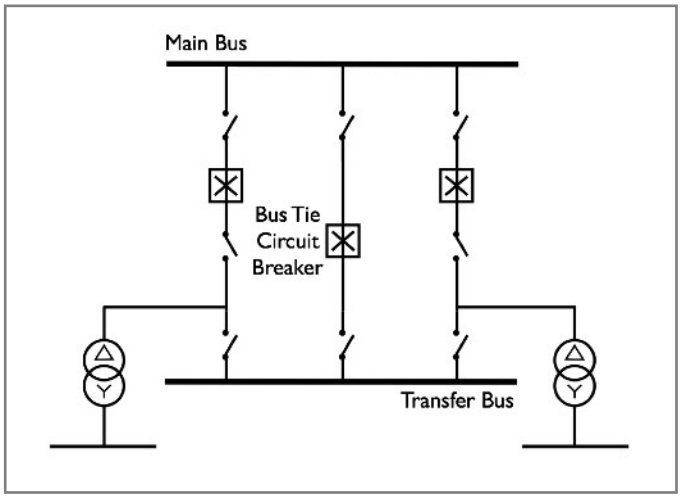
Typical bus configurations that can be built on the simulator:



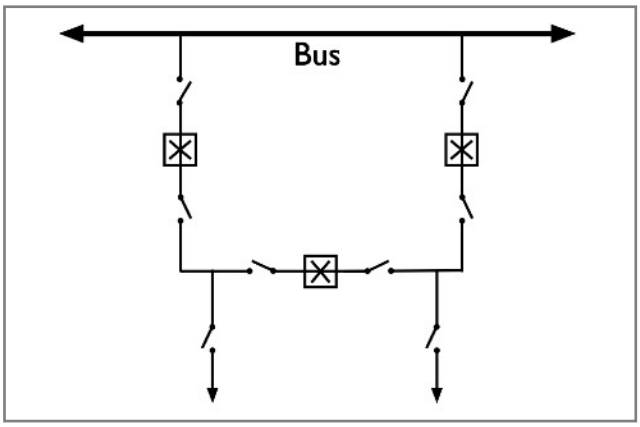
Single busbar



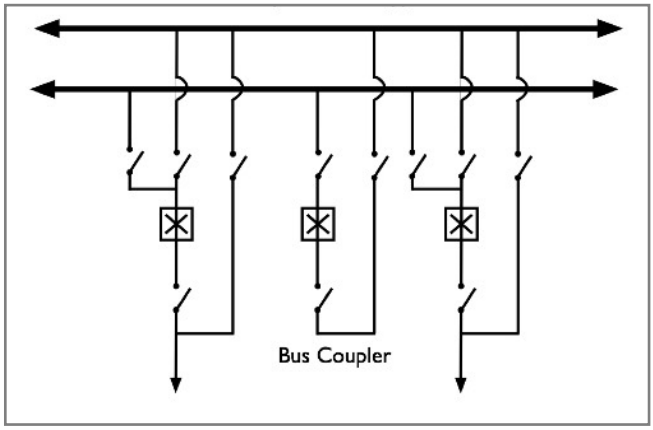
Single busbar with sectionaliser



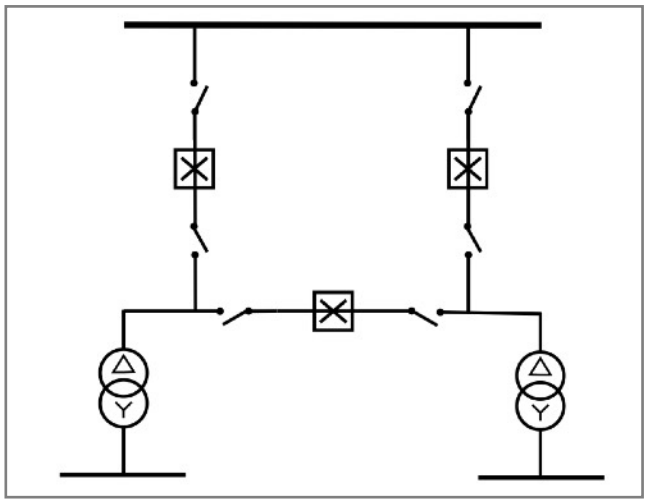
Main busbar with transfer bus



One and a half breaker busbar system



Double bus system with by-pass isolators



Double bus system with by-pass isolators

TSI-PTSS 5040 MV Distribution Lines Module

This module provides one simulated MV Aerial Line and a simulated MV Cable Line. It can be used to simulate the load flow between the MV lines using a PST (Phase Shifting Transformer) that is built into the Substation Simulator Module.

The 30 kV overhead line has a length of 30 km. The parameters of the simulated line over a 30 km length are:

- Rl [Ω] = 5.76
- Ls [mH] = 33
- Cs [µF] – 0.33

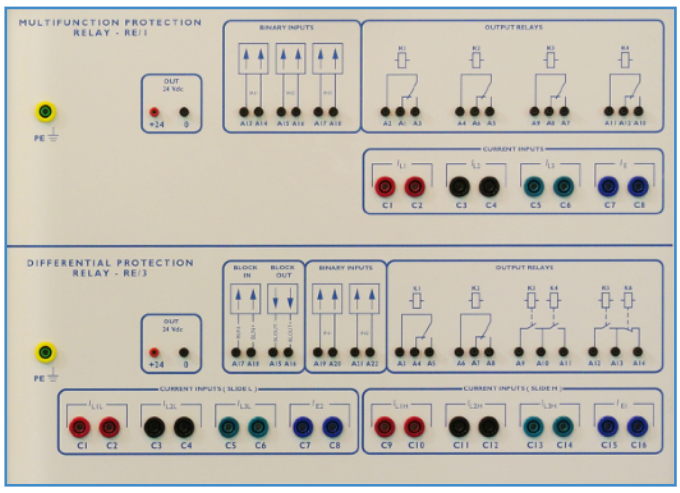
The 30 kV underground cable line also has a length of 30 km. The parameters of the simulated line in cable over a 30 km length are:

- Rl [Ω] = 4.95
- Ls [mH] = 0.351
- Cs [µF] = 6.6

The lines are protected using on-board Circuit Breakers CB1 and CB2. Circuit Breaker CB1 protects the aerial line 1. The line has been designed for the rated current of 1 A.

Circuit Breaker CB2 protects the cable line 1. The line has been designed for the rated current of 1 A.

In addition, the protective relays located on the PTSS 5010 Power Plant Module and on the PTSS 5030 Substation Module can also be used.

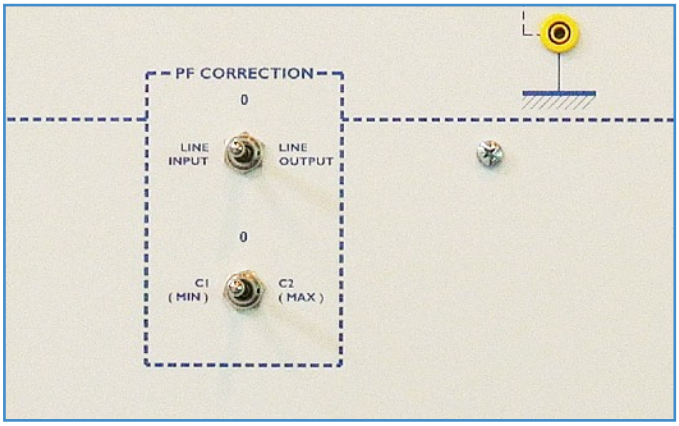


The lines are protected using on-board Circuit Breakers CB1 and CB2. Circuit Breaker CB1 protects the aerial line 1. The line has been designed for the rated current of 1 A. Circuit Breaker CB2 protects the cable line 1. The line has been designed for the rated current of 1 A.

Built-in facilities enable the creation of a range of faults located at different points in the system and of the following types:

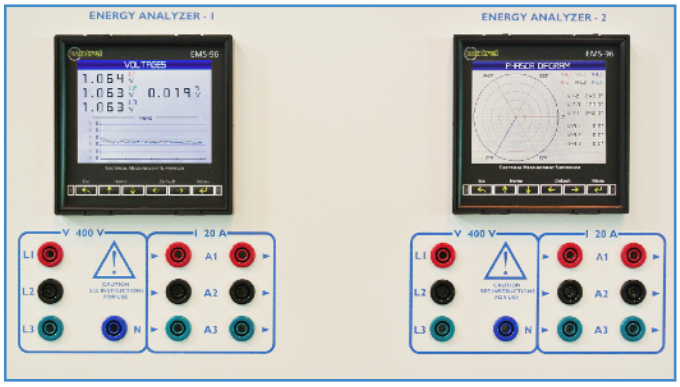
- **Three-phase short circuit**
- **Two phase short circuit (with series arc resistance)**
- **Phase to earth fault (also with series arc resistance)**
- **Missing phase**

The unit features an integral power supply which comprises a differential thermal breaker main switch and a power ON indicator lamp. It provides stand-alone 3-phase power to the module with a line



voltage output of 380 V on 4 mm safety sockets.

An on-board Power Factor Correction Module is also included. This has two switches for the insertion of the PF correction capacitor banks on the overhead line.

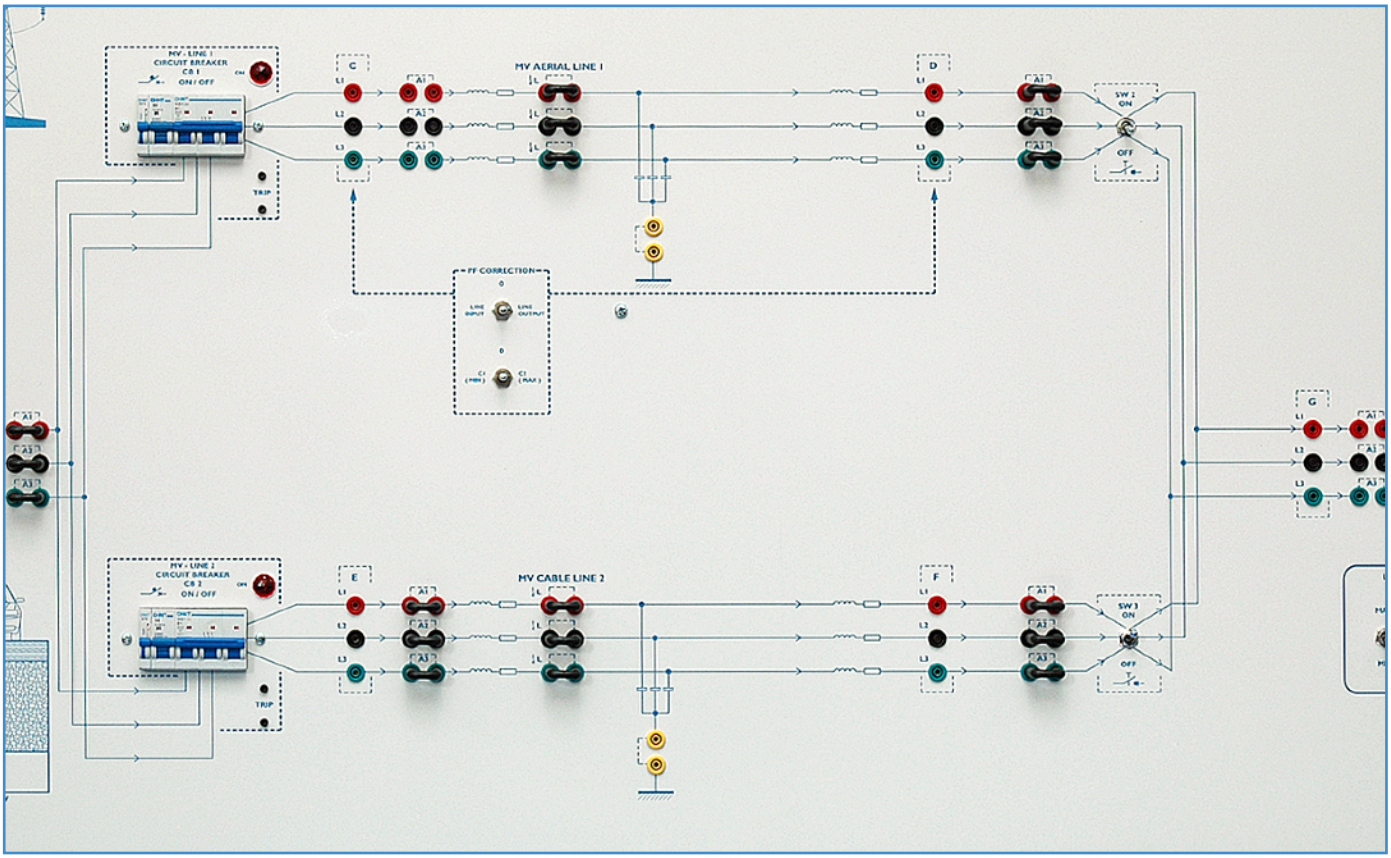


The module is equipped with two digital multifunction 3-phase instruments for measuring voltage, current, active power, reactive power, power factor and harmonics.

These units have both numerical and graphical display facilities.

A 24 V a.c. output for feeding the auxiliary release circuits of the line protection circuit breakers is also provided on the unit. The voltage is supplied by a 50 VA transformer that allows a maximum current draw of 2 A from the 2 mm safety sockets. The output is protected by a 2.5 A fuse.

A unique system of Transfer Blocks is also included on the unit to allow simple electrical connections with equipment located on the other modules.



TSI-PTSS 5050 RLC Load Module

This module provides a load that can be adjusted in 4 separate steps for each phase and for resistive/ inductive/capacitive loads.

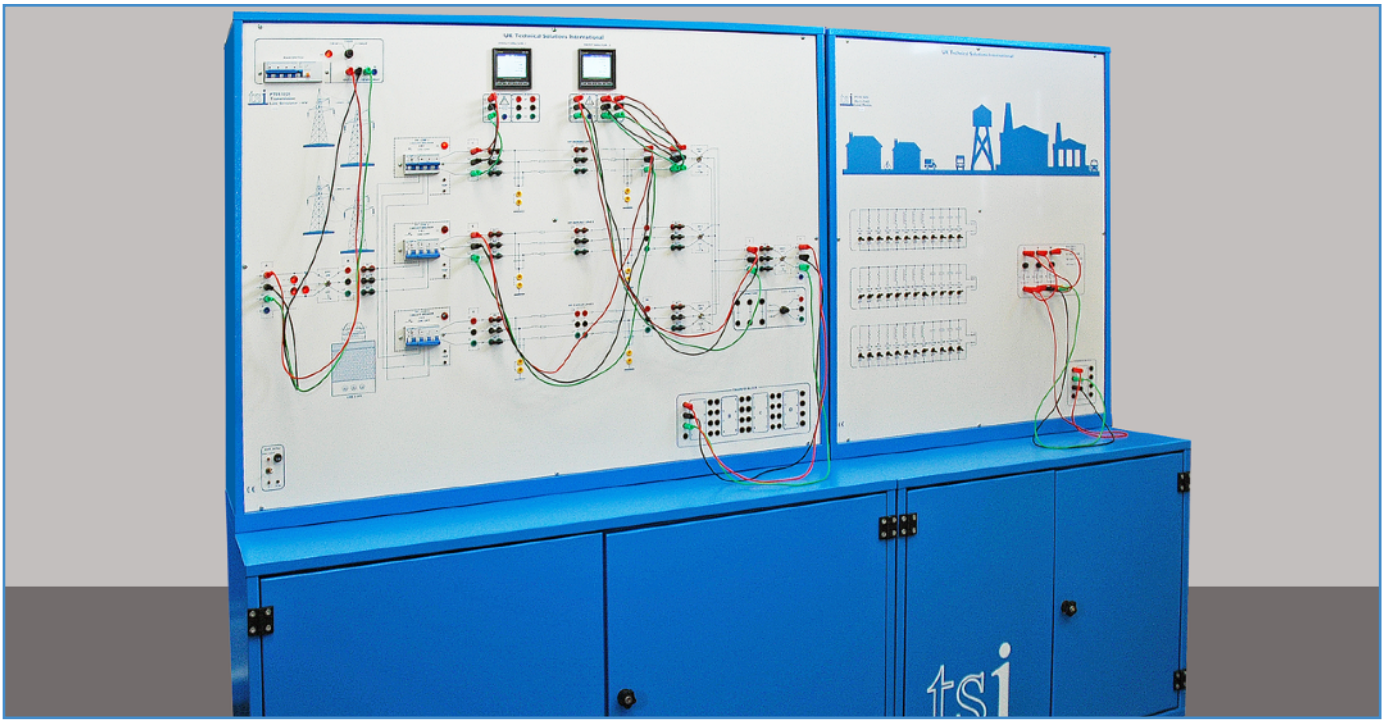
The load can be used in star or delta connection and it can be connected to:

- **The Power Generation Module**
- **Additional Power Generation Module**
- **The Substation Module**
- **The Substation Busbar Systems Module**
- **The Wind Power Generator Module**
- **The Solar PV Generator Module**
- **At the end of the HV transmission lines**
- **At the end of the MV distribution lines**

This module meets the following specification:

- Total active power: 1 kW in 4 steps (100-200-200-500 W).
- Total reactive power (inductive): 1 Kvar in 4 steps (100-200-200-500 var).
- Total reactive power (capacitive): 1 Kvar in 4 steps (100-200-200-500 var).

A Transfer Block is also included on the unit to allow simple electrical connections with equipment located on the other modules.



The PTSS 5050 RCL Load Module is seen here connected to the PTSS 5020 HV Transmission Line Module via the Transfer Blocks. Using the on-board 3-phase power supply of the PTSS 5020 this creates a stand-alone training station.

TSI-PTSS 5060 Power Factor Correction Module

This module has been designed to allow the user to assemble automatic power correction circuits with different capacitive steps managed by an electronic power factor control unit.

The module is equipped with two digital multifunction 3-phase instruments for measuring voltage, current, active power, reactive power, power factor and harmonics. These units have both numerical and graphical display facilities and can be used for both single and three-phase measurements.

It is intended for use with the PTSS System and can be used in combination with various units for a wide range of practical experiments.

The panel includes an automatic microprocessor power factor controller with a rated voltage of 380 - 415 V – 50/60 Hz. It has an ammeter current input with a forward current of up to 5 A (sensitivity range 0, 125 - 6 A).

The power factor range is: 0.8 inductive - 0.8 capacitive, with reconnection times of between 5s and 240s. It has a sensitivity range of 5s to 600s/step.

Connections are via 5 relay outputs with contacts rated at 5 A – 250 Vac. The setting parameters can be accessed manually from the display-assisted keyboard.

The panel also includes:

- 1 x four-pole rotary switch of operation - 16 A - 400 V
- 1 x noise suppression filter for three-phase line with neutral conductors - Vn 440 V; In 10 A; inductance of 0.4mH, current-carrying capacity of 0.1 µF
- 3 x three-pole contactors for power factor correction – Ith (AC1) 25A (7.5 kvar at 400 V) with transient limiting devices at the connection, excitation - 24 Vac at 50/60 Hz
- 1 x 1-phase transformer with a primary winding of 230 - 400 V and a secondary winding of 24 V. It has a power output of power of 72 VA
- 1 x bank of 3-phase capacitors of 450 V~ switchable between 2 and 4 µF with linked discharging resistors of 100 kΩ - 5 W
- 1 x bank of 3-phase capacitors of 450 V~ switchable between 4 and 8 µF with linked discharging resistors of 50 kΩ - 10 W
- 1 x bank of 3-phase capacitors of 450 V~ switchable between 8 and 16 µF with linked discharging resistors of 50 kΩ - 10 W

All the banks of capacitors can be connected in 1-phase or 3-phase star-delta configuration. This allows the user to assemble automatic power factor correction systems with up to 3 equal steps (4+4+4 µF), up to 3 unequal steps (one double the value of the other, i.e. 2, 4, 8 µF, or of 4, 8, 16 µF). Connecting the additional banks in parallel will allow for further combinations.

The power factor controller can also be connected to a PC using the supplied cable and software. This will enable the setting and simultaneous display of all the system measurements:

- Current power factor
- Set power factor
- Weekly average power factor
- Voltage
- Current,
- Reactive power of the system

This provides a complete picture of the power factor correction system. In addition, the elapsed time and the number of tripping operations generated by the settings of the system are indicated for each step. This provides preliminary service information for the contactors in the system.

TSI-PTSS 5070 Wind Turbine Module

This module represents the typical configuration of a wind power generator, used to convert the wind's kinetic energy directly into mechanical energy and then use that energy to generate electricity.

Typical Experiments include:

- Study of wind energy
- Calculation of the average power developed by the wind at a specific geographic location
- The wind power generator - typical structure, installation and orientation
- The "Brushless" generator
- Study of the voltage regulator and its performance in relation to variations in wind speed and energy conversion
- Storing energy
- Typical applications
- Charging batteries
- Parallel synchronisation of AC power output with a mains network

The PTSS 5070 includes a wind power generator mounted on a trolley with an interface and control panel.

Wind Turbine specification:

- Output: 400 W
- Startup Wind Speed 3,6 m/s
- Rotor Diameter 1.17 m
- Voltage 24V
- Turbine Controller Microprocessor-based Smart System
- Internal regulator
- Cast aluminium body
- Injection-moulded composite blades
- Permanent magnet alternator
- Load regulator

Simulation Mode (Indoor use)

A motor with a speed regulator and an adapter is installed in place of the turbine blades for generator operation in a windless environment.

This system, enables the user to power the wind turbine with its blades removed indoors and investigate its operation over a range of simulated

It is then possible to determine the power output of the turbine with the control panel instruments. The system is supplied with an inverter for speed control of the motor.

Two 12-volt batteries are used for storage of electricity and for experiments relating to battery charging.

The control panel has a large LCD display to monitor the system and 2 digital power analysers. It also includes a load regulator, digital ammeter, digital voltmeter, battery charge controller and an inverter for three-phase grid connection

The wind power module can be interconnected with other units from the Power Training Systems Simulator range such as the PTSS 5010 Power Plant Module.

This allows the user to experiment with the parallel connection of the 3-phase and 1-phase output from the wind power system and the mains grid.

TSI-PTSS 5080 Solar PV Power System Module

This is a modular system that provides a practical way to explore the technology of photovoltaic panels (PV) and the methods used to generate and store power and then export the power via parallel synchronisation with the mains. (Feed in tariff operation).

The system provides two 12V 100W PV panels (total 200W) mounted on a mobile tilt stand to adjust the lighting angle and allow the user to explore the conditions of maximum efficiency of the panel in relation to the incident angle of the suns rays. It is possible to practically explore series and parallel connections of the two panels.

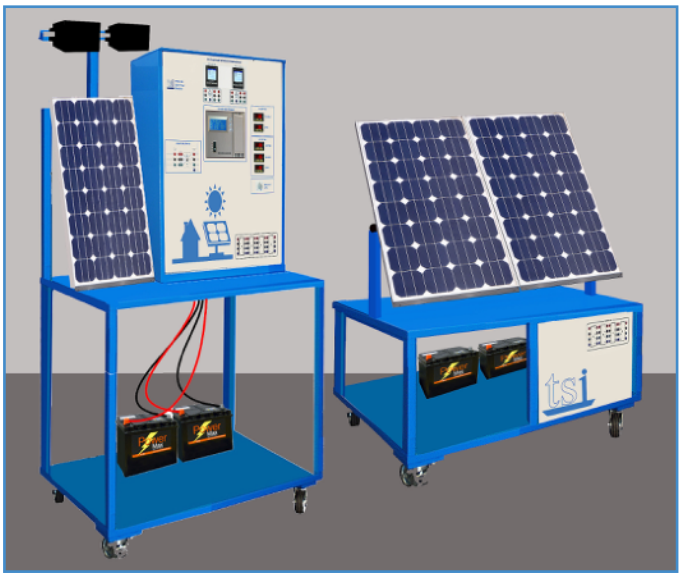
The unit can be easily located outside the lab for use in direct sunlight. A special PV Panel connection cable is provided for this use.

Typical Experiments include:

- Calculation of the average power developed by the sun in a particular location,
- Characteristics of the photovoltaic cells,
- Energy balance,
- Performance of the system
- Series and parallel connections of photovoltaic panels
- Conversion and distribution
- Energy storage
- Analysis of the use of energy system and measuring the voltage and current
- Battery charging
- Parallel synchronisation of AC power output with a mains network

A control panel is included on a separate trolley, this also has a single 12V 100W fixed position PV panel with an integrated sun lamp light source.

This allows for indoor experiments and instructor demonstrations. A clear screen printed legend provides circuit details and device identification for all the control and monitoring elements.



These include:

- 1 x Load regulator for solar panels
- 3 x Digital ammeter connected to the battery and load
- 1 x Digital voltmeter connected to the load
- 1 x Digital voltmeter connected on solar panels
- 2 x Batteries with charger and charge controller
- 1 x Solarimeter
- 1 x Inverter for 3-phase grid connection

Simulation Mode (Indoor use)

A single fixed position PV panel with an integrated sun lamp light source is located on the control module. Using a variable light level control it is possible to determine the varying power output of the PV panel with the control panel instruments.

The control panel has a large LCD display to monitor the system and two digital power analysers. The system can be connected wirelessly to a wi-fi router to enable remote operation via Ethernet from a PC or tablet.

The simulator can be interconnected with other units from the Power Training Systems Simulator range such as the PTSS 5010 Power Plant Module and the PTSS 5070 Wind Turbine Module

This allows the user to experiment with the parallel connection of the 3-phase and 1-phase output from the solar PV power system and the mains grid.

TSI-PTSS 50100-SG SCADA Software System and SMART Grid

The SCADA software system is used to monitor and control the power training system simulator. It is based on a commercial SCADA Design Package and includes one master authoring licence.

It gathers information on the different operating parameters and transfers the information back to a central computer. It will alert the home station when problems occur, carrying out necessary analysis and control, such as determining if the problem is critical, and displaying the information on the animated mimic screens.

The SCADA station is supplied as a complete integrated system based around a 120-degree desk with a Windows PC and four flat-screen LED monitors. The workstation is height adjustable and is supplied complete with a high-back operators chair.

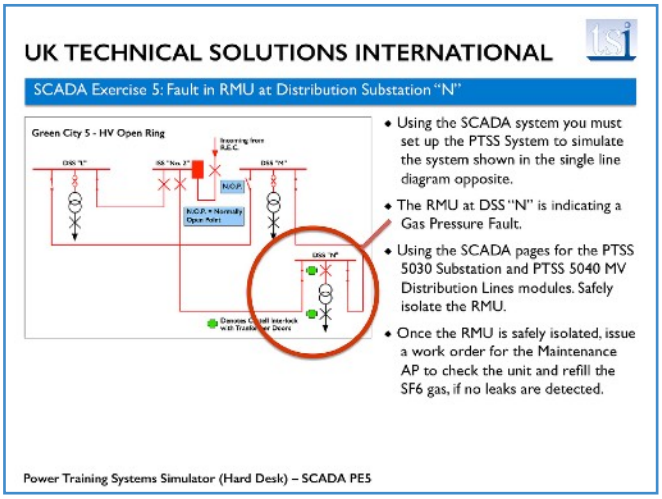
The SCADA system is connected to the master control PLC via a wireless an Ethernet connection. The master PLC uses a MODBUS network to interconnect the various simulator units as well as to all the digital measuring instruments and protective relays.

A number of remote stations can be set up around the simulator, giving a number individual trainees the opportunity to control and monitor the system.

A complete series of pre-configured training scenarios are supplied with the SCADA system. These present the trainee with different scenarios that involve the use of single line electrical diagrams that represent different power system configurations. These are constructed using the different power systems simulator modules.

Each scenario will provide a multi-level SCADA control system from the single-line SCADA overview screen to a series of drill-down screens for individual instruments and controls.

Learning materials lead the trainee through each of the SCADA exercises which are designed to provide realistic SCADA operator skills in system control.



Smart Grid Application

The Smart Grid application is powered by the SCADA system and uses the MODBUS data communication network that is controlled by the master PLC system. It takes information from the various digital multifunction meters in the system to perform smart grid operational functions.

A Smart Grid provides "intelligent distribution" of electricity. By installing Smart Meters at points of consumption we can measure on-time power demand and change the available supply accordingly.

The system can detect any potential overload of energy and excess energy can be redistributed to other areas that need it, based on the actual requests from end users.

The PTSS Smart Grid Application allows the system to be configured as follows:

Simulated Power Generation Sources:

- Traditional Energy Source – Carbon (Gas, Oil or Coal) (PTSS 5010. PTSS 5015)
- Renewable – Wind (PTSS 5070)
- Renewable – Solar PV (PTSS 5080)

Transmission and Substation

- HV Transmission (PTSS 5020)
- Sub Station (PTSS 5030, PTSS 5035)
- MV Distribution (PTSS 5040)

Loads

- Domestic and Industrial Loads (PTSS 5050)

Smart Grid Controller

- PTSS 50100-SG SCADA Control System - Smart Grid

The PTSS modules are equipped with multifunction Energy Management Meters that can operate as SMART Meters.

TSI-PTSS 50500 Instructor's Work Station

This Instructor's Work Station is specifically designed for use with the TSI Power Training Systems Simulator (Hard-Desk).

It can be used with the complete system, including the SCADA Control Station, or with individual modules if required. It can also be used with our Soft-Desk Power Station Simulator.

It provides the instructor with a comprehensive range of facilities including a video recording and playback system that can be used to record the trainee's physical responses to various faulted (Fixed and transient) and non-faulted operating scenarios such as plant start-up and shutdown and normal running.

The 1200mm x 1200mm, 120 degree workstation, is height adjustable and includes a powerful Windows PC with four LED flat screen monitors, wireless keyboard and mouse. A high-back operator's chair is also included.

The PC is pre-loaded with all the required software and this enables the instructor to configure various faults in the PTSS system.

The complete station is located within a special screened area that prevents the instructor's actions being seen by the trainees.

The screens incorporate eye-level, one-way tinted viewing panels that allow the instructor to observe the whole work area for the full PTSS system.

A series of fault scenarios can be set up using the Instructor station software, these include both HV and MV transmission line faults and load flow problems.

- PST (Phase Shifting Transformer) controlled load flow problem simulation
- HV Transmission Faults:
  - Three-phase short circuit
  - Two phase short circuit (also with series arc resistance)
  - Phase to earth fault (also with series arc resistance)
  - Missing phase
- MV Transmission Faults
  - Three-phase short circuit
  - Two phase short circuit (also with series arc resistance)
  - Phase to earth fault (also with series arc resistance)
  - Missing phase

TSI Power Plant Operator Training Simulators

The range of TSI Power Plant Simulators provide PC-based hi-fidelity, full-scope dynamic Operator Training Simulators that meet the operator training requirements of any coal/oil or gas fired power plant.

Each model is designed to operate over a variety of actual power plant operating conditions.

These include:

- **Cold start (no fuel, no utilities, pumps off, controllers in manual, etc.)**
- **Design Start (normal operating conditions)**
- **Restart from Trip Conditions**
- **Normal and Emergency Shut-downs**

The simulators can be connected to the TSI Hard-desk System and the instructor and the trainees can control the power system from the soft-desk.

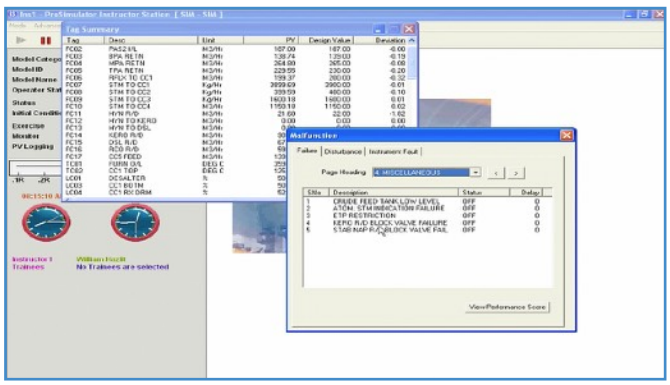
Instructor Station

The Instructor Station enables the instructor to control and direct the training sessions. They can assign multiple independent training sessions to one or more of the networked operator stations.

The graphics interface and easy to use menus allow the Instructor to work efficiently, even with a large group

Facilities include:

- Start up mode selection - Normal and Design Start
- Speed - Normal up to 10x normal operating speed
- History - Back-track or Snapshot
- Malfunction - Failure or Disturbance
- Tag summary
- Summary report
- PV logging
- Trend logging
- Realtime trend logging
- Monitor exercise
- Performance report
- Message to operator
- Full plant report



Operator Station

The Operator Station provides all the functionality of the associated DCS and the connected plant.

Under the direction of the Instructor Station, a series of operating scenarios are presented to the trainee and they have to respond accordingly.

These include both faulted and non-faulted conditions.

Our system provides emulation for several standard DCS (Distributed Control System) interfaces including:

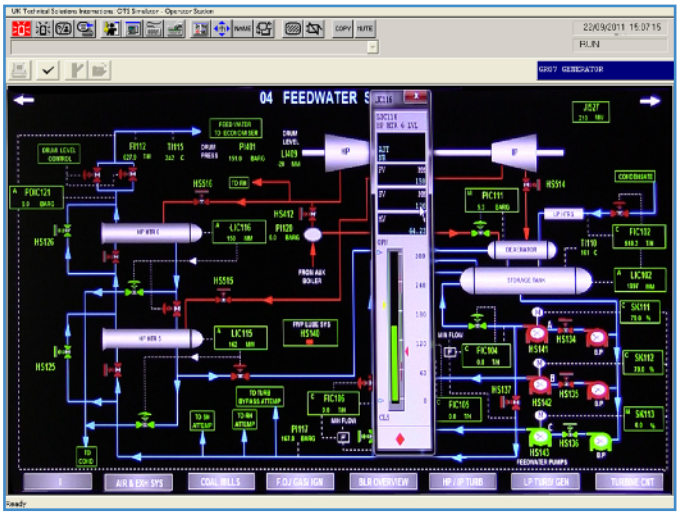
- **Yokogawa Centum CS3000/ VP**
- **Honeywell TDC3000/ Experion**
- **Fox I/A**
- **Siemens PCS7**
- **Delta V**
- **ABB Harmony**

All the functions and features that are essential for training are included. Using this system operators learn dynamic process interactions as well as the specific control and monitoring procedures for the plant.

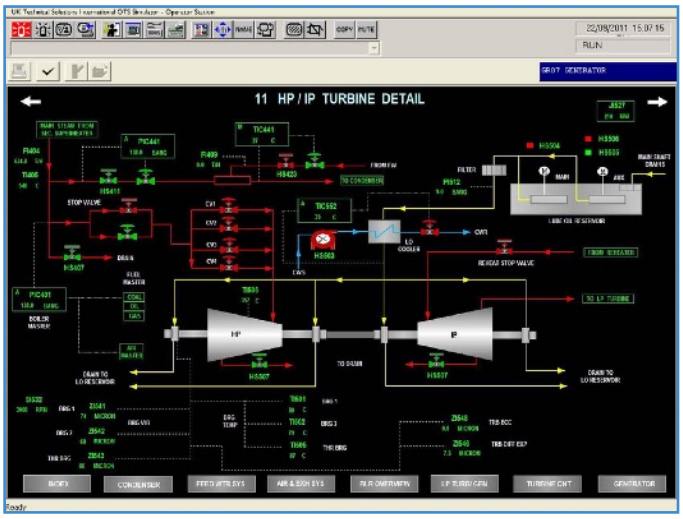
Using a PC keyboard or simulated keyboard (on-screen keyboard) or an optional emulated DCS keyboard, the trainee can operate the simulated plant across its full

The simulated windows for the emulated DCS that are provided to operate the simulator are:

- **Overview Window**
- **Control Group Window**
- **Tuning Window**
- **Graphic Window**
- **Trend Window**
- **Process Alarm Summary Window**



TSI-PTSS 50200 Power Systems Simulation Software – Thermal Power Plant 210 MW



Capacity: 210 MW

Fuels
- Coal
- Heavy Oil (warm-up)
- Light Oil (ignition)

Steam Generator
- Drum type
- Natural Circulation

Furnace Air and Gas Systems
- 2 Forced Draft Fans
- 2 Induced Draft Fans
- 4 Primary Air fans (1 for each Pulveriser)
- 1 Igniter Fan & 1 Scanner Fan
- Windbox
- 1 Regenerative Air Heater
- Soot blowers
- Electro-static precipitator

Fuel and Burner Systems
- 4 Coal Feeders
- 4 Pulverisers
- 2 Ignition Oil pumps
- 2 Fuel Oil Pumps
- Coal and Oil Burners at 4 Levels

Boiler Water and Steam Systems
- Economiser
- Steam Drum
- Downcomer
- Waterwalls
- Primary Superheater
- Secondary Superheater
- Reheater
- Attemperators for Superheater
- Auxiliary Steam Header

Turbine and Generator Systems
- HP/IP/LP Turbines
- Main Stop Valve with Bypass
- 4 Turbine Control Valves
- Turbine Turning Gear
- 2 Turbine Lube Oil Pumps
- Turbine Lube Oil Cooling Water Pump
- Bearing vibration monitors
- Generator with Exciter and AVR
- Synchroscope
- Hydrogen Cooler
- Hydrogen Seal Oil Pump
- Stator Cooling water Pump

Condensate and Feedwater System Equipment
- Condenser
- 2 Air Ejectors
- 2 Circulating Water Pumps
- 2 Condensate Extraction Pumps
- Condensate Storage Tank
- 1 Makeup Pump
- Air Ejector Steam Condenser
- Gland Seal Steam Condenser with Exhaust Fan
- Condensate Scrubber
- 3 Low Pressure Heaters
- De-aerator with Storage Tank
- 2 High Pressure Heaters
- 3 Boiler Feed Pumps (motor driven)

Instrumentation
- 43 Controllers
- 17 Auto-Manual Control Stations
- 17 Manual Stations
- 127 Indicators
- 131 Switches
- 80 Explicit Alarms
- Trips and Alarm Logic / Interlocks.

Instructor Functions
- Pump trips
- Fan trips
- Turbine trip
- Generator trip
- Fuel trip
- Valve malfunctions
- Instrument malfunctions
- Air temperature
- Cooling water temperature
- Low grade fuel

TSI-PTSS 50210 Power Systems Simulation Software – Gas Turbine Power Plant 42 MW

Capacity: 42 MW

Fuels

- Natural Gas
- Fuel Oil

Equipment

- **Air System:**
- Air intake louvre
- Air filter,
- Compressor for pulsation cleaning of air filter
- Anti-icing air heater
- Multi-Stage axial compressor with variable inlet guide vanes

Fuel Gas System:

- ESD Valve, Knock-out drum
- Steam heater
- 2 Coalescing filters
- Vent valves and Control valves for ignition and main fuel

Fuel Oil System:

- Fuel Oil Tank
- 2 Fuel Oil Pumps
- Steam Heater

Combustion Chamber:

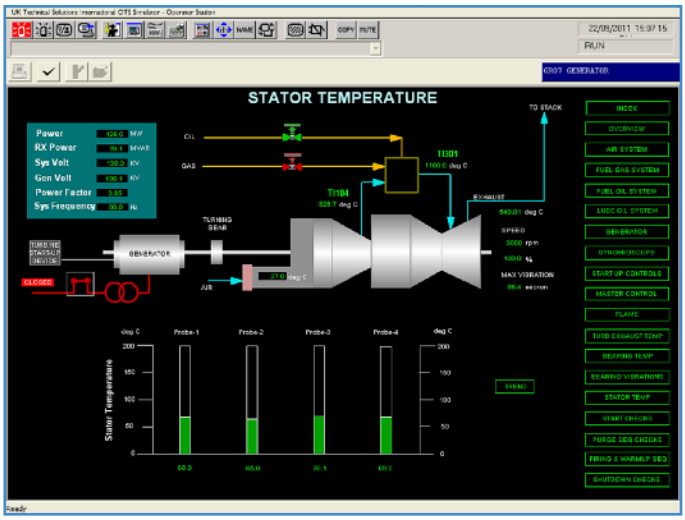
- Main Burners
- Ignition Burners
- Flame Monitors
- Vibration Monitors

Turbine and Generator:

- Multi-Stage Gas Turbine
- Bearing vibration monitors, Rotor displacement and phase angle monitors
- Turbine blades wash system
- Generator with Exciter and Automatic Voltage Regulator
- Synchroscope
- Static start-up device
- Main Transformer
- Voltage Regulator Transformer
- Air circulation fans and Water Coolers for air

Auxiliary Systems:

- Lube oil reservoir
- Electrical Heater
- Oil reservoir exhaust fan
- 2 Main lube oil pumps
- Emergency lube oil pump



- Lube oil cooler
- 2 Lube oil filters
- 2 Power oil pumps
- 1 Power oil filter
- 1 Jacking oil pump
- 1 Rotor barring pump
- 2 Oil pressure accumulators System
- Acceleration Control
- Manual Suppression of the Fuel Reference
- Speed Control
- Temperature Control
- Start-up Control
- Shut-down Control
- Operating Limit

Graphics

- Index
- Compressor, Gas Turbine-Generator Overview
- Air Intake System & Compressor
- Fuel Gas and Ignition Systems
- Fuel Oil System
- Gas Turbine and Generator
- Gas Turbine Lube Oil and Power Oil System
- Gas Turbine and Generator in various start-up & control modes

Instructor Functions

- Air temperature/Humidity
- Grid Frequency
- Pump trips
- Compressor trip
- Turbine trip
- Generator trip
- Fuel trip
- Tube Leaks
- Valve malfunctions
- Instrument malfunctions
- False alarms

TSI-PTSS 50220 Power Systems Simulation Software – Combined Cycle Gas Turbine Power Plant 450 MW

Capacity: 450 MW

Fuels

- Natural Gas
- Fuel Oil

Equipment

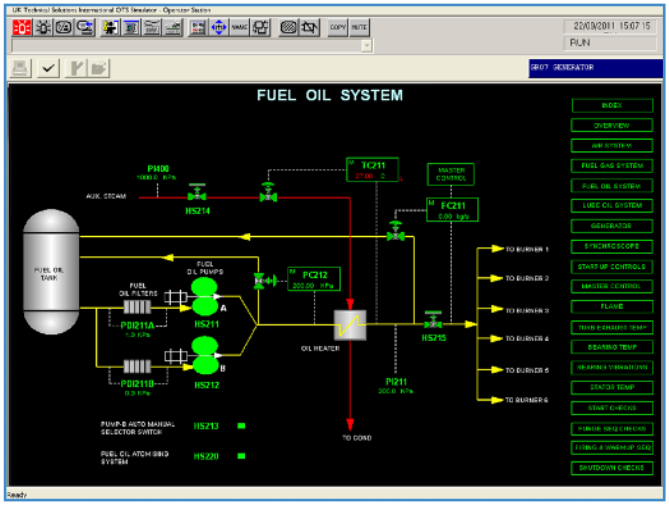
- Circulating water pump
- Gland steam condenser
- Feed water
- Condenser circulating water
- Make up water
- Air Compressor
- Evaporator
- Heat Recovery Steam Generator (HRSG)
- Steam Combustion Heat exchanger
- Burner
- Filter Fuel (Gas, oil)
- De-aerator
- Turbine
- Generator
- DC excitation Transformer

The simulated plant has the following features:

- Two Gas Turbines
- Two HRSG's with Supplementary firing
- One steam turbine
- Condenser
- Typical condensate and feed water systems
- Typical generation and power transmitting systems
- Typical HMI control system.
- Typical utility, auxiliary and ancillary systems for all the above-mentioned systems.

Control System:

- Load control
- Combustion control
- Steam air heater temperature control
- Feed water flow and drum level control
- Differential pressure control of feed water and economiser
- Steam temperature control
- HPT bypass control
  LPT bypass control
- Condenser hotwell level control
- Condenser pumps recirculation control
- Condenser flow and de-aerator level



- Feed water pumps and recirculation control
- Feed water heater level control
- Turbine glad steam pressure control
- Compressor control
- Flue gas temperature control
- Filter control
- Turbine exhaust hood temperature control
- Turbine lube oil temperature control
- Generator temperature control
- Evaporation rate control
- WHRU control

Alternative Energy OTS

In addition to traditional carbon fired power plants, we are also able to offer a range of alternative energy power plant simulators on request.

These include:

- Wind Power
- Solar PV Power
- Hydro Power
- Nuclear Power

TSI-PTSS 50230 Power Systems Simulation Software – Thermal Power Plant 600 MW

Capacity: 600 MW

Fuels
- Coal
- Heavy Oil (warm-up)
- Light Oil (ignition)

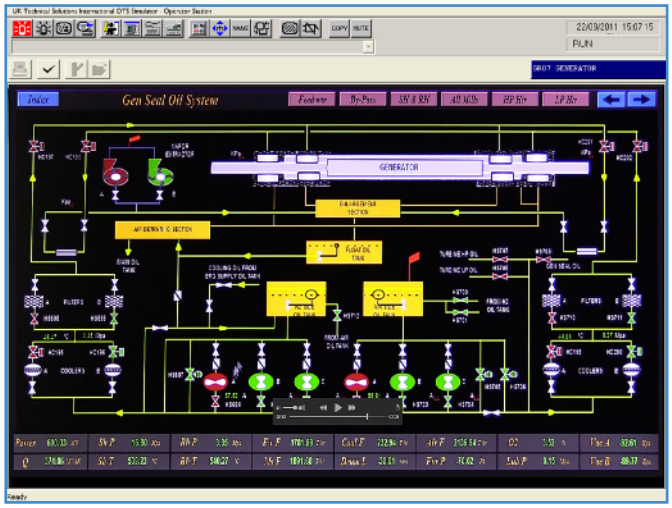
Steam Generator
- Drum type
- Natural Circulation

Furnace Air and Gas Systems
- Forced Draft Fans
- Induced Draft Fans
- Primary Air fans (1 for each Pulveriser)
- Igniter Fan & 1 Scanner Fan
- Windbox
- Regenerative Air Heater
- Soot blowers
- Electro-static precipitator

Fuel and Burner Systems
- 6 Coal Feeders
- 6 Pulverisers
- Ignition Oil pumps
- Fuel Oil Pumps
- Coal and Oil Burners at 4 Levels

Boiler Water and Steam Systems
- Economiser
- Steam Drum
- Downcomer
- Waterwalls
- Primary Superheater
- Secondary Superheater
- Reheater
- Attemperators for Superheater
- Auxiliary Steam Header

Turbine and Generator Systems
- HP/IP/LP Turbines
- Main Stop Valve with Bypass
- Turbine Control Valves
- Turbine Turning Gear
- Turbine Lube Oil Pumps
- Turbine Lube Oil Cooler
- Turbine Lube Oil Cooling Water Pump
- Bearing vibration monitors
- Rotor eccentricity monitor
- Generator with Exciter and AVR
- Synchroscope



- Hydrogen Cooler
- Hydrogen Seal Oil Pump
- Stator Cooling water Pump

Condensate and Feedwater System Equipment
- Condenser
- Air Ejectors
- Circulating Water Pumps
- Condensate Extraction Pumps
- Condensate Storage Tank
- Makeup Pump
- Air Ejector Steam Condenser
- Gland Seal Steam Condenser with Exhaust Fan
- Condensate Scrubber
- Low Pressure Heaters
- De-aerator with Storage Tank
- High Pressure Heaters
- Boiler Feed Pumps (motor driven)

Instrumentation
- Controllers
- Auto-Manual Control Stations
- Manual Stations
- Indicators
- Switches
- Explicit Alarms
- Trips and Alarm Logic / Interlocks.

Instructor Functions
- Pump trips
- Fan trips
- Turbine trip
- Generator trip
- Fuel trip
- Valve malfunctions
- Instrument malfunctions
- Air temperature
- Cooling water temperature

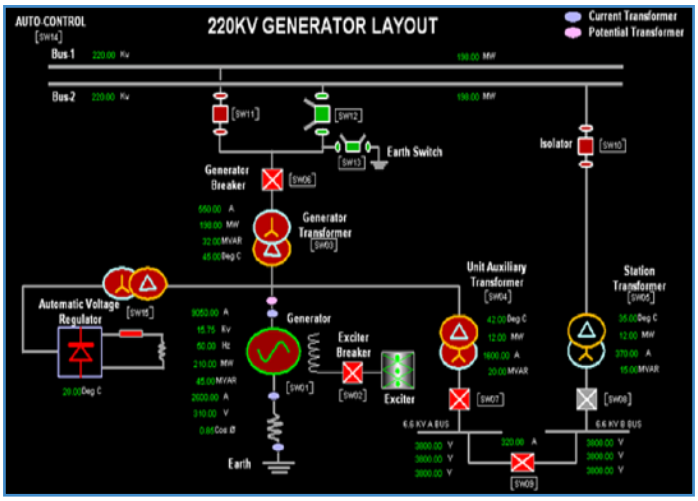
TSI-PTSS 50800 Electrical Operations Simulator Suite

This suite of simulators has been put together to offer a basic introduction to the typical electrical operations found in a power plant. We only focus on the main electrical elements:

- Generator
- Generator Cooling Water System
- 6.6kV System
- 220kV Switch Yard

Each individual simulator is fully functional and makes an ideal front of class teaching resource for the Instructor.

220 kV Generator



A machine, that converts mechanical energy into electrical energy, using the electromagnetic induction principle, is known as an AC generator. When the rated speed of 3,000rpm is achieved by the prime mover, which is coupled with the generator rotor shaft, DC voltage is injected into the rotating field device via slip rings and brushes. This creates a flux field and a corresponding AC voltage output. Then generator can then be synchronised with the grid frequency and voltage.

The generator can produce a terminal voltage of 15.75kV which can be attained using an automatic voltage regulator(AVR). This voltage is stepped-up using a generator transformer (GT) into a 220kV voltage which is then fed into the main bus using circuit breaker (CB) and isolator arrangements.

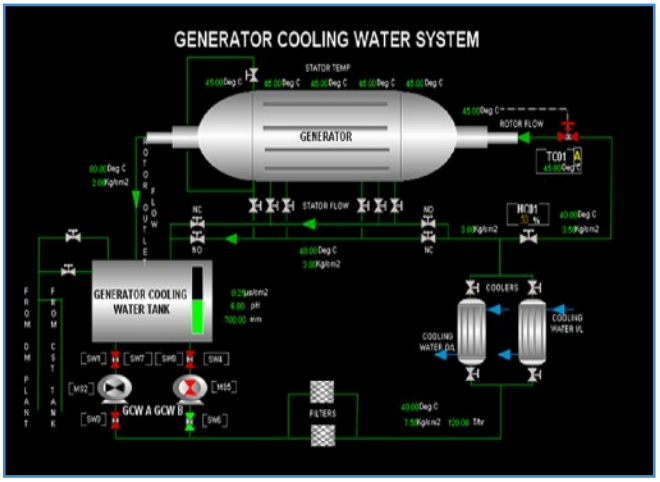
Then using a unit auxiliary transformer (UAT) voltage is stepped down 15.75/6.6kV which serves as the power source for all the power plant auxiliary equipment when the unit is in running condition.

A Station transformer (ST) steps down the voltage from 220/6.6kV which is given to the 6.6kV bus, it acts as a power source when the unit is in stand-by condition. A bus coupler is provided between the two 6.6kV bus lines in order to share the load between the two buses.

Interlocks:

- When the generator trips then the generator circuit breaker has to open.
- When the generator trips then ST CB has to close and UA TCB has to open in AUTO.
- When the generator is live, if UAT CB opens then ST CB has to close immediately.
- When the transformer excitation CB opens the generator has to trip.
- When DC Excitation fails then the generator has to trip.

Generator Cooling Water System



Cooling of the Generator will improve the system efficiency and life of generator. Moreover, this will maintain the temperature of the windings and components of the generator resulting a reduction of various losses.

De-Mineralised (DM) water is used for cooling but the conductivity must be maintained below 5µs/cm. It is first stored in a tank from which water is pumped to the stator core using a generator cooling water pump.

The pressure and flow of the cooling water must be maintained at 3 Kg/cm^2 and 25 T/hr. The temperature must be monitored at various points and must be maintained below 50 deg C.

The return line is taken back to the cooling water storage tank and cooled there it is then circulated back into the process.

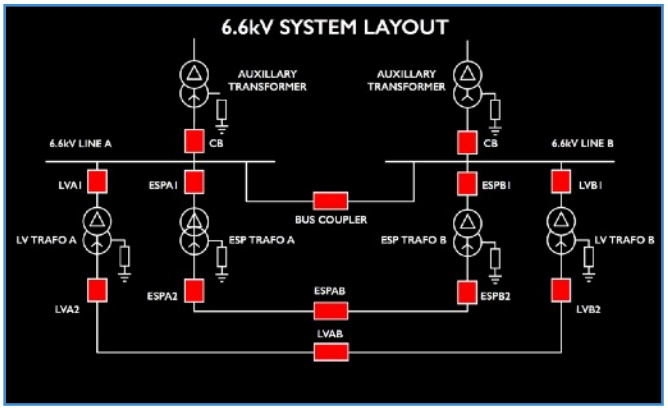
Control Schemes

- Pressure and flow controller at GCW P/P
- Temperature controller

Interlocks

- When one GCW P/P trips then the other has to start in AUTO.
- When the pressure drops below 2Kg/Cm^2 the 2nd ICW P/P has to start in AUTO
- When both side inlet valves close then the running GCW will cause a trip.

6.6 kV System



The 6.6 kV system consists of two buses A & B. Bus A is supplied by the Unit Auxiliary Transformer (UAT), and bus B is supplied by the Station Transformer (ST). Both these act as the power source for these two buses. It is provided with a bus coupler to share the load between the two buses.

A Unit Auxiliary Transformer (UAT) steps down 15.75/6.6kV which is given to the 6.6kV bus A, which serves as the power source for all the auxiliary equipment when the unit is in running condition.

A Station Transformer (ST) steps down the voltage from 220/6.6kV which is given to the 6.6kV bus B, it acts as a power source when the unit is in stand-by condition.

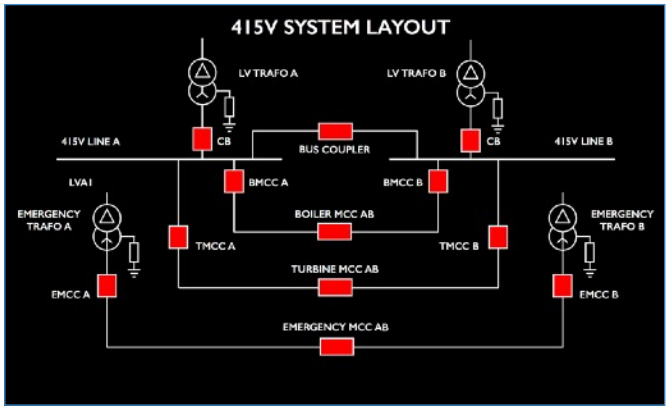
Buses A & B supply power for the ESP transformer and the low voltage transformers (A&B) respectively. Both these transformers are provided with an incoming and an outgoing circuit breaker and a bus coupler.

The low voltage transformer acts as a step down transformer which converts 6.6kV to 415 V which acts as a power supply for all the low voltage equipment. The ESP transformer serves as a source for all the ESP fields.

Interlocks:

- When Unit Auxiliary Circuit Breaker opens then ST circuit breaker has to close in AUTO.
- When incomer circuit breaker of ESP or LV TRAFO opens then it's corresponding out going circuit breaker has to open in AUTO.
- When one side of ESP or LV TRAFO fails then it's bus coupler has to close in AUTO.

415 V System



The 415 V system consists of two buses A & B. Bus A is supplied by Low Voltage Transformer A and bus B is supplied by Low Voltage Transformer B. Both these act as the power source for the Boiler and Turbine MCC. It is provided with a bus coupler to share the load between the two buses.

A low voltage transformer steps down 6.6kV/415V which is given to the 415V bus, which serves as the power source for all the auxiliary equipment connected with the Boiler and Turbine MCC.

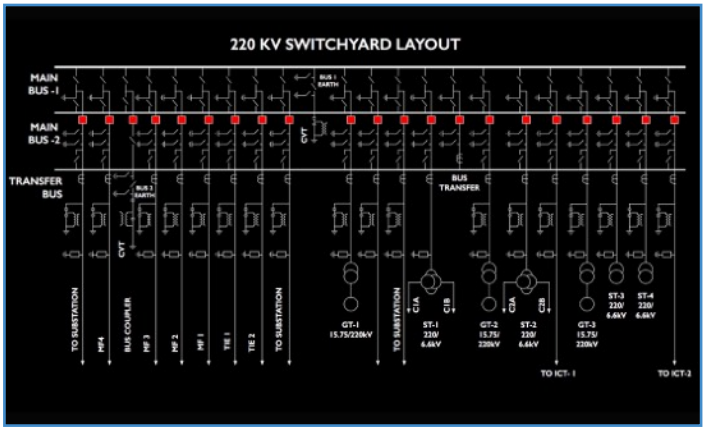
Bus A & B supplies power for the Boiler MCC and turbine MCC (A & B) respectively. Both these MCCs are provided with an incoming and an outgoing circuit breaker and a bus coupler to share loads between them.

An emergency transformer is provided as a power source for all the critical equipment which is connected with it, during The unit failure emergency transformer gets its supply from a back-up diesel generator or a battery bank, and acts as a power source for emergency equipment.

Interlocks:

- When LV TRAFO A CB opens then the BUS COUPLER has to close in AUTO or vice-versa.
- When the incomer CB of ESP or Boiler MCC or Turbine MCC opens then its corresponding out going CB has to open in AUTO.
- When one side of the Boiler MCC or Turbine MCC fails then it's bus coupler has to close in AUTO.
- When one side of the Emergency MCC fails then it's bus coupler has to close in AUTO.

220 kV Switchyard



The 220 kV Switchyard is built as a two main and one transfer bus system, which can be interconnected to the 400 kV system using the Inter Connection Transformer (ICT).

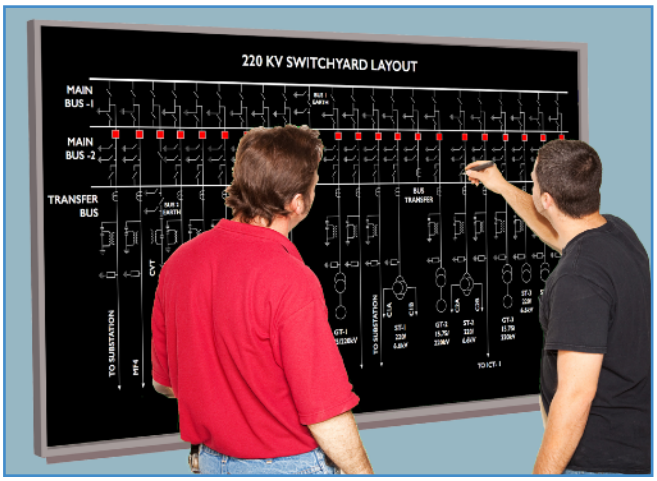
It comprises bus bar conductors, circuit breakers, isolators, Capacitive Voltage Transformers (CVT), Current Transformers (CT), lightning arresters, earth switches and earthing systems.

Busbar 1 has a Rated voltage of 220kV and current of 1,600A, it is connected with GT, ST, UAT and CT using circuit breakers and isolators. A transfer bus is provided for maintenance purpose, all the load of a single bus can be transferred to the transfer bus and then that bus can be isolated for maintenance.

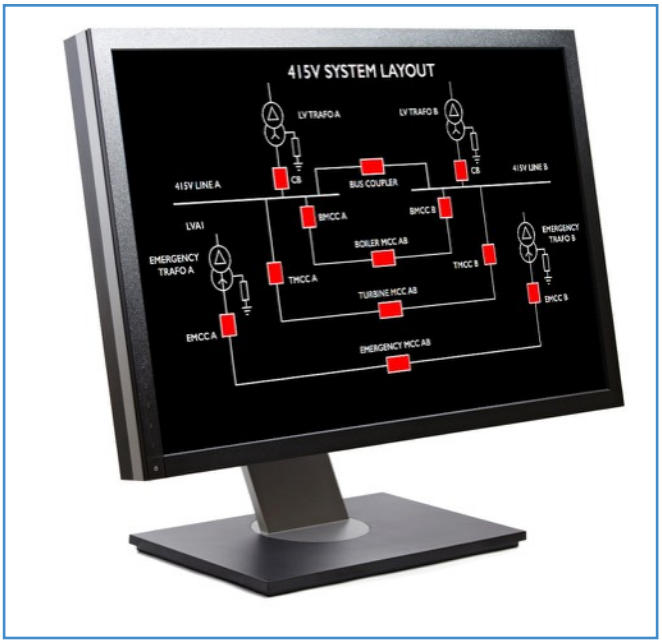
Isolators are off-load devices that can be used when there is no load on the line, while circuit breakers are on-load devices.

Circuit breakers are available in many types: oil circuit breakers, SF6 circuit breakers & vacuum circuit breakers. Based on the need and speed of operation they can be selected for the switchyard.

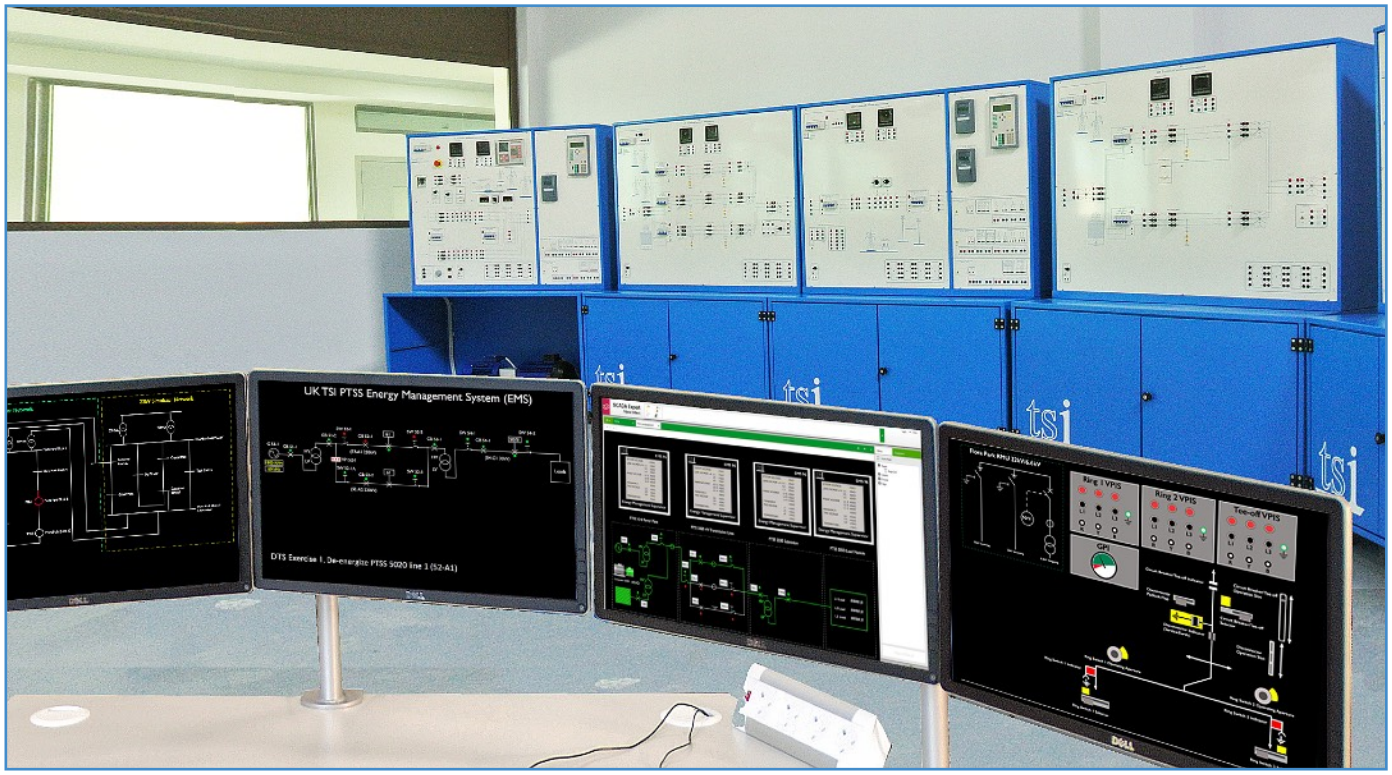
From this main bus, power can be transferred to respective substations using individual grid feeders.



Each individual simulator is fully functional and makes an ideal front of class teaching resource for the Instructor.



They can also be used for individual instruction on stand alone or networked PCs.



The TSI-PTSS/DTS100 Power Dispatcher Training Simulator

The PTSS/DTS100 is a unique extension package for the TSI Power Training Systems Simulator. It provides a dynamic Power Dispatcher Training Simulator that closely models current industrial practice.

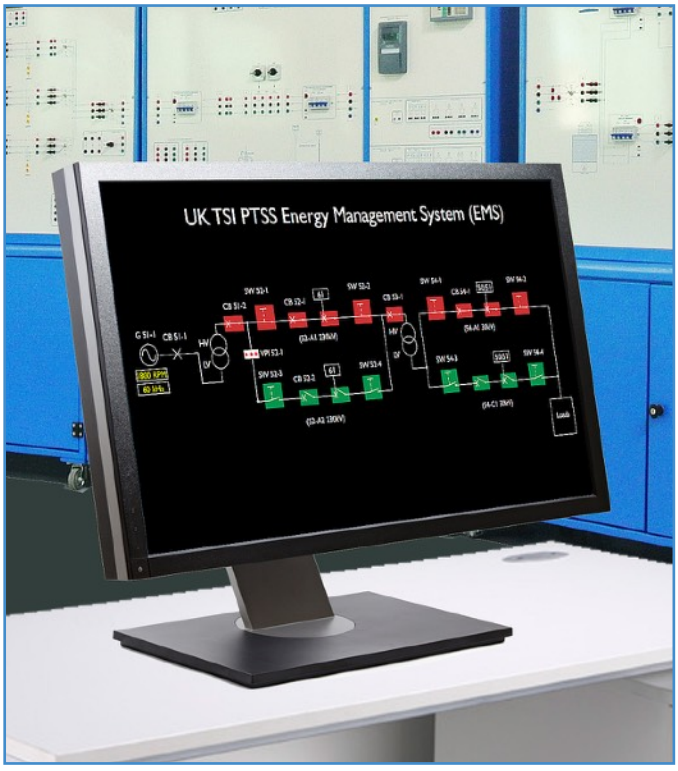
By utilising the PTSS SCADA system and the PTSS Instructor Station our new DTS software system provides a comprehensive range of facilities that allow instructors to interact with trainees as they perform system control operations under a number of controlled faulted and non-faulted Energy Management System (EMS) scenarios.

One of the most important aspects of the TSI system is that it interacts directly with the PTSS hardware units.

This allows us to create very realistic dispatcher training situations where they are able to issue work orders and direct maintenance staff to perform operations on a real "live" system.

The Instructor is able to work behind a special screened area so that their actions cannot be observed by the trainee. a two-way communication system allows them to interact with the dispatcher trainee, who in turn is able to use the same system to issue work instructions to the trainees working on the simulator hardware.

Links to the hardware simulator are via a wireless network connection allowing the complete instructor station to be housed in a separate room with a viewing window overlooking the DTS Simulation and the hardware system.



The DTS Interface

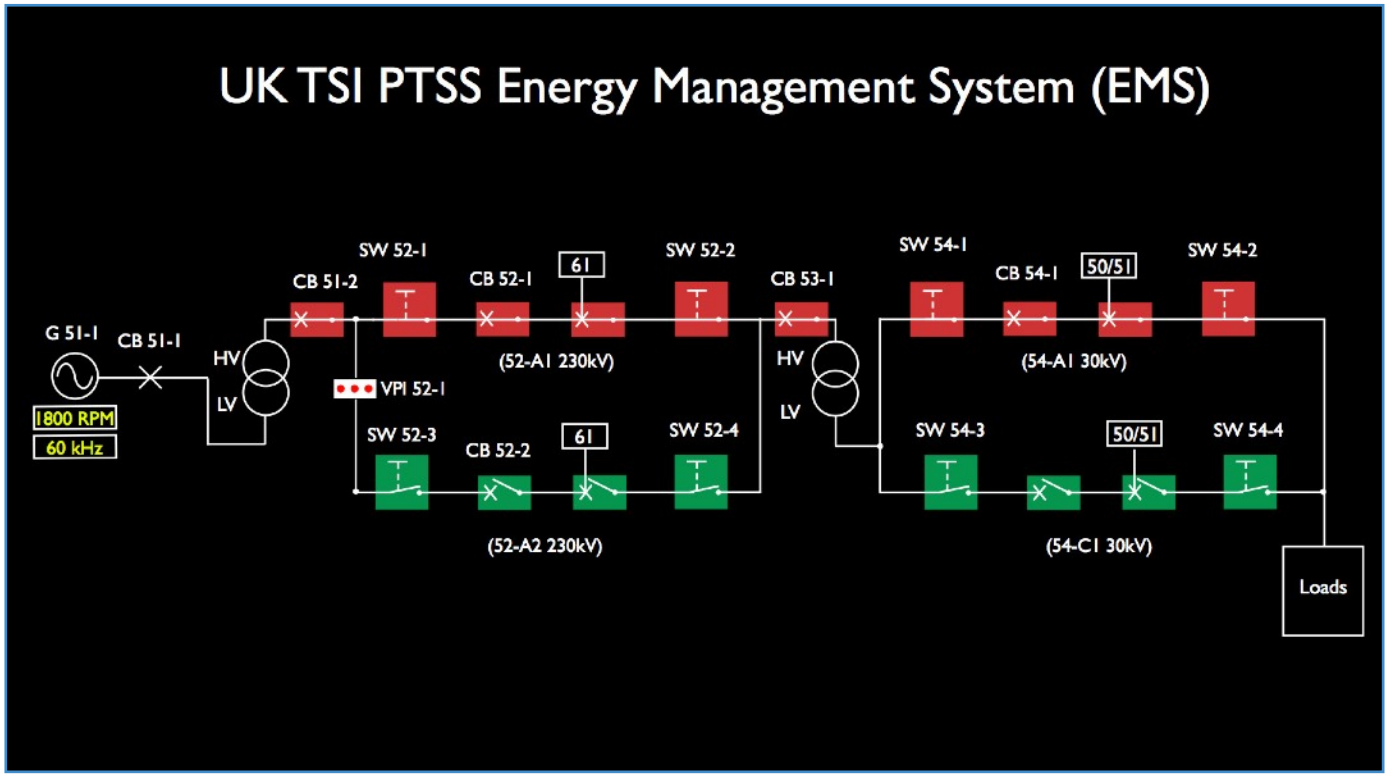
The DTS user interface displays the state of the transmission system on computerised one-line diagrams with controllable points for simulated operation of plant such as switches, circuit breakers or transformer tap-changers.

The PTSS SCADA system, provides collection and assimilation of data from the system hardware and transmits operator instructions back to the various items of plant.

A series of SMART Meters within the hardware system measure power flows and voltages on the transmission system and the SCADA system responses to disturbances such as line trips, relay action, and generator-demand mismatch.

Designed for Training - Built for Realism

The PTSS/DTS100 is supplied complete with a series of ready-made training scenarios that enable the Instructor to present realistic situations where the trainee dispatcher has to respond to the realtime data displayed on the system screens.



Each scenario-based lesson covers a different activity that is modelled on real industrial situation.

In the example above, the trainee dispatcher is directed to de-energise a 70km 230kV line, following the procedure laid out in the associated Power Company Work Orders.

They will issue verbal commands to the trainees working on the PTSS Simulator hardware to perform manual switching operations and any tag out/lock out procedures as required by the work orders.

These activities can be carried out on simulated electrical plant that is representative of typical units in service in the field.

Any diagnostics required to direct the plant operatives will be obtained from the status of the various indicators on the EMS mimic.

This will include power flow meters, circuit breaker status indicators, protective relay flays and manual switch position indicators.

They are even able to direct the power plant operators to change the generator parameters such as a change of output, maximum output voltage and voltage regulation.

Power Dispatcher Training System

Practical Experiment Manual

Section 1. Standard System Maintenance Procedures

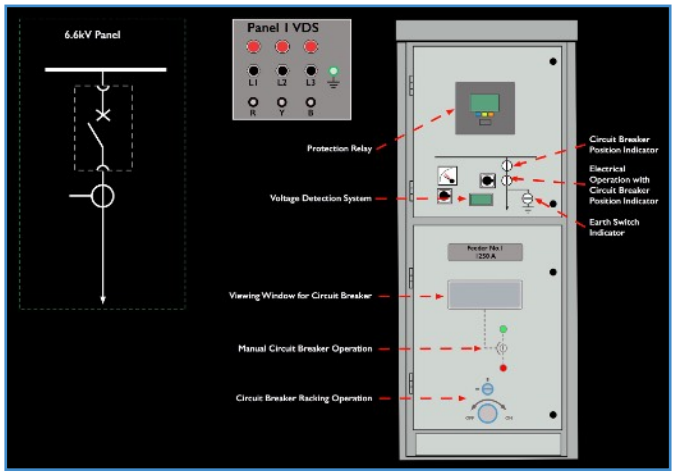
Practical Experiments

You will perform a series of integrated experiments that cover the use of the **PTSS/DTS100 Power Dispatcher Training System**. They are designed to enable you to apply the steps required by the PTSS Power Company Standard Maintenance Practice Work Orders. Each practical experiment is designed to help you develop the hands-on skills required to operate and maintain a typical Power Plant Generation system.

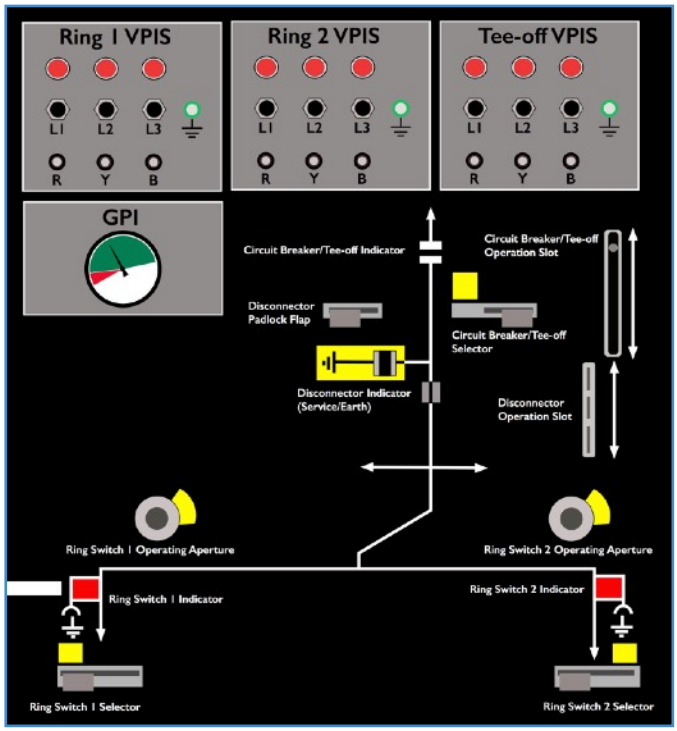
PEPTSS/DTS100/1 De-energizing of a 70 KM 230 kV transmission line. (Without 30kV network support)

Lesson Topic:	De-energizing of a 70 KM 230 kV transmission line. (Without 30kV network support)
Lesson Objective:	
Task:	De-energize PTSS 5020 line (52-A1)
Conditions:	30 kV line open at PTSS 5040 (54-C1)
Standards:	Follow approved communication procedures
	Perform switching in required sequence
Documentation:	PTSS Power Company Standard Maintenance Practice Work Orders Operating Instructions for PTSS Hardware
	PTSS EMS System Operating Manual
Pre-requisite Skills Knowledge:	Familiar with PTSS EMS (SCADA System)
	Knowledge of PTSS switching and blocking procedures.
	Knowledge of structured communication procedures
	Knowledge of transformer loads and firms
	Knowledge of the 34 kV support network.
Preparation of Simulator:	Base Case of at least 5700 *Mw* load
Preparatory Instruction:	Verbal brief by Instructor
Preparation for Scenario:	Simulator up and running
	SCADA Mimics updated to proper dataset
	Real time network analysis running
	Communications System operational

We include simulations of electrical plant such as HV/ MV cabinets with GIS switches or Ring Main Units that enable trainees to demonstrate safe working practice in the areas of switching, earthing and isolation.



Typical 6.6kV Switch panel with GIS breaker, protective relay and all operator controls and indicators, including Voltage Display System (VDS).

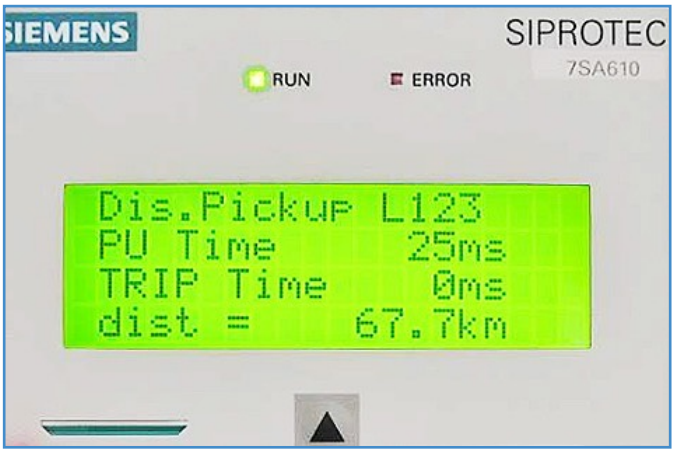


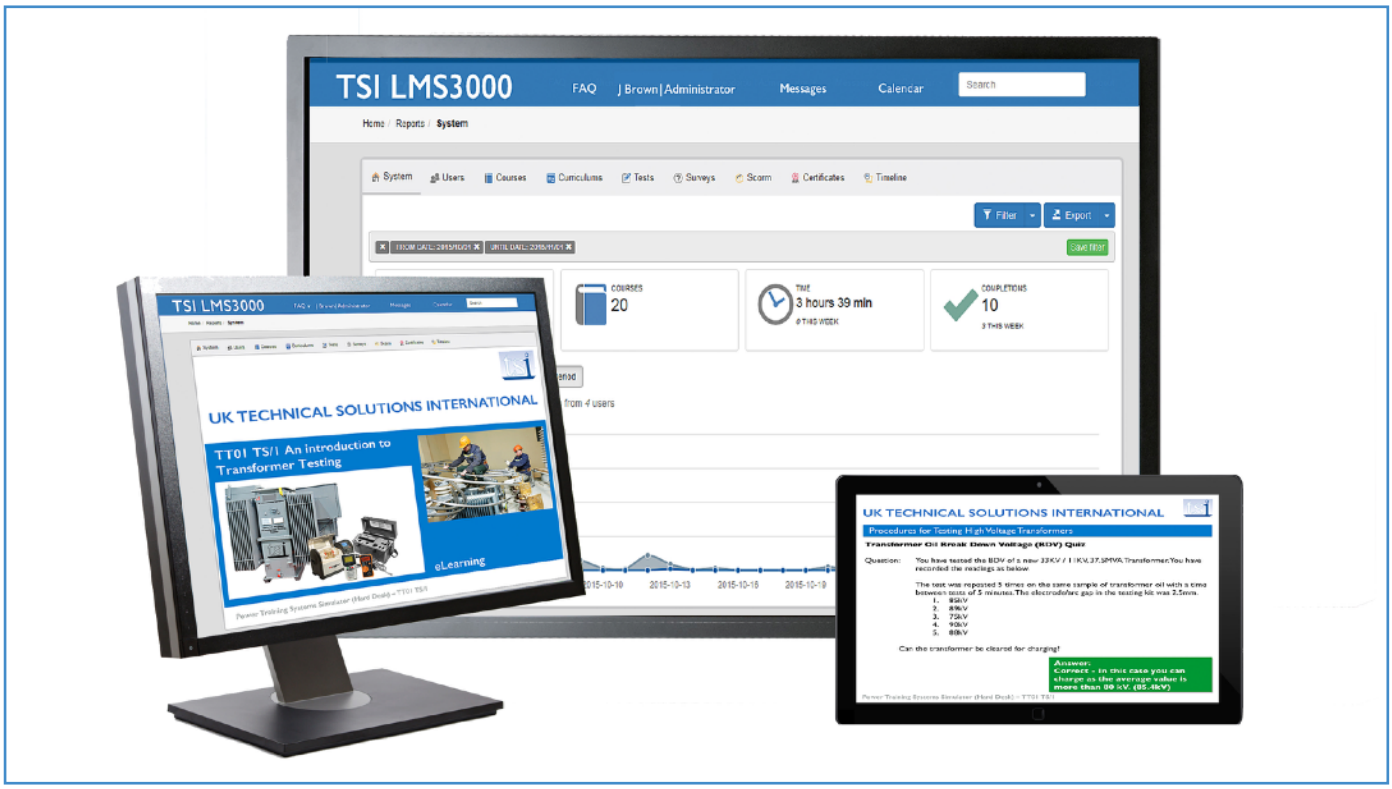
Typical 11kV/6.6kV Ring Main Unit with 2 incomers and one T Off, with GIS breaker, protective relay and all operator controls and indicators, including Voltage Power Indicator System (VPIS).

The simulated electrical plant can be configured on the actual PTSS hardware simulators for added realism in fault finding and rectification and testing.

Trainees are able to use professional test equipment such as Megger Relay Testers, Digital Multimeters and Resistance Testers. Realistic results will be obtained from the test points on the hardware units enabling them to practice test and diagnosis in a safe, controlled environment.

The information displays on the protective relays are also used to provide diagnostic data for faultfinding in numerous scenarios.





TSI-LMS3000 Learning Management System For Power Utilities Training

TSI LMS3000 is a reliable, secure, flexible and easy to use Learning Management System that has a rich functional specification and a modern user interface.

It has been specifically created to provide Power Utilities Training Centres with a powerful learning management system that meets their particular needs when it comes to training and certification.

It includes support for mobile devices., making it portable and suitable for use in the workplace or practical lab for observational assessments.

TSI LMS3000 is cross browser, cross platform and works on most available types of hardware

- **Blended learning services supported include:**
- **Online and off-line e-learning**
- **Informal online learning**
- **Instructor led sessions**
- **Collaborative learning**
- **Virtual classroom (video conferencing)**

The in-built assessment engine and course tracking features enables the real-time monitoring of user progress which allows for instant status reports.

The application provides a multitude of reports and the ability to apply filters in order to get the right information quickly and precisely.

By deploying the system, you will enrich the learning experienced by your students and staff. Plus you will minimise administration costs and enable the use of modern learning techniques and training media to deliver high impact blended learning.

The full range of TSI Power Utilities eLearning modules can be loaded onto the TSI LMS3000 to provide a rich source of learning material for your technical programmes.

If required content can be structured into lesson plans to match your curriculum.

We can even use it to deliver certification courses such as AP (Authorised Person HV) courses.

TSI LMS3000 can incorporate third party content using the SCORM standard.

This allows users such as Power Utilities Training Centres to incorporate other learning content such as Management Skills, Accountancy or customer Relations.

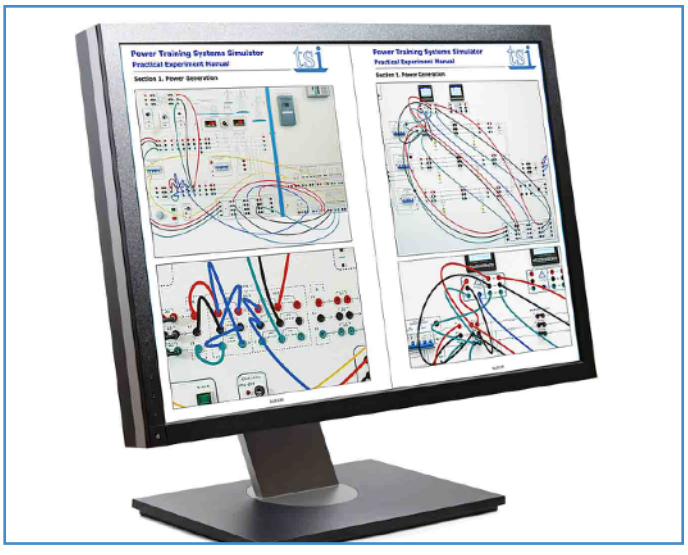
TSI Power Utilities eLearning

We offer a comprehensive range of eLearning materials that has been specifically authored to support our practical hardware trainers. This includes:

- **Instructor"s theory presentations with assessment and test questions**
- **Student theory support lessons with self-tests**
- **Practical exercises based on TSI hardware**
- **Theory support for Industrial Certification Courses**
- **Practical experiments for Industrial Certification Courses**
- **On-line technical manuals**
- **Stand-alone assessment to measure student attainment**
- **Engineering Systems Simulation software**
- **On-line instruction and experiment manuals for the Power Training Systems Simulator range**

All the content can be uploaded to our Learning Management System to provide competency based tracked and managed learning.

If required, TSI can assist with mapping these eLearning materials to your own curriculum and or qualifications. If you do not have a specific curriculum, then we can help in creating one based on a Training Needs Analysis



Power Training Systems Simulator Lab

Our eLearning materials provide practical instruction that is directly related to our lab and workshop equipment.

Emphasis is placed on providing the trainee with a strong background in safety related theory, in particular we focus on the dangers of working with high voltage and medium voltage electrical systems.

Work place skills are essential if trainees are to become the valued employees much in demand by Power Utilities.

Blended learning, using a combination of Instructor led theory, real hands-on practical work using simulators and industrial equipment together with self-based study, helps ensure that these skills are gained and retained.

Specialised Training Laboratories and

This section of the catalogue provides details of the range of specialised training laboratories and workshops that we offer.

Emphasis is placed on providing real hands-on training using professional test equipment and where ever relevant, actual HV/MV power equipment, including transformers, switchgear, protection relays and cabling.

Our training materials are focused on providing both the underpinning theory and the practical skills and we always place great emphasis on the essential workplace safety.

Electrical Machines and Transformers Lab

This is a complete practical laboratory that provides all the resources needed to deliver a comprehensive training programme that covers the principles of electrical machines and transformers.

We include our unique MCL/100 Motors and Generators Trainer to enable instructors and trainees to perform a wide range of experiments and practical troubleshooting tasks on an advanced system that directly relates to Power Generation applications as opposed to abstract theoretical ones.

The PTL/100 Power Transformers Lab provides an excellent introduction to single phase and three phase power transformers and their applications in power systems.

The trainer features three power transformers and a phase shifting transformer. Students can experiment with different Wye/Delta configurations and build step up and step down transformers as well as connecting transformers in series and parallel.

These help provide the trainees with the basic knowledge and skills to enable them to work on real industrial equipment in other OJT Workshops.

MCL/100 Motors and Generators Trainer

This unit has been specifically designed to provide a practical training resource that covers electric motors and generators.

The workstation incorporates a machine mounting bed where different DC and AC motors can be easily aligned and connected to a fixed 3-Phase Generator.

An automatic circuit breaker main switch provides overall power to the module. It also includes an emergency stop button. All circuit interconnections are made using 4mm safety leads and sockets.

The outputs from the electronic variable motor drive can be connected to the AC motor to allow for changes in the speed and torque of the fixed synchronous machine.

This is a fully programmable control and it can be used with the range of additional three-phase and single phase AC motors available for use with the MCL/100.

A tachogenerator is located in between the motor couplings to provide a speed feedback signal.

A separate variable DC excitation control is also provided to allow for changes in the voltage and reactive power of the 3-Phase Generator.

The outputs from this drive are available on the front panel and can be used to drive an the additional DC motors available for use with the MCL/100.

The unit is supplied as standard with the following specification AC Motor:

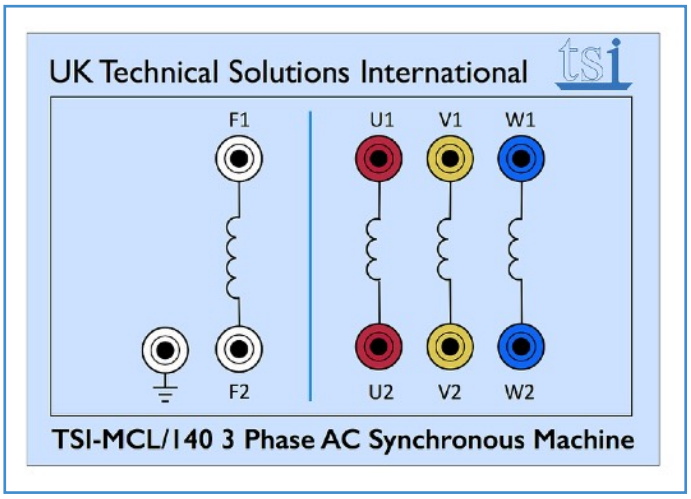
- V = 220/380V
- F = 60Hz
- Nominal maximum speed: 3,600 RPM approx.
- Rated power: P = 1.5 KW
- I = 7/4 A approx.

The generator has the following characteristics:

- Rated power: P = 1KW
- Nominal maximum speed: 3.600 RPM
- Vin = 220/380V
- f = 60 Hz when functioning as motor
- Vout = 220/380V
- f = 60 Hz when functioning as generator
- Iout = 2.8/1.6 A approx.

Additional Motors:

- TSI-MCL/110 Shunt/Compound DC Machine
- TSI-MCL/120 Single phase AC Motor
- TSI-MCL/130 3 Phase AC Squirrel Cage Motor
- TSI-MCL/140 3 Phase AC Synchronous Machine
- TSI-MCL/150 3 Phase Slip Ring Asynchronous Machine



All the motors and generators are intended for use in training and have a special adaptor box that brings the motor connections out onto 4mm safety sockets. A mimic diagram labels all the connection points for easy identification. A set off 4mm safety cables are included with the trainer.

Realistic Training Application for the Motor Generator Set

Because the TSI-MCL/100 has been designed specifically for Power Training, we have include a complete power station application on the system.

This allows the output from the generator to be connected to a step-up transformer.

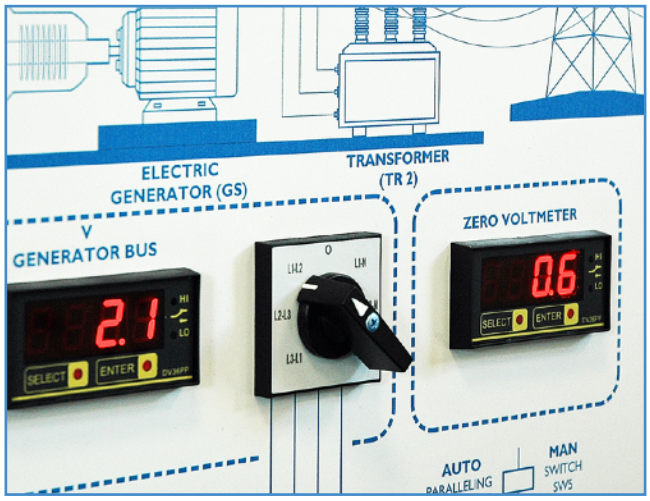
This has an apparent power of 1,000 VA. The primary voltage for DELTA connection is 150 V, for STAR connection it is 260 V. The secondary voltages for DELTA connection are 69 -127 V, for STAR connection they are 120 - 220 V.

By using the different motor and generator combinations made available for use on the trainer the user can perform a wide range of experiments related to the generation of three phase AC power.

Two methods of parallel synchronisation with the mains are also provided:

Manual parallel

This will allow manual selection of parallel synchronisation between the output of the 3-phase generator and the power training systems simulator systems infinite power grid using a voltmeter, zero-voltmeter and a synchroscope.



The voltmeter Zero Voltmeter also displays the voltage reading across the lamps and confirms the synchronised voltages before the user attempts manual closing of the paralleling switch. This system has a circuit that will automatically lock in and protect the synchronous generator.

Automatic parallel synchronisation

This mode is designed to automatically adjust the speed, voltage and phase shifting of the rotating generator in order to carryout automatic management of synchronisation and paralleling between the generator and the mains supply.

The user can make adjustment to the parameters of the controller's PID control loops, using the control panel interface.

After successful parallel synchronisation it will be possible to share the load between the mains and the synchronous generator.

An outgoing HV bus system is used to connect the additional power generation simulator module to the other simulator units. The unit has two circuit breakers, one for the protection of the medium-voltage windings of the transformer and one for the protection of the high-voltage windings of the transformer.

The module is equipped with two digital multifunction 3-phase instruments for measuring voltage, current, active power, reactive power and harmonics. These have both numerical and graphical display options.

The unit is supplied in a steel mobile cabinet with a durable powder coated finish with two lockable doors on the storage area. It includes all power connection points, cables and accessories.

Power Cable Fault Location and Cable

With the creation of new power networks and maintenance work on existing networks more and more power cables are being used, requiring well-trained engineers and technicians to maintain them.

Cable faults need to found quickly so that supply can be maintained with a minimum of interruption.

There are many locating methods, coupled with new detection technologies and there is no single method or combination of methods that can be used to locate all faults.

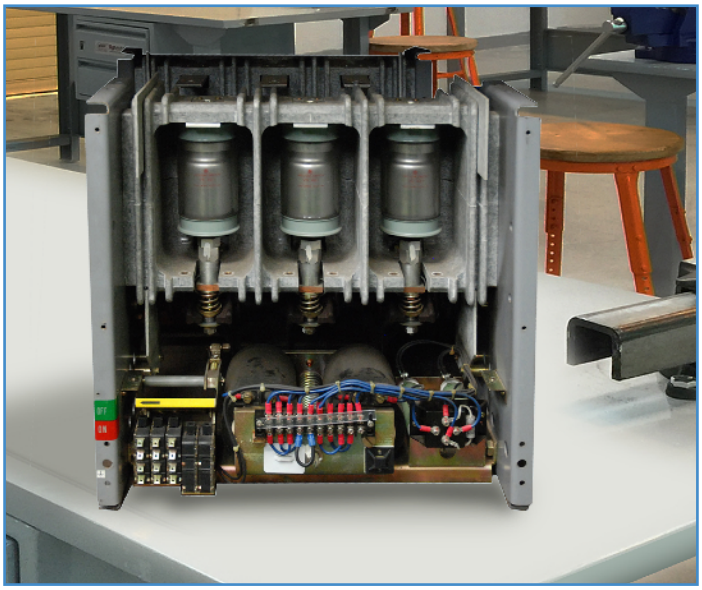
Our laboratory provides industrial test equipment and training kits to help make your trainees experienced in power cable fault locating using real professional test equipment in a safe and well controlled environment.

Transformers (HV/MV) and Switchgear Lab

When it comes to training technicians and engineers in the area of power transmission and distribution at high voltage and medium voltage it is important to expose them to the types of equipment they will meet on-the-job. (OJT)

TSI have designed a unique OJT workshop for high voltage and medium voltage transformers and switchgear. Trainees are able to practice real life maintenance and repair tasks in a safe, supervised workshop environment.

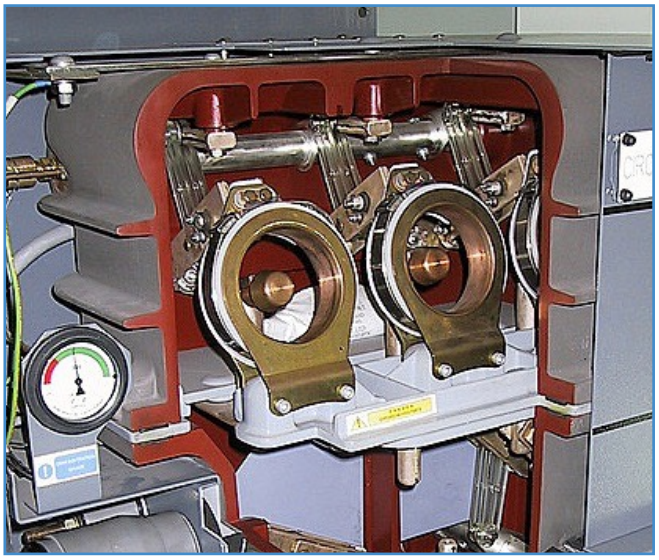
By providing the same equipment that technicians will work on in the field, we are able to provide you with a training environment where professional tools and test equipment are used to perform standard maintenance and test procedures.



All the equipment we provide is fully reconditioned and brought back to the original manufacturer's specification.

Where appropriate original manufacturer's data and instruction manuals are also supplied.

The items of HV and MV transformers and switchgear we offer have been selected to reflect the range of equipment typically found in HV and MV electrical distribution networks and substations from distribution voltages of 230kV down to 11kV, 6.6kV and 433V levels.



To help in the training process, we include a number of sectioned items of equipment which help trainees understand the inner workings of transformers, switches and breakers.

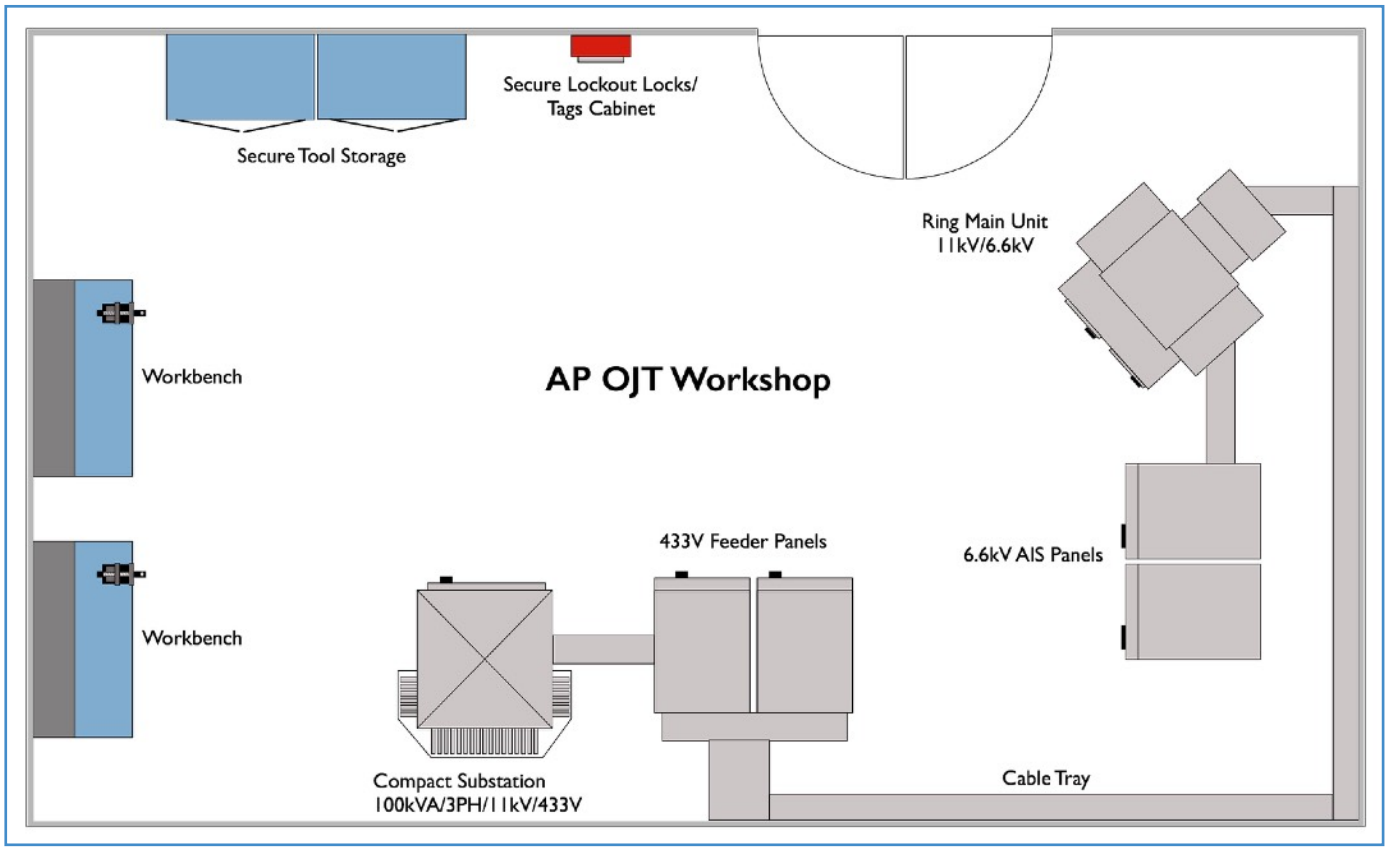
Specific items of equipment can be fitted with switched faults troubleshooting. An 8 x individual fault insertion box can be fitted to most items of equipment in this lab. ***Contact TSI for details.***

For safety reasons, none of the equipment should be connected to a mains voltage at any level.

Fault insertion and testing is all carried out using an independent low voltage (24V) to create trip

Professional test equipment from all recognised manufacturer's such as Megger are supplied as part of our HV/MV transformers and switchgear lab. This helps trainees develop real workplace skills.

Authorised Persons (AP) HV Training/Certification Lab



We have designed this workshop specifically for use in the delivery of AP HV Commercial Certification (Authorised Person) courses.

The equipment is used to allow the trainee to demonstrate safe working practices such as Lock out and Tag out and the safe isolation of equipment prior to working.

In this simulated workplace environment or "OJT workshop" , the Instructor is able to set tasks that require the use of professional tools and techniques to perform a range of tasks that replicate real industrial practice.

All the required tools, test equipment and safety lock sets and warning signs are provided together with 11kV/ 6,6kV and 433V equipment.

All the equipment we supply is fully reconditioned and is intended for dead working only. There is no medium or high voltage supply required in this workshop and for safety reasons none of the power equipment should be connected to any type of power

Authorised Persons (AP) HV Training/Certification Lab

The TSI Power Systems Simulator plays an important part in our AP training package. It is specifically designed to enable trainees to develop their safety awareness skills together with practical hands-on skills such as safe isolation working and fault finding.

Many of the aspects of AP training are best carried out initially on a simulated system. The PTSS can be configured by each trainee to represent a number of HV and MV generation and distribution systems.

Standard circuit breakers and protective relays in the system enable both planned isolation and protective fault tripping and isolation to be investigated.

The digital multifunction meters built into the system can be used for all the diagnostics work but they can be supplemented with commercial test equipment to help develop workplace familiarity.

Power Transformers Testing Lab

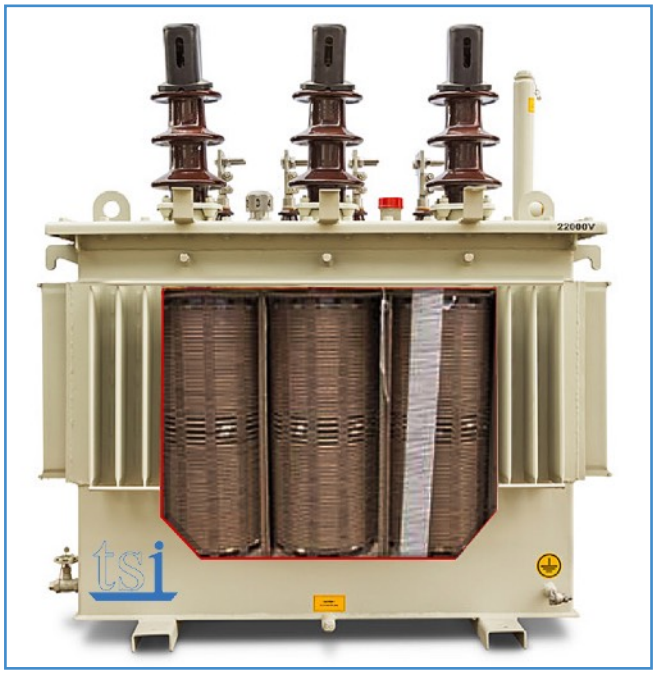
When it comes to training technicians and engineers in the area of transformer testing (high voltage and medium voltage) it is important to expose them to the types of equipment they will meet on-the-job. (OJT)

TSI have designed a unique OJT workshop for transformer testing. Trainees are able to practice real life maintenance and repair tasks in a safe, supervised workshop environment.

By providing the same equipment that technicians will work on in the field, we are able to provide you with a training environment where professional tools and test equipment are used to perform standard maintenance and test procedures.

These will include all the standard mechanical and electrical test that are regularly carried out on power and distribution transformers of all sizes.

Power Transformers Testing Lab



A range of different specification transformers are supplied as part of the complete workshop package. These are fully reconditioned units that meet the original manufacturer's specification.

Typical transformer specification:

- 500kVA Mineral oil cooled double wound standard ONAN transformer
- 11,000 / 433volts
- 3 phase
- 50hz
- No Load. 26.2 / 667 Amps
- Impedance volts 4.68%
- Connected Delta-Star to vector group ref Dy11
- Manufactured to specification ESI 35-1
- HV winding fitted with ±2.5 & 5% taps operated by external off-circuit tap change switch
- HV box: 3 pole 1 gland compound filled
- LV box: 4 pole 4 gland compound filled

NOTE: Specific equipment that meets a direct training need can be ordered on request, subject

Equipment is intended for dead working only. There is no medium or high voltage supply required in this workshop and for safety reasons none of the power transformers should ever be

We even include sectioned transformers to help trainees understand the inner workings of the power transformer.

The TSI eLearning resources help the instructor by providing valuable underpinning knowledge on both the theory of power transformers and the practical aspects of transformer testing and commissioning.

Typically in a practical workshop environment we would supply and eLearning sources pre-loaded onto laptop computers for both instructor and trainee use. An Interactive touch screen display is also recommended for use by the instructor for whole-class presentations.

kWh Meter Test Lab

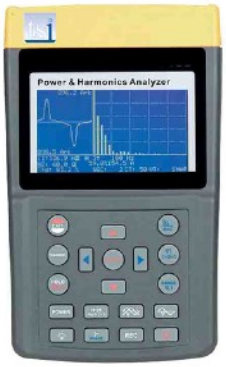
When it comes to training technicians and engineers in the area of electrical kWh meter testing and calibration it is important to expose them to the types of equipment and test procedures that they will meet in the workplace.

TSI have designed a unique OJT workshop for meter testing and calibration.

Trainees are able to practice real life maintenance and repair tasks in a safe, supervised workshop environment.

By providing the same equipment that technicians will find in the field, we are able to provide you with a training environment where professional tools and test equipment are used to perform test and calibration procedures on a range of standard kWh meters and new SMART meters.

Typical example meters are supplied as part of the complete lab package.



Standby Generator (Diesel) Maintenance and Repair

Standby generators are an essential part of any electrical network. They provide the start-up facility for the majority of power plants and in many cases often act as the sole source of electricity for many people.

The diesel engine driven generator is the real workhorse, although lightweight petrol engine generators are available. It is the power and economy of the diesel engine that makes them ideal for this application.

We have designed a unique OJT workshop for training in the maintenance and repair of diesel engine driven stand-by generators.

Trainees are able to practice real life maintenance and repair tasks in a safe, supervised workshop environment.

By providing the same tools and equipment that technicians will work on in the field, we are able to provide you with a training environment where professional tools and test equipment are used to perform standard generator maintenance and repair tasks.

We supply a range of different output generators in the workshop package. These are all running models and are intended for practice in maintenance and repair.

A complete sectioned generator set is also included together with the TSI Diesel Generator Trainer which includes switched fault capability for troubleshooting practice.

Electrical Installations and Maintenance (LV)

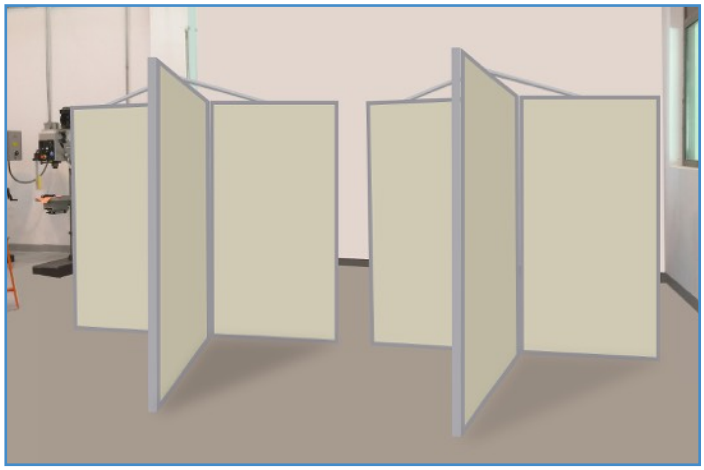
The practical resources available in this workshop have been selected to enable the training of electrical installations technicians who will work on domestic and light industrial installations.

All the practical work is carried out using special training bays that can be configured to cover different areas of electrical installations.

All necessary tools and test equipment are provided in this workshop package. Both eLearning and paper-based instructional materials are available to support the instructor and the trainee.

Electrical Installations Training Kits:

Electrical distribution systems and equipment must be correctly installed and maintained in accordance with accepted electrical engineering standards and practices, as stipulated in the publications of the International Electrotechnical Commission (IEC).

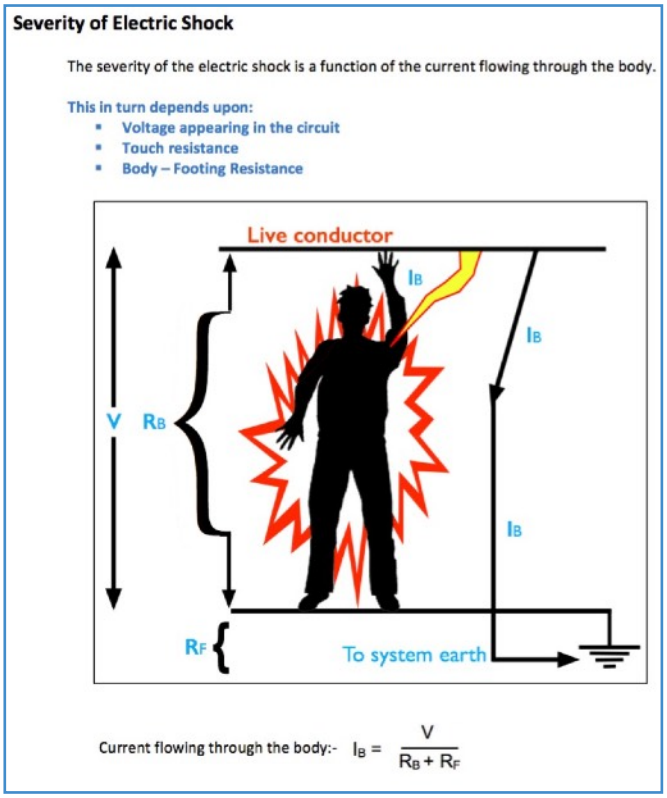


In addition to the practical equipment, including the TSI Electrical Installations Training Kits, we also provide a comprehensive range of paper-based and eLearning training materials.

These are intended for use by both the Instructor and the trainees, they provide underpinning knowledge and practical assignments.

As with all our complete workshop packages, emphasis is placed on providing real workplace experience and practice with a heavy emphasis on health and safety and professional working skills.

We are able to provide different electrical installation component kits to meet specific country and electrical system requirements.



Work covered includes:

- **Statutory regulations and codes of practice**
- **Safe systems of working**
- **Using technical information**
- **Tools and equipment**
- **Over current and short circuit protection**
- **Single phase domestic lighting circuits**
- **Single phase domestic power socket installations and appliances**
- **Single phase and three phase Light industrial electrical installations - lighting and power**
- **Single phase and three phase AC motor installations and motor**

Mechanical Workshop

This is a general-purpose mechanical workshop where trainees can develop a range of mechanical skills including assembly of drive systems.

Tools and machines to allow simple fabrication tasks to be performed, as well as turning, milling and fitting.

Many of the trades that will be covered in a power utility training centre will require basic mechanical skills such as system disassembly, use of fixtures and fittings and simple on-the-job mechanical repairs.

Different levels of tasks can be performed in this workshop, making it a useful addition to the training provision.

The tools and equipment supplied allow the trainees to work on many different items of equipment.

We do not include any specific mechanical systems training kits in this workshop. These are found in our Mechatronics Lab.

As an example, an electrician working on solar panel installations will need mechanical skills as well as electrical skills. They will need to be able to assemble and fix mounting frames and understand basic mechanical principles such as force and loading and the correct use of fixings.

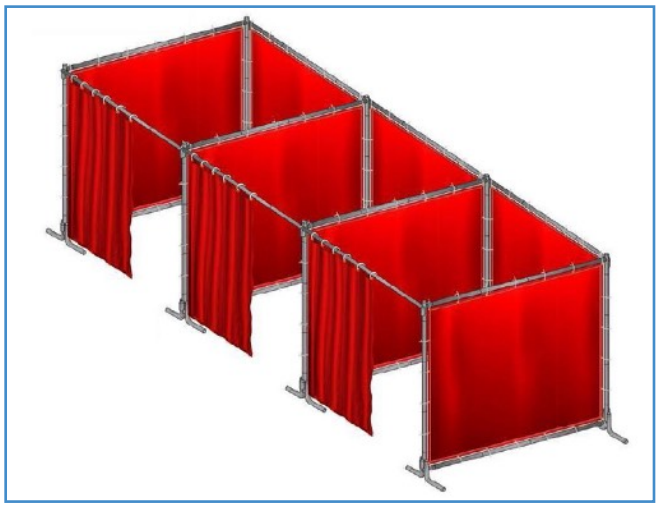
Welding Workshop

TSI have designed a unique OJT workshop for training in welding and light fabrication. Trainees are able to practice real-life welding repair tasks in a safe, supervised workshop environment.

Welding skills of differing levels are required by many of the trades that are covered in a typical Power Utilities training centre.

Trainees will be able to use gas, stick, TIG and MIG welders to perform sheet metal fabrication and light assembly tasks in a variety of materials, including steel and aluminium. We provide special welding booths for safety and environmental protection purposes.

eLearning materials on welding are also included. These provide interactive instruction on welding and theory support materials for both the instructor and the trainee.



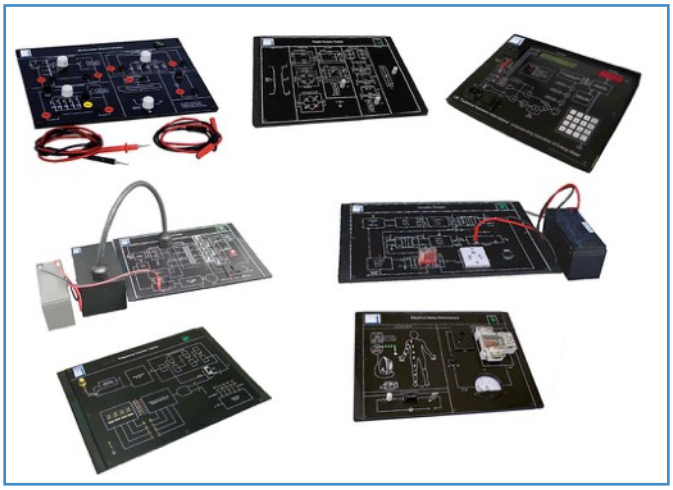
Electrical and Electronics Maintenance and Repair Lab

This lab has been designed specifically to be used to deliver practical courses in basic electricity and analogue and digital electronics principles.

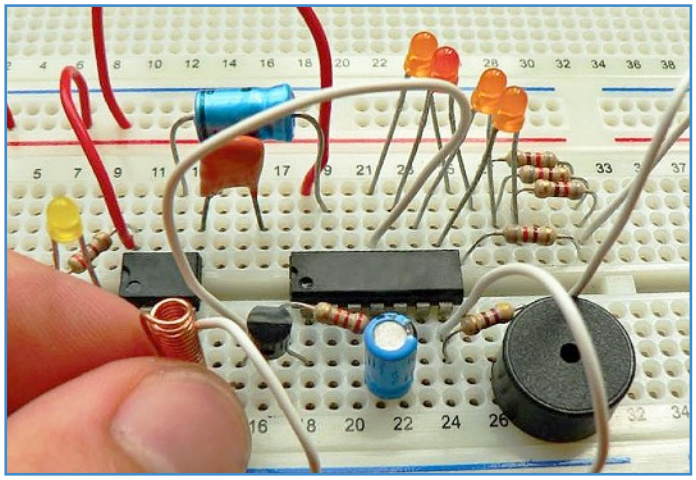
Trainees will gain the basic knowledge required to troubleshoot and repair electronic systems and equipment.

Although there is little demand to repair consumer electronics products, power utilities will have large amounts of specialised electronic equipment that is mission-critical and will require routine maintenance and repair.

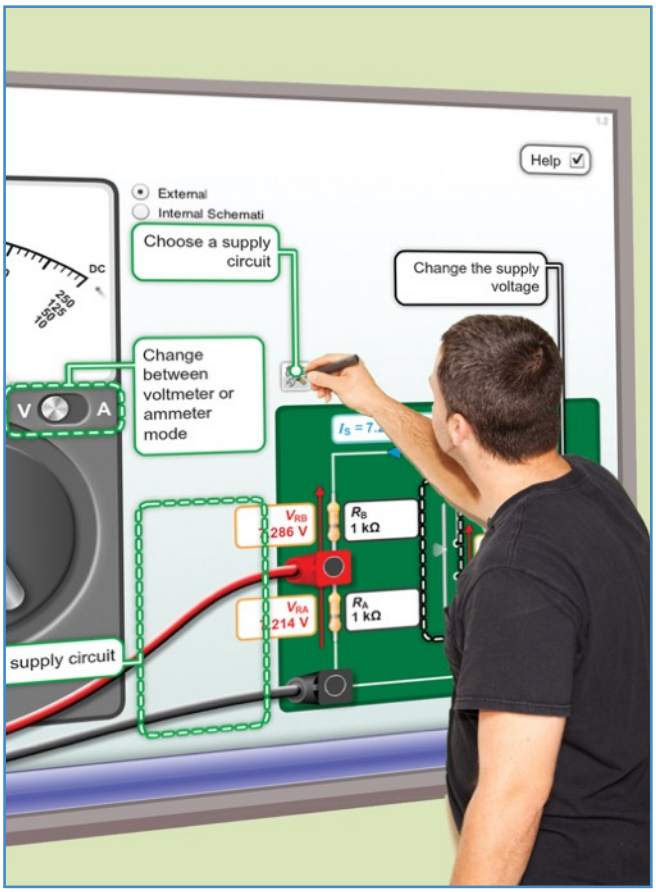
Working with real components and professional test equipment trainees will acquire the essential skills that they will need for the future.



This turnkey lab also includes soldering and desoldering stations, test and measuring equipment and tool sets. We also include a range of dedicated practical electronics fundamentals training kits supported by comprehensive eLearning, paper-based curriculum and a wealth of instructor support resources for front of class presentations and practical demonstrations.



The practical work includes building circuits using real electronic components and then testing those circuits to ensure that trainees really understand the principles that they are being taught.



Computer Lab with Engineering Science and Basic Engineering Principles

This general purpose classroom can be used to deliver a wide range of courses of study in Engineering Science and Basic Engineering.

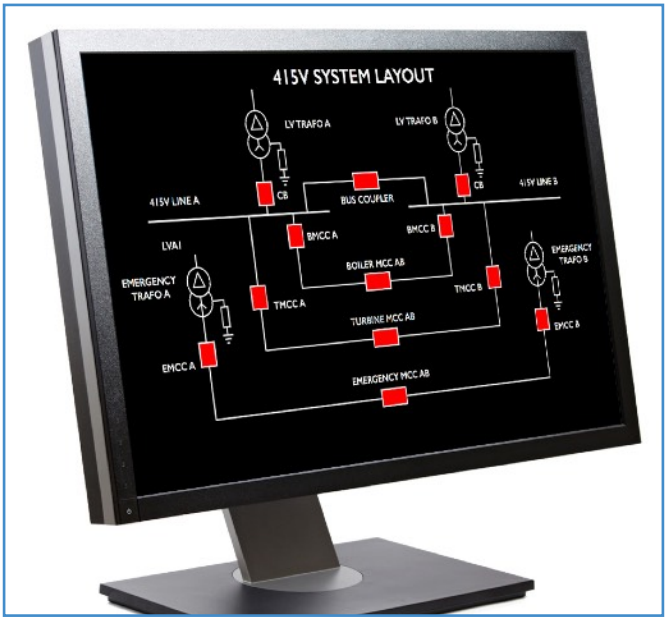
A comprehensive package of eLearning instructional materials is available to support the instructor and the trainee. These are delivered using a local server, reducing the need for continuous access to the Internet.

If required, the computer systems can be used to deliver additional supporting theory materials that underpin the technologies covered in other classrooms and laboratories in the training facility.

This is an ideal facility for our range of Simulator Software Systems, including the Operator Training Systems and the Electrical Operations Simulator Suite.

Topics covered by our Engineering eLearning include:

- **Basic engineering science**
- **Engineering maths**
- **Basic electricity**
- **AC/DC electronics**
- **Semiconductors and digital electronics**
- **Telecommunications**
- **Mechanical systems**
- **Pneumatics**
- **Hydraulics**
- **Robotics**
- **Industrial control and automation**
- **PLCs**
- **Power generation and distribution**
- **Materials and processes**
- **Engineering operations**
- **Alternative energy and SMART**



Computer Lab with Engineering Science and Basic Engineering Principles

The eLearning content can be delivered using the TSI Learning Management System. This provides a range of assessment and reporting facilities as well as content management.

Using the large screen interactive display we supply as part of this turnkey lab the instructor can present interactive theory lessons using the simulators and explorers included in our eLearning.

Test and assessments can also be given with the results being tracked by the Learning Management System. This enables the instructor to generate competency-based reports for individual trainees.

Many of the engineering systems training hardware we supply in other labs can be brought into this PC Lab to allow front of class demonstrations.

The equipment can also be used by the trainees to reinforce understanding through hands-on practice using a true blended-learning approach.

Mechatronics Lab

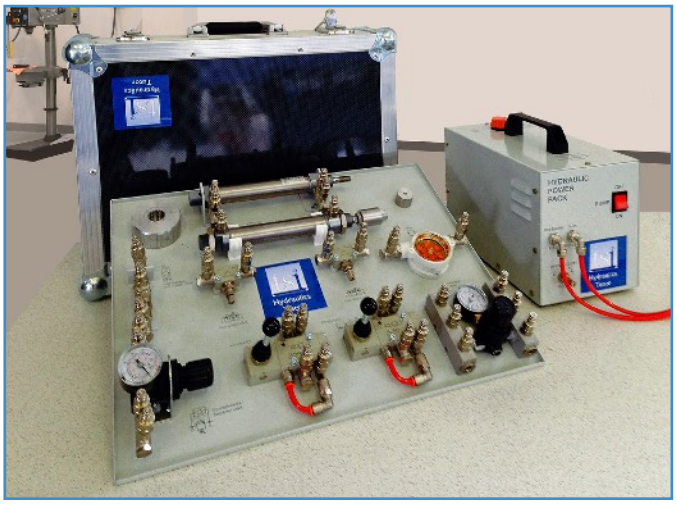
This is a complete practical laboratory that provides all the resources needed to deliver a comprehensive training programme that covers Mechatronics Systems.

Many of the trades involved in the Power Sector will require mechanical and electronics skills to maintain and repair industrial equipment that includes hydraulics. pneumatics, mechanical systems and control and instrumentation electronics.

We include a wide range of practical training kits to enable instructors and trainees to perform a wide range of experiments and practical troubleshooting tasks.

Areas covered include:

- **Mechanical systems - belt drives, chain drives, bearings, gears and gearboxes**
- **Electro mechanical systems**
- **Electronic control systems - microcontrollers**
- **Transducers and instrumentation**
- **PLCs**
- **Electro Pneumatics**



Alternative Energy Power Systems Installer Lab

This is a complete practical laboratory that provides all the resources needed to train technicians who will work on the installation of alternative energy power generation systems. These include:

- **Solar PV**
- **Solar Water (Tube Collector)**
- **Wind Power**

The focus in this lab is on building the skills and competencies that the trainees will need to work in the growing microscale generation industry for both domestic customers and light industrial installations.

We provide all the tools and equipment that are used by professionals in this rapidly growing field, as well as typical solar PV and wind power generation and control systems.

Model buildings are provided to give the trainees the opportunity to carryout installations in just the same way that they would on a customer's site.

To help instructors deliver the fundamental knowledge and understanding of the operation of both solar PV and wind power, we also include two of our PTSS Simulators.

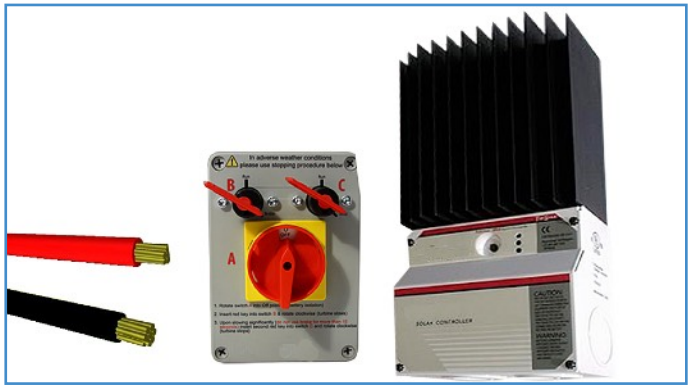
Typical solar PV and wind turbine kits for installation practice:

Solar PV

- Grid tie inverter for solar PV Panels
- Three high-performance 235W Solar PV panels
- MC4 Connectors
- 20 Meters of premium solar cable
- Mounting kit and fixings

Wind Turbine

- 48V 1kW Wind turbine
- Grid tie inverter
- Stop switch
- PC Link cable and software
- Wind Turbine Tower Kit
- Mounting kit and fixings



We also include a Tube Collector Solar Water Heating System demonstration stand. This allows the Instructor to demonstrate the operation of a different solar energy technology.

Trainees are able to use the stand to investigate the operation of the system and its electronic control system.

Installation and Professional Development

When it comes to making the most of any investment in new training facilities and resources, Professional Staff Development is a must.

Our factory-trained engineers will carry out the installation and training at your site. This will give an opportunity for your technical personnel to follow closely and become fully involved in the installation and commissioning should it be required.

Typically the installation will be carried out over a 3-day period and it will be followed by a training session, which would take, between 5-7 working days. The training will start with the basic overview of the system and then each module will be covered individually in detail.

Various training scenarios will be explored and we always encourage a hands-on approach, where the trainees will be working closely with the equipment under the close guidance of our trainer.

Usually, training will cover use of each of the individual modules in the lab. Once the individual modules are covered in detail, the training will then focus on the various scenarios that can be used to configure different sub systems and finally the complete end-to-end system. Again, the focus will be on simulating various real life scenarios.

The training session will end with a test for the trainees and certificates will be given to the trainees after the completion of the training.

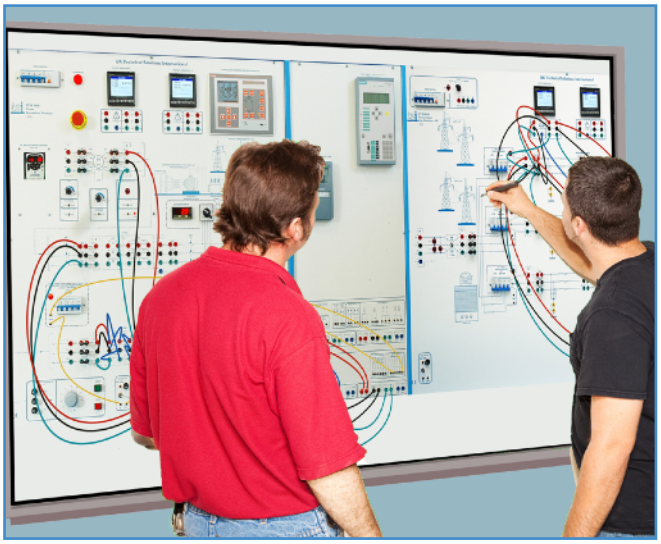
Refresher Training

Our main focus is on customer satisfaction and a key feature of our training is that we conduct a refresher on-site training session after a 6-month period. This is to ensure that the system is used to its optimum capacity and any possible doubts or questions can be addressed.

We will also use the visit of the trainer to conduct a check on the hardware and software system for any small adjustments if required.

Wherever it is relevant, we make use of the TSI eLearning when it is supplied as part of the package. The inclusion of a large wall-mounted interactive display makes this a valuable training tool.

It also illustrates how the instructor can make best use of the available resources with their trainees.



We ensure that the training covers all of the equipment we have supplied. Our trainers will make use of the eLearning content and the printed manuals throughout the training.

AP HV Commercial (Authorised Person) Course Package

AP HV Commercial (Authorised Person) Course

We can help provide training and assessment covering the essential requirements of safe working procedures on High Voltage (HV) electrical equipment and systems as required by the Electricity at Work Regulations 1989.

This UK standard is recognised Worldwide as one of the best HV electrical safety standards and has been adopted by many other Countries.

The TSI Power Systems Simulator plays an important part in our AP training package. It is specifically designed to enable trainees to develop their safety awareness skills together with practical hands-on skills such as safe isolation working and fault finding.

Many of the aspects of AP training are best carried out initially on a simulated system. The PTSS can be configured by each trainee to represent a number of HV and MV generation and distribution systems.

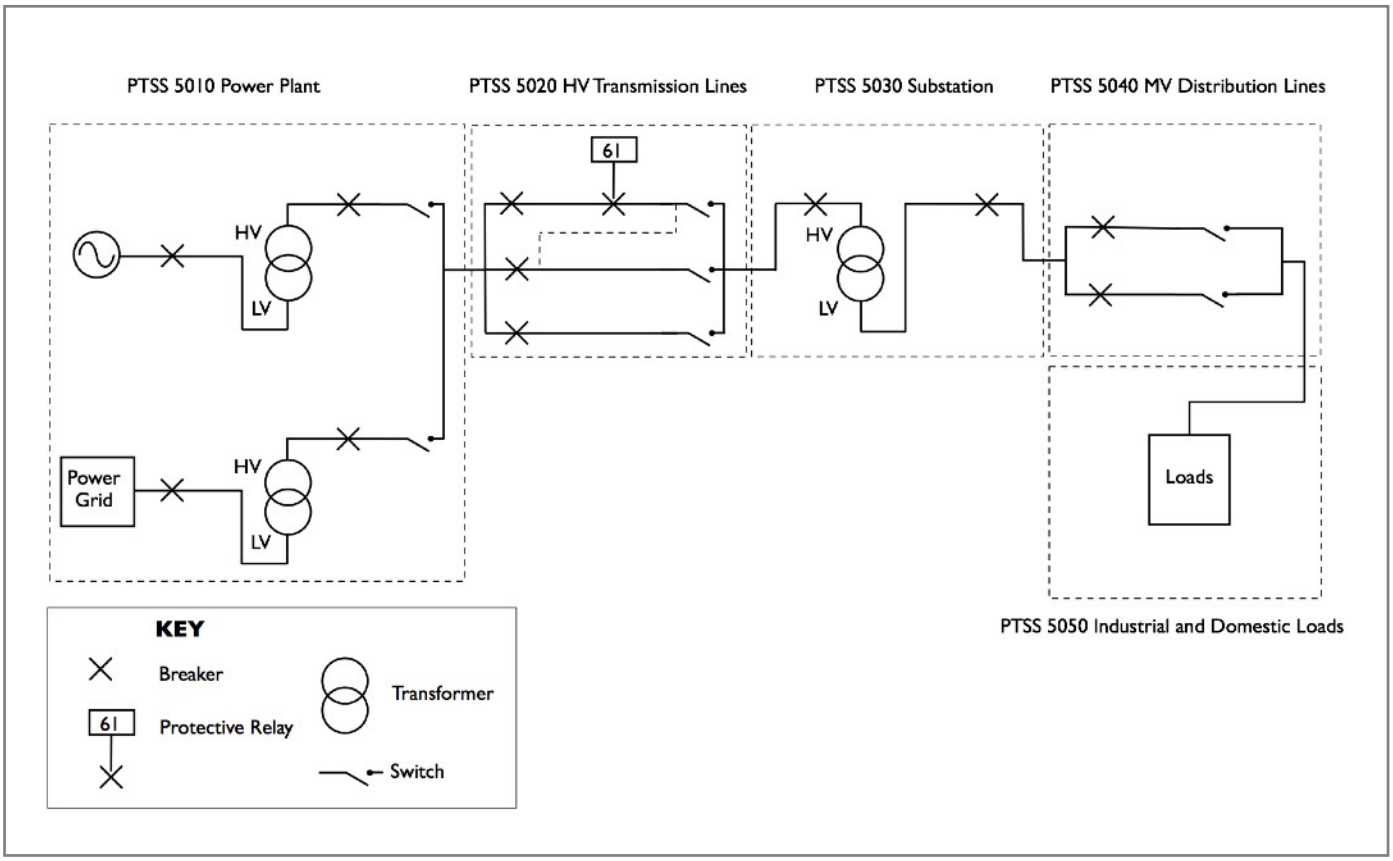
Standard circuit breakers and protective relays in the system enable both planned isolation and protective fault tripping and isolation to be investigated.

The digital multifunction meters built into the system can be used for all the diagnostics work.

They can be supplemented with commercial test equipment to help develop workplace familiarity.

Our training material cover the following aspects of this important training and certification area:

- **Requirements of statutory regulation/legislation**
- **Types of HV switchgear and their operation and maintenance**
- **Types of HV substation equipment, its operation and maintenance.**
- **Types of distribution systems and the equipment used**
- **Types of protective devices and their application**
- **Application of Electricity Safety Regulations to HV ring and radial distribution systems**
- **Issue of Permits to Work and Sanction for Test**
- **Methods of network operation**
- **Records and documentation**
- **Cable location and identification**
- **Testing/commissioning of electrical distribution equipment**



Training scenarios using the PTSS are based on standard single line electrical diagrams that represent different systems.

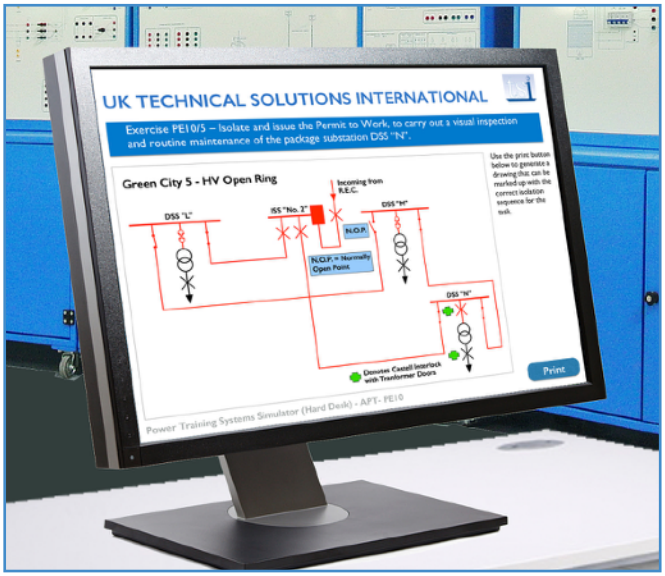
Trainees will be required to produce safety documentation such as permit to work/sanction to test, limitations of access and switching schedules, including annotated network isolation diagrams for each training task assigned.

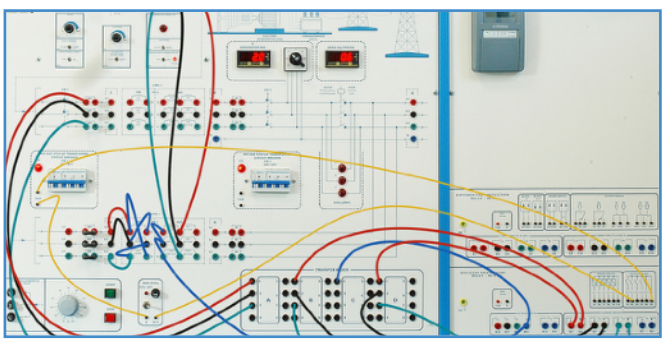
Because the PTSS system contains each of the elements of a HV network including substation and transmission lines, very realistic fault scenarios can be established.

Trainees will need to develop an understanding of the underpinning theory in order to be successful in the practical tasks. Experienced instructors can make use of the PTSS simulated facilities to do this.

To enable the full industrial certification to be carried out we have designed a specific workshop for the practical assessments that are carried out by the AP instructor.

This workshop contains all the tools and equipment needed to certify the trainees as competent in accordance with the AP standards (See page 47).





AP HV Commercial (Authorised Person) Course Package

The AP course pack includes the following:

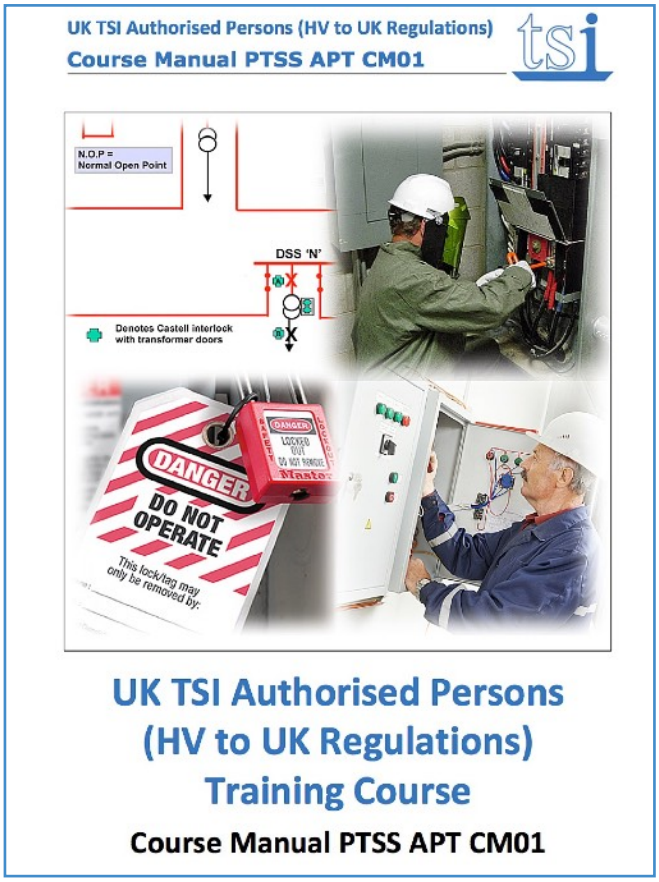
Printed Manuals

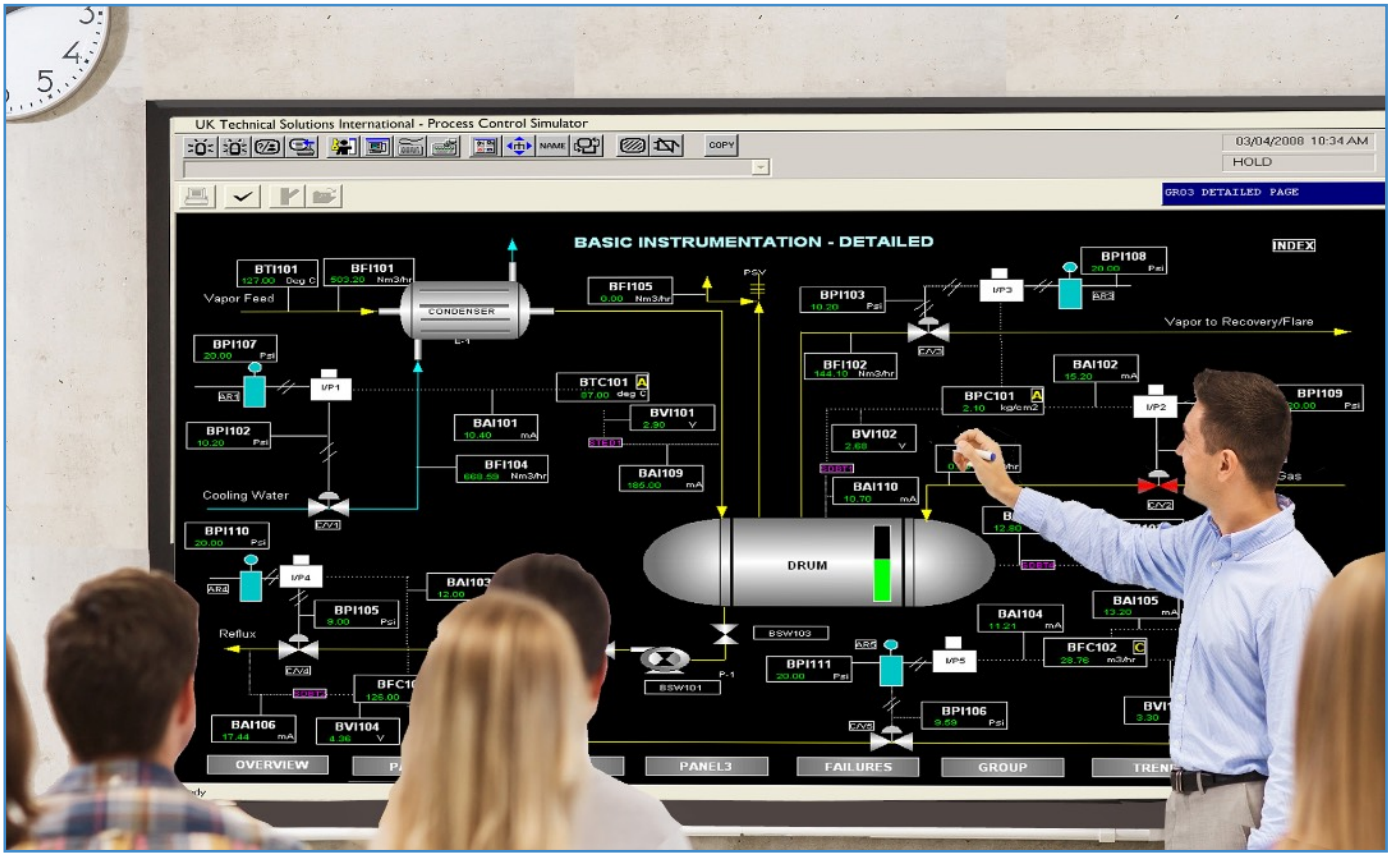
- **AP HV Certification Theory Manual - Trainee**
- **AP HV Certification Practical Assignments Manual - Trainee**
- **AP HV Certification Theory Manual - Instructor**
- **AP HV Certification Practical Assignments Manual - Instructor**
- **Set of Master Safety Signs and Notices**

eLearning Content

- **AP HV Certification Theory eLearning - Trainee/Instructor**
- **HV Certification Practical Assignments eLearning - Trainee/ Instructor**

In addition to the course materials, we offer a 4-day instructor training course that is delivered by one of our fully qualified and highly experienced AP HV trainers.





TSI-PCS/1000 Introduction to Process Control and Instrumentation Simulator

The TSI-PCS/1000 is a simulation software package that has been specifically designed to introduce Oil and Gas Sector trainees to the basic and advanced concepts of Process Control and Instrumentation.

The package consists of the following modules:

- On-Off Level Control
- On-Off Temperature Control
- PI & P Controller
- Pressure Controller
- Level Controller
- Direct and Cascade Control
- Split Range Pressure Control
- Ratio Control
- Feedback and Feed-forward Control
- Three Element Boiler Control
- Control Valve Characteristics
- Characteristics Co-Efficient of Control Valves
- Rangeability of Control Valves
- Interacting and Non-Interacting Level Systems
- Basic Instrumentation Troubleshooting System

Ideal for use as front-of-class presentations for the instructor, this package provides all the main control features such as Trending, Tuning, Alarms and Graphic Panels of a typical DCS system.

Trainees can manipulate Controllers (Take Controllers from Manual to Auto, Auto to Cascade, Change Set Values, change Outputs) and Digital Tags (Start/Stop, Open/Close) and monitor / study their effects on the process.

They can also tune the PID values of a controller.

Using this software, the trainee can learn:

- Basic concepts of measurement and Instrumentation
- DCS operations
- Basic controls – Flow, pressure, level, temperature
- Advanced control – Split range, cascade, ratio, three-element boiler, feed-forward / feedback controls
- Tuning of P.I.D values
- Instrumentation troubleshooting

Oil and Gas Sector Operator Training Simulators

TSI offer a comprehensive range of affordable, effective operator training solutions that can only be provided through high fidelity, dynamic, real-time simulation. Using simulations for operator training offers a number of benefits that include:

Plant familiarisation:

Each Simulator offers the best platform for learning process plant configuration, instrumentation, control system, critical parameters and their design values and normal plant operations.

Ensure smooth start ups:

Our simulators allow operators to become familiar with plant operation, while they increase their familiarity with the DCS controls and graphical layouts and displays. Continued training ensures increasingly smooth start-ups in the future.

Increase safety, reduce incidents and downtime:

Training personnel in a non-destructive environment enables you to validate emergency procedures controls

Testing modifications to controls can avoid damage. Instructors can trigger malfunctions (such as a trip) to test an operator's reactions and improve response reactions.

Maximise performance:

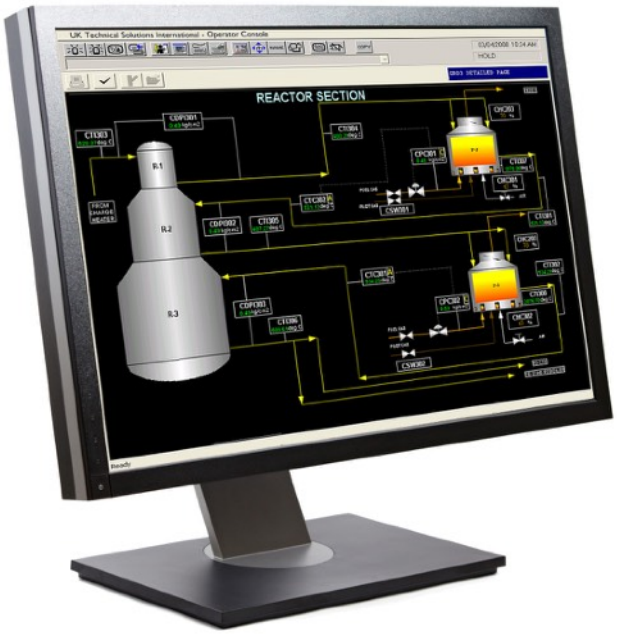
Our OTS simulators are based on rigorous first-principles models and actual DCS controls, allowing you to troubleshoot real process and control problems.

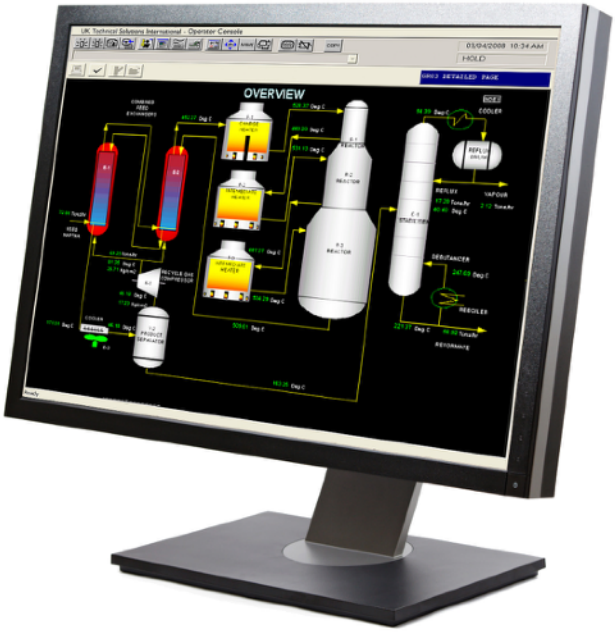
They unlock the fundamental understanding required to modify, test, and improve processes and maximise plant performance.

Benefits to Academic Institutions:

These Dynamic Simulators help to teach the students the fundamentals as well as complex process operations. They provide an opportunity for the chemical / instrumentation engineering students to know what is happening in the industry.

Simulator-trained students will have an edge over their counterparts in a competitive employment scenario with respect to their knowledge in Instrumentation and Control and Process operations.





TSI-ORSD/1000 Refinery Operations (Downstream) OTS Simulator

The TSI-ORSD/1000 is a simulation software package that provides a set of rigorous and detailed simulation models of Refinery process plants.

The package comprises the following modules:

- Atmospheric Distillation Unit
- Vacuum Distillation Unit
- Fluid Catalytic Cracking Unit
- Hydrogen Generation Unit
- Hydrodeslphurization Unit
- Catalytic Reforming Unit
- Continuous Catalytic Regeneration Unit
- Hydro-cracking Unit
- Sulphur Recovery Unit
- Amine Treating Unit
- Delayed Coker Unit
- Diesel Hydro-treater Unit
- Naptha Hydrotreating Unit
- Kerosene Hydrotreating Unit

Training Benefits

This dynamic simulator helps beginners, experienced operators and engineers to achieve the following objectives:

- To teach trainees and to recognise and understand the operating fundamentals of the Crude Oil Distillation process using dynamic simulation.
- To describe the operation of the Crude Oil Distillation process
- To recognise the main equipment found in the Refinery
- To use the DCS to startup and shutdown the various refinery processes using the documented procedures.
- To respond safely and efficiently to disturbances and malfunctions in the process

TSI-ORSU/1000 Gas Oil Processing Plant OTS Simulator

The TSI-ORSU/1000 is a simulation software package that provides a set of rigorous and detailed simulation models of Gas Oil Separation and processing facilities.

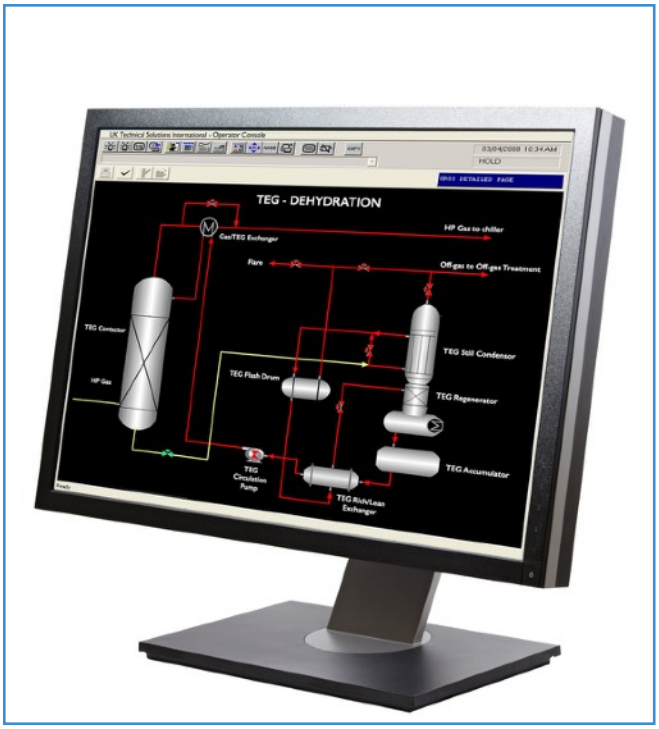
The package consists of the following modules:

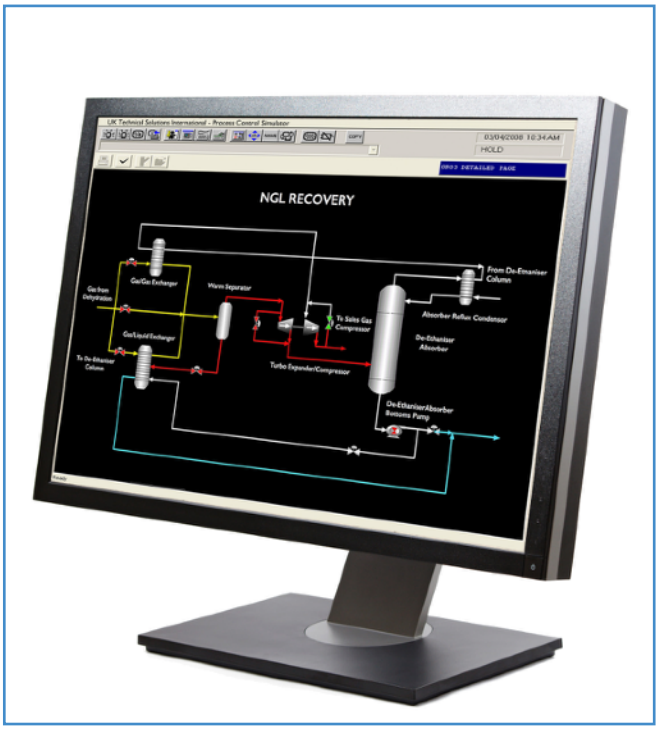
- Gas Oil Separation Plant (GOSP)
- Degassing Plant
- Gas Dehydration unit
- Gas Compression Plant
- LPG Unit
- NGL Recovery Unit
- LNG Plant
-

Training Benefits

This dynamic simulator helps beginners, experienced operators and engineers to achieve the following objectives:

- To teach trainees to recognise and understand the operating fundamentals of the different Gas Oil Processing operations using dynamic simulation.
- To describe the operation of the Gas Oil Processing operations
- To recognise the main equipment found in a Gas Processing Plant
- To use the DCS to startup and shutdown the various refinery processes using the documented procedures.
- To respond safely and efficiently to disturbances and malfunctions in the process

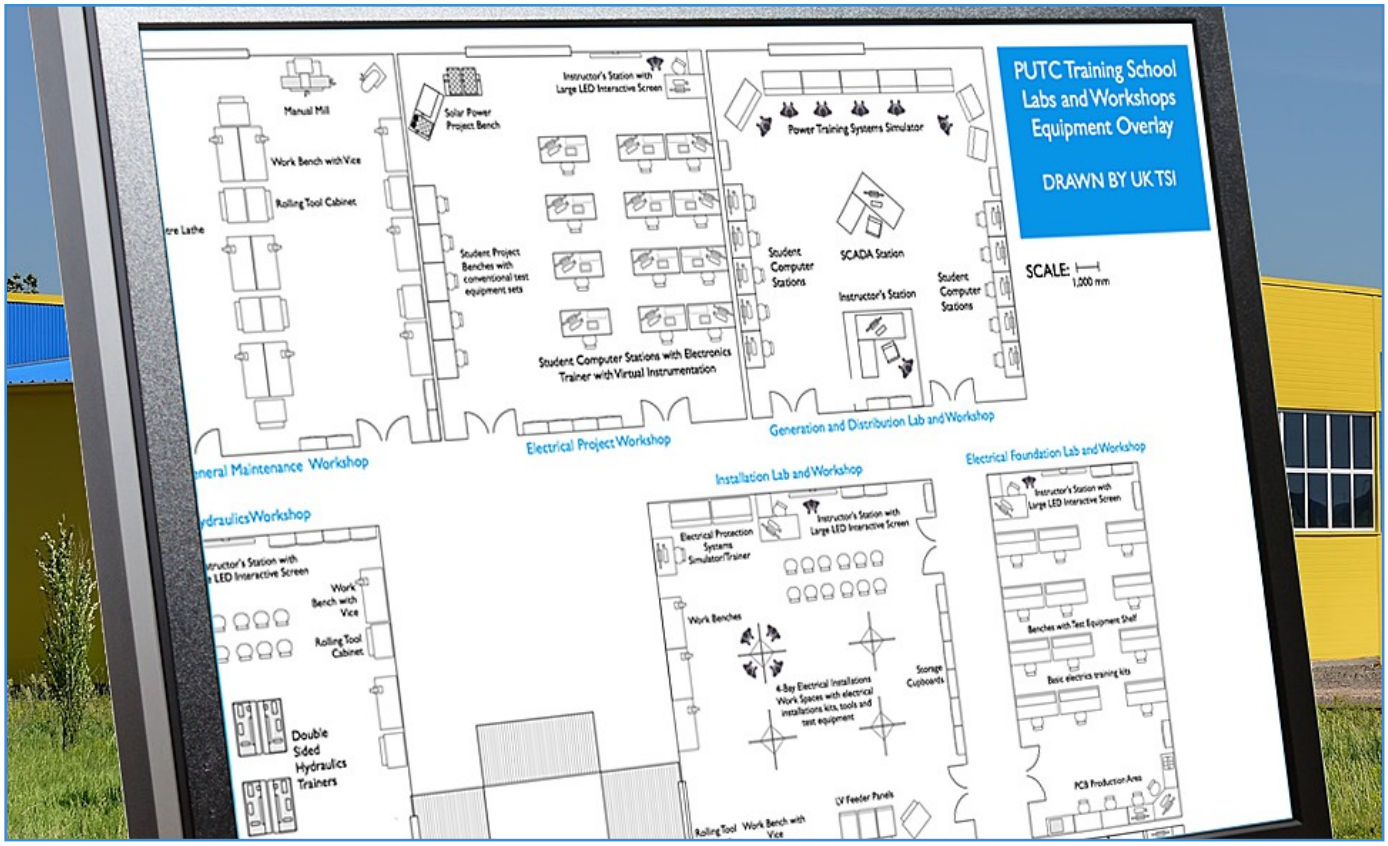




This matrix indicates the typical job titles found in power Utilities for maintenance technicians and engineers. I matches them to the labs and workshops detailed in this catalogue.

Laboratory - Workshop	Power Plant Operators	Power Plant Maintenance	Substation Maintenance	Overhead Lines	Underground Cables	Meter Testing and Installation	KWH Meter Calibration Technician	LV Electrical Installations	Wind Turbine Operations & Maintenance	Solar PV Installation and Maintenance	Stand by Generator Installation and Maintenance	Welder	Mechanical Maintenance
Electrical Installations (LV) and Maintenance Lab		■	■	■	■	■		■	■	■	■		
Computer Lab with Eng. Science and Principles	■	■	■	■	■	■	■	■	■	■	■	■	■
Electrical and Electronics Maintenance and Repair Lab		■	■	■	■	■		■	■	■	■		
Electrical Machines and Transformers Lab		■	■	■	■			■	■	■	■		
Mechatronics Systems Lab		■	■						■	■			
Power Station Operator Training Lab (Soft Desk)	■												
Power Systems Simulator Training Lab (Hard desk)		■	■	■	■	■			■	■	■		
Meter Test Lab						■	■						
Alternative Energy Power Generation Lab									■	■			
Transformer Testing Lab		■	■	■	■				■	■	■		
Power Cable Fault Location and Cable Jointing Lab				■	■				■	■	■		
Stand by Generator Repair and Maintenance W/S											■		
Transformers (HV and LV) and Switchgear Lab		■	■	■	■				■	■	■		
AP OJT Workshop		■	■						■	■			
Welding Workshop		■	■	■	■						■	■	■
Mechanical Workshop		■									■		■

Workshop and Lab Planning



The design of workshops and labs is an important part of planning any new training facility. At TSI we work on the principle that our labs and workshops have to support the delivery of the training programmes that the client will be delivering in the facility.

Practical work will always require a larger space allocation per trainee as compared with theory studies in regular classrooms.

Computer suites are part of the mix in a blended learning solution and these have to be designed to accommodate current a future trends in ICT.

In most instances we would recommend that these computer rooms are air-conditioned to provide a comfortable working environment for staff and trainees.

Labs and workshops will have to have different floor areas depending upon the type of work that will be carried out in them. For example a workshop where HV transformers and Switchgear will be worked on will require more floor space than a lab where an electronics programme is going to be delivered.

Other considerations are the working height required in the workshop and the outside access if heavy equipment is to be installed.

Floor loadings also have to be considered when designing a practical workshop or lab where very heavy equipment has to be located. Forklift truck access will almost certainly be required and this has to be addressed.

Workshop and Lab Planning

As part of the planing process, our designers will often work with a client's architectural CAD drawings to create detailed equipment overlays.

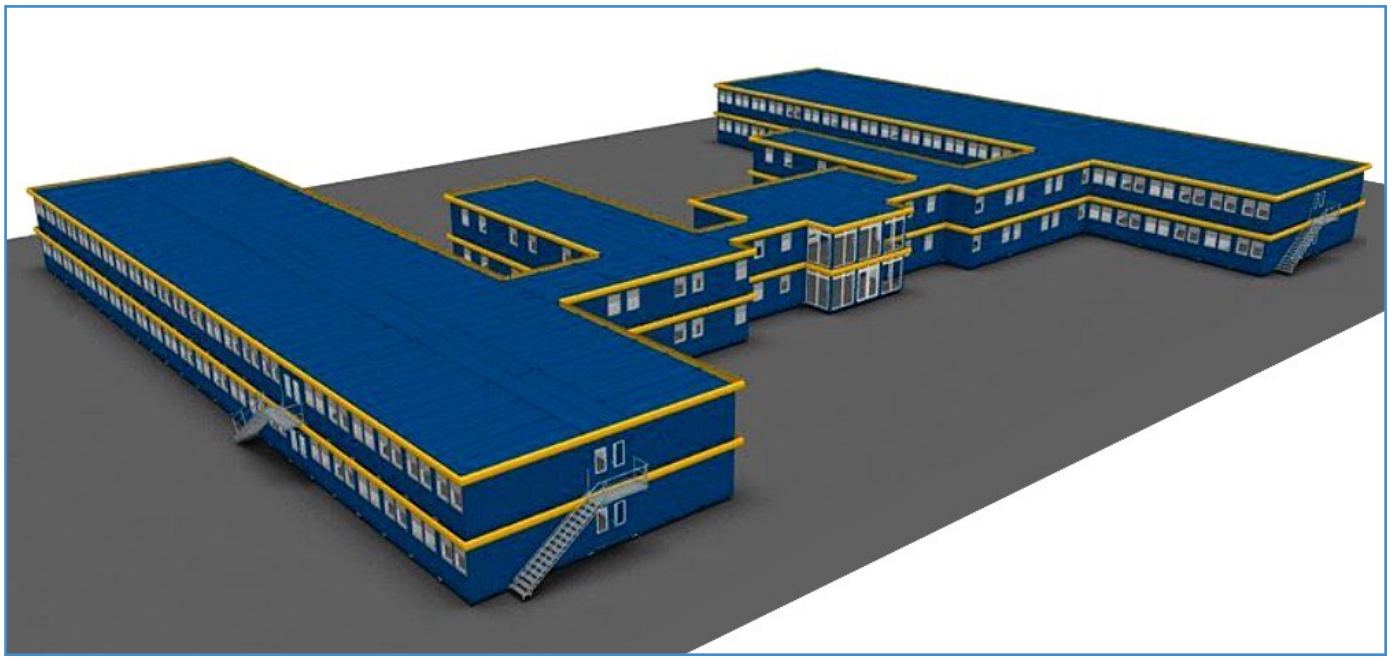
These will show all the equipment in situ, single and three-phase power connections, furniture, benching IT services and storage.

Where no building designs are available we will produce our own complete drawings that can be passed to an architect.

We create flexible training spaces using modular furniture which allows spaces to be used for both practical work and front-of-class presentations by the Instructor.

We know that modern, well design and equipped labs and workshops play a major part in student recruitment, motivation and attainment.

Pre-built Training Facilities



Where there is a requirement for a training centre, but no suitable facility is available, we are able to provide a modular building solution.

Based on a standardised series of modular container-based buildings, our designers will create a power training facility that provides practical labs, workshops and classrooms.

They can also include all the supporting facilities such as a cafeteria and student and staff common rooms.

There is even the option to add student and staff accommodation if it is required.

Please contact TSI or your local representative if you would like to discuss a turnkey Mobile Training Centre.

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