The use of the simulator a tool for training staff LNG terminals

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Abstract
Some possibilities of using computer simulation methods for LNG terminals operators have been presented in this article. A simulator in a training system is a very crucial tool because of practical application of the gained skills and knowledge. Maritime University is the only educational centre in Poland having the teaching base built on modern technical solutions allowing to train operators for LNG terminals.

Introduction

Having in mind the forecast for a considerable increase of natural gas consumption, the large potential to meet its daily requirements is attributed to LNG (*Liquefied Natural Gas*). It is produced from natural gas, after the removal of contamination and heavy hydrocarbons and is next condensed in the atmospheric pressure by means of lowering the temperature to – 160°C. The volume of LNG is approximately equal to 1/600 of natural gas volume in normal conditions, which allows for a relatively cheap transport at long distances. Natural gas transport by means of land installations is impossible and non – profitable but in the condensed form it can be shipped or transported by means of special LNG autocisterns at shorter distances [1].

Maritime University has developed its training base that allows present and future marine crews and land staff to gain knowledge and necessary qualifications and skills in that field.

That has been the answer to the dynamic development of Polish marine economy with safe liquid and gas fuels transport in mind. It is done, among others, by means of the building of condensed gases terminal in Świnoujście.

At present, the best way to improve qualifications any staff is training on different types of simulators. This type of training provides maximum real situations at minimum consequences due to made mistakes / errors. Proper preparation for the job "to be done" for the LNG terminal service is simply essential. Yet, there is LNG Operator Terminals Simulator [OTS] which plays an important role in the training process of the staff responsible for gas receiving, re-gasification and gas supply service to land network. It belongs to Polskie LNG and system operation training or system procedure supervision training are performed on it, at Maritime University of Szczecin.

LNG Terminal General Simulator simulates a standard LNG terminal and comprises the infrastructure for discharging of units transporting LNG, devices for LNG gas storing, boil off gas installations, degasification system and gas supply service.

The schema is presented in figure 1.

Systems simulated on the LNG operator training simulator:

1. Discharging system – from the ship – consists of 3 unloading arms: an arm for the boil off gas return [BOG] to the ship, an unloading arm, a boil off gas arm and a desuperheater for the gas return installation.
2. LNG Storing system, comprising 3 storing tanks equipped with 9 low pressure pumps (LP pumps).
3. Boil off gas system management comprising a desuperheater on the suction side of compressors, a separator on the suction side of compressors, a low pressure tank for condensate, 3 boil off gas compressors, a recondenser and a desuperheater.
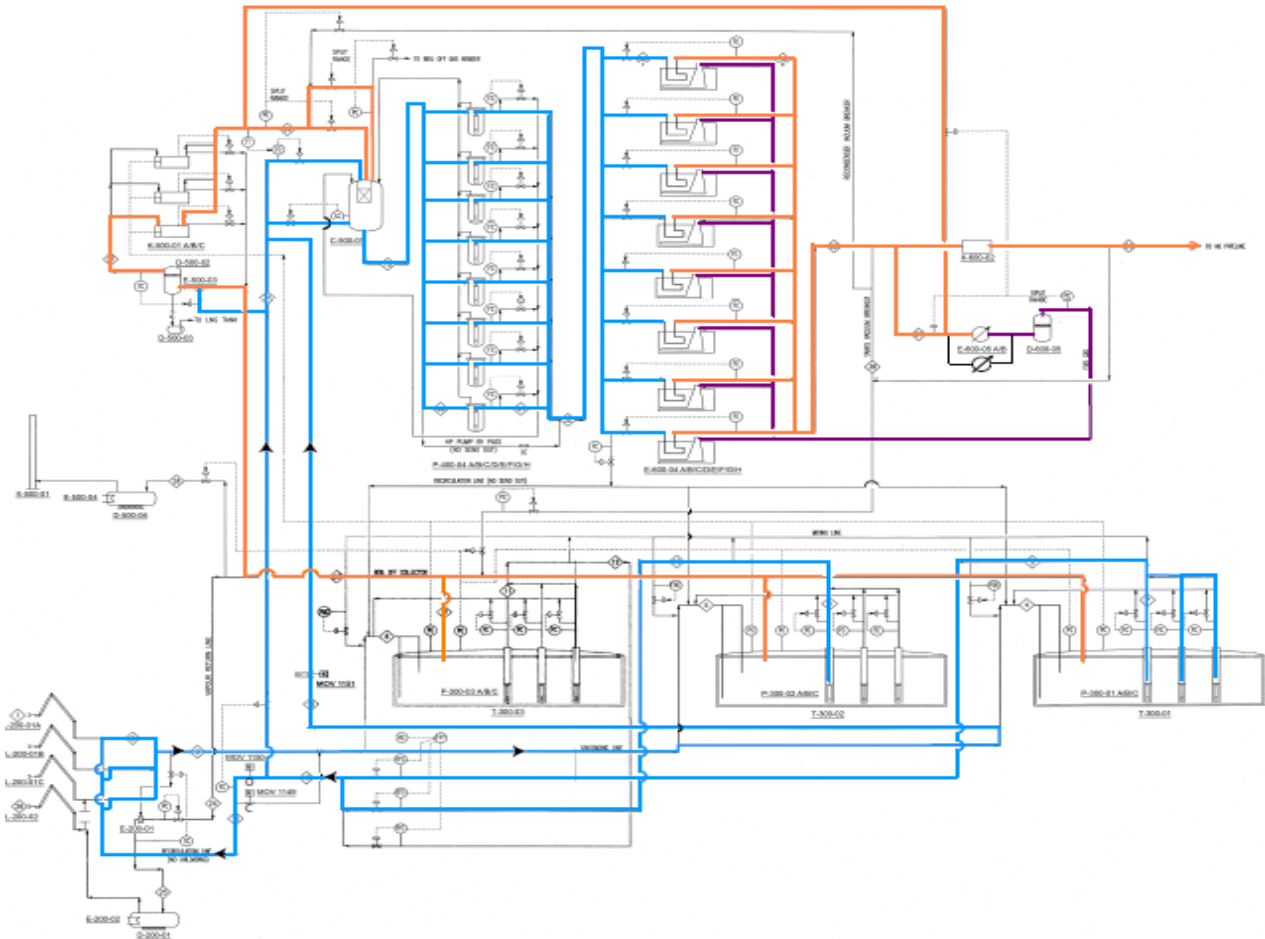
Fig. 1. OTS simulator systems schema

4. Dispatch system comprising: 8 high pressure dispatch pumps (HP pumps), 8 regasifiers SCV (Submerged Combustion Vapouriser – they burn the boil off gas in order to get necessary heat for LNG regasification), gas fuel installation equipped with two preheaters and a separator.
5. Exhaust system comprising a tank for the condensate from the exhaust and a ventilation stack.

The simulator works based on highly real dynamic simulations platform that has been provided by a set of well developed technological components and libraries based on fundamental technical principles.

Training supported by the simulator is created on scenarios and virtual environment which allows the trainees to get to know typical and exceptional situations that may happen during the operation in a relatively short time, even before starting of the operation. The trainees have a choice of many programmed scenarios. After the start of the simulator, the training participant can remotely begin one of the procedures (for example start, shut down, by-pass) or respond to one or many alarms signalling deviation of parameters from normal values.

The platform also contains special tools for the instructors dealing with the training to change one or a few working parameters, to generate disturbances (for example stop or emergency shut off of a device, introduction of deviation for a sensor indication etc.). These operations allow to check how the trainees manage some problems in non-standard situations.

There are 4 monitors in use by the LNG OTS and each of them shows the following information (Fig. 2):

Screen 1 – graphic presentation of the terminal (no change possible) (Fig. 3);

Screen 2 – list of alarms, graphic elements of Human Machine Interface, specific screens or front panel (depending on the operator's choice);

Screen 3 – main tool bar, graphic elements of Human Machine Interface, front panel, trend screens (Fig. 4) (depending on the operator's choice);

Screen 4 – status and alarm line, graphic elements of Human Machine Interface and one front panel (depending on the operator's choice).
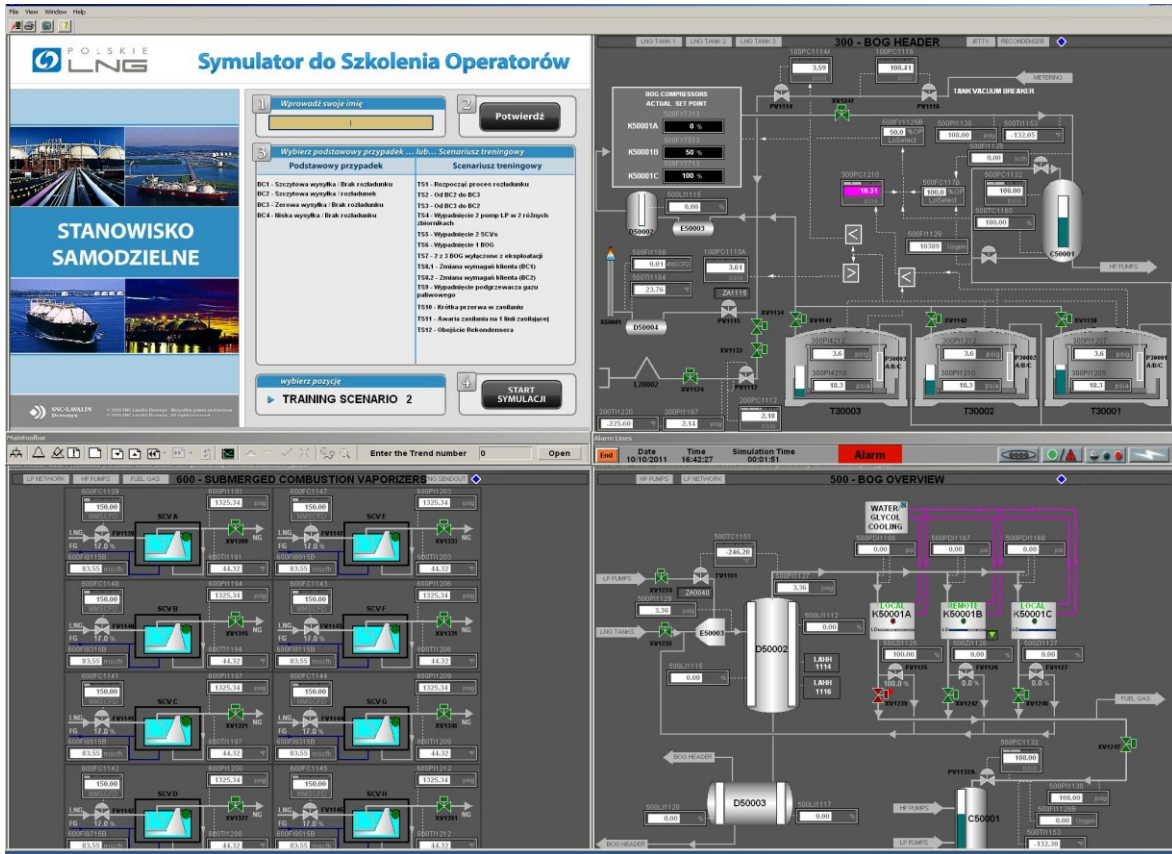
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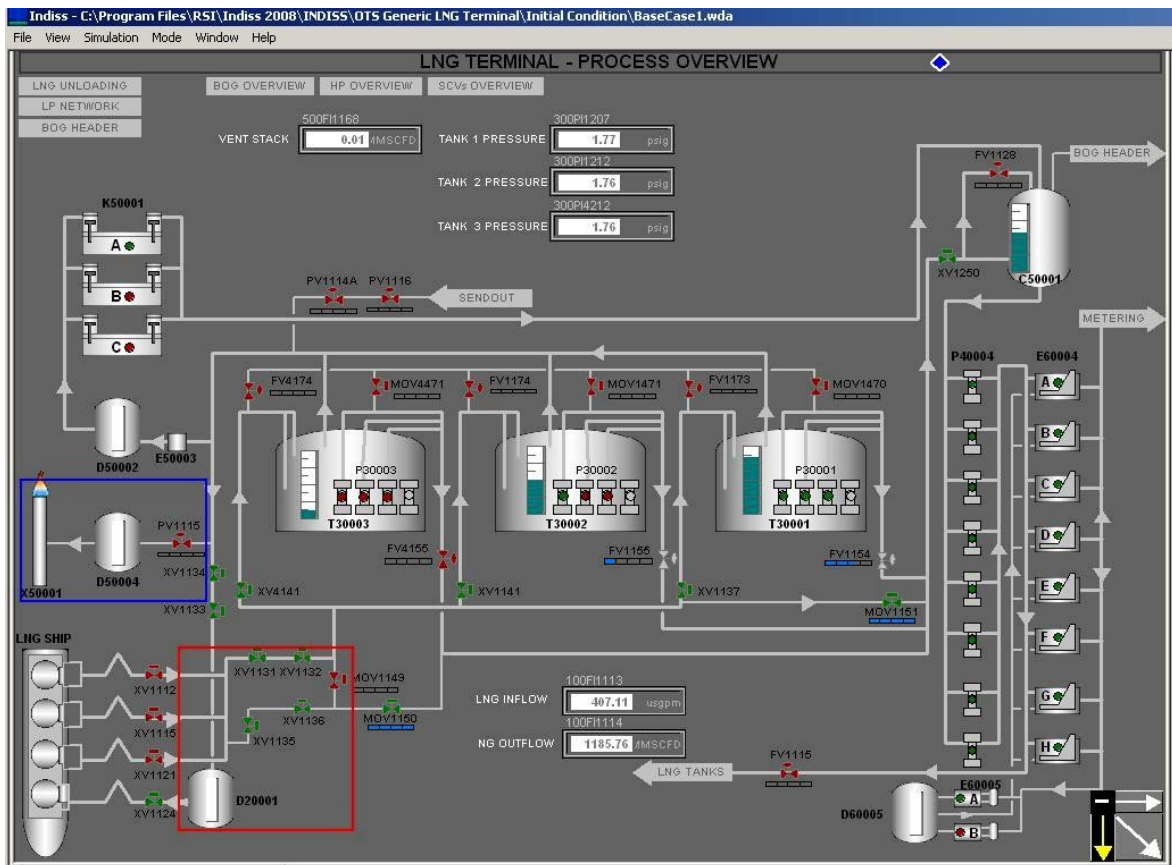Fig. 2. Operational screens of the simulator [3]

Fig. 3. Schema of the terminal system

Fig. 4. Trend displays present values of process variables against the selected time axis

An example of a view of operational screens is presented in (Fig. 2).

In order to create real training conditions, for the interaction of simulated processes in the simulator, Honeywell Process Knowledge System (PKS) Experion emulation of the following interface types has been applied:

1. Fifty two pages of graphic processes (Distributed Control System – DCS) for simulated processes.
2. Eight front panel of the device giving the possibility to access working parameters indications (process values), controls (adjustment, operating modes etc.), valves (open/closed, propulsion) and engines (shut down, start).
3. Nineteen defined ready trends that meet training scenarios goals.
4. Three specific screens allowing to get access to visualized LNG ship systems, normal/critical situations and devices controlled from the object.
5. Thirty four screens of Emergency Shut Down – (ESD) system.
6. Alarm list with the possibility of acknowledging them.

Basic cases and training scenarios:

OTS libraries are based on typical cases, that means operating conditions in a fixed time. The following instances have been considered as the a/m:

1. Top dispatch ability / no loading of the ship.
2. Top dispatch ability with unloading of the ship.
3. Zero dispatch ability / no loading of the ship.
4. Low dispatch ability / no loading of the ship.

Having in mind basic cases, the following training scenarios have been worked out, including all elements and procedures, which are necessary for correct service of the handling infrastructure.

1. Terminal changeover from top dispatch ability with discharging of the ship to zero dispatch ability / unloading of the ship.
2. Terminal changeover from zero dispatch ability and no discharging of the ship to top dispatch ability with discharging of the ship.
3. Damage to two SCV regasifiers.
4. Damage to one boil off gas [BOG] compressor.
5. Discharging operations while 2 from 3 compressors are non – operational.
6. Dispatch mixture adjustment, in order to consider the required increase of High Heating Value [HHV].
7. Dispatch mixture adjustment, in order to consider the required decrease of High Heating Value [HHV].
8. Terminal changeover to low ability of gas dispatch with no discharging of the ship after the fuel gas preheater damage.

Fig. 5. Tasks assessment screen

9. Restarting of the terminal operation after a short power supply breakdown.
10. Staring the discharging process of a LNG tanker.
11. Power supply breakdown on one supply line of the electric power.
12. Recondenser bypass and maintenance of terminal shipment ability.
13. Two low pressure pumps damage in two different LNG tanks.

Assessment

There is an application allowing for automatic training results assessment in the simulator software after the trainee completes the task. The system counts the working time and presents the exercise time, time of activities not connected with the task and finally it gives the score in numbers (Fig. 5). The rule is, that the lower the score, the higher the note because it shows the execution of activities strictly connected with the simulated situation. It is all connected with the fact, that there is strictly determined time for the task execution for all scenarios and it permits the operator to assess the tasks exactly after each one has been completed.

Conclusions

The use of the simulator as a tool for training staff connected with LNG shipment is a key issue, due to practical application of acquired skills. Practice on the most corresponding to reality object with the possibility of supplying scenarios based on used at work procedures, tools and probable emergency situations allows the trainees to perform technological operations safely and learn from their mistakes without any influence on reality.

It is difficult to estimate how much the training on computer simulators improves safety, yet most terminals are equipped with simulators being exact copies of real systems, where new or emergency operations are tested. It permits to prepare terminal crew to possible situations that can happen during LNG terminals operation.

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