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On the application of the appropriate type of simulators for the specific learning objectives

SUMMARY

This paper presents a proposal of classification of the engine room simulators. Its main subject is the relation between proposed simulator types and the learning objectives specified in the STCW International Convention.

It was also proved that in some cases the full mission simulator is not the best tool for the specific training tasks. Finally, the problem of simulator compliance with the provisions of STCW International Convention was discussed.

INTRODUCTION

STCW '95 International Convention on Standards of Training, Certification and Watch-keeping for seafares defines three levels of competency (management, operational and support) and lists the corresponding competencies. Each level of skills implies the set of learning objectives, and the objectives identification is the key point in the organization of the marine engineer education. The point is that the more complex skills include the simpler ones. This hierarchical growth of skill levels places a heavy burden on the course designer and the simulator instructor. The simulation exercise has to be designed to achieve specific competencies, which have been built upon previous training and knowledge.

SIMULATOR TYPES

It is hard to expect that one simulator (even very sophisticated and realistic one) will be able to fulfil all the above mentioned expectations. Higher requirements of a user, provoke the growing complexity of the engine room simulators, their higher cost and longer development time. On the other hand, the rapid changes in the engine room equipment and control techniques require great flexibility in the simulator architecture.

The need for the different simulator type can be very well illustrated when using the map choice problem as an example. The country road map can be compared to a full mission simulator – most complex, most comprehensive and covering the full scope of the engine room systems. However, this kind of map (and also a corresponding simulator type) – due to its complexity – cannot be very precise and go deeply into details ; otherwise it becomes huge in size, not convenient for use and costly.

The city plan on the other hand, should be very detailed, but it covers only a very limited area. The same description can be applied to Computer Based Training (CBT) software. Such software package covers usually only one engine room system or a machinery type, but this coverage is very detailed and includes the following issues :

- The operation principle
- The detail construction description
- The operational procedures for different situations
- The mini simulator of the system being the CBT main subject
- The assessment tests.

Let's try to identify two other simulator types using the cartographic example.

The special simulators are like special maps; the tourist maps for example. This kind of a map contains a lot of special information, but sometimes other information are completely omitted. The special simulators can have higher accuracy of simulation in certain aspects, but they will be probably very limited in the scope of the simulated systems.

For the PC based simulators it is not so easy to find the right analogy, but it could be compared to the electronic map on CD.

The map can be used only in personal computers, and it offers several unique features like route planning etc. The PC based simulator has also several features which are not typical for full mission simulators: integrated checklists, integrated assessment etc.

The complete list of analogical features of the maps and simulators are presented in Tab. 1.

However, the key problem when dealing with different map (or simulator) types is the question: which type is to be used in certain situations.

Tab.1. The analogy between different types of maps and simulators

Maps	Simulators
City maps	CBT software
Maps on CD	PC based
Country road map	Full mission
Special maps (tourist maps, hotel maps etc.)	Special (diagnostic, cargo handling etc.)

CLASSIFICATION OF SIMULATORS

The still missing simulator classification is a serious problem in discussing the issue of the simulator application. The realism and the engine room type cannot be the only criteria of the simulator classification, although this approach is commonly used (e.g. full mission, hybrid and part task simulator type). Also the outside-look classification (mock up, desktop, PC based) is a bit obsolete.The author proposes the following simulator classification based on the outcome of 4th International Conference on Engine Room Simulators (ICERS 4) workshop, presented at ICERS 5 in Singapore [10]:

- **B (Basic) Class** of simulators – includes Computer Based Training (CBT) software and Basic Machinery simulators such as Auxiliary Boiler, Separator, Biological Sewage Treatment, Steering Gear etc. This family of simulators has a form of computer software to be run on a single, multimedia PC. Despite the simulation module, this kind of simulator usually includes also the theoretical background, operation instruction and competency test. The user interface is based on the simple computer animation and simulated technical sounds. The absence of any special hardware consoles and the moderate cost are also typical. The Unitest CBT package which includes several B Class simulators can be an example of this simulator type [9].
- **P (Personal) Class** of simulators – includes mainly Hybrid and Part Task simulators and are designated for a single person training: both in a stand - alone mode and supervised one. The P Class simulator should model the specific engine room type and the simulator software can be run on a single PC or on the set of several networked PCs co-operating in the real time. The instructor facility is to be expected in the networked version as well. The user interface is like in B Class simulators, but a limited number of hardware consoles (usually of a desktop type) is sometimes offered. The simulator cost is usually higher than that of B Class, but still below the level of F Class simulators. Virtual Engine Room is an example of the P Class, software–only–based simulator, and Engine Room Console is a P Class simulator with special hardware console [7].
- **F (Full) Class** of simulators – includes highly realistic and very expensive Full Mission Simulators. The set of hardware consoles equipped with gauges, switches, lamps and push-buttons and many simulated sounds are obligatory for this simulator class. The required high realism of the engine room environment causes that even the single machinery mock-ups are sometimes used in the control room outer space. The high investment and operation costs are their main disadvantage. On the other hand, the possibility of team training is a very important advantage of the F Class simulators. The engine room simulator (ER-SIM) can be considered as a typical example of the class of simulators in question [4].

Tab.2. Relation between learning skills and simulator type

	Learning skills	B Class Simulators	P Class Simulators	F Class Simulators	S Class Simulators
	Example Simulator	Unitest CBT	VER2 / ERC2	ER-SIM	Turbo Diesel
Operational level	Maintain a safe engineering watch.		APPROPRIATE	**VERY** APPROPRIATE	
	Operate main and auxiliary machinery and associated control systems	**VERY** APPROPRIATE	APPROPRIATE	**VERY** APPROPRIATE	
	Operate pumping systems and associated control systems			**VERY** APPROPRIATE	**VERY** APPROPRIATE
	Operate alternators, generators and control systems	**VERY** APPROPRIATE	APPROPRIATE	**VERY** APPROPRIATE	
	Maintain marine engineering systems including control systems			*SOMETIMES* APPROPRIATE	**VERY** APPROPRIATE
Management level	Plan and schedule the operations			**VERY** APPROPRIATE	
	Start up and shut down the main propulsion and auxiliary machinery		**VERY** APPROPRIATE	**VERY** APPROPRIATE	
	Operate, evaluate and monitor engine performance		APPROPRIATE	**VERY** APPROPRIATE	APPROPRIATE
	Detect and identify the cause of machinery malfunctions and correct faults			*SOMETIMES* APPROPRIATE	**VERY** APPROPRIATE
	Control trim stability and stress		APPROPRIATE	APPROPRIATE	
	Manage fuel and ballast operations		APPROPRIATE	APPROPRIATE	
	Use internal communication systems		*SOMETIMES* APPROPRIATE	**VERY** APPROPRIATE	

❖ **S (Special) Class** of simulators – includes special simulators which usually are computer programs to be run on a single PC. However, when compared to B Class simulators, they have different (rather more complicated) tasks and rarely offer any theoretical background or operational instructions. The example of this simulator class can be Turbo Diesel, a diagnostic and maintenance simulator [3].

The application of different simulator types designed with the specific education task in mind can be a better and more effective solution than trying to build more and more complex simulators able to fulfil almost any educational task. In Tab.2 a number of example learning objectives together with appropriate simulator types assigned to them are presented in a compact form.

EXAMPLE TASKS AND TOOLS

Tab.2 shows that one learning task can be achieved with the use of many simulator types. At first glance, the most sophisticated and expensive F Class simulator should provide the best quality and results of the training. However, the example presented below shows that this is not always true. Let's compare how the fuel separator operation can be trained by using F Class, P Class or B Class simulator.

Fig. 1 and 2 shows how the fuel separator is modelled in the full mission engine room simulator (ER-SIM). It should be emphasized that the separator modelling is very sophisticated as it enables not only automated, but also manual operation. However, the controls are rather small in size, and the number of the animated elements is very limited. For example, it is rather difficult to observe the separator rotational speed (rpm) just because the animated gauge is very small due to the lack of free space on the screen. It is easy to understand what role the separator plays in the whole engine room, and what kind of the external conditions (steam, electrical power and the sanitary water) has to be provided in order to start the separator. On the other hand, it is not so easy to learn how the separator has to be operated in the manual mode.

Fig.2. Hardware Console of the fuel oil separators in F Class engine room simulator (ER-SIM) [4]

The manual operation of the separator can be also mastered in P Class simulator as it is shown in Fig. 3 and 4. In the case of virtual engine room (VER) the user can see not only the external connections of the fuel oil separator, but when he clicks the red separator symbol the new window opens and the more detailed separator model appears.

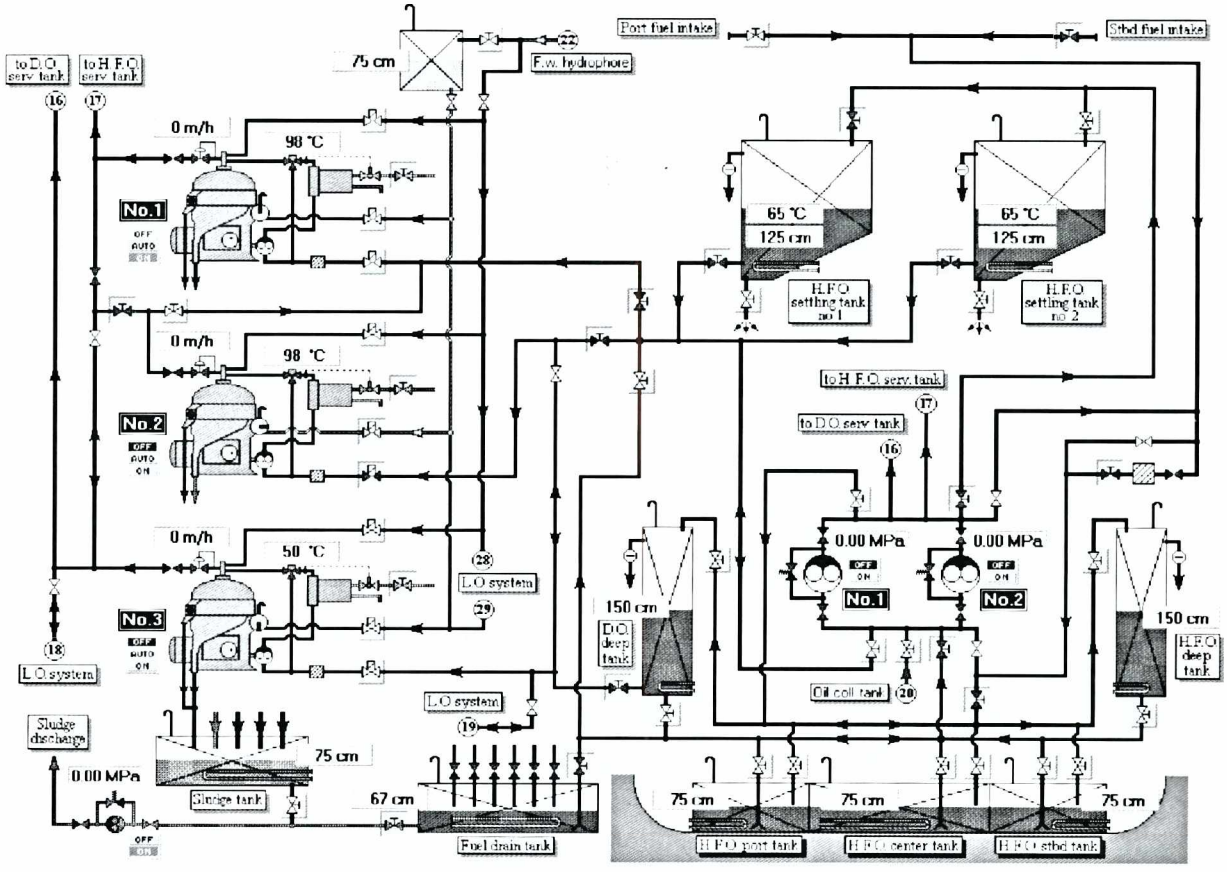

Fig.1. Mimic diagram of the fuel oil separators modelled in F Class engine room simulator (ER-SIM) [4]
Notice: *DO - diesel oil HFO - heavy fuel oil LO - lubricating oil*

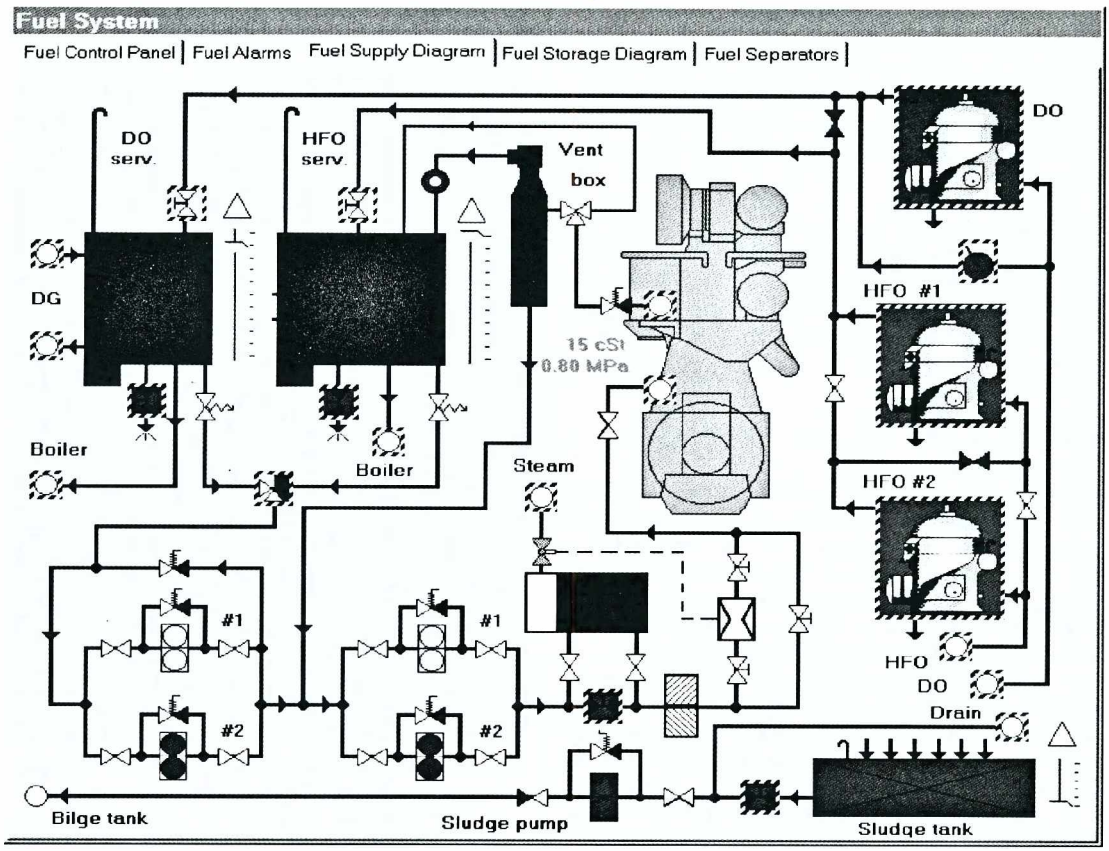

Fig.3. Fuel oil separators in P Class virtual engine room (VER) simulator

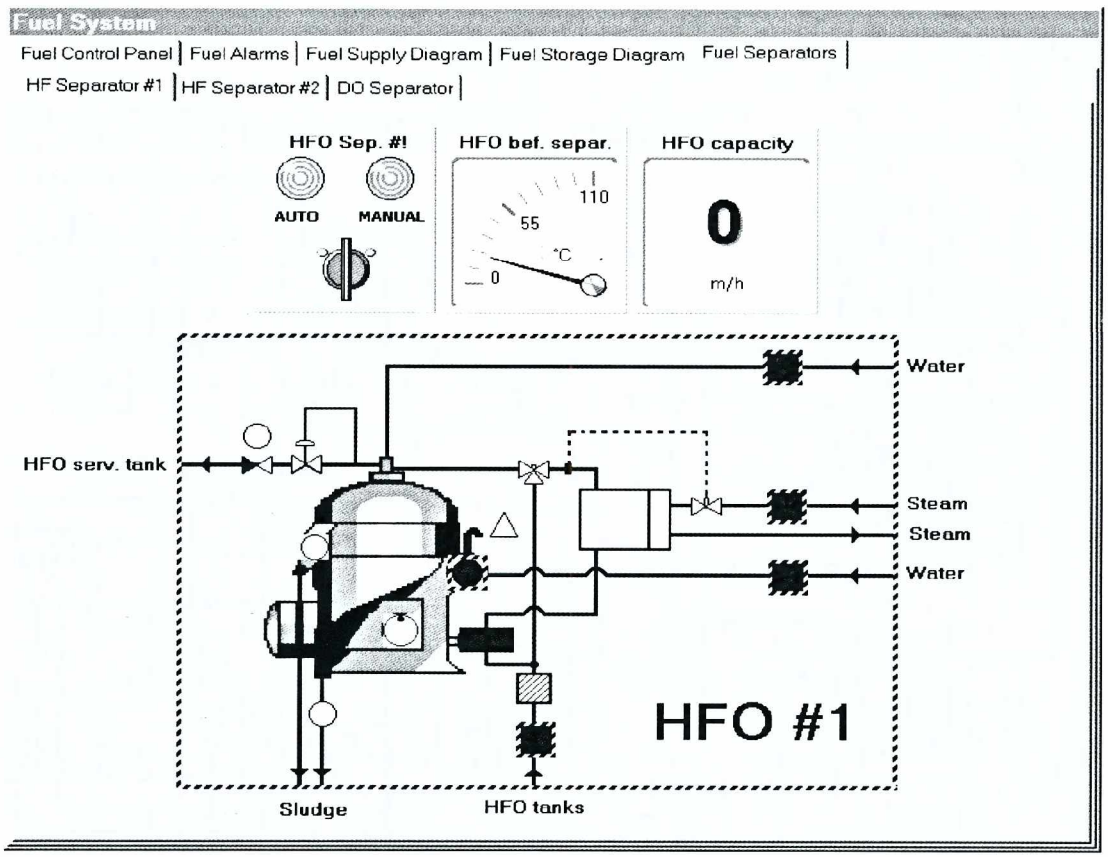

Fig.4. Single separator window in P Class virtual engine room (VER) simulator

Even if the VER separator model is very similar to ER-SIM one, it is easier to learn how to operate the separator, by using the first of them due to its bigger mimics and virtual controls. The VER unique feature, i.e. the integrated checklist gives an additional advantage over the F Class simulator as the user can be step-by-step guided how to fulfil each operational task at the fuel oil separator.

However the most detail modelling and presentation of the fuel oil separator can be found in B Class simulator (Unitest CBT for example). Fig.5 shows that the first important difference against P Class simulator is the animated internal view of the separator and the detail modelling of all valves and automation controls which are typical for this specific separator model. The trainee can learn not only how to operate the separator in the manual mode, but also how the automated control settings influence the way the separator works (Fig.6).

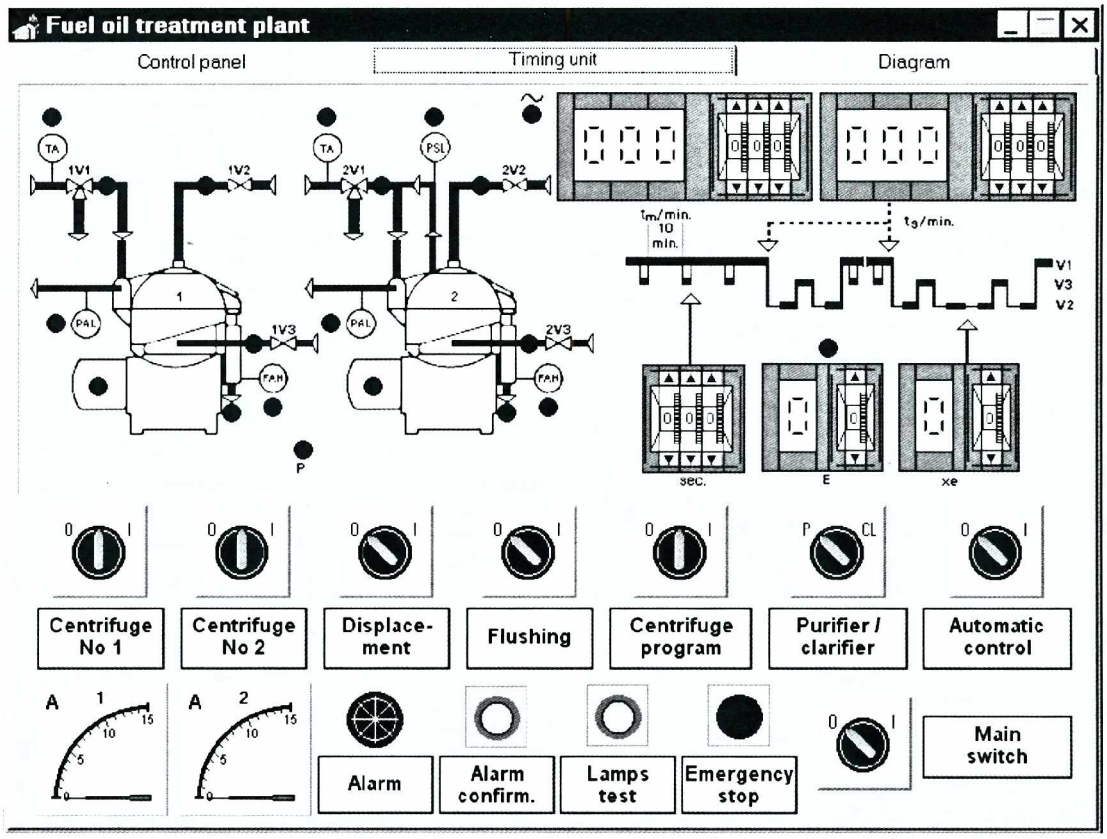

Fig.5. Separator operation window in B Class simulator – Unitest CBT [9]

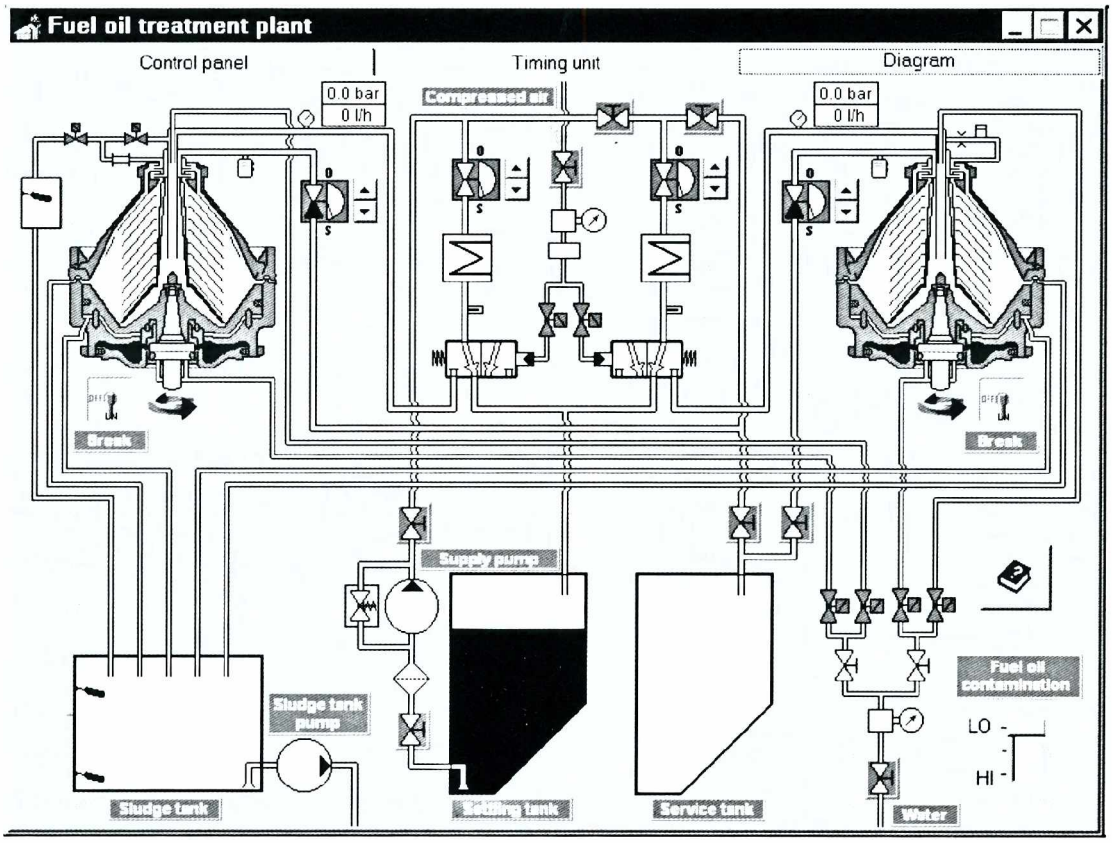

Fig.6. Separator automation window in B Class simulator – Unitest CBT [9]
Notice: *LO - low HI - high*

The disadvantage of this simulator type is, in comparison with F and P Class simulators, that it is more difficult to understand how the separator is integrated with the fuel, steam and sanitary water systems. In other words: it is necessary to use more than one type of simulators to learn almost everything about the fuel oil separator operation.

COMPLIANCE WITH STCW '95 INTERNATIONAL CONVENTION

It has become common habit that every training centre requires the compliance with STCW'95 International Convention when ordering a new engine room simulator. This requirement seems to be quite reasonable, however, it would be advisable to analyze what STCW compliance means in the case of the engine simulator specification.

Typically, the following parts of the STCW`95 Convention are referred to in the compliance requirements [8] :

(a) Regulation I/12 – *Use of simulators.*
(b) Section A-I/12 – *Standards governing the use of simulators.*
(c) Section B-I/12 – *Guidance regarding the use of simulators.*
(d) Section A-III/1 – *Mandatory minimum requirements for certification of officers in charge of an engineering watch in a manned engine room or as designated duty engineers in a periodically unmanned engine room.*
(e) Section A-III/2 – *Mandatory minimum requirements for certification of chief engineer officers and second engineer officers on ships powered by main propulsion machinery of 3000 kW propulsion power or more.*

The thorough analysis of the above specified regulations shows the following weaknesses and inconsistencies :

- There is no distinction in the requirement in reference to the different simulator classes. Example: *The requested high realism of the operating environment is not important in the case of B or S Class simulators, so the validity of this requirement should be limited to F class simulators only.*
- There is no distinction in the requirement in reference to the different engine room types. Example: *In the case of ordering a full mission engine room simulator for e.g. the fast patrol boat or ferryboat with water jets the simulator should comply with STCW`95 Convention provisions, but does it mean that the auxiliary boiler or the cargo pumping system (both specified in the provisions) should be also included ?*
- The basic and important requirements are mixed with sometimes nonsensical and very detail items. Example: *The deck steam, accommodation steam and deck air systems are listed as the factors to be simulated together with the bow thruster and ship loading. (N.B. The same situation is with IMO Model course 2.07 [2] where the main propulsion diesel engine is listed just together with steam cargo pumps or steam driven turbo generator.)*

All that means that it is very hard to fulfil all STCW`95 requirements, especially if the simulator belongs to the other than the full mission class. This means also, that it is necessary to introduce several corrections to the next version of STCW Convention and that the simulator users and experts should contribute to the updating. The main changes addressed to STCW Convention should include :

- The acceptance of different simulator types and their standard tasks.
- The requirements for engine room simulators should be different depending on the simulator class.
- The list of the simulated engine room systems should depend on the engine room type, thus to avoid a non-realistic, „all-in--one" simulator specification.

CONCLUSION

The realistic simulator classification should be internationally accepted and taken into consideration in the next version of STCW Convention. The convention should also include recommendations for selecting the simulator type appropriate for the specific educational tasks.

Appraised by Romuald Cwilewicz, Assoc.Prof.,D.Sc.

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Conference

A scientific seminar

On 15 February 2002 a scientific seminar was organized by Polish Register of Shipping (PRS) in its headquarter, which dealt with current results of research activity carried out by this institution.

The seminar titled :

Loads and strength of ship hull structures (simulation of physical phenomena)

consisted in presentation of and discussion on the following papers :

- *Simulation of motion of a damaged ship in waves* by A.Laskowski
- *Simulation of motion of liquid in a tank* – by M. Warmowska
- *Ultimate load-carrying capacity of corrugated bulkheads on bulk carriers* – by M. Bogdaniuk and W. Puch
- *Prediction of stresses in ship hull structure* – by J.Jankowski

Their authors were PRS scientific workers. They presented current results and conclusions of the performed research. The Seminar aroused a great interest as it gathered about 50 representatives of the technical universities in Gdańsk and Szczecin, Ship Design & Research Centre, maritime administration, shipyards and Polish navy.

The presented papers triggered vivid and comprehensive discussion which gave a deeper insight into the considered problems.