

THE USE OF COMPUTER SIMULATOR OF SHIP POWER PLANT IN EDUCATION OF MARINE ENGINEERS

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Abstract: Along with the development of technologies used on ships and their full automation, there are more and more restrictive requirements concerning the education of future engineer officers and electro-technical officers. Global rules on training students force universities to ensure a professional teaching base. Training simulators operating in virtual reality are currently one of the best ways of educating students and verifying the level of skills among officers.

One of the basic safety conditions on ships is to ensure continuity of power supply for all devices. Knowledge of the functioning of marine power plant becomes crucial.

The article presents possibilities of using the electric power plant simulator from Gdynia company under the name UNITEST in the process of educating students of the Faculty of Mechanical Engineering at the Maritime University of Szczecin.

Keywords: quality of education, STCW Convention, marine power plant simulator, Computer Based Training (CBT).

Introduction

Implementation of the idea of an unattended power plant on ships results in the increased automation of control and monitoring process. At the same time, shipowners tend to reduce the number of crew primarily for economic reasons. The increasing automation and computerization of vessels and minimization in the number of crew lead to the reduction of possibilities in the transfer of professional skills from a trainee to a chief engineer. The main tasks in education of future engineer officers and electro-technical officers are realized by maritime universities, and in the case of already practicing officers – by OTC (Officer Training Center).

Development of marine technologies and above all their automation result in a continuous expanding of the curriculum while retaining the duration of existing studies or courses in OTC. No possibility of extending the learning time is

connected with the search for new educational technologies for the realization of program objectives.

One of the most effective educational technologies is a simulator. The progress in computer techniques allowed programmers to create Computer-Based Training (CBT). These applications include a full multimedia range: 2D and 3D graphics, animation, photos, audio files and system descriptions.

CBT simulators used in the shipbuilding industry are realized on the basis of guidelines presented in the STCW Convention (International Convention on Standards of Training, Certification and Watchkeeping for Seafarers) [1], signed in London on 7 July 1978, which entered into force on 28 April 1984 and from that date it is in force in Poland (Dz. U. of 1984, No. 39, item 201 and 202). The STCW Convention has been modified by the introduction of two codes in 1995. It contains a list of the minimum theoretical and

practical knowledge, skills and required certificates and permissions necessary to perform tasks of mariners and officers. At the conference of the parties of the STCW Convention, which took place in 2010 in Manila [2], significant amendments to the STCW Convention (“amendments from Manila”) were introduced. The Convention in its records determines a requirement of using CBT simulators in the professional training of marine officers.

Advantages of the use of simulators in the education of crews are as follows [3]:

- Lower price of the simulator in comparison to the real object,
- Constant level of repeatability for a teaching process possible to achieve,
- Reduced time of education,
- No health consequences of a practitioner in the course of practices in the field of behavior in emergency situations,
- Possibility to carry out any operations at “any” time,
- Minimization of costs specifically related to the material losses that usually occur during the training of real objects,
- Ease in the system’s expansion,
- Possibility of a more objective assessment of a practitioner by the implementation of a unified testing program,
- High flexibility due to a modular architecture of the simulator.

The publication [4] proposed the division of marine power plant simulators for four classes:

- Class B (Basic Class of simulators) – simulators containing CBT software (Computer Based Training) and simulators of basic marine devices, such as: auxiliary boiler, reefer stores, steering engine, etc. This family of simulators usually has the form of a computer program without any additional consoles. It causes that their cost is moderate. Such a program can be run from an ordinary single PC station;
- Class P (Personal Class of simulators) – mainly hybrid simulators and so-called dedicated simulators (hybrid and part task simulators) designed for the training of one person. They are offered as a position with and without supervision. The user interface is similar to the interface of simulators from class B, but additionally it has in the offer a console in the form of a desktop;
- Class F (Full Class of simulators) – simulators containing a highly-advanced software that

largely reflect the realism of simulated phenomena. Presence of indicators, switches and control button in the console and real sounds of a certain operation are almost obligatory requirements in this class. The main disadvantage of these simulators is their very high price, while the great advantage is the ability to simultaneous training of a group of mechanics (e.g. maneuvers);

- Class S (Special Class of simulators) – simulators, which are more complex and designed to perform more tasks and operational activities in comparison with the class B. These simulators hardly contain theoretical information and operating instructions about the simulated process.

The article presents the use of CBT electric power plant simulator (class B) from UNITEST Company to raise knowledge of safety systems in electric power plant and operating procedures by future and current engineer officers and electro-technical officers.

Structure of the CBT simulator from UNITEST Company - Electric Power Plant

In modern marine power plant, control and measuring equipment is mainly located in a control room (CR), in which an engineer officer oversees its work. ELECTRIC POWER PLANT simulator from UNITEST Company [5] visually maps the operator panel in CR and fields of generating sets of the main switchboard. Electric power plant implemented in the simulator consists of 3 Diesel-Generator generating sets. Internal combustion engines (type: L28/32H) from MAN Company and GDB-1410S/02 current generators produced by DOZAMEL Company constitute a part of these sets. Moreover, an emergency generator room with D2866 E generating set from MAN Company and a current generator (STAMFORD UCM 274 G) are included in the electric power plant’s simulation program.

The main elements of Electric Power Plant simulator:

1. Main switchboard (MSB):

- Generator 1,2,3, control panel (Fig. 1),
- Prelubricating pumps control panel,
- Synchronisation panel (Fig. 2).

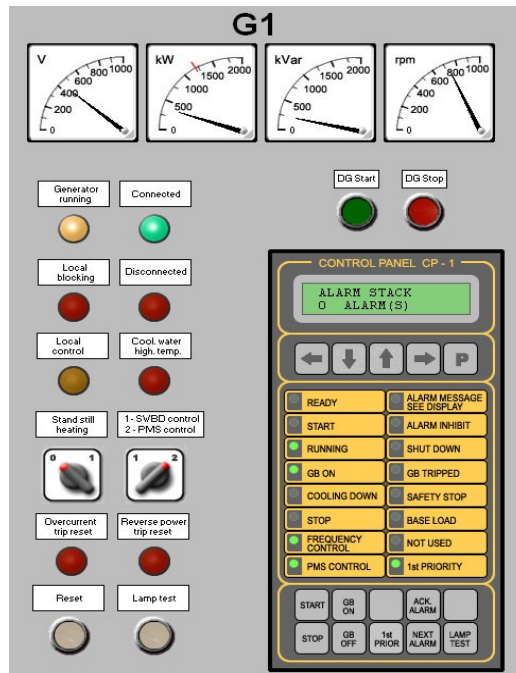


Fig. 1. Generator control panel [5].

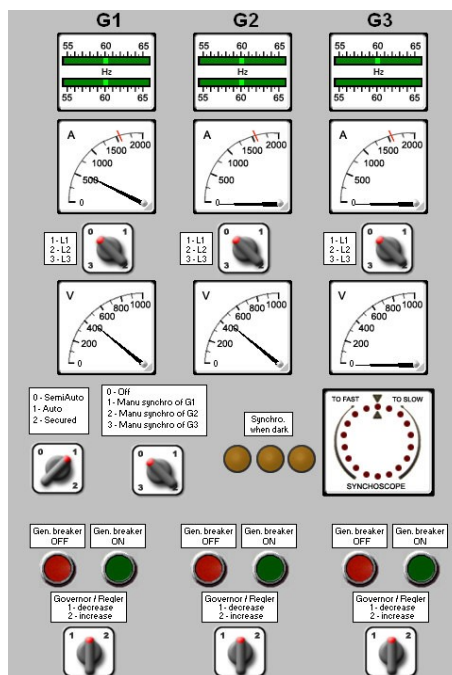


Fig. 2. Synchronisation panel [5].

On the panel of current generators located on MSB (Fig. 1), there are gauges, main operating states signaling and emergency states, switching the mode of operation in a power plant from manual to auto, as well as control panel of the auxiliary engine. Synchronizing panel (Fig. 2) enables the semi-automatic or

manual synchronization of current generators by using synchroscope or “synchro when dark”.

2. Power Management System

In the work of electric power plant we can distinguish two states: normal operation, which includes Power Management (PMS) and emergency work after blackout. PMS allows for

maintaining an optimum power reserve and shutting down next receivers.

Fig. 3 presents PMS work algorithm with the maintenance of absolute power reserve. When the load of one set has the amount of 80%, after a delay from 1 to 30 seconds, the second generating set activated for a parallel operation. After exceeding 85% of the load in two sets, the

second generating set is activated. Deactivation of successive generating sets from a parallel work is realized after a decrease of load below 70%.

In the simulator of Electric Power Plant, there is possible to check the PMS algorithm by changing the load in a power plant (Fig. 4).

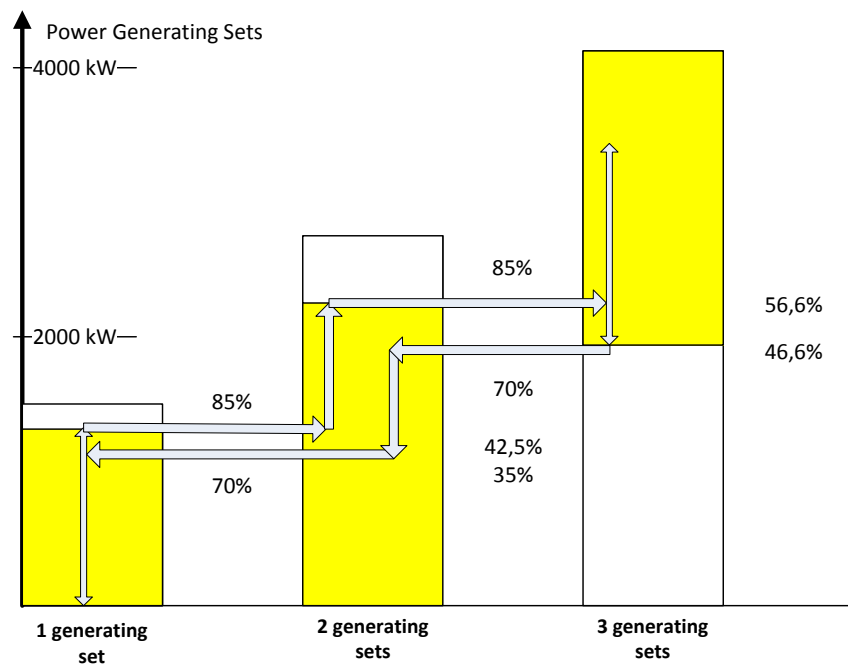


Fig. 3. PMS work algorithm with maintaining the absolute power reserve [7].

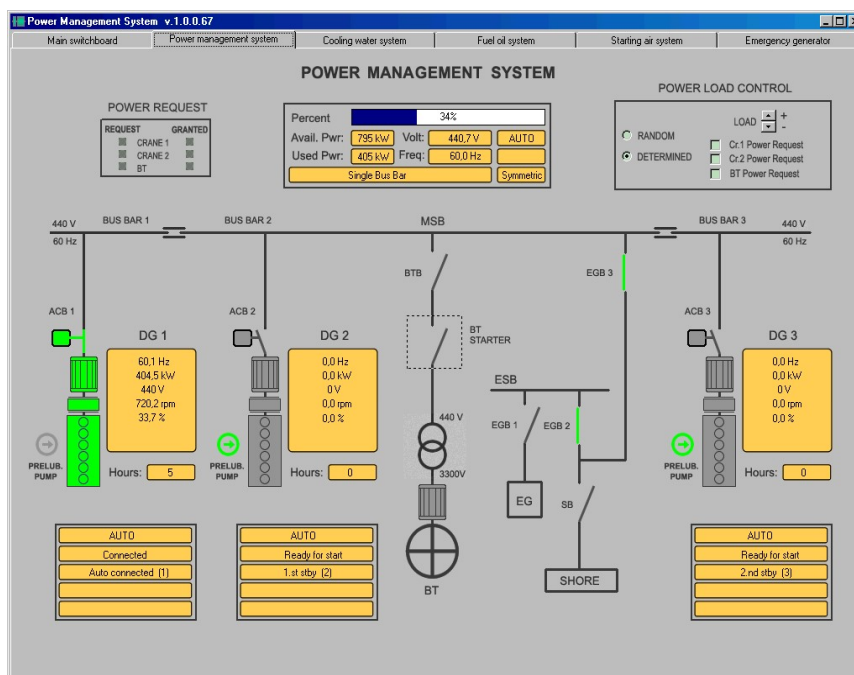


Fig. 4. Power management system [5].

PMS module also allows controlling the work of generating sets when switching on a very powerful load.

3. Power supply systems for auxiliary engines:

- Central cooling water system (Fig. 5),
- Starting air system (Fig. 6),
- Fuel oil system (Fig. 7, 8).

Three main power supply systems for auxiliary engines are implemented in the Electric Power Plant program. Power plant operator can choose the scenario proposed in the program (running generating sets – the electric power plant run in accordance with PMS) or operate the power plant through the preparation of power systems. Preparation of the cooling system is connected with the opening of valves of sea water on the

path of water from Kingston valves to outboard valves via the sea water pump and fresh water coolers. In the next step, a line of fresh water is opened through the opening of valves and activation of the fresh water pump (Fig. 5).

Preparation of the starting air system (Fig. 6.) involves the opening of cooling valves for compressors and valves of compressed air to power auxiliary engines and setting the operation of compressors in an appropriate mode.

Auxiliary engines are adapted to operate on a heavy fuel (HFO) or a light fuel (DO). The operator selects an appropriate fuel system by opening adequate valves (Fig. 7) and activates HFO feed pumps and booster or DO booster (Fig. 8) on the control panel.

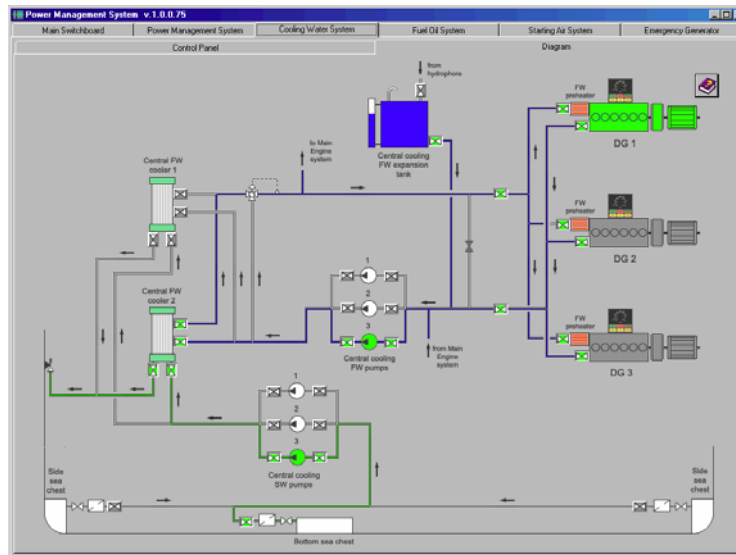


Fig. 5. Central cooling water system - diagram [5].

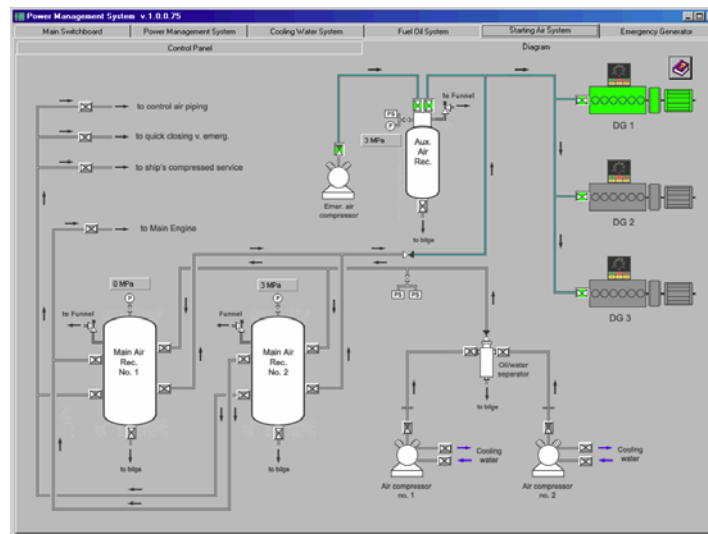


Fig. 6. Starting air system - diagram [5].

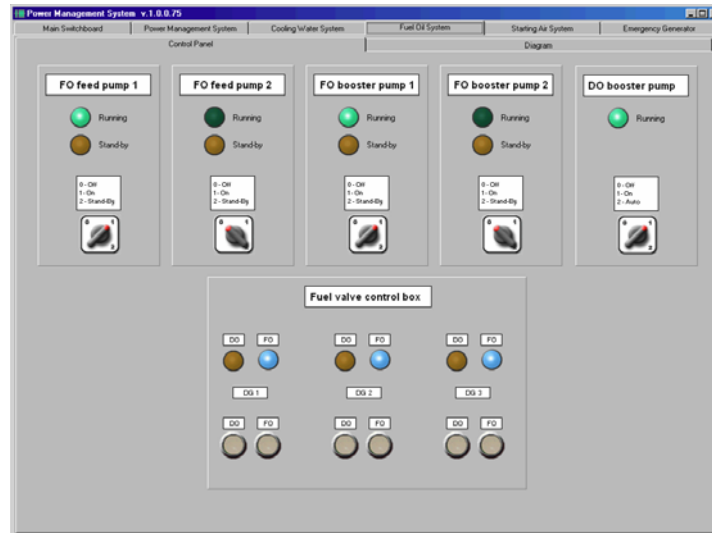


Fig. 7. Fuel oil system – control panel [5].

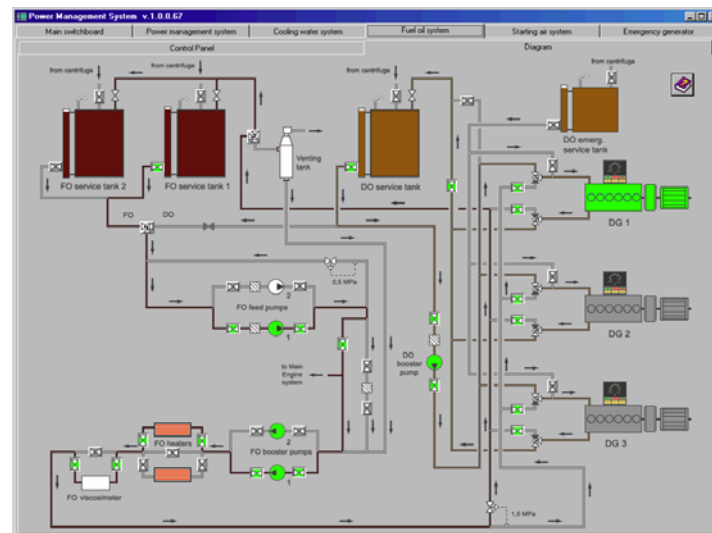


Fig. 8. Fuel oil system – diagram [5].

In the simulator of Electric Power Plant, it is possible to check some securities of current generators, as well as the safety system of auxiliary engines. The operator can “disrupt” the proper operation of power supply system of auxiliary engines, which in turn may lead to their stop and activation of the process of starting the next generating sets.

4. Emergency Power Plant (EMP)

EMP module is an integral part of PMS. The operator can observe on PMS panel (Fig.) the connection between MSB and ESB. Understanding the operating status of EGB1,

EB2, EGB3 breakers and a typical solution of combining MSB and ESB is crucial. The Emergency Power Plant Simulator consists of the following parts (Fig. 9.): Fuel Oil Tank – 1; Diesel Generator – 2; Diesel Generator Control Panel – 3; Emergency Transformers Boxes – 4; Battery Charger – 5; Emergency Switchboard – 6.

For realignment of a room, EDG is presented in three-dimensional space. The operator can select appropriate elements of EMP system by going to detailed elements of the system.

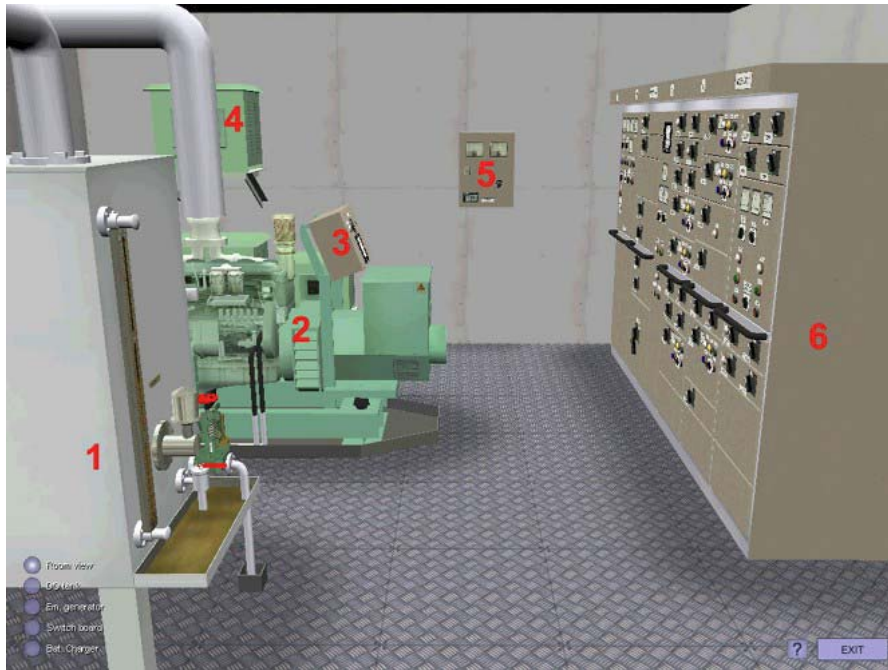


Fig. 9. Emergency Diesel Generator – general view 3D [5].

Automatic or manual starting of EDG is possible in the simulator. Diesel engine starting can be held via starter batteries or operated by the operator through the hydraulic starter. Thanks to EG panel (Fig. 10), the operator can carry out a test starting of EG by checking

parameters of work for diesel engine and generator. By selected EDG Emergency Switchboard in the room (6 Fig. 9), the operator can become familiar with the type of receptions powered from ESB.

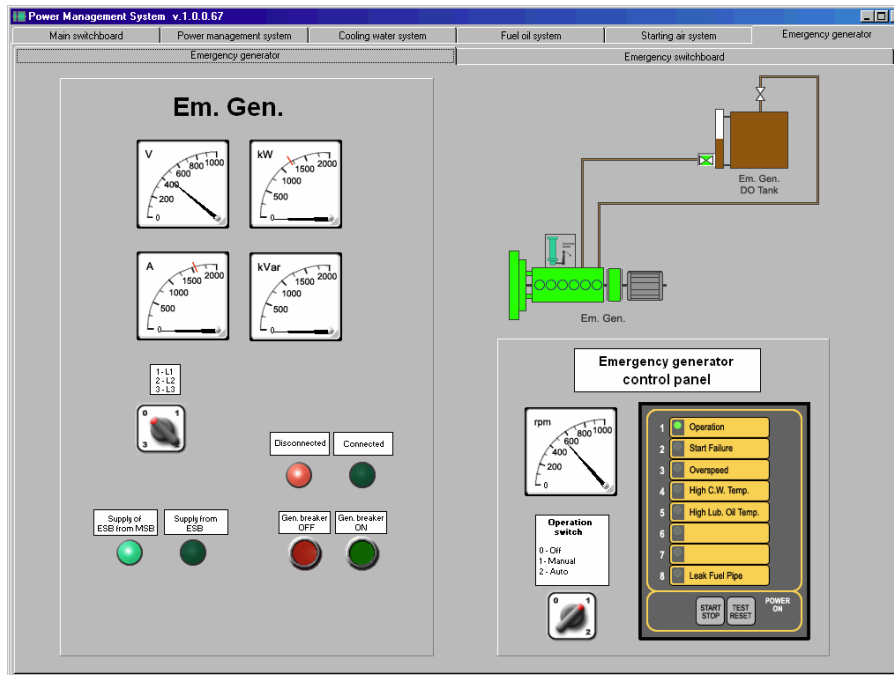


Fig. 10. Emergency generator [5].

Conclusions

Due to the emergence of new marine specialty in Maritime University [7] introduced new teaching tools. Computer simulator of electric power plant for marine vessels presented in this article can greatly expand educational base for future and current engineer officers and electro automation officers. Realization in the virtual

environment of the electro power plant ensures a sense of realism, and at the same time does not entail the risk of negative consequences (errors) that may occur during the traditional training.

An advantage of the presented class B simulator (CBT) in addition to its main feature – familiarization with PMS work algorithm – is its low cost.

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