SIMULATOR FOR THE STUDY OF ELECTRICALLY DRIVEN SHIPS

Mod. NEP-1/EV

ELECTRIC MARINE PROPULSION

At present most modern civilian vessels and warships are electrically driven for the several advantages offered by electric propulsion with respect to other systems.

The early electric propulsion systems used DC motors to drive the propellers, and DC generators to power the motors. A typical diagram was Ward Leonard connection (also used in railroads and in oil rigs).

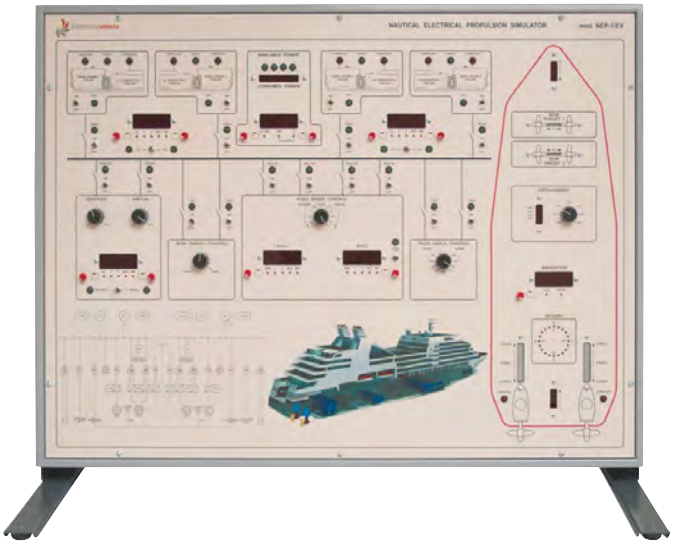
Then, when thyristor (SCR) AC-DC converters replaced DC generators, all the power consuming devices could be connected with a unique power supply unit, just like in a power station. In fact, the output power is three-phase alternating power part of which is shunted to the converters that drive the DC propulsion motors; the remaining power is used for the other services of the ship.

The servicing costs of DC motors are high. Therefore they have been replaced by (synchronous and asynchronous) three-phase AC motors powered by electronic drives, commonly known as inverters.

At present this last propulsion method is used in a lot of ships: big cruise ships, oceanographic research vessels, ice breaker ships, factory ships, oil rig platforms and vessels, vessels for laying gas / oil pipelines and cables; several types of warships, etc…

Electric propulsion offers a lot of advantages; in detail:

- it does not need the long, heavy and bulky shafts, supports, bearings, gearboxes, etc… which connect the prime mover with the propellers. In fact, the prime movers must be installed where required by the architecture of the ship, whereas propulsion motors are much smaller and lighter so that they can be installed near the propellers. Only flexible cables connect motors with the converters and inverters powering them.
- Electric propulsion enables to eliminate the rigid longitudinal shafts housed inside the hull of the ship. In fact, electric motors can be housed in pods outside the hull, with the possibility of rotation. Other motors are used for side propulsion and operation of the ship.
- What explained in the previous section leads to realize that the operation and dynamics of a modern ship are much more flexible (and complex) than those of mechanically driven vessels. This type of propulsion can be compared to that of VTOL aircrafts with respect to traditional take-off aircrafts.



- Modern electric propulsion enables a more accurate control of ship dynamics: in fact, even the propulsion mode (constant power or torque) can be chosen.
- Moreover noise level and vibrations will be reduced, especially at low speeds. This factor is very important in cruise ships for passengers' comfort.

AIM AND TRAINING PROGRAM:

This simulator is proposed as a **theoretical-practical introduction** to two basic topics of modern marine propulsion:

Study of electric marine propulsion systems:

- generation of electric power (prime movers, alternators),
- motors used in marine propulsion,
- electronic drives,
- accessory elements for the control of electric power,
- examples of circuit configurations according to the type of ship,
- examples of layout of the components inside the ship.

Study of ship dynamics:

- towrope resistance and its constituent factors;
- calculating the necessary power for propulsion;
- efficiency of energy chain;
- examples of movements of the ship according to the used drives.

TECHNICAL CHARACTERISTICS:

This simulator is a PC (not included)-aided vertical tabletop unit with a wide fore panel including silk-screen colour prints.
These silk-screen prints include: cross section of a ship showing the layout of propulsion elements, single-wire circuit of electric installation, the available controls and a view of the hull with the corresponding displays and controls for the movement of the ship.
The included software enables to display the parameters of the panel and the modification of the set values.

Power generation:

- 4 diesel generating sets of 7200 kVA. Each set includes 3 LEDs: a LED indicates READY and the two other LEDs signal the overload of diesel and of the alternator; they are provided with the corresponding switch for simulating the parallel of the alternator with bars;
- 2 displays indicate the parameters of alternators: Hz, V, A, kVA, kW; with 2 selectors: one for generators and the other for the parameters;
- instrument for determining the consumed power versus the available power; it includes a bargraph, 4 LEDs and a digital indicator.

Control of electrical consumptions:

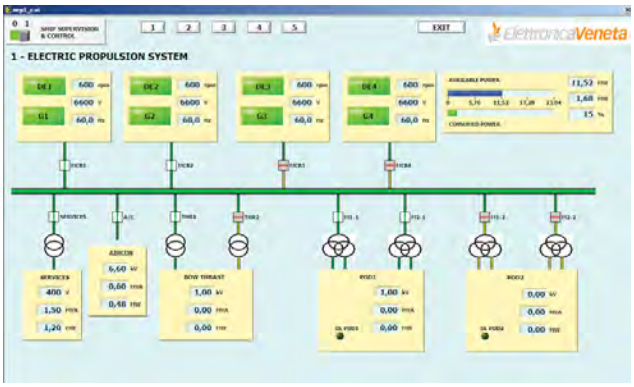
- Block of Services and Aircon: it includes 2 potentiometers of 0-100% to set the desired values of these loads and a digital indicator of the values of consumptions;
- Block BOW THRUST CONTROL: control of the two bow motors for side moves; it includes a bidirectional potentiometer for the drive in both directions of movement;
- Block PODS SPEED CONTROL: control of the propelllers of stern pods; step control of the speed in both rotation directions. Each POD can supply 50% or 100% of total rated power; this is the reason why 4 switches are included. Each POD is also provided with its own digital indicator;
- Block PODS ANGLE CONTROL: control of the angle of the pods of stern propellers. Both pods turn in parallel (same angle).

Indicators and blocks of ship movement:

These indicators are shown in the silk-screen print of ship outline.

- Indicator of towrope resistance: this is a red bargraph available at the bow of ship outline. It indicates the force opposing the movement of the hull; related with control DISPLACEMENT.
- Blocks BOW THRUST 1 and BOW THRUST 2: two green bargraphs placed perpendicularly to the longitudinal axis of the hull. The control of these motors is available in block BOW THRUST CONTROL.
- Block DISPLACEMENT: it includes a red bargraph and a potentiometer of 60-120%; it simulates the load of the ship (100% indicates the rated load) that defines the immersed part of the hull (called QUICKWORK). The Quickwork is the main component of towrope resistance.
- Block NAVIGATION: digital indicator of ship speed in KNOTS and in DEGREES (angle of longitudinal axis with respect to NORTH).
- Block HEADING: 20-LED digital indicator for the direction of movement of the ship. This is the graphical version of unit DEGREES of Block NAVIGATION.
- Blocks POD 1 and POD 2: two green bargraphs available at stern; they indicate the power output by each propulsion POD. Each POD is provided with a LED for overloads.
- Indicator of BACKWARD towrope resistance: red bargraph indicating the force opposing the movement of the hull; related with control DISPLACEMENT.

Power supply: 230 Vca 50 Hz single-phase - 400 VA
(Other voltage and frequency on demand)
Dimensions: 800 x 600 mm (panel)
840 x 450 x 680 mm (framework)
Weight: 35 kg



REQUIRED (NOT INCLUDED)

- **PERSONAL COMPUTER**

SUPPLIED WITH

THEORETICAL-EXPERIMENTAL HANDBOOK